Note:
This is a translation of the RSK recommendation entitled
"Alterungsmanagement
Umsetzungsstand und geübte Praxis zu den Anforderungen zum Alterungsmanagement gemäß KTA 1403 für elektro- und leittechnische Komponenten"
In case of discrepancies between the English translation and the German original, the original shall prevail.

RSK recommendation

(512th meeting of the Reactor Safety Commission (RSK) on 22/23 October 2019)

Ageing management
Status of implementation and common practice regarding the requirements for ageing management according to KTA 1403 for electrical and I&C components

RECOMMENDATTION

Contents

1 Advisory request

With advisory request RS I 3 - 17018/1 of 23 August 2017 [1], the BMUB asked the RSK for an assessment on the plant operators' approach regarding the fulfilment of the requirements of nuclear safety standard KTA 1403 "Ageing Management in Nuclear Power Plants" in the field of electrical and instrumentation and control (I&C) systems. To enable the RSK to fulfil this request and to evaluate the implementation of the requirements of KTA 1403 and the common practice in this context, the BMUB asked the nuclear regulatory authorities, i.e. the supervisory authorities of the *Länder* with nuclear power plants authorised for power operation to answer a detailed catalogue of questions [4].

2 Background and course of consultations

At its 247th meeting on 11 February 2016, the RSK Committee on ELECTRICAL INSTALLATIONS (EE) raised the question as to the current status of implementation of these requirements and the common practice within the framework of the discussion on the implementation of ageing management for the electrical and I&C equipment in accordance with the requirements of KTA 1403.

At the request of the EE Committee [2], VGB explained at the 257th meeting on 25 April 2017 in a generic and not plant-related presentation the implementation of the requirements of KTA 1403 for electrical and I&C components especially for the German nuclear power plants currently still in power operation [3]. In this context, it was pointed out that there are certainly plant-specific differences in the actual implementation of individual requirements of KTA 1403 and that the presentation is therefore of a general nature. The subsequent internal discussion led to the conclusion that the Committee did not regard itself as being in a position to assess the plant operators' approach to fulfilling requirements of KTA 1403 on ageing management with regard to this safety-relevant complex of topics.

Against this background, the above-mentioned advisory request [1] was issued. In order to enable an assessment in this respect, the BMUB asked the supervisory authorities of the *Länder* with nuclear power plants authorised for power operation for plant-specific information. The EE Committee developed a catalogue of questions in which the requested information is specified. The request, including the catalogue of questions, was sent to the *Land* authorities by letter dated 15 November 2017 [4].

At the 263rd meeting, the answers from the plants to all questions [5 – 8] were available to the Committee, some of which were confirmed by the authorities and accompanied by the opinions of the respective authorised experts. The Committee continued its consultations at the 264th meeting. The result of the consultations was to ask GRS to compile some exemplarily selected answers of the *Land* authorities in a clearly arranged form for the next meeting in order to be able to check on this basis to what extent the questions from [4] were answered with regard to the requirements. At the 265th meeting, the Committee continued its consultations and adopted the draft statement at the 267th meeting. The consultation results were presented to the RSK at its 509th meeting on 27 March 2019. At the RSK's request, the Committee revised the draft at the 272nd meeting on 19 June 2019 and submitted it to the RSK at the 512th meeting on 22/23 October 2019. The RSK discussed and adopted the recommendation at this meeting.

3 Assessment criteria

KTA 1403 “Ageing Management in Nuclear Power Plants”, Chapter 4.2 “Ageing of Technical Facilities of the Electrical and Instrumentation and Control Equipment” [9] was taken as the basis for the assessment. In particular, the requirements specified in sections 4.2.3(2), 4.2.3(3) and 4.2.3(7) are applied.

The structure of KTA 1403 comprises the following subject areas:

- scope (“Extent of ageing-related observation”) and functional requirements,
- relevant damage mechanisms and influences,
- measures for the mitigation of damage mechanisms, and
- effectiveness assessment.

Regarding the procedure for mitigating relevant degradation mechanisms, KTA 1403 distinguishes between electrical and I&C equipment, hereinafter also referred to as components, that can be examined with respect to the actual situation (i.e. examination corresponding to conditions in the event of required operation) and equipment that cannot be examined with respect to the actual situation. Examinations with respect to the actual situation means that the conditions of the examination (temperature, humidity, radiation, etc.) correspond to the conditions in the event of required operation and degradation causing functional impairment can be detected.

