AN OVERVIEW OF CZECHOSLOVAK APPROACH TO RADIOACTIVE WASTE MANAGEMENT

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ABSTRACT

The paper summarizes technology available in the Czech and Slovak republics to treat and dispose of all kinds of radioactive wastes. Three main groups are responsible for the production of such waste: the uranium mining and milling, the institutional use of radioisotopes and nuclear energy. The treatment methods include bitumination, cementation, vitrification, drying/calcination and low pressure compaction. There are three repositories in operation or in the preoperational stage, all being devoted to low and medium activity waste. The current spent fuel storage is going to be enlarged in order to provide an adequate capacity till the started project of development of deep geological repository is finished. Both republics follow the problems of low level nuclear waste independently, while institutional waste treatment and the disposal as well as the burial of high level waste are coordinated together.

INTRODUCTION

The history of the utilization of uranium goes back to the last century in Czechoslovakia. Its exploitation in glassworks were replaced by nuclear research in the fifties of this century and by putting the first reactor into operation in 1972. Currently eight reactors (each 440 MWe) are in use while six others are under construction (4 x 440 and 2 x 1000 MWe).

The production of radioactive waste reflects the three mentioned sources. As all producers are responsible for making radioactive waste harmless the waste management is governed independently in the following regions:

- uranium tailings and depleted metal uranium waste are treated by the "DIAMO" company at its own expense
- institutional wastes are within the responsibility of the "Institute for Development, Production, and Utilization of Radioisotopes" based in Prague (ÚVVVR); the expenses are covered by producers under the financial aid of the Czech government
- all reactor wastes and spent fuel are managed separately by both the "Czech" and "Slovak" Energetic Boards (CEZ, SEP) which are the owners of all nuclear power plants

Utilization of radioactive material is under the supervision of regional hygienic bodies and Czech or Slovak ministries of the environment. Reactor owners are furthermore controlled by State Office for Nuclear Safety while uranium producers are supervised by "Hygienic Institute of Uranium Industry".

Generally, the role, bonds and responsibilities of enumerated organizations in both successive states are parallel and follow the previous federal structure.

There are two types of legislative documents controlling radioactive waste management: The Government Resolution (GR) and the Legislative Acts (LA). Brief characteristics of key materials are as follows:

- LA No. 85/1976 - detailed adaptation of the procedure of territorial and construction licensing to gain approbation for siting and construction of nuclear facilities
- GR No. 197/1979 - conception of radioactive waste management based on Czechoslovak home capacities, bitumination (alternatively cementation) solidification technologies and construction of shallow-land engineered regional repositories
- GR No. 20/1981 - enumeration of precautions to make all radioactive waste arising during NPPs operation harmless safely
- LA No. 28/1984 - constitution of an office for state inspection of the nuclear safety of nuclear facilities
- LA No. 67/1987 - specification of requirements to ascertain nuclear safety during radioactive waste management (incl. prescribed safety documentation for repository licensing)
- LA No. 238/1991 - summarization of rights and duties during general waste management
- LA No. 17/1992 - definition of protection of the environment
- LA No. 244/1992 - procedure of the environmental impact statement

WASTE MANAGEMENT PRINCIPLES

Waste Treatment Practices

Uranium milling tailings are generally gathered in sludge ponds. After closure they will be covered by soil and recultivated. The sites are monitored and restricted to unlimited use.

Low and intermediate level wastes are treated prior their disposal by the following technologies: direct bitumination or cementation of liquids (prototype stage), drying/calcination followed by bitumination or cementation of liquids or resins (development stage), low pressure compaction of solid waste (in operation). Some technologies are in the R&D stage, namely: incineration, vitrification of ILW (high phrequency melter), calcination/pelletization, melting of some metal waste.

High level and long lived wastes are incorporated into borosilicate glass in a medium phrequency heated furnace with a capacity of 20 kg of glass per batch. A unique technology for solidification of alpha contaminated sludge with high chromium content from spent fuel storage has been developed.

