Verification/validation of the codes ERICA and MATLAB-Pandora

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This memo responds to QA related issues regarding the codes ERICA and MATLAB-Pandora, raised by SSM in a request for information additional to that given in the safety assessment SR-Site (reference SSM2011-2426-80).

1 ERICA Tool

The ERICA tool was developed within the ERICA EURATOM project in the area of radiological environmental protection (www.erica-project.org), by a large consortium of European countries lead by the Swedish Radiation Safety Authority. Currently the ERICA Tool is being maintained by a consortium comprising the Norwegian Radiation Protection Authority, Environment Agency (England andWales),Centre for Ecology & Hydrology (UK), IRSN (France) the Swedish Radiation Safety Authority and CIEMAT (Spain). The ERICA Tool is freely available (http://www.project.facilia.se/erica/download.html) and has a large international user base. ERICA is a widely used tool, which is becoming an internationally standardized tool for assessment of doses to non-human biota.

The quantification of uncertainties in the dose estimations with ERICA has played an important role from the very beginning of the tool development; see for example (Avila et al. 2004). The accuracy of the dose calculation methodologies implemented in ERICA, as well as the tool itself, have been verified in several studies where predictions using ERICA have been compared with measured data (Beresford et al. 2005, Wood et al. 2008). The ERICA Tool has also participated in several model comparisons exercises (Beresford et al. 2008a, b, 2009, 2010, Vives i Battle at al. 2011) within the IAEA's EMRAS I and EMRAS II programmes. The Bioprota Project (www.Bioprota.org) has investigated the applicability of the ERICA Tool in the context of safety assessment of radioactive waste repositories. In particular, a sensitivity analysis and a knowledge quality assessment of the application of ERICA and similar tools to the assessment of impacts from waste repositories (Smith et al. 2010) was recently carried out within this project.

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2 MATLAB-Pandora

MATLAB-Pandora is a tool for implementation of mathematical models and for performing deterministic and probabilistic simulations with these models. This tool was used in SR-Site to implement the radionuclide model for the biosphere, which was applied in derivation of Landscape Dose Factors (LDF) for dose assessments. The radionuclide model for the biosphere and the simulations performed with this model are described in the SKB TR-10-06 (Avila et. al. 2010). In Chapter 5 of SKB TR-10-06 results from uncertainty analyses of the radionuclide model for the biosphere are presented, which covers all different types of uncertainties: system (scenario) uncertainties, model (conceptual) uncertainties, numerical uncertainties, as well as parameter uncertainties. This uncertainty analysis has shown that the radionuclide model for the biosphere, implemented in the Pandora tool, is fit for purpose within the context of the SR-Site safety assessment.

The MATLAB-Pandora tool itself is described in the SKB R-11-01 (Ekström 2011). Pandora is a further development of the Tensit tool (Jones et al. 2004). Both Pandora and Tensit use the numerical solvers available in Matlab/Simulink, which are widely applied in many scientific areas. The basic concepts underlying Pandora are the same as in Tensit and the latter has been compared with several analytical results as well as numerical results from other simulation tools, such as AMBER (Robinson et al. 2003) with satisfactory results. These comparisons are described in (Jones et al. 2004) and have been repeated in SR-Site, using Pandora, to ensure that quality has been maintained during the transition from Tensit to Pandora.

Pandora has incorporated capabilities for performing probabilistic simulations using Monte Carlo methods. The methods applied for this are not directly available in Matlab/Simulink and were therefore been specially tested (Ekström 2011) in SR-Site. For this purpose, the models in the PSACOIN Level 1B exercise (Klos et al. 1993) were implemented in Pandora and the simulations specified in the exercise were carried out. The PSACOIN Level 1B exercise was an international intercomparison, where eight participating groups compared their results after having simulated a given dose model, both deterministically and probabilistically. As shown in (Ekström 2011), the results obtained with Pandora in this exercise were satisfactory.

In SR-Site the different simulations that were carried out with Pandora were also carried out using the Ecolego tool (Avila et al. 2003). Results of comparisons of Pandora and Ecolego (Avila et al. 2010) have showed that both tools give practically identical results. It should be noted that Ecolego has undergone several comparisons with other tools (Maul et al. 2003) showing that this tool give accurate results for similar types of models to those used in SR-Site.

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