RSK RECOMMENDATION

MANAGEMENT OF AGEING PROCESSES AT NUCLEAR POWER PLANTS

of 22.07.2004 (374th Meeting)

Table of Contents

1.1 Introduction

The Federal Ministry for Environment, Nature Conservation and Nuclear Safety (BMU) asked the Commission on Reactor Safety (RSK) for a statement on the guarantee of a suitable national process regarding ageing management, in which concepts referring to all types of facilities for the registration, evaluation and measures to be taken should be recommended [1.1].

At RSK meeting No. 347 on 10.01.2002, the RSK adopted the statement "Principles on the proceeding regarding the control of ageing processes in nuclear power plants". This statement dealt with the general proceeding with regard to ageing management.

Later on, RSK and its committees on PLANT AND SYSTEMS ENGINEERING, PRESSURE-RETAINING COMPONENTS AND MATERIALS, ELECTRIC INSTALLATIONS and REACTOR OPERATION discussed the specific issues related to ageing management at several meetings. This recommendation contains the results of these meetings and an update of the RSK statement from RSK meeting No. 347. Thus, this recommendation replaces the statement from meeting No. 347.

At meeting No. 370 on 04.03.2004, at meeting No. 371 on 29.04.2004, on meeting No. 373 on 24.06.2004 and finally on meeting No. 374 on 22.07.2004, RSK discussed the draft of this recommendation and adopted it at meeting No. 374 on 22.07.2004.

1.2 Terms and Definitions

The RSK understands the terms “ageing”, “becoming obsolete” and “ageing management” as follows:

Ageing *is the time-dependent changing of function-related characteristics of*

- *technology (mechanical components, constructions and constructional installations, electrical engineering and instrumentation and control),*
- *the systems relevant for operation,*
- *the specification and documentation documents, and*
- *the personnel.*

Ageing means time-dependent changes of the quality and design characteristics having existed at the time of approval which may occur during the operating time of the facility. Mechanisms (e. g. wear and fatigue), which are predictable and monitored with corresponding programs, can contribute to ageing-caused loss of quality. On the other hand, changes have to be observed which emerge in spite of the design, production, commissioning and operation of the installations concerned according to specification as a result of ageing mechanisms (e. g. corrosion and crack formation) that were originally not foreseen. Finally, there are ageing mechanisms assumed in the design which lead to unforeseen effects.

Becoming obsolete *concerns facility concepts and technological methods as well as administrative regulations with respect to the state of the art in science and technology.*

Implemented concept solutions concerning both the overall safety concept of the facility as well as the single technological characteristics can age during the operating time.

Ageing management *means all organisational and technical measures to be performed by the operator with which the ageing phenomena significant for the safety of a nuclear power plant are controlled. The priority task of ageing management is to register possible ageing mechanisms and to preclude their damaging effects in a well-aimed and effective way.*

Well-aimed countermeasures that preclude possible quality losses form the basis for an efficient ageing management. A solid knowledge base with regard to the possible ageing mechanisms and their effects is required for the conceptual design of such measures, which supports effectively a preventive decision strategy. Ageing management is oriented towards the pursuit of trends and the optimising of processes and, thus, represents a supplementation to the existing maintenance management.

1.3 Ageing Management and Existing Regulations

Varied regulations to ensure quality exist already, whose implementation is monitored within the scope of corresponding supervisory activities. For example, the measures of the operators within the scope of inspection and maintenance programs and operational monitoring comprising the centrepiece of ageing management in the facilities are officially evaluated by both permanent supervision and Periodic Safety Reviews.

The existing German regulations include comprehensive requirements with respect to the avoidance or reduction of quality losses during operating time. Regarding depth and extent of regulation, the requirements are heterogeneous. A complete representation of requirements that comprises all aspects of ageing management has not been available yet and at the national level, no rules and regulations on ageing management exist so far or any other provision representing the state of the art in science and technology. In addition to workshops, lectures and position papers, there are expert opinions on the ageing management concepts of plant operators given on behalf of the regulatory authorities with regard to general issues related to ageing management.

The International Atomic Energy Agency (IAEA) presented numerous documents which include helpful ideas for a systematisation of ageing management in the facilities and for the harmonisation of the corresponding evaluation by the competent authorities [1.2-1.14].

