Note:
This is a translation of the statement entitled
"Umsetzung der ESK-Leitlinien für die Zwischenlagerung radioaktiver Abfälle mit vernachlässigbarer Wärmeentwicklung".
In case of discrepancies between the English translation and the German original, the original shall prevail.

E S K

STATEMENT of the Nuclear Waste Management Commission

Implementation of the ESK guidelines for the storage of radioactive waste with negligible heat generation

Here: Evaluation of the answers given by the Länder to the ESK query of 16 March 2017 for keeping track of the recommendations made in the ESK Statement of 07 May 2015

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1 Background information and objective

In 2014, prompted by noticeable problems in connection with the storage of radioactive waste, the Nuclear Waste Management Commission (ESK) developed a first catalogue of questions for reviewing the implementation of the ESK guidelines of 10 June 2013 [1], which referred to all facilities and installations in which waste packages with radioactive waste with negligible heat generation are stored. By letter of the BMUB of 18 December 2014 [2], the competent regulatory authorities of the *Länder* were subsequently requested to comment on the various issues in connection with the implementation of the ESK guidelines.

On the basis of the response and after evaluation of the answers, the ESK prepared the statement "Implementation of the ESK guidelines for the storage of radioactive waste with negligible heat generation" (*Umsetzung der ESK-Leitlinien für die Zwischenlagerung radioaktiver Abfälle mit vernachlässigbarer Wärmeentwicklung*) with a total of nine recommendations and adopted it on 07 May 2015 [3]. In this statement, the ESK stated that the ESK guidelines have been implemented to a very different extent so far and criticised i.a. the lack of systematic and uniform monitoring and inspection programmes, particularly in storage locations and storage rooms operated under the licensing regime of a nuclear facility.

At its 45th meeting on 26 January 2017, the WASTE CONDITIONING, TRANSPORT AND INTERIM STORAGE (*ABFALLKONDITIONIERUNG, TRANSPORTE UND ZWISCHENLAGERUNG – AZ*) Committee prepared the catalogue of questions for a second query. On 15 March 2017, a draft of the questionnaire was presented and discussed at a special meeting of the Technical Committee for Nuclear Fuel Cycle (FA VE) of the *Länder* Committee for Nuclear Energy (LAA). Considering the results of this special meeting, the catalogue of questions was adopted at the 60th meeting of the ESK on 16 March 2017 [4]. Subsequently, the competent *Länder* authorities were asked by the BMUB to answer the catalogue of questions by 30 June 2017.

The aim of the second query is to determine the current status of the implementation of the ESK guidelines of 10 June 2013 [1] and the recommendations of the ESK statement of 07 May 2015 [3], respectively. As in the first query, the questions refer to all facilities and installations in which waste packages with radioactive waste with negligible heat generation are stored. In addition, this query is also intended to obtain information and recommendations for a revision of the ESK guidelines.

The evaluation is carried out generically and does not establish any concrete reference to individual facilities. Accordingly, the final recommendations are also generic in nature, i.e. recommendations are made even if the relevant facts only concern individual facilities. For specific facilities, any need for action can only be determined in the respective regulatory procedure.

2 Consultations

The AZ Committee started discussing the responses of the Länder to the ESK catalogue of questions of 16 March 2017 [4] at its 48th meeting on 07 September 2017.

For the systematic processing of the extensive database, it was agreed with the BMUB that GRS should support the ESK by electronically recording the data. With regard to the systematic evaluation, related questions of the ESK catalogue of questions were bundled, divided into the six categories *storage facility, inventory, findings, monitoring concepts, qualification concepts* and *requests regarding the ESK guidelines,* and the objective of the processing was specified for each of the six categories. The answers of the *Länder* were edited by GRS and evaluated by the AZ Committee.

An ad-hoc working group set up by the AZ Committee prepared the draft statement in two meetings; it was discussed among the AZ Committee at its 50th meeting on 22 January 2018 and adopted at its 51st meeting on 14 February 2018. The statement was submitted to the ESK at its 64th meeting on 01 March 2018 and discussed at the meetings of the FA VE on 25/26 April 2018 and on 30 August 2018. In addition, written comments were submitted by competent *Länder* authorities. After implementation of the resulting modifications, the statement was adopted at the 69th meeting of the ESK on 07 September 2018.

3 Overview of the feedback, results of the query

The 2017 Länder survey [4] provides a comprehensive overview of existing radioactive waste storage facilities. In accordance with the scope of application of the ESK Guideline, it covers storage facilities regardless of the type of facility or installation in which they are located: central interim storage facilities, decentralised storage facilities at the sites of nuclear installations or inside these installations, and public or private collection facilities. A total of 52 installations or facilities with a total of 168 storage rooms are covered. The number of storage rooms per installation is between 1 and 11.

