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Special Edition

Includes translation of Japanese Leaflet released by *KK Scientists* on 24 February 2008

We demand that the Kashiwazaki-Kariwa Nuclear Power Plant be closed

The *Group of Concerned Scientists and Engineers Calling for the Closure of the Kashiwazaki-Kariwa Nuclear Power Plant (KK Scientists)* was formed shortly after the Chuetsu-oki earthquake.*1 It was started by four people who, on 21 August 2007, issued an appeal. To date over 200 scientists and engineers have endorsed this appeal. They are actively demanding that objective scientific and technical investigations be carried out "keeping in mind the possibility of permanent closure of the plant".

The Nuclear and Industrial Safety Agency (NISA) of the Ministry of Economy, Trade and Industry (METI) has established the "Subcommittee for Investigation and Response to the Nuclear Facilities affected by Chuetsu-oki earthquake", chaired by Haruki Madarame, a professor of Tokyo University, and ordered Tokyo Electric Power Company (TEPCO) to check equipment and carry out seismic response analysis. However, these investigations are clearly being carried out based on the premise that the plant will be restarted in the near future. It would therefore be difficult to call them objective scientific and technical investigations. In addition, the nuclear industry is trying to lend authority to these investigations being carried out by the government and TEPCO by holding an international symposium in February this year in Kashiwazaki City*2.

As scientists and engineers, we believe that it is necessary to condemn and highlight the problems of this type of biased investigation, which is being carried out by the regulatory authorities and TEPCO without the participation of residents. We have prepared this document for this purpose and welcome comments on its contents.

Our key arguments are as follows:

- Kashiwazaki-Kariwa was never a place to build a nuclear power plant. (page 2)
- Sloppy safety examination overlooked an over 40 km-long submarine active fault. (page 2)
- This time was a miraculously lucky escape. (page 3)
- The danger of another large earthquake remains. The government is violating its own seismic design rules. (page 4)
- Important safety equipment may have been seriously damaged. (page 5)
- TEPCO's equipment checks are not capable of identifying all the damage. (page 5)
- TEPCO's seismic response analysis fails to identify the true situation. (page 6)
- Struck by the double blow of aging and an earthquake, Kashiwazaki-Kariwa should not be restarted. (page 6)

Footnotes

*1. The Chuetsu-oki earthquake (magnitude 6.8) occurred at 10:13 am on July 16 just off the coast of Niigata Prefecture on the Japan Sea side of Honshu, Japan's largest island. As a result of the quake, four reactors (units 2, 3, 4 & 7) at Tokyo Electric Power Company's (TEPCO) Kashiwazaki-Kariwa Nuclear Power Plant shut down automatically. At the time, unit 2 was being started up after a periodic inspection, while the other three units (1, 5 & 6) were still shut down for periodic inspection.

*2. The International Symposium on Seismic Safety of Nuclear Power Plants and Lessons Learned from the Niigataken Chuestu-oki earthquake was held in Kashiwazaki City on 26-27 February 2008.

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Earthquakes and Ground Condition

Just how safe is the Kashiwazaki-Kariwa Nuclear Power Plant?

By Katsuhiko Ishibashi and Mitsuhisa Watanabe

Kashiwazaki-Kariwa was never a place to build a nuclear power plant

The Kashiwazaki-Kariwa area in Niigata Prefecture is located in the middle of an earthquake belt that stretches from the Japan Sea coast in the Tohoku district to the north through to the Shinshu and Hokuriku regions in the Chubu district to the southwest. It was known before the planning of the nuclear power plant that Niigata Prefecture had undergone many magnitude (so-called Richter scale) 7-class destructive earthquakes. Major quakes since the 16th century occurred in 1502, 1666, 1670, 1751, 1762, 1802, 1828, 1847 and 1964. Furthermore, this area is right in an active fold[*1] region known as the U-etsu Fold Zone, and has many active faults each of which is evidence of repeated large earthquakes in the last several hundreds of thousand years. Thus ample reason existed to assume a risk of a major earthquake in the Kashiwazaki area.

It was known all along that the ground condition of the Kashiwazaki-Kariwa site was the worst among all of Japan's nuclear power plants. It was necessary to dig down about 40 meters to get the supporting stratum for a nuclear reactor. Even then, the stratum is geologically too young and could never be called hard bedrock.

In a word, the Kashiwazaki-Kariwa area was never a place where a nuclear power station should have been built from the viewpoint of seismic safety.

But in 1977, ignoring a warning from a specialist in active faults, who was a member of the examination committee[*2], and the regulatory guide for reviewing siting adequacy[*3], the government approved the installation of the No. 1 unit of the Kashiwazaki-Kariwa power plant. Subsequently, as we will see below, choosing to overlook the presence of huge submarine active faults nearby, approval was given for six more units. This can only be viewed as suicidal ignorance and disregard of the forces of earthquakes as natural phenomena, as was starkly revealed by the 2007 Niigata Prefecture Chuetsu-oki earthquake.

Sloppy safety examination overlooked an over 40 km-long submarine active fault

In the safety examination of reactors No. 6 and 7, which were licensed in 1991, both the government and TEPCO claimed that there was no submarine active fault in the area to threaten the plant's safety. They acknowledged the presence of the 7-8 km long F-B fault, as shown in Fig. 1, but stated that it was not an active fault. However, when Watanabe *et al.*[*4] examined the records of seismic profiling included in TEPCO's application for reactor establishment after the 2007 Chuetsu-oki earthquake, it was easy to identify many such large-scale submarine active faults, as shown in Fig. 1. There are four main ones, three of which run along either edge of the Sado Basin, a depression between Sado Island and mainland Kashiwazaki.

