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# Repository incidents in Germany and abroad - What can be learnt ? -

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**Abstract:** The evaluation of operating experiences plays an important role in the continuous optimisation of safety in nuclear facilities. Although the risk resulting from a repository for radioactive waste is much lower than that from nuclear power plants, operating experiences should also be evaluated systematically in this field. On behalf of the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety GRS therefore evaluates information on incidents and other experiences in radioactive waste disposal facilities. The information is derived from generally available publications, e.g. regularly issued journals of authorities and operators, conference proceedings or from the internet. The results show that from an operational point of view the handling and final disposal of radioactive waste in near-surface facilities and deep geological formations can be performed in a safe manner. The safety of waste disposal facilities has significantly been increased during the last decades. Most of the problems arising in older facilities can now be avoided by better designs and the implementation of engineered technologies. Nevertheless the exchange of lessons learnt from the operation of waste disposal facilities will be helpful to further improve the safety of these plants and to minimise remaining low risks.

## 1. INTRODUCTION

In the field of nuclear engineering, the evaluation of operating experiences is of special importance with regard to safety. Notifiable events and special occurrences related nuclear power plants in Germany, for example, are not only evaluated thoroughly by the operator himself but also by the authorities and their expert organisations. With regard to plant safety, the objectives of these evaluations are the event analysis, including causes and consequences, the assessment of potential other consequences of the event, the examination of the precautionary measures performed or still to be initiated to avoid recurrences, as well as the question of transferability of the event to other nuclear installations. These generic evaluations also consider events at foreign installations as far as sufficient information on the event and corresponding technical data from the plant are available.

The operation of a repository for low-level and intermediate-level waste does not result in a risk potential comparable to that of the operation of nuclear power plants. Not least for the optimisation of the safety culture, however, operating experience should also be evaluated systematically in the field of final disposal of radioactive waste material. With regard to the final disposal of low-level and intermediate-level waste, today the European countries have integrally some 50 years of experience with the final disposal of radioactive waste material in deep geological formations and more than 270 years of experience in the field of final disposal near the surface. However, this is not much compared to the operating experience with nuclear power plants, but nevertheless it allows to cautiously make a general survey and to draw first conclusions.

## 2. ACTUAL SITUATION

Since many years, GRS is preparing, on behalf of the federal authorities, safety-related experts' opinions, analyses and statements on facilities for final disposal and the handling devices used in them.

Efforts are being made by GRS to consider also international experiences in these assessments. In this connection, GRS evaluates for several years publications on waste management, reports of expert conferences, information from the internet, press reports and regularly issued and country-specific publications with regard to information on deviations and events related to the final disposal of radioactive waste material. As a result, about 35 indications to deviations in repositories of several countries have been identified. Of course, by the investigations conducted until now it is not claimed that all of the deviations and events occurred have been registered entirely, especially since no consistent method for the publication of special events and deviations was recognisable.

With regard to these evaluations, the major part of information comes from Germany, Great Britain and France. In some cases, information are available from the USA, the Russian Federation and Hungary. The events reported concerned the respective dis-posal technology, the conditioning and the corresponding quality assurance, the re-lease of activity, transgression of regulations and events which occurred during the transport to the respective repository.

In the last years, the International Nuclear Event Scale INES has been applied to as-sess deviations and events related to the final disposal of radioactive waste material. The events which became known due to the investigations were classified as level 0 (i.e. "below scale") or level 1 as a maximum. There are no information available on events classified higher. The major part of events under investigation was finally caused by human errors.

In the following, examples are given for such events:

- A conditioning facility was operated, although the control for the exhaust air was not active due to maintenance work [1].
- A fire was caused in a repository trench due to waste material (zirconium tubes) not fulfilling the acceptance criteria [2].
- Impermissible contamination of waste packages were detected during entry control [3].
- During compacting of radioactive waste material, fire was caused because the waste contained significant amounts of alcohol, which is against the existing rules. [4].

The events where human errors were found to be the cause, also include such deviations which only became apparent at the repository and which are not due to the repository.

Only some reported events are due to the failure of systems and components or deficiencies in the design. An example for inadequate design of a system is the overfilling of a rainwater reservoir after heavy showers [5]. Examples for technical failures are crashes of waste packages after malfunction of an automatically operated crane [6] and after rupture of a lifting cable of a crane [7].

With regard to the events registered during the last ten years, there were no significant releases of radioactive substances into the environment or radiation exposure for the staff in all of the cases. According to the authorities, the mentioned crashes of waste packages [6, 7] did neither cause relevant contamination within the plant nor releases of radioactive particles and radiation exposure of the staff or the surrounding area as a consequence thereof. Most of the events were classified as level 1 of the INES.

### **3. CONCLUSIONS FROM THE REGISTERED EVENTS**

The investigations performed showed that reports are prepared on operating experi-ence with the final disposal of radioactive waste also internationally. This operating experience represents an experience feedback which can be valuable and useful regarding the planning and design of new facilities or for the safety assessments of existing plants, respectively. This, however, requires that the operating experience are described with technical details which enables a substantiated safety assessment. In general, the information available on the reported events do not allow to make a detailed evaluation and assessment of the events. So, for example, it cannot be determined in the specific case which relevance a reported event might have regarding the operation of other repositories. Insofar, the works presented shall induce to report on operating experience with the final disposal of radioactive waste and

to give technical descriptions which enable a safety-related assessment of operating experience and thus to avoid misinterpretations.

