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A Major Accident that Nearly Ended in a Meltdown

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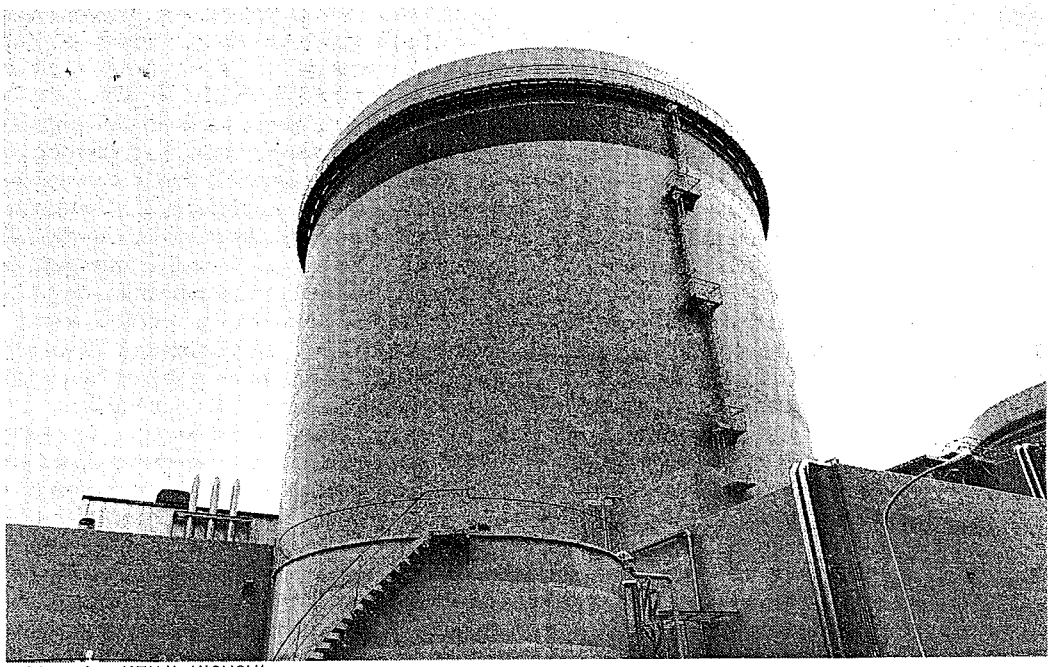


Photo by KENJI HIGUCHI

IN THIS ISSUE

ECCS Operated for the First Time in Japan, But Did Little to Cool the Core

A major accident occurred at Kansai Electric Power Co.'s (KEPCO) Mihama Nuclear Power Station Unit 2 (PWR, 500 MWe). There was a tube rupture in the steam generator, the part said to be the Achilles' heel of pressurized water reactors, and more than 50m^3 of primary coolant flowed into the secondary side,

resulting in the accident people had always feared. The emergency core cooling system (ECCS) was activated, but did not function as expected. The accident was stopped on the very brink of the worst situation of all, a core meltdown.

We cannot dispose of the matter simply because there was no significant release of radioactivity into the surrounding environment. If this was the first time in the history of Japanese nuclear power that the last defense against a core meltdown - the ECCS - was activated, it was also the first time a steam generator tube double-ended rupture occurred. This was the biggest accident in the history of Japanese nuclear power, and it has incalculable significance.

Although the information made available to the public thus far is not necessarily adequate, let us examine what we have. At 1:40pm on 9 February the air ejector gas monitor of the condenser (which changes steam that has passed through the turbines back to water) at Mihama 2 showed a count of 2,000/minute (the normal reading is 800), and an alarm sounded. For this reason operators began at 1:48pm to decrease output in order to shut the reactor down manually, but at 1:50 the reactor went into a scram (an automatic emergency shutdown) due to a signal that pressure in the pressurizer had dropped (134 kg/cm^{2}G). Then, 12 seconds later, pressurizer pressure dropped further, (128 kg/cm^{2}G) a low water level alarm sounded, the ECCS was activated, and emergency coolant was pumped into the core. The gas monitor at this time read as high as 1.5 million counts/minute.