On the basis of answers [5] to [8] to the BMUB letter [4], it was to be checked whether the respective plant-specific description shows that a differentiated procedure is applied in the plants in accordance with the above-mentioned requirements of KTA 1403 and thus the requirements of KTA 1403 are fulfilled.

4 Consultations

A large part of the safety-relevant electrical and I&C equipment can be examined with respect to the actual situation. For these components, sufficient knowledge on ageing behaviour is available.

The situation is different for components that cannot be examined with respect to the actual situation. Here it is to be expected that ageing phenomena have an unrecognised influence on the function and only lead to unavailability in the event of required operation. Due to the systematics associated with such phenomena, a simultaneous failure of redundant components that have aged during operation cannot be ruled out in the event of required operation.

Therefore, KTA 1403 requires analytical assessments and adapted measures for this area of electrical and I&C components in order to identify such functionally relevant ageing phenomena. For this purpose, KTA 1403 (Section 4.2.3(3)) stipulates that proof shall be provided that the operating and environmental conditions at the assigned location have no impermissibly detrimental effects on the functional features.

First of all, the safety-relevant equipment has to be identified that cannot be examined with respect to the actual situation for various reasons. In a next step, the testing and inspection concept may have to be adapted or other safety assessment methods have to be chosen. To what extent the components to be identified are completely covered in conformity with KTA and which safety assessment methods are chosen for this equipment in the individual case to fulfil the requirements of KTA 1403 could not be assessed by the RSK due to the lack of related information.

The question also arises as to how it was determined and documented in the respective plants for which of the safety-relevant electrical and I&C equipment requirements within the scope of ageing management are already covered by examinations with respect to the actual situation. In addition, the question is raised as to how the existing requirements for safety-relevant electrical and I&C equipment that cannot be examined with respect to the actual situation are fulfilled and how this is documented in a comprehensible and traceable manner.

The operators refer to the in-service inspection, repairs, preventive maintenance as well as the maintenance of basic knowledge as tools for ageing management [3]. The RSK basically agrees, however, it asserts that the in-service inspections, which cover a large part of the requirements according to KTA 1403, are performed under the conditions of undisturbed normal operation and not under those of a case of required operation on which the design is based. Thus, some ageing phenomena with effects on the specified normal function in a postulated case of required operation could not be detected by the in-service inspection.

As an example of the measures to be taken then, the operators present the proceeding for covering possible gaps to demonstrate the functionality of I&C modules. Aged I&C modules are to be tested under collapse load conditions (e.g. temperature, stresses, seismic loads). Up to now, parts of the initial qualification were repeated on EDM reactor protection system modules that had been pre-aged in addition to operational ageing. With regard to the maintenance of the quality features verified within the framework of the type approval tests, a system-related procedure was applied on the basis of the test procedures described in a requirement specification.

VGB further stated that different safety demonstration methods for ageing management (e. g. demonstration of LOCA resistance in accordance with KTA 3706, plant-wide failure statistics) are brought together in a structured manner. The relevant results would be summarised in the basic and status reports. In the field of electrical and I&C systems, however, generic statements would be difficult due to the large number of variants of the systems and technologies used, different operating conditions, etc. The implementation progressed differently in the individual plants. Via the VGB committees, the knowledge of the individual plants is passed on to all other plants, especially with regard to preventive maintenance.

Despite questioning focused on the issue under consideration [2], VGB gave a rather general answer. The RSK then substantiated its enquiry with the objective to obtain detailed information on the procedure practised at the individual plants for its analysis. The EE Committee prepared 14 questions [4], which were submitted to the supervisory authorities of the *Länder*. The questions relate to the four subject areas of KTA 1403 under consideration (see Section 3).

Most of the questions include the request to illustrate the information by giving examples.

With the exception of one plant, the plant-related answers given by the supervisory authorities were very abstract and in the majority of cases the answers given by the plant operators were similar. Only in a few cases, the answers to the questions contain information with practical examples.

From the documents it could be concluded that from the point of view of the supervisory authorities of the *Länder*, KTA 1403 is implemented in all plants in accordance with established procedures. These procedures were primarily based on the processes and contents described in the basic reports.

In the answers, reference was made to the above-mentioned EDM system tests, which have meanwhile been completed, or to proofs of LOCA resistance concurrently with plant operation.

