

Preface

Nuclear power plants and many of the facilities and structures used for the processing, the temporary storage and the disposal of radioactive waste materials generated by the fuel cycle use concrete in their construction. These structures are required to function safely and reliably in challenging and varying environments for periods of time that can potentially range up to thousands of years or even longer. During their operational life, these structures will in all likelihood be subjected to a number of environmental stresses or ageing factors that may adversely affect their performance and result in shortened service lives. The use of reinforced concrete in modern applications dates back around 100 years. Additional information is therefore required in several areas to help provide the continued assurance that these structures will continue to meet their operational requirements throughout their service life. The long-term service life and performance of concrete may be predicted with some confidence but cannot be fully validated. Analyses of archaeological analogues such as Roman concretes are a good example to build confidence in the stability of hydrated phases that can be expected in thousands of years. We can predict evolution and behaviour in the long-term but cannot validate these predictions beyond a few hundred years. It has to be acknowledged that a lot of work has already been done in this regard but key issues still have to be addressed or require additional understanding in order to build confidence.

Previous work made in RILEM by other TCs on the subject of long-term performance of reinforced concrete structures, but also in NEA/OECD related to the use of concrete structures in nuclear power plant fuel cycle facilities, pointed out several technical areas where additional knowledge was needed. The working programme of TC 226 CNM followed the TC 202 RWD managed by Dan Naus. The definition of the working programme also made use of the outcomes of the CSNI/RILEM 2004 workshop on Use and Performance of Concrete in NPP Fuel Cycle Facilities and of the NUCPERF 2006 workshop on Corrosion and Long-Term Performance of Reinforced Concrete in Nuclear Power Plants and Waste Facilities. TC 226 CNM involves interdisciplinary fields that are linked with the “core business” of RILEM and utilizes developments of several existing

RILEM committees. The activities of the Technical Committee cover the main following areas:

- Functional and performance requirements for concrete structures in the context of nuclear facilities;
- Degradation processes and their effects, particularly where the degradation phenomena can operate over extended periods of time, or where synergistic effects are present (coupling);
- Phenomenological modelling (linked to the previous point) dedicated to the long-term behaviour is problematic;
- Field experiences (collection of data during decommissioning, archaeological analogues, etc.);
- Tests approaches, instrumentation and monitoring methods dedicated to performance assessments;
- Service life models, development and validation that take into account reliability methods and updating as additional data become available (Bayesian);
- Ageing management of NPP, repair techniques to extend the performance period;
- Codes and standards specific to radioactive and hazardous waste facilities.

The main scope of the TC is the subject of R&D in several countries where nuclear industry is implemented (USA, Canada, Japan and many countries in Europe). Due to the recognized importance of the subject, it seems necessary to provide a review on existing R&D programmes on long-term prediction for nuclear applications, as well as to identify the gaps in the existing knowledge in order to propose subjects that need further research.

The Committee for Safety of Nuclear Installations (CSNI) of the OECD/NEA and the European Federation of Corrosion (EFC, Working Party 4, Nuclear Corrosion) also contributed to the activities of the TC. There was also interaction/collaboration with other projects dealing with similar topics: the Workshop on Cementitious Materials Used for Radioactive Waste Treatment, Containment, ER and D&D held in Aiken South Carolina, USA in December 2006, the International Workshop on Sulphur-Assisted Corrosion in Nuclear Waste Disposal Systems held in Brussels in 2008, and the 4th International Workshop on Long-Term Prediction of Corrosion Damage in Nuclear Waste Systems held in Bruges in 2010.

Three workshops were organized by the TC and the edited proceedings produced: NUCPERF 2009 & 2012 and AMP 2010. At the end of each workshop a summary session was conducted providing an overview of the main outcomes, questions and answers and recommendations arising during the workshops. Key input was provided by researchers from countries that are main contributors in the R&D, design, construction, operation and regulation of waste nuclear reinforced concrete facilities.

The main outcomes of RILEM TC-226-CNM are summarized in the present report.

Gif-sur-Yvette, France
Brussels, Belgium

Valérie L'Hostis
Robert Gens

Performance Assessment of Concrete Structures and
Engineered Barriers for Nuclear Applications

Conclusions of RILEM TC 226-CNM

L'hostis, V.; Gens, R. (Eds.)

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