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Decontamination – Sluggish and Ineffective

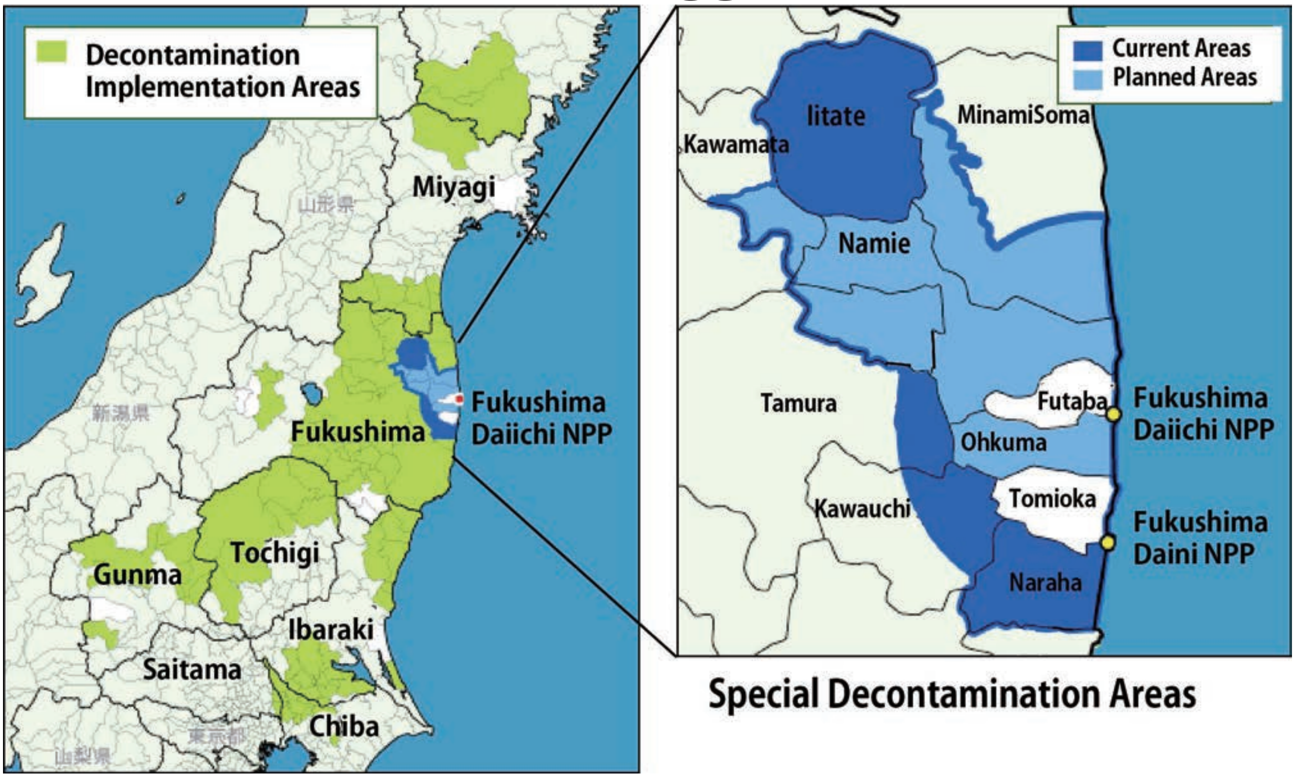

Figure 1. *Decontamination Zones (From the Ministry of the Environment website)*

Decontamination is now ongoing in many areas, including Fukushima. This article summarizes the current state of decontamination. Although we use the term "decontamination," since the radiation does not disappear, it should perhaps more properly be termed "relocated contamination," but here we use the term "decontamination."

Basic Policy

The actual organization carrying out the decontamination differs according to the degree of contamination with radioactive material in each target zone, the zones being divided into Special Decontamination Areas, which are directly controlled by the national government, and Decontamination Implementation Areas, where decontamination is carried out by the local municipality.

Of the former, where the pre-decontamination level exceeded 20 milliSieverts/hour (mSv/yr), decontamination targets have been set based on the results of model decontamination projects and so on, and in zones where the pre-decontamination level was lower than 20 mSv/yr, a target of a 50% reduction in dose rate has been set for

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August 2013. Additionally, a 60% reduction will be aimed for in the daily life environment of children, such as schools and parks. These targets include the physical decay of radioactive cesium, which would show a roughly 30% reduction in two years and five months after the nuclear accident due to the radiological half-life even if no action were taken. The long term target is to reduce the dose rate to less than 1 mSv/yr.

The latter are zones where the air dose rate exceeds 0.23 microSieverts/hour (μSv/h). It is possible that this is based on a standard of 1 mSv/yr. (Depending on the location, natural environments are usually thought to be less than 0.1 μSv/h.) Decontamination plans are formulated by each municipality.

Decontamination Effectiveness

According to the Ministry of the Environment Decontamination Model Demonstration Project Report[1)], decontamination methods show high effectiveness in some cases and low effectiveness in others, and there is wide variation depending on the location and the actual object being decontaminated.

Looking, for example at the radioactive material decontamination rate for wiping methods, a 57% effectiveness was achieved for house walls and so on. While it was as high as 77% for clay roof tiles, only low effectiveness was achieved for cement tiles (0%) and slate roofs (24%). In cases where the clay tiles contained cracks, the decontamination effectiveness was 0%. As a result of house decontamination, the air dose rate in the vicinity of the house at a height above the ground surface of 1 m was reduced by an average of 18% to 74%. Out of ten model decontamination zones, only three zones were able to reach the 50% reduction target. It would seem that the expected effectiveness could not be achieved in actuality.

The realities of decontamination carried out under the report are described in another report[2)] by Kenichi Hasegawa, a former resident of the Maeda district of Iitate Village. The crews who came to carry out the decontamination did not even try to decontaminate difficult objects such as old houses with cement tiles or houses with clay walls, but simply stuck "difficult to decontaminate" stickers on them. As a part of the decontamination operations they also felled large trees that had been planted as windbreaks and just left them lying where they fell, making the situation actually worse than it had been before.

In addition, there are reports that the air dose rate declines immediately following the decontamination of a house, but rises again after some time has passed. This is probably because only an area of 20 m around a house is decontaminated, and therefore cesium returns to the grounds of the house from the mountain forests in the surrounding area due to the action of wind and rain.

The Sloppy Reality of Decontamination

To add to the problems, the Asahi Shimbun reported on widespread negligence in decontamination operations in a scoop on January 4, 2013. At first, the general construction contractors who were involved in the decontamination work denied the negligence, but were finally forced to admit problems when they were faced with robust video evidence amassed by the Asahi Shimbun research team. The video showed fallen leaves collected as part of the decontamination, which should be appropriately handled, being simply kicked into a river; the runoff from roofs and verandahs washed with high pressure hoses not being recovered; the runoff from car parks decontaminated with high pressure hoses being allowed to drain off into side gutters instead of being reclaimed, and so on. The Ministry of the Environment finally awoke from its slumbers on January 24 to set up a decontamination 110 hotline[3)] and called on the population to provide information. By February 14, however, in a display of unenthusiastic management, the ministry refused to recognize the seven cases reported as instances of improper decontamination due to the difficulties of confirming the facts.

Figure 2. *Roofing Materials*
Left to right: slate roof, clay tiles, cement tiles

Despite the fact that the Act on Special Measures for Toxic Waste contains punitive regulations for such widespread improprieties, and the fact that the decontamination guidelines stipulate detailed operations, the cause of the problem appears to be that the Ministry of the Environment has thrown the whole operation over to the general construction contractors and is totally unable to manage what goes on (See Nuke Info Tokyo 153 page 8).