Almost two thirds of the storage rooms have a directed air flow, and in 69 % of the cases, the temperature cannot fall below the dew point. About half of the rooms are ventilated via a measuring and filter system. Most of the waste is stored in stacks.

The survey also gives a detailed overview of the inventory of the waste in interim storage. It covers a total of 150,631 waste units [1].Of these, 64 % were produced from 2002 onwards (first publication of the guidelines, period C), 23 % between 1989 and 2001 (establishment of comprehensive waste package quality assurance requirements by the BfS, period B) and the remaining 13 % are from the period before 1989 (period A).

In addition, raw waste (RA) and pretreated waste (VA) were reported as masses for the individual periods, namely approx. 22 Mg from period A, approx. 105 Mg from period B and approx. 3,600 Mg from period C, corresponding to a total of approx. 3,727 Mg. These masses could not be considered for the further evaluation, which refers to findings on waste packages.

The feedback from the current, second survey allows an evaluation including a quantitative analysis with regard to all known findings in relation to the inspected packages of the same type as well as to all packages of the same type in a storage room.

[1] Depending on the state of conditioning, the term waste unit includes, for example, pieces of large components, collection containers for raw waste, waste drums or waste packages

The results of the survey also provide new information on the inspection programmes. On the one hand, quantitative statements can be made regarding the packages with findings, on the other hand, qualitative statements are possible, e.g. about the range of existing inspection concepts, even if the feedback is manifold and inhomogeneous. Regarding the questions on existing qualification concepts, many answers are generalised and often it is not clear if they are complete.

3.1 Inspection results and findings

A total of 7,608 waste units with findings were reported in the *Länder* survey. Of these, 2,909 findings can be attributed to handling. Most of these are paint damage on the outside of the waste package, caused by handling during emplacement or transfer. 40 % of these findings relate to thick-walled cast-iron containers, all of them from the same facility. Another 50 % concern 200-l drums from another facility.

No further statistical evaluation is carried out for handling-related damage as no correlation with the parameters considered relevant can be identified from the available data records. These findings are therefore not included in the following statistical evaluations to avoid any erroneous conclusions. The ESK recommends that it should be ensured that systematic handling damage is avoided.

Table 3.1 gives an overall presentation of the reported 4,699 findings not attributable to handling damage, sorted by

- type of finding (e.g. inner corrosion, pressure build-up/ballooning)
- production period of the waste units (A: before 1989, B: 1989 to 2001, C: from 2002)
- categorisation of the waste units affected according to the list of radioactive waste [5] (see Annex 1) as follows:

  - raw waste (RA)
  - pretreated waste (VA)
  - waste products in inner containers (P1)
  - product-controlled waste products (P2)
  - Konrad-type waste packages or waste products packed in Konrad-type containers (G1)
  - product-controlled waste packages (G2)

Table 3.1: Number of waste units with findings (handling damage excluded) differentiated by type of findings and treatment/packaging time in relation to the waste category

Type of finding	Waste categories						
Treatment/ packaging time	RA	VA	P1	P2	G1	Not specified	Total
Defective seal	**1**	**1**	**1**			**1**	**3**
B (1989 – 2001)			1				1
C (from 2002)		1					1
Not specified						1	1
False declaration of sources	**2**						**2**
B (1989 – 2001)	2						2
Oil of unknown origin on drum lid			**1**				**1**
C (from 2002)			1				1
Corrosion	**28**	**1,484**	**2,925**	**4**	**144**	**10**	**4,595**
A (before 1989)	12	731	459		59	3	1,264
B (1989 – 2001)	5	753	2463	3	85	1	3,310
B/C	2		3				5
C (from 2002)	9			1			10
Not specified						6	6
Paint damage: buckling, delamination			**3**		**75**		**78**
A (before 1989)			1				1
A/B					75		75
B (1989 – 2001)			2				2
Damage to drum interior upon loading			**1**				**1**
A (before 1989)			1				1
Colour change due to heat impact from outside			**1**				**1**
C (from 2002)			1				1
Lid curvature due to overpressure	**1**	**7**	**8**	**1**	**1**		**18**
A (before 1989)			4	1			5
B (1989 – 2001)			3				3
B/C		7					7
C (from 2002)	1		1		1		3
Total	**31**	**1,492**	**2,940**	**5**	**220**	**11**	**4,699**

During the evaluation, it was found that different procedures were applied for the assignment of waste to the categories VA and P1. In most notifications, 200-l drums containing waste products are classified as P1. However, there are also notifications where these waste drums are reported as VA. This is probably due to the

fact that the drums have to undergo further conditioning, or possibly also that previous to the introduction of the category system [5], waste drums were listed partly as Z (intermediate product) and partly as K (conditioned).