Although the investigated selection of events and deviations in the field of final disposal do not allow to prepare a systematic and statistical evaluation, nevertheless they allow to make a first general assessment and to draw first conclusions.

The events known in connection with the final disposal of radioactive waste show that until now no incidents or events occurred during operation of repositories for radioactive waste which led to radiological damages, endangerment of the staff or the environment. Especially in the beginning of final disposal near the surface, when radioactive waste was normally disposed of in simple trenches without engineered barriers, in some cases considerable problems occurred. It was reported from American plants that also in areas with small amounts of precipitation leakages from the repositories have been identified. Measured data showed that radionuclides, depending on the boundary conditions given, moved unexpectedly fast through unsaturated zones of 100 m and thus reached the groundwater. A better understanding of transport mechanisms nowadays in connection with real measured data showed that dryness and mighty unsaturated zones alone are not a reliable protection against groundwater contamination. These findings have been taken into account in planning and design of modern repositories. The considerably more expensive safety-related design of the plant, not at least resulting from the operating experience at older facilities, cannot be compared to the practice at that time and makes such events sufficiently improbable in future.

Against the background of operating experience with the final disposal of radioactive waste, which covers integrally more than ten years throughout Europe, we conclude that the operation of repositories for low-level and intermediate-level waste obviously does not represent a particular or considerable risk for the staff or the surrounding area and environment.

The recording of operating experience made until now with the final disposal of radioactive waste in deep geological formations and the final disposal near the surface according to new technologies showed that there are no specific differences in operating experience concerning the very different forms of disposal.

In the specific cases where safety-relevant systems or components failed, it can generally be assumed that the operators of the repositories provided corresponding measures to avoid recurrences for the purpose of availability and reliability of their facilities. This can be stated definitely in connection with events occurred during final disposal of radioactive waste in Germany. For example, a roof plate of a large container became detached during the transport of waste packages to the final repository for radioactive waste in Morsleben (ERAM). This was caused by the detachment of the bonding joints by which the roof plate was fixed on the container. As a consequence of this event, the joints at all containers of this type have been replaced by mechanical joints. ERAM was only the place of destination for the waste material and there is no causal relationship with the event. The detachment of the roof plate had no impact on the waste packages in the container. The event did not cause any radiation exposure or contamination..

The events indicating human errors show that in the fields of operation of repositories, conditioning and the preceding controls there are optimisation possibilities in the specific case. This optimisation can be realised, for example, with regard to preciseness of operating procedures, training and instruction of operating personnel, supervision and quality management measures.

The requirements of the radioactive waste for final disposal have to fulfil the requirements for specified normal operation, preventive measures for incidents and accidents and the requirements regarding long-term safety of repositories. For the purpose of quality management measures, measures for product control and entry control at the repository are absolutely necessary to preclude events, as for example the fires mentioned before, in a reliable way. The ensurance of the compliance with the radiological requirements for waste packages for final disposal is an important contribution to the radiological protection of the operating personnel involved in final disposal. By means of the quality management measures "product control" and "entry control at the repository", human errors cannot be precluded, but failures and misdirections and especially their impact on the safe operation of repositories can be detected at an early stage and harmful consequences avoided by these tools.

## 4. SUMMARY

The available operating experience in the field of final disposal of radioactive waste shows that from an operational point of view the handling and final disposal of radioactive waste in near-surface and deep geological formations is possible and reliable with regard to safety.

The events in connection with final disposal which became known due to the investigations were classified as level 1 of the International Nuclear Event Scale INES as a maximum. Until now, there are no information on serious incidents related to final disposal of radioactive waste. Likewise, there were no reports on additional radiation exposures in connection with special events. The reported operating experiences did not indicate any safety-related difference between the modern near-surface facilities and deep geological repositories.

The causes leading to deviations and events can basically be assigned to technical failures and human errors. With regard to the frequency of causes human errors are clearly dominant. As it can be assessed today, the approaches to optimisation in this field can be found in precise operating procedures, in sound instruction and advanced training strategies for the operating personnel and, if case of demand, a strengthening of supervisory and control functions. Further, the investigations showed that the preceding quality assurance of the radioactive waste to be stored in repositories is of special importance with regard to product control and entry control at repositories.

The existing approach to use the experience feedback from the operation of repositories shall encourage to intensify the exchange of experiences in this field also internationally, so that in the specific case the need for optimisation can be taken into consideration adequately. An international exchange of experience is not at least of special importance because the number of national repositories for radioactive waste is low compared to the number of operated nuclear power plants. To intensify the exchange of experiences, it is, however, necessary that the descriptions of operating experience are based on profound technical knowledge. By this, misunderstandings with regard to the assessment and evaluation of events should largely be avoidable.

## 5. LITERATURE

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