For the Decontamination Implementation Areas, where decontamination is carried out by the local municipality, national government subsidies are available for the costs of the decontamination. The problem is that the work for which subsidies are available does not match with the realities on the ground. As an example, the Gunma Prefecture Council adopted a written opinion demanding that the total cost of radioactive material decontamination be borne by national subsidies, pointing out that "The basic operation (the decontamination method covered by the subsidy) was deep cutting of lawns. However, the decontamination of the surface soil and the re-laying of the lawns were not recognized as being covered by the subsidy. In some places the deep cutting of the lawns did not result in the reduction of the dose, and there were many problems in the implementation of decontamination in the municipalities."[4)]

Moves to Review Targets without Debate

Large areas of Fukushima Prefecture have been designated evacuation zones because of the nuclear accident. Along with a grasping of the reality of the air dose rates and their decline, a review of the evacuation zones is ongoing, but many municipalities are making the achievement of the long-term target of decontamination, 1 mSv/yr, the condition for the return of the population. According to a Yomiuri Shimbun news report, on February 17, 2013, the Governor of Fukushima Prefecture, during an exchange of views with the national government, demanded that the 1 mSv/yr target be reviewed. The 1 mSv/yr target had originally been "the strong desire of Fukushima," but since with the low level of decontamination effectiveness the return of the prefecture's people now enduring daily life in evacuation has greatly receded into the future, it can be said that this was a demand to relax the target instead. The previous minister for the environment, Goshi Hosono, stated in a separate Yomiuri Shimbun interview published on March 10 that while "the position of the national government is to make efforts toward achieving 1mSv, even if that takes time, it is also important that the dose level and the decontamination methods are handled in a flexible manner in line with the wishes of the towns and the residents."

However, if the wishes of the residents are to be respected, then efforts should be put into achieving the 1 mSv/yr target, and it has to be said that claiming that relaxation of the standard is in line with the wishes of the residents is putting the cart before the horse.

What is necessary above all is that the national government should indicate clearly its willingness to carry out the following three points and discuss matters with the residents:

1) the risks of living for extended periods in an area that would be of high exposure rates be explained,
2) compensation by the national government should health impacts occur, and
3) the provision of funds for those who wish to evacuate or relocate to other regions.

Sluggish plans and implementation

There are huge doubts about the effectiveness of the decontamination, but lastly let's look at how fast progress is being made. Although the total number of zones scheduled for decontamination has not yet been finally determined, according to a news report[5)], as of March 3, 2013, in 715,740 scheduled locations (e.g. private houses and so on), only 46,015 places have been completed, a mere 6.5%. Even if this were compared with the number of scheduled locations (148,378) to be completed by the end of FY2012, it would still only be a completion rate of 31%. It would seem that the FY plans are almost impossible to achieve.

There are various reasons why the plans are not progressing satisfactorily. To understand this, it would be necessary to look at each area in detail, but one of the serious issues is thought to be the difficulty in reaching agreement over the location for depositories for the waste materials that result from decontamination.

(Hideyuki Ban, Co-Director of CNIC)

References:

1) *http://josen.env.go.jp/material/download/pdf/model004.pdf*
2) "'Beautiful villages' will not return under a bogus 'reconstruction,'" Sekai, April 2013, Iwanami Shoten
3) *https://josen.env.go.jp/tekiseika/report_summary.html*
4) *http://www.pref.gunma.jp/gikai/s0700522.html*
5) Yomiuri Shimbun, March 3, 2013.

Fukushima Daiichi Nuclear Power Station: Still too many unknowns about the accident and the current condition of the plant

One of Japan's major newspapers, the Asahi Shimbun, reported on February 7 that Tokyo Electric Power Co. (TEPCO) had obstructed the investigation of the accident at Fukushima Daiichi Nuclear Power Station (FDNPS) by the National Diet of Japan Fukushima Nuclear Accident Independent Investigation Commission (NAIIC). TEPCO clearly gave commission members false explanations concerning the condition of the Unit 1 reactor building.

A group of NAIIC members led by Mitsuhiko Tanaka was in charge of the investigation into the causes of the nuclear accident, and this writer participated in the investigation as a collaborator. As part of the investigation, the group planned to inspect the plant reactor buildings. There were two primary objectives for the inspection, **1)** to determine the source of the serious water leakage in Unit 1, which was witnessed by workers on the fourth floor of the reactor building in the wake of the Great East Japan Earthquake, and **2)** to confirm the suspected damage of the pipes which were connected to the isolation condenser on the same floor.

Our perception was that we would be able to reach the site of the massive water leakage and conduct an inspection there, although it would be difficult to stay at the site for any length of time due to the extremely high dose rate. These assumptions were based on the air dose rate in the reactor building published on Dec. 3, 2011, and TEPCO's video of this site released on October 21, 2011.

When TEPCO explained to us in the preparatory meeting that it was too dark to walk around inside the reactor building, we were therefore quite astonished.

Later, the Asahi Shimbun revealed that this explanation by TEPCO was totally untrue.

In the end, the NAIIC group was unable to conduct an inspection inside Unit 1 reactor building, and the two questions that were to be resolved by the inspection remained unanswered. We suspect that there

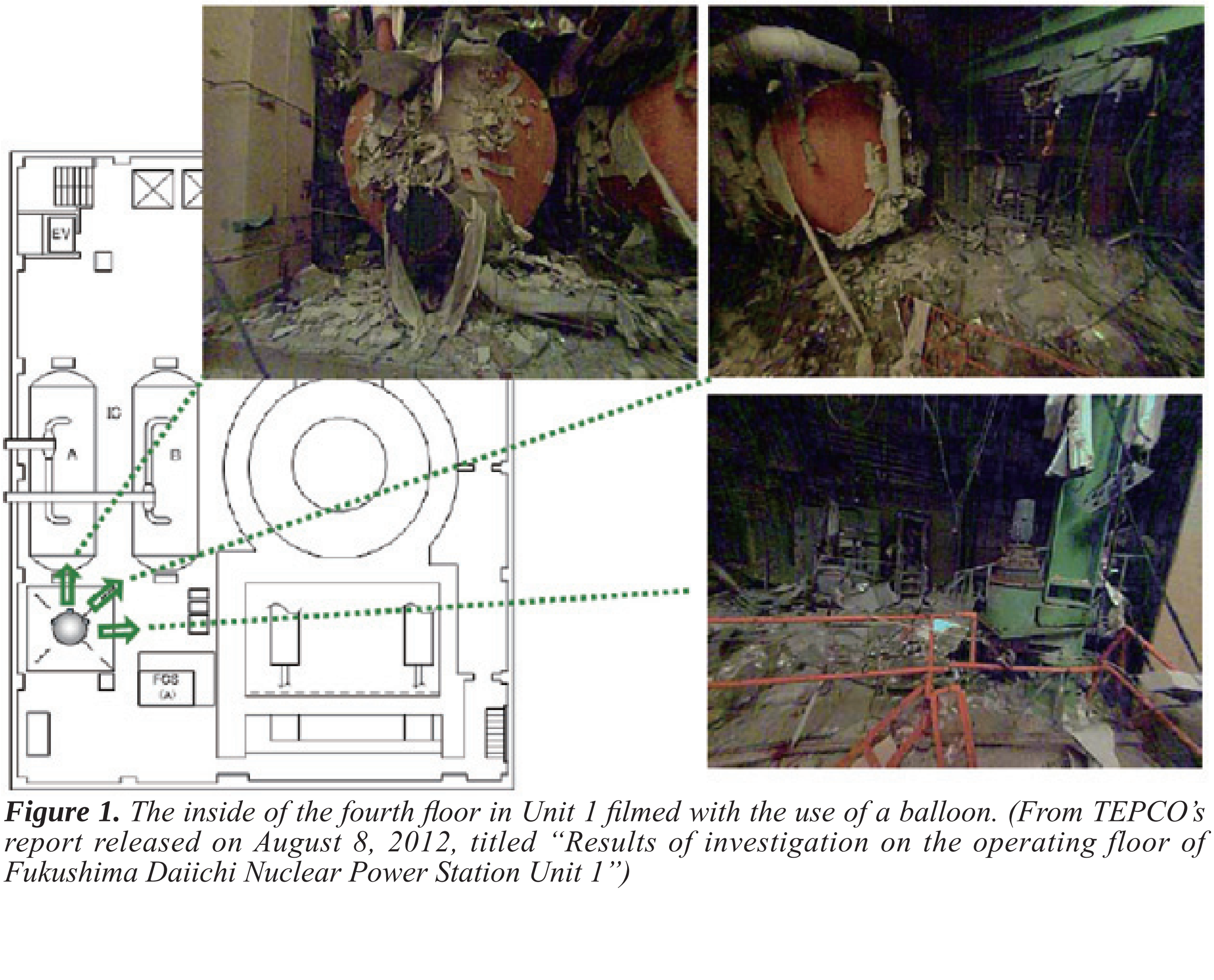


Figure 1. *The inside of the fourth floor in Unit 1 filmed with the use of a balloon. (From TEPCO's report released on August 8, 2012, titled "Results of investigation on the operating floor of Fukushima Daiichi Nuclear Power Station Unit 1")*