Table 3.1 therefore shows the categories VA and P1 separately in accordance with the survey, but it is not possible to differentiate exactly between the conditioning statuses.

In some cases, the reported findings did not specify the treatment/packaging period and indicated it as "A/B" or "B/C". This information has been included in the above table because, especially in the case of the indication as B/C, only small numbers are involved, so that a more detailed query would not have led to any significant gain in knowledge.

Out of the total of 4,699 findings, less than 0.5 % relate to production period C from 2002 onwards.

A more specific evaluation reveals that the largest share, namely 96.6 % (4537) of the findings that are not caused by handling, is due to corrosion from inside; only 1.2 % (58) of the findings result from corrosion initiated by external influences. This may be caused, for example, by the type of coating, by damage to the coating e.g. due to handling damage during conditioning, or by the geometry of the drum (condensation e.g. on rolling hoops).

Due to the small number of findings caused by external corrosion, no systematic correlation between the findings and the storage conditions (e.g. room air conditioning) and the way of placement of the package can be identified.

Hence the further detailed analysis in Chapter 4 and the evaluation of earlier and the derivation of new recommendations in Chapters 5 and 6 essentially will focus on the findings due to corrosion from inside.

3.2 Monitoring concepts and inspection programmes

Chapter 10.4.3 of the ESK Guidelines of 10 June 2013 [1] contains the following requirement regarding the monitoring concept and inspections:

"If it has to be assumed that the retention properties of the waste packages in storage are subject to a relevant change in the course of time, measures have to be taken for an early detection of any developments with negative impact. For this purpose, a concept has to be developed. Considering the specific type of storage facility and waste packages, examples of such concepts are:

- Emplacement of the waste packages in the storage facility can be performed such that they can easily be made accessible for visual examinations and inspections upon request.

- The visual examinations and inspections are performed on reference packages. Based on the condition of these reference packages, conclusions are drawn on the condition of the other waste packages. This

requires that the reference packages are stored under representative conditions regarding potential degradations of their retention properties.

Reference packages are to be preferred in particular if visual examinations and inspections carried out directly on the waste packages stored in groups would lead to relevant radiation exposure due to a high local dose rate."

The query also provides the following definition of the monitoring concept (see also Annex 2 to this Statement):

"A monitoring concept is the description of all measures for the detection of findings related to the inventory as well as of the associated documentation and evaluation procedure".

In response to the question whether a binding monitoring concept is laid down in the operating documents, various types of documents such as work and operating instructions, operating manual, inspection manual etc. were mentioned. In 23 cases, however, it was also stated that there were no corresponding specifications in binding documents.

The feedback on the inspection programmes is very varied: Regarding the scope of inspection, they show a wide range, from "inspections of the entire inventory of packages", "of reference packages" to the statement "no regular inspections". As concerns the answers regarding the inspection frequency, there is also a large variation. Answers include e.g. "during handling", "visually on a case-by-case basis", "every six months" or "annually". A rough estimate shows that about 1/3 of the storage rooms are not inspected regularly. This was concluded from answers such as "upon emplacement", "in individual cases" or "waste package quality assurance only". A differentiation of the scope of inspection according to the type of containers (e.g. thin-walled steel plate) and the type of waste cannot be deduced.

There are about 50 different answers to the question of inspections carried out or accompanied by the regulatory body or its technical support organization (TSO); reference is made e.g. to one-off or event related inspections, regular facility walk-downs, and inspections as a part of the waste package quality assurance programme. However, the waste package quality assurance programme only describes the conditioning/qualification of waste up to a waste unit suitable for interim storage, i.e. containers or drums as inner containers for packages intended for disposal.

Neither the information on the monitoring concepts nor on the inspection programmes allows the derivation of any correlations with the characteristics of the waste units, the storage rooms, or the way of placement.

3.3 Qualification concepts

In accordance with Section 9.1 et seqq. of the ESK Guidelines [1], before the actual work within the framework of the management of radioactive waste is performed, the waste management procedure has to be planned with consideration of already existing waste management concepts, starting with the raw waste

accumulation and continuing with the conditioning and interim storage period up to the time when the waste packages are called off for emplacement in the Konrad repository. Section 9.5 of the ESK Guidelines [1] explicitly deals with the post-qualification of waste/waste packages that have not yet been finally qualified in the above sense. As explained in Annex 4 to the catalogue of questions for keeping track of the recommendations of the ESK Statement of 07 May 2015 [4], the planned procedure has to be described within the framework of concepts (see also Annex 2 of this Statement).

