RADIOACTIVE WASTE MANAGEMENT IN AUSTRIA

by

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At the Austrian Research Centers Seibersdorf, there are several facilities installed for treatment of waste of low and intermediate radioactivity level (radwaste). A separate company within Centers, Nuclear Engineering Seibersdorf, has been formed recently, acting as a centralized facility for treatment, conditioning and storing of such waste within the country. The relevant treatment technology is applied depending on the waste category. In total about 6900 m^3 of solid waste of low and intermediate radioactivity level originating from Austria was treated in the period between 1976 and 2002. Presently, there exists no final repository for radwaste in Austria. A study is under way to identify the structure for a long term storage facility.

Key words: radioactive waste, water treatment facility, incinerator, high force compactor, cementation equipment, interim storage facility

INTRODUCTION

Austria had the intention to join the countries using nuclear energy for electricity production. Therefore, as the first step, a research organization, Austrian Research Centers Seibersdorf (ARC), was established in 1956 and a research reactor was built, sited at Seibersdorf, about 35 km south of Vienna, and put into operation in 1960. Two other research reactors were built in Vienna and Graz and put in operation a few years later. During the seventies, a power reactor was built and was ready for use in 1978; however, as a result of a referendum, it was never put in operation.

At about the same time, an agreement between the Ministry of health and environment and ARC was signed with the aim to establish and operate a centralized facility for treatment, conditioning and interim storage of radioactive waste. It was finally built at the site of ARC and is operated now by Nuclear Engineering Seibersdorf (NES), comprising several facilities. They include a water treatment facility, an incinerator for the treatment of burnable radwaste, a high force compactor for non-burnable material, cementing equipment for conditioning and interim storage halls for unconditioned and conditioned radwaste.

Not all facilities were erected at the same time, for example, the storage halls were built in the seventies, the incinerator was put in operation in 1980 for a test phase and commissioned for radioactive material in 1983, which was followed by routine operations with radwaste, and the high force compaction unit started operation in 1995.

Planning, building and operation of all facilities was carried out in accordance with the relevant regulations and laws in close co-operation with the authorities. In the absence of a nuclear industry in Austria, only waste of low and intermediate radioactivity level collected during medical, research, and industrial use of radioactive material is treated, conditioned and stored. Only Austrian waste is collected and treated, with the exception of a project of treating contaminated ion-exchange resins, which came from a power plant in Italy. After treatment and conditioning, the waste was sent back to Italy, the originating country, for interim storage there.

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RADIOACTIVE WASTE MANAGEMENT

The radwaste in Austria results from the former operation of research reactors, the application of radioactive materials in medicine, research and development (R&D), industry, IAEA laboratories at Seibersdorf, and technically enhanced natural radioactive materials as by-products at industrial metallurgical and other processes. All such waste is transferred to NES for treatment, conditioning and interim storage.

The aim of treatment and conditioning is the safe enclosure of radwaste by the use of barriers to surround and isolate the waste and transform it to an insoluble form. At the same time, it is important to reduce the volume of the row waste by applying the appropriate treatment technologies, in order to save space in the storage facilities and, connected to that, to reduce costs.

As a pre-treatment measure, segregation of different categories of radwaste is required and has to be done by a waste producer. Requirements for segregation are established by NES and are transmitted to radwaste producers every year together with the actual price list.

Main categories of radwaste where strict segregation is required are:
- solid burnable,
- solid non-burnable
- liquid burnable,
- liquid non-burnable,
- sealed sources, and
- fissile material.

Additional information regarding radionuclides has to be provided by the radwaste producer on their physical and chemical state, and their infectious and chemical hazards. This kind of information is required by transport regulations and for the safe manipulation of the radwaste at NES.

Transportation is carried out via railway or road according to the international regulations as ADR/RID which are integrated in national regulations [1].

Collection of radwaste is carried out by using 100 liter steel drums, which are provided by NES.

The first step after arrival of radwaste drums at NES is to label them and check their content by radiation monitoring and visual inspection. If it is found that the content of a drum violates requirements, the price charged is doubled because additional work is necessary. Unnecessary risk may be incurred during additional segregation work (*e. g.* handling iwection needles), so additional precautions must be taken.