A look at the course of the event shows that the pressure, during a mere 6-7 minutes, dropped precipitously from the operating pressure of 157 kg/cm^{2}G to about 100 kg/cm^{2}G, and that the gas monitor count jumped to 2,000 times the normal reading. This indicates that there was a tube rupture in the steam generator. What significance does this have for the safety of PWRs?

In a PWR the primary coolant that runs through the core does not go directly to the turbines, but passes through the reverse-U-shaped tubing (inside diameter, 2cm; thickness, 1.3mm) in the steam generators, and then returns to the core. In the steam generator the secondary coolant is heated as it flows around the tubes, so the primary coolant is not directly turned to steam to drive the turbines. This structure is said to offer added protection against the release of radioactivity, but it is also the PWR's weakest point.

Steam generator tubing is thin-walled in order to facilitate the transfer of heat. Since all thermal strain is applied here, the tubing suffers various kinds of damage which are called thinning, stress corrosion crack, denting, intergranular attack and fretting. At such plants as Mihama 1, Takahama 2, Ohi 1, and Genkai 1, over 20 percent of the tubes, numbering between several thousand and well over 10,000 depending on the plant, have some kind of disorder, and are either plugged and out of use or have been repaired with sleeves.

What happens when a tube suddenly ruptures? Primary coolant would flow with great force from the high-pressure (approx. 150kg/cm^{2}G) primary side to the low-pressure (approx. 50kg/cm^{2}G) secondary side, and radioactivity would escape to the outside from the secondary side, which has low control over radiation leaks. Water would flow out of the core and produce a condition of "coolant loss." If such a condition went unchanged the core would be like a heated teakettle containing no water, and would proceed toward a meltdown, the worst of all situations. In this accident, the plant only managed to avoid a meltdown by releasing hot steam from the undamaged steam generator. The company and the Ministry of International Trade and Industry (MITI), as well as the Nuclear Safety Commission,

announced that the ECCS successfully functioned to cool the reactor core, but this was later found not to be the case. The two ECCS high-pressure injection pumps, each with a capacity of 159m³/hour, were able to inject a total of only about 30m³ water during the 47-minute activation period. The reason was that the reactor core pressure remained nearly constant at about 100kg/cm²G, while the two pumps were designed to function effectively at pressures lower than about 90kg/cm²G. The operators tried to open the two pressurizer relief valves to depressurize the core but they remained closed. They finally gave up trying to open the valves, and instead attempted to depressurize the primary system by using the pressurizer auxiliary spray, but it took six minutes to release the spray interlock. The high pressure of the primary system prevented the ECCS from injecting water into the core, and the control room record charts, disclosed three weeks after the accident, showed that the pressurizer water level meter continually read zero from 13:52 to 14:35.

During this period of time the primary system pressure remained nearly constant at 100 kg/cm²G, and primary coolant kept leaking into the secondary system. The total amount of water that leaked into the secondary side was tentatively estimated by KEPCO to be 55m³. The leak was stopped by switching off the ECCS pumps, which contributed to lower the primary system pressure. This maneuver was, however, very problematic in view of the low water level in the pressurizer. It is believed that the reactor primary system experienced boiling twice due to sudden depressurization, firstly at the beginning of the accident and secondly when the ECCS was switched off, forming a stem void at the reactor vessel top.

SITUATION OF STEAM GENERATOR TUBES (91·2·18) –

Power Company	Reactor Name	Start of Operation	SGs in Total	Tubes in Total	Plugged Tubes	Plugged Ratio(%)	Permissible Plugging Ratio	Sleeved Tubes	Percentage of Damage
JAPCO	Tsuruga2	1987. 2	4	13528	2	0.015	10(%)	0	0.015(%)
Hokkaido	Tomari 1	89. 6	2	6764	0	0	-	0	0
KEPCO	Mihama 1	70.11	2	8852	1631	18.4	28	0	18.4
	Mihama 2	72. 7	2	6520	411	6.3	20	41	6.9
	Mihama 3	76.12	3	10164	227	2.2	15	0	2.2
	Takahama1	74.11	3	10164	654	6.4	25	96	7.4
	Takahama2	75.11	3	10164	1580	15.5	25	3106	46.1
	Takahama3	85. 1	3	10146	24	0.2	10	0	0.2
	Takahama4	85. 6	3	10146	21	0.2	10	0	0.2
	Ohii 1	79. 3	4	13552	1952	14.4	18	4064	44.4
	Ohii 2	79. 4	4	13552	163	1.2	18	7	1.3
Shikoku	Ikata 1	77. 9	2	6776	217	3.2	10	14	3.4
Electric	Ikata 2	82. 3	2	6764	0	0	—	0	0
Kyushuu	Genkai 1	75.10	2	6776	709	10.5	15	2548	48.1
Electric	Genkai 2	81. 3	2	6776	1	0.015	10	0	0.015
	Sendai 1	84. 7	3	10146	0	0	—	0	0
	Sendai 2	85.11	3	10146	0	0	—	0	0