In particular in IAEA Safety Reports Series No. 15 the Ageing Management Programme (AMP) is recommended as a tool for systematic and integrated action. The main matter of concern of such a programme is the registration and evaluation of all ageing-relevant occurrences in the facility, taking into account the operating experiences of other, also foreign operators and of the results of research projects and their implementation (Figure 1).

The Committee on Nuclear Regulatory Activities (CNRA) of the Nuclear Energy Agency of OECD sees a main topic of consultation in the regulatory aspects of ageing and supports a systematic approach which goes beyond the purely physical ageing of structures, systems and components [1.15 – 1.17].

Ageing phenomena are registered in the facilities in different ways, part of them not systematically. Within the scope of maintenance or as a consequence of events, unexpected ageing phenomena were

found in single cases, part of them accidentally. The operation of the facilities passes under changing conditions: deregulation of the energy market, new generations of personnel, suppliers and manufacturers no more available. Likewise, the area of conflict between the increasing age of the facilities and the further development of the state-of-the-art of science and technology becomes more and more succinct.

The operating experience is documented and updated by the plant operators, among other things, in the documentation, in the design reports, the reports on maintenance and on the results of the recurrent inspections. However, these activities, which are de facto part of the ageing management, are not performed according to a standardised and comprehensive approach. In addition, it has to be stated that the approach, in general, is "event based". An effective ageing management, however, has to be realised "knowledge based" as a tool of prevention.

1.4 Requirements on the Proceeding Regarding the Management of Ageing Processes

The strategic aim of ageing management is to prevent by suitable measures that the safety level reduces as a result of possible ageing processes.

Ageing processes shall be identified within the scope of the evaluation of plant-relevant indications from external and internal sources of information. As a result of the evaluation of the knowledge base, adequate measures have to be initiated and implemented, taking into account the actual state of the plant.

In the following, generic requirements on the fields of ageing are explained. More detailed requirements are presented in Chapter 2 of this recommendation.

1.4.1 Ageing of Technical and Structural Installations

For the technical and structural installations, an adequate ageing management concept has to be developed under consideration of the quality levels to be ensured. Kind and scope of the corresponding monitoring and maintenance measures have to be oriented towards the safety relevance, as e. g. the degree of redundancy of the systems, components and other installations.

A well-structured knowledge base shall be available for a well-aimed ageing management designed for the long term. This knowledge base should enable plant-relevant technological developments and the processing of all ageing-relevant information. Corresponding sources of information including e. g. material data and characteristics, construction and design data, inspection and analysis results as well as data from monitoring are suitable for this.

The plant-relevant ageing mechanisms that are known according to the state of the art in science and technology and under consideration of available operating experience and/or failure behaviour are to be identified and pursued. Considerable deviations from specified operational parameters, the practised monitoring measures and the essential safety-relevant findings have to be registered and assessed with regard to ageing relevance by means of the implemented management system. If

required, reliable trend analyses have to be carried out for relevant systems and components. Appropriate measures have to be proposed and implemented on the basis of the findings or trend analyses available.

More details are given in Chapter 2.1 for mechanical components, in Chapter 2.2 for electrical and I&C components, in Chapter 2.3 for buildings and structures, and in Chapter 2.4 for operating supplies.

1.4.2 Ageing or Becoming Obsolete of the Systems Relevant for Operation, of Operational Regulations and Documentation

Operation management systems are organisational and logistics systems which do not have any real-time depending plant process control and control functions. They can be used in fields like documentation, reporting of disturbances, conclusion of work orders, personal dosimetry, IT technical working and management of operational regulations. As far as they are relevant to safety, a corresponding ageing management has to be developed for these fields as well. The operation management systems have to be adapted to the changing work processes.

Ageing management regarding documentation must also take into account the possible ageing effects with respect to up-to-dateness and the physical state and availability of the documents.

In all documents relevant to safety the ageing process as regards content referring to the adaptation to the current plant state has to be monitored. This may be done in dependence on time as well as on events.

More details are given in Chapter 2.5 for integrated operation management systems and in Chapter 2.6 for the documentation.

1.4.3 Maintenance of Technical Competence

The main emphasis in the consideration of personnel questions is on the maintenance of technical competence required for the safe operation of the plant. This can be regarded as the total of education and training qualification of the personnel and their occupational experiences. On the one hand, an increase in experiences of the personnel can be expected with increasing operational life of the plant and low personnel fluctuation, on the other hand, loss of know-how due to the leaving of staff members with significant experiences has to be prevented.

