Management of Radioactive Waste Materials in South Africa

All industry, including the nuclear industry and important related activities such as medicine, produces waste. Our modern society creates toxic and hazardous waste materials. Every day we live and breathe amidst non-degradable products and discharges such as noxious gases, CFCs, aerosols, gas emissions, poisonous mercury, other toxic chemicals, biological toxins and litter such as plastics and scrap metals. This mass of waste is growing every day and the toxic contaminants are posing a life-threatening problem to our world.

Environmental laws in South Africa have been enacted to encourage people to "clean up their act" but still we allow our world to be polluted with a host of very undesirable products. People must be educated on an ongoing basis to create an awareness and stimulate creativity for enhancing a sustainable environment for future generations.

The management of radioactive waste in South Africa is taken very seriously and Vaalputs, the radioactive waste disposal facility, has been internationally acclaimed as an ideal and well-planned facility. Radioactive waste in South Africa consists mostly of redundant by-products used in medicine, the mines, certain chemical industries and the nuclear fuel cycle. In some instances chemical toxicity is also associated with radioactivity.

Because of the potential radiation hazards and toxicity associated with radioactive waste, it must be stored for a long enough period to guarantee that the radioactivity will have decayed and become harmless with no future implications for human life and the environment. To accomplish this the radioactive waste must be handled in accordance with international codes of practice.

Management of radioactive waste implies the separation, processing, containment, storage and disposal options, all of which are applicable to all forms of radioactive waste during their respective life cycles. The disposal option for short-lived isotopes is usually in the form of shallow-land burial in trenches such as those at Vaalputs, which are only 8 m deep. The long-lived isotopes will be disposed of in deep geological facilities at depths between 500 and 1000 m and to date no such operational facility has been constructed anywhere in the world. The management and disposal of radioactive waste in certain parts of the world exemplifies a kind of dilemma that is all too common in the modern world, a problem involving both technology and politics. Disposal technology is available but human emotions frequently cloud the main issues at stake, which unnecessarily complicates sound judgement.

Environmental concern and in particular the phenomenon of global warming being caused by the pouring of greenhouse gases such as carbon dioxide, sulphur dioxide, methane and nitrous oxides into the atmosphere by conventional fossil-fuel electric power stations is becoming the major issue of our present generation. Nuclear power generation does not release any of the greenhouse gases into the atmosphere, which makes it a future strong contender for assisting to curtail the problem of global warming.

To illustrate this comparatively, suppose a coal-fired electric power station had been installed, in Cape Town the Koeberg Nuclear Power Station located close to Cape Town has, since its commissioning in 1984 until June 1995, avoided the release of the following greenhouse gases: 83 million tons of carbon dioxide, 950 thousand tons of sulphur dioxide and 410 thousand tons of nitrous oxides. Compared to this, since it commenced operations Koeberg has produced about 1000 tons of all wastes comprising low- and intermediate-level wastes and spent fuel. This goes to illustrate that within the next decade nuclear power will play an important role in global environment management because, whether it is liked or not, without it sustainable development will not be possible even if the contribution of clean technologies and renewable energy sources take an increasing share of the future global energy mix.

South Africa does not have an unending resource of coal and gas and perhaps these should be conserved and applied to the manufacture of products such as plastics and other specialised chemicals. In a qualitative way the amount of energy contained in 235U the size of a golf ball is equivalent to approximately 11300 tons of coal.

The Development of Vaalputs: South Africa's Radioactive Waste Disposal Facility

In 1978 a select committee examined scenarios for the management of radioactive waste that could be generated by the Koeberg Nuclear Power Station. It recommended that an off-site radioactive waste management facility should be constructed in a suitable environment to cater for both storage and long-term disposal options. In addition, it should be multipurpose for the disposal of low- and intermediate-level radioactive waste, storage of spent fuel and in the very long-term the deep geological disposal of spent fuel or alternatively high-level radioactive waste. Through a process of using specific site selection and evaluation criteria, Vaalputs was chosen, purchased, developed and subsequently licensed by the Council of Nuclear Safety for the disposal of low- and intermediate-level radioactive. The initial regional and site selection criteria used for Vaalputs included detailed geological, socioeconomic, environmental and demographic studies to demonstrate the potential
within a radius of 50 km of Vaalputs is less than one person per square kilometer.

