

depth, safety margins, physical barriers, redundancy and independence, core damage, and large release frequency, should be considered to determine a baseline against which to review the current safety provisions and past operating performance.

Specifically, the assessment for long-term operation should document the following:

- The extent to which the plant conforms to modern standards and practices.
- The extent to which the (updated) licensing basis will remain valid to the end of the plant's proposed extended operating life.
- The adequacy of the arrangements that are in place to maintain plant safety for long-term operation.
- The improvements to be implemented to resolve the safety issues that have been identified.

The review of the current and proposed safety provisions will indicate whether modifications to the facility or operational procedures are meeting existing standards and whether the optimization of protection and the limitation of risk are adequate for long-term operation.

Safety challenges

Member states use different strategies and methods to demonstrate safe and long-term operation of nuclear power plants, but their regulatory rules regarding the conduct of safety reviews are not always clearly defined. Safety reviews focus primarily on physical aging management of SSC and do not systematically consider all important safety elements, such as those in a periodic safety review, to conclusively demonstrate that the arrangements to maintain plant safety through the intended long-term operation period remain adequate.

One of the main challenges facing operators is demonstrating conclusively that the strategies for managing physical aging of SSC remain effective for long-term operation. This can be

because of gaps in knowledge of the plant's condition, limited demonstration that safety and safety-related SSC will perform their functions during the intended period of long-term operation, incomplete aging management programs and time-limited aging analyses for SSC, and incomplete or missing equipment qualification programs.

Effective strategies to manage the physical aging of SSC, particularly the revalidation of time-limited aging analyses, rely strongly on the availability of up-to-date design basis documentation for nuclear power plants prior to entering the long-term operation period. This information is often incomplete or inaccessible, and its reconstitution requires significant time and effort. The unavailability of the design basis documentation prevents timely implementation of modifications and safety upgrades.

Another challenge is associated with systematic identification of reasonably practicable safety upgrades. Regulators do not have exact rules to determine what improvements might be required. Reasonable and practical modifications, however, should be considered based on an understanding of the extent to which a plant conforms to up-to-date standards. Since this information is rarely available due to the limited consideration given to modern standards in the safety reviews supporting the preparation for long-term operation, including in the periodic safety review, safety upgrades are selected mainly based on operating experience, taking into consideration the safety significance and cost-benefit evaluation.

Well-established workforce planning for the long-term operation period of a nuclear power plant is key to addressing these challenges and to ensuring that competence and knowledge are available and up to date. Knowledge transfer to the authorities, equipment manufacturers, suppliers, and contractors is also crucial. **N**

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