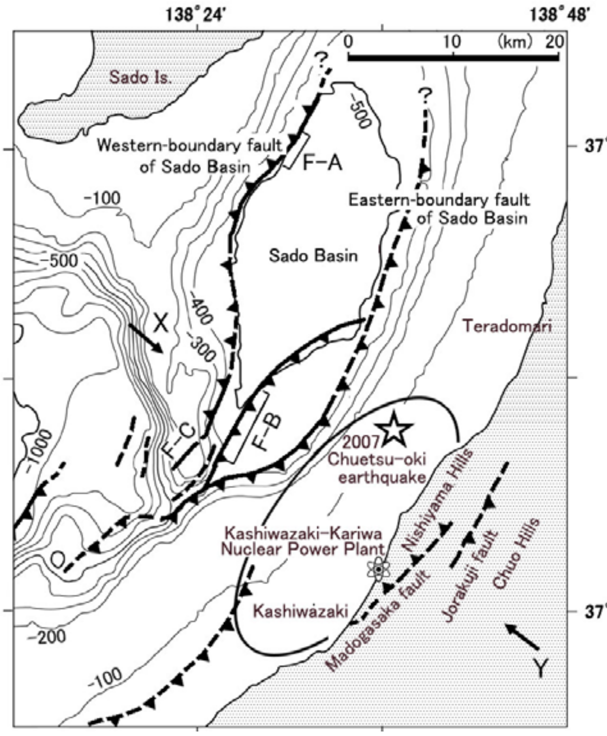

Fig. 1 Major active faults in the vicinity of the Kashiwazaki-Kariwa Nuclear Power Plant
The star shows the epicenter of the 2007 Chuetsu-oki earthquake. (Underground rupture along the seismic fault plane began directly beneath this point.) Slip on the fault plane spread to almost the whole area where aftershocks occurred (ellipse). Thick lines show active faults. (Broken lines are inferred ones.) Black triangles on the lines show dip-directions of the faults. The sea area is based on Watanabe *et al.*[*4]. F-A, F-B and F-C are faults after TEPCO's application for a license variation for Units 6&7. The Madogasaka fault is after Watanabe *et al.*[*4]. The Jorakuji fault is after Nihon no Katsudanso (New Edition) (Research Group for Active Faults of Japan Ed., University of Tokyo Press, 1991). X-Y indicates the line of cross section shown in Fig. 2.

In June 2003 TEPCO made a report to the Nuclear and Industrial Safety Agency revising their estimate of the F-B fault as a 20 km-long active fault. However, neither side made this new estimate public. Only finally in December 2007, after the Chuetsu-oki earthquake, was it publicly announced to be an active fault 23 km in length.

TEPCO stressed that this was "recent information" and wasn't known at the time of the license application. However, this is utterly incorrect. Watanabe *et al.*[*4] checked the data that TEPCO obtained and interpreted in its original application and, on the basis of criteria which were already authorized back in 1980, they were easily able to establish the existence of active faults at that location.[*5] TEPCO's evaluation of active faults is mistaken as to both position and length. In fact, the most important submarine active fault is not the F-B fault, but the Eastern-boundary fault of Sado Basin[*6] shown in Fig. 1. This is over 40 km long, and capable of generating a major earthquake of magnitude 7.3~7.7.[*5]

Thus, TEPCO's study and the government's review of active faults in the offshore area of Kashiwazaki-Kariwa power plant is very slipshod, and it is obvious that they made a most peculiar evaluation of this crucial matter of active faults.

A major earthquake of magnitude 7 or greater could and should have been anticipated at the application and examination stage, and it must be a matter of grave concern that both TEPCO and the government "didn't realize" this. They are refusing to admit their responsibility, and are bent on starting up production at the plant again as soon as possible, though they say they are carrying out a new investigation. Given this attitude, the same thing or worse could happen again.

A miraculously lucky escape

The recent Chuetsu-oki earthquake is thought to have resulted from underground rupture on the fault plane southeasterly-dipping from the Eastern-boundary fault of Sado Basin in which the land-side block thrust up northwestward over the sea-side block (Fig. 2). It is possible that the slight displacements on the Madogasaka fault adjacent to the power plant and the southern extension of the Jorakuji fault to the east caused the uplift of the Nishiyama Hills and the Chuo Hills. There was, in short, a sudden outbreak of crustal movement centered around the nuclear reactor area.

Repeated major earthquakes of this type appear to have formed the general topographic features in this area both on the sea bottom and on land. The 2007 Chuetsu-oki earthquake, however, was of smaller scale than is anticipated from the Eastern-boundary fault of Sado Basin, and there was not a great deal of alteration in growth of relief on this occasion; that is, it was an aborted quake for this area. The region can count itself lucky that this time what was in store for it did not eventuate. A quake of around magnitude 7.5 could easily have occurred, but thanks to the whims of nature the quake only reached 6.8.[*7]

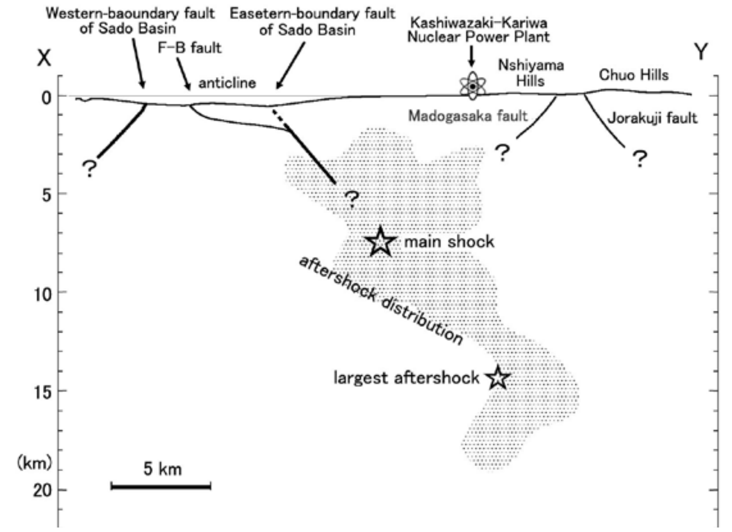

Fig. 2: Schematic vertical cross-section along the line X-Y in Fig. 1 showing geomorphological interpretation.

Looking from the southwest, based on Watanabe *et al.*[*6]. The shaded area shows roughly where aftershocks occurred in the region shown in this cross section. This area, as well as the location of the main shock and the largest aftershock, are based on results published by the National Research Institute for Earth Science and Disaster Prevention (http://www.hinet.bosai.go.jp/topics/niigata070716/). This figure is a rough sketch, because it is presumed that the seismic fault plane is warped and the topography is not absolutely perpendicular to this cross section.

The Chuetsu-oki earthquake struck the Kashiwazaki-Kariwa Nuclear Power Plant with violent ground motion far beyond that of the basis of seismic design. The plant suffered considerable damage, and there was radiation leakage. However, the three reactors that were in active operation and the one reactor that was being started up at the time scrammed and a major disaster was avoided. Some take this to be proof that nuclear reactors are safe and earthquake-proof. But this is surely a case of culpable optimism.

Thanks to a happy combination of chance and circumstance, this recent case miraculously let us off the hook, but it could well have been a very different story. If the earthquake had been of magnitude larger than 7 (instead of 6.8), or had there been a large aftershock immediately following, or had all seven of the reactors been in operation at the time, we might instead have been faced with a fatal accident in which massive amounts of radioactive material were released, making uninhabitable not only the Kashiwazaki and Kariwa environs but a wide area of Niigata Prefecture.

