Planning for unconditional release measurement

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1. Introduction

The term "unconditional release measurement" is taken to mean the release of residual substances or refuse from the realm of nuclear approval regulations. Here, it must not just be ascertained through measurement that the residual substances are free from artificial activity with regard to the official approval values, but also that all measurements are documented and available so that they can be verified quickly and logically. Often, due to the low amounts of residual substances that are released, manual measurements are carried out which only provide an adequate level of safety if the rules regarding these measurements are properly followed. Increasingly, different nuclide inventories in the residual substances must be considered. This requires special procedures in data processing.

That the unconditional release technique is becoming more and more important is at least partially linked to the fact that the dumping costs for residual substances have, as expected, reached levels which make every other legal possibility of disposal economical. Here, the gross gamma method represents a very economical method.

2. The gross gamma method

The gross gamma method is based on an approximate 4π measurement of gamma activities. The better the background, which may be present at elevated levels in nuclear power plants, can be reduced in the interior of the chamber, the lower the measurement times are for the actual measurement.With systems without 4π shielding, the background can lead to material of high density and large volume being unable to be measured according to the limits of DIN 25482 for unconditional release. In particular, changing fields, such as for example contaminated residual substances which are moved in the vicinity of the system, produce erroneous results.

The advantage of the gross gamma measurement is in the very short measurement time(about 10 seconds). Here, precise knowledge of the activity inventory as the nuclide vector is essential, because it is used computationally to find the total activity. Also with unconditional measurement systems, which measure spectroscopically, the laboratory determination of the nuclide vector is essential, because all radiation sources are to be measured, including those which cannot penetrate the packaging material (e.g. Fe-55 and many more). For residual material containing ^{40}K, differentiation may be possible with correspondingly extended measurement times. The extra amount of time required for this however does not lead in most cases to a positive cost/benefit calculation, because contaminated material cannot be assumed.

Unconditional release measurement systems with a lid can also handle long-format material, e.g. fluorescent tubes. An enclosed measurement is then carried out. The length that can be measured is only determined by the chamber volume.

The system calibration is carried out with different types of measurement material, i.e. different refuse substances are combined to form one type of measurement material and a calibration standard is set up for this material. Different interpretation of influences can lead to a conservative or progressive determination of the activities, but normally over-estimation of the activity inventory occurs in both cases. In practice about 10 types of measurement material are used.

3. Large unconditional measurement systems or manual measurements

The question of whether the procurement of a comprehensive unconditional release measurement system is economical, cannot be answered solely based on the quantities of residual substances that are to be measured. Certainly, the answer to the question would be affirmative for quantities over a few 10,000 Mg/a, such as arise with demolition. However, here the fact is ignored that even large systems have their limits with such large throughputs. Unconditional release measurements can only have a supplementary role here.

Anyway, the question becomes more interesting with regard to lower quantities, such as for example a few 10 Mg/a which would arise in normal power plants, because the cost/benefit calculation is significantly less favourably slanted towards an unconditional release measurement system. Apart from the procurement costs, the servicing and actual operational costs must also be taken into account. If this calculation is carried out over a few years, the procurement costs play a lesser role. The servicing and repair costs are clearly below a few 10k DM/a and can therefore be largely regarded as negligible. The personnel costs therefore remain the main cause of expenditure. Here, two fundamentally different methods can be applied. Firstly, charges of residual substances can be measured with high priority and without delay by using the help of external personnel. This method is needed for modification work or partial demolition, where either no deposition area is available or the costs for the unconditional release measurement arise simultaneously. Secondly, the measurements can be taken using one's own personnel in periods of less workload, so that internal storage capacity is relieved. With this method the personnel costs should not be assigned completely to the unconditional release measurement, because they represent part of the fixed costs. Here in present circumstances, the procurement of a system is worth it even with a few 10 Mg, whereas a positive cost/benefit calculation can be assumed for the first method from quantities above 60 Mg with 70% unconditional release.

Substantial personnel costs, which are often not taken into account, also occur with manual measurements. The advantage of manual measurement is in the clearly higher sorting rates of contaminated residual substances. The disadvantage is in the difficult later management of result documentation and the very awkward and time-consuming execution of the method. In addition, with the throughput of larger quantities, a reduction in the measurement accuracy is to be expected. At first sight, this presents no problem until a serious incident arises.

4. Concept of the unconditional release measurement

A chamber with a volume of at least 300 to 400 litres is used for the unconditional release measurement. A drum with residual substances taken from the charge to be measured is used as a standard for calibration. If slightly different measurement charges are to be measured at a later point in time, it is recommended that a specially developed calibration drum is used, which is able to accommodate radiation sources with any iron equivalent. With this method and with appropriate preliminary measurements, almost all refuse drums and refuse densities can be produced. The calibration is arranged to be as progressive as the approval authorities or the regulations allow. The necessary safety margins should already be included in the calibration. Additional safety margins should be defined by the radiation protection personnel or by the operator applying clearly defined rules. This avoids a measurement result being later interpreted as being just under the permissible limits.