Storage capacity is offered at NES for short lived radwaste decay. Since only combustible waste of that kind is stored at NES, polythene drums are used for its collection, transport and storage. After the decay of radionuclides (mainly ^{125}I and ^{35}P) and appropriate radiometric checks, the drums are transported to a suitable incinerator facility accepting non-radioactive waste. Strict monitoring ensures that radioactivity is below the official release level before leaving NES to be treated as non-radioactive waste.

Drums with radwaste awaiting treatment are stored in separate storage halls according to their category before the relevant treatment steps are carried out.

Conditioning method at NES is cementation where the 200 liter steel drum concept is in use, *i. e.*, conditioned waste is placed in such drums. Then, all drums with conditioned radwaste are transferred in dry engineered storage halls for interim storage. The interim storage facility will be in operation till 2030 in accordance with the contract with the relevant ministry.

During the treatment, a quality assurance program for characterizing waste and the quality of conditioning is applied. A comprehensive documentation is set up, following all steps from the arrival of radwaste at NES via treatment and conditioning to the interim storage, including all data provided by the waste producer. The record keeping is computerized.

Presently, there is no final repository for radwaste in Austria. There are intentions to identify a suitable site where the repository could be built and design criteria studies are being carried out.

Figure 1 shows a flow sheet of radwaste management.

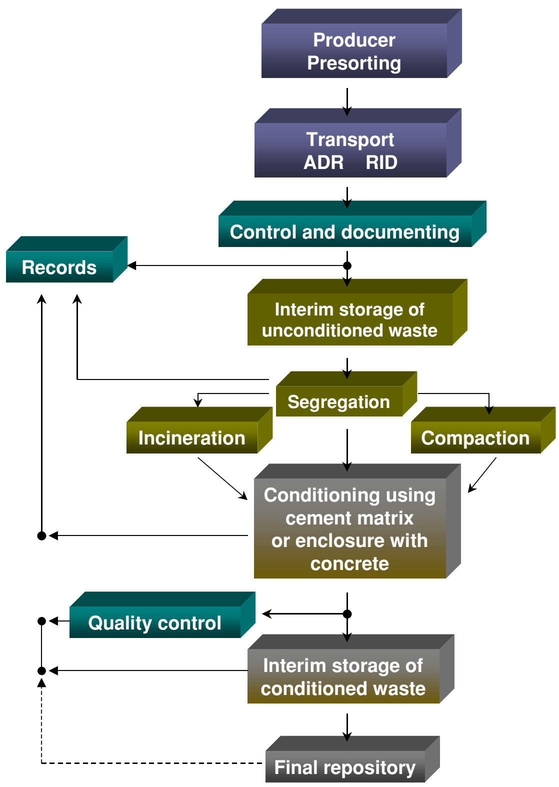

Figure 1. Flow sheet of radioactive waste management in Austria

SOURCES, CATEGORIES AND QUANTITIES

Austria does not use nuclear power for generation of electricity. There are two research reactors still in operation and one research reactor (ASTRA, reactor at ARC Seibersdorf) is in the state of decommissioning. Radioactive material is widely used in the fields of medicine, R&D and industry. These activities are the sources of radwaste to be dealt with in Austria.

All types of radwaste are present in the country, *i. e*,. radwaste of high, intermediate and low radioactivity level, but only radwaste of intermediate and low radioactivity level has to be treated, conditioned and stored in Austria. Used fuel elements from research reactors, *i. e*., waste of high radioactivity level, are transferred out of the country for treatment and disposal under international agreements.

In comparison to countries using nuclear power, only very small quantities of radwaste are produced, but all categories of waste are produced (liquid and solid waste, sealed sources, *etc*.) and have to be handled, treated and stored applying the same safety standards and techniques used for larger quantities of waste. Therefore, the fixed costs of waste treatment are especially high.

Up to the end of 2002, the following quantities of low and intermediate radwaste were produced in Austria:
– solid radwaste 6 900 m³, and
– liquid radwaste 50 000 m³.

Since NES acts as the centralized facility for Austrian radwaste, all the waste has been treated, conditioned and stored in the interim storage facility.

The dominant quantity of solid radwaste is combustible waste from hospitals.

Liquid waste originates mainly from reactor operations and the incinerator (wet scrubber) operation itself. Only a small fraction of liquid waste originates from medical facilities and universities.