Danger of another large earthquake remains Government is violating its own rules

The 2007 earthquake was preceded by one in the same region in 2004, pointing to a build-up of seismic energy in the area. Both were relatively small, magnitude 6.8, and there are many active faults both in the seabed and on land, so it is impossible to dismiss the likelihood of further major earthquakes. The next severe quake may be caused by major slip on the Madogasaka fault, for example, which may have perhaps undergone slight movement in the recent quake. It is also impossible to rule out a late aftershock of magnitude 6.5 or so occurring some years down the track directly under or in the immediate vicinity of the nuclear power plant. The possibility that this plant will be restarted is of grave concern indeed, given the extreme seismic hazard of the site, and the high possibility that it still carries considerable undetected damage from the recent quake.

In the 2006 revised version of the government's *Regulatory Guide for Reviewing Seismic Design of Nuclear Power Reactor Facilities* the fundamental guideline states that "(all) buildings and structures shall be settled on the grounds which have sufficient supporting capacity". The ground of the Kashiwazaki-Kariwa plant was deformed remarkably by the Chuetsu-oki earthquake, affecting and in many cases causing considerable damage to structures right across the plant site. It has already given ample proof that it does not have sufficient supporting capacity. Therefore, the plant is in clear violation of the fundamental guideline stated above.[*8] Even by the standards of the nuclear power industry itself, the Kashiwazaki-Kariwa Nuclear Power Plant must not be allowed to continue to operate

Footnotes

*1. Presently ongoing fold - a very slow wave-shaped distortion of strata during geological time span, mainly under lateral compression, where buried faults, which could potentially be the origin of earthquakes, often exist.

*2. See *Niigata Nippo: Tsunen Kikaku* ("Kashiwazaki-Kariwa Genpatsu - the Shaky Safety Myth", 4.1, http://www.niigata-nippo.co.jp/rensai/n78/n78h5klml.html.

*3. The *Regulatory Guide for Reviewing Siting of Nuclear Power Reactors* (decided in 1964 - the basis of the scheme of regulatory guides for licensing review of nuclear facilties) states that the first principle for siting a reactor is that "there should be not only no event in the past such as would cause a large-scale accident, but no possibility of any such occurring in the future. Furthermore, there should be a minimum of factors likely to exacerbate the extent of any disaster."

*4. Watanabe Mitsuhisa, Suzuki Yasuhiro, Nakata Takashi: *Programme and Abstracts*, Japan Association for Quaternary Research, No. 37, Suppl., 4(2007).

*5. Suzuki Yasuhiro, Nakata Takashi, Watanabe Mitsuhisa: *Kagaku*, 78, No.1, 97 (2008).

*6. This fault has been named by Watanabe Mitsuhisa, Nakata Takashi, Suzuki Yasuhiro: *J. Geol. Soc. Japan*, 114, 2008 (forthcoming).

*7. The seismic wave energy of a magnitude 6.8 earthquake is a little under 10% (i.e. less than one tenth) of that of a magnitude 7.5 quake.

*8. It should be added that this plant was in violation even of the earlier guidelines, which stated that "important buildings and structures should be on hard bedrock".

Is the equipment and machinery OK?

By Hiromitsu Ino and Mitsuhiko Tanaka

Important safety equipment may have been seriously damaged

All of Japan's nuclear power plants were designed under earthquake guidelines which have since been superceded[*1]. The Kashiwazaki-Kariwa nuclear power plant was designed for basic horizontal earthquake ground motions of 300 Gal[*2] (S1) and 450 Gal (S2). These figures apply to a hypothetical surface called "free surface of the base stratum"[*3], where S1 is an earthquake ground motion that could actually occur, while S2 is an almost inconceivable hypothetical earthquake ground motion. However, during the Chuetsu-oki earthquake, a seismometer[*4] set deep underground in the Unit 1 site recorded a horizontal acceleration as large as 993 Gal. This figure cannot be directly compared with the abovementioned 300 Gal and 450 Gal readings. In order to compare the figures, it is necessary to carry out a "strip off inversion analysis".[*5] However, if this analysis were carried out the 993 Gal figure would be expected to rise even higher. This demonstrates that the Kashiwazaki-Kariwa nuclear power plant was struck by a massive ground motion that far exceeded the basic S1 and S2 earthquake ground motions assumed when the plant was designed.

Under the old guidelines, for standard earthquake ground motion S1, it was a legal requirement that key equipment and structural components of nuclear power plants be designed so as not to exceed the bounds of "elastic deformation"[*6]. However, for standard earthquake ground motion S2 they are allowed to cross the boundary of "elastic deformation" to a certain extent. That is to say, a certain amount of "plastic deformation"[*7] is permitted. Because it is almost inconceivable that an S2 earthquake ground motion will actually occur during the life of the plant, a certain amount of permanent deformation is acceptable, even of key equipment and structural components, "as long as they don't break"[*8]. This very dangerous concept was adopted, because cost was prioritized over safety.

To recapitulate, during the Chuetsu-oki earthquake, the Kashiwazaki-Kariwa nuclear power plant was struck by a massive earthquake ground motion that far exceeded both S1 and S2. Something occurred which was unprecedented in the history of nuclear power. A huge stress was exerted on key equipment and structural components that directly affect the safety of the plant: the reactor pressure vessel, nozzles, reactor internal structural components, support skirts, major pipes (e.g. main feedwater pipes, main steam pipes, recirculation pipes), the primary containment vessel, all kinds of pumps, turbines, and so on. We are concerned that metal materials may have suffered serious damage. Even if there were no visible changes to the structure and dimensions, it is possible that microscopic internal, potentially dangerous defects arose within the metal materials. As long as there is a possibility that important equipment and structural components have suffered this type of undetectable damage, we maintain that the Kashiwazaki-Kariwa Nuclear Power Plant is dangerous and should be closed down.

TEPCO's equipment checks not capable of identifying all the damage

Under the auspices of Nuclear and Industrial Safety Agency's (NISA) "Subcommittee for Investigation and Response to the Nuclear Facilities affected by Chuetsu-oki earthquake", a working group was established to assess management and control and the integrity of equipment (Chairperson, Naoto Sekimura, Professor of Tokyo University). The working group is trying to assess whether or not equipment was damaged by the earthquake. The assessment involves "equipment checks" and "calculation-based analysis". However, in reality this is being done by TEPCO and the working group just discusses the results.

What sort of checks is TEPCO doing? First, it is doing "visual checks". These can only reveal large flaws and distortions. Next it is carrying out "non-destructive tests" on sections which it judges to be suspicious. These involve looking for flaws using ultrasonic waves, or by permeating the section with liquid. These tests can only reveal the larger cracks. It is very difficult to find small flaws and it is completely

impossible to find local distortion (plastic deformation) of the material and hardening before cracks form. As explained in the previous section, even if there are no detectable changes to the structure and dimensions, it is impossible to deny that internal microscopic flaws could have formed in the metal material. Furthermore, there are practical difficulties with the work environment. It is extremely difficult to find tiny flaws in huge structures such as the primary containment vessel. It is also likely that some parts which were subjected to great stress during the earthquake are very difficult to access and that sufficient testing cannot be carried out on these parts. Also, it is no easy matter to conduct tests in the highly radioactive environment around the reactor.

