NEWSLETTER

RADIOACTIVE WASTE MANAGEMENT

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The FNCA Workshop on Radioactive Waste Management (RWM)

November 20-24, Beijing, China

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The FNCA 2006 Workshop on Radioactive Waste Management was held from November 20 to 24, 2006, at Beijing, China. This Workshop was hosted by the China Atomic Energy Authority (CAEA) and the China National Nuclear Corp. (CNNC) as the local host organizations and the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan, in cooperation with Japan Atomic Industrial Forum, Inc. (JAIF).

Representatives involved in policy making, regulation, operations and R&D on radioactive waste management attended the Workshop from the nine FNCA countries, i.e. Australia, China, Indonesia, Japan, Korea, Malaysia, the Philippines, Thailand, and Viet Nam.

On the first day, Session 1, country reports were presented on present status and progress of radioactive waste management activities in each FNCA country. Summary of each session is attached as Annex-1 to this document.

After Session 1, Poster/Mini-Exhibition was held. This Poster/Mini-Exhibition was successful in enhancing further the understanding of activities in RWM among FNCA countries.

On the second day, sub-meetings were held on "Conceptual Design of Near Surface Repository", "Waste Treatment and Conditioning for Disposal" and "Management of Medical Waste" as Session 2, 3 and 4, to promote comprehensive understandings from different viewpoints of FNCA countries.

On the third day, a technical visit to China Institute of Atomic Energy (CIAE) was undertaken.

On the fourth day, a roundtable discussion on "Interim Report of Decommissioning and Clearance Task" was held as Session 5 to confirm the result of Discussion/Survey Meeting in Australia and Malaysia highlighting the importance of collection of technical data on-site and assessment of the local situation. It was also recognized that common approaches should be investigated to settle scientific and rational regulation in order not to place unnecessary burden on the public and industry of the FNCA region.

In Session 6, a roundtable discussion was held on "Progress of RWM Consolidated Report". It was recognized that the update of the Consolidated Report is important and useful for FNCA countries. The Revised Report will be collected by the end of March 2007 and will be published in 2008.

Finally in Session 7 "RWM 3-Year Work Plan for 2005-2007" under FNCA framework was discussed. Items agreed upon by the Workshop participants on the activities in and after fiscal year 2007 are as follows:

- 2007 RWM Workshop will be held in Thailand (Nov. 18-23, 2007).
- The Task Group Activities (Discussion/Survey Meetings) on decommissioning and clearance will be held in Thailand (July29-Aug. 03, 2007) and Viet Nam (Aug. 19-24 2007) in 2007.

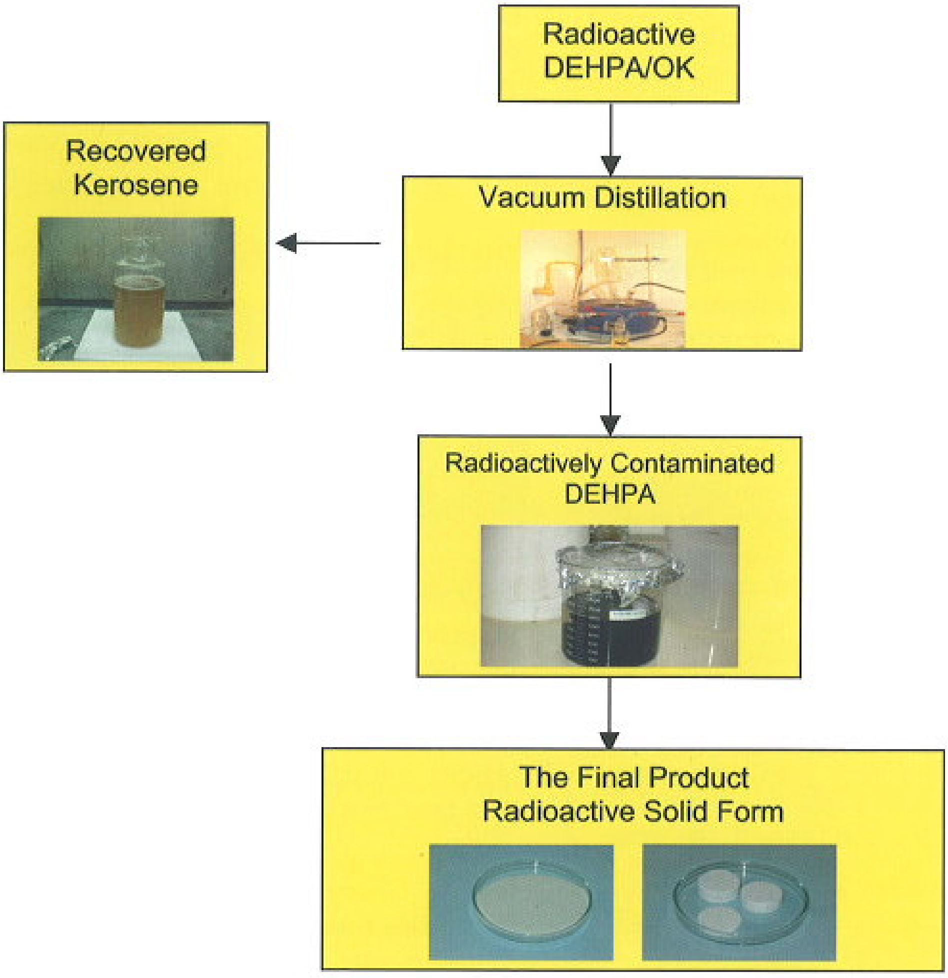
immobilizing the waste into a cement matrix. This process has been carried out together with the ANSTO's group beginning in 2002. The only drawback with this process is that it