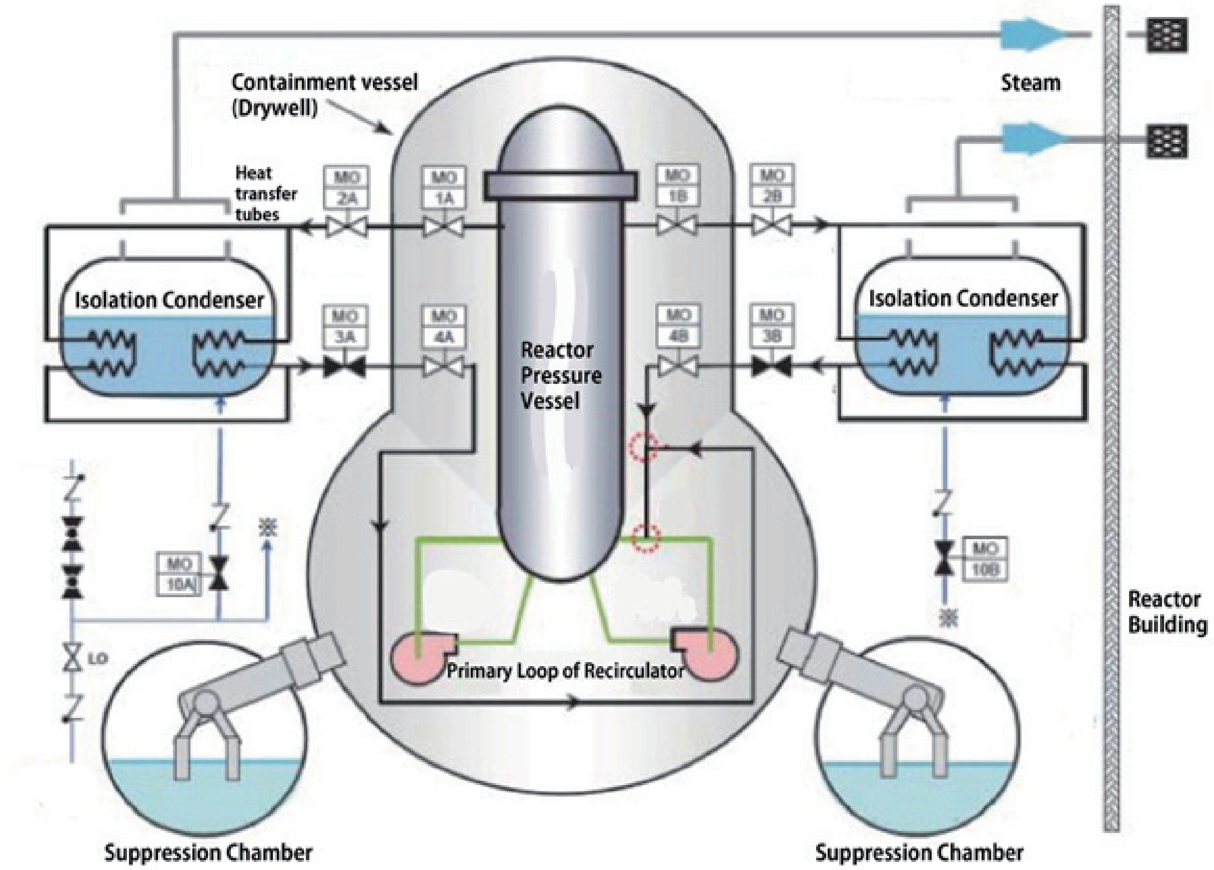


Figure 2. *Conceptual diagram of nuclear reactor (from the NAIIC report)*

was something on the fourth floor of the building which TEPCO wanted to conceal if at all possible. Although TEPCO refused to guide us to the site, the utility staff is said to have visited the site a number of times, and on February 15 this year released the video it took at the site on November 30, 2012

In the report on the results of the inspection conducted at that time, TEPCO referred to the cause of the water leakage on the fourth floor of the reactor building pointed out by NAIIC, explaining that the water in the spent nuclear fuel pool had sloshed around during the powerful earthquake, flowed out of the pool and leaked through the heating and cooling ducts. The worker mentioned above described water gushing out, and this description does not fit TEPCO's explanation. This inconsistency gives the impression that there is something unsatisfactory about TEPCO's explanation.

1) In the isolation condenser (IC), the steam running inside the heat exchanger tubes will be cooled by the water that is pooled in the outer section of the condenser's body .

Many puzzling aspects

There is a possibility that isolation condenser heat transfer tubes inside Unit 1 were damaged.[1] As mentioned in the NAIIC report, the Unit 1 operator testified that he manually stopped the two isolation condensers that were automatically started after the reactor came to a halt due to the massive earthquake, because he suspected that the pipes connected to the condensers were damaged and that this had caused a sudden decline in the pressure inside the reactor.

TEPCO, however, explained that the Unit 1 operator took the action in order to prevent damage to the nuclear reactor pressure vessel, which could have occurred when the rate of decline of the water temperature in the reactor exceeded the official limit of 55ºC/hr, but this is a lie. Why has TEPCO not retracted this lie?

As for the time when the tsunami reached the nuclear power station, TEPCO has been citing the time when the tsunami arrived at the wave-height measuring scale installed at a point 1.5 km off-shore, neglecting the 2 to 3 minute difference in the actual arival time

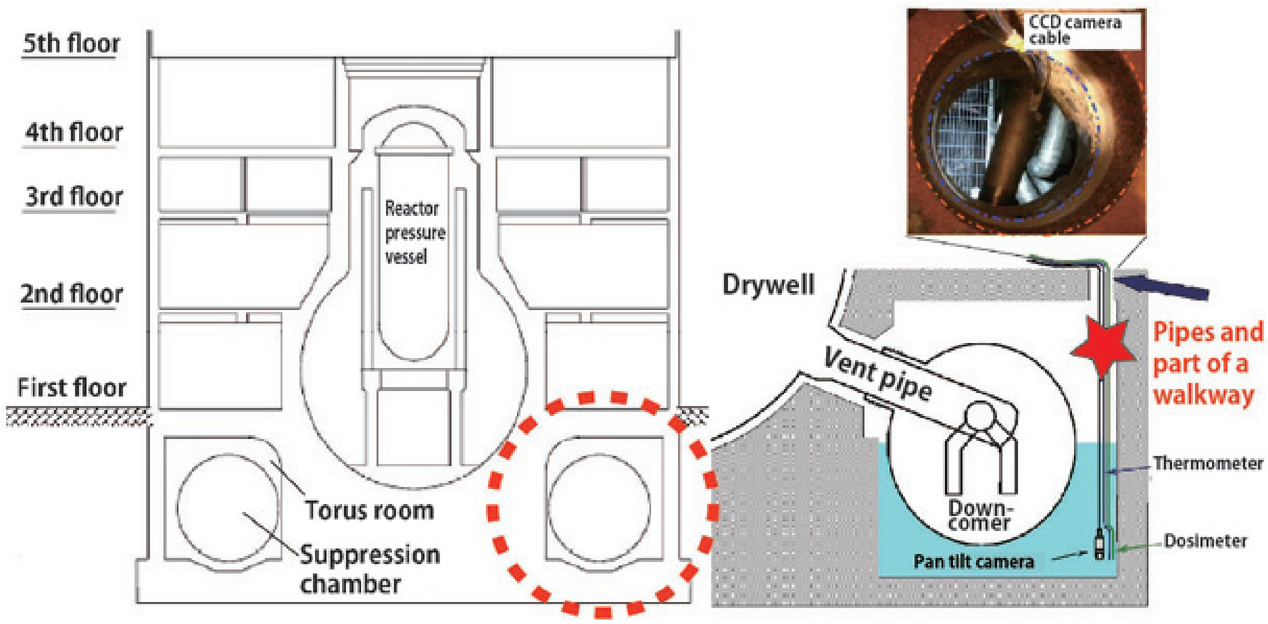


Figure 3. *Hole created in Unit 2 torus room ceiling showing pipes and part of a walkway through the hole (From TEPCO's report released on January 28, 2013, titled "Results of hole-creating work for investigation on torus room in Fukushima Daiichi Nuclear Power Station Unit 2")*

at the site. No matter how many times experts point out the gap, the nuclear power plant operator has never corrected the arrival time of the tsunami. This is because TEPCO does not want to admit the fact that the emergency diesel generators had stopped before the tsunami arrived at the nuclear power plant, and insists that the devices became unusable because of the tsunami.