TEPCO's seismic response analysis fails to identify the true situation

TEPCO relies on "seismic response analysis" (analysis of structural strength). NISA has indicated its basic policy on this to TEPCO and TEPCO has begun preliminary analysis. In regard to equipment and structural components which are important for the safety of the plant, NISA regards the issue of whether or not "elastic deformation" has been exceeded (i.e. whether or not plastic deformation has occurred) as a key distinction in the assessment of the integrity of equipment.

However, there is a big problem in this. Under NISA's basic policy, the integrity of equipment is deemed to be confirmed as long as no flaws are found and the results of the analysis indicate that elasticity was maintained (i.e. that plastic deformation did not occur). But, as we have explained, the tests being conducted are incapable of discovering plastic deformation (local distortion), so even if the results of the analysis indicate elastic deformation, it is still possible that plastic deformation has occurred. Since this possibility is ignored, any declaration that the integrity of the equipment has been maintained would be based on an unconditional acceptance that an unverifiable theoretical analysis was correct. Hence, it is impossible to escape the conclusion that the assessment methodology is unscientific.

There are also problems with the methodology of the analysis itself. According to the analysis steps published by TEPCO, first a simplified calculation is conducted. If the results of this calculation indicate plastic deformation, an analysis equivalent to that used when the plant was designed is carried out. If plastic deformation is still indicated, a detailed assessment of whether plastic deformation has occurred is carried out, varying the damping constant[*9] and amending the calculation model. If the results of this detailed assessment still indicate plastic deformation, they will

confirm whether the equipment is capable of carrying out its function. In other words, if three stages of the assessment all indicate plastic deformation, theoretical analysis will be abandoned and the equipment will be given a rubber stamp of approval as long as it can still carry out its function. If this is their attitude, one wonders why they bother with the theoretical analysis in the first place. One can only conclude that they intend to derive the assessment result that the integrity of the equipment has been maintained no matter what, so that they can restart the plant. Their attitude is a far cry from our demand that "objective scientific and technical investigations" be carried out "keeping in mind the possibility of permanent closure of the plant."

We demand that TEPCO publish not only the numerical results of its seismic response analysis, but that it publish its results in such a way that the whole analytical process can be reproduced. We also demand that NISA independently crosscheck TEPCO's analysis and that it publish the whole process.

Struck by the double blow of aging and an earthquake, Kashiwazaki-Kariwa should not be restarted

The Kashiwazaki-Kariwa nuclear power plant is not new. Unit 1 began operations 22 years ago. Unit 7, the newest reactor, commenced operations 10 years ago. During that time the equipment has aged.[*10] TEPCO's seismic response analysis assumes that the equipment and machinery are new. But what if tiny cracks, not visible to the naked eye, have arisen as a result of aging? After the body blow from aging, along comes this huge punch from an earthquake. Considering the circumstances, a fundamental assessment of the integrity of the plant is necessary.

As an experiment, what about decommissioning and disassembling Unit 1 - which, being the oldest reactor, has aged most - taking samples and conducting metallographical tests and fracture tests, carrying out the latest instrumental analysis, and undertaking a fundamental and thorough assessment of the integrity of the plant? This would also be an extremely useful exercise from the point of view of research into the effects of earthquakes on nuclear power plants.

In a small country like Japan, a single nuclear accident would be enough to make a large part of the country uninhabitable for generations. On top of this risk, Japan is also one of the most earthquake-prone countries in the world. Not only would the scale of the destruction for Japan would be orders of magnitude greater than for larger countries, there is also the continual risk of an earthquake. To attempt to restart the Kashiwazaki-Kariwa nuclear power plant under these circumstances, without even fully confirming that it is safe, is a violation of corporate and professional ethics.

Footnotes

*1. The current guidelines were approved in September 2006, but so far no plants have been designed based on these new guidelines.
*2. Gal is a unit of acceleration. Gravitational acceleration at the earth's surface is 980 Gal.
*3. Tertiary layers, or earlier bedrock that has not been eroded are generally referred to as "ground". Hypothesizing that above this ground there are no layers or structures, the surface spreading out horizontally is called the "free surface of the base stratum".
*4. Seismometer located 250 meters below sea level under reactor number 1.
*5. Method of deriving the hypothetical seismograph for the surface in question by analytically removing all superimposed layers and considering the layer in question to be an exposed surface.
*6. As with the deformation caused by pulling a rubber band, there is a proportional relationship between the force applied and the extension, and when the force is released the material returns to the same length and shape that it was before.
*7. With plastic change, after the force is released most of the change (distortion) remains permanently.
*8. Expression used on page 208 of the following practical design handbook: Takashi Hayashi, "Structural Design of Nuclear Power Plants" (Nikkan Kogyo Shimbun "Business Line", 1984)
*9. See footnote 7 on page 9.
*10. Items being considered by a committee established within the Ministry of Economy, Trade and Industry (METI) to investigate aging management for nuclear power plants include embrittlement of reactor pressure vessels due to neutron irradiation, stress corrosion cracking (SCC) of pipes, and metal fatigue. In 2002, when it was revealed that TEPCO had concealed cracks, SCC in the stainless steel of shrouds and recirculation pumps in the Kashiwazaki-Kariwa power plant were revealed and all 7 units were shut down. Since then no fundamental solution to the problem of SCC has been found and cracks continue to appear.

Column 1

By a member of *KK Scientists*

TEPCO suppression of 34-year-old dispute about ground condition

Since as far back as 1974, the local anti-nuclear movement has been making the following claims. "Kashiwazaki-Kariwa was an oil field. It has active folds and active faults and is therefore unsuitable for a nuclear power plant. TEPCO's survey for the construction of the plant ignored inconvenient facts which were discovered during oil field surveys. The ground is too soft to withstand an earthquake."

Reassessments of submarine active faults were ordered by the Nuclear and Industrial Safety Agency for all Japanese nuclear power plants in June 2002. The reason given was that during the safety review for Hokkaido Electric's planned Tomari-3 reactor a submarine fold was assessed to be a fault.

On 29 August 2002 it was announced that TEPCO had passed periodic inspections of its nuclear power plants by altering inspection data and concealing cracks. This was the first TEPCO scandal. After the scandal was revealed, TEPCO nuclear reactors shut down for periodic inspections could not be restarted and in the spring of 2003 operation of all 17 TEPCO reactors was suspended.

