Revk – a Tool for the Fulfilment of Requirements from National Rules for Tracking and Documentation of Radioactive Residual Material and Radioactive Waste

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ABSTRACT

According to the German Radiation Protection Ordinance treatment, storage, whereabouts of radioactive material etc. have to be documented.

Due to legal requirements an electronic documentation system for radioactive waste has to be installed.

Within the framework of the currently largest decommissioning project of nuclear facilities by Energiewerke Nord GmbH, a material flow-waste tracking and control system (ReVK) has been developed, tailored to the special needs of the decommissioning of nuclear facilities. With this system it is possible to record radioactive materials which can be released after treatment or decay storage for restricted and unrestricted utilization. Radioactive waste meant for final storage can be registered and documented as well.

Based on ORACLE, ReVK is a client/server data base system with the following modules:

1.   data registration,
2.   transport management,
3.   waste tracking,
4.   storage management,
5.   container management,
6.   reporting,
7.   activity calculation,
8.   examination of technical acceptance criteria for storages and final repositories.

Furthermore ReVK provides a multitude of add-ons to meet special user needs, which enlarge the spectrum of application enormously. ReVK is validated and qualified, accepted by experts and authorities and fulfils the requirements for a radioactive waste documentation system.

INTRODUCTION

The ReVK has been especially developed for the presently largest decommissioning project in Lubmin near Greifswald, Germany. Here, in total 8 power plant units of the NPP Greifswald (KGR) are being dismantled of which 5 were in operation and 3 under construction.

In the course of the elaboration of the licensing documents, the technological facilities have been radiologically evaluated and the dismantling material has been categorized. Thus, the disposal processes can be organized efficiently.

The following categories have been defined:

Category I	unrestricted material
Category II	suspected material
Category III	contaminated material.

The classification of the individual systems and facilities into the categories mentioned above is defined in the license for 'Decommissioning of the overall plant and the dismantling of plant parts of the Greifswald Nuclear Power Plant' issued on 30 June 1995.

With this categorisation of residual material in the KGR two procedures for release and exemption from Atomic Law have been licensed by the authority.

For the different categories of residues a graduated measuring scope and different measuring procedures for the proof of contamination absence (control measurement) for material of category I or the falling below release limit values (decision measurement) for material of the categories II and III have been fixed in operational instructions.

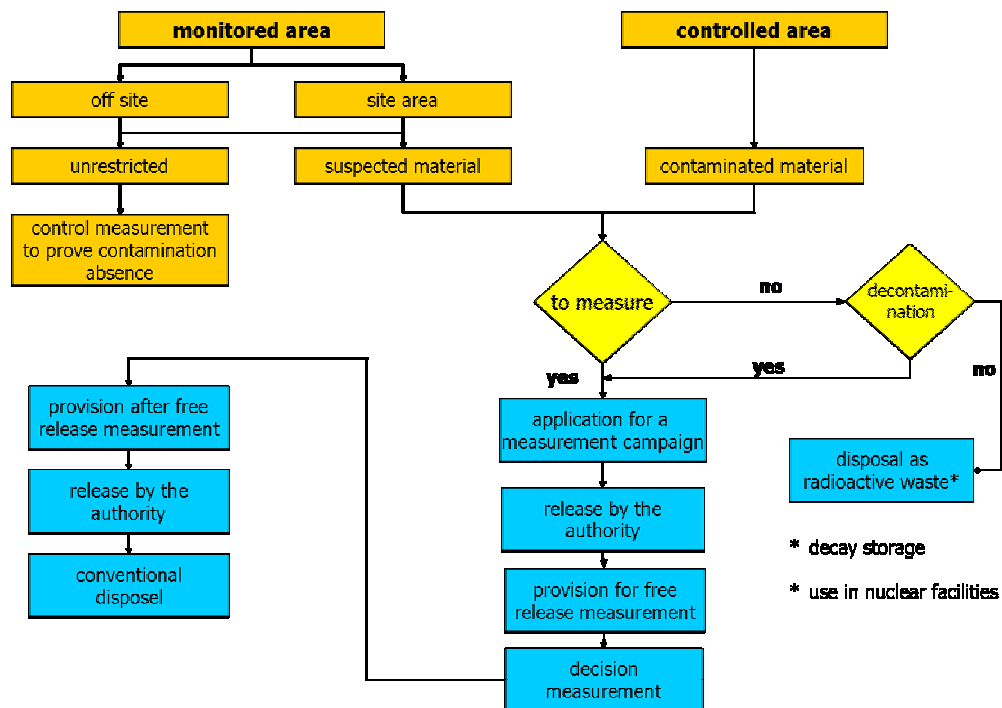The procedures are shown in Figure 1 below.