Picture shows Mr. Ned Blagojevic from ANSTO taking samples of cemented waste for further analysis

The second process, which is currently being patented, is to convert the waste into a ceramic material. The process was developed by Dr. Meor Yusoff, a researcher from Nuclear Malaysia's Advance Material group, looks

increases the volume by a factor of two and a half.

more favourable judging from the volume reduction obtained compare to the initial one. Moreover, analysis of the recovered kerosene showed that it was free of uranium contamination and hence was re-usable. The conversion process basically involved transforming DEHPA into a thick gel by mixing with calcium hydroxide. Subsequently, the gel was subjected to low heating to produce an amorphous brownish powder. This powder was then calcined at 800C resulting a white crystalline powder. Finally the powder was pressed into pellet suitable for long-term storage. At present, efforts are being focused into scaling up the process from laboratory to a pilot plant scale.



Simplified schematic process for conversion of liquid DEHPA/OK into solid material

easy workability without dispersion of contaminants, and possible connections with CWDS. A feasibility study on the granulation of dried borate wastes using liquid sodium silicate as a granulating agent was performed.

Through reviewing many materials, we found that liquid sodium silicate was suitable for a granulating agent of boric acid (BA) powder. It is an inorganic binder and its molecular formula is generally expressed as Na_2O-$nSiO_2$-xH_2O. Its chemical structures and properties depend on mole ratio of Na_2O/SiO_2. When an acidic component is added to liquid sodium silicate, pH of sodium silicate decreases by neutralization reaction and viscosity increases by siloxane bond and gelation starts to occur. Generally, increasing rate of viscosity and reaction rate of gelation depends on type of acid, additional volume of acid, concentration of solution, and temperature, etc:

And if liquid sodium silicate reacts with metal ions such as Ca, Mg, Al, and Ba, etc., then insoluble metal hydrate silicate, metal hydroxide silicate, and silicic acid are formed simultaneously along with gelation.

Different kinds of granules were prepared according to mixing ratio of BA and liquid sodium silicate. It was found that the distribution of granules depends on rotating speed of two motors and mixing ratio of liquid sodium silicate (Figure 1). The optimum loading of liquid sodium silicate was determined by considering workability, homogeneity of granular size, and compressive strength of specimen. Figure 2 shows a photo of scanning electron microscope (SEM) for the surface of solid granular form. It was observed that BA powder was securely encapsulated in honeycomb structure of the mixture.

It was demonstrated that liquid sodium silicate successfully worked for a granulating agent of boric acid powder and the final granular products were having a dense and hard structures. The developed granulation process will be directly applied to in situ polymer solidification in the future.

Figure 1. Granular forms of simulated wastes

Figure 2. SEM of a granule

Conversion of Liquid Organic Waste into Solid Waste Form

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A mixture of 70% DiethylHexyl Phosporic Acid (DEHPA) with 30% Kerosene has been used as a solvent in extracting rare earths from monazite. Since the mineral contained natural uranium and thorium, it resulted in contaminating the solvent. Analysis of the solvent showed that the uranium and thorium concentrations were about 1,400 and 100 ppm respectively.

