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Radiation Safety & Radioactive Waste Management

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Contents

The 2013 FNCA Workshop on Radiation Safety & Radioactive Waste Management (RS&RWM)

10-13 September, 2013, Ulaanbaatar, Mongolia

The FNCA 2013 Workshop on Radiation Safety and Radioactive Waste Management (RS&RWM) was held from September 10 to 13 2013, in Ulaanbaatar, Mongolia. This workshop was co-hosted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan, and the Nuclear Energy Agency of Mongolia (NEA). Sixteen researchers and experts from eleven FNCA member countries, namely Australia, Bangladesh, China, Indonesia, Japan, Kazakhstan, Malaysia, Mongolia, Philippines, Thailand, and Vietnam participated in the workshop.

The first day was initiated with country report presentation, given by member countries detailing the public exposure in normal and emergency situation. Additional information, mainly in the area of regulatory framework, radiation emergency, and national monitoring systems were provided for the updating of the drafted 2010 FNCA consolidated report. Participants then had a discussion about the report on radiation safety that is consolidating drafts from the member countries. To check and review the latest report, member countries were divided into 3 groups and each group discussed areas to improve comparing their reports.

Fig1: The 2013 RS&RWM Workshop

In the morning of the second day, participants delivered a presentation about status of radioactive waste disposal and treatment at research institutes. In the afternoon, a technical visit to Central Geological Laboratory(CGL) was conducted. Initially, the FNCA participants were given a presentation that described the CGL's activities including its various cooperation with other professional organizations both local and international and its accreditations. This was followed by a guided tour of various facilities and laboratories where the participants got to observed and discussed the state of the art equipment and analytical procedures implemented by the CGL highly competent staff. After the tour, a roundtable discussion was carried out wherein the participants provided their impressions, comments and recommendations that would further support the activities of the CGL.

Fig2: Technical Tour at Central Geological Laboratory

An open seminar on Radiation Safety Control and RI Analysis/Control in FNCA Member Countries was held at National University of Mongolia on the third day. It was attended by around 60 local students and lecturers from universities, researchers, radiation safety inspectors from nuclear related institutes in Mongolia. A poster session was also held during the open seminar. Some leaflets related to RS&RWM, personal dosimeters, and survey meters from the member countries were displayed.

Fig3: Open Seminar at National University of Mongolia

On the last day of workshop, participants reviewed the project activities implemented during phase 4(2011-2013) and agreed to cooperatively work towards the completion of a consolidated report on radiation safety and the publication of the newsletter. All member countries agreed to continue the project with the theme -Progress of radiation safety of the general public during emergency and radioactive waste disposal situations. Subjects to be discussed for the next three years include emergency response and preparedness, radioactive waste disposal, decommissioning, disused radiation source management, transportation, storage of spent fuel, uranium mining, NORM waste etc. Kazakhstan was proposed as the next workshop venue.

Fig4: Discussion with CGL staffs

Topics from Participating Countries

Australia

Mr. Lubi Dimitrovski

Australian Nuclear Science & Technology Organisation (ANSTO)

The Australian Nuclear Medicine Project

Radioisotopes of Interest

Technetium-99m (Tc-99m) is the most widely used radioisotope in the nuclear medicine industry accounting for over 80% of diagnostic nuclear medical imaging worldwide. Its excellent nuclear and chemical characteristics lends itself to multiple medical and research uses, including the evaluation of the medical condition of the heart, kidneys, liver, spleen and bone, as well as blood flow studies. Its use is expected to continue to grow as countries expand their healthcare programs.

Molybdenum-99 (Mo-99), with a half-life of 66 hours, is used as the precursor for the generation of Tc-99m, whose half-life is only 6 hours. Over 95% of the Mo-99 required for Tc-99m generation is obtained by the fission of uranium-235 targets in nuclear reactors.

There are only a handful of nuclear reactors producing radionuclides for nuclear medicine on an industrial scale. The majority of these reactors along with the Mo-99 production plants have been in operation since the 1950s and 1960s. The reliability of the supply chain has been challenged in the recent years as the aging facilities become increasingly prone to unexpected shutdowns. Furthermore, as the market is supplied by only the few major producers, supply disruptions inevitably occur when one or more of the reactors undergo scheduled or unscheduled shutdown at the same time.

The ANM Mo-99 Facility

The need for improvement of the Mo-99 supply is increasingly recognised. With the upcoming retirement of Canada's and France's multi-purpose research reactors in the next couple of years, a shortfall in the Mo-99 supply market is imminent. Australia has positioned itself to fill that global supply gap with its AUD83 million ($73 million) investment on a new Mo-99 manufacturing facility. It will be situated at the Australian Nuclear Science and Technology Organisation's (ANSTO's) Lucas Heights site near Sydney, where the state-of-the-art low-enriched uranium (LEU) Open Pool Australian Lightwater (OPAL) reactor, commissioned in 2006, will be providing irradiation for the LEU-targets.

OPAL is also the first research reactor in the world to use only low-enriched uranium as a target for neutron irradiation in the production of Mo-99 (as well as for fuel), in support for the Global Threat Reduction Initiative (GTRI) in its nuclear non-proliferation mission.