Question 7 ("Are qualification concepts available for all of the stored radioactive waste?") in [4] was often answered in general terms with "yes" or "no" or "in progress". From at least 44 responses it can be concluded that no qualification concepts exist. Some of the responses, however, provide a good insight into the handling of qualification concepts, e.g. "[...] A concept for the qualification of the waste and the timing of the production of packages suitable for disposal is available. For the implementation of the concept, the necessary applications have been or will be submitted to the regulatory authority in accordance with the concept" or "Qualification concept has been prepared and reviewed, monitoring and qualification concept are currently being incorporated into the waste management concept".

4 Assessment of the results

Based on the available feedback, it is possible to make a quantitative analysis of the findings. With regard to the safety relevance of all findings, the previous statement of the ESK [3] of 2015 can be reaffirmed: In any case of integrity loss due to corrosion occurring during the storage of radioactive waste, the direct radiological impacts on the environment were negligible.

4.1 Statistical classification of the findings

For a quantitative evaluation of the reported findings, these can be related to the total number of inspected packages of the same type. Due to the above-mentioned accumulation of findings of internal corrosion, corresponding considerations were made in an exemplary manner for this type of finding. This results in the following relations:

Of the total of 4,595 waste units with reported corrosion findings, a more detailed analysis shows that 4,537 waste units can be assigned to the finding "corrosion from inside" from the overall total number of 44,167 same-type waste packages. Of these, 19,231 waste packages were inspected. This corresponds to an average proportion of inspected waste packages of more than 43 %, with the individual inspection rate in the individual facilities concerned here ranging between 3 % and 100 %. Of these inspected waste packages, almost 24 % showed a finding. Therefore, it can be assumed that similar findings can be expected for the waste packages that have not yet been inspected.

4.2 Corrosion from inside

The waste with findings of corrosion from inside (4,537 pieces) originates mainly from periods A and B. Most of them are 200-l drums that are assigned to waste categories VA and P1. Only 144 findings can be assigned to G1 waste packages (Konrad-type containers), which were also manufactured in periods A (59 waste packages) and B (85 waste packages).

The corrosion phenomena of the conspicuous drums can largely be attributed to damage to the inner drum coating which occurred during loading, in conjunction with moisture inside the drum. Older cemented waste in particular is conspicuous, e.g. ashes or evaporator concentrates stirred into cement mortar; here, damage to the inner drum coating caused by contact with the stirrer can be assumed. However, some compacted waste from period A in which mechanical damage to the inner drum coating also occurred was conspicuous, too. The cause was most likely scratches on the inside of the drum due to contact with the pellet grab or the pellet itself upon filling of the drum. It is also possible that no new drums (for use as inner containers in Konrad-type containers), but old, possibly pre-damaged drums were used. The accumulation of findings for waste from time periods A and B is attributed to the fact that in earlier times (before 2002), the focus of the conditioning procedure was on product properties relevant to disposal (e.g. basic requirements or compressive strength). Specific aspects of longer-term interim storage, e. g. intactness of the internal coating, shrinkage behaviour of the solidifying agent in connection with condensate formation, were only increasingly considered from 2002 onwards.

The above statement also applies analogously to corroded G1 waste packages. These are thin-walled sheet steel containers the void volumes of which are either filled with cement mortar or solid, low grain size material. Here, too, special attention to the protection of the inner coating has only been paid since 2002, e.g. when filling in building rubble or inserting drums. The grouting of sheet steel containers also meant that a lot of additional water was into the waste package. Precipitation of moisture in the gap between the concrete matrix and the (unprotected) container wall causes contact corrosion, which over the years and decades has led to the containers being corroded from the inside.

Since 2002, the qualification of conditioning procedures has also taken into account specific aspects of longer-term interim storage, e.g. the container properties (regarding the inner coating) and the product properties (of the cement used). The fact that the waste units from period C do not or only rarely show any findings is a strong indication that suitable measures are effective. Although the waste units from this period have only been in storage for comparatively short periods of time, findings would nevertheless already be expected in case of any systematic adverse effects at the assumed speed of corrosion processes. Verifying measures should ensure that systematic adverse effects can be ruled out even over longer periods of time.

4.3 Monitoring concepts, inspection programmes and qualification concepts

In accordance with the requirements of the ESK Guidelines [1], a monitoring concept has to be specified which, among others, defines inspection programmes for all kinds of waste. The necessary scope of inspections depends for each specific facility i.a. on the storage conditions and the type of waste. Since it can be concluded from the feedback that monitoring concepts do not exist for all storage rooms, the ESK again points out the necessity to prepare and implement them. In doing so, the waste categories identified above as being susceptible to findings should be considered as a priority.