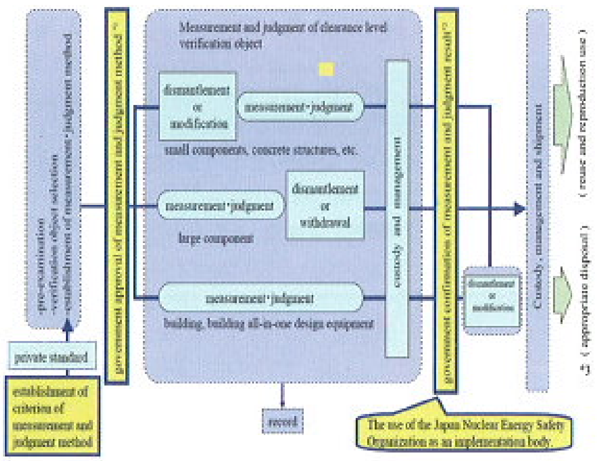
About 33 cubic meters of this waste was transferred to Nuclear Malaysia in 1996, and is still being stored in two 17.5 cubic meters HDPE tanks at the Low Level Effluent Treatment Plant (LLETP). Since the waste is in liquid form, in addition of its corrosive nature, there is need to convert the waste into a more stable solid form. Leaving the waste as it is for a long-term storage may pose risk of contamination should there be any leakage to the tanks or piping components.

MINT has been evaluating various options in managing the waste based on cost, feasibility, secondary waste generation, re-usability, practicability, volume of secondary waste generated etc. One of the option was introduction of the clearance system into Japanese regulation in 1997.

The NSC distributed a document showing both the clearance levels for radionuclide and an ideal procedure for verification of stability of the clearance system for nuclear reactors in 2001; that is "Ideal Clearance Level Verification in Nuclear Reactor facilities". Japanese regulatory authorities for nuclear reactors (METI and MEXT) published some effective reports following the discussion and revised their related regulation laws and ordinances in 2005.

It is one of the key points to keep both the stability and reliability of the Japanese clearance system that regulatory authorities play an important part in its checking procedure. They firstly approve an operator's procedure to identify the radioactivity of an object to be tested and then to judge this to be a clearance object or not. Secondly they check and confirm the records of the results of an operator's measurement and judgment. The double-checking procedure by regulatory authorities is important to maintain the clearance system in Japanese regulation.

*METI = Ministry of Economy, Trade and Industry, in charge of commercial reactors
*MEXT = Ministry of Education, Culture, Sports, Science and Technology, in charge of research reactors



Granulation of Dried Borate Concentrates from Nuclear Power Plants

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Borate concentrated wastes generated from liquid waste evaporator of 12 pressurized water reactors (PWRs) have been processed to be dry using concentrated waste drying system (CWDS) in Korea. Borate wastes had been stabilized or solidified using paraffin as a binder since 1995, but the solidification process is stopped and concentrated wastes are just stored in drums and on standby at present because paraffin waste forms have some sorts of problems such as heterogeneous forming (stratification), low compressive strength, and high leaching rate. According to No. 2005-18 of Notices of the Ministry of Science and Technology (MOST), all of low- and intermediate level waste (LILW) forms must satisfy the requirement of solidification before they are delivered to the final repository in Kyeongju.

In this study, polymer solidification technology is proposed to treat borate concentrated wastes. Originally, this technology has been developed and used to solidify the spent ion exchange resin in many countries. Most commercial polymer binders include epoxy, polyester and vinylester styrene, etc. Recently in May 2003, Idaho National Engineering and Environmental Laboratory (INEEL) issued a report confirming that APS™ (Diversified Technologies Services), a kind of polymer waste form, met the NRC's Waste Form requirements for Class B and C wastes. The Conference of Radiation Control Program Directors (CRCPD) reviewed the INEEL report, and the E-5 Committee issued a letter of waste form approval for the APS™ process. This serves as a national approval in the US, replacing the now-defunct NRC Topical Report Program.

