NEWSLETTER

RADIOACTIVE WASTE MANAGEMENT

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The FNCA 2004 Workshop on Radioactive Waste Management,

27 September – 1 October 2004, Kuala Lumpur, Malaysia

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The Ministry of Science, Technology and Innovation of Malaysia represented by the Malaysian Institute for Nuclear Technology Research (MINT) and Atomic Energy Licensing Board (AELB) together with the Ministry of Education, Culture, Sport, Science and Technology (MEXT) of Japan in Cooperation with the Japan Atomic Industrial Forum, Inc. (JAIF) have jointly organised the FNCA 2004 Workshop on Radioactive Waste Management. The event was successfully held in Kuala Lumpur, Malaysia for the period of 27 September to 1 October 2004.

The Workshop received full support from the nine FNCA member countries comprised of Australia, China, Indonesia, Japan, Korea, Malaysia, the Philippines, Thailand and Vietnam who sent delegates to participate the meeting. Like in the previous years, during the meeting the delegates briefed on the current status of radioactive waste management of their respective countries and exchange views on other issues of concern by all members such as security of radiation sources and management of TENORM.

The programme on the first day was mainly dedicated for participants to present country report on the current status of radioactive waste management. It was interesting to note on the variety of issues raised by the participants ranging from regulations/ legislations, waste inventory as well as technologies involved as means to control radioactive waste. Perhaps establishment of repository for disposal of radioactive waste presented the most complex issue for the majority of the countries. The first day ended with the review of the project evaluation results. Participants of the meeting have unanimously agreed that the Forum has provided a useful platform among others, for promoting safe management of radioactive waste, exchanging experience and information, creating awareness among member countries and equally important maintaining cooperation.

On the second day, the participants discussed issues of TENORM as raised by several member countries. Again, the issue revolved from the legal and technical stand points. The theme for the session was 'regulatory Aspects including, Exclusion, Exemption and Clearance on NORM/TENORM, treatment, characterization, siting, disposal and waste acceptance criteria.

The third day was allocated for technical visits. The participants were taken for their first visit to natural radioactive elements namely uranium and thorium and their daughters. On the way back, the delegation paid a short visit of the new office of the Atomic Energy Licensing Board (AELB) where they were briefed on the activities of the Board. Subsequently, the participants made a quick tour to MINT and had the opportunity to glance the storage facility for oil sludges and were briefed on the project. A lunch hosted by the AELB was held at a hotel in Bandar Baru Bangi. Prior to returning to Kuala Lumpur, the delegation was taken to the Malaysian new Federal Government Administration Centre in Putrajaya.

On the fourth day, the participants concentrated on the TENORM Task Group activities, planned of the activities for the next three year activities, and prepared minutes of the meeting. It was decided that the next workshop would be held in Tokyo. In addition to that, an international conference on disposal of radioactive waste has also been planned to be held at about the same time to enable the participants to join the conference as well.

On the last day of the workshop, participants finalised and adopted the minutes. All participants expressed their appreciation that the workshop has run smoothly and achieved the set objectives.

Disposal of Free Release Waste From ANSTO

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As a result of reactor operations, radioisotope production and various research activities using radioactive substances, a wide range of radioactive wastes are produced at ANSTO. A number of radiation detection systems are employed to monitor and characterise these waste streams. Gamma ray spectrometry for quantitative determination of radionuclides is a key component in the waste assessment and classification system at ANSTO.

All non-liquid wastes generated at ANSTO are classified according to their physical properties. Gloves, disposable personal protective equipment, laboratory glassware and small plastic items produced from laboratories, and radioisotope production areas are classified as soft waste. Additionally other potentially radioactive non-soft wastes are produced on site including metal and non-metal plant equipment, scrap wood, contaminated demolition waste and some various minerals from mine wastes. These materials are classified as solid waste. All other types of wastes such as large structures, metal components and furniture resulting from plant modifications and upgrades, excavation and demolition activities are classified as bulk waste.

ANSTO's waste management activities are regulated under the Australian Radiation Protection and Nuclear Safety (Consequential Amendments) Act 1998 and the New South Wales Radiation Protection Act (1990). ANSTO has established criteria for releasing waste for unconditional disposal based on the international best practice and regulatory requirements.

A commercial Canberra® Q^2 low-level waste assay system is used for gamma ray spectrometry of waste designated for clearance or exemption at ANSTO. The comprehensive shielding in the Q² system significantly improves the detection limits of most gamma emitting nuclides making it ideal for assessing waste against clearance or exemption limits. Minimum Detection Activities (MDA) for the Q² system are significantly lower than most clearance and exemption limits (Table 1).