Concerning the hydrogen explosion that occurred in the buildings of Units 1, 3, and 4, it is believed that the main source of hydrogen was the chemical reaction between zirconium, one of the components of the fuel assembly, and high-temperature water. But there are several things that remain unknown about the explosion, for example:

1) to what extent radiolysis of water and other chemical reactions contributed to the explosion,
2) in which part of the reactor building the explosions occurred,
3) through which channels the hydrogen gas reached the explosion site, and
4) what triggered the explosions.

In the case of the explosion in the Unit 4 building, in particular, no pictures and videos of the explosion or fire currently exist, and no one has seen pictures or videos of these. Why not?

The Unit 2 suppression chamber (S/C) is considered to have been damaged, judging from the steep decline in pressure. But it is still unknown what caused this sharp pressure decline and how serious the damage is. A hole has been opened up to investigate the inside of the torus room (the space where the S/C is located). Several objects have become visible through the hole, such as pipes and part of a steel walkway that are not shown in the design blueprint. This finding will be mentioned again later. Where did the pipes and the walkway come from?

It will still be quite a long time before it becomes possible to investigate the condition of the pressure vessels and the containment vessels in Units 1, 2 and 3, and where and in what condition the melted nuclear fuel debris remains. It is reported that the nuclear power plant is discharging approximately 200 million Bq of radiation per day. This amount was calculated by TEPCO based on data collected by the company around the nuclear reactor buildings. It is still impossible to estimate the total amount of radiation discharged from the nuclear power plant after the 2011 accident, and it is also impossible to predict when this accident will finally come to an end.

Attempts to inspect the inside of reactor buildings, torus rooms, and containment vessels

Serious attempts to probe into the damage and radioactive contamination inside the reactor buildings have been made using various methods since around July 2011. In and after April 2012, robots were used to video the inside of the torus rooms in Units 2 and 3, and to measure the dosage rate there.

According to TEPCO's reference data for the news conference of July 24, 2012, titled "Various approaches for probing the condition of the nuclear power plant" and "The results of TEPCO's investigation on the inside of the containment vessels and the plan to detect the channels of the water leakage from the vessels," the data from the monitored parameters in each plant (such as the atmospheric dose rate, the water level, the water temperature, etc.) and the above-mentioned investigation results have prompted TEPCO to suspect that the upper part (the gaseous phase) of the S/C in Unit 1 and the lower part (the liquid phase) of the S/C in Unit 2 were damaged.

After the beginning of 2013, TEPCO carried out work to collect basic data on the atmosphere, the accumulated water and sediment by making a hole in the floor of the first floor into the ceiling of the torus room, which is located in the basement of Unit 1 and 2 buildings. Whether this was done in connection with the above-mentioned attempts is unknown.

The work was first carried out in Unit 2 on January 27-28. The heat-exchange room in System A of the reactor residual heat removal system was chosen as the first place to investigate because its design drawings and other data showed that nothing in the room would obstruct the probe that would be passed through the hole. Moreover, the air dose rate around the heat-exchange room stood at between 6 mSv/h and 8 mSv/h, which was a relatively low level for the reactor building as a whole.

However, when the hole was created, it was discovered, as shown in Figure 3, that there were pipes and part of a walkway just below the hole and it proved impossible to collect the necessary data. This attempt was therefore suspended. The work in Unit 1 was carried out on February 20 and 22, as scheduled, and it was found that the water depth in the torus room was about 4.9m, and the dose rate near the water surface was 920mSv/h. Samples of the accumulated water and sediment were collected.

The situation involving Unit 2 is quite serious. What are the pipes and walkway for? Were the pipes built in disregard of the blueprint? Or did the pipes belong somewhere else but were broken and jolted to their current location by the powerful earthquake? In any case, the pipes and the walkway will be a major stumbling block in future work to clarify the condition inside the reactor building and the work to investigate the cause of the nuclear disaster. The video showing the inside of the torus room, including the part of the room that can be seen through the hole, has yet to be published, and the condition inside the room is still unknown.

(Chihiro Kamisawa)

CNIC was selected as the award winner of the international division of the 15th Kyobo Award for Environment. Hajime Matsukubo accepted the prize on behalf of CNIC on 22 April at Sejong Hall, Sejong Center for the Performing Arts in Seoul, Korea.

The Status of Nuclear Fuel Stored at the Fukushima Daiichi and Fukushima Daini Nuclear Power Plants

This report summarizes the status of nuclear fuel stored at the Fukushima Daiichi (F1) and Fukushima Daini (F2) nuclear power plants.

Fuel in the reactors and fuel in the spent fuel pools at F1 and F2

Table 1 lists the data for the nuclear fuel loaded (melted down) in the reactors and fuel stored in the fuel pools in the individual reactor buildings of the F1 and F2 plants as of January 31, 2013. The fuel from F1 Unit 4 reactor had been entirely unloaded for shroud replacement work. The removed fuel was in the spent fuel pool (SFP), in which as many as 1,535 fuel assemblies, including new fuel assemblies, were stored, generating a great amount of heat (Table 2). All the fuel in the F2 Unit 4 reactor was unloaded and placed into the F2 Unit 4 SFP in October 2012.

F1 Unit 4 spent fuel pool

Since a hydrogen explosion occurred in the upper part of the F1 Unit 4 building on March 15, 2011, a large amount of debris fell down onto the pool. There is strong concern both in Japan and overseas about the integrity of the fuel assemblies and Unit 4 building. Tokyo Electric Power Company (TEPCO) reinforced the lower part of the SFP with rigid supports and concrete walls. The company has stated repeatedly that “The pool is sufficiently quakeproof and will resist an earthquake as great as the 2011 Earthquake off the Pacific Coast of Tohoku” (intensity 6 plus). This explanation has no scientific grounds. A detailed diagram of the fuel assembly configuration in the F1 Unit 4 SFP is available on the Internet (**Fig. 2**).

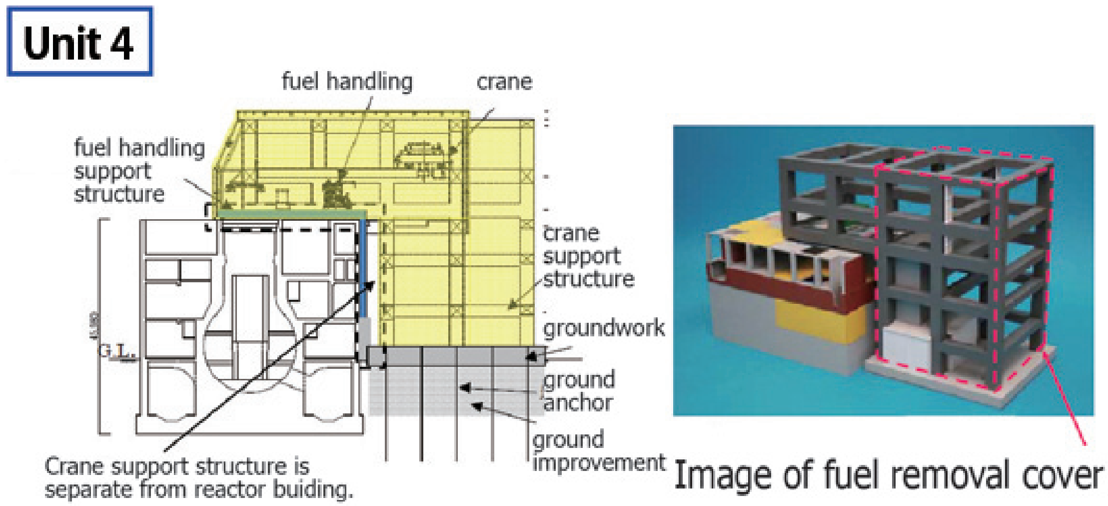
“Fuel removal cover”

TEPCO plans to begin the work of removing fuel from the F1 Unit 4 SFP in mid-November, 2013, and to complete the work about one year later, at the end of 2014. To ensure the feasibility of the removal work, the power company transferred two new fuel assemblies from the SFP to the common pool, inspected them, and reported that they were free from corrosion and deformation. However, this is far too hasty a conclusion, since great volumes of seawater were poured into the SFP and because only two fresh fuel assemblies were inspected, not spent fuel assemblies.

