

THE COLD WAR'S LEGACY OF RADIOACTIVE WASTES

Over the past decade, the military dimensions of radioactive waste management have drawn increasing attention. Large amounts of radioactive waste subject to military jurisdiction have accumulated at numerous sites throughout the world, particularly in the United States and in the former Soviet Union, during the Cold War period. Reports and studies have documented problems arising from military waste management practices, and steps that are being taken in response to them.

A significant amount of radioactive waste from military operations entered the environment due to the production of nuclear weapons and their atmospheric and underground testing, large-scale radiation accidents, and disposal of radioactive wastes into seas. Especially during the initial period of operations, several mishaps occurred which led to discharges of radioactive wastes into the environment. In the former Soviet Union, discharges entered the Techa River and later Karachay Lake and other open water reservoirs in the Chelyabinsk region; the Yenisei River, near Krasnoyarsk and the Tom River, near Tomsk. Accidents included the explosion of a tank with radioactive wastes at Mayak and a wind-borne scattering of radioactive dust from the banks of Karachay Lake, both in the Chelyabinsk region, in 1957 and 1967, respectively, and the explosion of a reprocessing plant in Tomsk in 1993.

The US Programme. In the USA, large amounts of financial resources are being obligated for managing radioactive waste from defense activities. The US Department of Energy's (DOE) Environmental Management Programme (EMP) is responsible for addressing the environmental legacy of nuclear weapons research, production, and testing and of DOE-funded nuclear energy and basic science research. (*See box, next page.*) These activities collectively produced large volumes of nuclear materials, spent nuclear fuel, radioactive waste, and hazardous waste, resulting in contaminated facilities, soil, and groundwater at 113 sites around the country.

The EMP manages some of the most technically challenging and complex work of any environmental programme in the world. Despite the complexity and size of its mission, EMP has already completed active cleanup at 69 of the 113 sites. Since 1997, EMP has been implementing a site closure initiative to improve programme management, accelerate and complete cleanup, and close as many sites or portions of sites as possible by 2006. The cost of this major operation is huge and will probably approach several hundreds of billion US dollars. The life-cycle cost estimates include approximately \$35 billion in costs incurred by EMP from the programme's inception in 1989 through fiscal year 1996. EMP still faces formidable tasks that are likely to require \$168 to \$212 billion to complete.

Russian Federation & Cooperative Programmes. On the other side of the Atlantic, the International Institute for Applied Systems Analysis (IIASA) has established the Radiation Safety of the Biosphere (RAD) project to conduct a series of studies on the problems created by the radioactive waste in the former USSR. Within the Russian Federation, the problems of this radiation legacy are being handled in the framework of the Russian Federal Programme called "Management of Radioactive Wastes and Spent Nuclear Materials, Their Utilization and Disposal for 1996-2005." An important contribution to this programme is being made through a project called Radleg of the International Science and Technology Center (ISTC). IIASA is an initiator of this project and its major customer. The results of the Radleg project are to provide major inputs into the broader RAD project.

In addition, a Contact Expert Group was set up in 1995 for international cooperation in areas of radioactive waste management in the Russian Federation. A document now is nearing completion on an Overall Strategy for Radioactive Waste and Spent Fuel Management in the Russian Federation to facilitate financial support for high priority projects. Financial arrangements for some priority spent fuel storage and waste processing activities have already been completed. (*See article, page 64.*)