Rupture Actually Occurred, LBB Refuted

Until now the electric power companies and MITI have maintained that even if tubes are damaged, they will not undergo a complete and instantaneous rupture as they did in this instance. They have asserted that defects such as pinholes would appear first, and the problem could be solved by detecting them in regular inspections and effecting repairs. This accident proved just how this assertion was meant to tide the industry over for the moment. This seemingly sensible assertion has tended to reaffirm the "LBB" (leak before break, meaning that prior to a rupture a small leak occurs) principle, but in this accident a rupture occurred suddenly, before the operators could discover any preliminary indications (the rise in radioactivity one hour before cannot be considered forewarning of the accident).

This problem is not restricted to Mihama 2. This reactor actually has a lower degree of damage to its tubes than others. Now that the claims previously made by the power companies and government no longer explain why a rupture occurred at the reactor in question, how that event proceeded, and how safety was maintained when it happened, we must thoroughly elucidate the cause and reassess the safety evaluations. Even the cases of previous instances of damage to steam generator tubing have yet to be adequately elucidated, and although they have tried changing the quality of water and materials, new kinds of damage have been discovered each time, thus making the very operation of plants with such high damage rates as risky as a tightrope act. People are now questioning this safety-ignoring attitude itself. To begin with, the cause of the accident should be thoroughly clarified, and until a conclusion is reached all 17 PWRs, which basically have the same problems (representing about half of Japan's nuclear plants), should be shut down.

If the government and power companies say that electric power demand makes this difficult, then this fact itself indicates the frightening and fragile aspects of a society dependent upon nuclear power. As of this time it has been revealed that the rupture is a complete double-ended break near the U-bent part of a tube, i.e., a guillotine break that is a sharp crosswise cut. As far as we can judge, this is the most serious type of rupture, similar to the 1987 accident that occurred at the North Anna plant in the United States.

The rupture at North Anna involved a break that occurred - without the slightest forewarning - two months after a regular inspection showed the tube to be normal. The cause was said to be metal fatigue brought on by vibration with the part of the support plate coming in contact with the tubes, but on that occasion authorities plugged the ruptured tube and resumed operation without thoroughly elucidating the cause. This resulted in a rupture accident involving another tube two years later (caused by the expulsion of the plug), and might be a good lesson for the Mihama 2 accident. Of primary importance is a complete elucidation of the cause (when the North Anna accident occurred, Japan's MITI and Nuclear Safety Commission claimed without examining the matter that "This could not happen in Japan," and one might say this attitude led to the Mihama accident).

On March 20, KEPCO announced that their investigation had assigned the cause of break to be due to high-cycle vibration fatigue induced by erroneous installation of the anti-vibration bars, at the time of construction and such erroneous construction work was only limited to Mihama 2 and Takahama 2 (Takahama 2 was shutdown on that day). But many experts believe every PWR reactor is subject to steam generator tube rupture and the rupture cause is not limited to high-cycle

vibration fatigue.

Facts Still Hidden

There are still many unknowns concerning the progress of the accident and the release of radioactivity, with KEPCO and MITI releasing important facts only a few at a time.