Fig. 1. Relevant steps of the release procedure

With consideration to the division into these 3 categories it was found out that from the 1.8 Mio Mg of material to be dismantled and treated approx. 1 234 Mio Mg had to be classified under category 1 and approx. 564 000 Mg under categories II and III.
With the additional introduction of disposal classes

Class A   unrestricted release
Class B   reuse
Class C   deposition of residues as conventional waste
Class D   decay storage
Class E   utilisation or use in nuclear facilities
Class F   disposal as radioactive waste

and material classes (e.g. C-steel, austenite, concrete etc.), important prerequisites for the successful application of the ReVK were established.

REVK-CONCEPT

The ReVK serves for registration, massflow supervision and control of the data of the produced radioactive residues/waste from the dismantling of the Greifswald and Rheinsberg nuclear power plant units. The ReVK records and updates all treatment steps so that a continuous tracking of residues/waste is guaranteed from the production to disposal phase.

ReVK consists of a database used as back-end to save all relevant data of radioactive wastes and materials and a user-friendly front-end. The front-end supports all diverse tasks, which are related to the treatment of radioactive materials. Data input takes place by use of ergonomically designed input forms, which allow comfortable and reliable data registration. On entering the data, the user is assisted by input aids and automatic plausibility checks. The permanent plant specific parameters like storage sites, PC-sites, places of origin, container types, material types, etc. are available as drop-down reference lists.

Each input form has two or more registration pages within a page frame which makes it possible to switch immediately from form to browse mode. The representation in browse mode can be changed freely according to the Windows standard. Hot keys are available within the table for fast operation.

ReVK consists of a base version with basic functionalities and user specific modules and adaptations, which use ReVK-data and which fulfil user specific requirements (see Figure 2).

Package recording
The documentation of the residual material flow starts with the assignment of an identification number (ID-No.) for the package and the issuing of a packing card with the necessary data:

–   origin,
–   description of residue (system affiliation or function),
–   geometry of part or parts,
–   quantity,
–   mass,
–   package type (packaging type),
–   material type and class as well as nuclide vector,
–   treatment path/ disposal goal,
–   date of dismantling,
–   conditioning and storage campaign,

− responsible person for work and radiation protection officer on site sign for the correctness (four eyes principle).

The package is marked with the packing card. It remains assigned to the package over the whole disposal path.

By using bar codes it is easier to identify the packages. The data will be input at the place of waste generation.

Fig. 2. ReVK – mask for package recording – packing card

To record the most important radiological data from the treatment of residues, a routing card will be created for each package. Corresponding to the treatment and disposal goal this card records the following data:

− all data of the packing card including ID-no. as heading,
− dose rate values,
− contamination values,
− radiological measurements in the frame of the release procedure with date, result, and reference,
− executed treatments with date, result, and reference.

For the documentation of all activities performed in the different treatment stations a series of interfaces to other systems was created as:

− release measurement facility,
− drum measuring facility,
− conditioning facilities in the ISN (high pressure compactor, drying facility).

By these interfaces it is possible to transfer data from the ReVK to the operational systems of these individual facilities as well as to transfer the results of the treatment (e.g. values from the release measurement facility, pressure power etc.) from the facilities to the ReVK. Thus, transmission errors can be excluded.

The routing card is included in the data processing system and can be printed at any time if required.

Due to the great variety of the stored data it is obvious to treat also other tasks beside the major tasks of residues/waste tracking.

TRANSPORT MANAGEMENT

Not only the data are registered and administered with the ReVK, also the whereabouts of all residues/waste-packages are documented.

All transport movements of the produced packages are registered by the transport module of the programme. The data are retrievable at any time. By the input masks the transport-relevant data are administered and the package is released for transport. For a transport, several packages can be summarized.

When the so created transport package (transport lot) arrives at its destination, it will be reconfirmed. The transport in the data processing system is performed simultaneously to the really performed transport. With the reconfirmation the data for a package have arrived at their destination.

Furthermore, transport sheets necessary for the transport are created by this module.

WASTE TRACKING

Waste tracking means to register waste data at the arising of a waste package and to update the data at each disposal step (storage, shipment, treatment) up to final disposal. Thus, at any time within the lifetime of the waste package a complete proof of location and state of treatment etc. can be produced on short notice.
Besides the shipment and storage module an independent waste tracking module is part of ReVK, which can reproduce and document the origin and transport histories as well as the current storage site of a waste package.

Graphic representation of the waste flow is also possible. It shows all stages the waste has passed. Buttons between stages are marked with the number of the respective shipment or storage documents. By pushing the marked button, the corresponding transport or storage instruction are represented, also showing the waste packages pertaining to the particular transport.