The marginal conditions required for the first education and the maintenance of the technical competence of the personnel working in the nuclear power plant have been regulated nationally in corresponding directives. The qualification measures of the operator have to be designed such that, in particular, knowledge gaps in key positions that are important for the safe operation of the plant are prevented which may occur due to the loss of senior experts. Taking into account the aforementioned aspects, a targeted personnel development is required with early training and preparation of the follow-up personnel for the future tasks.

More details are given in Chapter 2.7.

1.4.4 Ageing of Concepts and Technological Ageing

An integral evaluation of the safety concept of the facility is carried out within the scope of the Periodic Safety Review. Additionally, the operator must continuously pursue the progress of science and technology and evaluate the relevance of the determined deviations regarding the safety requirements and analysis methods with regard to plant-specific implementation.

The results of these reviews have to be documented, stating which consequences have been drawn from the reviews and comparisons for the plant and its operation, to what extent the changed requirements of the nuclear or relevant conventional regulations are fulfilled or to what extent the purpose and objective of these requirements can be reached in another way, taking into account plant-specific conditions.

More details are given in Chapter 2.8.

1.5 Recommendation

The RSK considers a comprehensive and systematic ageing management, as it is described in this recommendation, necessary. The RSK assumes that the plant operators pursue an effective ageing management that fulfils this demand. Organisationally, ageing management is to be implemented as a permanent task on a high level in connection with the management responsible for safety. Ageing management requires co-operation between different disciplines and different organisational units of the plant operator. This has to be ensured within the organisation.

The RSK recommends that an annual report on ageing management be submitted to the competent supervisory authority, other report cycles being possible in well-founded cases. If there is already the duty to report on single ageing phenomena, the RSK considers it advisable to integrate them in the report.

In order to reach a standardised proceeding with regard to ageing management on a broad knowledge base, the RSK recommends to evaluate the plant-specific reports of the plant operators generically. The results obtained from the evaluation have to be considered in the ageing management of the different plants. For this purpose, corresponding procedures have to be specified.