The event that should be regarded as a harbinger of the accident, the rise in the radiation indicator, happened not at 1:40pm, but actually at 12:40pm, and this fact became known the day after the accident. The fact that the pressurizer relief valves did not operate was revealed two days after the accident. It is worth noting that there is no manual, and hence no operator training, to cope with this type of accident - a steam generator tube rupture with the pressurizer valves remaining closed. Also, it was revealed three weeks after the accident that the main steam isolation valve of the damaged steam generator could not be activated from the control room, and an operator had to be sent to close the valve manually. Shocking facts are thus made known one at a time, and there is a considerable possibility that the truth of the accident is much more serious than was thought at first. One would like to demand that KEPCO and the government make all the facts known.

The most recent official estimates for the release of radioactivity - approximately 20 billion Bq in rare gases, 400 million Bq of iodine, and 700 million Bq in liquids - seem to be very questionable, most probably largely underrated.

Not only were local residents informed late, they are still hiding the truth from the residents. This too is unforgivable. In these respects as well, this accident once again exposed the dangers of nuclear power and the terrifying nature of the electric companies and government.

Revive the Great Tide for the Nuclear Power Phase-Out

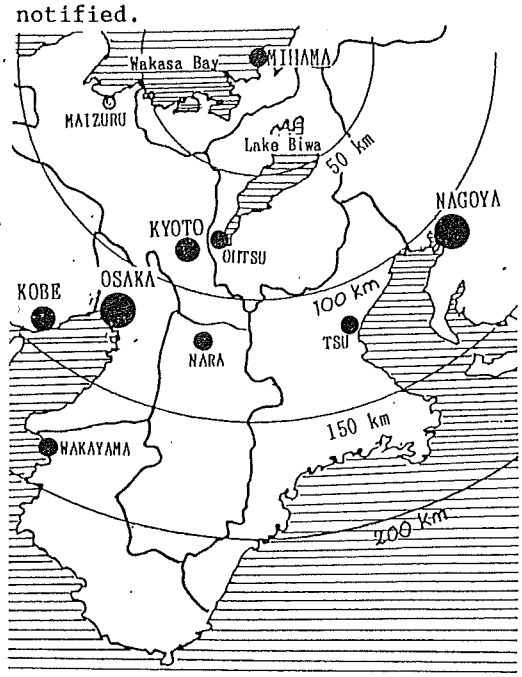
We cannot expect much from the MITI and Nuclear Safety Commission inspections, which have allowed steam generators to remain in a rundown state. Additionally, a look at the members of the special Accident Investigation Commission established by MITI shows that almost all of them are closely connected with the nuclear power industry, and thus we can expect absolutely nothing of them. As for the Nuclear Safety Commission, Chairman Uchida declared early on that "The accident is a textbook example, and no big deal," which sums up the Commission's attitude. KEPCO's Vice President Iida made a "radical statement" when he spoke for the company with, "You can bet we're not going to stand around for half a year trying to figure out what went wrong." People with such reckless attitudes will say anything. It scares one to think that people like this are operating nuclear power plants.

The work of elucidating the direct causes of this tube rupture has just begun, but it is clear the root cause is the attitude of the government and power company in ignoring safety. If Japan's dependence on nuclear power for electricity increases still more while the plants continue to deteriorate, the situation will become even more frightening. There is no more time to wait, and we must phase out nuclear power as soon as possible. People in each area of Japan will now be working on this problem in various ways, and it is essential that we create a national groundswell of opposition even greater than in 1988.

Local Governments Unprepared for Nuclear Accidents

When the Mihama reactor accident occurred on Feb. 9, it was a full 64 minutes before the local town was notified. It was told of the accident only after the Ministry of International Trade and Industry and the Fukui prefectural government had been informed. The town in which the plant is located was notified last, and local residents were never officially informed or alerted by the town until they heard the news on TV and saw it in the newspapers. There were even visitors touring the plant when the accident occurred. They witnessed the B steam generator puffing out clouds of steam, but were never told what it was and finished their tour course as scheduled.

The adjacent city of Tsuruga, 13km away, which has 2 nuclear plants, 1 ATR Fugen in operation, and a proto-type FBR Monju under construction, was not informed until the next day. Nor was any other neighboring city or town officially notified.



The area where the Mihama plant is located is well known as Japan's N-Plant Ginza (Avenue), as there are 12 N-plants in operation and 3 under construction around Wakasa Bay, a beautiful national park. 10 of the major cities and towns of Fukui pref. are located within a 50km range of Mihama.