Sealed sources are widely used for industrial purposes. Radionuclides as ^{60}Co, ^{137}Cs, ^{241}Am, and others are in use. Some sealed sources as ^{60}Co and ^{137}Cs are used for medical application as radiation sources for high dose treatments. Such sources are few in number but their level of radioactivity dominates the total activity in the NES radwaste facilities as soon as they are declared as spent sources and transferred to NES for interim storage.

Spent sealed sources may need shielding before conditioning and storage. A special category of sources includes radium sources for which a special conditioning method is applied.

A special category of sources comprises radium sources used from around 1900 to about 1960 for medical treatment. They were produced in different qualities and showed tendencies for leaking. Due to the high radiotoxicity of radium, their usage was stopped and radium was replaced by safer sources as soon as they were available. More than 13 g of radium are conditioned by a special method and stored at the interim storage at ARC. This special conditioning method has been developed at NES and is adopted now by IAEA for the application in developing countries [2].

There are small quantities of fissile materials stored at NES Seibersdorf:
– enriched uranium from R&D,
– Pu-Be neutron sources,
– natural uranium, and
– depleted uranium.

TREATMENT FACILITIES AT NES

For the radwaste management in practice, equipment and facilities are available for reducing the quantity of row waste by various appropriate treatment techniques. In order to isolate the waste, a conditioning process is applied, and the packages obtained by that process are transferred into interim storage facilities. All pieces of equipment and installations are designed and operated with the aim to protect the staff, the community and the environment from unacceptable exposure to ionising radiation.

The following facilities are available at NES:
– water treatment facility,
– incinerator for solid and liquid burnable radwaste,
– high force compactor,
– cementation equipment, and
– interim storage facility.

Water treatment facility

The water treatment facility was the first radwaste treatment plant in operation. Due to the reactor start up and other laboratory activities, it was necessary to operate such a unit right from the beginning. The reactor operating and handling the radioactive materials produce large quantities of liquid waste which can be stored only in very limited quantities. The plant started with very simple equipment in 1960; it has been rebuilt and technically improved several times since, thus keeping up with the technical standards and the regulations imposed by the authorities.

Presently, the plant includes a number of tanks and basins, equipment for chemical precipitation and filtration with very high efficiency, having a capacity of about 100 m³ per week. Residues from filtration have been conditioned by cementing or, as it is done now, by drying and high force compaction.

In total about 50 000 m^3 of liquid radwaste resulting from all relevant activities in Austria has been treated in this facility. The solid content of all the liquid waste has been very low. Effluents from laboratory, incinerator and reactor operations have been dominant. Only about 300 m^3 of contaminated liquid have arrived from outside ARC over the years.

Short lived radwaste in the form of effluents produced mainly in medical facilities were decay tanks are directly attached to such facilities is not included.

The special equipment is in operation at NES serving only for potentially alpha bearing liquid radwaste.

The resulting number of 200 liter drums containing conditioned solids, resulting from water treatment, is about 500.

Figure 2 shows a simplified flow sheet of the plant.

Incinerator

The shaft incinerator of the "Karlsruhe" type is an excess air unit having a capacity of about 40 kg per hour and a combustion chamber with the volume of about 4 m^3. Feeding is carried out batchwise from the top. The off-gas cleaning system consists of a set of ceramic hot gas filters, quench, two stage wet scrubber and HEPA filters.

Over the years, a number of modifications to the original design have been carried out in order to improve safety, to keep up with the technical standards and to meet requirements of the changing regulations. Especially the off-gas cleaning system has been improved considerably compared to the original design.

In addition, modifications of the shaft have also been carried out; for example, the additional openings have been introduced in order to facilitate the incineration of powdery material. The largest single project was the incineration of about 1600 m^3 of dried ion-exchange resins, where the material was transferred into the combustion chamber via a screw and a blowing system [3].

Technical data of the incinerator are:

Excess air incinerator
Shaft type, single chamber combustion:1 m in diameter, 5 m high,
Combustion temperatire: 1000 C
Capacity: 40 kg/h solid burnable waste (calorific value: average 21 ^{6} J/kg = 5000 kcal/kg)
Underpressure in combustion chamber: 10^3 Pa = = 10 mbar
Air flow: 300-600 m^3 variable, depending on underpressure in combustion chamber
Feeding from top batchwise (2-3 kg) through airlock, liquids through burner,
Feeding of powdery material by blowing system into combustion chamber,
Hot gas filter, in brick-lined filter box, silicon-carbide candles, mean porosity: 20 μm,
Quench, spray cooler with nozzles, decreases off-gas temperature from 700 to 70 °C,
Two stage scrubber (one trickle flow, one spray) using caustic soda solution to pH 8.1,
Heater, raises off-gas temperature to 100 °C
HEPA filters,
Off-gas draft fan, radial blower, regulated by underpressure of combustion chamber,
Mixing chamber, and
Stack, 35 m high.