In view of the knowledge about waste categories susceptible to findings, the inspection programmes to be established within the framework of the monitoring concepts should place particular emphasis on packages that were produced in periods A and B and for which "aqueous" processes (grouting, stirring or filling with cement mortar) were used. Especially in facilities with a low inspection rate for waste categories susceptible to findings so far, the ESK recommends that the proportion of inspections should be increased in the near future.

According to the regulations of the ESK guidelines [1], qualification concepts are the basis for the planned management of the waste during all steps of conditioning and interim storage. As it can be concluded from the feedback that qualification concepts do not exist for all kinds of waste, the ESK again points out the necessity to prepare, bindingly document and implement them. Especially for the waste categories susceptible to findings, remediation activities for actually or potentially impaired waste units also have to be planned within the scope of the qualification concepts.

5 Proposals for amending the existing ESK guidelines

In total, the query produced 40 data records including proposed changes. Not all modification proposals refer directly to the ESK guidelines on interim storage [1]. Various comments address e.g. the question of how queries on stored waste are carried out.

In essence, the following comments were made:

- define the scope of the ESK guidelines clearly,
- use uniform terminology,
- include the comments and specifications from the ESK Statement of 07 May 2015 and the ESK’s catalogue of questions of 16 March 2017, and
- provide clear wording in Chapter 7 "Structures, systems and components".

The ESK will consider the proposed changes in the next revision and adapt the guideline text appropriately.

As both the preparation and the evaluation of the query also showed the need for a further standardisation of terms, the ESK will address this issue in an appropriate manner in the future.

6 Keeping track of the recommendations of 07 May 2015

The ESK statement *"Implementation of the ESK guidelines for the storage of radioactive waste with negligible heat generation"* of 07 May 2015 [3] resulted in nine recommendations which are generically reviewed in the following section with regard to their topicality.

Regarding recommendation (1) – From the point of view of the ESK, Annex X of the Radiation Protection Ordinance [6][2] should be adapted to the new waste categories according to the Inventory of radioactive waste [5] in order to achieve the required transparency even without double-entry bookkeeping by the waste producers.

The terminology for the categorisation of existing waste according to the Inventory of radioactive waste [5] as presented in the ESK statement of 07 May 2015 in comparison to Annex X of the Radiation Protection Ordinance has been established and will be included in the new mandatory regulations. The recommendation has thus been implemented.

Regarding recommendation (2) – Regarding the requirements made in the ESK guidelines [1] for the licensees to deal rapidly with their wastes of the entire spectrum, the ESK recommends that a detailed inventory with associated qualification concepts as well as information and justifications of the time sequence of the processing should be requested from the licensees.

The evaluation of the information about qualification concepts (Question 7 in [4]) suggests that these are not available throughout in all facilities or, if they are, only cover partial aspects. Sometimes, the licensees refer to waste and material management concepts; other answers indicate that conditioning is currently carried out according to approved schedules. Concrete concepts with time schedules – especially for the post-qualification of older waste of categories A and B – are not described except for a few individual facilities. The ESK recommends that this recommendation should be followed up and that corresponding qualification concepts should be requested.

The ESK also points out that the owner of the waste is responsible for qualification concepts. As far as the owner of the waste is not identical with the storage operator, the different responsibilities have to be observed and the request for establishing qualification concepts shall be addressed to the waste owner.

Regarding recommendation (3) – For plant rooms in which packages are stored, there are usually fewer regulations than for dedicated independent storage facilities. In these cases the ESK strongly suggests a review of the corresponding operational rules – particularly with regard to storage and monitoring – in the respective waste and materials management procedures of the plants to be necessary since the requirements

[2] References adapted

of the ESK guidelines [1] apply to all types of waste materials and wastes and irrespective of the designation of the location where they are stored.

Concerning the monitoring of storage rooms by operators and by their regulatory authorities, feedback was very inconsistent; no regular inspections are performed in approx. 1/3 of the storage rooms, but it is not clear whether these are storage rooms in which only waste packages are stored for which no relevant change of the retention properties is expected during the interim storage period. This group includes storage rooms in plants as well as in dedicated independent storage facilities. The recommendation therefore has to be pursued further.

Regarding Recommendation (4) – Regarding the internal storage areas of nuclear power plants, a revision of KTA Safety Standard 3604 "Storage, Handling, and Plant-internal Transport of Radioactive Substances in Nuclear Power Plants (with the Exception of Fuel Assemblies)" (version 11/05) [7] is necessary.

The currently ongoing revision of KTA 3604 with regard to radioactive substances stored for longer periods (> 12 months) addresses the more precise scope of application of the ESK Guidelines [1] for all types of waste materials and wastes, irrespective of the licensing basis for handling or the designation of the location where the waste materials and wastes are stored. Also, the contents of comments and recommendations by the ESK's AZ Committee have already been largely considered.