Waste Volume

There is no precious information on the production of uranium tailings in Czechoslovakia. The estimates are within many tens of millions of metric tones.

At the end of 1992 the volume of buried institutional waste was about 3,000 m^3 with annual increase between 100 and 200 m^3. The production of waste contaminated solely by natural radioisotopes (Ra, Th) is several m^3 per year.

Nuclear power plants are the main sources of low and intermediate level waste. Production of each doubleunit (2 x 44O MWe) is about 300 m^3 of solidified and 100 - 200 m^3 of solid wastes annually.

Experimental energetic reactor A-1 is a principal producer of high level and alpha contaminated wastes. Due to a significant accident (melting of fuel) the reactor is being decommissioned. The quantity of long lived waste is estimated to be several hundreds of m^3.

Annual production of spent fuel is 14 MT/reactor, total production of all plants will be some 8000 MT. It is in store at each nuclear power plant site for several years, and the restricted capacity of a centralized storage facility in Jaslovské Bohunice (600 MT) calls for the early construction of some new capacities. Dry storage in casks is projected at Dukovany for the Czech republic, while the siting procedure for centralized facilities is in progress in both republics.

Disposal Facilities

Currently, there are two repositories in operation in the Czech and Slovak republics. Another one is closed, further two are under licensing procedure, and the last one is in the early R&D stage.

The oldest (closed) repository Hostim (3O km SW of Prague) was fed by institutional waste in l959 - 61. It was built in near surface corridors of an abandoned limestone mine. Its inventory is not higher than 10^{12} Bq of beta-gamma isotopes and its volume reached up several hundreds m^3.

An old uranium mine in Jáchymov (approx. 120 km W of Prague) has been used as a repository of waste contaminated by natural isotopes. The gross ^{226}Ra activity (both in the form of Ra and ^{238}U) is 10^{13} Bq and capacity of its spaces (1,200 m^3) is exhausted to 25 %. This facility is accessible horizontally and is situated nearly 300 m below the ground level. The safety analysis of the site did not recommend the enlargement of the repository due to the unfavorable hydrogeological situation.

Since l964 institutional wastes have been disposed of in an abandoned limestone mine - Richard II - near Litomerice (60 km NW of Prague). The host rock is marlstone. The mined spaces lying up to 60 m below the surface were supported by reinforced concrete structures. The total volume of restored underground system is approx. 17,000 m^3. The utilizable disposal volume (8,850 cub.m.) is exhausted up to 6O %, annual average addition varies between 100 and 200 m^3. Final activity is supposed to reach 10^{16} Bq while the present activity is less than 10^{13} Bq. The site is provided with drainage which is at he same time a part of its monitoring system.

The two repositories under licensing procedure are of shallow land type. They are designed for low and medium level waste without a significant amount of long-lived radionuclides arising at nuclear power plants. Both constructions consist of reinforced concrete structures with isolation lining. At Dukovany (30 km W from Brno) concrete modified by asphaltopropylene, while at Mochovce (100 km E from Bratislava) clay soil, was used for that purpose. The current capacity of completed structures (62,000 m^3 at Dukovany and 44,000 m^3 at Mochovce) is supposed to be extended according to future needs. Final volume capacity can reach up to 310,000 m^3 and 220,000 m^3 in Dukovany and Mochovce site resp. Maximum permitted inventory of each 550 m^3 concrete vault is 0.8 GBq alpha and 10^{14} Bq beta, gamma radionuclides.

In connection with the decommissioning of nuclear power plants and with the management of spent fuel, a program of deep geological burial has started by candidate regions identification. Crystalline, clay and volcanic formations are considered as potential host rocks in both republics. 34 regions, all crystalline, have been chosen for further investigation as a result of siting in the Czech republic. It has not been yet decided whether spent fuel shall be reprocessed or buried directly.

RESEARCH AND DEVELOPMENT

As a result of the privatization process most of the R&D capacities lost their government sponsorship. However, due to the limited availability of specialists, their role was not changed. To cover the waste management responsibilities both Czech and Slovak governments plan to establish respective bodies (probably similar to the French ANDRA). The needed legislation is in preparation and should be accepted this year.

