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Earthquake Zone

Tombstones toppled by the earthquake. Tombstones have long been used as an indicator of the strength of earthquakes. They are still used to gauge the strength of earthquakes that occurred before seismic records were available. The regularity of their shape makes them a good indicator. (Photo by Kazuyuki Takemoto)

It might seem obvious to the average man or woman in the street, or the average child in the playground for that matter, that you don't build nuclear reactors in an earthquake zone. But the average man or woman in the street, not to speak of the average child in the playground, would be na_ve to make such an assumption. Here in shaky Japan we've got 52 of them (soon to be 53) and not a single one has come crashing down - not yet at least. Just take the recent spate of tremblers in Niigata Prefecture. Buildings came down and the lights went out in Kashiwazaki City, but the nuclear power plant (NPP) stood out like a lighthouse in a sea of darkness, a beacon of hope proving that man is master of the elements, technology conquering nature once again[1]. If, for a moment, the inhabitants of Kashiwazaki felt that nature had got the better of them, all they had to do was glance over at that island of light. Not that any of that light shone in Kashiwazaki itself. That precious commodity was all sent off to the capital[2], but still, they could enjoy it vicariously. I suppose we should acknowledge the reports that a few hundred liters of coolant overflowed from spent fuel storage pools, but we can be sure that not a drop would have been released into the environment.

Nevertheless, it must have been difficult in the early days to convince a skeptical public. No matter how good your propaganda department is, the public isn't totally stupid. To deal with this problem, the visionaries in the government and in industry thought up a very clever scheme to help people understand that the nuclear reactors they proposed to build would not fall over. This scheme had three basic aspects. The first was

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to claim that scientists knew where earthquakes would and would not occur. The second was to claim that these same scientists could predict how powerful the strongest earthquake would be in a given place. The third aspect of this scheme was to play on people's belief (common at the time, though few subscribe to it these days) in technology. Ever since Homo sapiens strode out of Africa about 150,000 years ago, with just a club and a few stone tools in his hands, it's been all progress. Our manifest destiny was to conquer nature and technology was the means by which we would fulfill that destiny. Such was the popular belief at the time, so when these visionaries told people that the nuclear power plants that they were going to build could withstand the most powerful earthquake possible, people swallowed it.

But apart from the shining example in Niigata the other day, how has the record been? Well, it has to be admitted that the scientists got it wrong pretty often, but heck, they were trying to sell a great idea. You can't blame them for a bit of exaggeration. Anyway, let me give you a few details.

When designing earthquake-resistant features for nuclear power plants, buildings and equipment are categorized in four levels of importance, on the basis of the potential damage from a release of radiation into the environment. Until July 1981 there were only three classes: Class 'A' being the most important; Class 'B' being for buildings and equipment with less safety significance than Class 'A'; and Class 'C' being for buildings and equipment which have the same safety significance as general industrial facilities. Class 'A' buildings and equipment must be able to withstand the strongest predicted earthquake, known as the 'design-basis strongest earthquake'. The magnitude of this earthquake is assessed on the basis of past earthquakes and the likely effect of active faults. A higher classification, Class 'As', was introduced in July 1981. This includes buildings and equipment in Class 'A' which are deemed to be especially important. These buildings and equipment must be able to withstand what is called the 'design-basis upper limit earthquake'. People could be forgiven for wondering what the difference is between the 'strongest earthquake' and the 'upper limit earthquake'. It's probably easiest to put aside your linguistic intuitions and just believe me that the 'upper limit earthquake' is envisaged as being even bigger than the 'strongest earthquake'. That would have to make it a real whopper one might think, but not necessarily. In cases where no active fault has been discovered in the vicinity, it is considered to be a magnitude 6.5 earthquake directly beneath the NPP active fault.

Astute readers might have noticed that reactors built before July 1981 weren't designed to cope with the 'upper limit earthquake'. Fortunately, the new rules specifically state that they don't have to go back and redesign the old reactors. Actually, in several cases the original calculations for both 'strongest earthquake' and 'upper limit earthquake' were found to be too low and subsequent reactors were built to more stringent design standards. But none of them is designed to withstand an earthquake of the scale of the one which hit Kobe in 1995. The most severe earthquake considered is for Hamaoka-3,4&5, built right on top of a major plate boundary[3]. These are designed to withstand an earthquake of 600 gals[4] at bedrock level. The Kobe earthquake was 833 gals.

Just for the record, the measuring device on the Kashiwazaki-Kariwa-5 reactor recorded 54 gals at bedrock. Measurements were recorded in the order of 1,700 gals on the surface near the epicenter, but the Kashiwazaki-Kariwa NPP is about 30 kilometers away from there. Also the shaking is generally less at bedrock level. Power companies make much of this, pointing out that the foundations of their power plants rest on the bedrock.

Almost all of Japan's NPPs are in, or very close to areas which are officially designated as requiring specific monitoring for earthquakes (a high chance of an earthquake of magnitude 7 or greater.). Also one shouldn't forget nuclear facilities other than NPPs: for example, the complex at Rokkasho, including, or soon to include uranium enrichment, spent fuel storage, reprocessing, MOX fuel fabrication and maybe even the ITER nuclear fusion facility. But Rokkasho was very conveniently left off the list of areas requiring special earthquake monitoring. It was on the original draft list, but at the time it was thought to be too remote and irrelevant, even though the risk of an earthquake was no less than other areas. Well it has become more relevant since they fingered it to become the center of the nuclear fuel cycle.

I have mentioned the four classes of building and equipment. Some people might be interested to know what types of things are actually included in these classes. As one would expect, the reactor containment vessel and the spent fuel pit are in Class 'As'. But there are some surprises too. For example, the turbine and the turbine building of Pressurized Water Reactors, made famous in the recent Mihama-3 accident, are in Class 'C'. The Nuclear Safety and Industrial Agency has admitted that the secondary system (i.e. the turbine side) really should be taken seriously in future, so it will be interesting to see whether the impending revision of the current earthquake guidelines reflects this new awareness. I've heard nothing to suggest that it will though. Actually, I suspect they would very much like to keep Mihama-3 strictly separate from the issue of earthquakes. If they drag that in they might be forced to address the problem of aging reactors. In as much as Japan's reactors were designed to be resistant to earthquakes (dubious enough in itself), those designs only applied to new reactors. They provide very little insight into the ability of old, poorly maintained reactors, with pipes below the regulation thickness, to withstand an earthquake.

So returning to the question of how's the record, the visionaries might have understated the magnitude of the design basis earthquakes, they might have been a bit wayward in their classifications, they might have been a bit too optimistic about the durability of the reactors and they might even have missed a few active faults and earthquake zones here and there, but lets face it, no reactors have fallen over, no radiation has been released into the environment as a result of an earthquake, so what's all the fuss about? And in their defense, I return to my earlier point, namely that they were just trying to sell a great idea. No salesman is going to tell you that he's selling you a dud and no visionary technologist is going to tell you that we would have been better off without the industrial revolution. Give the guys a break. Break their bloody necks, I say.