Demand for Mo-99

In Australia, an estimated 550,000 people undergo nuclear medicine procedures each year. The OPAL reactor is not only able to meet the demands of the domestic market, but has the capacity to produce half of the world's Tc-99 demand.

The new investment will enable ANSTO to significantly increase output, provide some 20 million doses per year, launching Australia as a major international supplier of the isotope. It will meet about one-quarter of the world's demand which currently numbered at about 45 million doses (23,000 six-day TBq) per year. The investment will also create some 250 jobs and deliver a AUD1 billion return to Australia.

The contract to design, develop and construct of Australian Nuclear Medicine (ANM) Molybdenum-99 manufacturing facility has been awarded to Australian company Watpac Constructions Pty Ltd. Design planning will commence in February 2014 and the project is scheduled for completion in early 2016, in time to alleviate the anticipated Mo-99 shortfall in the international market due to the shutdown of the main players in Canada and Europe. Potential export markets for the radioisotopes include USA, Japan, China and Korea.

Fig1: How the ANM Mo-99 facility at Lucas Heights may look.

Figure 1 above depicts how the ANM Mo-99 facility may look. The building will be classed as a nuclear installation and will be designed to meet regulatory requirements of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and Australian Non-proliferation and Safeguards Office (ASNO).

The ANM Waste Treatment Facility

Together with the Molybdenum-99 manufacturing facility (ANM Mo-99), the Australian Nuclear Medicine program also includes a 'first-of-a-kind' waste treatment plant for managing the subsequent radioactive by-products from production.

The co-located waste treatment plant will use the SYNROC technology, which is a suite of technologies developed by ANSTO for immobilising various forms of intermediate- and high-level radioactive wastes for disposal. In the ANM Waste Treatment Facility (**Figure 2**), the intermediate level liquid waste produced from the Mo-99 production facility will undergo a volume reduction and encapsulation process. The SYNROC process with its glass-ceramic waste form, made from a unique formulation of several natural minerals, is able to incorporate nearly all of the radioactive elements present in waste into their crystal structures. A significant volume reduction of up to 99% can be achieved.

Fig2: How the Synroc facility at Lucas Heights may look.

This technology is chosen as a permanent, safe and economical way of treating the intermediate level waste.

The SYNROC Technology

SYNROC's flexible process technology is able to accommodate variations in waste chemistry, allowing it to treat both acidic and alkaline wastes from ANSTO's past, current and future manufacture of nuclear medicines. The resultant waste volume using the SYNROC technology will only be 1% of the same wastes treated using cementation.

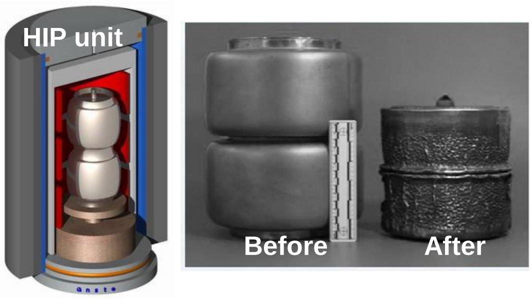


Fig3: Volume reduction achieved through the hot isostatic pressing (HIP) process, one of SYNROC's suite of technologies used for Mo-99 intermediate level liquid waste treatment.

The final SYNROC-treated wasteform (**Figure 3**) will be sent from Lucas Heights to Australia's National Radioactive Waste Management Facility (NRWMF), planned to be operational by the end of the decade.

More information on the ANM Mo-99 and SYNROC project can be found on the ANSTO's website. Information on Australia's National Radioactive Waste Management Facility can be found on the Department of Industry website.

Bangladesh

Dr. M. Moinul Islam, Ms. Moutushi Shidha Shome , and Mr. Shanjib Karmakar
Bangladesh Atomic Energy Commission (BAEC)

Regulatory Framework in Bangladesh

Legislative and Statutory Framework

The Regulatory Authority of Bangladesh is authorized for issuing rules and regulations and conducting licensing and supervisory processes for issuing licenses, and thereby regulating nuclear and radiation safety for siting, design, equipment manufacturing, construction, commissioning, operation and decommissioning of nuclear/radiological facilities. Nuclear Safety and Radiation Control Division (NSRCD), now called Bangladesh Atomic Energy Regulatory Authority (BAERA) is responsible for the regulation of issues related to accounting and control of nuclear materials, radioactive substances and physical protection. The BAERA is the competent authority for licensing shipments out of Bangladesh and giving consent to shipments into Bangladesh.

Fig1: Bangladesh Atomic Energy Regulatory Authority (BAERA), Dhaka

Legal Background

National policy is to provide adequate protection for man and the environment against undue exposure to ionising radiation from radiation sources and radioactive wastes for the present and future generation. Nuclear Safety and Radiation Control Act 1993 was duly approved and enacted (1993) and the Regulations have been put into force (1997). NSRC Rules -1997 are based closely on the BSS and cover most of the principal elements necessary for an effective radiation protection regime. They apply to all practices in Bangladesh, including those carried out in establishments of the BAEC.

The following acts that address the basic nuclear activities have already been approved by the Government of Bangladesh. This act will establish the set up basic requirements for management of radioactive waste; define basic requirements, licensing procedures and responsibilities of different organizations involved in nuclear activities and related radioactive waste management.