Figure 3 shows a simplified flow sheet of the plant.

High force compactor

Non-burnable solid radwaste can be treated using the high force compactor. This unit is of horizontal design. Hundred liter steel drums containing solid radwaste are fed through a top opening into the chan-

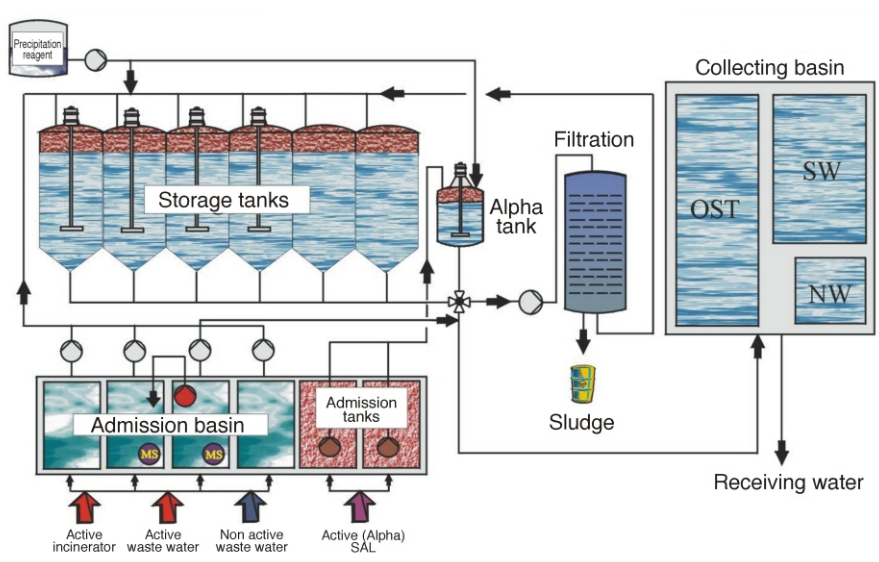

Figure 2. Diagram of the waste water treatment plant Seibersdorf for active and non active waste water

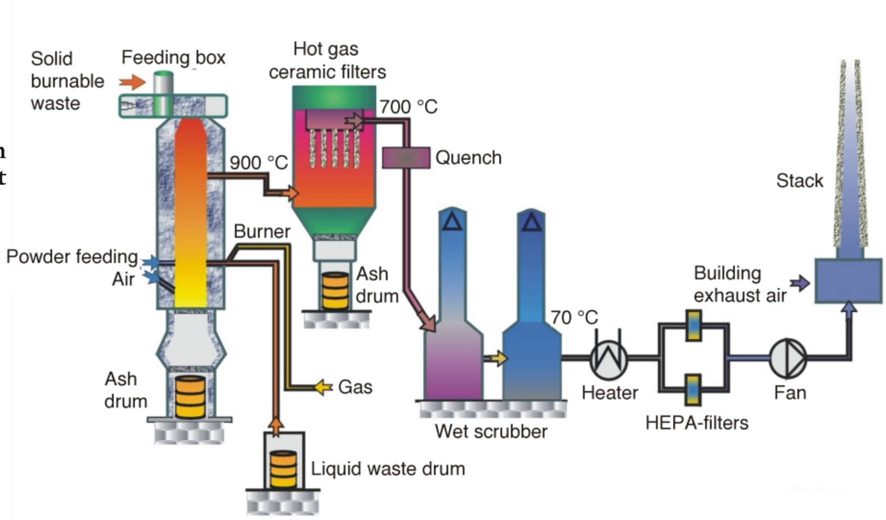

Figure 3. Simplified diagram of the exess air incinerator at Seibersdorf

nel of the ram. When the ram is in operation, the content in the channel is compressed into the compaction station with a compaction force of 12 MN. Pellets formed in this way are ejected after opening the compaction station and transferred into a 200 liter drums for storing.

