IV International Media Forum On the Protection of Nature

"Protection of Nature, Protection of Health"

Roma, 4-7 Ottobre 2006

Abstract

Radioactive Waste and The Viability of the Biosphere

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The unresolved question of radioactive waste remains the single most important hazard for the earth ecology and human health for both current and future generations. At present, the United States alone has accumulated over half a million cubic meters of high level radioactive waste in the production of nuclear weapons and over 40,000 tons of spent fuel rods from nuclear reactors. The current storage facilities for the temporary deposition of the radioactive waste over 100,000 tons are almost fully utilized. Yet, no permanent solution for disposal of high level active waste has been identified. After over six decades and multibillions of dollars spent on research and development, this adds to the larger problem of the fragile ecosphere of the planet already disturbed by the atmospheric, stratospheric, tectonic, and deep ocean alterations in the testing of thermonuclear weapons. Radioactive waste is classified in four categories: 1) natural radioactive materials consisting mostly of uranium, radium, and thorium from the minerals, coal, oil, and gas – all alpha emitters, 2) medical, mostly beta and gamma emitters from nuclear medicine, radiation therapy, and brachytherapy, 3) industrial, from the nuclear fuel cycle and used nuclear fuel, and 4) reprocessing of the nuclear weapons.

While low-level waste presents a low radiotoxic hazard, disposal of medium level radioactive waste involves the process of volume reduction, absorption to the chemicals, and containment in the metal drums mixed with the cement disposed of as solid waste. Disposal of high-level radioactive waste however, remains an unresolved problem with no foreseeable solution at present. The long-term radioactive waste disposal has been managed by the various procedures and technologies including vitrification, calcination, containment in the stainless steel cylinders, and underground storage. Vitrification commercial plants have operated in Europe for over 30 years with the capacity of over 3,000 cylinders a year. The Australian concept, used in the US military waste disposal of mineral synthetic rock immobilization, has been utilizing different minerals for different types of high-level waste.

Geological management of radioactive waste and the final site for deep waste deposit sites beneath the abyssal plain have been studied for decades. In about five years from present time, an international research facility for the final deposit sites of high-level waste is planned in Grimsel, Switzerland. While the government of Sweden has approved of this method as a safe disposal of spend fuel, it has not been accepted in Germany, where the Wendtland village of Gorleben has been selected as a repository area. The United States' final repository site in Nevada Yucca Mountain is still a matter of considerable controversy. The proposal of an international high-level waste storage in Australia and Russia has been studied by geological teams and has encountered particularly prominent opposition in Australia.

The ocean disposal of high-level radioactive waste is no longer an option because of the international laws of the sea with the concerns of unforeseeable dimension of adverse affects to the world's ecology in the event of the release of the deposited high-level waste into the ocean environment.

Placement of radioactive waste in the empty uranium mines after mixing with mill tailings and bringing it to the original activity of uranium ore has been proposed, but it has not progressed on the wide-scale. Other disposal methods, such as transmutation, integral fast reactors, sub critical reactors, and fusion reactors have been studied, again without wide applications. The international thermo nuclear experimental reactor has also been proposed as a method of disposal of transuranic waste which would simultaneously generate gigawatts of electrical power.

Biological transmutation of the cultures of microorganisms has been proposed and studied as a waste disposal method in Russia, Ukraine, Sweden, and the United Kingdom as a potential method in stabilizing radioactive waste in the subsurface environment and immobilizing radionuclides.

Disposal of radioactive waste into the orbit towards the moon and Venus or reorbiting to the sun has also been proposed as a method of high-level waste disposal. A rocket capable of carrying 30 ton load would contain five tons of radioactive waste encased in 25 tons of steel. Apart from the safety risks of such disposal methods (Challenger), disposal into space would contain prohibitive cost of over 100 million dollars per launch or tens of thousands of dollars per kilogram of waste. It has not developed much further than the original idea.

Current research and development of high-level radioactive waste management includes several new concepts such as the Russian project of high temperature immobilization, catalytic oxidation of the mixed waste (USA), shallow land disposal of intermediate levels of radioactive waste (Pakistan), bioremediation (UK), vitrification with plasma torch melter (South Korea), deep well injections (Russia), above ground concrete structures (Lithuania), strontium and uranium removal from high-level waste (USA), chem-gar gasification, cementation, and vitrification of actinides (USA) have all remained unresolved. The situation is even worse in developing countries. The recent report from the university of Ibadan Nigeria emphasizes the total ineffectiveness of the disposal of high-level radioactive waste.

Whereas the continuous research on the permanent safe handling of radioactive waste is inevitably warranted, the most pragmatic approach is to reduce proliferation of radioactive waste. This task is going to encounter significant challenges by the nuclear industry, military, and political establishments in most of the Nuclear Club countries, having the power of changing radiation dosimetry regulations. As an example, on August 22, 2005, the US Environmental Protection Agency issued new regulations for radiation dosimetry in proposed Yucca mountains repository which allows different radiation exposure limits for different time periods.

In conclusion, the high-level radioactive waste remains a hazard for the human health and environment which in the past six decades has exceeded all previous hazards of history. The vulnerability of the biosphere, already dramatically altered by the man-made intrusion on atmospheric, stratospheric, ocean, and tectonic stability, brings the delicate ecology of the planet earth and human somatic and genetic adverse affects to the brink of irreversible adverse consequences.