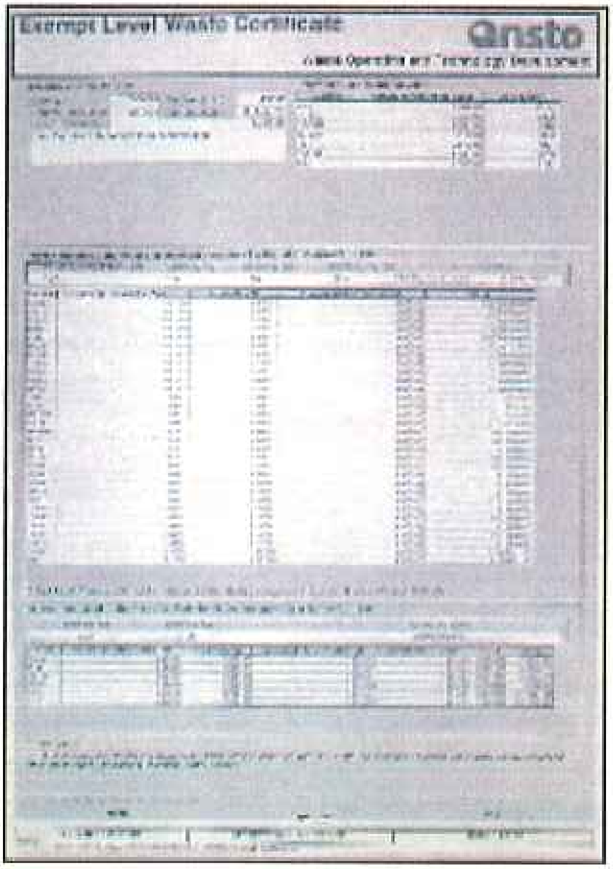
Some radionuclides present in the waste produced at ANSTO cannot be identified by gamma ray spectrometry. Nuclide correlations and release control/waste certification systems have been implemented to ensure that these nuclides are taken into consideration in the final assessment of the wastes.

The release control and waste certification system at ANSTO takes a 'defence in depth' approach in its assessment and release of waste. Wastes deemed to be suitable for free release are subjected to a three separate assessment processes using beta/gamma counting techniques and process knowledge in each of the stages.

At the point of generation, waste generators classify waste as radioactive ('active') waste or provisional free release ('white') waste, based

Table 1: Some MDA values for a 200 L drum containing 85 kg of activated carbon

Nuclide	*MDA value (Bq/kg)*
Am-241	160
Co-57	3.1
Co-60	1.3
Cs-137	1.8
Eu-152	5.5
I-131	1.7
Mn-54	1.3
Mo-99/Tc-99m	2.5
Na-22	1.5
Pb-202 (using Tl-202)	1.8
Ra-226 (using Pb-214)	13
Sb-125	4.7
Th-nat (using Ac-228)	6.2
Tl-201	16
U-235	3.4
U-nat (using Pb-214)	13
Zn-65	4.0



on process knowledge and appropriate total gamma/beta count rate measurements. Most types of wastes deemed suitable for free release at this initial assessment are packaged in 200 L drums for Stage 2 assessment.

Gamma ray spectrometry is the key technique used in the Stage 2 assessment of waste. Other forms of assessment, such as contamination monitoring or total beta/gamma counting are used only when gamma scanning is not possible.

Gamma spectrometry results for each drum are recorded and a certificate of classification as either 'Exempt Level Waste' or 'Radioactive Waste' is issued. Waste that is not suitable for free release is managed as low level radioactive waste. All waste arising from controlled areas are assumed to be radioactive unless measured activity levels are below clearance levels. (1/10 of limits specified in the IAE Basic Safety Series). Wastes arising from other areas are assessed against the exemption limits. All wastes found suitable for release are released for unconditional disposal are released under the broad category of 'Exempt Level Waste'.

The third and the final assessment of free release waste is the use of an Exploranium® AT-900 vehicle radiation monitoring system to scan waste consignments prior to disposal.

On the basis of gamma ray spectrometry, over 35 tonnes of waste have been shown to meet regulatory requirements for free release.

A particular challenge in waste management is dealing with materials which contain naturally occurring radionuclides (NORM) in concentrations close to or in excess of recommended clearance levels.

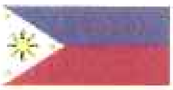
Radionuclide activity data used in conjunction with process knowledge may be used to assess such wastes on a case by case basis with a view to permitting free release. As shown in Table 2 below, approximately 300 kg of refectory bricks resulting from decommissioning a furnace used in the testing and development of ceramic wasteforms was released on the basis of exemption, although it contained natural radionuclides above clearance levels.

