Chapter 6
Conclusions

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Abstract After the three workshops organised and the edited proceedings produced: NUCPERF 2009 and 2012, and AMP 2010, the TC identified some R&D drivers. These fields of interest for R&D are presented in the present chapter.

Keyword R&D drivers · Processes · Properties · Understanding

The use of reinforced concrete in modern applications dates back around 100 years. The long-term service life and performance of concrete may be predicted with some confidence. For disposal systems, the longer time periods for performance necessitate confidence building rather than demonstration. Confidence may be supported not only by modelling but by showing robust solutions, together with a good knowledge of the processes involved. Confidence building is a continuous and iterative effort. Continuous improvement of the knowledge is the basis for providing confidence and supporting improvement of the safety assessment. The assessment of the safety of a disposal system requires a detailed knowledge base and adequate analysis tools: these form the assessment basis, whose development, through an iterative and stepwise process, is a major objective of the R&D programme.

The key degradation processes which will determine the long-term behaviour of EBSs should be identified for specific contexts and environments. A prerequisite for assessing the subsequent evolution of the system is good knowledge and understanding of its initial state.

Phenomenological studies include laboratory tests, in situ site characterisation studies, full-scale tests and demonstrations, and studies of natural and anthropogenic analogues. Experts in phenomenology consider the evolution of the

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disposal system including all its interactions (thermal, hydraulic, mechanical, biological and chemical) and pursue the goal of continuously refining their understanding of the spatial and temporal evolution of the system through an iterative R&D programme.

Analyses of natural and archaeological analogues such as Roman concretes are a good example of verifying the stability of hydrated phases that can be expected in thousands of years. It has to be acknowledged that a lot of work has already been done but key issues still have to be addressed and/or their understanding deepened in order to build confidence.

The R&D drivers identified by the Technical Committee (TC) are:

- New materials now being considered
- Extension of facilities lifetime (NPP)
- Performance assessment capabilities

The TC identified a number of fields of interest for R&D focus (not an exhaustive list). It is important to stress that it is not necessarily true that because a subject has been identified by the TC it is relevant in all cases, for all systems. Their relevance is case dependent (to be assessed case by case taking into account the specific details of each application).

We briefly list here some key issues:

- Multiple processes and properties have to be considered as a function of material composition
- Need for development of probabilistic approaches to account for uncertainty in materials characteristics and performance
- Models need to take account of experimental data on real systems
- Need for guidance to establish consistent and complete data sets
- Need to understand ageing and degradation phenomena for new materials (e.g., carbon fiber-cement paste interfaces in bulk material and exposure face, low pH cement)
- Potential consequences of passive corrosion on the long-term integrity of concrete (cracking)
- Need to couple corrosion, radiation and geochemical models
- Need for appropriate instrumentation/sensors to determine the ageing of the structures as well as to provide information for the proper design of future facilities
- Development of methodologies for inspection of inaccessible areas such as emergency cooling water tanks, grouted tendons in pre-stressed systems, etc.
- Effective ageing management for concrete structures with alkali-aggregates-reaction and delayed ettringite formation
- Need for a better understanding of how cracking evolves and how this leads to a developing loss of physical containment
- Potential influence of spatial and temporal evolution of geochemical conditions on radionuclide parameters to be used in performance assessments
- Impact of carbonation on corrosion and radionuclides transport