Depending on the kind of waste a volume reduction factor of 2 to 10 can be reached.

Up to the end of 2002, about 800 drums containing pellets with radwaste from about 800 m^3 of row waste were produced.

Cementation equipment

For immobilizing radwaste the method of cementing is applied for conditioning.

With one exception, only 200 liter steel drums are in use. The exception is a small number of pre-cemented containers used for storing radwaste of intermediate radioactivity level which needs additional shielding. These containers offer a wall thick 20 cm of concrete and can take up one 200 liter drum each.

Cementing is carried out by in-drum cementing in 200 liter steel drums or by mixing waste with cement and water in a separate equipment to be filled into 200 liter drums. In such cases the radwaste must be mixable.

If radwaste can not be mixed, 100 liter drums are used for taking it up; they are centred in 200 liter drums and surrounded with mortar.

Pellets are conditioned in the analogue way.

Interim storage

All conditioned radwaste is stored in two dry engineered construction storage halls. The capacity is limited to 15,000 drums of 200 liters of volume. At present 9500 drums are stored. It can be estimated that the capacity is sufficient till 2015.

Only radwaste from Austrian facilities to be decommissioned and Austrian users of radioactive materials is stored at the ARC facility.

Figure 4 shows the interim storage with drums containing conditioned radioactive waste.

Figure 4. Interior view of the hall 12A of Austrian interim storage for low and intermediate level radioactive waste in ARC Seibersdorf

CONCLUSIONS

Most radionuclides used in nuclear application, especially those used for diagnostic purposes in hospitals, have relatively short half lives allowing disposal as non-radioactive waste after a suitable decay period.

Other radwaste consisting of longer lived radionuclides produced in Austria is collected, treated, conditioned and stored in the relevant facilities at NES. With those facilities and together with the Austrian regulatory framework an effective radwaste management infrastructure is provided for the country and a closed cycle for radionuclides from the production to the interim storage of conditioned material is achieved.

A comprehensive quality assurance program together with regulatory authority controls ensures a high safety standard in this field.

Presently, all contaminated organic material is chemically stabilized by combustion. The resulting ash is conditioned by cementing or compacting and is stored in the interim storage in this form.

In order to further improve the stability and leaching resistance, an R&D project for vitrifying ashes and other materials has been started at a small scale. Improvement of leaching resistance will be investigated. It is expected that vitrified products will offer significantly better characteristics for continued interim storage and at the same time for final disposal. Relevant investigations should reveal to what extent different radionuclides can be fixed into the glass matrix. Only radwaste of low and intermediate radioactivity level is considered for investigation.

In spite of the small quantities of radwaste in Austria and efforts to further minimize this amount, volume reduction by different treatment methods is still an important option due to limited space for interim storage and future need of long term storage [4]. Changes in volumes of radwaste are reflected in the price structures. Costs for the present radwaste services in Austria have to be paid by radwaste producers.

Within an agreement between NES and the Austrian state for the time period until 2030, the tasks of both partners are regulated. In this agreement the Austrian government asserts that by 2030 there will be a repository for conditioned radwaste identified, built and put in operation.

Since the amount of radwaste produced in countries that do not use nuclear energy for electricity production is by at least two orders of magnitude lower than radwaste produced in countries using nuclear power, it should be discussed whether the construction of final repositories in every country is the best solution. From a technical, economical and ecological point of view, a common European repository for countries not using nuclear power would certainly have preference, even if the political acceptance is not given at present.

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Јозеф НОЈБАУЕР

УПРАВЉАЊЕ РАДИОАКТИВНИМ ОТПАДОМ У АУСТРИЈИ

У Аустријским истраживачким центрима (ARC) у Сајберсдорфу постоји већи број изграђених постројења за обраду отпада ниског и средњег нивоа радиоактивности. Недавно је у ARC-у оформљено предузеће Нуклеарни инжењеринг Сајберсдорф које делује као централна аустријска установа за обраду, одлагање и смештај оваквог отпада. У њему је примењена технологија прераде примерена категорији отпада. У периоду од 1976. године до 2002. године, укупно је обрађено око 6900 m^3 чврстог отпада ниског и средњег нивоа радиоактивности, домаћег порекла. У Аустрији, у којој за сада не постоји коначно одлагалиште, управо је у току израда студије за утврђивање структуре постројења за дуготрајно одлагање радиоактивног отпада.