- Nuclear Safety and Radiation Control Act 1993, Act No. XXI of 1993,
- Nuclear Safety and Radiation Control Rules – 1997 SRO. 205 – Law/97, Date: September 04, 1997

The Radiation Protection Regulations contains information on clearance and sets up clearance levels and limits for authorized discharges of radioactive substances from nuclear facilities. In addition, Nuclear Safety and Radiation Control Division (NSRCD) presently known as BAERA have prepared new rules for the 'Radioactive Waste and Spent Fuel Management. The following regulations under BAER Act-2012 are being prepared:

- Regulation on the Safety of Nuclear Installations- Site Evaluation
- Regulation on Radiation Protection
- Regulation on Management of a Nuclear or a Radiological Emergency
- Regulation on Licensing of Nuclear Installation
- Regulation on Radioactive Waste and Spent Fuel Management
- Regulation on the Safety of Nuclear Power Plants Operation
- Regulation on the Safety of Nuclear Power Plants Design.

Present Status of Regulatory Framework:

A new act, called 'Bangladesh Atomic Energy Regulatory (BAER) Act-2012', has been passed 29 March 2012 by the parliament. As per act there is provision to establish an independent Regulatory Authority under the Ministry of Science and Technology to perform its regulatory activities. New Act will empower the regulatory authority to develop safety principles and criteria. The New Act and NSRC Rules-1997 include exclusion, exemption and clearance criteria. The new act allows appeal against regulatory decisions. Under the proposed act, a four member regulatory body, titled 'Bangladesh Atomic Energy Regulatory Authority' headed by a chairman, will be constituted to supervise the nuclear and radiological activities. Besides, an advisory committee will be formed with experts from related sectors. The issues of definition, goals and activities of the authority, determination of compensation, security and safety of the power plants as well as safety measures against radiation and management of nuclear waste have been mentioned in the proposed act. The public and other bodies are involved in regulatory process through training, workshop and seminar.

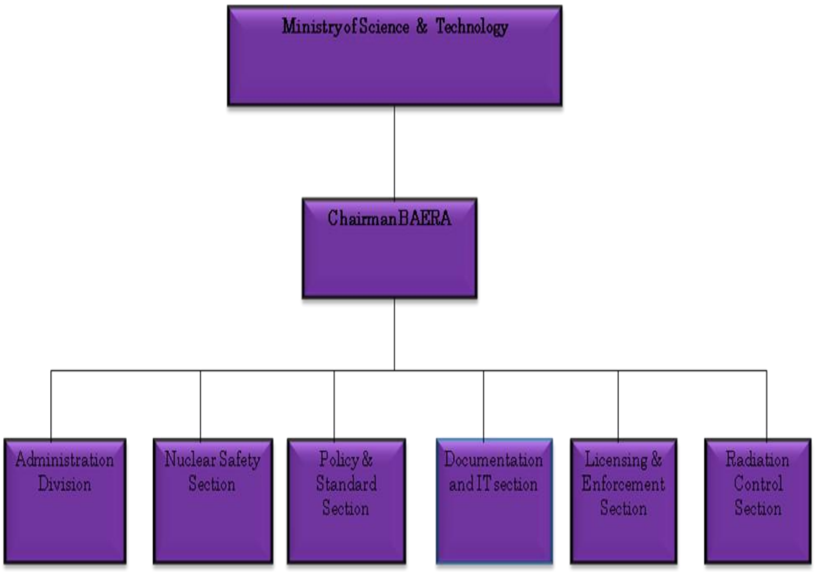


Fig2: Present Structure of Bangladesh Atomic Energy Regulatory Authority (BAERA)

Indonesia

Dr. Budi SETIAWAN
Dr. Suryantoro
National Nuclear Energy Agency (BATAN)

Radioactive Waste Management in Indonesia

INTRODUCTION

To anticipate the possibility of interim storage facility becoming full with radwaste packages, BATAN is preparing a location near waste treatment facility in Serpong Nuclear Area is used as a radwaste disposal site for demonstration purpose (SP-4 site, see Fig. 1), and near surface disposal type was chosen. Existence of a disposal facility for demonstration purpose in Indonesia is expected could show the ability and mastery of technology and safety on radwaste management activities to the public.

Disposal facility for demonstration purpose was also intended as a disposal facility for very low level radwaste with a half-life very short (less than 5 years) which are now being storage in the interim storage facility. Through a certain sorting system, some waste packages in the interim storage facility can be moved and placed at the demonstration disposal facility in the future.