Table 2: Examples of waste exempted or cleared from radiological control

Description of waste	*Origin*	*Activity concentration (Bq/kg)*		*Weight (tonne)*	*Method of release*
Activated carbon	Filters used in radioisotope production facilities.	K-40 U-nat Sb-125 Th-nat Cs-137 Na-22 Co-60	99 28 6 6 3 2 1	3.6	Clearance
Refractory lining and bricks	Waste from decommissioning of a furnace.	K-40 U-nat Th-nat Co-60	330 100 64 2	0.3	Clearance
Top soil	Excavation spoil.	Th-nat K-40 U-nat	264 129 52	4.5	Exemption
Grit blast	Lead contaminated grit blast used in the removal of lead paint from effluent paint from effluent mixing tanks.	Cs-137 Th-nat U-nat K-40 Co-60	59 34 31 23 15	22.6	Exemption

Surface Radioactive Waste Repository in the Philippines

Preliminary Results of the Site Characterization Study for a Near



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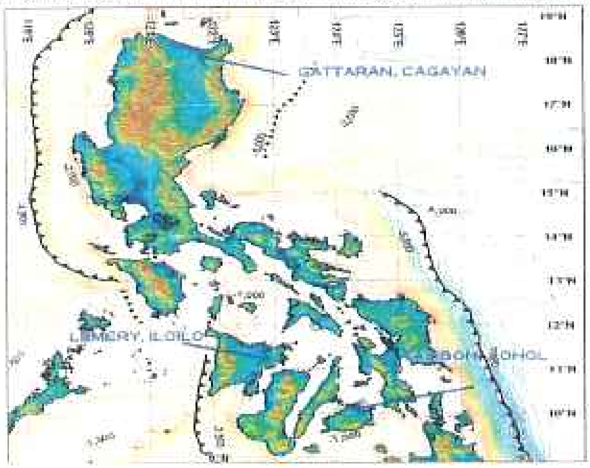
Based on the results of preliminary field investigation and available technical data, the final three (3) candidate sites depicted in figure 1 were identified for detailed site assessment study. The objective of the site assessment is to establish the geological, geomorphologic and hydro-geological characteristics of each of the 3 sites and rank them in the order of suitability for subsequent detailed sub-surface investigation. In consideration of the vast resources needed to perform detailed sub-surface investigation the technical committee working on the project agreed that a single site would be identified thereby allowing focused work activities on this single particular location.

Several auger holes were drilled at different depths and appropriately spaced from each other in order to cover the conceived footprint of the planned facility. The auger holes were ensured to reach depths that penetrate into the upper highly weathered sections of the underlying bedrock. In-situ permeability tests were conducted and soil samples were taken for basic laboratory analysis of engineering properties. Rock samples were collected for petrographic analysis while surface water samples were obtained for basic chemical analysis. Landslide and erosion scars were noted in the assessment of surface and subsurface site stability.

All observations and auger hole locations were plotted using a 1:50,000 topographic map. Preliminary results indicate that the 3 candidate sites were found to be significantly away from the active subduction zones. They are all located in areas with low seismicity level. The relative ranking of the sites was evaluated based on

Figure 1
Location and Landform Features in the Three-Candidate LILW Depository Sites. The Terrain is shown as Shaded Relief Map. Colored Lines are Ocean Floor Bathymetry with Few Depths Indicated. Toothed Lines are Subduction Zones Marked by Deep Oceanic Trenches, Showing Direction of Plate Underthrusting.



hydro geological conditions, foundation suitability, potential for mass movement, site development, and accessibility. A score of 1 to 3, i.e. most favorable to least favorable was used and applied for each of the parameter. The site with the least total score was considered the most favorable.

NORM waste from uranium mining and milling facility in Japan

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Reclamation program on waste generated from uranium mining and milling at the Ningyo-toge, Okayama, Japan is being conducted (Fig.1). Related wastes are mainly composed of uranium mill tailings and waste rocks left after a domestic exploitation project from mid 50's to late 80's. Dismantling debris that will be generated accompanied by decommissioning of mining facilities is also expected (table 1). Currently, they are maintained for the purpose of environmental protection including radiological and non-radiological hazard accordance with the mine Safety Law (MSL). Regarding to radiological hazard, these wastes are currently controlled by 1mSv/a at site boundaries under MSL, and would be also applied a policy regarding exemption of NORM/TENORM which was formulated by the Radiation Council in 2003. Radionuclides contained in the waste consist of uranium-series with long half-lives, and require long-term waste management. Measures will be principally carried out with encapsulation in accordance with MSL which is similar to remediation measures on uranium mill tailings and mining sites applied