	Unit No.	Type of Reactor	Power (10MW)	Reactor Loading Stored fuel		Spent fuel pool Managing capacity		Total stored		Spent fuel		Damaged fuel		New fuel	
				Fuel assemblies	(ton) *1	Fuel assemblies	(ton)	Fuel assemblies	(ton)	Fuel assemblies	(ton)	Fuel assemblies	(ton)	Fuel assemblies	(ton)
Fukushima Daiichi	1	MARK I	46.0	400	69	500	86	392	67	292	51	70	12	100	17
	2	MARK I	78.4	548	94	692	119	615	106	587	101	3	1	28	5
	3	MARK I	78.4	548	94	672	116	566	97	514	89	4	1	52	9
	4	MARK I	78.4	0	0	1,042	179	*2 1,533	264	1,331	229	3	1	*2 202	35
	5	MARK I	78.4	548	94	1,042	179	994	171	946	162	1	0	48	8
	6	MARK I	110.0	764	131	1,006	173	940	162	876	151	1	0	64	11
	Common Pool			—	—	6,840	1,176	*3 6,375	110	6,375	1,101	0	0	*3 2	0
	Dry cask storage facility			—	—	408	74	408	74	408	74	—	—	—	—
Fukushima Daini	1	MARK II	110.0	764	131	1,898	330	1,570	273	1,570	273	0	0	200	34
	2	MARK II	110.0	764	131	2,005	340	1,638	285	1,638	285	2	0	80	14
	3	MARK II	110.0	764	131	1,976	340	1,596	277	1,596	277	0	0	184	32
	4	MARK II	110.0	0	0	2,005	340	*4 1,672	290	1,672	290	0	0	80	14

Table 1; *Status of Nuclear Fuel Stored at the Fukushima Daiichi and Fukushima Daini Nuclear Power Plants (as of January 31, 2013)*
Prepared by CNIC based on data published by the Agency for Natural Resources and Energy and TEPCO

*(*1) Calculated value (ton) from number of fuel assemblies.*
*(*2) Total number of fuel assemblies is 1,535, including 204 new fuel assemblies, as of March 11, 2011, since two new fuel assemblies were removed on 2012/7/18-19.*
*(*3) Including two new fuel assemblies removed from the F1-4 spent fuel pool.*
*(*4) All fuel assemblies in the reactor transferred to spent fuel pool in October 2012.*



Fugure 1; *Fukushima Daiichi (F1) Unit 4 Fuel Removal Cover*

Because the original fuel crane and other facilities of F1 Unit 4 were destroyed in the hydrogen explosion, TEPCO plans to transfer the fuel from the SFP after removing the fifth floor of the reactor building. All the debris will then be cleared off the SFP and a structure named a fuel removal cover will be installed next to the building. The structure is planned to stand 53 meters above ground, measure about 69 meters north–south, and about 31 meters east–west (**Fig. 1**). According to TEPCO, the structure of the cover supporting the crane is designed so as not to place any load on the reactor building. Nevertheless, the quake resistance of the cover will not be sufficient. It is planned to transfer the removed fuel assemblies to the common pool by means of two shipping casks (model NFT-22B), which have a capacity of up to 22 assemblies.

Common spent fuel pool

A total of 6,375 nuclear fuel assemblies are currently stored in the F1 common pool. The pool is expected to accept a total of 3,108 fuel assemblies from the SFPs of F1 Units 1 to 4 in the future. As Table 1 shows, however, the common pool has almost no extra capacity (it is about 93% full). Accordingly, about half the fuel assemblies currently in the common pool are expected to be transferred to temporary dry cask storage facilities, explained below, to provide capacity for the fuel assemblies being transferred from the SFPs. These fuel assemblies include those whose storage is not included in the construction permit of the common pool, such as spent fuel (7×7 fuel assemblies), fresh fuel (9×9 fuel assemblies), and damaged fuel, as well as almost all the variations of boiling-water reactor fuel assemblies, as shown in Table 2. The fuel assemblies being transferred from the SFPs to the common pool are assumed to be damaged or contaminated with salt, and common pool renovation is planned to maintain water quality.

	Type of Fuel	Number of fuel assemblies		Date of removal of spent fuel from reactor	Storage period (2011/3/11) [years]	Decay heat [W/assembly]
Spent fuel 1331	7x7	1		1980/9/26	30.5	186.2
	8x8	4	4	1986/9/2	24.5	209.1
	New 8x8 Zircalloy Liner	30	2	1995/2/26	16	250.3
			6	1996/4/21	14.9	257.3
			10	1999/3/19	12	278.2
			12	2000/5/17	10.8	288.9
	High Burn-Up 8x8	560	16	1999/3/19	12	278.2
			92	2000/5/17	10.8	288.9
			132	2001/10/2	9.4	304.6
			88	2002/9/16	8.5	318.5
			78	2005/6/25	5.7	393.6
			4	2006/10/2	4.4	472.5
			101	2007/2/11	4.1	506.6
			49	2008/3/28	3	676.9
	9x9(B)	736	1	2006/10/2	4.4	472.5
			87	2008/3/28	3	676.9
			100	2009/9/29	1.5	1267
			548	2010/10/30	0.3	3416
New fuel 204	9x9(B)	204	204			0
Total: 1535		1535	1534			

Table 2; *Fuel Assemblies Stored in Fukushima Daiichi (F1) Unit 4 SFP (by year of unloading) and Decay Heat (as of March 11, 2011) Prepared by CNIC based on SAND2012-6173, Fukushima Daiichi Accident Study (Status as of April 2012) and TEPCO*