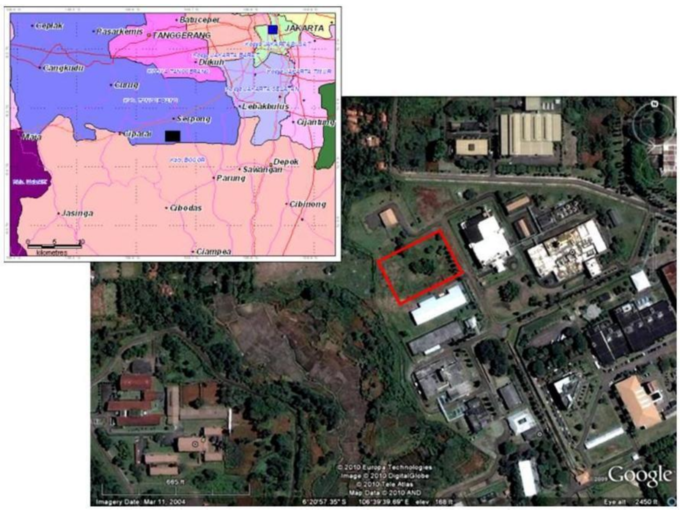


Fig1: Location of site candidate for demonstration disposal facility at Serpong Nuclear Area

Such as other radwaste disposal facility, the facility will be equipped with multibarrier system which consists of engineering barrier and natural barrier system to ensure the realization of environment and public safeties at the surrounding facility. SP-4 site as natural barrier system made the facility site provide an important position on the step of radwaste disposal facility preparation, and all information related to the condition and subsurface around the site need to be investigated in detail to determine soil ability supports facility construction, pattern and direction of groundwater distribution in the environment. The information can indicate possible direction of radionuclide spreading into environment when demonstration disposal facility operates. Placement of disposal and waste treatment facilities at a nearby location (as co-location principle) is expected to be a good example of radwaste management strategy in Indonesia in the future.

OBJECTIVE

To obtain field observation and drilling data on SP-4 site to be used for preparation of demonstration disposal facility construction meet the environmental safety requirement.

METODHOLOGY

Through field observation around the site and drilling work at some points in SP-4 site the information were searched. The data consists of seismicity and volcanic condition, site morphology, lithology and stratigraphy, depth of water table, and groundwater flow direction was collected.

RESULTS AND DISCUSSIONS

SP-4 site was classified as undulating plateau of fluvio-volcanic in geomorphology unit. Almost no difference in topography in the location with small slope, and geomorphologic processes became small. While the lithology up to 10 m depth including to black sandstone area which inserted with clay stone lenses. Massive clay stone was found at more than 20 m depths. Based on the unified soil classification system (USCS), soil at SP-4 site was classified as organic clay and silt with high compressibility, groundwater flow and variation of groundwater table. From XRD analysis, site soil contains calcite, dolomite and montmorillonite minerals. Calcite could be dissolved in groundwater and it can be an additional pathway for radionuclides migration into environment. The use of shallow foundation system in facility construction is less ideal. Soil stratigraphy at some drilling points on SP-4 site is shown in Fig. 2.

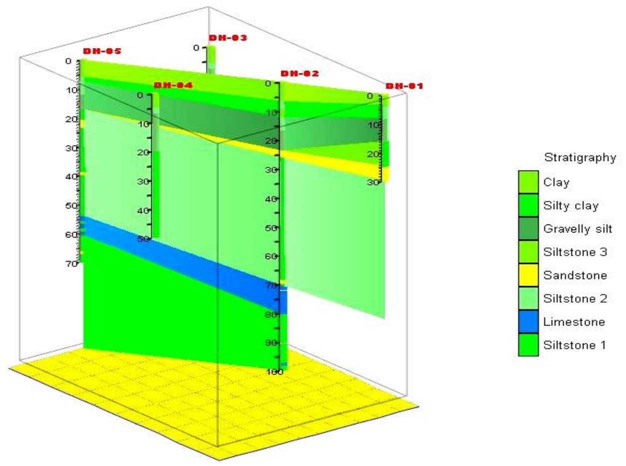


Fig2: Stratigraphy of soil in SP-4 site

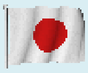
Environment of SP-4 site include to the Cisadane watershed, where about 180 m towards the west direction is found a surface water body, Cisalak river. While SP-4 site has groundwater level in 9-8 m depth, and its groundwater flow follows hydraulic gradient according to groundwater level contour to the southwest side slopes. Monitoring equipment on the groundwater pathway is needed to monitor the possibility of radionuclides release to the environment later, and the groundwater distribution will be controlled by lithology spread of and site morphology conditions.

Based on seismic zonation map of Indonesia, SP-4 site include to the area with seismic ground acceleration 0.15-0.3 g on the MMI scale $\leq$ IV. Nearby volcano is mount Salak with harmless status (dormant), located at a distance of > 50 km toward south direction with ash rain or lapili as a potential hazards to the facility.

CONCLUSION

Based on field observation and drilling work has obtained the data on the site morphology, lithology and stratigraphy, depth of water table, and groundwater flow direction, seismicity and volcanic condition,. The obtained of lithological and groundwater flow conditions indicate that the location is less ideal for shallow foundation system using, and the design of disposal facility need to be strengthened with multibarrier system.

Fig3: Current condition of SP-4 site



Japan

Prof.Toshiso Kosako
University of Tokyo
Dr. Yuji Matsuzoe
Fuji Electric Co., Ltd.