Fig. 1
Locality of Ningyo-toge

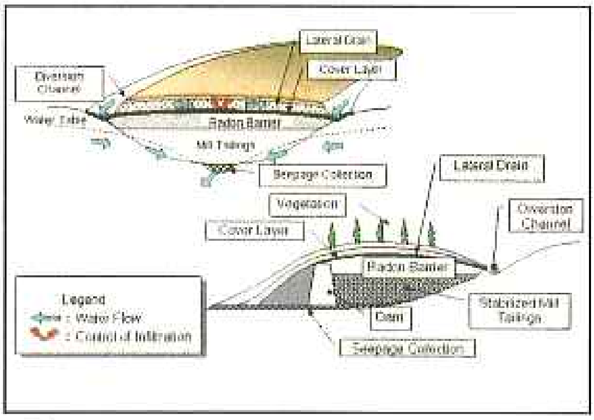

Fig. 2
Suppositional measures on uranium mill tailings

in several countries (Fig.2). The objectives of the site measures included are; solids containment, control of radiation exposure, control of radon gas, control of liquids, stability and integrity of site structures. Monitoring and surveillance will be carried out in every phase of reclamation. In order to verify that site measures would be maintained by the institutional control.

Concept of measures has been established with a perspective through safety analysis after a series of discussion at boards consisting of specialists and experts from other organizations. Current phase is the stage to perform various field measurements, laboratory-scale tests and demonstration-scale tests in order to collect data for safety analysis and site designing including analysis to evaluate site stability.

A current topic of the program is on measures of waste rock in the Katamo site, one of 17 yards around the Ningyo-toge following a decision of the Supreme Court (Fig.3). That decision includes displacement of waste rock which was estimated about 3,000 m^3 according to an agreement concluded between a local community and the Power Reactor and Nuclear Fuel Development Corporation, former JNC, in 1990. Those inventories correspond to higher level than 0.3 micro Sv/h. Suppositional measures would be displacement and disposal in an inclined shaft or a shaft with plugging. The site and methodology for disposal does not come to an agreement with interested parties i.e. local communities and/or local governments, and JNC due to difference of their opinions.

Year of 2005 will be the 50th anniversary of the uranium ore deposit discovery in Ningyo-toge. That was the first findings in Japan and led to the dawn of the Nuclear Age. The RWM workshop of FNCA will be held in Japan next year. We hope we can meet you and share some issues on the management of radioactive waste among Asian countries.

Fig. 3
Waste rock yard with relatively high radioactivity
The lower right portion shows a hole left after illegal and compelling displacement of waste rocks in a flexible container by a citizen's group

Table1 Major characteristic on waste

Waste	Volume	Average U Concentration (Bq/g)	Average ^{226}Ra Concentration (Bq/g)
Waste Rock (17 sites)	ca 200,000 m^3	< 0.09 - 0.42	-
Mill tailings	ca 34,000 m^3	ca 3	ca 16
Heap Leaching Facility [a]Tank, Valve, Ion Exchange Resin, Concrete, etc	ca 10,000 drums(estimated)	-	-

a) Demolition of heap leaching facility is now under consideration, therefore waste volume described here is based on estimation. Radionuclides contained in waste rock are considered to be uranium and its progeny, whereas mill tailings that is residue of ore extracted by sulfuric acid, is depleted in uranium only (relatively rich in ^{226}Ra).

NORM/TENORM activities in Thailand

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The Discussion/ Survey Meeting on NORM/ TENORM in Thailand was held on 23-27 August 2004 under the support of TENORM Task Group, JAIF, MEXT and OAP. The meeting comprised of presentation on the status of NORM and TENORM in Thailand and Japan, discussion on several relevant issues on NORM and TENORM as well as technical visits. Personnel from industry, regulatory authority, waste operator and research organisations participated in the meeting.

Thailand has a variety of mineral resources – so far a total of 40 minerals have been developed and exploited in the country. About 20 minerals are considered to be of important due to their sizable amount for production and economically feasible for exploration. The minerals industry in Thailand may be divided into a small mining and mineral processing sector of ferrous and nonferrous metals, and a large mining and mineral processing sector. On the othe hand the energy sector, which includes production of coal (lignite), natural gas, and crude petroleum , although small but is growing.

Currently, Thailand has no established regulations which directly control NORM and TENORM. The existing regulations to control natural radioactive materials are different from those of artificial radioactive materials. The fact is, it is impossible and impractical to isolate a very large amount of materials containing relatively high concentrations of long lived natural radionuclides from the environment. Therefore, the exemption and clearance levels for natural radionuclides should be carefully set up to avoid unnecessary control of a large number of industries without any benefit of radiological protection.

A clear picture of industrial processes that encounter problems with natural radionuclides can be obtained based on inventory of work activities. In many cases, we know that the problems are associated with enhanced concentration of natural radioactivity in processing ores, products or residues. In case of Thailand, the selected industries under consideration are phosphate and fertilizer industry, metal and rare earth production industry, cement industry, oil and gas production, and water treatment.

