Projected Worker and Public Doses from Long-term Intermediate Storage of Radioactive Waste at Nuclear Engineering Seibersdorf

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Abstract

As sole contractor to the Austrian government, Nuclear Engineering Seibersdorf is responsible for collection, treatment, and interim storage of any radioactive waste generated within the country of Austria. With the recent extensions of the contract for these activities by the Republic of Austria and the Municipality of Seibersdorf and the licence for the treatment and storage facilities by the Competent Authority for radiological protection, it has become obvious that Nuclear Engineering Seibersdorf will have to develop a sound strategy for long-term intermediate storage of the waste currently already on site and projected to be received within the course of the next 20 years.
Moving from short- to long-term intermediate storage of radioactive waste, however, will require significant investment in renovation, upgrade, and extension of the facilities currently in use, together with the implementation of a program of activities tailored to ensure long-term stability of historic and future waste packages. Design of changes to the available facilities and the future work programs include, to a large extent, current knowledge and data on worker and public doses due to established methodologies and existing work programs. Optimized rather than minimized exposures will be the result from these considerations; in particular, some of the projected work will necessitate increased worker doses in order to establish a system which will be acceptable to the public and which ensures ALARA public exposures.
Data from the accredited measurement laboratories for radiation protection at the Austrian Research Centers are presented together with radiological considerations provided by Nuclear Engineering Seibersdorf staff. Comparisons are drawn to current technology in on-site radiological decay facilities in Austrian hospitals, which have to include similar considerations for their licensing of this short-term radioactive waste storage.

Introduction

In 2004, Nuclear Engineering Seibersdorf GmbH (NES) was contracted by the Austrian government for the collection, treatment, and interim storage of any radioactive waste generated within the country of Austria. To that purpose, NES was established as an independent non-profit organization and legally and administratively separated from the Austrian Research Centers – ARC, the owner of NES. At this time, NES is the sole contractor to the Republic of Austria with regards to the management of radioactive waste.
Currently, NES is operating several facilities for the conditioning of radiological waste and for interim storage. The original design of the facilities was conceived for service until 2012, the time political negotiations for long-term storage or final disposal would have resulted in a transfer of the conditioned waste packages to other locations.
The treatment and conditioning facilities at NES include an incinerator plant for solid and liquid burnable wastes, a water treatment plant for liquid non-burnable wastes, and a machine and workshop facility for handling and disassembly of large components and processing and conditioning of non-burnable solid waste. The principal treatment and waste management strategy involves volume reduction and stabilization of the waste. Burnable materials are incinerated, and the ashes have been homogenized in concrete in historical waste or, currently, are welded into stainless steal cartridges and stored in a standard waste package. Non-burnable liquids are treated chemically to solidify radionuclide ions. The resulting sludges are mechanically separated from their liquid base, dried, and subsequently homogenized in concrete. Non-burnable materials are compacted by a 1000 t compactor;

the resulting pellets have been surrounded by concrete in historical waste or, currently, are stored in a standard waste package. The standard conditioned waste package at NES is a 200-l steel barrel.
Recently, the contract for the waste management activities at NES and the licence for the treatment and storage facilities have been extended by the Republic of Austria and the Municipality of Seibersdorf and by the Competent Authority for radiological protection until 2032. This life time extension requires Nuclear Engineering Seibersdorf to develop a sound strategy for long-term intermediate storage of the waste currently already on site and projected to be received within the course of the next 20 years.
Moving from short- to long-term intermediate storage of radioactive waste, however, will require significant investment in renovation, upgrade, and extension of the facilities currently in use, together with the implementation of a program of activities tailored to ensure long-term stability of historic and future waste packages. Design of changes to the available facilities and the future work programs include, to a large extent, current knowledge and data on worker and public doses due to established methodologies and existing work programs. Optimized rather than minimized exposures will be the result from these considerations; in particular, some of the projected work will necessitate increased worker doses in order to establish a system which will be acceptable to the public and which ensures ALARA public exposures.
Designs to enhance the technological and administrative safety measures in place in the various work areas have been procured or are currently being evaluated. Most notably, the monitoring systems have been adapted to the current state of technology by employing new digital devices with a central control and switchboard based on PC and network applications. Plans to provide a sealed semi-remote handling environment for the feed and the ash removal in the incinerator plant are maturing, and a new molecular sieve filtration system is being procured for the treatment plant for liquid radiological wastes.
The two most important considerations, however, concern the long-term stability and accessibility of the waste packages. As the Municipality of Seibersdorf requires unrestricted access for inspection for every individual waste drum, additional storage space has to be provided. Construction on the necessary facilities has already begun.
Inspection of the outermost physical barrier of historical waste drums is revealing first onset of corrosion due to chemical and electro-chemical processes within the concrete and between the conditioned waste material and the steel drum. To a large extent, these processes are attributed to excess water in the concrete and to condensation in the storage facilities. For the new storage areas under construction and as part of the upgrade of the existing facilities, well designed heating and moisture removal systems for the ambient facility air and adequate insulation will ensure that the temperature in the storage areas will not drop below the dew point in order to prevent condensation on the waste drums. And a rigorous program of re-treatment and additional conditioning of historical wastes and of removal of any excess water in the drums is designed to prevent further internal corrosion. For that purpose, it is planned to extend the existing workshop area to include a large drying facility for multiple waste packages and several separate mechanical handling containers for removal of corroded components and re-conditioning and re-packaging of the drum contents.