Research and investigation activities are delegated to some leading institutions, the "Nuclear Research Institute", Rez, in the Czech republic - waste treatment and disposal, and the "Research Institute of Nuclear Power Plants" Trnava in Slovakia - waste treatment. They are supported by many tens of subcontractors of which the "Czech Geological Institute", Prague, and "Institute of Nuclear Fuel", Prague, are among the most important. The main research areas include:

- treatment of waste from operation and decommissioning of energetic reactors;
- techniques for decommissioning of nuclear power plants;
- radioactive waste transportation and manipulation;
- radioactive waste disposal (siting, near field and far field);
- safety studies of waste management processes.

FUTURE ACTIVITIES

In spite of the fact that some of the treatment or disposal technologies have not been put into full scale operation, the problem of the treatment of low and intermediate level waste may be considered to be practically solved. Available bitumination, cementation, and compaction apparatuses are able to process most of the radioactive waste produced in Czechoslovakia. Two licensed regional repositories and one operated institutional waste facility have enough capacity to accept all low and intermediate level waste. The prototype vitrification plant is prepared for cold operation and for trial experiments at the decommissioned power plant site. That is why our effort is focused mainly on the following items:

a. R&D activities connected to the preparation of a deep geological repository designed for wastes nonacceptable by existing facilities (long lived, spent fuel, high level waste); and

b. in this connection, the construction of long term storage capacities that are able to accept respective sorts of waste till the repository is opened

c. the adaptation of available treatment technologies and/or development of progressive ones to process new waste types (decommissioning, uranium and radium contaminated waste)

d. design and implementation of techniques for the decommissioning of reactors

e. the securing of legislative background of radioactive waste management, namely the approval of the prepared "Radioactive Waste Management Act"
   - the issue of connected and executive regulations
   - the installation of a waste management funding system

f. the clearing of bonds, duties, rights, and responsibilities among all institutions involved in waste management (producers, repository operators, supervising, licensing and control bodies) (see Fig. 1.).

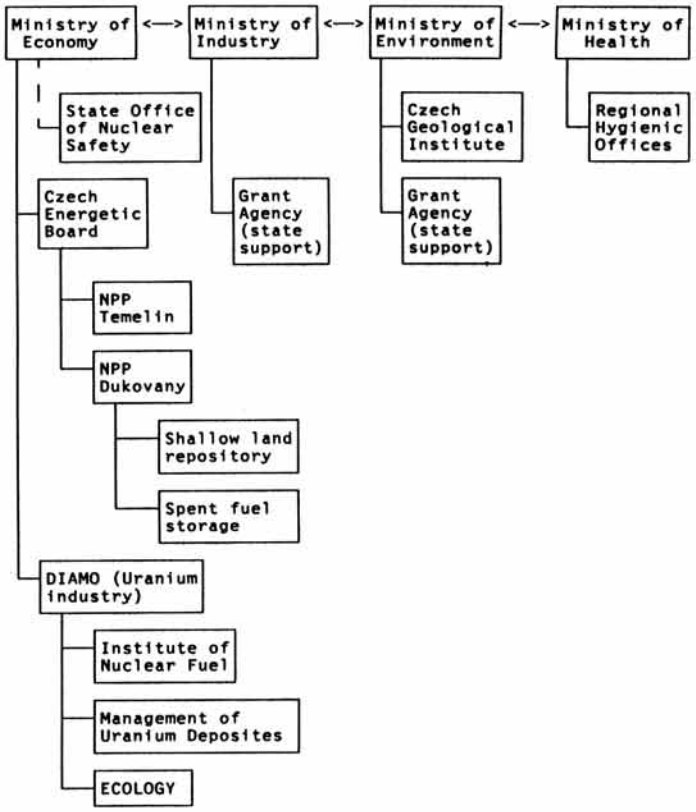

Fig. 1. Bonds among organizations dealing with radioactive waste in the Czech Republic (effective in January 1993).