In principle however, all unnecessary safety margins which are only required for the operators' peace of mind should be avoided so that the successive limits are not brought far below the activities occurring in nature.

The calibration procedure is described and documented.

The charges of measurement material are measured drum by drum. The drums which lie above the defined limits are sorted separately. Depending on the personnel capacity and time available, the drums which cannot be released unconditionally can be analysed more closely.Graphical representation of the measurement results enable a preliminary estimation. If possible, individual parts with high activity are singled out after the drums have been opened. Here, a manual measurement is again required. The drum should be measured again immediately after this treatment. Using this method, rates of about 80 to 90 % for sorting out can be achieved. It is not recommended that samples are taken of the charge of measurement material.

The most important data from the unconditional release measurement should be fixed to the drum in the form of an adhesive label. All the required data and results should be documented drum by drum. This can take place by a log printout or by saving data files in a data base or, better still, using both methods. For uncontrolled release projects complete and understandable documentation should be maintained to serve as documentation for the authorities.

With present-day PC technology these are requirements that can be easily fulfilled, even far more than is necessary.

5. Conclusion

In the course of forthcoming demolition projects in the FRG important knowledge about the process engineering involved in coping with large quantities of refuse will be obtained. In particular it will be seen that very large single amounts can be measured for unconditional release.

The available devices must be able to be quickly adapted to forthcoming requirements and to special individual needs. Now that it has been shown that the total gamma method represents a successful concept, the measurement technology can be refined such that even more interpretations are possible with regard to the activity inventory.

Enlargened chamber volumes with improved detector quality will increasingly be a feature of future monitor designs.

The documentation of the results will be more and more matched to the requirements of the individual user and will accompany and support the approval procedure for an unconditional release project more than ever before.

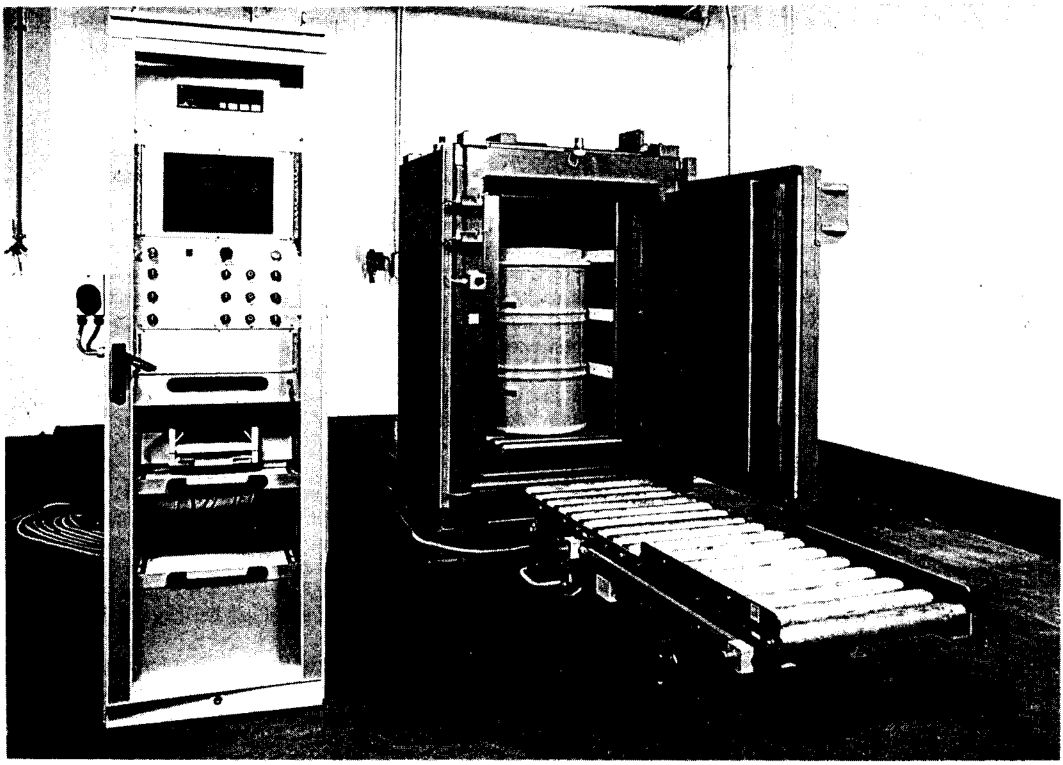

Fig. 1)

Example of an unconditional release measurement system: The RADOS Release Measurement Station H13640 for 200 litre containers. A total of ten separate detectors ensure adequate segmentation. Special design methods in the construction of the frame minimise the effect of the background. The cover and door guarantee optimum charging of the system and the capability of measuring longer objects. With the presence of strong changing fields, a supplementary external detector can be included to take these fields into account.