So finally, what of the people in Kashiwazaki City and Kariwa Village? They have been through a terrible ordeal, albeit less terrible than for people in towns nearer to the epicenter. If the epicenter had been right under the NPP, there might well have been a nuclear catastrophe. In that case, the emergency systems would have failed totally. People were sleeping out of doors, in their cars, in tents and so on to get away from collapsed and collapsing buildings. The last thing they needed was to be forced indoors to escape a release of radiation. The train services and the roads were in chaos. How would they have escaped if a major evacuation from the area had been necessary? There are emergency procedures in place in regions which host nuclear facilities, inadequate though they may be, but the logic of a nuclear evacuation stands in total contradiction with the logic of an earthquake evacuation. Realizing this, some people appealed to Tokyo Electric Power Company (TEPCO) to shut down the reactors until things returned to normal. But TEPCO management, due to its unshakeable belief in its own technology, or else through sheer bloody-mindedness, kept them going. However, of this, not a peep from the media[5], so I doubt if many people in Tokyo were even aware that the power that supplied their TV sets, came from the region where the disaster was unfolding before their very eyes.

Philip White (NIT editor)

1. On November 4th, after this report was written, another tremor hit the region and Kashiwazaki-Kariwa reactor no. 7 scrammed. Tokyo Electric Power Company (TEPCO) says that the cause of the scram was a problem in the turbine. The other reactors continued to operate. The earthquake registered a magnitude of 5.2 and on the Japanese seven point seismic scale it registered 5 in Kariwa Village and 4 in Kashiwazaki.
2. Even though the Kashiwazaki-Kariwa nuclear power plant belongs to TEPCO, Niigata Prefecture is supplied by Tohoku Electric Power Company.
3. The Hamaoka NPP is right over the boundary of the Philippine and North American Plates (see map page on 5). In fact, it is sandwiched between three plates - the two just mentioned, plus the Eurasian Plate, with the Pacific Plate not far away. Hamaoka-5 is due to commence commercial operations in January 2005.
4. Gal is a measure of acceleration. 1 gal = 0.01 m/s2.
5. The media did, however, report on the reactor 7 scram, almost two weeks after the original earthquake.

We Oppose Removal and Dismantling of Tokai Reactor

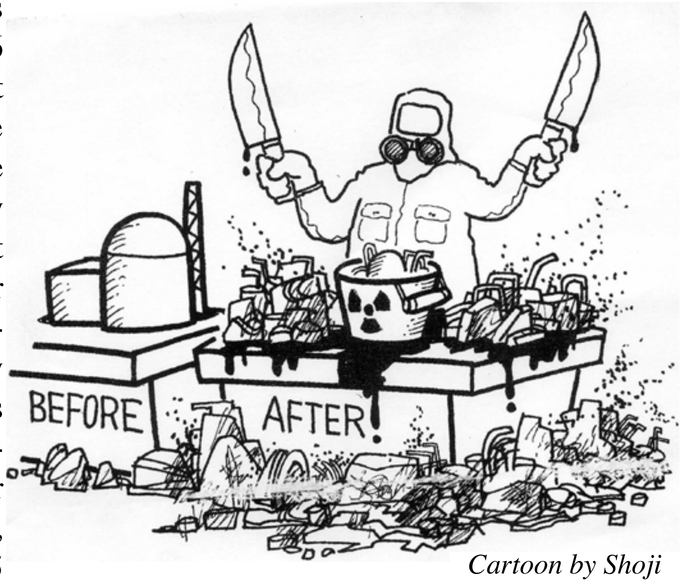
By Gan Nemoto (Ibaraki Anti-nuclear Collective)

The Japan Atomic Power Company's Tokai gas-cooled reactor (magnox, 166 MW), located about 120km north-east of Tokyo in Tokai Village, Ibaraki Prefecture is currently being dismantled. From the time it commenced commercial operations in July 1966, until it was shut down in March 1998, it operated for 215,320 hours and produced over 29 million MWh of electricity. It was operational for 77.5% of the time and had a capacity factor of 62%. During 31 years and 8 months of operation there were 61 officially acknowledged accidents and the reactor was down for a total of seven years. Based on these figures, it became old and unprofitable in a mere 25 years of operation. The reasons for the decision to close the reactor were economic - cost of replacing parts, escalating costs of maintenance and so on - but the company refuses to acknowledge that aging was a factor.

Other than Tokai, there are 37 gas-cooled reactors (GCR) worldwide. Twenty-four are no longer operating: eight in France, one in Spain, one in Italy and fourteen in England (as at the end of 2003). Of these, none has yet been dismantled, not even those which have been closed for more than twenty years. Tokai is the only one which is being dismantled, so it might be looked upon as a test case for other GCRs.

From the beginning we have publicly opposed the dismantling and removal of the reactor, on the grounds that this is both dangerous and expensive. At every opportunity we have demanded, and we continue to demand, that instead, the Tokai reactor should be sealed and monitored for the long term.

The program for dismantling the Tokai reactor is a long-term one, broken into four phases: phase one from 2001-2005, phase two from 2006-2010, phase three from 2010 to 2016 and finally, from 2015 to 2017, the building will be dismantled. Currently they are still in the first phase, removing instruments from within the turbine building. Over this extended period it is predicted that several thousand workers will be involved in the dismantling work, so worker radiation exposure will be a serious problem. The company has released no details about worker exposure. Most of the workers live in the surrounding area.



Cartoon by Shoji Takagi

Another big problem is the waste generated by dismantling the reactor. The total quantity of waste will be 180,000 tons, of which 18,000 tons will be radioactive waste. The theory is that eventually the radioactive waste will be buried, but there is no detailed plan for this and the question of where it will be buried has not been decided. Also the distinction between radioactive waste and general waste is vague. Waste which is really radioactive waste will be given a clearance and disposed of as industrial waste. The intention is to either bury this vast quantity of waste, or use it to pave roads. Metals will be reused. It is possible that before we know it, low level radioactive waste will have crept into our daily lives.

Another problem is the cost of dismantling the plant. Costs are estimated at 6.7 billion yen for phase one, 8 billion yen for phase two, 78 billion yen for phase three, for a total of 92.7 billion yen. That is two to three times the cost of the construction, but it doesn't include the cost of disposing of the radioactive waste, nor the cost of dealing with worker exposure and covering health costs. Funds have been reserved for dismantling, but the accumulated amount is only 51.9 billion yen. No decision has been made about how to make up the difference.

They have in mind building two 1,350 MW next generation reactors on the site of the dismantled reactor. At a time when nuclear power is in decline, they think they can go against the trend. It just shows how out of touch they are.

JCO Site

At the same time as all this is happening, a struggle is going on between the village, the company and the local people over the fate of the site of the 1999 criticality accident at the JCO uranium processing plant (see NIT 97, 102). We have supported calls from residents who don't want the accident to be forgotten and who want to preserve the site so that it can act as a warning in regard to nuclear development. Opinion is divided between those residents who support preservation and those who want the plant to be dismantled. Some people waver when the benefits of nuclear energy are expounded. Also, for many people, although five years have elapsed since the accident, at the bottom of their hearts the vivid memory of that fear remains. Some even say, "I feel sick every time I go past that building." But these villagers have solemnly stated that they want the site preserved and the documents and data to be put on display.