The reassessment of submarine active faults was being carried out in the middle of all this scandal.

As a result of the reassessments required by the government, active faults were reported on 25 May 2003 for Hokuriku Electric's Shika nuclear power plant, on 16 June for TEPCO's Kashiwazaki-Kariwa plant and in July for Chubu Electric's Hamaoka plant. Active faults were also reported for Japan Atomic Power Company's Tsuruga plant, Kansai Electric's Mihama, Ohi and Takahama plants and for Chugoku Electric's Shimane plant. In the case of Kashiwazaki-Kariwa, Shika, Tsuruga and Mihama, it was recognized that if these submarine active faults caused an earthquake, it could give rise to an earthquake ground motion exceeding the S1earthquake ground motion assumed when the licenses for these nuclear reactors were approved. However, this was concealed from the public on the grounds that the earthquake ground motion would not exceed the S2 earthquake ground motion.[*1]

The power companies and the government were afraid that a public announcement concerning these active faults would only increase public distrust towards them and it would become difficult to restart the nuclear power plants. Thus electric power supply was prioritized over safety. At the time, TEPCO was running a PR campaign claiming that it would enforce corporate ethics, put safety first and disclose information.

Likewise, TEPCO's announcement on 5 December 2007 of submarine fault F-B was not spontaneous. Immediately after the Chuetsu-oki earthquake, a group of geologists had pointed out that the Chuetsu-oki earthquake[*2] was caused by a submarine fault and questioned why this obvious submarine active fault had not been discovered. In the face of this professional challenge, TEPCO belatedly confessed that it was aware of the submarine active fault since 2003 and had reported it then to the government.

Footnotes

*1. For an explanation of S1 and S2 earthquakes, see the section, "Important safety equipment may have been seriously damaged" (page 5).

*2. See footnotes 4, 5 and 6 in the section "Earthquakes and Ground Condition - Just how Safe is the Kashiwazaki-Kariwa Nuclear Power Plant?" (page 4).

Column 2

Materials get stronger when deformed by an earthquake!?

There is a line of thinking in TEPCO and NISA that equipment can still function OK after incurring plastic deformation (distortion), even though the design does not permit this. Hideo Kobayashi, a member of the working group assessing management and control and the integrity of equipment, made a very surprising statement at the working group's first meeting (4 September 2007). "The word 'damage' keeps coming up. The problem is that when [metal materials] incur very great plastic deformation, they actually become stronger, so in fact I think damage is not a worry." The truth is that metal materials do not get stronger when they incur plastic deformation, they get harder. Hardening is a step along the path to brittleness.

No one says that blood vessels become stronger when hardening of the arteries occurs. It is totally unacceptable for equipment to be assessed to have maintained its integrity on the basis of the notion that metal materials get stronger when they incur plastic deformation and that damage is not a concern.

Hideo Kobayashi has made several peculiar remarks. For example, "I think questions of whether it's OK or not OK by existing seismic standards and design standards are almost useless in this case. 'Out' is the only answer that you will get..." and "I would like the assessment to be carried out using actual values for strength and the latest scientific techniques, techniques not bound to existing regulations and standards." NISA's response to this was, "For equipment that shows no particular outward appearance of damage, where the seismic response exceeded the stress permitted under the seismic design in the approved construction plan, as you have pointed out, I believe it is necessary to carry out the assessment on the equipment's actual strength." It appears that the "actual strength value" is being used as the final escape route to allow the plant to operate, even if its distorted and damaged.

Column 3

By a member of *KK Scientists*

Through the eyes of a power plant designer - what happened at the Kashiwazaki-Kariwa nuclear power plant?

It is reported that so far no serious damage to the equipment of the Kashiwazaki-Kariwa nuclear power plant has been found. How should we interpret this claim? When actually designing a plant, besides the seismic load, load arising from such things as pressure, temperature and weight are taken into consideration, so even if the seismic load is great, if its contribution to the total load is relatively small there might be no damage. Alternatively, there could be cases where some parts incur considerable damage, but this damage does not emerge on the surface and the total structure somehow manages not to collapse.

Besides damage to equipment, another important issue is whether the function of equipment related to the safety of the nuclear power plant is maintained after an earthquake. If an earthquake arises in the future while the plant is operating and, for example, control rods fail to insert due to the violent shaking, or pumps and valves in the emergency core cooling system[*1] (ECCS) fail to function, this could lead to a runaway chain reaction[*2] or a core melt down[*3].

The details are unclear, but a control rod could not be removed from the core of Kashiwazaki-Kariwa reactor 7 after the Chuetsu-oki earthquake. No matter what the circumstances, equipment that is so fundamental to the safety of the plant must not be allowed to fail. On those grounds alone, one would have to say that it would be a dangerous gamble to restart the plant.

Plant design must take into account the worst-case

The design must guarantee that the plant can withstand the worst-case situation. For example, in the case of an earthquake the shaking of the plant varies depending on the input spectrum*4 transmitted through the ground. If the period of the vibration does not match the natural period of the structures, equipment and pipes, they will not be severely shaken. However, if the periods match, they will resonate and the shaking will be amplified many times. In complex nuclear power plants it is possible that such large shaking could occur in many places and cause damage. The current case was the result of a strong force from earthquake ground motion accompanied by a particular spectrum. A different strong earthquake ground motion with a different spectrum would produce a different type of response in the plant. Also, different modes of operation (eg if the ECCS was in action) would produce different kinds of load besides the seismic load, so the damage is likely to be different.

When it was discovered that Japanese architects had faked the strength of buildings and that these buildings were not designed strong enough to withstand earthquakes, they had to be pulled down. In another case, people were killed by car wheel hubs, which flew off because they were not designed strong enough. In this case the manufacturer was held responsible in court for not recalling the cars. But here we have TEPCO carrying out analyses and assessments aimed at restarting the Kashiwazaki-Kariwa nuclear power plant. In situations where by rights the nominal value*5 for material strength should be applied, TEPCO is trying to apply the actual value*6. They chose a damping constant*7 which made the resonance response at the time of the earthquake appear small, even though the basis of this damping constant has not been confirmed.

It seems that TEPCO is attempting to respond by employing inadequately verified methods that designers know should never be used. These types of assessment methods are sometimes used for accident reviews and to assess, based on average values, situations which are most likely to arise, but they are precisely the wrong methods to use when discussing safety. One wonders whether the professors and officials on the working group assessing the integrity of the plant's equipment understand the basics of plant design.