Site of Phosphogypsum

Conditioning of Spent Radium Needles in Malaysia


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The conditioning of radium needles was an important project carried out by MINT in September 2004. The project involved radium needles that had been collected from the medical sector in Malaysia and stored at the waste storage facility in MINT since 1994. All the radium needles were from the Radiotherapy Institute, Kuala Lumpur Hospital. The activity for the needles, ranged from 0.5 to 24.0 μCi each.

MINT requested the assistance of the IAEA under the IAEA TC INT/4/131- Sustainable Technologies for Managing Radioactive Waste program in carrying out this project, using the conditioning method developed by the IAEA. References and guidelines were made from IAEA Publications: (1) IAEA, Conditioning and Interim Storage of Spent Radium Sources (TECHDOC-886) 1996 and; (2) Technical Manual for Conditioning of Radium Sources (Working Material) 2000.

Preliminary planning for the work started in early 2004. Conditioning of these radium needles were successfully carried at the Waste Management Centre, MINT from 6th to 10th September 2004, with the technical assistance from an IAEA expert, Mr. Janos Balla. The team from MINT involved 7 operational and 5 support personnel.

The radium needles were sealed in stainless steel canisters and placed in stainless steel drums and securely stored in the interim waste storage facility at MINT. Future planning would take into consideration the Ra-226 from other sources.

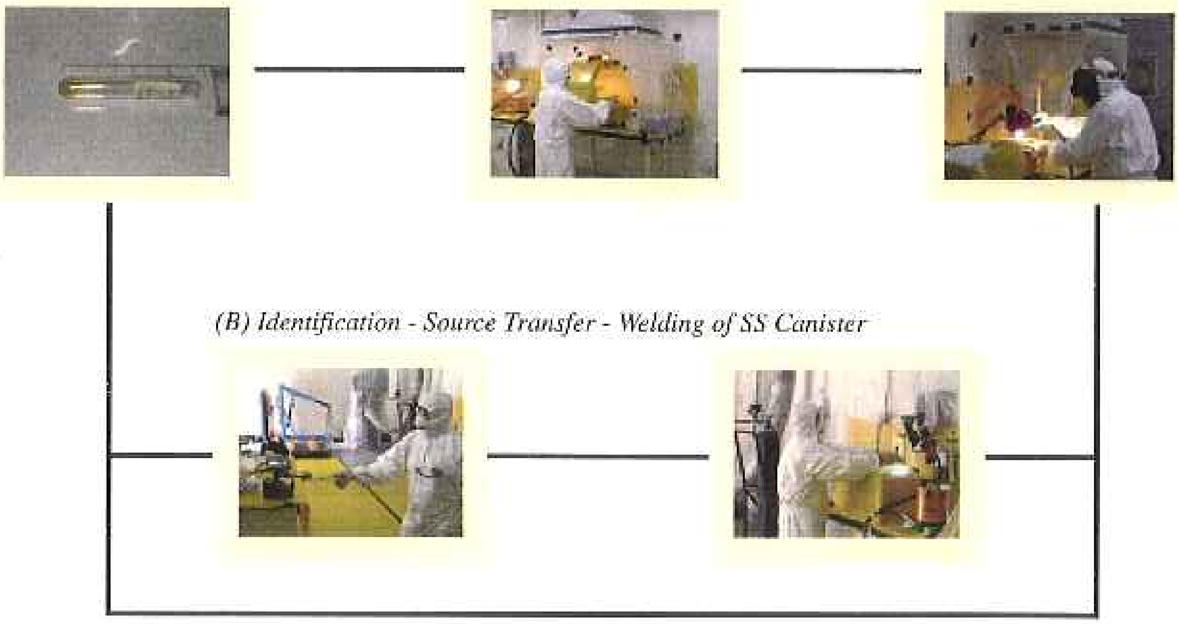
Information on Ra-226 Conditioning

Package No	*Shield No*	*Capsule No*	*Capsule Position*	*Activity*		*Number of sources*[2]
				mg	*GBq*	
		ML-1-01	*1*	*5.5*	*2.035*	*22*
		ML-1-02	*2*	*48.5*	*1.795*	*20*
		ML-1-03	*3*	*42*	*1.554*	*16*
		ML-1-04	*4*	*45*	*1.665*	*3*
		ML-1-05	*5*	*45*	*1.665*	*3*
		ML-1-06	*6*	*50*	*1.850*	*5*
1	*1*	*ML-1-07*	*7*	*50*	*1.850*	*2*
		ML-1-08	*8*	*35*	*1.295*	*3*
		ML-1-09	*9*	*46.5*	*1.721*	*12*
			Central	*0*	*0*	*0*
			TOTAL	***417.0***	***15.430***	***86***