Prioritizing economic factors, the government and the nuclear industry jumped for nuclear energy and uncritically promoted development. As a consequence, the environment has been contaminated and people have lost their lives. Now, when they choose a site to dispose of their radioactive waste, they will impact upon people far away from nuclear power plants. The management of radioactive waste will be foisted onto the next generation. So as a caution against this too, the Tokai reactor must not be dismantled and removed. Along with the JCO plant, it must be preserved.

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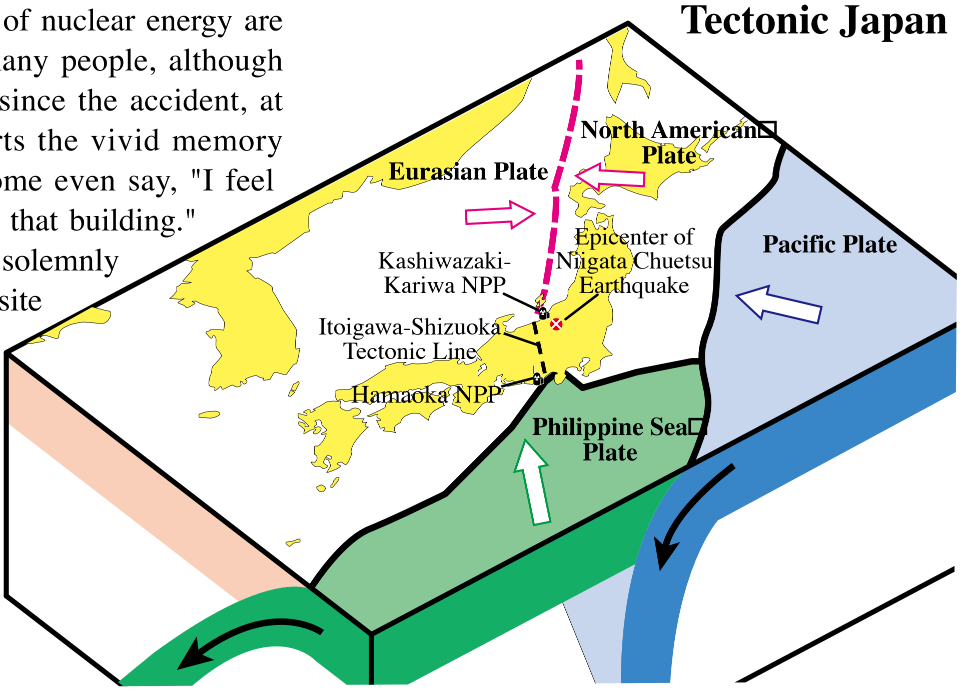
Rejects High-Level Radioactive Waste Disposal Facility

On September 16, the town council of Saga Town, Kochi Prefecture, decided to reject a petition submitted by some residents proposing that the town become a candidate site for a high-level radioactive waste disposal facility. The petition was submitted in December 2003 under the joint signatures of about 30 town residents. Four neighboring municipal councils had passed resolutions against the petition. On September 6 the Saga Town Fisherpeople's Cooperative had submitted a petition opposing the propos-

Tectonic Japan



Long-Term Nuclear Planning Committee Publishes Costs of Nuclear Fuel Cycle

Introduction

The Atomic Energy Commission's (AEC) Long Term Nuclear Program sets out Japan's basic policy on the research, development and utilization of nuclear energy. A review of this program commenced in June (see NIT 101). In the context of this review, a comparison was made of the costs of the nuclear fuel cycle, considering two basic methods of dealing with spent fuel: reprocessing and direct disposal (deep burial). This article discusses this cost comparison.

Why compare costs now?

Japan's basic policy is to reprocess all spent fuel. As of July, construction of the Rokkasho Reprocessing Plant in Aomori Prefecture is 95% complete. Given that construction is so far advanced, why was a cost comparison carried out now? Likely reasons are as follows:

1) At the end of last year the Ministry of Economy Trade and Industry's (METI) Electricity Industry Committee revealed that the total backend costs of reprocessing would come to an enormous 18.8 trillion yen.

2) Costs of the direct disposal option were previously calculated in the 1990s by METI (when it was still MITI), the electric power industry and AEC, but the results were kept secret. This fact came to light this summer. At the same time it was also revealed that they had covered up the fact that the direct disposal option came out cheaper.

But beneath all this lies the fact that the fast breeder reactor program shows no signs of going ahead and there is a uranium surplus. Therefore, not only opponents of nuclear energy, but even supporters can see that the reprocessing policy is inappropriate.

Cost comparison of reprocessing and direct disposal

In order to make the comparison, first the costs of direct disposal were calculated, in light of overseas experience and Japan's own glass canister technology. In all, eight disposal methods were costed. The methods varied according to whether the canisters were to be buried in soft or hard rock, horizontally or vertically, at one disposal site or two, and containing two fuel assemblies or four. Thus a range of costs was produced. The cheapest method was to horizontally bury canisters containing four spent fuel assemblies. This came to 3,835 billion yen, assuming disposal in soft rock. The most expensive method was to vertically bury canisters containing two spent fuel assemblies. This came to 9,463 billion yen, assuming disposal in soft rock at two different sites.

Next, costs over a 60-year period for four scenarios were calculated and compared (table 1). (In these calculations, only five vertical disposal methods were considered.) In regard to the nuclear fuel cycle, the result was that the direct disposal option was 0.5~0.7 yen per kilowatt hour cheaper than the reprocessing option. This might not seem like a big difference, but in fact it is. If one considers the total cost, it works out at 121 trillion yen for reprocessing all the spent fuel, compared to 108.1~116.6 trillion yen for direct disposal. Thus the maximum difference works out at 13 trillion yen.

So does that mean AEC will shift its policy to direct disposal? Well, no. In addition to these calculations, they also calculated the 'cost of a change of policy'. This includes (1) as unrecoverable costs, investments already sunk into the Rokkasho Reprocessing Plant plus the cost of dismantling the plant, and (2) the cost of additional thermal power supply to cover the shortage of electric power. This is because it is assumed that if the Rokkasho Plant doesn't go ahead, there will be nowhere to store the spent fuel and nuclear power plants will be shut down. These costs are around 0.2 yen/kWh and around 0.7~1.3 yen/kWh respectively. If these costs are added to the costs of direct disposal and interim storage, in the case of direct disposal the total works out at 5.4~6.2 Yen/kWh, which is more expensive than the approx. 5.2 Yen/kWh for full reprocessing.

But there is a trick in this line of reasoning. It is certainly necessary to consider the cost of changing policy, but this is the result of the failure of a program promoted by the national government and the power companies, so they should foot the bill. It isn't a cost that consumers should have to pay in their electricity rates. Furthermore, in regard to (2), fuel costs and the cost of CO_2 abatement measures (emissions trading price) are calculated not just on the basis of the cheapest alternative, LNG. Coal and oil are also included in the calculation. This is very strange. Given that the impact of the failure of this program will be felt throughout the country, it is important to keep the costs as low as possible. Despite this, they have used high prices in their calculations.