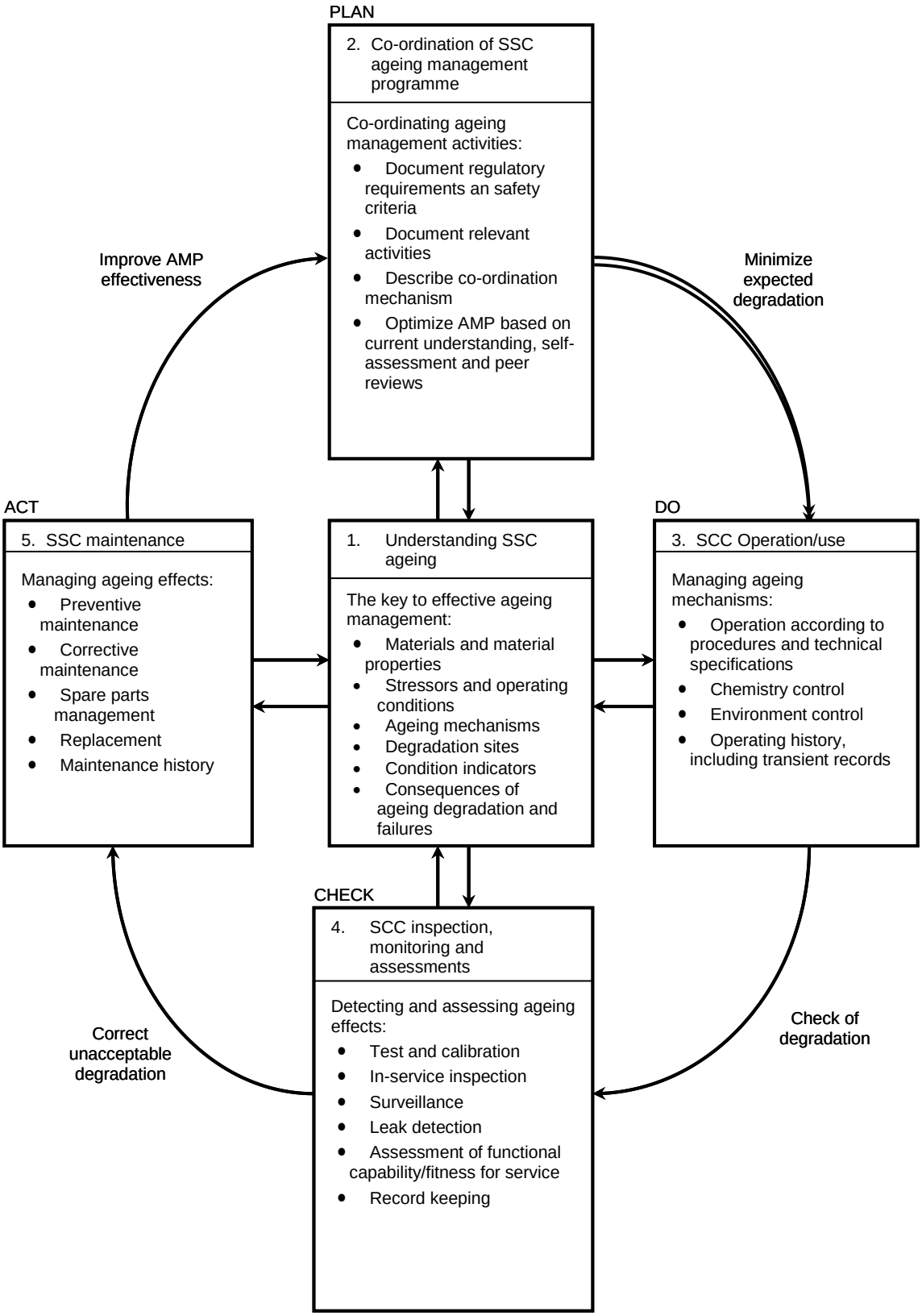

Figure 1: Systematic ageing management process (AMP: ageing management programme, SCC: system, structure or component, after IAEA [1.6])

References

[1.1] Letter of the BMU AG RS I 4 – 13126/2 of 22.11.2000 to the RSK Secretariat

[1.2] International Atomic Energy Agency, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: Primary Piping in PWRs
IAEA-TECDOC 1361 (2003)

[1.3] International Atomic Energy Agency, Management of Ageing of I &C Equipment in Nuclear Power Plants, IAEA TECDOC 1147 (2000)

[1.4] International Atomic Energy Agency, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: In-containment instrumentation and control cables, Volume I and II; IAEA-TECDOC-1188 (2000)

[1.5] International Atomic Energy Agency, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: Metal components of BWR containment systems, IAEA-TECDOC-1181 (2000)

[1.6] International Atomic Energy Agency, Implementation and Review of Nuclear Power Plant Ageing Management Programme, IAEA SAFETY REPORT SERIES No. 15 (1999)

[1.7] International Atomic Energy Agency, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: PWR Pressure Vessels, IAEA-TECDOC-1120 (1999)

[1.8] International Atomic Energy Agency, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: PWR Vessel Internals, IAEA-TECDOC-1119 (1999)

[1.9] International Atomic Energy Agency, Safe Management of the Operating Lifetimes of Nuclear Power Plants
INSAG-Series No. 14 (1999)

[1.10] International Atomic Energy Agency, AMAT Guidelines: Reference Document for the IAEA-Ageing Management Assessment Teams, IAEA SERVICES SERIES No. 4 (1999)

[1.11] International Atomic Energy Agency, Equipment Qualification in Operational Nuclear Power Plants: Upgrading, Preserving and Reviewing, IAEA SAFETY REPORT SERIES No. 3 (1998)

[1.12] International Atomic Energy Agency, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: Concrete Containment Buildings, IAEA-TECDOC-1025 (1998)

[1.13] International Atomic Energy Agency, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: Steam Generators, IAEA-TECDOC-981 (1997)

[1.14] INTERNATIONAL ATOMIC ENERGY AGENCY Data Collection and Record Keeping for the Management of Nuclear Power Plant Ageing; Safety Series No 50-P-3 (1991)

[1.15] OECD/NEA: Technical Aspects of Ageing for Long-term Operation, NEA/CSNI/R(2002)

[1.16] OECD/NEA: Regulatory Aspects of Life Extension and Upgrading of NPPs, Report NEA/CNRA/R (2001)

[1.17] Regulatory Aspects of Ageing Reactors, OECD/NEA/CNRA/R (99) 1 (1999)