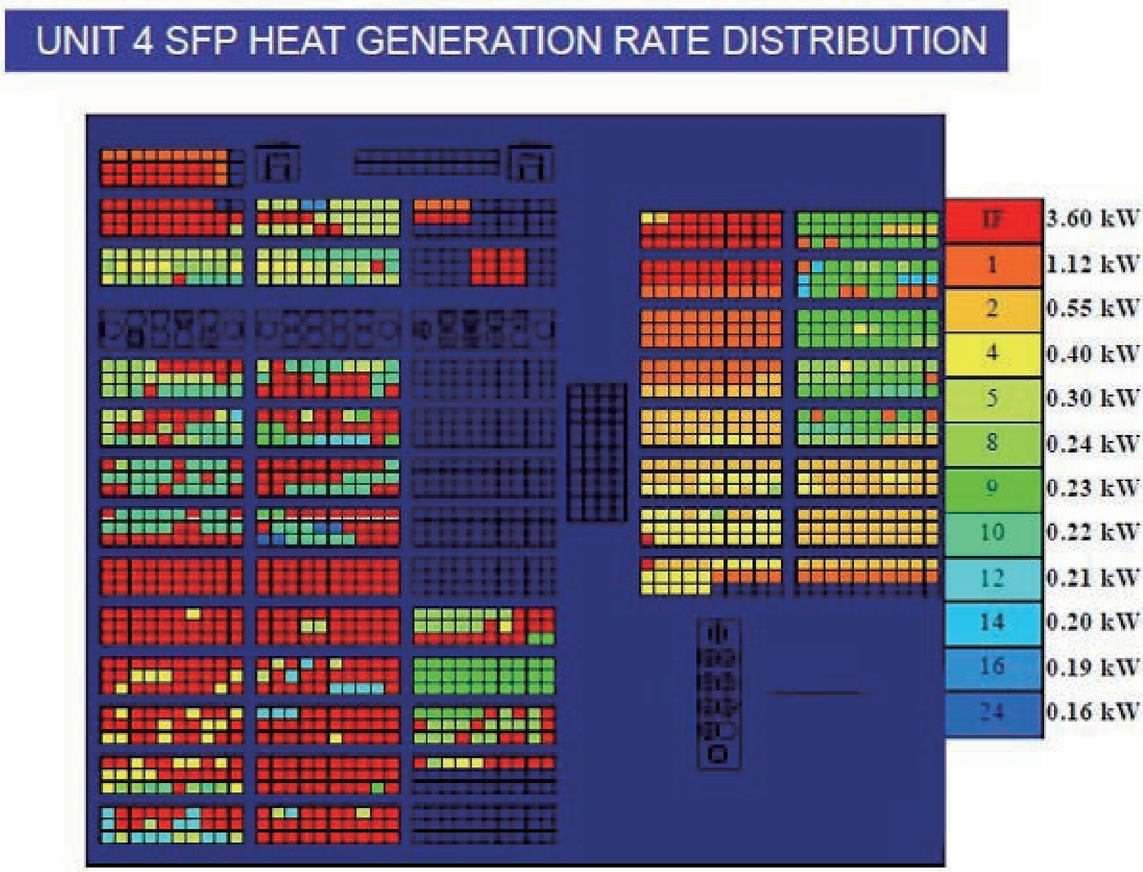
Dry cask storage facilities

The F1 plant is equipped with a facility to store spent fuel assemblies in dry casks. A total of 408 spent fuel assemblies are stored in the facility, in four middle-sized casks (each storing 37 assemblies) and five large casks (each storing 52 assemblies). The facility is located near the ocean and is assumed to have been partially inundated in the earthquake and subsequent tsunami on March 11, 2011. The integrity of the stored fuel will be investigated at some point in the future. The facility is severely damaged inside, and the monitoring instruments, such as thermometers, and the ceiling crane are out of order. “The facility is no longer useable,” says TEPCO. The casks are due to be transferred.

Temporary dry cask storage facilities

TEPCO plans to transfer dry storage casks and spent fuel assemblies in the common pool to a new temporary dry cask storage facility which will be built on the F1 site. This facility is scheduled to hold 20 dry storage casks (a design storage period of 40 years) and 45 dual-purpose transportation and storage casks (which can store 69 fuel assemblies each and have a design storage period of 50 years). Though the facilities are for temporary storage, they will be used for a period of 50 years. Japan is not highly experienced in the dry storage of fuel, and it is a great challenge for the country to ensure the integrity of dry-stored fuel for such a long period of time.

(Masako Sawai)



Fugure 2; *Unit 4 Fuel Storage Configuration*
Reproduced from “DOE Response to Fukushima Dai-ichi Accident,” by John E. Kelly, May 26, 2011, available at http://pbadupws.nrc.gov/docs/ML1114/ML11147A075.pdf (page 188/210).
TEPCO provided this configuration to the US Department of Energy (DOE), but to date has not published it in Japan.

Leaking Radioactive Water at Fukushima Daiichi Nuclear Power Plant

The rising tide of contaminated water and TEPCO's makeshift countermeasures

The constantly increasing amount of radioactive water stored at the Tokyo Electric Power Co. (TEPCO) Fukushima Daiichi Nuclear Power Plant is becoming a grave problem. This article focuses on the contaminated water leaks.

Despite the fact that no one knows where or in what condition the melted nuclear fuel from the reactor core is located at present, it is absolutely necessary to continue cooling it. The cooling operation will have to be maintained over a long period of time, until the fuel is fully recovered and removed.

As of January 22, 2013, approximately 360 tons of cooling water was being poured daily into the reactor vessels. The cooling water eventually becomes highly radioactive and contaminated, leaks into the reactor building basements, and from there to the turbine building basements.

Moreover, roughly 400 tons of groundwater is flowing into the basement of the reactor buildings each day. This is because TEPCO maintains the level of the radioactive water at around three meters above the sea level to reduce the risks of discharging and leaking the contaminated water into the ocean.

Since July 2011, the cooling water has been recycled and reused, but the amount of inflowing groundwater is steadily increasing. The contaminated water contains a huge amount of radioactive material and is highly radioactive. For this reason, safe management of the water is extremely difficult. The plant operator removes cesium and salt from the contaminated water before storing it in storage tanks and underground storage pools on the plant's premises.

Contaminated water leaking from underground storage pools

The pools are like large ponds dug in the ground, protected by multiple layers of plastic sheeting and covered with soil. There are seven such pools in the plant, of which three were used for storing contaminated water. Originally the pools were designed for storing water purified to some extent after passing through the advanced liquid processing system (ALPS), but the start of the ALPS operation was delayed and consequently contaminated water was stored in the pools.

Leaking of the contaminated water was first discovered in the No.2 storage pool. This was made public late at night on April 5. The leaking pool measures 60m in length, 53m in width, and 6m in depth, and was filled with 13,000 tons of contaminated water. Judging from the fact that the water level began declining and radioactivity was detected from the water samples collected from the detection holes, TEPCO appears to have suspected that the water leaks began sometime around March 20. The radioactivity levels of the sampled water continued to surge, while the water level in the pool declined further, forcing TEPCO to disclose the water leaks.

When the company brought the leaks to light, it estimated that the leaked contaminated water totaled 120 tons. They calculated this based on the fact that the water level in the pool dropped by 4 cm. TEPCO also estimated the total amount of radioactivity in the leaked water at 710 billion Bq.

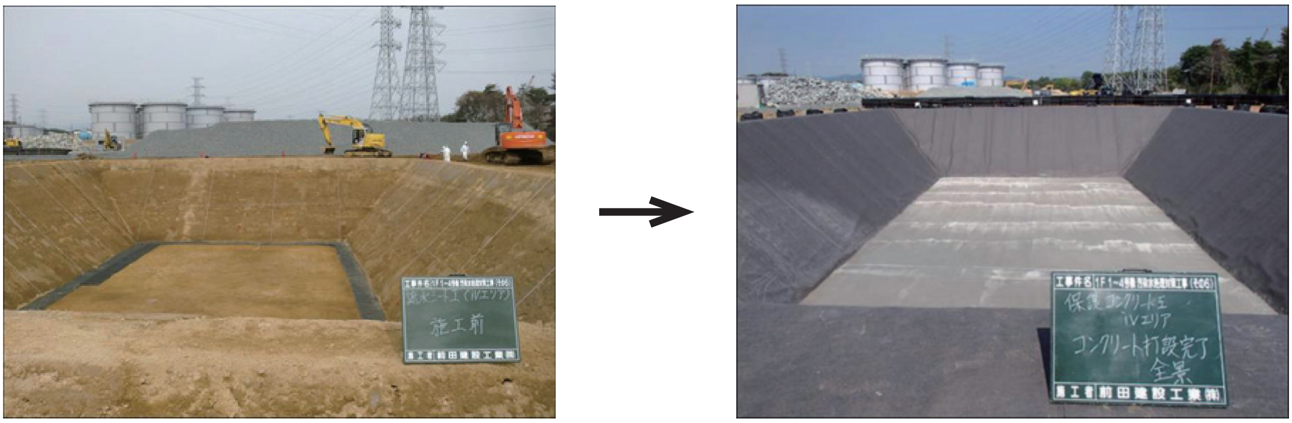


***Figure 1.** Photos of an underground tank for contaminated water (Photos by TEPCO)*

Figure 2. *Some of the large number of storage tanks at Fukushima Daiichi Nuclear Power Plant (Photo by TEPCO)*

On April 7, it was discovered that water was also leaking from the No.3 storage pool. TEPCO took the temporary measure of moving the contaminated water from the faulty No.2 storage pool to the No.1 storage pool, but on April 9, it was discovered that water was also leaking from the No.1 storage pool. TEPCO is said to have moved the water quickly to yet another underground pool.

Radiation in the contaminated water

In its report on the water in the underground storage pools, TEPCO released the results of its analysis of the water from the pool's drain holes and leakage detection holes.