GRS evaluated some exemplarily selected answers with regard to whether the submitted answers allow an assessment of the implementation of the requirements of KTA 1403 in the field of electrical and I&C systems [10]. The assessment focused on the question whether the implementation of KTA 1403 for the different plants is described plausibly and comprehensibly in the answers to the BMUB's catalogue of questions [4]. However, due to the rather general, abstract character of the answers, an appropriate assessment was only possible for a part of the questions, even if the answers were supported by plant-related basic reports.

Question 9 is of particular importance with regard to equipment that cannot be examined with respect to the actual situation: "Which safety assessments have been chosen for those applications where examinations are not carried out with respect to the actual situation? The procedure should be explained by giving examples of typical events of required operation, i.e. cases where functionality of the required equipment must be available, e.g. loss of coolant, earthquake, aircraft crash and blast wave".

The repetition of parts of the initial qualification on EDM reactor protection system modules that had been pre-aged in addition to operational ageing, which was mentioned as an example in the operators' answers, is seen by the RSK as a positive example for the implementation of KTA 1403. According to the plant operators, it is intended to extend this demonstration also to other equipment families.

In contrast, the rather general considerations on other electrical and I&C components, e.g. in the two basic reports submitted, are not sufficient in the RSK's view. Here, no information has been given whether systematic considerations were made on ageing-related degradation mechanisms that may impair the function in the above-mentioned cases where functionality of the required equipment must be available. In particular, from the point of view of the RSK, the answers contain too little detailed information regarding the appreciation of the topic of equipment that cannot examined with respect to the actual situation.

In the following, examples are given of component groups with areas that cannot be examined as installed with respect to the actual situation that were discussed in the RSK:

- Batteries of the emergency power supply: In the event of external hazards, the induced vibrations can cause exfoliation and lead to plate short circuit.

- Junction boxes: Changes to the built-in components (cable ducts, disconnect terminals, cable routing) caused by ageing or foreign bodies with impacts on resistance, e.g. to induced vibrations.

- Fuses and circuit breakers: Age-related changes in the tripping characteristics (current, time).

- Circuit-breakers: Behaviour in the event of induced vibrations due to decreasing forces for closing and/or opening springs.

5 Summary

The RSK considers that a large amount of information on ageing condition and ageing mechanisms of these components and equipment is available for the majority of the safety-relevant electrical and I&C systems if the various measures from in-service inspections and maintenance measures are applied appropriately. If necessary, remedial measures can be initiated. Due to the broad-based feedback of experience, it is also possible to act proactively within the framework of preventive maintenance.

All in all, the RSK does not see any additional need for action with regard to the implementation of the requirements of KTA 1403 on ageing management of safety-relevant electrical and I&C systems that can be covered by examinations with respect to the actual situation and preventive maintenance.

The RSK has exemplary identified areas (see also Section 4) which cannot be examined with respect to the actual situation. However, it could not be demonstrated to the RSK that such areas (components with their operating and ambient conditions and functional features) were identified by means of a systematic analysis in accordance with KTA 1403 Section 4.2.3 and that appropriate measures were derived.

For full implementation of the requirements of KTA 1403, the RSK therefore recommends performing a systematic analysis of the components that cannot be examined with respect to the actual situation in terms of relevant ageing mechanisms and their detection and to present the derived remedial measures (recommendation).

6 Recommendation

To ensure full implementation of the requirements of KTA 1403, the RSK recommends performing a systematic analysis of the components that cannot be examined with respect to the actual situation in terms of relevant ageing mechanisms and their detection and to present the derived remedial measures.

7 References

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[4] Schreiben des BMUB an die atomrechtlichen Aufsichtsbehörden der Bundesländer mit Kernkraftwerken mit einer Berechtigung zum Leistungsbetrieb, „Alterungsmanagement im Bereich der Elektro- und Leittechnik“, Aktenzeichen: RS 1 3 - 17018/1, Bonn, 15.l 1.2017 einschließlich Fragenkatalog EE260 / lnfo-6, 07.11.2017

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[9] Sicherheitstechnische Regel des KTA, KTA 1403 „Alterungsmanagement in Kernkraftwerken“, Fassung 2017-11

[10] Dagmar Sommer, GRS, „Alterungsmanagement für elektro- und leittechnische Einrichtungen gemäß KTA 1403 - Bewertung der Antworten zu ausgewählten Fragen“, 24.04.2018, 264. Sitzung des RSK EE, Foliensatz