Radioactive Waste Disposal/ Treatment in Japan

Clearance level contamination monitor

Radiation handling facility (NNP and uranium mine, etc) occur the large amount of radioactive waste such as metal and concrete when facility is decommissioned

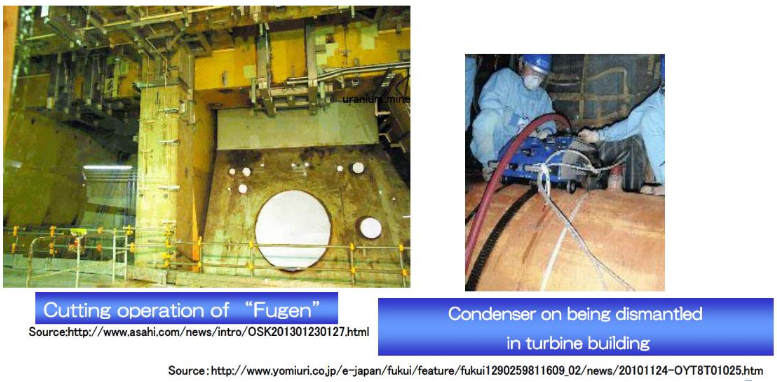


Fig1: Dismantling of Radiation Handling Facility

Radioactive waste is categorized into as following "High level", "L1","L2","L3"and clearance level. Clearance level is the level to discriminate "no need to handle as radioactive material". In case of cobalt 60 and 0.1Bq/cm2 or less, it can be handle as general waste.

Fig2: Clearance Level

Clearance monitor is to detect the shape of the article and radiation dose and evaluate the clearance level.

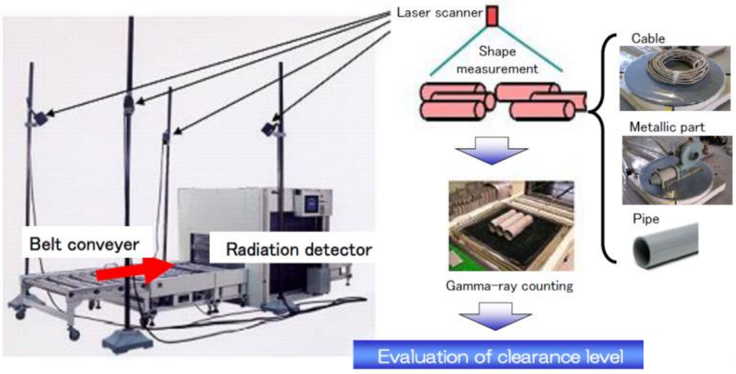


Fig3: Clearance level radiation monitor

Article contamination monitor

When the articles are taken out from radiation controlled area, it is necessary to confirm whether or not the contamination exists and contamination level is less than 4Bq/cm2. The monitoring equipment varies depending on article size such as pipe or concrete block and clothes to be measured.

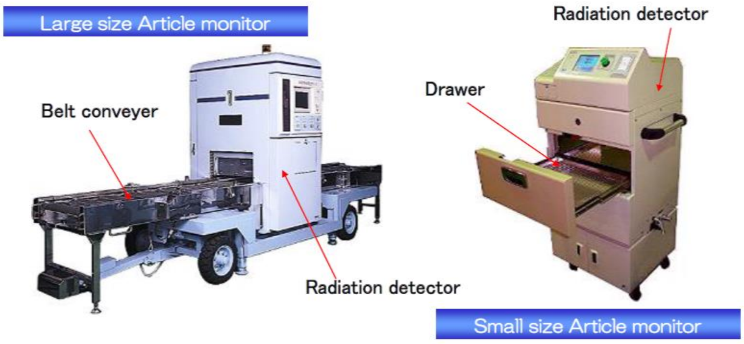


Fig4: Article contamination monitor

Wearing clothes in the radiation controlled area is monitored by Landry monitor which can detect the contamination generating from the radioactive material on clothes.

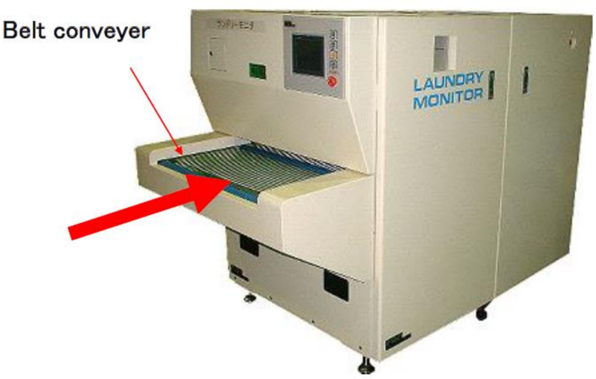


Fig5: Landry monitor

Food contamination monitor

In Japan, concern about radioactive material in food is increased since Great East Japan earthquake result in TEPCO Fukushima NPP accident.

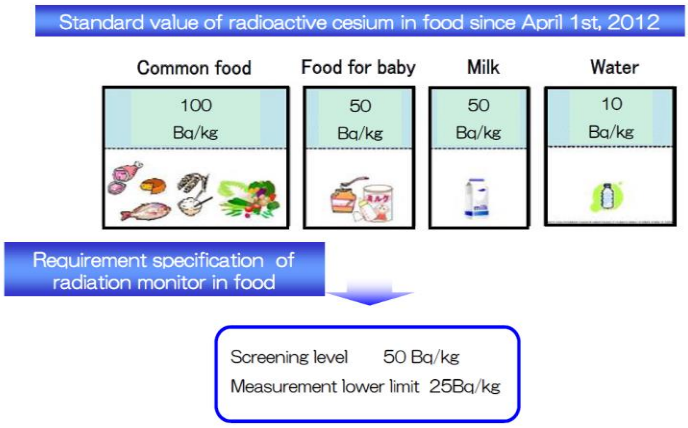


Fig6: Contamination provision of radioactive material in food

Fig7: Food contamination monitor

Fig8: Set up example of food contamination in Japan farmers' cooperative

Malaysia

Ms Nurrul Assyikeen Bt. Md. Jaffary
Dr Mohd Abd Wahab Yusof
Malaysian Nuclear Agency