Granulation of dried powder waste is prerequisite for the successful operation of polymer solidification process. Granular wastes permit the maximum waste loading, in situ process without in-line mixing or in-drum mixing, The first meeting of the Topical Group (TG) on Radioactive Waste Management (RWM) was held in Tokyo, Japan, hosted by the Japan Nuclear Energy Safety Organization (JNES). Sixteen representatives from China, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand, and Vietnam, together with external experts from France and Germany, attended the meeting.

The objective of this meeting is;

1. To identify and share best practices for safety of national radioactive waste management strategies
2. To establish usable support systems and database for safety of national radioactive waste management strategies
3. To assist to join and meet national obligations of the Joint Convention
4. To serve as a forum for information exchange and to provide training course.

In the meeting, coordinator Kihara (Japan) chaired and Mr. T. Kurasaki, Director, Radioactive Waste Regulation Division, Nuclear and Industrial Safety Agency, Japan, made the welcoming address.

After an introduction on the ANSN and its TGs, the current situation with regard to RWM in each country was reported upon and discussed by the participants. This provided a good opportunity for an effective and active information exchange on RWM experiences and practices.

The chair proposed the outline of the TG's activities, and a 'Support system for IAEA Safety Standards' that permits word/phrase searches was demonstrated.

The relationship between the countries' assistance needs and the IAEA's proposal of assistance were discussed.

The possible IAEA's regional activities on RWM were as follows;

- Trainings Courses e.g. Safety Assessment for Radioactive Waste Disposal Facilities or Establishment of Limitations and Controls on Effluent Discharges and Associated Regulatory Review and Control etc.
- Workshops e.g. the Joint Convention or Safety Assessment for Predisposal Waste Management Facilities and Activities and Related Regulatory Review and Control etc.

The TG meeting is held once in every year regularly and the activity plans are reviewed and discussed.

Based on the conclusion of the meeting, new activities have started.

Roll of Regulatory Bodies for Japanese Clearance System

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Introduction of a clearance system into the Japanese regulation requires its reliable system to check whether it works adequately, or not. NSC (Nuclear Safety Commission of Japan) started to discuss

One industry that growing fast is ship industry (ship dock yard), that is relocated from Singapore, and as the consequence of this situation, the local government observed there is problem emerging, i.e. generation of NORM and hazardous waste from the blasting activity of shipping industry. By this reason, the local government requested BATAN to examine the situation.

Fig. 1. Activities on the ship sandblasting in Batam Island

Material of sandblasting consists of garnet, copper slag, tin slag, and steel grit. These materials contain NORM such as U-238, Th-232, Th-228, Ra-228, Ra-226, Pb-210, and Po-210; also include hazardous heavy metals such as As, Cd, Hg, Pb, Cu, Sn, and Cr; and Si (an element that cause silicosis).

After several investigations by joint work between Batam Environmental Monitoring and Protection Agency and BATAN, it was decided that landfill method is suitable for sandblasting waste disposal, and as result, a proposal of BATAN for the conceptual design study was submitted to the Environmental Protection Ministry, on August 2006, and it was agreed on September 2006.

This conceptual design is a start point to make the technical design of landfill for Batam Island and other location in Indonesia. In case of Batam island, the design consists of 44 cells, that are expected to be constructed step by step, and each cell has a capability to receive blasting waste generated for a year. So this landfill has an operation time of 44 years. The total area required is 7.7 acres, but the local government agrees to give 10 acres

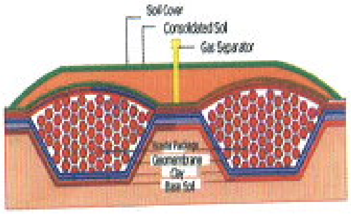

Fig.2. Conceptual Design of Landfill for NORM and hazardous waste

in the Kabil site. The design is expected to have facilities for waste collection, gas treatment and water release.

Based on the site data, and annual meteorology, the design was evaluated by using software HELP (Hydrological Evaluation of Landfill Performance). The simulation shows that average water leaching rate to the environment for 100 year is $31.06m^3$/year or $0.085m^3$/day. By this value, and by consideration that the concentration of NORM and other hazardous materials are low, it is expected that the radiology and toxic influence of the landfill to the surrounding environment is small. It is concluded that the conceptual design can be implemented in Batam island.