Start again from the design stage

We are talking about a nuclear power plant which, if an accident were to occur, would be expected to cause an irreversible disaster. With seven reactors, the Kashiwazaki-Kariwa Nuclear Power Plant is the biggest nuclear power plant in the world. It is our view that the earthquake ground motion should be redefined to take into account the "unforeseen" earthquake ground motion that occurred this time. We further believe that the resulting seismic load should be combined with the loads for all modes of operation and redefined and that the whole plant should be redesigned accordingly. Arbitrary values like the "actual strength value" should not be used for issues affecting safety. Instead, wherever in the light of standards used hitherto the strength is inadequate, the equipment should be rebuilt. Unless that is done, it is unthinkable that the plant could be restarted.

Footnotes

*1. Safety system to inject water into the reactor core in an emergency to prevent overheating.

*2. Failure to control nuclear fission leads to an explosive chain reaction. This is the worst type of nuclear accident. The Chernobyl accident was of this type.

*3. Overheating of the reactor core due to lack of coolant leads to melt down of the nuclear fuel and core internals. If this situation continues a 3-Mile Island type accident occurs. This situation can also arise from a runaway chain reaction.

*4. Earthquake ground motion spectrograph: a graph showing the strength of the shaking from the earthquake for each period.

*5. Value for the lower limit of strength determined for a particular material.

*6. Not the nominal value, but the assumed strength of a material being used.

*7. Vibration damps away with time. The damping constant is a coefficient appearing in the equation of vibration; the higher the value of this coefficient, the faster the rate at which the vibration dies out. For example, a value of 2% is used in an analysis of the present assessment instead of 0.5% employed in the design.

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Pluthermal Developments and Plutonium Use Plans

During February, there were several developments in Japanese power companies' pluthermal*1 plans. Also, plutonium use plans for the 2008 financial year were released on March 7th (see page 11).

Problems with MOX fuel for Kyushu Electric's Genkai-3

Fabrication of MOX fuel for Genkai-3 (PWR, 1180MW) began in October 2007. On 1 February 2008, Kyushu Electric Power Company announced that springs and end plugs which had not received the necessary quality checks had been used. France's MELOX is fabricating the fuel, but the end plugs of the fuel rods and the springs to hold the pellets in place were made by Japan's Mitsubishi Heavy Industries. In addition to end plugs and springs that had been quality checked by Kyushu Electric, test items which had not been checked were also sent to MELOX. This contingency was not covered in the technical manual. As a result, 1516 test fuel rods for which the end plugs and springs had not been checked were used. They will now all be replaced.

Kyushu Electric audited the quality assurance systems of both MHI and MELOX before fuel fabrication began, but one suspects that the audit was just a formality.

Other companies' plans

Kansai Electric Power Company (KEPCO) carried out similar audits of Nuclear Fuel Industries Ltd. and MELOX on February 12 and February 18-21 respectively. KEPCO plans to introduce pluthermal in Takahama reactors 3 and 4 (both PWR, 870 MW). MOX fuel was fabricated for these reactors by BNFL in 1999, but the fuel was returned after it was discovered that quality control data had been faked. Preparations for fabrication of fuel, which had been suspended, were recommenced after the governor of Fukui Prefecture gave his approval on 30 January 2008.

On February 29th, Shikoku Electric announced that fabrication of MOX fuel for its Ikata-3 reactor (PWR, 890 MW) would commence at the MELOX plant in late March.

Chubu Electric received permission from the Minister for Economy, Trade and Industry in July 2007 to implement its pluthermal plan at its Hamaoka-4 reactor (BWR, 1137 MW). It received approval from Shizuoka Prefecture on 29 February 2008 and on March 4th applied to the Minister for inspection of the fuel it will import (document review).

The Nuclear and Industrial Safety Agency completed its safety review of the pluthermal plan for the Chugoku Electric's Shimane-2 reactor (BWR, 820 MW) on February 26th. The Nuclear Safety Commission is now carrying out a double check.

Rokkasho Reprocessing Plant and FY 2008 plutonium use plans

It is very significant that the electric power companies are now proceeding with their pluthermal plans. This lays the ground for the commencement of full operation of the Rokkasho Reprocessing Plant (see News Watch), in the sense that it creates an alibi that the plutonium extracted will not be surplus to requirements.

The fact that this is nothing more than an alibi is illustrated by the plutonium use plans released each year since 2006. As explained in NIT 117*2 in regard to the FY 2007 plans, these plans are essentially meaningless. There is no indication of by when the plutonium separated at the Rokkasho reprocessing plant will be used up. Furthermore, the power companies intend to use plutonium extracted overseas before the plutonium extracted at Rokkasho. Consequently, their plutonium use plans provide no evidence that the plutonium extracted at Rokkasho will not be surplus to requirements.

Baku Nishio (CNIC Director)
Philip White (NIT editor)

*1. The term 'pluthermal' refers to the use of plutonium in the form of mixed oxide fuel (MOX) in 'thermal' - as opposed to 'fast' - reactors.

*2. There were two errors in the table in NIT 117. The projected quantity to be used annually for TEPCO should have been 0.9-1.6 tons Puf/year, the same as 2006 and 2008. Also the figure for Hokuriku (0.1 tons Puf/year) was omitted.

Federation of Electric Power Companies of Japan (7 March 2008)

Utilization Plan for Plutonium Recovered at Rokkasho Reprocessing Plant (Fiscal Year 2008)

Owner	quantity to be reprocessed *1	quantity held *2			purpose (to be used as fuel for Light Water Reactors) *3		
	quantity of Spent Nuc. Fuel planned to be reprocessed in FY08 (tons U) *4	projected quantity of Pu held at end FY07 *5 (tons Puf) *6	projected quantity of Pu to be recovered in FY08 (tons Puf) *6	projected quantity of Pu held at end FY08 *7 (tons Puf) *6	reactor(s) to utilize recovered Pu	projected quantity to be used annually *8 (tons Puf/year) *6	time planned to start using Pu *9, and approximate time required to use Pu *10
Hokkaido	24	0.1	0.1	0.1	Tomari N.P.P.	0.2	In or after FY2012 about 0.7 years equivalent
Tohoku	14	0.1	0.1	0.1	Onagawa N.P.P.	0.2	In or after FY2012 about 0.6 years equivalent
Tokyo	168	0.7	0.7	1.4	On the basis of attempting to recover the trust of local residents, plan to utilize 3 to 4 reactors belonging to TEPCO.	0.9-1.6	In or after FY2012 about 0.9 to 1.5 years equivalent
Chubu	74	0.1	0.1	0.3	Hamaoka N.P.P. reactor 4	0.4	In or after FY2012 about 0.7 years equivalent
Hokuriku	8	0.0	0.0	0.0	Shika N.P.P.	0.1	In or after FY2012 about 0.2 years equivalent
Kansai	19	0.4	0.4	0.8	Takahama N.P.P. reactors 3 & 4, plus 1 or 2 reactors at Ohi N.P.P.	1.1-1.4	In or after FY2012 about 0.6 to 0.7 years equivalent
Chugoku	47	0.1	0.1	0.2	Shimane N.P.P. reactor 2	0.2	In or after FY2012 about 0.8 years equivalent
Shikoku	20	0.1	0.1	0.2	Ikata N.P.P. reactor 3	0.4	In or after FY2012 about 0.5 years equivalent
Kyushu	-	0.3	0.2	0.5	Genkai N.P.P. reactor 3	0.4	In or after FY2012 about 1.3 years equivalent
JAPCO	20	0.1	0.1	0.2	Tsuruga N.P.P. reactor 2, Tokai 2 N.P.P.	0.5	In or after FY2012 about 0.5 years equivalent
sub total	**395**	**2.0**	**1.9**	**3.9**		**4.4-5.4**	
J-power		Will be tranferred from other utilities *11			Ohma N.P.P.	1.1	
Grand Total	**395**	**2.0**	**1.9**	**3.9**		**5.5-6.5**	