Package No	Shield No	Capsule No	Capsule Position	Activity mg	Activity GBq	Number of sources(2)
		ML-1-01	1	5.5	2.035	22
		ML-1-02	2	48.5	1.795	20
		ML-1-03	3	42	1.554	16
		ML-1-04	4	45	1.665	3
		ML-1-05	5	45	1.665	3
		ML-1-06	6	50	1.850	5
1	1	ML-1-07	7	50	1.850	2
		ML-1-08	8	35	1.295	3
		ML-1-09	9	46.5	1.721	12
			Central	0	0	0
			TOTAL	**417.0**	**15.430**	**86**

The Conditioning Process

(A) Working Area Set-up



(B) Identification - Source Transfer - Welding of SS Canister

(C) Contamination survey - Bubble Test

(D) Tranfer to Pb Shield - WMC Personnel

Current Status of Korean Low and Intermediate-Level Radioactive Waste Repository Project and R&D News from KHNP

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1. Changing Policy on Radwaste Management

The policy on low- and intermediate-level radioactive waste management has been changed after the meeting of the Atomic Energy Commission on Dec. 17, 2004. The new plan for a radwaste management facility is basically to separate the site each for the low- and intermediate-level radwaste disposal facility and the spent fuel interim storage facility instead of constructing both in one site.

Korean government will announce candidate sites for a low- and intermediate-level radwaste early this year and a final selection will be completed by the end of the first half after the sufficient agreement of local community.

The separated construction plan comes after the government failed to find a candidate site for a radioactive waste management complex site as none filed applications by the deadline of Nov. 30, 2004. The government has not found a candidate since the government's plan to build a radwaste repository in Wido, an island in the West Sea, was failed by strong opposition from residents last February.

It will be promised to the residents of the host community that the low- and intermediate-level radwaste disposal site will not be incorporated with the spent fuel interim storage.

2. Starting Commercialization of New S/F Storage System

KHNP-NETEC, is now carrying out the detailed engineering project for the commercialization of MACSTOR/KN-400 CANDU spent fuel dry storage system, which is planned to be installed in Wolsong NPP, Korea. Detailed engineering work started from last October, and construction and test operation are planned to be completed by the end of 2007.

The MACSTOR/KN-400(M/KN-400) system which has very high storage density compared with currently commercialized CANDU spent fuel dry storage system has been jointly developed by KHNP-NETEC and the AECL of Canada. The M/KN-400 storage system is based upon the technology of MACSTOR-200, originally developed by the AECL, and has twice the storage capacity of MACSTOR-200. One M/KN-400 storage module has capacity to store 24,000 CANDU spent fuel assemblies, which is the amount of spent fuel generated during more than one year by 4 CANDU reactors (700MW each) located in Wolsong NPP site.

Once M/KN-400 CANDU spent fuel dry storage system is successfully completed, it will be the first system with highest storage density for the CANDU spent fuel dry storage in the world.

3. Developing Decontamination Equipment

The development of soil decontamination equipment and its experiments have also been performed in KHNP-NETEC.

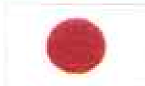
To develop the soil decontamination equipment, the most suitable soil washing process was selected among several decontamination processes. To achieve design data for the equipment, a series of lab-scale experiments were performed using contaminated on-site soil. On the basis of these design data, soil washing equipment was manufactured and installed in nuclear power plant.

The NETEC's soil decontamination equipment is composed of a particle separator using vibration screen, a soil washer and a liquid waste circulator. Both water and chemical agents are used as a washing agent. The decontamination equipment is installed in Younggwang site as shown in Fig. 1.

Fig. 1
NETEC's Decontamination Equipment

Recent activities related to clearance in Japan



Prof. Toshiso KOSAKO, Dr. Hidenori YONEHARA and Mr. Minoru OKOSHI

Radioactive materials generate from the development and utilization of nuclear energy, radioisotope utilization in the field of research, medicine, agriculture, industry, etc. It is indicated that some types of radioactive material do not need to be subject regulatory control because they can only give rise to trivial radiation hazards [1]. The process to remove such materials from regulatory control is called as "clearance". The corresponding levels of activity concentrations are called clearance levels. Clearance is the important concept to manage slightly contaminated materials from the view points of adequate allocation of human and economic resources. Especially for the dismantling of nuclear facilities the clearance is very useful because those operations generate a huge amount of slightly contaminated materials with radioactivity.

In Japan, the Nuclear Safety Commission (NSC) has the responsibility to derive clearance levels, and has already determined the clearance levels for solid materials generating from reactors and post irradiation examination facilities. After that the International Atomic Energy Agency (IAEA) published a Safety Guide related to clearance levels in 2004. The title of the report is "Application of the concepts of exclusion, exemption and clearance [2]." In the report the exemption levels for bulk quantities (greater than the order of a ton) of solid materials for all type of nuclear facilities. The clearance levels for artificial radionuclides are derived based on the following dose criteria;

- an effective dose criterion of 10 micro Sv/y in case of using realistic parameter values,
- an effective dose criterion of 1 mSv/y in case of using low probability parameter values, and
- a skin equivalent dose limit of 50 mSv/y.