7 of these cities and towns along Wakasa Bay were especially unnerved by the fact that an accident which was never supposed to happen (as they were told) had actually occurred, and that the people who should have been notified first were totally neglected. They formed a coalition and made a strong protest to the Fukui prefectural government and Kansai Electric Power Company (KEPCO).

Each local government drew up a Safety Agreement with the power company when they first decided to site a nuclear plant. Under this agreement, the power company is obligated
to inform the local government in times of accidents and emergencies, to allow local government representatives into the plant for inspection, and to compensate the community for any damage caused. But this agreement is valid only for N-plants sited within the borders of that town or city, and not for plants in neighboring towns or cities, even as close as 10km away. So the 7 cities and towns in the vicinity of Mihama got together to negotiate a new type of safety agreement and a better system for the urgent circulation of alerts to neighboring cities and towns.

While the local governments are demanding better safety agreements, the residents are demanding an evacuation drill. No nuclear disaster drill involving the residents has yet been conducted, and only 3 drills have been performed

with local government participation. The existing Nuclear Disaster Prevention Plan covers only a 10km range. Until now, a serious accident has never even been on the agenda of the local government, and the local people are totally unprepared.

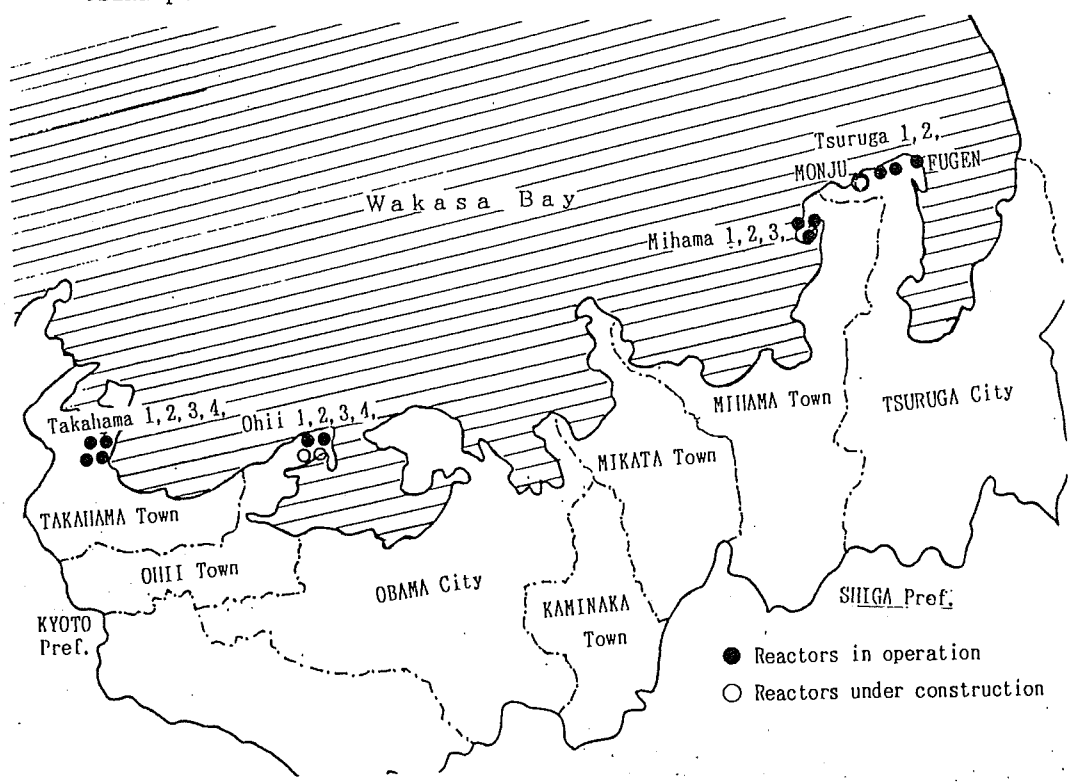
Concerned residents are also demanding the suspension of Mihama 1, Takahama 2, and Ohi 1, the 3 worst PWRs within the area.