Methods and Materials

Current monitoring programs at the NES site include personal monitoring of all workers. Except for administrative staff, NES employees are considered occupationally exposed workers Category A. Personal physical monitoring is achieved by TL-dosimeters, which are analyzed and interpreted by the accredited dosimetry laboratory at the ARC, and by electronic personal dosimeters. The latter are used by NES staff as direct indicators of dose rate and dose during their presence in radiation areas and are read out results stored by NES radiation protection personnel.
Work place monitoring is provided by dose rate and contamination measurements, both by static and by hand-held systems, and by the measurement of the activity concentration in ambient air in the treatment and storage facilities. Data on the contents and the surface dose rate of the waste drums were recorded upon transfer into interim storage and are archived for retrieval of information in future activities.

Emissions of radioactive materials are monitored in the treatment facilities for releases by the ventilation systems and the water pathway from the liquid waste treatment facility. For conditioned waste packages, no significant emissions have been observed in the past nor are they expected, with the possible exception of the slow release of ^{3}H. However, as ^{3}H disperses rapidly, significant doses for the work force and the public are not expected. In fact, the results of the personal monitoring program for workers in the storage facilities have not shown any indication for incorporation of ^{3}H.
Programs for environmental sampling and ambient dose rate measurements in the areas surrounding the NES site and in nearby settlements are designed to measure the environmental impact of the radiological waste management activities at NES. These programs include regular sampling in the surrounding ground and surface water, collection and analysis of soil and plant samples, in-situ gamma spectrometry, and the measurement of various local crops. These analyses are provided by the ARC as contractor to NES.

Results and Discussion

To assess doses to workers and persons outside the NES boundaries, the most data most directly applicable are the ambient dose rate measurements at the NES perimeter, in the surrounding settlements, and at the surface of the waste drums. Supplemented by the personal dosimetry data for the NES workforce obtained over the course of the past 20 years, projections for expected dose due to the planned future processes of re-treatment and additional conditioning of current and historical radiological waste can be provided. For the purpose of a safety analysis for these processes, initial dose estimates will be sufficiently conservative.
Treatment, conditioning, and storage of radiological wastes at NES have not resulted in incorporation of radioactive materials yielding committed effective doses exceeding dose limits in the past. However, identified potentially hazardous processes in intermittent handling of unconditioned waste will be addressed in future facility upgrades. Even though this will improve overall safety within the treatment processes, no immediate effect is expected to be observable in terms of dose reduction for the NES workforce, as committed effective doses due to incorporation of radioactive material are already low presently. Data on the committed effective doses from inhalation or ingestion, as far as they can be traced into the past, do not show any conclusive evidence for values above 1 mSv for any of the NES staff.
Including ambient background from external exposure of approximately 1 mSv per year at the location of the NES facilities, data from the personal TL-dosimeters of the NES personnel generally do not exceed values of 2.0 mSv to 2.5 mSv per year. Occasional external exposures of single individuals in slight excess of the values stated above can usually be attributed to increased efforts in removal of sealed sources from their transport or shielding containers.
Dose rates at the NES perimeter being generated by stored waste packages, whether conditioned or unconditioned, are limited to 0.5 μSv/h, such that exposure of people outside the perimeter is not expected to exceed 1 mSv per year, even when the annual duration of a stay at the perimeter is conservatively estimated as 2000 h. To ensure compliance with this dose rate limit, appropriate shielding structures were constructed and are planned inside and external to various buildings. The estimate of a duration of stay of 2000 h at the NES perimeter can be applied, as the surrounding land is part of the ARC site and as such not accessible except during regular work hours. Future facilities are designed to include shielding structures of equal or higher shielding factors; when combined with the radioactive decay in the stored waste packages, where the largest contributions to the ambient dose rate are due to ^{137}Cs and ^{60}Co, the ambient dose rate at the NES perimeter is expected to decrease significantly over the time period of the currently projected long-term intermediate storage.
In order to ensure long-term stability of the radiological waste packages, an intensive program of re-treatment and additional conditioning steps is planned to be implemented over the next few years. Measurements of the dose rate on the waste drum surfaces reveal that, in compliance with transport regulations, they do not exceed 2 mSv/h. Even though most of the currently conditioned 10000 drums do not exhibit dose rates larger than a few 10 μSv/h, some exceptional cases do not meet transport regulations unless surrounded by an overpack for additional shielding. Accounting for the whole sample of conditioned waste drums at NES, the average drum surface dose rate exceeds 100 μSv/h. A

program involving significant handling of and work with, in particular if that work has to be performed in close proximity to the drums, may result in an increase in personal external doses for NES staff. In order to comply with national radiological waste management policy and municipality requirements, careful scheduling of the planned work processes and close monitoring will have to ensure both dose optimization and compliance with national dose limits.

Conclusions

Nuclear Engineering Seibersdorf, as contracted by the Republic of Austria and the Municipality of Seibersdorf, is preparing the move from short-term to long-term intermediate storage of radiological waste generated in Austria. In compliance with legal requirements and conditions posed by the national Competent Authority for radiation protection, stability and accessibility for inspection for all historical and future waste packages will have to be ensured. The design and planning phase for necessary facility upgrades and renovations and additional work processes in the treatment and conditioning cycles have to include dose considerations for NES staff and the public.
No significant impact due to these activities is expected for doses to the public which should remain negligibly low as they currently are. However, first conservative estimates of worker doses seem to indicate a potential increase due to the necessity to include additional re-treatment and conditioning steps. Only rigorous scheduling of the work processes and personal monitoring might ensure dose optimization according to the international ALARA system and compliance with dose limits.