The analysis results, however, contain data on only four items, the radionuclides Iodine-131, Cesium-134 and 137, and total beta radioactivity. The maximum dosage registered on April 10 in the sample water from the leakage detection hole on the northeastern side of No.1 storage pool stood at 1,100 ppm of chlorine, below the detection limit of iodine and cesium, and 23,000 Bq/cm^3 of total beta radioactivity. Total gamma radioactivity was also included in the results, which stood at 28 Bq/cm^3.

Nevertheless, the analytical data for the radioactive water in the underground storage pools have yet to be made public, and the contamination levels of the water is unknown.

The contaminated water passes through the cesium adsorption filtration system, but other radionuclides are not removed. The water contains Strontium-90 (half-life about 29 years), and other radionuclides, such as plutonium and americium, although the amount of these substances seems to be small. In addition, the water also contains cobalt. There is thus a need to publish the detailed results of the analysis of the contaminated water.

Faulty facility

The underground storage pools are lined with a three-layer impermeable lining material comprised of two 1.5 mm polyethylene sheets and a 6.4 mm layer of bentonite clay. Non-woven fabric is included between the two sheets.

TEPCO explained that since the leak monitoring pipe passes through the lining material covering the top of the pool, the company had previously presumed that the lining had moved slightly due to the weight of the water, creating a space around the pipe, allowing water to seep out. If this analysis were correct, the water leak would continue only for a limited time, until the water level dropped. Moreover, water leaks would not occur there unless the pool was full.

The reality is that leaks were discovered when the No.1 storage pool, containing highly radioactive water from other storage pools, was half full. TEPCO's explanation contradicted this fact and was therefore proved false. As a result, the most likely cause of the water leaks would be a tear in the liner, or a gap created where liner sections are joined.

The seven water storage pools were built to the same design. Water leaks from one of them means that other pools may have similar defects. TEPCO was, therefore, forced to conduct checks on the other pools, and on April 19, expressed the view that a crack had emerged in the concrete base under the liner sheets, placing localized pressure on the liner and creating a hole in that location. However, hampered by the high radiation level, the utility is facing great difficulty in substantiating this view.

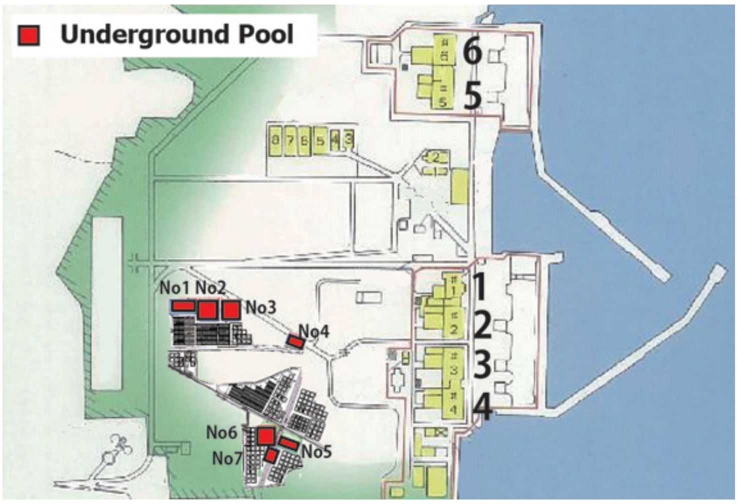


Figure 3. *Location of storage tanks at Fukushima Daiichi Nuclear Power Plant*

TEPCO on a tightrope devising contaminated water storage plans

In a news conference on April 10, TEPCO announced its plan to discontinue the use of the storage pools, and to build more tanks above ground into which the contaminated water from the pools would be transferred. According to the plant operator, the company had constructed the large-capacity underground storage pools because it was difficult to build tanks under transmission lines, and because the existing tanks had already taken up almost all available space at the plant. With the outbreak of the water leaks, TEPCO is being pressed to totally rethink effective countermeasures for dealing with the increasing amount of contaminated water.

The utility also announced that it will transfer the 7,100 tons of the contaminated water from the No.1 and No.2 underground storage pools to tanks by the first half of May, and the 16,500 tons from the No.3 and No.6 pools by the first half of June. The company went on to say that the transfer of the contaminated water from the No.4 storage pool to the tanks will be carried out after these transfer operations. This means that the water leaks from the Nos.1, 2, and 3 storage pools will continue until the transfer operations are completed.

The combined storage capacity of the existing tanks totaled 267,000 tons as of April 2, of which about 95 %, or 253,000 tons, was already being used. It is therefore impossible to transfer all of the remaining 23,600 tons of water from the storage pools to tanks.

In view of this situation, TEPCO plans to build more tanks (with a combined capacity of 126,000 tons) by September, and at the same time, use filtrate tanks (total capacity 22,000 tons) designed for storing purified water for cooling nuclear reactors.

Now that approximately 400 tons of groundwater is flowing into the reactor buildings each day, the plant operator appears to be walking a tightrope in dealing with the swelling amounts of contaminated water.

Fundamental measures need to be taken

TEPCO insists that the pools were built using widely-used water-storage technology. But what consideration was given to the adequacy of the storage pools for highly radioactive water, which are required to be absolutely leak-free? We suspect that the utility introduced the storage pool in haste, taking advantage of their low cost and short construction period, and without making a full feasibility study of the plan.

Furthermore, TEPCO seems to have the intention of operating ALPS and discharging the processed water into the ocean after removing the radionuclides. The company is apparently attempting to resolve the storage capacity shortage problem in this way.

The operation of ALPS, however, has been delayed substantially due to vulnerabilities of its storage vessel, pointed out by the Nuclear Regulation Authority (NRA). The system is currently undergoing experimental operation. If it works well, ALPS is not capable of removing tritium, a radioactive isotope of hydrogen.

Although TEPCO says it will release the processed water into the sea after obtaining consent from the local residents, fishermen are worried about the possible impacts and are strongly opposed to this plan. Under these circumstances, it will not be easy for the utility to win consent from local residents.

The fundamental cause of the growing amount of contaminated water at the plant is the groundwater flowing into the reactor buildings. Considering the need to continue cooling of the molten nuclear fuel for decades, TEPCO should promptly take more fundamental measures, such as measures to block the flow of groundwater into the facility.

(Hideyuki Ban, Co-Director of CNIC)

Anti-Nuke Who's Who

Hiroyuki Kawai,

Lawyer Fighting to Shut Down All Nuclear Power Plants in Japan
"We will continue to fight the nuclear village until we win."

By Natsuko Matsuda*

Hiroyuki Kawai was born in 1944 in the former Japanese colony of Manchuria in northeast China. After graduating from the Faculty of Law, University of Tokyo, he began to practice law in 1970. Today he is president of Sakura Kyodo Law Offices, Tokyo. As a lawyer specializing in business cases, he is active in bankruptcy cases and inter-company lawsuits. He has also been active in social contribution activities, such as assistance to Japanese wartime orphans who wish to move from China, where they were left behind, to Japan, and who hope to become naturalized Japanese citizens.

After the Chernobyl nuclear accident, Mr. Kawai became acquainted with the late Jinzaburo Takagi, who is one of the founders of Citizens' Nuclear Information Center (CNIC), and acquired a belief that nuclear power plants are the greatest destroyer of the environment. While absorbing knowledge at CNIC and learning at the Takagi School, Mr. Kawai became actively involved in the anti-nuke movement. In cooperation with a close lawyer friend Yuichi Kaido, a leading expert in lawsuits against nuclear power plants, Mr. Kawai began to fight to shut down nuclear power plants through the courts by involving himself in lawsuits against Hamaoka nuclear power plant in Shizuoka Prefecture and against the Ohma nuclear power plant project in Aomori Prefecture.

