The challenge of radioactive waste management

With the country going for nuclear power in a big way, it needs to reassess its guidelines on disposal of radioactive waste and prepare a comprehensive arrangement for nuclear waste management, says **BHASKAR BALAKRISHNAN.**

Facility being built for storage of spent fuel in La Manche, France. With the planned ramp-up in nuclear power generation, India will need to have specialised waste processing facilities too. — AFP

The end of India's nuclear isolation in 2008 led to some well-deserved euphoria. India is poised to embark on a massive expansion of its nuclear power programme from 4,120 MW at present. The six reactors already under construction would add another 3,160 MW. The plans are to reach 20,000 MW nuclear power by 2020 and nearly 65,000 MW by 2032.

This massive development would, of course, be subject to financial and technical constraints, but nuclear fuel and technology can now be imported. Foreign players from Russia, France, and the US are involved in India's plans. The private sector is also expected to enter this field. Nuclear power seems to be the answer to India's energy problems with minimal climate change impact.

Nuclear power is, however, not an unmixed blessing. Nuclear power inevitably leads to substantial amounts of radioactive waste, generated during fuel processing and consumption, treatment of spent nuclear fuel, as well as repair and maintenance of reactor components. There has not been much public discussion of policies and strategies India will follow to deal with massive amounts of nuclear waste. With India's nuclear power programme set to take off, it is time this issue was discussed in detail.

15 NEW PLANTS

Nuclear power sites for future development have already been identified by the Government. A total of 15 new nuclear plants are to be built at eight different sites. French firm Areva is earmarked to build two reactors in Jaitapur in Maharashtra; Russian firms will build two more reactors, in Kudankulam, Tamil Nadu, and in Haripur, West Bengal; and US firms are set to build a plant in Kovvada, Andhra Pradesh, and in Chayamithi Virdi, Gujarat. These new reactors are of much larger size, 1200 MW, compared to the 540-MW indigenous built reactors.

Nuclear reactors use fuel in the form of rods that are inserted into the reactor core, and "burn up" over time by means of nuclear fission. The fission products include highly radioactive materials, including some that can accumulate in human tissues, such as Strontium-90, Cesuim-137, and Iodine-131, and some gaseous radioactive elements. Spent nuclear fuel rods contain these highly radioactive materials generated by nuclear fission and other reactions.

The current practice is to store these spent fuel rods under water for about 2-4 years, so that some of the radioactivity decreases, and then process them. The fuel is subjected to chemical processing, resulting in waste of three kinds — low-level radioactive waste (in high volumes), intermediate-level radioactive waste (intermediate volumes), and high-level radioactive waste (low volumes).

GUIDELINES

The Atomic Energy Regulatory Board (AERB) issued comprehensive guidelines in March 2004, on waste management for nuclear power plants using PHWR reactors, which were the mainstay of India's programme. The guidelines cover all aspects of waste management, including transport, storage and disposal facilities. Each plant is to set up its waste management organisation, plant, and related facilities before commissioning. However, in the Indian context, implementation of guidelines and codes needs to be carefully monitored, especially by citizen's groups.

A typical 1000 MWe reactor produces 25 tonnes of spent fuel a year. If this is reprocessed, 97 per cent of this can be recycled into depleted Uranium and about 230 kg of Plutonium, which can be made into mixed oxide fuel (MOX), and used. This leaves about 700 kg of high level waste a year, which needs to be environmentally isolated for very long periods of time.

Isolation is achieved by converting the high-level waste into glass-like solid cakes (vitrification), about 4.8 tonnes, stored in steel canisters. Extreme care is needed in processing this highly radioactive material, and specialised facilities are necessary. After storage for about 50 years, these canisters can be put into deep underground repositories for long-term storage.

However, the time-scales involved are of the order of 10,000 years or more, beyond human experience. Global production of high-level radioactive waste is already around 12,000 tonnes a year, and is set to go up with the increase in nuclear energy production.

Obviously, if India is to ramp up its nuclear power generation to, say, 20 GW, there will be a sharp rise in waste generated, and the requirement for management of high-level waste would go up to 14 tonnes a year, or storage of 96 tonnes of vitrified waste a year. This will keep accumulating over the life of the power plant. This also brings out the importance of reprocessing technology in waste management.

The costs for the various activities associated with waste management will have to be included in the tariff charged for electricity sold to consumers. The amount charged by some countries comes to about $0.001 per kwH.

In the US high-level civil wastes all remain as used fuel stored at the reactor sites. It is planned to encapsulate these fuel assemblies and dispose of them in an underground engineered repository at Yucca Mountain, Nevada. However, due to local opposition, this plan has not been implemented so far. $26 billion has been collected from consumers so far for this purpose, of which about $6 billion has been spent.

EUROPE EXPERIENCE

In Europe most of the spent fuel is sent for reprocessing, either in the UK or France. The recovered uranium and plutonium is then returned to the owners (the plutonium via a MOX fuel fabrication plant) and the separated high-level wastes are vitrified, sealed into stainless steel canisters, and either stored or returned, to be eventually sent for geological disposal.Sweden follows a different route. It has a centralised used fuel storage near Oskarshamn, and will encapsulate used fuel there for geological disposal by about 2015. Finland is establishing a final repository at Olkiluoto.

India being geographically distant from Europe, the transport of spent fuel and waste over long distances would be impracticable and could also pose security risks. Therefore, India would need to have its own reprocessing and waste processing facility.

Security and safety considerations would imply that a centralised facility for reprocessing and high-level waste storage and disposal, similar to Sweden, would be more suitable. This would involve transport of high-level radioactive materials between the nuclear plants and the centralised facility, which would require appropriate security and safety procedures. The site selection for such a facility could also run into opposition from environmental activists.

Clearly, the AERB and our policy-makers need to revisit the present guidelines and arrangements for nuclear waste management and prepare the ground for anticipated nuclear power expansion in India.

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