The discussions among the working committee of the KTA UA-ST concerning the implementation of some further points, such as the specification of the waste for the storage rooms, the information of the authority about abnormalities, the excessive sampling for small test batches, the evaluation of operating experience and the decision path "storage properties", have not yet been concluded.

According to the evaluation in Section 3, by far the largest share of findings is due to corrosion (mainly from the inside) in the case of older waste units, in particular in drums conditioned before 2002. The frequency of findings amongst those waste units that were generated later on in accordance with the RSK recommendations on long-term interim storage [8] is significantly lower.

These findings should be taken into account when developing monitoring concepts and determining the inspection scope/frequency of the relevant waste units. The factors "type of conditioning" and "time of conditioning" should be given appropriate priority in the derivation of corresponding inspection programmes within the framework of the ongoing revision of KTA Safety Standard 3604. In particular, special emphasis should be placed on packages that were produced before 2002 and where "aqueous" processes such as grouting or filling or stirring-in in cement were applied. The recommendation is being implemented within the framework of the ongoing revision of KTA Safety Standard 3604.

Regarding recommendation (5) – A monitoring concept for radioactive waste implementing the requirements of the ESK guidelines [1] shall be submitted to the nuclear regulatory authority, covering all waste streams/categories in all storage rooms and interim storage facilities. For storage facilities with limited inspection possibilities, it has to be checked whether adjustments can be made and specific inspection programmes have to be submitted to the regulatory authority.

The answers regarding the monitoring concept (Question 5.1 in [4]) were of very different quality and depth; thus no clear conclusion can be drawn on the implementation of the recommendation. Also, no conclusions are possible to what extent, in accordance with the intention of the ESK guidelines, inspection possibilities are provided in monitoring concepts if it must be assumed that the retention properties of the waste units are subject to a relevant change over time during their interim storage. The recommendation still applies. The competent regulatory authorities should examine whether an adequate monitoring concept exists or – taking into account what is said in Section 3 of this statement – has yet to be developed for all those storage rooms with waste units that might be subject to deterioration during a longer-term interim storage.

Regarding recommendation (6) – Inspection results shall be systematically recorded, evaluated and documented. In addition, such results shall regularly be submitted to the competent nuclear regulatory authorities. Furthermore, abnormalities should also be communicated to the operators of other storage and waste processing facilities so that this exchange of experience in a preventive manner can lead to improvements of the storage situation and the stability of radioactive waste packages.

The query has contributed to the implementation of the recommendation. Hence, appropriate systematic surveys and the exchange of information with the regulatory authorities should be intensified.

The extent to which any abnormalities are also communicated to the operators of other storage facilities and to conditioners was not subject of the query. Nevertheless, the ESK recommends that a corresponding exchange between the operators should take place. The recommendation remains valid.

Regarding recommendation (7) – If the inspection of waste packages in a storage facility is limited to accessible external surfaces or to reference packages, care has to be taken that a representative overview of the different waste types is ensured. In the past, most conspicuous features of radioactive waste packages were caused by a reaction of the waste product with the container or by reactions within the waste product itself. The possibilities for such reactions have to be evaluated for the different combinations of waste container and waste product emplaced and have to be considered in the selection and compilation of reference packages. Thus, the proportion of the reference packages may vary depending on the waste product and the waste container.

The evaluation of the individual findings shows an accumulation in waste units produced before 2002 and where "aqueous" processes such as grouting or filling or stirring-in in cement were applied. The main cause is corrosion from the inside, whereby damage to the inner coating inside the drums cannot be excluded. These factors should be taken into account when determining the scope/frequency of inspection and reference packages. Recommendation (7) is thus still valid.

Regarding recommendation (8) – The ESK recommends close regulatory control of the inspections of waste packages and storage rooms by on-site checks as well as by reviews of the inspection results submitted by the operator.

Due to the great variety of information on regulatory monitoring and control of inspections, there is no sufficient basis for an evaluation of the implementation of this recommendation. The recommendation is upheld.

Regarding recommendation (9) – Within the framework of the monitoring concepts for the radioactive waste in the individual storage facilities which have to be submitted to the nuclear regulatory authority, the ventilation concepts should also be considered from the point of view of the ESK.

Since the proportion of findings with external corrosion is very small, the evaluation does not show a systematic correlation between the findings and the storage conditions (ventilation concept) and the type of emplacement. Corresponding measures from the past, e.g. the use of waste containers with coatings suitable for longer-term storage as well as the possibility of adequately limiting the relative humidity for storage facilities with waste units with insufficient corrosion protection or unfavourable geometry (drums with attached rolling hoops where corrosion can occur due to condensation water, especially on the rolling hoops), have obviously been effective.