More details will be added as the pluthermal program proceeds and the MOX fuel fabrication plant comes on line.

*1. The 'quantity of Spent Nuclear Fuel planned to be reprocessed' is in accordance with the reprocessing plan put together by Japan Nuclear Fuel Limited (JNFL)..

*2. Listed under the 'quantity of Pu held' are the quantity of plutonium that is projected to be held by each company at the end of FY2007, the quantity projected to be recovered at the Rokkasho reprocessing plant in FY2008, and the total of these two quantities, which is the quantity projected to be held at the end of FY2008. The recovered plutonium will be allocated to each electric power company in proportion to the amount of fissile plutonium contained in the spent nuclear fuel they sent to the Rokkasho Reprocessing Plant. Consequently, plutonium may be allocated to some companies whose plutonium was not actually reprocessed in that year. However, when all spent fuel has been reprocessed, the amount of plutonium allocated to each company will correspond to the amount of fissile plutonium contained in the spent fuel that they sent for reprocessing.

*3. Besides the amount to be used in LWRs, some plutonium will be transferred to JAEA to be used in their research projects. The amount to be transferred from each power company to JAEA will be announced when it is decided.

*4. Figures are rounded, so totals do not add up in some places.

*5. On 18 September 2007, JNFL released “Concerning the revision to the plan for receiving spent fuel in FY2007” . The quantity of spent fuel to be reprocessed in FY 2007 was reduced from 392 tons U to 315 tons U. Then on 25 February 2008, JNFL released “Concerning submission of a revised works plan for the reprocessing plant” . This time the quantity to be reprocessed was reduced from 315 tons U to 210 tons U.
The figure shown here reflects these revisions. Therefore, the figure differs from the figure shown in the Federation of Electric Power Companies’ 23 February 2007 “Utilization Plan for Plutonium Recovered at Rokkasho Reprocessing Plant (Fiscal Year 2008)” shown in for “projected quantity of Pu held at end FY07” (2.9 tons Puf).

*6. The 'amount of plutonium to be allocated' is shown in terms of fissile plutonium. The amount allocated to each company is rounded to the first decimal place, so in some cases a value of 0.0 is shown.

*7. 'Projected quantity of Pu held at end FY08' equals 'projected quantity of Pu held at end FY07' plus 'projected quantity of Pu to be recovered in FY08'. Figures are rounded to the first decimal place, so the totals do not add up in places.

*8. The 'projected amount to be used annually' shows the amount of plutonium contained in MOX fuel to be loaded according to the plans provided by each electric power company, adjusted to a yearly basis. In some cases the amount of plutonium to be used includes plutonium recovered overseas.

*9. The 'time planned to start using Pu' is after 2012, when the planned MOX fuel fabrication plant, located next to the Rokkasho Reprocessing Plant, is planned to start operating. Until the MOX plant commences operations, recovered plutonium will be managed and stored at the Rokkasho reprocessing plant in the form of uranium-plutonium mixed oxide powder.

*10. The 'approximate time required to use Pu' is calculated by dividing the 'projected quantity of plutonium held at end FY08' by the 'projected quantity to be used annually'. (Note that because some plutonium is to be transferred to J-Power and JAEA, and because in some cases 'the quantity to be used' includes plutonium stored overseas, the actual time taken might not match the span shown here.

*11. The amount to be transferred from other power companies to J-Power will be announced after it has been decided.

Anti-Nuke Who's Who

Teisuke Ishio's Freedom of Nuclear Information Campaign

by Hiroshi Nakashima*

In 1955 the Ningyo Toge uranium deposit was discovered in Kagamino, Okayama Prefecture where Teisuke Ishio lives. Ever since then, the local office of the Japan Atomic Energy Agency (JAEA) has been a base for Japan's nuclear energy development, engaging in research and development into mining, refining, enrichment, and so on.

In order to take on the environmental pollution from the uranium operations at Ningyo Toge, in December 1980, along with colleagues in the anti-nuclear movement, Teisuke established the Committee to Consider Uranium Pollution. In July 1981 the group was reorganized and changed its name to the Tsuyama Anti-Nuclear Citizens' Group. As Director of the group, Teisuke has continued his activist work in the north of Okayama Prefecture (Mimasaka District) for 28 years since then. He has been involved in campaigns including monitoring fuel shipments to Ningyo Toge and nuclear power plants and monitoring pollution, in particular uranium contaminated soil, at JAEA's Ningyo Toge facility. Through these local campaigns, he has carried on the fight against the government's nuclear development policy.

He has tackled these issues through a tenacious freedom of information (FoI) campaign, forcing the government and its agencies to release documents that they had concealed and tracking down the inconsistencies in them. Through painstaking reading and analysis of the huge quantities of documents thus obtained, the objectives and actions of the proponents of nuclear energy became clear.

Japan's FoI system was only introduced a few years ago and it is inadequate in comparison with Europe and the US. Teisuke was putting a huge effort into this campaign even before the FoI system was in place. The former Power Reactor and Nuclear Fuel Development Corporation (PNC - now JAEA) even went so far as to send him a bill for 690,000 yen for releasing documents. This incident occurred just before the FoI law was established. It was raised in the Diet and made an important contribution to the improvement of the FOI system.

His sustained and persistent FoI campaign brought to light some important issues. One of

these was a secret report by PNC on selection of a site for a final repository for high level radioactive waste (HLW). This has been used by citizens' movements opposed to siting of a HLW dump, for example in the Ningyo Toge region, in western Kochi Prefecture and in Tsushima City (Nagasaki Prefecture). Attempts to find a HLW dump site have been thwarted as a result.