STORAGE MANAGEMENT

The management of waste-packages in a buffer, an interim storage facility or a final repository is made transparent by the storage function implemented in ReVK. This function allows the individual configuration of storages with distinct emplacement sites with the definition of their positions, exact size, maximum load and maximum activities of their individual areas.
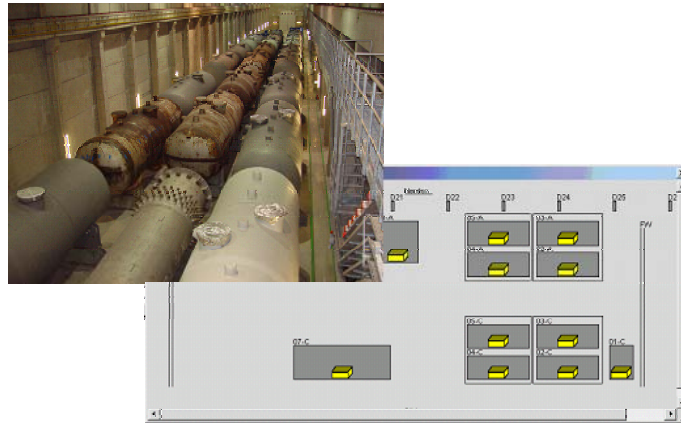
Fig. 3. Storage for components at Greifswald and its presentation in ReVK

Figure 3 shows a storage for large components at the ISN (Interim Storage North) in Greifswald and its presentation in ReVK. The dark grey shaded rectangles mark the emplacement sites, the yellow boxes the respective stored components. Information on the stored component or waste package is provided on mouse click.

Once the configuration of an emplacement site is complete – there is no restriction on the number of different emplacement areas – packages can easily be assigned to the respective position.

CONTAINER MANAGEMENT

Because of the large number of containers used in a d&d-project an effective container management may mean significant economic benefits. A special functionality of ReVK is a container management module. With this module all the containers and packages used in the respective d&d-project are registered. I. e. the following information has to be entered into ReVK for each container:

- container id,
- type of container,
- location,
- level of decontamination,
- state of fill.

With the update of a waste record, e.g. after a change in location, the respective container record is updated simultaneously. Thus, a current survey of the use of all containers is available at any time.

REPORTING

All data registered in the ReVK can be compiled in form of reports or on the screen in table form. The selection module serves for the compilation of the data. By the help of this module, type and scope of the demanded data are generated.

With the reporting module monthly reports, balance sheets of ingoing/outgoing material as well as clearing of dismantled masses are prepared.

The presentation of information in the form of reports is executed via a comprehensive report generator by the help of which formatted documents can be created. In addition, it is possible to calculate and evaluate data with this module.

By means of the report generator new forms are created or existing reports are adapted to new requirements.

ACTIVITY CALCULATION

Radiological data are a significant part of each waste package record. The radiological data consist of nuclide specific activities, total alpha- and total beta/gamma-activity, dose rates and values of surface contamination. These values can either be entered into ReVK as measured or externally acquired data, or they can be calculated by ReVK. For this purpose, ReVK has its own calculation module which can be adapted to user-specific requirements with exceptional flexibility.

ReVK considers approx. 180 radionuclides. These are beta/gamma emitters with half lives of some days and more and the transuranic isotopes with their decay chains.

For nuclide specific activity calculations two different procedures can be applied, either separately or in combination.

The most common procedure is the use of scaling factors, see Eq (1):

$$A_i = P_i \times R \tag{1}$$

with

A_i : activity of nuclide i

P_i : scaling factor for nuclide i

R : reference quantity, e. g. total activity

Scaling factors are elements of nuclide distributions, which are part of the ReVK database. Each nuclide distribution has a code, which may be put in the relevant waste data registration form. In case of activity calculation ReVK automatically uses the nuclide distribution related to the waste record.