Follow up training course on environmental monitoring at Nuclear Malaysia

FOLLOW UP TRAINING COURSE ON ENVIRONMENTAL MONITORING AT NUCLEAR MALAYSIA

Malaysian Nuclear Agency (Nuclear Malaysia) in collaboration with Japan Atomic Energy Agency (JAEA) has conducted 2nd Follow up Training Course on Environmental Radiation Monitoring from 16th until 20th of December 2013. Participants in particular from the Ministry of Health, Atomic Energy Licensing Board (AELB), Nuclear Malaysia and Malaysia - Japan International Institute of Technology (MJITT) were gathered at Nuclear Malaysia for 2 weeks to meet, networking and learn from distinguished local instructors and JAEA Experts.

JAEA and Nuclear Malaysia have recognized the importance of promoting and accelerating human resources development activities in each agency. This training course has been planned and launched to support the human resources development activities. All the local core-instructors contribute during Follow-up Training Course (FTC) are graduated from Instructor Training Course (ITC) program on Environmental Monitoring after attending 6 weeks train the core-trainers programs in Japan since 2010. The ITC is conducted under annual sponsorship by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of JAPAN (MEXT) of Japan government. The ITC program had contribute to human resources development in Asian countries, using Japan's knowledge, experiences and know-how in peaceful uses of nuclear energy.

The course was inaugurated by Dr Mohd Ashhar bin Hj Khalid, Deputy Director General, Malaysian Nuclear Agency. Mr Norfaizal Mohamed as the Project Course Coordinator, in his opening remarks hoped that this course will increase participants capability and skill in collecting, preparing, measuring and analysing of radioactivity sample and measure radiation in environment surrounding.

The FTC provided a series of lectures and basic practical experience for collection, preparation of environmental samples such as soil, water and grass in terrestrial and subsequent radionuclide analyses. The participants were also exposed practically in performing environmental radioactivity analysis using selected nuclear instrument such as Gamma Spectrometry System and Liquid Scintillation Counter. All participants were expected to understand theoretically and practically in performing environmental monitoring. Further, the participants were also given lectures on nuclear safety. This training program gave benefit to participants and it is that they will disseminate and share their knowledge to other staff at their respective work organization for better implementation of radioactivity and radiation monitoring in the environment.

In general, pollution of environments is global issues threatening the health of the beyond country borders. Fukushima Daiichi Nuclear Power Plant, accident on March 2011 gave us more concerned to the environments health. A failure to monitor the terrestrial and marine environment and recognize and deal with the effects of pollution result in negative impacts at all levels of economic activity, from subsistence uses of environment resources to commercial food processing, import and export of food product activities, agriculture operations and tourism. Therefore, the effort made by JAEA to lead and implement the training course on environment monitoring and nuclear safety is highly commendable to evaluate the possible impact of the releases of radioactivity into our environment.

Fig1: Group photo of the participants after opening ceremony in front of administration building, Malaysian Nuclear Agency

The Philippines

Ms. Editha A. Marcelo
Philippine Nuclear Research Institute (PNRI)

Conditioning of Spent High Activity Radioactive Sources(SHARS) in the Philippines Using the Mobile Hote Cell

The Philippines, through the Philippine Nuclear Research Institute, availed of the International Atomic Energy Agency (IAEA) technical assistance for SHARS conditioning in the early 2008. In November 2008, an IAEA pre-mission team conducted an evaluation of the SHARS inventory and the PNRI Radioactive Waste Management Facility.

Finally, the technical assistance request for SHARS conditioning was funded in 2012, and the Nuclear Energy Corporation of South Africa was contracted by the International Atomic Energy Agency in January 2013 to condition the SHARS using the Mobile Hot Cell.

The objective of the conditioning project was to ensure safe and secure management of high risk spent high activity radioactive sources (SHARS) in a long term storage container.

The containment process reduced the radiation level at the surface acceptable for long storage, thereby eliminating the risk of overexposure to the public and also possible covert action.

NECSA was authorized to conduct the SHARS conditioning at the PNRI Radioactive Waste Management Facility (RWMF) after complying with the regulatory requirements. The conditioning activity was conducted from March 21, 2013 to April 28, 2013.

SHARS Inventory and Description

SHARS are Category I radioactive sources from radiotherapy and irradiation facilities. These radiotherapy sources were used in the hospitals for treatment of cancer or tumor, while the irradiator sources were used by the different research laboratories at PNRI.

These sources were in the range of 100TBq-10PBq. Due to their high activities, they still pose a high risk to human health if not properly managed at the end of their useful lives.

A total of 22 units of spent teletherapy sources (Co-60, 18 units) and spent irradiator sources(4 units, 3 –Co-60 & 1 –Cs-137)) were stored in the PNRI Radioactive Waste Management Facility since late 1970s. These sources were received in original working device (teletherapy head), fabricated shielded container or original transport container.