A recent success in his FoI campaign was obtaining the release of 1,300 photos taken after the July 2007 Chuetsu-oki Earthquake by the Nuclear and Industrial Safety Agency of the damage to the Kashiwazaki-Kariwa Nuclear Power Plant. The damage to the plant immediately after the earthquake was exposed for all to see when these photos were uploaded onto the web site of a local anti-nuclear group. No matter how much the government and other proponents of nuclear power try to gloss over the problems, it is clear that there is no choice but to close down the plant.

As an anti-nuclear activist, he spends his time fighting the establishment, but there is also another side to his life. He delights the neighbourhood each year when the several hundred chrysanthemums which he grows are in flower. It seems that his activism stems from his love of both nature and people.

* Hiroshi Nakashima is a member of Tsuyama Anti-Nuclear Citizens' Group.

NEWS WATCH

Further delay in commercial operation of Rokkasho Reprocessing Plant

On February 25, Japan Nuclear Fuel Ltd (JNFL) officially announced that active testing of the Rokkasho Reprocessing Plant, which was scheduled to end in February, would not be completed until May. As explained in NIT 122, problems with the glass vitrification facility meant that a delay was inevitable.

This is the twelfth time the planned starting time has been delayed. Even if government approval is received in May, meetings still have to be held to explain to the citizens and safety agreements must be signed with Aomori Prefecture and Rokkasho Village and surrounding villages. It is, therefore, unlikely that commercial operations will begin before July.

Explanatory meetings for restart of Monju

Having completed modifications to the Monju prototype fast breeder reactor (280 MW), which has been closed since a sodium fire in December 1995, the Japan Atomic Energy Agency (JAEA) is now looking to begin trial operations. On February 8th, the Nuclear and Industrial Safety Agency (NISA) accepted the appropriateness of changes proposed by JAEA in response to issues pointed out in NISA's comprehensive safety check. On February 19th, the Minister of Economy, Trade and Industry approved the loading of new fuel (quantity of fissile plutonium increased by 1%) to replace degraded old fuel. Having obtained these approvals, JAEA held explanatory meetings in Tsuruga City on February 25th and neighboring Mihama Town on March 5th. Citizens are very worried and the governor of Fukui Prefecture commented that receiving approvals and restarting the plant are different things.

Health damage from JCO criticality accident not recognized

On February 27th, the Mito District Court handed down its verdict in a case for damages for impaired health as a result of the September 1999 criticality accident at the JCO uranium processing plant. The claim was lodged in September 2002 by a husband and wife, who ran a car part factory next to the plant, against JCO and JCO's parent company, Sumitomo Metal Mining. They claimed that they suffered health effects including Post-Traumatic Stress Disorder and aggravation of skin rashes. The court refused their claim, accepting JCO's defense that the radiation exposure was minimal and rejecting any cause-effect relationship.

The plaintiffs did not accept the verdict and have appealed to the Tokyo High Court.

Rokkasho Uranium Enrichment Plant down to a single line

Japan Nuclear Fuel Ltd (JNFL) has been forced to stop uranium enrichment lines one after the other at its uranium enrichment plant in Rokkasho Village. Another one stopped on February 12th, so now only one of the plant's 7 lines is still operating. (The 7 lines constructed so far are supposed to have a capacity of 1050 tSWU/year). JNFL claims that it will maintain the last line until a new centrifuge, which is now under development, is introduced, although the capacity of that line has fallen to such an extent that it might as well be stopped.

The original aim was for the plant to have a capacity of 1,500 tSWU/year, but the capacity is now down to less than one tenth of this.

Joint uranium exploration in Canada

On February 11th, Japan Oil, Gas and Metals National Corporation (JOGMEC) signed a letter of intent with Canada's Titan Uranium concerning joint uranium exploration in Titan's Virgin Trend Project. This project is located in the Athabasca Sedimentary Basin, where one third of the world's uranium is mined.

JOGMEC will provide Can$9 million for uranium exploration over a three-year term, giving it a 50% interest in the project. JOGMEC also has the option to provide an additional Can$6 million to obtain the exclusive marketing rights of the mineral products of the joint venture for a 10-year period from first commercial production.

NEXI to insure nuclear exports

In a move that is clearly designed to support Japanese companies trying to export nuclear power plants and related equipment, Nippon Export and Investment Insurance (NEXI) plans to offer preferential insurance conditions for exports that contribute to lowering greenhouse gas emissions. The insurance would cover such situations as disruption to projects due to natural disasters and acts of terrorism.

The proposed new scheme was reported on the front page of the 19 February edition of Nikkei Shimbun newspaper. According to the article, the scheme will come into effect this summer. Worth 2 trillion yen, it will represent one seventh of NEXI's total underwritings (14 trillion yen), meaning that large-scale projects, including nuclear power plants, could be covered. (Until now, government finance and loan guarantees have not been granted for nuclear exports to developed countries, but this restriction would not apply to this scheme.) Insurance premiums would be reduced by 30% to 70% and, where usually a maximum of 97.5% of the loan or export value can be insured, under this scheme the full value could be covered.

Besides NEXI, the Japan Bank for International Cooperation (JBIC) is also moving to increase its financing of nuclear projects. Last year the government announced its intention that JBIC and NEXI should provide finance and insurance to support Japanese companies bidding to build new nuclear power plants in the US (Nikkei Shimbun, 23 June 2007). The article was reporting on the first meeting of the steering committee of the United States - Japan Joint Nuclear Energy Action Plan. The meeting was held in Washington on 22 June 2007 between officials from Japan's Ministry of Economy Trade and Industry and the US's Department of Energy.

IAEA releases second report on Kashiwazaki-Kariwa

According to the IAEA's press release (1 February) for its second report on the Kashiwazaki-Kariwa nuclear power plant, the follow-up fact-finding mission "concluded from the examination of the plant's key safety areas that there was no significant damage to safety equipment from a strong earthquake last year." The media faithfully reported this conclusion, but a closer reading reveals that the report was not the unequivocal endorsement that it is made out to be. The points made in the following extract (page 9 of the report) are very similar to the issues raised by KK Scientists (see pages 1-9 of this issue of NIT).

> "- While discussing the analytical portion of the integrity evaluation plan, the following points were noted:
>
> • The simple models used in the analyses may not always provide conservative results;
>
> • The analysis presented used a set of assumptions that may need to be reviewed, if the plant is required to be re-evaluated to a similar or greater seismic input. It was suggested by the IAEA expert team that it would be better to adopt a more realistic set of assumptions, methods and modelling and acceptance criteria for these analyses, in order to proceed consistently during the entire re-evaluation process.
>
> - It was noted that the conducted (sic) visual inspections conducted are adequate to detect large and widespread deformation such as bent piping. However, the visual inspections will not identify damage that may be internal to the component or localized plastic deformation...there is no standardized inspection method to detect localized plastic deformation in a non-destructive fashion..."

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