Tariq Bin Tahir, Director General, Nuclear Power Waste, Pakistan Atomic Energy Commission

Radioactive Waste Management Policy and Strategy of Pakistan

1. Introduction

The first nuclear power plant of the country was commissioned in 1971. It was a 137 MW Pressurized Heavy Water Reactor (PHWR) type power plant, Karachi Nuclear Power Plant (KANUPP), through a turn-key agreement with Canadian General Electric. This NPP has completed its first 35 years of commercial operation and it has been re-licensed and is expected to operate till 2015.

The second nuclear power plant of the country, a 325 MW Pressurized Water Reactor (PWR) type, Chashma Nuclear Power Plant unit-1 (CHASNUPP-1), constructed by China National Nuclear Corporation, also through a turn-key agreement, started commercial operation on 15 September 2000. This NPP is operating quite successfully at capacity factor of over 80%. The third nuclear power plant of the country, CHASNUPP-2, a 325 MW PWR, is already under construction at the Chashma site. It is scheduled to be commissioned in 2011.

Total installed electricity generation capacity of Pakistan is about 20 000 MW. Two-thirds of it is generated by thermal sources such as gas and oil. About one-third is produced from hydro sources, and only about 3% is from nuclear power plants. Pakistan is facing a shortage of electricity and demand is expected to increase further in the foreseeable future.

The successful functioning of KANUPP and CHASNUPP-1 has given the country great confidence and the Government of Pakistan has approved a plan to increase the nuclear share of electricity production in the country. The expanded nuclear power program envisages a nuclear capacity of 8800 MW by 2030. This will be achieved by the establishment of 4 more 300 MW units and 7 units of 1000 MW each. All these reactors will be of PWR type.

Pakistan has an independent and fully functional regulatory authority, the Pakistan Nuclear Regulatory Authority (PNRA). It is responsible for all regulatory matters related to the nuclear industry, including radioactive waste. Pakistan has signed the IAEA Nuclear Safety Convention and the Convention on Physical Protection of Nuclear Material, but has not yet signed the Joint Convention on the Safety of Radioactive Waste and Spent Fuel, due to certain technical reservations. All the nuclear power plants in Pakistan are under IAEA Safeguards.

2. Current radioactive waste management situation

The Pakistan Atomic Energy Commission (PAEC) has the responsibility of managing the radioactive waste generated by its nuclear power plants and nuclear research centres. It is also responsible for accepting and disposing of radioactive waste generated by all public and private industrial, medical and educational institutions of the country. Normally, such radioactive waste is received by two centres of the Pakistan Atomic Energy Commission, one located at Karachi and another at Islamabad. A waste disposal fee is charged for each waste consignment received for disposal, in accordance with an approved formula which is based on the activity and half-life of the radioactive waste.

The radioactive waste received from the industry and medical institutions are mostly Disused Radiation Sealed Sources (DSRS). Most of these sources are of short half lives (< 1 year). These sources are stored in shielded containers until their activity is reduced below clearance limit. However, some disused sources are of very long half lives. Significant among them are the Radium-226 needles used until some time ago for the treatment of cancer at the nuclear medicine hospitals. These disused sources are conditioned and packaged in accordance with IAEA specifications and stored until a final disposal solution is found.

The major generators of radioactive waste in the country are the nuclear power plants. The radioactive waste generated by the nuclear power plants at Karachi (KANUPP) and at Chashma (CHASNUPP-1) are conditioned and stored on site. The storage capacities at these sites are, however, quite limited and there is a need to enhance the storage capacities at these sites.

Most of the compactable radioactive waste is compressed by a hydraulic compactor in steel drums and these are stored in waste storage buildings. The liquid waste is stabilized by mixing it with concrete, and stored in steel drums. The most problematic is the management of spent ion-exchange resin, which is highly radioactive and requires special pre-treatment and storage methods.

The spent fuel from the power reactors is currently kept under water in the spent fuel pools located inside the plants. The capacity of these pools is also limited and the old spent fuel has to be moved out of the pools to create space for fresh fuel discharged from the reactors.

3. National radioactive waste policy

Recently, a new National Radioactive Waste Policy has been proposed for the country. This policy was developed in conformity with the approach adopted by the IAEA for radioactive waste management. This policy covers all radioactive wastes produced from civilian nuclear installations, radiation facilities and activities.

Some significant points of the policy are as follows:

- Pakistan is committed to manage radioactive waste in such a way as to avoid imposing an undue burden on future generations; that is, the generations that produce the waste have to seek and apply safe, practicable and environmentally acceptable solutions for its long term management.
- Pakistan will follow the Fundamental Safety Principles of the IAEA for the management of radioactive waste and will abide by international agreements to which Pakistan is a signatory.
- Radioactive waste shall not be imported or exported, unless otherwise approved by the government. However, the purchase/import of sealed radioactive sources and return of disused sealed radioactive sources to the supplier will be carried out in accordance with the regulations.
- The government shall support the development of the regulatory and technical infrastructure for the safe management of radioactive waste.
- Every generator of radioactive waste shall be responsible for the safe and secure management of its radioactive waste and shall pay for its safe disposal. However, the government will be responsible for bearing the cost for management of ownerless waste and orphaned sources.
- The Pakistan Nuclear Regulatory Authority shall ensure safe control of all radioactive waste that is generated and shall also be responsible for the verification of compliance with regulatory requirements.
- The Pakistan Atomic Energy Commission shall be responsible for safe and secure disposal of civilian radioactive waste generated from all sources and activities, including waste transferred from other activities within the country. PAEC shall establish a Radioactive Waste Management Fund (RWMF) and is authorized to charge a fee from the generators of radioactive waste.
- All radioactive waste management activities shall be conducted in an open and transparent manner and the public shall have access to information regarding waste management.
- The Pakistan Atomic Energy Commission shall formulate national radioactive waste management strategy in accordance with the national policy on radioactive waste. PAEC, while formulating the strategy, will consult relevant national authorities.