Based on the above mentioned dose criteria and the following enveloping scenarios activity concentrations in Bq/g are calculated and the minimum levels for each radionuclide are selected;

- Scenario WL: Worker or landfill or in other facility (other than foundry),
- Scenario WF: Worker in foundry,
- Scenario WO: Other worker (e.g., truck driver),
- Scenario RL: Resident (adult and child) near landfill or other facility,
- Scenario RF: Resident (child) near foundry,
- Scenario RH: Resident (adult) in house constructed of contaminated material,
- Scenario RP: Resident (child) near public place constructed with contaminated material, and
- Scenario RW: Resident (adult and child) using water from private well or consuming fish from contaminated river.

In above mentioned scenarios, external exposure, inhalation exposure, ingestion exposure (direct and indirect) and skin exposure are considered. Finally calculated activity concentrations are rounded 3×10^{x} - $3\times10^{x+1}$ to 10^{x+1}. The IAEA recommends using those exemption levels to clearance levels and national and international trade. The detail information to derive the exemption levels are given in the Safety Report [3].

The NSC reexamined their clearance levels based on the new information given in the IAEA document. The reexamination was mainly carried out from the following view points:

- Addition of skin dose equivalent,
- Use of new dose coefficients given in ICRP Publ. 68, 72 and 74,
- Evaluation of effective doses for child including infant, and
- Addition of direct ingestion of dust including radionuclides.

The reevaluated clearance levels for major radionuclides are shown in Table 1 comparing with the clearance levels derived by the IAEA. The NSC concluded that both numerical values are almost same and the newly derived clearance levels are adequate to release contaminated solid materials safely.

The advisory committee for the NISA (Nuclear and Industrial Safety Agency) prepared a report

(Unit: Bq/g)

Radionuclide	NSC	IAEA	Radionuclide	NSC	IAEA
^{3}H	60	100	^{94}Nb	0.2	0.1
^{14}C	4	1	^{99}Tc	1	1
^{36}Cl	0.3	1	^{129}I	0.5	0.01
^{54}Mn	2	0.1	^{134}Cs	0.5	0.1
^{55}Fe	2000	1000	^{137}Cs	0.5	0.1
^{60}Co	0.3	0.1	^{152}Eu	0.4	0.1
^{59}Ni	30	100	^{154}Eu	0.4	0.1
^{63}Ni	100	100	239Pu	0.2	0.1
^{90}Sr	0.9	1	^{241}Am	0.3	0.1

Table 1 Clearance levels for major radionuclides derived by the NSC and the IAEA

for clearance systems in 2004 after public consultation involving the two times of symposiums in Tokyo and Osaka. The report includes the basic concepts for safety assurance systems for clearance including the monitoring system of clearance levels. The NISA planned to stipulate the old clearance levels derived by the NSC, but they decided to use the clearance levels by the IAEA from the view point of the international harmonization.

The flow chart of clearance is shown in Fig. 1. The operators who wish to release contaminated materials have the main responsibility to demonstrate the compliance with the clearance levels. On the first stage, the operators evaluate the activity levels and amounts of candidate materials and collect the information to perform the monitoring adequately. And they submit a report how to perform the monitoring of the clearance. The regulatory authority checks the adequacy of the monitoring program. If they review the adequacy of the operator's monitoring program, they should approve the monitoring program.

On the second stage, the operators should submit the documents of monitoring results to the regulatory authority. The authority verifies the monitoring results based on the submitted report and also they measure the activity levels of samples if necessary.

The detailed monitoring program of clearance has been developed the Japanese Atomic Energy Society [4]. The operators plan to use the program for the decommissioning procedures of their nuclear facilities in the future.

The NISA is drafting a bill for clearance and will present the bill in the Diet in 2005. After the completion of the amendments of the Nuclear Regulatory Law, the NISA will establish the order and notification for clearance. Those rules will be applied for the decommissioning of nuclear facilities including the Tokai NPP which is under the dismantling and they will contribute the reasonable waste management.