IAEA Meeting of the ANSN Topical Group on Radioactive Waste Management

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Increasing use of nuclear energy in Asia indicates importance of radioactive waste management in the region. In recognition of this, the IAEA recently started a new activity in the framework of ANSN (Asian Nuclear Safety Network).

years, major work was focused on methodology development, including siting, radiochemistry, engineering design, performance assessment and safety assessment. Preliminary siting work was conducted for both soft media (clay and loess) and hard formation (mainly granite), though most effort were focused on site characterization for hard rock in Beishan, Gangsu province, northwestern China. In the area of radiochemistry, experimental and model simulation were performed for radionuclide species existance in the simulated geological environment. Underground water sample was collected from Beishan for radiochemical study. Some basic experimental devices and experimental procedures were developed. For the engineering of geological, conceptual design was intiated, and a bentonite was chosen for engineered barrier material study. Safety assessment methodology was in developing. Some foreign codes used in geological disposal simulation were introduced, radionuclide migration test and modelling were carried out.

Under the Law 2003, the CAEA, China Ministry of Science and Technology and CEPA jointly issued High-Level Radioactive Waste Geological Disposal Research and Development Guideline in April 2006, in which the development philosophy, goal, technological approach and schedule are set.

The development philosophy is to make plan in a holistic way, to develop in a coordinating way, the make decision by step, and to move forward iteratively.

According to the Guideline, the disposal system would be sited in a geologically stable formation considering social, economic and environmental factors. The safety of the disposal system should be assured through both geological barrier and engineered barrier for the protection of human health and environment of both present and in the future.

Roughly, the development is defined into three phases: (1) laboratory development and site selection (2006-2020); (2) Underground research (2021-2040); and (3) pilot scale test and construction (2041-the mid of this century).

The work of research and development defined in the Guideline are categorized into five themes: (1) Strategy, approach, planning, legislation and standards development, social factor is one part of the theme; (2) engineering study, including waste inventory, conceptual design of the underground research laboratory and the disposal facility, engineered barriers and system optimization of the disposal system; (3) disposal geology disposal, covering geology, hydrology, engineering geology, site characterization; (4) disposal chemistry, including performance of waste form and waste container, radionuclide existance and migration; (5) safety assessment of geological disposal, including the safety objectives, safety assessment methodology, scenario development, modelling and total system simulation, risk communication. According to this strategy, the final site for China's URL and repository will be confirmed in 2015, in which the construction of an URL will be started. In about, 2020 the URL will be constructed. It is expected that the disposal facility would be available in the middle of the century.

CONCEPTUAL DESIGN OF LANDFILL FOR NORM AND HAZARDOUS WASTE IN BATAM ISLAND

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Batam Island is located very near to the Singapore Island where the business is growing fast, and Batam local government is trying to use this situation for speeding up the industrialization. Different with the other part of Indonesia, to accelerate the development, the island is granted by the central government an exclusive industrial zone.

At ANSTO contaminated sludge from the slurry stream (centrifuge), is pumped into a drum where it is heated and the liquid is boiled off under a vacuum (Figure 4). The boiled off liquid is condensed and joins the LLLW stream. The drum is replenished by more sludge until the drum is filled with solid material. The resulting cake is dried to remove all liquid. The drum dryer can then be switched off and the drum sealed. Once this is complete, the drum is ready for further processing (such as full gamma spectroscopy for radionuclide characterisation) and, followed by volume reduction by compaction, packaging and storage.

The environmental impact of this process is much lower than for the solar ponds. There is no easy path for radioactive material to enter the environment. The manual handling issues are mainly eliminated by using this equipment rather than shovelling dried cake into drums. This process also has the advantage of packing more waste into the drums, decreasing the volume of waste requiring storage.

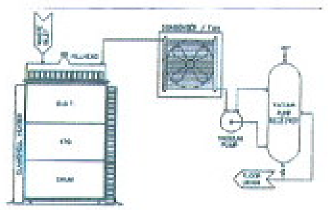

Figure 4: Drum Dryer Schematic

During the commissioning process of the drum dryer there were some problems that had to be resolved. It was determined that: black drums were more efficient (as they don't reflect the heat); the thickness of the epoxy coating on the drums made no difference; the corrosiveness of the liquid (pH 10) didn't affect the drums; and the temperature had to be controlled for the specific application. Ensuring the system is adequately shielded is a further issue for consideration.