Final Remarks

Promoters of nuclear energy have always strongly maintained that "nuclear power is economically viable", but now they have changed their tune to "economic viability isn't everything". But whether they really believe that reprocessing will succeed is unclear. The government doesn't want to admit its policy failure and power companies are profit oriented. They no doubt think that if reprocessing fails, the government will come to their rescue. Beneath the surface, the Long-Term Nuclear Program Planning Committee is putting off the final decision and trying to shove the blame onto someone else.

Tadahiro Katsuta (CNIC)

Table 1: Calculation Results (in Yen/kWh)

	Full Reprocessing (3)	**Partial Reprocessing** (4)	**Direct Disposal of all Spent Fuel** (5)	**Interim Storage** (6)
Generation Cost (1)	Around 5.2	Around 5.1	Around 4.5-4.7	Around 4.7-4.8
Nuclear Fuel Cycle Cost (2)	Around 1.6	Around 1.4-1.5	Around 0.9-1.1	Around 1.1-1.2
Front End	0.63	0.63	0.61	0.61
Back End	0.93	0.77-0.85	0.32-0.46	0.48-0.55

Notes regarding table 1:

(1) The figure used for the difference between the generation cost and the nuclear fuel cycle cost (3.6 Yen/kWh) was calculated by METI's Electricity Industry Committee.

(2) The economic value of the depleted uranium and the recovered uranium was not calculated. The economic value of plutonium is taken to be zero.

(3) All Spent Fuel will be reprocessed. The amount in excess of reprocessing capacity will be reprocessed after interim storage. A second commercial reprocessing plant will be built.

(4) Spent Fuel will be reprocessed, but the amount in excess of reprocessing capacity will be directly disposed of after interim storage. No second commercial reprocessing plant will be built.

(5) After interim storage, all spent fuel will be directly disposed of.

(6) Spent fuel will be stored for the time being. A decision about what to do with it will be made at an appropriate time in the future.

(For more details see the following page on our web site:
http://cnic.jp/english/data/longterm12Nov04.html)

Workers' Radiation Exposure at Japanese Nuclear Facilities

In July this year the Nuclear and Industrial Safety Agency (NISA) released figures relating to the radiation doses received by workers at Japanese nuclear facilities during the 2003 business year (April 2003 - March 2004). The report is entitled Situation Regarding Management of Radioactive Waste and Management of Radiation Doses of Workers in Radiation-Related Industries (our translation).

As can be seen from the first chart, total doses increased compared to 2002. It was pointed out at the April 2002 Meeting of Contracting Parties under the Convention on Nuclear Safety that radiation doses in Japan were the highest in the world. Nothing in the latest figures would suggest that Japan will be able to report an improvement at the next meeting, which is to be held in 2005.

In the total increase of 11.7 person-sieverts, there was an increase of 11 person-sieverts at Boiling Water Reactors alone. The major cause was continuing work flowing from the TEPCO cover-ups revealed in 2002. This work included such things as inspections and the replacement of shrouds and recirculation pipes.

Comparing the NISA figures for the 15-20mSv and the 20-25mSv ranges with data compiled for nuclear power plant workers by the Radiation Effects Association, we see that the latter estimates are much higher. The REA estimates were 1,038 (15-20mSv) and 6 (20-25mSv) NPP workers respectively. This is because they take into account the fact that some people worked at more than one nuclear power plant.

As always, subcontractor workers bore the overwhelming bulk of the total dose and represented the overwhelming majority of the workers exposed.

Mikiko Watanabe (CNIC)

Annual Worker Exposure at Nuclear Power Plants 1991-2003 (including Fugen and Monju)

Year	Total Exposure (person sieverts)			Number of People		
	Power Company	*Sub-contractors*	***Total***	*Power Company*	*Sub-contractors*	***Total***
1991	2.86	56.06	58.92	6,646	50,597	57,243
1992	2.92	63.53	66.45	7,002	56,806	63,808
1993	2.98	86.4	89.38	7,692	63,588	71,280
1994	2.66	64.63	67.29	8,030	62,456	70,486
1995	2.97	63.87	66.84	8,111	62,354	70,465
1996	3.15	69.32	72.47	8,357	63,739	72,096
1997	3.2	80.33	83.53	8,455	66,073	74,528
1998	3.23	71.81	75.04	8,303	59,959	68,262
1999	3.23	81.33	84.56	8,406	63,274	71,680
2000	3.31	77.93	81.24	8,499	60,290	68,789
2001	3.53	76.47	80	8,540	57,420	65,960
2002	3.55	81.62	85.17	8,394	57,400	65,794
2003	3.86	93	96.87	8,550	59,813	68,362

Worker Exposure at Reprocessing Plants in 2003

Plant Name	Category	Distribution of exposure (people)				Total Exp.	Avg. Exp.	Max. Exp.
		~ 5mSv	5~10mSv	10~15mSv	15mSv ~	(person Sv)	(mSv/person)	(mSv)
Tokai-mura	Repro. Co.	492	0	0	0	0.05	0.1	4.3
	Sub-con.	1,614	3	0	0	0.15	0.1	6.2
	Total	2,106	3	0	0	0.2	0.1	6.2
Rokkasho	Repro. Co.	618	0	0	0	0.04	0.1	3.8
	Sub-con.	3,369	46	1	0	1.84	0.5	10.1
	Total	3,987	46	1	0	1.88	0.5	10.1
Total	Repro. Co.	1,110	0	0	0	0.09	0.1	4.3
	Sub-con.	4,983	49	1	0	1.99	0.4	10.1
	Total	6,903	49	1	0	2.08	0.3	10.1