This proposed policy will be formally issued by the Government after it has been reviewed by all relevant national agencies.

4. Waste management strategy

The radioactive waste received from the industry is mostly short-lived disused radiation sources and can easily be stored at waste storage sites until its activity goes below the clearance level. Long-lived disused radiation sources have to be disposed of in the final repository being planned for the country.

The radioactive waste from the nuclear power plants require a new strategy, since the country will now have 13 operating power plants and one decommissioned nuclear power plant by the year 2030. This requires significant improvements in the infrastructure for managing and transporting radioactive waste.

To improve the waste management infrastructure, it is proposed to establish two Waste Management Centres at the two existing plant sites at Karachi and Chashma. At Karachi, there is an operating NPP at present which will be decommissioned by 2015. It is planned to establish two 300 MW PWR NPPs and, later, two 1000 MW PWR NPPs near the same location. Similarly, a Waste Management Centre will be established at the Chashma site, where one NPP is already operating, another one is under construction and two more are being planned. These centres will have facilities to condition low and intermediate level waste and to store it safely for an extended amount of time. More such centres will be established at each NPP site. Facilities at these centres will be: compactor/super compactor, incinerator, evaporator, hot cells, fabrication workshops, cementization, cask fabrication facilities, etc.

The low and intermediate level waste (short-lived) will be conditioned for pre-disposal and stored on site. After a period of time, this waste will be transported to a low and intermediate level waste disposal facility for permanent disposal.

The spent fuel from the reactors is presently stored in spent fuel pools at the plant site. It is planned that at each plant site Dry Storage Facilities will be established. The spent fuel which has cooled for over 10 years will be removed from the pool and placed in Dry Storage. It is expected that the Dry Storage Facility will be licensed for 50 years or more.

Although Pakistan is not reprocessing its spent fuel from NPPs, it has not yet declared it as waste. With increasing uranium prices, it may be feasible in the future to use the spent fuel as a resource and it may be reprocessed (under IAEA safeguards) to obtain material to be used in the production of mixed fuel. Therefore, at present, the decision to put the spent fuel in a non-retrievable Deep Geological Repository is deferred for about 10-15 years.

5. Waste disposal facility

All low and intermediate level waste, once it is properly conditioned and packaged, can be disposed of in a low and intermediate (short-lived) level waste disposal facility. This facility will be required for Pakistan quite soon, as the quantity of waste generated from the operating power plants is filling up the existing storage space and this rate will further increase as new nuclear power plants come on line.

Whereas the technology required in establishing a Low/Intermediate Waste Disposal Facility is not very complex, the siting issues have great importance. Although Pakistan has a varied geological environment and a number of sites could be suitable for a disposal site, socio-political factors come into play for waste disposal. Whereas there is no significant opposition when it comes to selecting a site for a nuclear power plant, siting for a waste site attracts an immediate negative response from the public. This phenomenon is similar the world over, and may require similar means to overcome the opposition in selecting a waste disposal site.

Quite often the best site selected on a technical basis cannot be used as a disposal site because of public opposition. The site selection therefore has more to do with socio-political acceptance rather than best technical choice. In any case, a number of sites are under consideration and, after preliminary technical and regulatory vetting, detailed site investigation will begin. The disposal facility is expected to start receiving waste within 6 years.

6. Deep geological repository

A Deep Geological Repository (DGR) will be required to safely dispose high level waste, the long-lived intermediate level waste, some long-lived disused sealed sources and the spent fuel when declared as waste.

A DGR presents a technological challenge to prove that the radioactive waste disposed in it will be safe for a very long time. Even the most advanced countries with large nuclear power programs do not yet have an operational Deep Geological Repository. We are evaluating the research done by other countries in this regard, and will soon have a decision to start the work of site evaluation for a DGR.

Pakistan has a varied terrain and geological formations, and some of these appear promising for establishment of a DGR. The work is complex and expensive and there are many socio-political and regulatory issues to be resolved before this work is undertaken.

7. Conclusion

Pakistan's energy requirements are increasing at a significant rate. Enhancement of electricity production is very important for the national development programs and production of electricity from nuclear energy will be a significant fraction by 2030. The radioactive waste produced by the NPPs has to be managed to meet the national regulatory requirements and international expectations. Adequate funds will be allocated for radioactive waste management and the facilities developed will be of international standards. Pakistan has committed itself to manage all its radioactive waste in a safe and secure manner.