The recommendation still applies to the design of facilities and to the definition of monitoring concepts for existing facilities.

7 Summary

The 2017 query among the Länder gives a comprehensive overview on the storage facilities with their individual storage rooms, the waste stored there, and the status of implementation of the ESK guidelines [1] with regard to the establishment of monitoring concepts, inspection programmes, and qualification concepts. It thus contributes significantly to the improvement of the level of generic knowledge.

The quantitative, statistical evaluation of the feedback on findings affecting the waste units shows a clear majority of findings that are due to corrosion from the inside. This mainly affects drums with cemented and concreted waste, but also partly with compacted waste, belonging to age classes A (before 1989) and B (1989 to 2001). Containers with backfilled construction waste from the age classes mentioned above also showed signs of corrosion. Here too, the cause may be damage to the coating upon the loading of the containers. This is mainly due to the coating systems and conditioning processes used until 2001.

Due to the generic nature of this statement, no specific references to individual facilities are made. Accordingly, the following recommendations are of a generic nature, i.e. recommendations may only relate to individual facilities. For specific facilities, the need for action can only be determined in the respective regulatory procedure. In accordance with the results of the above-mentioned assessments, the following ESK recommendations have been derived:

- The ESK recommends ensuring that systematic handling damage to packaging is avoided.

- In the case of waste units from period C (from 2002 onwards) – these have so far shown no or only rare findings – verification measures should ensure that systematic impairments can be ruled out even over longer periods of time.

- The ESK considers it necessary to develop and implement monitoring concepts. In this context, priority should be given to waste categories that were produced in the periods A and B and to which "aqueous" processes (grouting, stirring or filling with cement mortar) have been applied (hereinafter referred to as waste categories susceptible to findings).

- The inspection programmes to be established as part of the monitoring concepts should place particular emphasis on the waste categories identified as susceptible to findings.

- In particular, the proportion of inspections should be increased in a timely manner in facilities where the level of inspection for categories of waste susceptible to findings has so far been low.

- Qualification concepts have to be prepared, bindingly documented and implemented for all types of waste. As regards the waste categories that are susceptible to findings in particular, the qualification concepts must also plan the handling of the actually or potentially impaired waste units.

- The essential factors in deriving an inspection frequency are the aspects of conditioning type and time. These should be taken into account accordingly when formulating the requirements for inspection programmes as currently developed, e.g., in the revision of KTA Safety Standard 3604. On the positive side, it has to be noted that waste packages produced from 2002 onwards show considerably lower proportions of findings. This fact also has to be considered when drawing up inspection programmes.

The ESK furthermore states that the majority of the recommendations from the statement on the implementation of the ESK guidelines of 2015 [3] still need to be considered. In summary, these are the following recommendations:

- The regulatory authorities should demand qualification concepts for all waste streams. In addition, the following recent aspect has to be noted: The waste owner is responsible for the qualification concepts. If the waste owner is not identical with the storage operator, the different responsibilities must be taken into account and the requirements for a qualification concept must be addressed to the waste owner.

- The operator's procedures and measures for monitoring the storage rooms have to be designed in accordance with the ESK guidelines [1].

- The competent regulatory authorities should examine whether an adequate monitoring concept exists or still needs to be established for all storage rooms in which waste units are stored whose retention properties might change unfavourably during a longer period of storage.

- A systematic exchange between operators and regulatory authorities and among the operators themselves should be maintained.

- When determining the scope/frequency of inspections and reference packages, the knowledge available on the waste categories susceptible to findings has to be taken into account.

- Regulatory control of the inspections of waste packages and storage facilities by way of on-site inspections as well as by reviewing the inspection results submitted by the operator is further recommended.

- When determining monitoring concepts, the ventilation concepts should still be considered, even if the evaluation of the query has not shown a direct dependence of the reported findings on the ventilation concept.

8 References

[1] Empfehlung der Entsorgungskommission
ESK-Leitlinien für die Zwischenlagerung von radioaktiven Abfällen mit vernachlässigbarer Wärmeentwicklung,
Revidierte Fassung vom 10. Juni 2013, Bundesanzeiger AT 22.01.2014 B3, S. 2-47.

[2] Schreiben des Bundesministeriums für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMUB) (Az.: RS III 3 – 15 700/17) vom 18.12.2014 an den Fachausschuss Ver- und Entsorgung des Länderausschusses für Atomkernenergie; betr.: Fragen zur Umsetzung der ESK-Leitlinien für die Zwischenlagerung von radioaktiven Abfällen mit vernachlässigbarer Wärmeentwicklung.

