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CURRENT WASTE MANAGEMENT PRACTICES AT PINSTECH

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Abstract.

The waste being generated at PINSTECH is of the intermediate and low level Category that is in the form of gas, liquid and solids. It is collected, monitored, segregated, treated, packed and immobilized for its final disposal. Basic concepts of delay decay, disposal and containment of radioactive waste are followed to prevent its direct contact with human and its environment. PINSTECH follows shallow ground disposal in the restricted area. The disposal site has favorable characteristics e.g. sun shine dry climate and high evaporation rate. The gaseous waste is directed towards stack, where it passes through charcoal and HEPA filters and then released to the atmosphere. Post disposal monitoring of the disposal area is performed to check leaching/migration of radionuclides from disposal locations to the surrounding environment. No migration of radioactivity has been detected indicating satisfactory performance of the waste management system.

1. Introduction

The Pakistan Institute of Nuclear Science and Technology (PINSTECH) is a multidisciplinary nuclear research centre of the Pakistan Atomic Energy Commission (PAEC). Amongst its nuclear research facilities the prominent ones are: Pakistan Research Reactors, PARR-I and PARR-II. The Pakistan Research Reactor-I is a Low Enriched Uranium (LEU) fuel (U_3-Si_2-Al, 19.99 % ^{235}U) swimming pool type reactor with thermal output of approx. 10 MW. ARR-II is a miniaturized neutron source, approx. 27 kW tank-in-pool type reactor with highly enriched uranium (HEU) fuel (U-Al alloy, 90% ^{235}U). range of radio-isotopes is also produced from PARR-1 for utilization at medical centers and research facilities in Pakistan.

The bulk of radioactive waste generated at PINSTECH comes from the operation of PARR-I, PARR-II, and radioisotope production facilities. The volume and nature of the radioactive waste are dependent on the frequency, duration of operation and specific needs. PINSTECH radioactive waste is mostly low in specific activity. Re-generation of the reactor ion-exchange resin and operation of radioisotope production facility also generate small volumes of medium level liquid and solid radioactive waste.

Safe handling/management of the radioactive waste at PINSTECH in accordance with the national regulations and international practices is the prime responsibility of the Radioactive Waste Management Group (RWMG) of the Health Physics Division (HPD). PINSTECH has also been made responsible to manage radioactive waste generated by hospitals/medical centers and spent Sealed Radiation Sources (SRS) coming from users in the provinces of Punjab and other places in the country. The RWMG follows the Code of practice for the safe use of radiation at PINSTECH, and the regulations, guidelines on the subject issued by the Pakistan Nuclear Regulatory Authority.

Basic concepts of Delay, Decay, Disposal and containment of radioactive waste are followed to prevent its direct contact with human and its environment. PINSTECH follows shallow ground disposal in the restricted area. The disposal area for this purpose was selected in 1967. The area has favorable characteristics: sunshine, dry climate, high evaporation rate (approx. $2m^3.Y^{-1}M^{-2}$), adsorption and retention and ion-exchange properties of the soil. Segregation/classification of the generated radioactive waste is in line with IAEA's recommendations and international standards.

2. Handling of liquid radio active waste

Approximately 2000 m^3 of low level and 100 liters of medium level liquid waste (with short-lived. beta and gamma activity) is handled and managed annually.

The low level radioactive waste effluents are collected in storage tanks of different capacities installed at different location. These storage tanks are equipped with level indicators, re-circulation and mixing/purging system. The contents of the storage tanks are frequently sampled. monitored for gross beta-gamma activity and analyzed for concentration of different radionuclides so as to decide further storage or disposal. If radioactivity is less than 3.7 MBq/m^3, the radioactive waste is disposed of into shallow ground pits (two in number, 30 x 15 x 2m) specially allocated for this purpose in the controlled area. A pilot scale chemical treatment facility based on co-precipitation technique for separation of major radionuclides in the liquid radioactive waste is in the process of development. The precipitates so obtained will be immobilized into a concrete cement matrix.

The medium level liquid radioactive waste is stored in an underground trench with adequate shielding where it remains for few years. After this delay for decay, the radioactive waste is treated and diluted for its disposal into shallow ground seepage pits. A part of the medium-level radioactive waste is also immobilized into a cement-sand-concrete matrix filled in concrete lined 200 liters standard Mild Steel (MS) drums. These cemented drums are kept in the interim storage waiting for their final placement in an engineered near-surface trench located in controlled area.