Worker Exposure at Nuclear Power Plants in 2003

NPP Name	**Category**	**Distribution of exposure (people)**						**Total Exp.**	**Avg. Exp.**	**Max. Exp.**
		~ 5mSv	5~10mSv	10~15mSv	15~20mSv	20~25mSv	25mSv ~	(person Sv)	(mSv/person)	(mSv)
Tokai	EPCO	292	0	0	0	0	0	0.00	0.0	0.1
	Sub-con.	694	0	0	0	0	0	0.02	0.0	2.7
	Total	986	0	0	0	0	0	0.02	0.0	2.7
Tokai II	EPCO	396	0	0	0	0	0	0.21	0.5	4.1
	Sub-con.	3,298	123	8	0	0	0	3.02	0.9	13.1
	Total	3,694	123	8	0	0	0	3.23	0.8	13.1
Tsuruga	EPCO	422	1	0	0	0	0	0.21	0.5	5.5
	Sub-con.	3,283	106	5	2	0	0	3.07	0.9	17.6
	Total	3,705	107	5	2	0	0	3.28	0.9	17.6
Onagawa	EPCO	407	0	0	0	0	0	0.08	0.2	3.3
	Sub-con.	2,158	91	52	23	0	0	2.64	1.1	19.0
	Total	2,565	91	52	23	0	0	2.72	1.0	19.0
Fukushima I	EPCO	879	42	0	0	0	0	0.97	1.0	9.9
	Sub-con.	7,438	936	421	193	0	0	21.66	2.4	19.4
	Total	8,317	978	421	193	0	0	22.63	2.3	19.4
Fukushima II	EPCO	628	1	0	0	0	0	0.19	0.3	5.9
	Sub-con.	5,363	421	169	18	0	0	8.24	1.4	19.8
	Total	5,991	422	169	18	0	0	8.43	1.3	19.8
Kashiwazaki Kariwa	EPCO	983	9	2	0	0	0	0.53	0.5	14.1
	Sub-con.	5,385	478	290	178	0	0	13.78	2.2	19.7
	Total	6,368	487	292	178	0	0	14.31	2.0	19.7
Hamaoka	EPCO	708	6	0	0	0	0	0.44	0.6	9.7
	Sub-con.	3,543	390	289	118	0	0	10.61	2.4	19.2
	Total	4,251	396	289	118	0	0	11.05	2.2	19.2
Shika	EPCO	272	2	0	0	0	0	0.10	0.4	6.8
	Sub-con.	1,801	186	32	16	0	0	3.25	1.6	18.0
	Total	2,073	188	32	16	0	0	3.36	1.5	18.0
Shimane	EPCO	331	7	0	0	0	0	0.29	0.9	9.1
	Sub-con.	2,226	210	63	8	0	0	4.01	1.6	17.2
	Total	2,557	217	63	8	0	0	4.30	1.5	17.2
Tomari	EPCO	301	0	0	0	0	0	0.05	0.2	4.2
	Sub-con.	1,626	28	7	1	0	0	1.24	0.8	15.2
	Total	1,927	28	7	1	0	0	1.30	0.7	15.2
Mihama	EPCO	403	1	0	0	0	0	0.12	0.3	5.2
	Sub-con.	2,810	102	8	0	0	0	2.68	0.9	13.5
	Total	3,213	103	8	0	0	0	2.80	0.8	13.5
Takahama	EPCO	473	3	0	0	0	0	0.15	0.3	5.4
	Sub-con.	3,149	220	35	3	0	0	4.63	1.4	16.4
	Total	3,622	223	35	3	0	0	4.77	1.2	16.4
Ohi	EPCO	485	2	1	0	0	0	0.22	0.5	10.2
	Sub-con.	2,740	227	57	13	0	0	4.81	1.6	18.6
	Total	3,225	229	58	13	0	0	5.03	1.4	18.6
Ikata	EPCO	400	1	0	0	0	0	0.09	0.2	5.8
	Sub-con.	2,254	108	28	2	0	0	2.62	1.1	17.5
	Total	2,654	109	28	2	0	0	2.71	1.0	17.5
Genkai	EPCO	461	0	0	0	0	0	0.06	0.1	3.9
	Sub-con.	2,802	130	3	0	0	0	2.73	0.9	12.0
	Total	3,263	130	3	0	0	0	2.79	0.8	12.0
Sendai	EPCO	247	4	1	0	0	0	0.09	0.4	10.3
	Sub-con.	1,845	182	45	2	0	0	3.59	1.7	15.9
	Total	2,092	186	46	2	0	0	3.68	1.6	15.9
Total Commercial	EPCO	8,088	79	4	0	0	0	3.80	0.5	14.1
	Sub-con.	52,415	3,938	1,512	577	0	0	92.60	1.6	19.8
	Total	60,503	4,017	1,516	577	0	0	96.41	1.4	19.8
Fugen	EPCO	143	1	0	0	0	0	0.06	0.4	5.4
	Sub-con.	684	15	2	0	0	0	0.40	0.6	11.2
	Total	827	16	2	0	0	0	0.46	0.5	11.2
Monju	EPCO	234	0	0	0	0	0	0.00	0.0	0.0
	Sub-con.	670	0	0	0	0	0	0.00	0.0	0.0
	Total	904	0	0	0	0	0	0.00	0.0	0.0
Grand Total	EPCO	8,465	80	4	0	0	0	3.86	0.5	14.1
	Sub-con.	53,769	3,953	1,514	577	0	0	93.00	1.6	19.8
	Total	62,234	4,033	1,518	577	0	0	96.87	1.4	19.8

Interim Report on Mihama-3 Accident

The inescapable conclusion that must be drawn from the Mihama-3 accident is that the full length of the piping in nuclear power plants must be checked at regular intervals. This, however, is a conclusion that the nuclear regulators and the government want to avoid at all costs.

NISA's Interim Report

The Nuclear and Industrial Safety Agency (NISA) released its interim report on the accident on September 27th and the Nuclear Safety Commission (NSC) released an interim report on October 21st. This article focuses on NISA's report, with comments about NSC's report in the 'Further Details' box on pages 6 and 7 (FD 1,5).

NISA concludes that the maintenance guidelines (FD 2) for pipes in the secondary system of Pressurized Water Reactors (PWR) are 'generally appropriate' and claims that data submitted by power companies indicates that, with some exceptions, thinning of pipe walls has proceeded no faster than predicted. However, a closer look at the data provided by power companies suggests that one should not place too much confidence in NISA's sanguine assessment.

Two days after the accident NISA requested power companies to report on the status of monitoring of the thickness of pipe walls in their power plants. (Had all locations that should have been listed for inspection in fact been listed and duly inspected?) As if as an afterthought, it also requested data on the thickness of pipe walls, though there is no publicly available documentary record of this request. NISA claims to have obtained data on the thickness and the rate of thinning of pipe walls at a single point in each of 21 PWRs and 27 BWRs, as well as at 38 locations in the Mihama-3 reactor. Selection of the locations was left up to the power companies. One would not expect the power companies to provide information that incriminates them if they could avoid it, so clearly general conclusions based on this meagre data should be treated with caution.

NISA's Recommendations

Nevertheless, NISA asserts that in the majority of cases thinning has proceeded no faster than the predicted rate and sees no reason why the exceptions should cause any problems (FD 3). It concludes that the current guidelines are 'generally appropriate', but recommends that, just to be sure, new guidelines should be developed based on international experience and data compiled over the years. These new guidelines should be developed in a transparent manner by a neutral organization. (No mention is made of public involvement in developing the guidelines.) Standards currently being developed by the Japan Society of Mechanical Engineers (JSME) for management of pipe thickness in power plants should also be implemented when they are completed.

Investigations into the mechanism and underlying causes of the accident will continue, but some major factors have already been identified. These include quality control and communication failures by the owner of the Mihama Nuclear Power Plant, Kansai Electric Power Company (KEPCO), and its subcontractors. Measures should be taken to rectify these failures.

A final report is expected by the end of the year, but it is important to adopt measures as soon as possible to prevent a recurrence of this accident.