[3] Stellungnahme der Entsorgungskommission
Umsetzung der ESK-Leitlinien für die Zwischenlagerung radioaktiver Abfälle mit vernachlässigbarer Wärmeentwicklung vom 07.05.2015.

[4] Fragenkatalog der Entsorgungskommission
Umsetzung der ESK-Leitlinien für die Zwischenlagerung radioaktiver Abfälle mit vernachlässigbarer Wärmeentwicklung. Hier: Fragenkatalog zur Nachverfolgung der Empfehlungen der ESK-Stellungnahme vom 07.05.2015.
Revidierte Fassung vom 16.03.2017.

[5] Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMUB), Verzeichnis radioaktiver Abfälle, Bestand zum 31. Dezember 2014 und Prognose (August 2015).

[6] Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (Strahlenschutzverordnung – StrSchV) vom 20. Juli 2001 (BGBl. I S.1714; 2002 I S. 1459), die zuletzt durch nach Maßgabe des Artikel 10 durch Artikel 6 des Gesetzes vom 27. Januar 2017 (BGBl. I S. 114, 1222) geändert worden ist.

[7] Regel KTA 3604 „Lagerung, Handhabung und innerbetrieblicher Transport radioaktiver Stoffe (mit Ausnahme von Brennelementen) in Kernkraftwerken", Fassung 11/05.

[8] Empfehlung der Reaktor-Sicherheitskommission: Sicherheitsanforderungen an die längerfristige Zwischenlagerung schwach- und mittelradioaktiver Abfälle, Fassung vom 05.12.2002 mit Neuformulierung in Abschnitt 2.7.1 (dritter Spiegelstrich) vom 16.10.2003.

Annex 1: Categorisation of waste units

Other radioactive waste (radioactive waste with negligible heat generation) is categorised according to its processing state for presentation in the radioactive waste inventory [5]:

Code	Description
RA	Raw waste: Raw waste is radioactive waste in the form in which it is generated.
VA	Pretreated waste: Pretreated waste has been pretreated for better handling or storage. For disposal, however, it has to be further conditioned.
P1	Waste products in inner containers: Waste products (P1) packed into inner containers that are intended to be put in Konrad-type containers. The waste products are conditioned to such an extent that further treatment normally does not change their product properties. However, these waste products still have to be packed into a final storage container for disposal.
P2	Product-controlled waste products: Provided at least radiological product control was successfully performed within the scope of product control by the federal company for radioactive waste disposal (BGE), a category P1 waste product becomes a category P2 waste product.
G1	Konrad-type waste packages or waste products packed in Konrad-type containers: Waste products packed in Konrad-type containers (with or without inner container). The waste products are conditioned to such an extent that further treatment usually does not change their product properties.
G2	Product-controlled waste packages: Waste packages that are product-controlled and documented in accordance with the requirements of the waste acceptance requirements and whose suitability for disposal has been confirmed by the BGE, whereby material product control must also be completed.

Annex 2: Definitions

(The following definitions correspond to those in the Annex to the catalogue of questions [4])

Monitoring concept

A monitoring concept is the description of all measures for the detection of findings in the inventory as well as of the associated documentation and evaluation steps.

Qualification concept – concepts for conditioning and disposal as well as for later qualification

According to the ESK guidelines, Section 9.1 et seqq., before the actual work within the framework of the disposal of radioactive waste is carried out, the procedure for disposal has to be planned with consideration of already existing disposal concepts, starting with the production of raw waste and continuing through the conditioning and storage period up to the time when the waste packages are called off for emplacement in the Konrad repository.

Concepts describe procedures for the disposal of waste materials and raw waste as well as for the post-qualification of existing packages (Section 9.5 of the ESK guidelines) and must generally be described or documented in the internal regulations which are typical of the facility (e.g. disposal concept according to the waste materials and waste guidelines, qualification concepts, organisation manual, process description, radiation protection instruction). The concepts thus ensure that the waste disposal is fully described, i.e. regarding the type of waste and details on conditioning and documentation, with a plan of the time sequence.

Reference packages

If it has to be assumed during storage that the retention properties of the waste packages as well as the manageability are subject to a relevant temporal change, measures have to be taken for a timely detection of any adverse developments. A concept has to be developed for this purpose. The emplacement of the waste packages in the storage facility basically has to be carried out in such a way that they can be made accessible and subjected to visual inspections if required. The visual examinations and inspections may also be carried out on reference packages if the condition of these reference packages can be used to draw conclusions about the condition of the other waste packages.

Finding

Findings can generally be divided into findings on the storage units which can be detected from the outside and findings which cannot be detected from the outside (for examples, see Annex 4 in the catalogue of questions [4]).