SHARS Mobile Hot Cell

SHARS cannot be handled safely without utilizing standard remote handling tools in a shielded facility; otherwise, it could result in individual radiation exposure. The site must not be close to any multi-storey building to avoid the sky-shine during the conditioning operation. The site for the assembly of hot cell must have at least 30m x 30m surface area with a hard surface area of 8 m x 8 m in the center, reinforced and concreted. The site must be leveled.

The conditioning facility is a mobile hot cell that can be assembled, disassembled, packaged and transported to a site. It consists of a biological shield with a window for viewing the work in progress inside the hot cell cavity. The biological shield has a double wall cavity filled with ordinary river sand as shielding material. It has a telescopic master slave manipulator, an internal crane to handle and lift objects inside the hot cell. A movable overhead crane outside the biological shield lifts heavy object in and outside the hot cell. The hot cell is fitted with video cameras and lights to allow viewing of the inside of the hot cell. A ventilation system maintains negative pressure within the hot cell, so as to contain and prevent the possible spread of contamination. A long term storage shield container is coupled to the side of the biological shield for easy and safe transfer of the encapsulated spent high activity radioactive sources from the hot cell.

Fig1: Assembled Mobile Hot Cell

SHARS Conditioning

The shielding head, transport container or working device containing the high activity sources were lowered into the mobile hot cell cavity by a crane, one at a time. A trained operator used the master slave manipulator to remove the drawer containing the source from the shielding head, transport container or the working device inside the plastic lined hot cell cavity. Prior to source removal, the drawers were leak tested for possible contamination.

Teletherapy sources were removed from the drawer by cutting the pin of the source cap or plug using an air-driven circular saw or a special tool. The drawer is rotated and the source drops. The retrieved sources were loaded in the special form stainless steel capsule, TIG welded and leak tested using bubble test inside the mobile hot cell cavity. Capsules were pulled one after the other through the transfer port into the drawers of the long term storage shield.

Long Term Storage Shield

A unit of the long term storage shield has 4 drawers in a rotating carousel, and can accommodate a total activity of 370TBq. The long term storage shield design is based on a standard transport container and can be used in case of source repatriation to the country of origin. It was designed to maintain integrity for at least 50 years in high-humidity covered storage and to provide shielding for the sources to maintain dose rate not greater than 2 mSv/hr on contact.

SHARS Conditioning Result

A total activity of 204 TBq for the sixteen (16) units of spent high activity radioactive sources from teletherapy (13 units) and irradiator (3 units) were conditioned successfully. Teletherapy sources ranged from 18mm to 45mm in diameter, and 33mm to 40mm in length. The irradiator sources were pencil-type containing 6 pencils per unit, with a diameter of 12mm to 15mm, and length of 150mm to 345.5mm.

All conditioned sources were Co-60 and were distributed in the two units of long term storage shield (LTSS-1 and LTSS-2). The total dose rate of Co-60 sources loaded in the LTSS-1 is 10.5 Sv/h containing 1 unit irradiator and 9 units teletherapy sources. The LTSS-1 maximum contact dose rate is 103 µSv/h and 25.4 µSv/h at 1 meter. The Co-60 sources in LTSS-2 has a total dose rate of 3.35 Sv/h containing 4 units teletherapy and 2 units irradiator sources. The LTSS-2 has maximum contact dose rate of 102 µSv/h and 34 µSv/h at 1 meter. The dose rate is below the 2 mSv/h contact limit for safe transport of radioactive material.

Six (6) units with a total activity of 73.8TBq of spent high activity radioactive sources remained unconditioned because the source cannot be extracted from the drawer due to heavy corrosion. These units are currently stored in the interim storage together with the long term storage shield.

ALARA Program

The SHARS conditioning team was divided into two teams with six persons per team. A team is composed of a team leader, 3 technicians and 2 radiation protection officer. Team 1 assembled the mobile hot cell, commissioned and started with the conditioning of the sources. After three weeks, Team 2 came in to relieve the first team. They completed the conditioning work and dismantled and packaged the mobile hot cell and components.

The ALARA principle was used to set an occupational ALARA objective of less than 5mSv and public ALARA objective of less than 20µSv for the whole operation. The ALARA objective is a value used in the design of the mobile hot cell as an objective value for doses. These values are below the IBSS dose limits for occupational and public exposures. The TLD whole body dose value of all team members were below the ALARA objective limits, thus indicating an effective ALARA program.

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Thailand

Ms. Nanthavan Ya-anant
Thailand Institute of Nuclear Technology (TINT)

Management of Disused Sealed Radioactive Source(DSRS) in Thailand

Introduction

In many countries, radioactive sources may have been used prior to the establishment of effective regulatory requirements and may not have been disposed of appropriately. Therefore, information should be gathered about the "early days" of radioactive material use as soon as possible, while individuals who were present at the time are still alive. The earliest uses of radioactive material in Thailand typically involved radium particularly in medical applications. For Thailand and other developing countries, the earliest use are more likely to be in the medical field, and particularly in cancer therapy using Co-60 or Cs-137. In addition, radioactive sources are used in agriculture, industry, mining, research and education as well as in consumer products. They provide many benefits to the country. The safety record of these technologies with regard to the radioactive sources that they employ has generally been good. However, occasionally a lack of appropriate control or circumvention of those that exist, has led to sources becoming orphaned or vulnerable resulting in serious radiological accidents, or to harmful environmental, social and economic impacts.