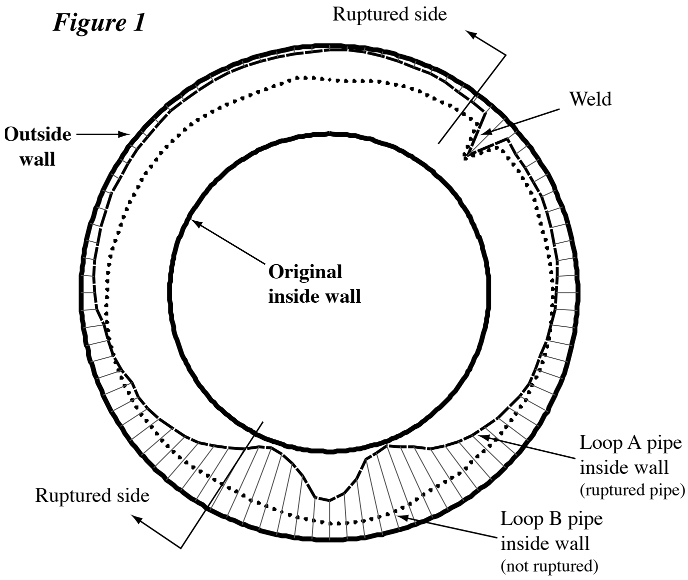
Comments on Interim Report

The phrase 'generally appropriate' ('oumune datou/tekisetsu' in Japanese) and other similar expressions recur throughout the report. Apparently they are used to allay any safety concerns the reader might have. In fact, they have the opposite effect, because they point to the existence of exceptions. Is not the whole purpose of the inspection regime to ensure that no pipes burst? It is not good enough to ensure that 80%, or 90%, or even 99.9% of pipes don't burst. It only takes one burst pipe to cause a catastrophe. But the authors of the report hope to convince us that the problems are *only* exceptions and that by and large there is nothing much wrong with the status quo. Companies that were not directly involved in this particular accident are spared criticism. The situation in regard to Boiling Water Reactors receives scant attention, even though the problem of pipe wall thinning has begun to emerge there also, notably at the Onagawa and Fukushima-I power plants. All the blame is focused on KEPCO and its subcontractors, Mitsubishi Heavy Industries and Nihon Arm. In sum, language is used to confine the blame and thus limit the political fallout, so that the nuclear industry can continue to operate without suffering serious disruption.

But the principles involved in the Mihama-3 accident are not so easily confined. Pipe wall thinning in nuclear reactors has occurred at varying rates over time, at varying rates for identical pipes, and even at varying rates for different points around the diameter of a single location (figure 1). Despite all the research that has been carried out in order to elucidate the mechanism of the erosion/corrosion process (FD 4), which is thought to be the culprit in this case, the mechanism involved is still not fully understood. A predicted rate of thinning is used when determining the life expectancy of pipes, but this rate has no scientific basis. There are plenty of exceptions, but these are said to fall within the range of error, or are discounted altogether. Under these circumstances it is impossible to claim that any location is safe unless it has been checked recently. NISA has been forced to accept that there are variations in the rate of pipe wall thinning and that the phenomenon of localized thinning is a problem for the inspection regime. The data leaves it with no choice. But it refuses to draw the logical conclusion - that the full length of the piping must be inspected regularly.

Other than its recognition of localized thinning, the interim report contains one other important recognition. It plainly states that since one role of the secondary system is to remove heat produced by the reactor, from the point of view of safety it is necessary to recognize that

Figure 1



Comparison of thinning of A & B loop pipes
Cross-section viewed from upstream
(Original outer diameter 560mm, thickness 10mm)

the primary and secondary systems are part of a total system. This would seem to be obvious, but since the low priority given to the secondary system was one factor leading to the Mihama-3 accident, it is important that this historical neglect be reversed. One wonders, however, whether the message has got through to KEPCO. The General Manager is reported to have said that the accident was just a workers' compensation case. Clearly he didn't see the connection with reactor safety.

The other outstanding feature of NISA's report is its studied avoidance of self-criticism. NISA and its parent body the Ministry of Economy, Trade and Industry (METI - formerly MITI) were responsible for approving the original licenses for all nuclear power plants. In approving these licenses they share blame with regulators throughout the world for failing to recognize the problem of erosion/corrosion-induced thinning. Then when this problem came to light, particularly after the 1986 Surry accident, they claimed that accidents such as this couldn't happen in Japan. It was they who established the regulatory regime and they were the ones who supposedly checked that inspections were carried out properly. However nothing about their errors of judgment, their complacency and their regulatory failures appears in the interim report.

The interim report speaks of the need for NISA to remind the power companies of their responsibilities and to confirm that they are doing the right thing, but the focus is on what the power companies, particularly KEPCO, ought to do, rather than on what NISA ought to do. The things that the power companies ought to do mostly relate to quality control. They are things that they were already required to do, either legally, or as a common sense corollary of their legal obligations. Indeed, as recently as May this year NISA approved an amendment to the Mihama-3 license that included obligations which KEPCO failed to fulfill. In this regard, the interim report refers specifically to the issue of management of the subcontracting process. All this begs the question: what guarantee is there that the power companies will fulfill their obligations any better in future and why should we believe that NISA's oversight will be any more effective than it was in the past?

Conclusion

Perhaps all the references to the things that NISA needs to 'confirm' ('kakunin' in Japanese) can be interpreted as a tacit admission that it failed to confirm these things in the past. If so, we would prefer that NISA admitted its failure more directly. However, to expect direct admissions of failure would be to misunderstand the process. This interim report is not about getting to the bottom of the Mihama-3 accident. It is about political damage control. NISA will remain steadfast and true to its principal mission, which is to keep the nuclear industry going. Admissions of failure would not serve this purpose, so NISA will not provide any. Nor will it recommend measures that would make nuclear energy prohibitively expensive, so most of the piping in nuclear power plants will remain unchecked.

To us all this is plainly ludicrous. The challenge is to make more and more people aware of this fact. Perhaps when NISA and the nuclear industry become a public laughing stock, we will be well on the way to eliminating nuclear energy. However that may be, CNIC and others are holding meetings with NISA in order to get to the bottom of the matter and to ensure that superficial reports are exposed for what they are.

Philip White (NIT Editor)

Some Further Details

FD 1: After the accident NISA convened the Mihama Nuclear Power Plant, No. 3 Reactor, Secondary System Pipe Rupture Accident Investigation Committee (our translation). NSC convened another committee with a name barely distinguishable from that of the NISA committee and both committees have now produced interim reports. NSC's report basically assesses the appropriateness of the findings of NISA's report, so we will only comment on points where they add something new or are critical of NISA's report (see TD 5). In addition to these two committees, NISA also requested the Japan Atomic Energy Research Institute (JAERI) and Japan Nuclear Energy Safety Organization (JNES) to investigate the mechanism involved in this accident. Some of their findings are included in NISA's interim report and they are still following up other issues. The Fukui Police are investigating the accident to see if charges should be laid, so presumably a report will come out of that process too.