The climate on Vaalputs is harsh, with summer temperatures often exceeding 40°C and winter temperatures plummeting below freezing with a high wind-chill factor. The rainfall averages only about 75 mm per annum and years may go by without good rains ever falling.

The most significant type of farming in the surrounding area is sheep grazing and the land carrying capacity is extremely low with only one sheep being grazed per 9 ha of land. The population density within a radius of 50 km of Vaalputs is less than one person per square kilometer.

The main rock formations are granite, constituting part of the 1000 million years old Namaqualand metamorphic complex. In the east the area is covered by the Karoo sequence. A large number of kimberlitic related pipes, diatremes and basalplugs of Tertiary age (about 20–40 million years) intrude into the basement rocks. Low magnitude seismicity has been measured in the area around Vaalputs. This seismic activity poses no threat at all to the facility.

Geohydrological studies have indicated that groundwater is associated with fractures in the granite and usually only occurs at depths below 50 m. The water found near the waste disposal site varies in age from 6000 to 10000 years and no more recent recharge of water has since taken place. This water is usually saline and not palatable for human consumption.

To obtain an operational license from the Council of Nuclear Safety it was necessary to model the facility for 300 years to determine the probability of the radionuclides reaching the human food cycle. Movement of radionuclides from the disposal site would most likely occur via the infiltration of rain water through soil and rock, eventually percolating down to the water table at a depth of 50 m. Model calculations have shown that a period of 45000 years would be required for this to happen based on the episodic low rainfall and the natural physical and chemical characteristics of the soil.

Detailed geobotanical investigations were also carried out to determine the impact of the disposal activities on the environment. This work also assisted with developing a rehabilitation programme for the disturbed areas. A long-term programme has been instituted to rehabilitate and reintroduce, respectively, the indigenous flora and fauna to the area. Vaalputs is not only a waste disposal facility but also a nature reserve with fascinating nature trails and a small number of reintroduced game.

Within the context of medicine, industry and the nuclear fuel cycle, radioactive waste will always be there and its management in South Africa has been undertaken in a sound and responsible manner. The compliance with internationally acceptable norms and guidelines has formed the cornerstone for all the radioactive waste management scenarios. Vaalputs has been examined by experts, some of whom are internationally recognised authorities in this field, to great acclaim.

Confronted with the monumental socio-political task of organising a decent life for 6 billion people on the earth, radioactive waste management and disposal would appear to be a relatively minor problem. But its importance cannot be overestimated as it gives an example of how patient work and sound scientific reasoning leads to the acceptance of satisfactory solutions, and to the overcoming of irrational judgement within parts of the human society.

**The South African Forum for Radiation Protection**

The South African Forum for Radiation Protection, a national advisory body funded by the Medical Research Council, the Atomic Energy Corporation, the Council for Nuclear Safety and the Department of Health, reports in its 7th Annual Report 1994 that during that year, it undertook the following activities:

- Concluded exchange agreements with the USA National Council on Radiation Protection and the UK National Radiological Protection Board
- Updated its report on indoor radon exposure, taking into account the newest International Commission on Radiological Protection (ICRP) recommendations
- Investigated biological dosimetry, the handling of radiation incidents, radiation exposure from diagnostic radiology and non-ionising radiation dangers

For more information and publications, contact:
SA Forum for Radiation Protection, PO Box 19070, Tygerberg 7505, South Africa

---

**Ghana**

The prestigious SNM/Medi-Physics Research Grant for Therapeutic Nuclear Medicine was awarded this year to Dr. Ben Adarwa Dwamena from Ghana, who is presently attached as chief nuclear medicine fellow to the University of Michigan in Ann Arbor, USA.

Dr. Dwamena plans to use the $30 000 awarded to him to develop a monoclonal antibody-based treatment for brain tumours; specifically, he wishes to develop transferrin receptor antibodies to see if they can eventually destroy malignant gliomas.