The drum dryer is designed to operate unattended and only requires an operator during system start-up and shutdown. Auto functions include drum filling, heat control, and system shutdown to a safe condition in the event of loss of power, or other abnormal circumstances. These shutdown modes protect the drum dryer as well as plant systems. Manual valves and local pressure gauges give the unit's operator feedback to allow safe, efficient use without continuos monitoring.

The liquid decant stream will also be further treated in the future. A cold evaporation and cold crystalliser unit will be installed to remove the last remaining radioactivity from the liquid decant stream prior to discharge. The sludge in the evaporator and crystalliser unit will then be put into the drum dryer system for final treatment (Figure's 5 and 6).

This new process will lead to a much lower release of radioactive material into the sewer, and will allow ANSTO more flexibility in the way it uses water. By removing the radioactivity from the liquid waste stream there is no need for water to be diluted. This means that the diluted water could be recycled to be used on site (such as in cooling towers, on the grounds and for other non-potable water uses).

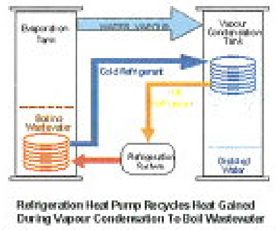

Figure 5: Cold Evaporation Schematic

Figure 6: Cold Evaporator System

China Issued R&D Guideline for Geological Disposal

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China started study on geological disposal of HLW in 1985. In the past twenty

- The candidate of themes on the next Sub Meetings were as follows.

For example: "Safety assessment of disposal facility", "Site investigation for disposal facility", "Conceptual design of near surface disposal facility", and "Management of Medical waste".

Participants of this Workshop expressed appreciation to the organizers, i.e. CAEA, CNNC and MEXT, and to the cooperation of JAIF.

Drum Drying and Cold Evaporation of Low Level Liquid Wastes at ANSTO

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Environmental issues surrounding the management of radioactive waste are receiving greater attention as a result of an increase in public interest. With effective campaigns by environmental groups on the hazards associated with radioactive waste, it is up to the producers of nuclear waste to demonstrate that their operations are undertaken using the safest possible methods. This might include approaches such as upgrading old equipment or processes to make use of more environmentally sound solutions. ANSTO's treatment of low level liquid waste (LLLW) is an example of such an approach.

Most of ANSTO's LLLW is generated during the production of radiopharmaceuticals, as this process utilises the nuclear research reactor at ANSTO to produce isotopes used by hospitals to diagnose and treat patients. The LLLW generated is piped and collected in 5 x 210m^3 mixing tanks (Figure 1), and is then treated by a generic acidification, flocculation, alkalisation, and decanting process.

The LLLW treatment process produces two streams, a liquid decant stream (with minimal radioactivity) and a slurry stream (with up to 90% of the radioactivity of the original waste). The liquid decant is combined with the non-radioactive liquid wastes, analysed to ensure compliance with authorised levels prior to being discharged to the local sewer for treatment at an external sewage treatment plant.

The slurry is further concentrated by a centrifuge and the resulting sludge is pumped into solar ponds to dry out (Figure 2). After the sludge has been dried in the solar ponds it is manually handled into drums for storage as low level radioactive solid waste.

Figure 1: Mixing Tanks

Figure 2: Solar Pond Drying of LLLW Sludge

The use of the solar ponds presents the potential for environmental impact to arise as the dried sludge (powder dry) can be dispersed by the wind into the surrounding area. The manual handling of the sludge into the drums is also a source of potential airborne dispersion.

ANSTO is assessing the use of drum drying technology to replace the current open solar pond drying system.

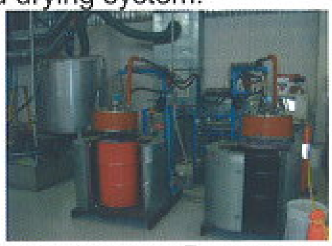

Figure 3: Drum Dryer system

As part of an integrated project ANSTO purchased a drum drying system (Figure 3) from Diversified Technology Services (US based company). The drum dryer system is an efficient, economical system that dries contaminated wet solids (sludges, resins, and filter elements), liquid concentrates, and decontamination solutions to a solid cake. The waste, after being dried in 200 litre steel drums, can then be safely stored, handled and transported.