In addition to scaling factors nuclide correlations may be used for activity calculations. This procedure was developed in Germany for final disposal purposes in order to assess hard to measure radionuclides. The procedure bases on the assumption that correlations between hard to measure and easily to measure radionuclides, e. g. Co 60, exist. In order to determine such correlation many measurements were carried out, see Figure 4.
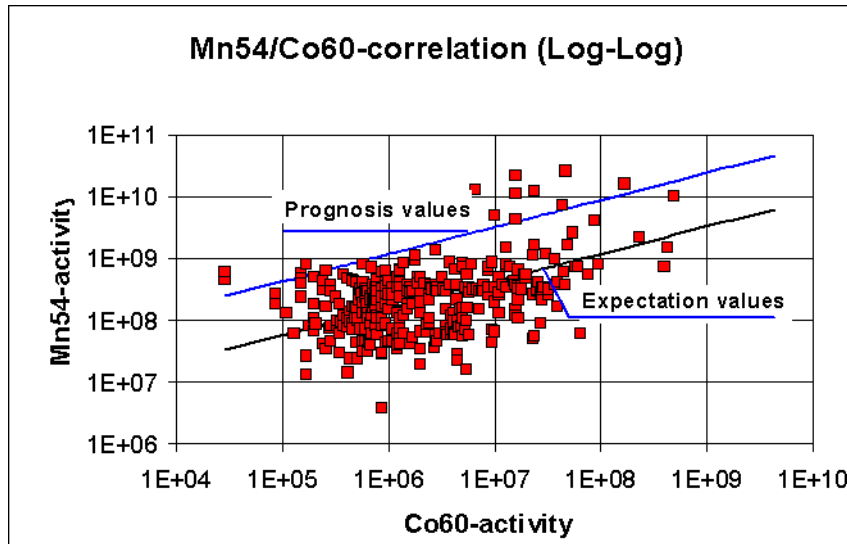
Fig. 4. Mn54/Co60-correlation

The correlation procedure is described using Mn54 and Co60 as example. The red dots mark simultaneous measurements of Mn54 and Co60, and the Mn54 value is plotted over the Co60 value in log-log-scale. A linear regression in this scale gives the expectation values. The prognosis values cover the uncertainties of the procedure. The resulting correlation is given in Eq. (2):

$$A_{Mn54} = a \times A_{Co60}^{b} \qquad\qquad (2)$$

with

A_{Mn54} : activity of Mn54

A_{Co60} : activity of Co60

a,b : correlation parameter

The correlation parameters are part of the ReVK database. Although the correlation approach is a general approach, ReVK provides the option of choosing between various correlation sets.

In combination with the scaling factor approach a wide range of activity determination options are available.

In order to determine the activity level a dose rate to activity conversion procedure is included in ReVK. This means, information about the dose rate is sufficient for an assessment of nuclide specific activity assessment.

Decay and build-up is calculated using the Bateman approach, see Eq. (3).

$$N_n(t) = \sum_{i=1}^{i=n} \left[\left(\prod_{j=1}^{j=n-1} k_{j,j+1} \right) \times \sum_{j=1}^{j=n} \frac{N_i(0) \times e^{k_i \times t}}{\prod_{p=i(\neq j)}^{p=n} (k_p - k_j)} \right] \qquad (3)$$

With this, the nuclide specific activity inventory can be exactly calculated for any time after its origin.

An additional feature of the activity calculation module is the additional option for wastes with various data of origin. ReVK calculates the activity inventories of the respective wastes for a certain date of interest and then sums up the nuclide specific activities of all wastes.

This option is useful for the determination of summary data, e. g. the total activity inventory of a storage.

CHECK OF ACCEPTANCE CRITERIA ERAM, KONRAD, ISN

The till now performed check of the acceptance criteria with the programmes AVK - ELA for radioactive waste packages for the final storage Morsleben or in the KONRAD pit can now be performed also with ReVK. The results of the activity calculation and the check of the acceptance criteria are submitted to the competent authorities in paper form or as electronical document.

For the storage of residues in the Interim Storage North, there are also several criteria which have to be adhered to.

SUMMARY

The company ISTec (Institut fuer Sicherheitstechnologie GmbH) as one of the leading sellers of diagnosis and safety technology in Germany designed and developed the technical solution ReVK for the management of necessary data being related to radioactive wastes.

The efficient and very close cooperation between supplier and customer during the development phase resulted in a flexible high performance application fulfilling all requirements of a decommissioning workflow.

The data acquisition via the ReVK has been practised since 1995. The ReVK has been developed in three development stages. The first stage comprised a minimal scope or service with the modules necessary for waste tracking. In the second stage the data base was converted to an ORACLE data base. In 2002, the third stage, the functions for activity calculation and check of acceptance conditions ERAM/KONRAD were included and the programmes AVK/AVK-ELA could be replaced. In 2003 the check for the ISN acceptance criteria has also been implemented.

Till the end of October 2005 approx. 122.771 Mg material has been produced in the Greifswald Nuclear Power Plant. These are residues/wastes from decommissioning as well as from post operation.

At 63 working stations approx. 261.000 data sets on residues/waste packages have been created. They have been supplemented with 38.300 data sets on transport or storage processes as well as 1.100.000 data sets on package movements.

These enormous documentation efforts are not controllable without a powerful computer supported documentation system. Experience showed that with a modern programme development as the ReVK the documentation effort during the decommissioning and dismantling of a nuclear facility can reliably be controlled.