The residents of Kyoto prefecture are also seriously concerned about the accident, since many of the major cities in the prefecture are within 80km of Mihama. The prefectural governor and Kyoto city mayor have filed a protest with KEPCO, asserting that such an accident should never have happened but that in such an event they should also be notified. The prefectural government has adopted a statement unanimously demanding a thorough investigation of the cause and the suspension of all PWRs in Japan.

Osaka prefecture is also within a 100km range. On the day KEPCO held a briefing on the accident, more than 500 citizens assembled for a meeting, which lasted into the night.

Citizens of 104 organizations in the Tokyo area have filed a protest with MITI and KEPCO, calling for the suspension of all PWRs until the cause of the accident is made clear. Residents in Fukuoka sat-in in front of Kyushu Electric from the day after the accident, demanding the outage of Genkai 1 which has the worst percentage of SG tube damage. The sit-in lasted until negotiations ended in stalemate 3 days later. Residents in Shikoku protested against the 3 Ikata N-plants, and residents in Hokkaido against the 2 Tomari power plants.

While the details of the Mihama accident are still far from clear, one thing is sure. The government is going to find it increasingly difficult to find sites for the nuclear power plants they still plan to construct.



Defeat in Aomori Elections

Voters of Aomori have been saying "no" to the nuclear fuel cycle for a year and a half beginning with Takao Mikami's victory in the Upper House election in '89, and continuing with the 2 victories in the Lower House election in '90.

Meanwhile, however, construction work has continued, and the uranium enrichment plant is almost completed.

In our efforts to stop the project we supported Mr. Shigeru KANAZAWA as a candidate for the Feb. 3 gubernatorial election. Mr. Kanazawa is a lawyer and a representative of the Nuclear Phase-Out/Anti-Nuclear Fuel Cycle Aomori Network. Had he been elected, he would have abolished the "Basic Agreement on the Nuclear Fuel Cycle Facilities" which was drawn up between Aomori pref., Rokkasho-mura, and the industries. The petition against the project submitted to the prefectural government last December collected more than 520,000 signatures, which is close to a majority of the 1.1 million voters in the prefecture. Union workers, farmers, and citizens joined forces for the election campaign. Citizens' groups formed the coalition "Stop the N-Fuel Cycle Facilities with Shigeru Kanazawa" and campaigned throughout Aomori. The coalition received nationwide support both with donations and volunteer staff.

Despite our considerable efforts, however, the election results totally betrayed the people's feelings. (Polls taken by Asahi newspaper last Nov. showed that 62% of the people were against the N-fuel cycle.)

Votes Obtained

Kanazawa	(Anti-nuke)	247,929 (33.4%)
Kitamura	(Pro-nuke)	325,985 (44.0%)
Yamazaki	(Freeze)	157,558 (22.6%)

A second election followed on Feb. 24 for the Upper House seat vacated by Mr. Yamazaki, who was running for governor. Mr. Seiichi Kubo, chairman of the Farmers' Union Against the N-Fuel Cycle, ran for the seat, but lost by a 40,000 vote margin.

The main reason for the defeats was pressure from the LDP and the power companies, which poured in enormous amounts of money, called in all the influential people in the prefecture and almost threatened them to vote for Kitamura. Two slogans they used were: "The N-Fuel Cycle is not the only prefectural policy issue," and "Don't hand prefectural politics over to the radicals," and both were very effective. Their daily public acceptance activities must have overwhelmed our campaign, which was run by volunteers. Many people said their opposition to the project was a separate issue from the election.

Mr. Kanazawa, in his speech after being defeated, said "the people of Aomori have chosen to co-exist with the N-Fuel Cycle. But once the facilities start operating, the pure, clean environment we now enjoy will never be restored. Despite the election of a pro-nuclear governor, we must continue our struggle to stop this project for the sake of our dear children and grandchildren, however difficult that struggle may be."