3. Handling of solid radioactive waste

The low-level solid radioactive waste mainly comprises cotton over-shoes, polythene/plastic items, bags, sheets, dusters, sample bottles, gloves, glass metallic and ceramic articles. As soon as the bins lined with removable polythene bags reserved for solid radioactive waste are filled, the polythene bags containing radioactive waste are collected by RWMG staff. Dose rate at surface of package is monitored and if found less than 2 mSv/hr (200 mrem/hr), the package is transported to disposal/treatment area immediately; otherwise if the dose rate is higher than 2 mSv/hr it is transported to disposal area in a shielded container.

The compactible radioactive waste is compacted using a hydraulic press in standard 200 liter MS drums. The compacted and uncompacted waste is then disposed into a near-surface engineered trench measuring approx. 15 x 3 x 4m. The trench, when filled up to 3 meters, is capped with clay and concrete. The medium level solid radioactive waste consisting of air and charcoal filters, liquid and water filters and spent ion exchange resin from demineralizer, reactor core parts, precipitates and sludge concentrates etc. is embedded in cement-sand-concrete matrix and placed in concrete lined 200 L MS drums/RCC barrels. A small sized cementing facility is available for this purpose. The cementized radioactive waste drums are first stored in interim storage for curing and then monitored until safe surface radiation levels

are reached before their final disposal. These drums/barrels are then transferred to engineered trench for storage/disposal. Approximately 20 $m^3$of solid radioactive waste is handled yearly. Management of spent sealed Radiation Sources has also been started on commercial basis.

4. Stack monitoring for release of gaseous radioactive waste

Gases are released into atmosphere through stacks (60 meter high for PARR-1 & Isotope production facility and 14 meter high for PARR-II) after passing through High Efficiency Particulate Aerosol (HEPA) filters and charcoal filters to retain radionuclides. Air monitoring instruments have been installed in the exhaust lines which give alarm in the reactor emergency ventilation systems when pre-set release limits are exceeded. Additional air sampling with paper/fiber-glass filters and Tri-Ethylene-Di-Amine (TEDA) impregnated charcoal is conducted by RWMG, especially during reactor and isotope production plant operation. It keeps an indirect check of the performance of the filters installed in the exhaust lines. It also generates data to verify that legal release limits are not exceeded. In case of PARR-II, a purge system has been provided to disperse gases from reactor vessel into atmosphere via mechanical filters, which remove radioactive aerosols. In case of failure of fuel pins, the gases are routed through activated charcoal filters to trap radioactive iodine.

5. Decontamination

A small sized decontamination work-shop equipped with relevant facilities is available for decontamination of valuable and costly metals. The contaminated protective clothing like overshoes, laboratory coats, dungarees etc. are decontaminated/washed at 'Active Laundry' for re-circulation and reuse.

6. Environmental safety and post disposal monitoring

A continuous check on the leaching/migration of radioactivity from disposal/storage location to surrounding environments is kept through dry wells (boreholes) of different depths at different locations around seepage pits and trenches. These boreholes are periodically monitored by gamma logging and gamma spectrometry of water samples collected from the wells. Radiation profiles are made by lowering G. M tube inside these boreholes up to water table. No migration of radioactivity has been detected, indicating satisfactory performance of our radioactive waste management system and safe disposal practices. Nearby rain water stream is also monitored for any suspected contamination due to migration of radioactivity. No radioactivity has been traced in the strata and sub-surface water of the surrounding environment.

The ambient radiation levels are regularly monitored in the disposal area by a number of Thermoluminescent Dosimeters (TLDs) installed at different locations at one meter height above ground. These dosimeters are replaced and evaluated every month. No abnormal behavior of gamma dose-rate has so far been indicated in the area. The group has the support of a Mobile Radiation Monitoring Laboratory and Meteorological Station, which can be called in at very short notice, during any emergency.

7. Analytical laboratory

RWMG is also equipped with the analytical laboratory and necessary infrastructure for radiochemistry, which contains gamma spectrometry equipment using NaI and HPGe

detectors. Various steps and action taken during the management of radioactive waste are based on the analytical data.

8. Other developments

A chemical treatment facility for liquid waste based on scavenging/co precipitation techniques is under consideration. Working plans for the establishment of a National Repository has also been initiated. The research and development work on radioactive waste management to produce suitable immobilization matrices like cement, bitumen, polymers, glass and ceramics etc. is planned. Development of an incinerator with scrubber etc. and of an evaporator are included in our future programmes. Collaborations with other international organizations interested in radioactive waste management are welcome.