**Errata** 2011-10

# SKB TR-10-67

# An update of the state-of-the-art report on the corrosion of copper under expected conditions in a deep geologic repository

In the earlier distributed report, there are errors that have now been corrected. The corrected page 111 is enclosed. The changed text is marked with a vertical line in the page margin. An updated pdf version of the report, dated 2011-10, can be found at www.skb.se/publications.

**Svensk Kärnbränslehantering AB**
Swedish Nuclear Fuel
and Waste Management Co
Box 250, SE-101 24 Stockholm
Tel +46 8 459 84 00

# 6 Stress corrosion cracking

***Summary of changes to stress corrosion cracking section***

Stress corrosion cracking (SCC) of copper canisters continues to be an area of active research in a number of national programmes, including Finland, Sweden, and Canada. The following updates have been made to the SCC section:

- The entire section (Section 6 in the new report) has been renumbered as a result of combining the old Sections 4 and 5 into a single section in the revised report.
- A more-detailed discussion of the scientific basis for the surface mobility model has been included (Section 6.1.1(d)).
- Copper SCC studies since 2001 have been summarised, with an emphasis on studies performed in support of nuclear waste disposal programmes (Section 6.1.2).
- Tables 6-1(a), (b), (c) have been updated with studies since 2001 and a new Table 6-1(d) has been added.
- A fault-tree approach to predicting the possibility of SCC of copper canisters is introduced (Section 6.2.2.1 and Figures 6-8 and 6-9).
- The possibility of SCC during the long-term anaerobic phase in the evolution of the repository environment is discussed (Section 6.2.2.1).
- A number of figures summarizing experimental observations of SCC in ammonia, acetate, and nitrite solutions (Figure 6-1) have been added.

## 6.1 Literature studies of the SCC of pure coppers

The SCC of Cu alloys is the oldest form of environmentally assisted cracking known, dating from the "season-cracking" of brass munitions in the mid-late 19th Century. Apart from the SCC of stainless steel in chloride solutions, the cracking behaviour of Cu and Cu alloys has probably been studied more than any other form of SCC. A number of reviews of the likely SCC behaviour of Cu canisters have been written (Farmer et al. 1988, King 1996c, King and Litke 1997, King and Newman 2010, Ikeda and King 2001, Saario et al. 1999), on which this section has been based.

The three pre-requisites for SCC are a susceptible material, a tensile stress, and a suitably aggressive environment. The proposed canister material cannot be claimed to be immune to SCC, since pure coppers, especially those containing phosphorus, have been shown to be susceptible. Tensile stresses on the canister surface are possible during various stages in the evolution of the repository environment, either due to external loads or from residual manufacturing stresses. Finally, the possibility that known SCC agents, i.e. ammonia, nitrite, or acetate, may be present in the repository cannot be excluded. Therefore, the possibility of SCC of Cu canisters must be considered.

Of all corrosion processes, SCC is probably the most complex and the most difficult to predict. The extensive database on the SCC of pure coppers is summarized in the first section, followed by a discussion of the expected long-term SCC behaviour of Cu canisters in a deep underground repository.

The SCC of pure coppers has been reported to be caused by ammonia, acetate, nitrite, and recently also by sulphide ions. Table 6-1 summarizes the various literature studies on the SCC of pure coppers in these different environments, with an emphasis on studies associated with the SCC of Cu canisters.