Errata 2011-12

SKB TR-10-17

Design, production and initial state of the closure

In the earlier distributed report, there are errors that have now been corrected. The corrected page 30 is enclosed. The changed text is marked with a vertical line in the page margin. An updated pdf version of the report, dated 2011-12, can be found at www.skb.se/publications.

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3.5 Borehole sealing

A number of investigation boreholes, both holes drilled from the surface and holes drilled from underground openings have to be sealed, at the decommissioning of the final repository facility. With respect to that the closure shall "*prevent that water conductive channels that may jeopardise the barrier functions of the rock, are formed between the repository and the surface*", only boreholes going deeper than the top sealing (thus passing –200 meter) have to be sealed. In the layout of the final repository facility the locations of the boreholes are considered in order to avoid that boreholes connected to the surface intersect underground openings. Deposition tunnels must not be intersected by investigation boreholes connected to the surface, and deposition holes must not be intersected by any investigation boreholes.

The geometry of a borehole seal is mainly determined by the dimensions of the drilled holes. The length of surface-based boreholes ranges from a few metres to more than 1,000 metres and the diameter will range from 56 to 120 mm. The tunnel-based boreholes are expected to have a length of a few hundred metres and a diameter of 56 to 76 mm. The shallowest parts of the boreholes may have larger diameters. Some boreholes may be more or less horizontal.

In addition a large number of grouting holes and holes for installation of rock support will be drilled during construction of the repository, see the **Underground openings construction report**. However, they do not need to be sealed.

SKB has studied and developed several concepts for borehole sealing. The main principles for sealing boreholes as well as results from tests and experiments are summarised in /Pusch and Ramqvist 2007/.

3.5.1 Reference design of borehole sealing

To conform to the design premises for borehole sealing (see Table 2-1) the following reference design is applied.

Highly compacted bentonite is used where tight seals are needed and cement-stabilised plugs are cast where the boreholes pass through fracture zones, see Figure 3-6 and 3-7. For the reference design MX-80 bentonite is chosen. To prevent erosion during the installation phase the clay shall be pre-dried to a water content of about 6% and then compacted to a dry density of 1,900 kg/m^3. The clay blocks are contained in perforated copper tubes that are jointed as they are inserted into the holes. The copper tubes provide mechanical protection against abrasion in the installation phase. The reference borehole has a diameter of 80 mm (investigation holes with a original diameter of 76 mm have to be enlarged) and the perforated copper tube an outer diameter of 76.1 mm and an inner diameter of 72.1 mm (which is a standard dimension). The tubes have a perforation ratio of 50% with 10 mm diameter holes in order to allow the clay to swell into the volume between the tube and the rock.

Along sections where the borehole passes water-conducting fracture zones the clay could potentially erode. In such positions the holes are therefore filled with silica concrete, which is a permeable and erosion-resistant material, see Figure 3-6. These plugs do not need to have a low conductivity but must be physically stable for supporting the surrounding rock and the clay plugs that rest on them or are located below them. In the construction phase they must be stable and rapidly become strong enough to carry overlying clay plugs without settling. This is attained by using a fast curing cement binder. To minimise the negative impact of cement contacting clay plugs, the cement content will be very low and low-pH cement will be utilised. Further details are found in /Pusch and Ramqvist 2007/.

The upper part of boreholes connected to the surface will be sealed with material that can sustain the swelling pressure exerted by the clay part and offer resistance to mechanical impact like intrusion, erosion and glaciations. For the reference design the concept illustrated in Figure 3-5 is selected. The main components are: rock cylinders, concrete plugs cast on site and anchored in reamed recesses and well compacted till /Pusch and Ramqvist 2007/.