FD 2: The current maintenance system for PWR secondary system pipes is based on guidelines introduced in May 1990. Originally, inspections covered by these guidelines were 'voluntary', but they were made mandatory under the Electric Utilities Industry Law in October last year. These guidelines distinguish: (a) key locations, which require regular checks; (b) locations which may be checked on a 'sampling' basis; and (c) locations which don't need to be checked at all. Those locations checked on a 'sampling' basis should be checked at a rate of 25% of the total area over a period of 10 years.

This means that some locations listed for sampling might not be checked for 40 years. The method by which the thickness of pipe walls should be measured is not specified, but in practice four to eight points on a given cross section of pipe are subjected to ultrasound checks. Where measurements indicate that pipe walls are thin enough to be of concern, more detailed checks are carried out around that location. NISA's interim report recommends that, in the course of revising the guidelines, the method by which these measurements are carried out should be included.

FD 3: NISA's reasoning is as follows:

An initial rate of thinning is set. For locations that are checked regularly this rate and the predicted life expectancy of the pipe can be revised if the first check, or subsequent checks reveal that actual thinning is proceeding at a faster rate. As long as checks are scheduled with sufficient leeway and pipes are fixed or replaced as necessary, no safety problems should arise. Indeed, in the case of the Mihama-3 accident, subsequent calculations show that the actual rate of thinning was very close to the predicted rate (0.47×10^{-4} compared to 0.45×10^{-4} mm/hour, based on a minimum thickness of 0.6 mm at the time of rupture). The problem in this case was not that the predicted rate of thinning was wrong. It was rather that the pipe was never checked. For locations checked on a sampling basis, NISA takes that view that where necessary the schedule can be brought forward. NISA also concedes that it might be necessary to add some extra locations to the list of locations subject to regular checks, but nowhere do they acknowledge that sampling per se is an inappropriate method.

FD 4: Erosion/corrosion has been identified as the process that weakened the pipe which burst at Mihama-3. Evidence for this includes the scaly appearance of the interior of the burst pipe, the location of the rupture just downstream from a turbulence-inducing fixture ('orifice' - see NIT 102), and the fact that the temperature of the pressurized water at the point of rupture (around 140^{0}C) was within the range where erosion/corrosion typically occurs. The pipe involved in the Mihama-3 accident was a carbon steel alloy. It is well known that these pipes are prone to erosion/corrosion. Although the mechanism has not been fully described, in broad terms the process is well known. In the first place a layer of metal oxide forms on the inside of the pipe. Because this layer is chemically inert it protects the underlying metal from corrosion, but erosion of this layer can be exacerbated by such things as turbulent flow. Once the surface has been eroded, corrosion proceeds until a new layer of metal oxide forms. The pipe gradually thins as this process is repeated over and over again.

The ruptured pipe at Mihama-3 was just 0.4 mm at the thinnest place. Allowing for stretching, it might have been a little thicker at the time of rupture. However, considering that the regulatory limit is 4.7 mm, it is no surprise that a pipe this thin and under 10 atmospheres pressure should burst. Nevertheless, we wonder whether there might not have been some other catalyst. Was there any manipulation or mechanical fault that triggered the accident, right at the time when preparations were being made for a periodic inspection? The interim report provides no clues to help answer this question.

FD 5: Some findings from NSC's interim report:

- The mechanism of the pipe rupture is not yet understood, so investigations into this matter should continue.
- Did pipe wall thinning alone really cause the accident with no other trigger mechanism? The sequence leading from pipe thinning to rupture should be clarified.
- NISA concluded that failure to monitor pipe thickness was the direct cause of the accident, but the sequence of events which caused this failure needs to be clarified.
- NSC believes in an audit approach to regulation. It believes that confirming the effectiveness of the company's own quality control system is more important than strengthening regulations and confirming compliance with standards.

Our response to these recommendations is that, even where they are desirable in themselves, we doubt whether some of them are achievable. In the end we conclude that ensuring the safety of nuclear power plants is actually an impossible task.

Anti-Nuke Who's Who

Shoji Takagi always does things in his own time

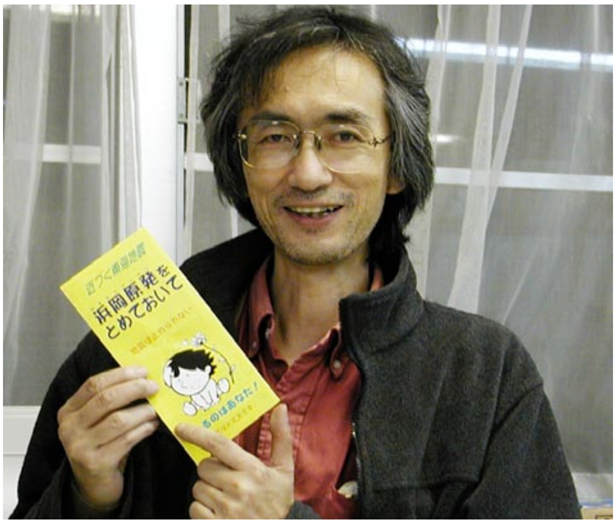
by Yukiko Mukai, Stop Nuclear Energy Saitama Liaison Group

Me write an article introducing Shoji Takagi? CNIC asked me to do it, but I'm in a bind. How do you get a handle on someone like Shoji Takagi? There's nothing to grab hold of. He's great at drawing illustrations. He's second to none at making banners and placards. But if you ask what his real line of work is, the answer has to be 'anti-nuclear energy activist'. He draws illustrations and makes banners to oppose nuclear energy. He'll go anyway to oppose nuclear energy, from Hokkaido in the north to Kyushu in the south. If he can't go there, he'll make a phone call. Though often you can't reach him on the phone, because he hasn't paid his phone bill.

He acts as a go-between for groups of all shades for the sake of the anti-nuclear cause. I would like to say that he doesn't shirk from hard labor for the sake of the anti-nuclear cause, but that wouldn't be strictly true. "Oh no, Shoji's illustration hasn't arrived. Without that we can't print the leaflet. We'll have to change our schedule." You can try to pressure him, but he always does things in his own time: no rush, no panic. He comes into his own in negotiations with Tokyo Electric Power Company, or with government agencies. He remains completely unruffled as he presses his questions.

He never gives up and never becomes pessimistic. Whenever there's an accident or a cover-up is discovered, he immediately launches a protest action. It's hard to rush into action on weekdays, but he will always ask people to get involved. Some can only take part once in a while, but as long as there are a few willing people, Shoji will start the ball rolling.

For many years Shoji hasn't looked after himself properly, so he's not very healthy. The Chuetsu region of Niigata Prefecture, scene of the recent spate of earthquakes, is home to some of Shoji's anti-nuclear friends. When the earthquake struck, Shoji couldn't restrain himself. He just had to go there. If he was strong and in



good health, or if he had lots of money, perhaps he would have been of some use, but as it is, he meets none of these criteria. As a friend, I warned him that he would just be a nuisance, but he wouldn't listen.