After the March 11, 2011 disaster, Mr. Kawai became even more active in anti-nuke activities. He established the National Network of Counsels in Cases against Nuclear Power Plants, which consists of lawyers who have fought against nuclear power plants across the nation. The network has now filed lawsuits against almost all nuclear power plants in Japan. He also serves as the leader of the counsel group for the shareholders of Tokyo Electric Power Company (TEPCO), who claim compensation of 5.5 trillion yen, the largest compensation claim in Japanese history. For the Fukushima Nuclear Disaster Criminal Complainants Group, which pursues the responsibility of alleged wrongdoers, including TEPCO executives, in the March 11 accident and ensuing damage, he serves as the attorney representing 14,716 complainants. At rallies and gatherings against nuclear power generation, he captures the attention of people as a fascinating speaker. Furthermore, believing that Japan as a state should steer toward independence from nuclear power, he works as the representative secretary to the National Network for the Legislation of the Nuclear Power Generation Abolition Law. He is thus actively rushing around day in and day out to realize a society independent of nuclear power generation.

His schedule is extremely tight and timed by the minute. He attends multiple meetings a day on anti-nuclear activities, appears in the courts, and responds to interviews by mass media and small independent media, treating all media equally. "To shut down nuclear power plants, I would even collaborate with the devil." Saying so, he deftly meets with various people, well-known or unknown, and visits various places, ignoring the concerns of the people around him. Handling business cases as well, he is extremely busy and has virtually no days off. However, he is an extremely cheerful and positive person and says, "I am enjoying my life now more than ever!"

Mr. Hiroyuki Kawai

Even with his very tight schedule, he does not give up on his many interests, including riding a three-wheeled Harley-Davidson, traditional Noh plays, and group singing. He appears at the office in *kimono* at the New Year and in *yukata* in summer. He sometimes appears in jeans.

Mr. Kawai sometimes makes unreasonable demands on people around him, surprising and bothering them. Because he makes phone calls at all times, even late at night or on holidays, he tends to be taken as self-centered or short-tempered. However, he is liked both by citizens and by the staff of his office. This is because he is innately cheerful and forgetful of anger, thinks positively, and always works seriously and honestly.

His current opponent is the Japanese nuclear village. It is a gigantic profit-making structure occupying 60% to 70% of the Japanese economy, consisting not only of electric power companies but also of general construction companies, banks, trading firms, manufacturers, mass-communication companies, researchers, and politicians. However, Mr. Kawai says: "We will never give up however many times we lose. We will continue to fight until we win."

Encouraged by the powerful stance of Mr. Kawai, we individual staff members who support him intend to continue to fight against nuclear power generation from our respective standpoints.

*Anti-Nuke Secretary to Hiroyuki Kawai

NEWS WATCH

Nuclear cooperation agreements signed with UAE and Turkey

While touring Middle East countries, Prime Minister Shinzo Abe was present at the signing of nuclear cooperation agreements between the Japanese government and the UAE (May 2) and Turkey (May 3). In the Joint Declaration on the Establishment of Strategic Partnership, PM Abe and Prime Minister Recep Tayyip Erdoğan of Turkey "Expressed their satisfaction with the signing of the 'Agreement between the Government of Japan and the Government of the Republic of Turkey for Co-operation in the Use of Nuclear Energy for Peaceful Purposes' and the 'Agreement between the Government of Japan and the Government of the Republic of Turkey on Co-operation for Development of Nuclear Power Plants and the Nuclear Power Industry in the Republic of Turkey', and the granting of the exclusive right of negotiations to Japan regarding the construction of the Sinop Nuclear Power Plant. They also affirmed their hope that the negotiations will lead to establishing a new avenue of co-operation in the field of peaceful uses of nuclear energy."

In talks between PM Abe and Crown Prince Salman bin Abdul Aziz Al-Saud of Saudi Arabia on April 30, agreement was reached on the consideration of concluding a nuclear cooperation agreement between the two countries.

Photo of the corpse of the rat that stopped the spent fuel pool cooling system (TEPCO)

TEPCO exchanges plutonium with German power company

On April 23, TEPCO announced that it had agreed to exchange, through amendments to balance sheets, a part, 434 kg, of the 2.5 tons of plutonium that it owns in France for the same amount of plutonium held by a German power company in the UK. With the decommissioning of Fukushima Daiichi NPP Unit 3, TEPCO no longer has any use for either MOX fuel now being processed or plutonium, while the German company finds itself unable to process MOX fuel due to the closure of a processing factory in the UK, and thus the two sides found themselves with matching interests. The German side will now process the MOX fuel in France, and TEPCO will have a part of the plutonium stored in France now stored in the UK.

Rat stops spent fuel pool cooling system

On March 18 at TEPCO's Fukushima Daiichi Nuclear Power Plant, a rat somehow gained entry to an outdoor electrical junction box, resulting in a loss of power when it caused a short by touching a terminal. The spent fuel pools of Units 1, 2, and 3 (now undergoing decommissioning due to the March 2011 accident) and the common fuel pool could not be cooled from between 19 and a half to 29 hours. On April 5, while installing a steel mesh fence as a countermeasure, a wire from the steel mesh came into contact with a terminal in the junction box, causing another short and making the cooling for Unit 3 spent fuel pool inoperable for three hours. Furthermore, on April 22, two dead rats were found inside an outdoor transformer, causing the Unit 2 spent fuel cooling to be suspended for 4 hours while the rats were removed and the transformer inspected.

US-ROK civilian nuclear cooperation agreement to be extended for two years

The US-Republic of Korea (ROK) civilian nuclear cooperation agreement was signed in November 1972 and came into force in March 1973. At the time, it was to be valid for 30 years, but this was extended to 41 years when an amended agreement was signed in May 1974. This agreement is due to expire in March 2014. The two countries have been negotiating a renewal since October 2010, but have been unable to reach a compromise. On April 24, it was announced that agreement had been reached on a two-year extension.

The renewal negotiations stalled because the ROK side is demanding a comprehensive agreement on uranium enrichment and the reprocessing of spent nuclear fuel. An ROK government official has been reported as stating that the ROK sense of rivalry has been stimulated by the fact that "Japan is allowed to do these."

The reprocessing method that the ROK is attempting to introduce is a dry form of reprocessing known as pyroprocessing, in which the oxidized spent nuclear fuel is reduced to metals, from which the fission products are then separated by electrolysis. The ROK side is claiming that since the minor actinides are not separated from the plutonium when it is extracted, this method is more proliferation resistant. The US side, however, does not acknowledge that the method is more proliferation resistant and maintains that both reprocessing and enrichment contravene the 1992 Joint Declaration on the Denuclearization of the Korean Peninsula.

Having for the time being extended the validity of the agreement, the two countries will now continue negotiations every three months.

MOX fuel for Takahama Unit 3 departs from France

On April 17, 20 MOX fuel assemblies for the Kansai Electric Power Company (KEPCO) Takahama NPP Unit 3 were loaded onto two specialized UK-registered ships (the Pacific Heron and Pacific Egret) and began their journey from the French manufacturer to Japan. The two ships are armed and the idea is that they will escort each other. The ships will round the Cape of Good Hope and take the southwest Pacific route, apparently due to arrive at Takahama NPP's private port in late June.

The consignment was supposed to have been shipped in the spring of 2011, but was postponed due to the Fukushima Daiichi NPP accident. Takahama Unit 3 has been shut down since February 2012, but KEPCO is reportedly planning to apply to the Nuclear Regulation Authority to restart the reactor as early as July this year. However, loading of the MOX fuel is not yet scheduled.

Order suspends Monju operation

On May 30, the Nuclear Regulation Authority (NRA) ordered the suspension of preparations for a restart of trial operation of Japan Atomic Energy Agency's (JAEA) prototype fast breeder reactor, Monju, due to failure to carry out roughly 10,000 inspections within the facility, and the ensuing sloppy response. With the exception, for example, of checks necessary for maintaining security, activities connected with pre-operation work, including an exchange of fuel, are suspended. The suspension will be enforced until the NRA has completed its assessment of the report on the implementation of improvements related to the suspension order. A major reason for the NRA issuing this very severe order is that not only the non-inspection of equipment and time between inspections were unilaterally altered without taking necessary procedures, even after the submission of a flawed report on the situation no new measures were taken. JAEA president Atsuyuki Suzuki announced his resignation on May 17.

Nuke Info Tokyo is a bi-monthly newsletter that aims to provide foreign friends with up-to-date information on the Japanese nuclear industry as well as on the movements against it. It is published in html and pdf versions on CNIC's English website: http://cnic.jp/english/

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