Management of Disused Sealed Radioactive Sources (DSRS)

When radioactive sources has no longer used, it should be returned back to the country of origin as written in the Ministerial Regulation on Procedure on RWM B.E.2546 (2003). But most of DSRS could not be returned to the origin, therefore the Radioactive Waste Management Center (RWMC), Thailand Institute of Nuclear Technology (TINT) has a duty on managing of DSRS under the regulatory control by the Office Atoms for Peace (OAP)

Fig1: Disused Sealed Sources

The DSRSs (as Fig.1) have been managed as the followings;

1. The register of DSRS

   The following information should be recorded:
   - The former owner who possess the source and associated device, including contact information
   - The unique identification of the source (manufacture, model number, serial number, and date of manufacture)
   - The unique identification of the associated device(manufacture, model number, serial number, and date of manufacture)
   - The location of the source
   - The radionuclide, the sources activity and the date on which the activity was measured
   - The category of the source
   - The form of the radioactive material (physical and chemical) including its special form status
   - A record of where the source was received from or transferred to
   - The date the source and associated device was entered into the register
   - The planned disposition of the sources such as the planned date of its transfer to any waste storage/ disposal facility

Note : A register of DSRS has been generated and maintained using a database software.

2. Relocation & Reorganization

The mission of relocation and reorganization of DSRS has been operated as the national work plan, the IAEA Project : RAS 9071.

Fig2: Checking dose-rate of DSRS

Procedure

The procedure is as the followings;

1) Prepare the operational area
2) Check the radioactive contamination of each DSRS before moving for operation
3) Take the individual source to the operational area and check dose rate (Fig.2)
4) Check the identification label, and take photos (Fig.3)

Fig3: Identification of DSRS

5) Place temporary the sources in the empty room, organized by type of source and radionuclide (segregation) as in Fig.4

Fig4: Segregation of DSRS

6) Volume reduction by removing DSRS from big containers and re-packing in 200 Litre -drum.
7) Complete inventory of DSRS
8) Improve the storage conditions by cleaning he floor and cellar
9) Arrange sources in baskets and put in shelves, grouping by radionuclide /type of radiation
10) Record keeping for regulatory control

Fig5: Before and After the Reorganization

Result

The outputs achieved as the results of activities implemented as follows:

1. The record keeping of DSRS was developed.
2. The reorganization of DSRS was well done within the storage facilities (Fig.5)
3. Unknown DSRS was determined to the known DSRS and was segregated, due to the characterization technique.
4. The national inventories of stored DSRS is up to dated.
5. The proper operational procedures and quality control at the storage of DSRS was established and implemented.
6. A training material by recording (filming) all activities was carried out during the operation.

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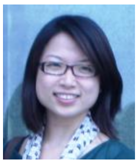
The FNCA RS&RWM Project Leaders

Australia



Ms.Lynn TAN
Project Transition Leader
Waste Projects and Strategic Planning
Australian Nuclear Science and Technology Organisation

Bangladesh

Dr. Moinul Islam
Principal Scientific Officer,
Health Physics & Radioactive Waste Management Unit,
Atomic Energy Research Establishment (AERE), Bangladish Atomic Energy Commission (BAEC)

China

Dr. Zhang Jintao
Deputy Director General,
Department of Safety, Protection and Quality,China National Nuclear Corporation (CNNC)

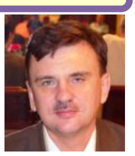
Indonesia

Mr. Suryantoro
Head of Radwaste Treatment Division, Radioactive Waste Technology Center, National Nuclear Energy Agency of Indonesia (BATAN)

Japan

Prof. Toshiso Kosako
Professor,
Nuclear Professional School,
Graduate School of Engineering,
The University of Tokyo

Kazakhstan



Mr. Yuriy Aleinikov
Head of Laboratory,
Department of Reactor Research,
Institute of Atomic Energy,
National Nuclear Centre of the Republic of Kazakhstan

South Korea

Dr. Chang Lak Kim
Director,
Radioactive Waste Management Policy Office,
Korea Radioactive Waste Management Corporation (KRMC)

Malaysia

Dr. Mohd Abdul Wahab Yusof
Senior Research Officer,
Waste Technology & Environment Division,
Malaysian Nuclear Agency (Nuclear Malaysia)

Mongolia

Ms.Oyuntulkhuur Navaangalsan
Head,
Radiation Regulatory Department,
Nuclear and Radiation Regulatory Authority,
Nuclear Energy Agency

Philippines

Ms. Maria Visitacion B. Palattao
Head, Regulations and Standards Development Section, Philippine Nuclear Research Institute (PNRI)

Thailand

Ms. Nanthavan Ya-anant
Head, Radioactive Waste Management Section,
Radioactive Waste Management Center,
Thailand Institute of Nuclear Technology (TINT)

Vietnam

Dr. Le Ba Thuan
Director,
Institute for Technology of Radioactive and rare Elements,
Vietnam Atomic Energy Institute (VINATOM)

The FNCA Framework