I've been poking fun at him, but actually I met Shoji Takagi through Jinzburo Takagi's 'Anti-Nuke Delivery' lectures (NIT No. 2, Dec. 1987). Both Shoji and I, along with most of those who attended these lectures, found out about Japan's nuclear reactors in the wake of the Chernobyl accident. Aghast at the number of reactors in Japan, we thought, "This is no good. Something has to be done about it." But being allergic to science, and faced with all that jargon, I soon dropped out. I concluded that what's bad is bad and what's dangerous is dangerous, but gave up ever being armed with theory. Rather, I decided to let my activism remain at an emotional level. I suspect that Shoji felt much the same. But things are different now. He put everything he had into studying and gathering information about his opponent's intentions, so that now his knowledge about nuclear energy is amazing. He's also an expert on the particular circumstances of all the local regions. So a huge gap has opened up between us. Now I want to do whatever I can to help Shoji, who *is* armed with theory, in his activism.

The cartoons in the last few editions of NIT were drawn by Shoji Takagi.

NEWS WATCH

Hitachi Joins in the Development of ESBWR in the U.S.

Hitachi Industries Co., Ltd. recently revealed that it would take part in the development of a next generation reactor in the United States. The reactor, known as the European Simplified Boiling Water Reactor (ESBWR), is a natural circulation type based on the BWR, with an output of around 1,400 MW. GE has already completed the basic design. It is expected to file an application for design certification to NRC next year and complete technical development by 2010.

Hitachi has also been working on the development of the Advanced Canadian Reactor (ACR) (700 MW) jointly with Atomic Energy of Canada, Ltd. and Bechtel and Dominion Resources of the United States. It is hoping to win orders in the US and China.

Mitsubishi to Tender for New Reactors in China

Mitsubishi Heavy Industries, Ltd. (MHI) revealed in October that it had received an official request for proposal from China in regard to the international bidding for four reactors: two 1,000 MW Pressurized Water Reactors each for the planned Sanmen and Yangjian nuclear power plants.

MHI plans to form a consortium with Westinghouse and Bechtel, and bid for them with the Westinghouse designed AP 1000 (Advanced Passive 1000).

Government/Industry Panel Formed to Discuss Reactor Export

On November 5, the Ministries of Economy, Trade and Industry (METI), Foreign Affairs (MFA) and Education, Culture, Sports, Science and Technology (MEXT), and Japan Atomic Industrial Forum, Inc. (JAIF) launched a "Panel on an International Vision for Nuclear Power". Members include executive officers of power companies, manufacturers, trading companies, the Japan Bank for International Cooperation, as well as people from the mass media, lawyers and academics. The Panel is scheduled to compile a report by January next year.

Meetings are closed. Discussions will relate to issues necessary for arranging a system to allow Japanese manufacturers to export whole nuclear plants, rather than just parts. Topics listed include indemnity, safety regulations, security measures, infrastructure development, and financing.

Target countries include Vietnam and Indonesia. It is believed that consideration is being given to the export of reactors in the 300 to 400 MW range.

METI Launches a Study Group for Developing Energy Businesses in Asia

On October 13 the Ministry of Economy, Trade and Industry launched a Study Group for Developing Energy-Related Businesses in Asia. Membership consists of electric power, gas, oil, heavy electrical machinery and trading companies, as well as METI. This is a part of the Asia Energy Partnership Task Force that METI set up within the ministry this summer. The group is expected to explore possibilities for developing a wide-range of energy business areas, including electric power, nuclear power, clean coal technology, gas supply, oil, energy service companies (ESCO), cogeneration and renewable energy.

FNCA Holds First Study Panel Meeting

The Forum for Nuclear Cooperation in Asia (FNCA), organized by Japan's Atomic Energy Commission, held its first study panel meeting in Tokyo on October 20-21. Its theme was "the Role of Nuclear Energy in the Sustainable Development of Asia." In addition to Japan, China, Indonesia, Korea, Malaysia, Philippines, Thailand and Vietnam participated. Reports were presented by five countries, including China and Indonesia, on their mid- and long-term energy plans and trends in nuclear development.

China reported that by 2020 it would increase nuclear power capacity to 36 GW, aiming to increase the share of nuclear power in the total generated output to 4%. Indonesia reported that Badan Tenga Atom Nasional (Atomic Energy Agency or BATAN) proposed to the government that it would commence operations at its first nuclear power reactor by 2016.

Saga Town

News Watch continued on page 5

Updated Plutonium Inventory

In NIT 102 we presented data on Japan's plutonium inventory for the 2003 business year. Since then, on September 21st the government published data for the 2003 calendar year. It is, in fact, more detailed than ever before, specifying for the first time how much of the plutonium is fissile. Japan has published data on its plutonium holdings since 1993. In this table we have only included the data from 1996.

Plutonium Holdings (kg at year end)

		1996	1997	1998	1999	2000	2001	2002	2003
1. Separated Plutonium									
Reprocessing Plant	plutonium nitrate	384	385	384	375	365	539	545	478
	plutonium oxide	217	153	154	154	217	303	260	218
	Total	602	538	537	528	582	842	806	695
	Total Fissile Plutonium							551	474
Fuel Fabrication Plants	plutonium oxide	2,346	2,553	2,737	2,652	2,515	2,323	2,530	2,465
	testing and fabrication stage	786	726	473	481	539	551	506	739
	fabricated fuel	411	370	386	358	360	420	308	331
	Total	3,543	3,649	3,596	3,491	3,413	3,294	3,344	3,536
	Total Fissile Plutonium							2,358	2,488
In Nuclear Reactors	Joyo	48	23	2	38	18	64	29	18
	Monju	367	367	367	367	367	367	367	367
	Fugen	43	0	34	0	0	0	0	0
	power reactors in use				465	465	670	416	415
Research and Development	critical assemblies	429	429	429	428	440	444	445	445
	Total	887	819	832	1,298	1,290	1,546	1,256	1,244
	Total Fissile Plutonium							936	928
Total			5,006	4,965	5,318	5,285	5,681	5,405	5,475
Total Fissile Plutonium								3,844	3,889
2. Use Status									
Supply	recovered	605	133	1	0	63	86	180	167
	transferred from overseas	0	0	0	0	0	0	0	0
Used	Monju etc.	178	-10	-183	85	125	187	14	270
3. Plutonium Oxide Held Overseas									
Overseas Stockpile	UK	2,437	3,549	6,109	6,957	10,118	10,713	11,640	13,614
	France	12,653	15,534	18,290	20,639	21,953	21,666	21,611	21,554
	Total	15,090	19,083	24,398	27,596	32,070	32,379	33,251	35,168
	Total Fissile Plutonium							22,554	23,838

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. Please write to us for a subscription (Regular subscriber - $30 or ¥3,000/year; supporting subscriber $50 or ¥5,000/year). When paying in Japan, the subscription fee should be remitted from a post office to our post office account No. 00140-3-63145, Genshiryoku Shiryou Jouhoushitsu. Due to costly processing fees on personal checks, when sending the subscription fee from overseas, please send it by international postal money order. We would also appreciate receiving information and newsletters from groups abroad in exchange for this newsletter.

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