In the former USSR the structure of the nuclear complex included plutonium and tritium production reactors; nuclear fuel manufacturing for the reactors; highly enriched uranium (HEU) production; the reprocessing of spent fuel (SNF) from production reactors aimed at plutonium recovery; nuclear weapon components production from metallic HEU and plutonium; plants and institutions engaged in design and manufacturing of nuclear warheads and related devices; the production works for manufacturing nuclear fuel for naval ship propulsion reactors (SPRs) and facilities for SNF reprocessing; nuclear power plants, research reactors, civilian nuclear SPRs, nuclear fuel manufacturing plants and SNF reprocessing plants; facilities for production of radioactive isotopes and ionizing radiation sources for use in the national economy; and enterprises for radioactive waste processing and disposal (Radon Special Enterprises). The production of primary nuclear materials for both military and civilian purposes was conducted, as a rule, at common industrial facilities. The main facilities of the Soviet nuclear complex were the Industrial Association Mayak in Chelyabinsk region, the Siberian Chemical Combine in Tomsk region, and the Mining & Chemical Combine in Krasnoyarsk. The Russian Federation has inherited more than 80% of the nuclear industrial potential of the former USSR and therefore its radioactive wastes. The total amounts of radioactive waste and

**AMOUNTS OF RADIOACTIVE WASTE AND SPENT FUEL
FROM DEFENSE ACTIVITIES IN THE UNITED STATES**

In the USA, the management of radioactive wastes from defense activities involves:

- remediating nearly 10 trillion liters of contaminated groundwater, an amount equal to approximately four times the daily US water consumption;
- remediating 40 million cubic meters of contaminated soil and debris, enough to fill approximately 17 professional sports stadiums;
- safely storing and guarding more than 18 metric tons of weapons-usable plutonium, enough for thousands of nuclear weapons;
- managing over 2000 tons of intensely radioactive spent nuclear fuel;
- storing, treating, and disposing of radioactive and hazardous waste, including over 160,000 cubic meters that are currently in storage and over half a billion liters of liquid, high-level radioactive waste;
- deactivating and/or decommissioning about 4000 facilities that are no longer needed to support active missions;
- implementing critical nuclear non-proliferation programmes for accepting and safely managing spent nuclear fuel from foreign research reactors that contains weapons-usable highly enriched uranium; and
- providing long-term care and monitoring -- or stewardship -- for potentially hundreds of years at an estimated 109 sites following cleanup.

**AMOUNTS OF RADIOACTIVE WASTE AND SPENT FUEL
ACCUMULATED IN THE RUSSIAN FEDERATION**

Ministries, departments, and organizations	Liquids		Solids		Spent Fuel	
	m ³	Bq	m ³	Bq	Tons	Bq
Ministry of the Russian Federation for Atomic Energy (Minatom) Uranium ore mining and processing, uranium enrichment, nuclear fuel manufacturing, nuclear power production, spent fuel reprocessing, and nuclear weapon materials production	4.0 10 ⁸	6.3 10 ¹⁹	2.2 10 ⁸	8.14 10 ¹⁸	8700	17.02 10 ¹⁹
Ministry of Defense of the Russian Federation (Navy) Operation and utilization of nuclear ships and submarines	1.4 10 ⁴	4.44 10 ¹²	1.3 10 ⁴	29.6 10 ¹²	30	5.55 10 ¹⁷
Ministry of Economy of the Russian Federation Department of Defense Industry Construction, repair, and utilization of nuclear ships and submarines	3.2 10 ³	18.5 10 ¹⁰	1.5 10 ³	3.7 10 ¹²	*	*
Ministry of Transport of the Russian Federation Operation and utilization of nuclear icebreakers	4.4 10 ²	5.5 10 ¹³	7.3 10 ²	3.7 10 ¹⁶	10	17.39 10 ¹⁷
Radon Special Enterprises Processing and disposal of radioactive materials, used in medicine, scientific research, industry, etc.	-	-	2.0 10 ⁵	7.77 10 ¹⁶	-	-
Total	4.0 10⁸	6.29 10¹⁹	2.2 10⁸	8.51 10¹⁸	8740	17.39 10¹⁹

*More than 100 nuclear-powered submarines and their spent fuel are awaiting decommissioning.

spent fuel accumulated in the territory of the Russian Federation is estimated at more than 600 million cubic meters of radioactive waste and 8700 tons of spent fuel awaiting final disposal (*see table*), in addition to large amounts of residual

wastes from mining and milling activities. According to IIASA, these radioactive wastes “are being managed in a way that does not completely meet modern international standards of radiation safety”.