References

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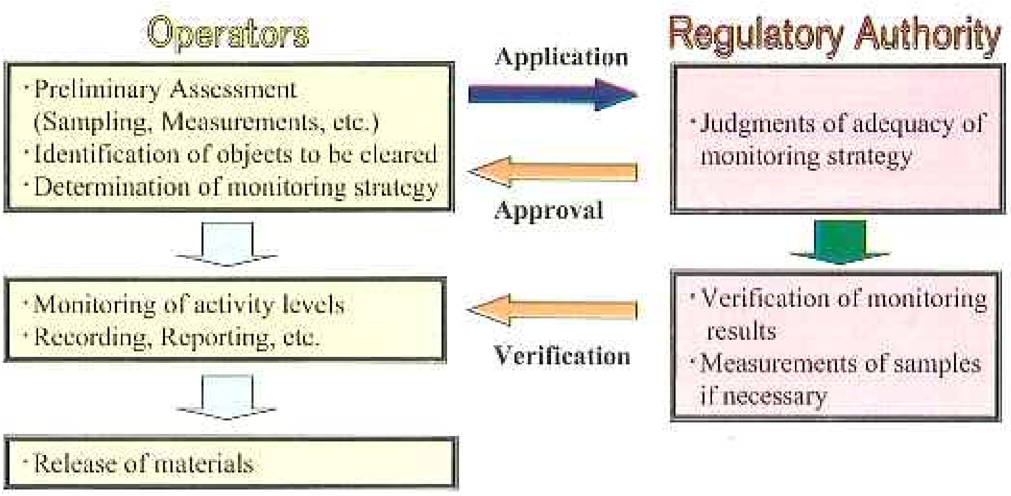

Fig. 1 Verification scheme for clearance in Japan

CLEARANCE CRITERIA OF Ra-226 IN SOILS FOR NORM DISPOSAL IN MALAYSIA

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A decommissioning and decontamination program for a monazite processing plant facility is currently conducted in Malaysia. The Atomic Energy Licensing Board (AELB) of Malaysia has approved the criteria for release of the site right after the decontamination and disposal of the decommissioning wastes related to NORM/ TENORM. The criteria are given in the form of acceptable residual radioactivity levels of Th-232 and U-238 for soil and pavement material, describes as the following:

a From ground surface to a depth of 1 meter: 0.33 Bq/g for U-238 (not including background) 1.0 Bq/g for Th-232 (not including background) (U-238/0.33) + (Th232/1.00) = < 1.0

b. From a depth of 1 meter to bedrock: 0.90 q/g for U-238 (not including background)
1.0Bq/g for Th-232 (not including background)

c. Combined Th-232 and U-238: (U-238/0.90) + (Th-232/1.00) =< 1.0 where U-238 are concentrations above established background concentrations.

However, in view of the Ra-226 radionuclide as part of the decay chain of U-238 and coupled with its high radiotoxicity and mobility, it is deemed to be grossly inaccurate and technically unacceptable to ignore the presence of this radionuclide, and to exclude its consideration in the assessment of radiological hazard of the site. Therefore, lately the AELB is now considering including additional clearance criteria of acceptable residual radioactivity levels of Ra-226 for soil and pavement material.

It is a good practice to include radium as one of the key radionuclides to be considered in the cleanup criteria for safe release of a contaminated site with NORM wastes from past activities involving uranium and thorium. From past practices by some countries in cleanup activity of former uranium mines or mineral processing facility, radium is a very critical radionuclides in any remediation activities. Among the examples are:

(1) In Spain, design criteria used for the remediation activities for uranium mills and mines environmental restoration include the limit for radium radionuclides in their soil cleanup criteria. It requires reduction of the residual concentration of radium-226 in land, averaged over an area of 100 m^2, so that the background level is not exceeded by more than 195 mBq/g (0.2Bq/g) (averaged over the first 15 cm soil) and is less than 555 mBq/g (averaged over 15 cm thick layers of soil more than 15 cm below the surface).

(2) In Canada site characterization and an examination of human and environmental toxicity were used to develop cleanup criteria. The contaminants of concern at the site associated with uranium ore were uranium, arsenic and radium. The most restrictive criterion for the cleanup was the Ra-226 criterion of 0.1 Bq/g, which is the upper end of the range of background values found at the site.

(3) In Brazil, radium is the only radionuclide considered in the soil cleanup criteria used by the regulatory authority of Brazil for the decommissioning of a monazite processing plant at the Santo Amaro Mill located in a densely populated residential district of Sao Paulo City.

Based on factual information and technical evaluation of radium given above, it is strongly recommended to consider inclusion of the radium radionuclide into any clearance criteria of the residual radioactivity levels for soil at any potential site which intend to dispose NORM wastes. It has also been a practice in other countries to include radium as one of the key radionuclides to be considered in the cleanup criteria for safe release of a contaminated site from past activities involving uranium and thorium. In addition, conferences and seminars organized by IAEA and by some developed countries that in a cleanup activity of former uranium mines or mineral processing facility, radium is a very critical radionuclide in any remediation activities. For the remedial activities to proceed, data from background study, site characterization and an examination of human and environmental toxicity must also be taken into consideration to develop the cleanup criteria by the regulators.

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