We have lost the perfect chance to stop the project, but we must now get back to the drawing board and once again appeal to each of the citizens of Aomori and get across to them what having the N-Fuel Cycle would mean.

by Tohru MIKAMI

NEWS WATCH

Shutdown at Tokai reprocessing plant

On March 9 there was an accident at PNC's Tokai fuel reprocessing plant, when the dissolver stopped automatically. It was the first time an emergency shutdown had ever occurred. The pressure in the dissolver went up to 1.2 atm, whereas it should normally stay under atmospheric pressure, at 0.996 atm. One possible cause is a sudden burst of nitrogen oxide bubbles, which might have resulted from an uncontrolled reaction between uranium and nitric acid.

The Tokai fuel reprocessing plant has already experienced a series of troubles in which the dissolver suffered leaks due to corrosion. But the dissolver which stopped this time is a new one, made in 1984, and this was its first accident.

Plan for Pu use revealed

The Plutonium Use Program Working Group of the Atomic Energy Commission's Nuclear Fuel Recycling Committee submitted its report on plutonium use on March 19. According to the report, plutonium will be used as MOX fuel in LWRs for the time being, since the FBR program is not yet within sight of commercial viability. MOX fuel will be used in 4 LWRs (1,000MWe) by the end of the 1990s, and 12 LWRs by the year 2005. It suggests for the first time that MOX fabrication will be carried out partly in Europe to assure nuclear material protection. The report also indicates for the first time the projected supply and demand of plutonium until the year 2010. The supply would be 84 tons in total, some 49 tons from the planned Rokkasho-mura reprocessing plant, and 30 tons returned from Europe, etc. Of the total supply, 2/3 (53T) will be burned in LWRs.

However, experts on plutonium issues observe that the report's projection for burning plutonium extensively in LWRs is quite unrealistic and will not get much support from the nuclear industry. Neither does the report refer to any method of preventing nuclear proliferation. 84 tons of plutonium is equivalent to about 10,000 atomic bombs. Nuclear proliferation should be prevented technically as well as legislatively. Also, while MOX fuel is to be burned in 16 LWRs, the report does not mention which ones.

Japan-Korea N-safety cooperation agreement implemented

Early in March, Japan's Agency for Natural Resources and Energy and Korea's Ministry of Science and Technology agreed on concrete steps to implement 'the Nuclear Safety Cooperation Agreement' drawn up between Japan and Korea last May. It was decided that:

1. A meeting for information exchange will be held once a year.
2. The exchange of engineers will be promoted, with Korean engineers in the fields of earthquake-proof, human factor management and deterioration management technology, invited by NUPEC (Nuclear Power Engineering Test Center) and JAPEIC (Japan Power Engineering and Inspec-

tion Corporation).
3. Published information will be exchanged four times a year on a regular basis.

The agreement runs for five years till 1996 but can be extended with the consent of the two governments.

Successive power failures at Tokai facilities

Successive power failures at the PNC reprocessing plant and the JAERI Waste Safety Test Facility (WASTEF) in Tokai-mura, Ibaraki prefecture led to the stoppage of the duct fans which keep the pressure inside the facilities lower than atmospheric pressure to prevent radioactive particles from escaping. On February 13 a worker at the reprocessing plant was killed by an electric shock which resulted in a power failure. The auxiliary power supply did not work, and power failed in four buildings including the storage facility for high-level radioactive waste. The fans stopped for one and a half hours. PNC said that no leakage of radioactivity had been detected.

The power failure on February 23 at WASTEF was caused by trouble with the diesel generator used as an emergency power supply. The transformer substation building was under construction for remodeling and the emergency power unit was on line. The fans stopped for one hour and fifty minutes. Radioactivity spilled out from the test cell which handles high-level waste and contaminated a 430m^2 area of the facility to a level of 9Bq/cm^2.

Mutsu gets official recognition

The nuclear-powered ship Mutsu has finally been officially recognized as a nuclear-powered experimental ship on February 14, 22 years after it was first launched in 1969.

Ever since, Mutsu suffered series of radioactive leaks and troubles.

Although Mutsu was finally launched as an official experimental ship, it is expected to be scrapped after about a year of experimental sailing. And there is little prospect that the data obtained from this experimental voyage will be used in the future.

Mutsu has been called a 'politics-powered' or 'face-saving' ship. It is a white elephant which has so far cost the nation ¥120 billion. The thermal output of the reactor is 36MW, and the total tonnage of the ship is 8,242 tons.

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