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## **THERESA**

### **Coupled Thermal-Hydrological-Mechanical-Chemical Processes for Application in Repository Safety assessment**



# **Executive Summary**

Instrument: STREP

Thematic Priority: Nuclear energy – management of radioactive waste

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Period covered: From 01/01/2008 to 31/12/2008

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Start date of project: 01/01/07

Duration: 36 months

Project coordinator name: Lanru Jing

Project coordinator organization name: Kungliga Tekniska Högskolan

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#### **Dissemination Level**

|           |  |  |
|-----------|--|--|
| <b>PU</b> | Public   |  |
| <b>RE</b> | Restricted to a group specified by the partners of the [THERESA] project |  |
| <b>CO</b> | Confidential, only for partners of the [THERESA] project                 |  |

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## Executive Summary

This project aims to develop a scientific methodology for evaluating the capabilities of mathematical models and computer codes used in Performance Assessment (PA - using process level models) or Total System Performance Assessment (TSPA - mostly using simplified PA models), and applied to the design, construction, operation, performance and safety assessment, and post-closure monitoring of geological nuclear waste repositories, based on the scientific principles governing coupled thermo-hydro-mechanical and chemical (THMC) processes in geological systems and geo-materials. The project work concentrates on the most essential issues for PA, with focus on rock salt, buffer materials and the buffer-rock interface, as guided by the tool of Issue Evaluation Tables (IET). The evaluation is carried out by scientific/technical auditing (TA) procedures. The evaluation examines the participating teams' codes and approaches in terms of system characterisation (conceptualisation, simplification, mathematical representation and parameterisation), flexibility in handling realistic *in-situ* geological conditions, capacities in uncertainty source identification and treatment, and computational aspects. The evaluation is organised around numerical simulations of small-to-moderate scale laboratory tests, specifically defined generic Bench-Mark Tests (BMT), and large-scale in-situ experiments (Test Cases - TC) involving coupled THM, HMC or THMC processes in rock salt and buffer material, so that simulations and evaluations are conducted within a realistic physical context. This proposed project represents a coherent and logical effort based on sound scientific principles, and with potentially far-reaching consequences in the field of nuclear waste disposal.

Five work packages (WP1-WP5) were planned to achieve the above objectives. WP1 is the overall planning package, designed to oversee the implementation of the other four work packages throughout the duration of the project. WP2 will, in "Issue Evaluation Tables" (IETs), identify the specific issues in PA that are related to THMC modelling, and will, through continuous updating, guide the project in addressing the relevant issues. WP3 and WP4 are the packages addressing numerical modelling of coupled THMC processes in salt and buffer, respectively. WP5 is defined to implement the TA of the models and codes applied in WP3 and WP4, according to specifically developed IETs and TA procedures. The exchange of ideas and work implementation check-ups will be achieved mainly through regular workshops and specific task force group meetings.

For the second reporting period of the project (Jan. 1 - Dec. 31, 2008), the work focused mainly on the updating overall project plan (WP1), upgrading of the LETs (WP2), further development of the computing tools (WP3 and WP4), laboratory experiments on rock salt (WP3), benchmark problem simulations and code calibrations against laboratory experiments (WP3 and WP4), and preparations for their technical auditing (WP5). The work performed and achievements during this period are summarized, as below, in the order of work packages.

WP1: The overall project plan that was completed in this period and delivered (Deliverable 1), and updated during the second period of the project. No deliverable is required in this period.

WP2: The first drafts of the two IETs were constructed for WP3 and WP4 during the first period, through internal discussions and improvements, and submitted for external review by the members of a Scientific Advisory Committee (SAC). The SAC members reviewed the LETs without recommendation for further improvement. No deliverable is required in this reporting period.

WP3: The main work performed is the continued code calibration against laboratory experimental data and improvements of constitutive models of rock salt, and laboratory experiment on salt. The work defined for the second reporting period progressed well, and the required Deliverable 5 and Deliverable 6 were submitted with slight delays. The results were reported on a task force meeting (April 15-16, 2008) and on a project plenary meeting (Dec. 11-12, 2008).

WP4: Besides the improvement of the IET for WP4, the work performed included the continued code preparation and laboratory experimental data collection and analysis for validation and improvements of constitutive models of buffer, and development of buffer-interface models. Three Bench-Mark-Test (BMT) problems were defined and simulated by contractors working with WP4 in order to verify their codes and models. Deliverable 11 was required for this reporting period but was delayed. The results were reported on a task force meeting (May 14, 2008) and a project plenary meeting (Dec. 11-12, 2008).

WP5: For the second reporting period, the work performed consisted of mainly the auditing of the benchmark simulations in WP3 and WP4 for Deliverable 16. The work was delayed due to the changes of working plans in WP3 and WP4 due to delays in laboratory experiments and modelling. The Deliverable 16 will be completed in early 2009.

Besides the above work performed, planning work for use and disseminating of knowledge was conducted mainly through a planned international conference on the THMC processes during Sep.30 – Oct.1, 2009, Luxembourg, in co-operation with TIMODAZ project in the EC 6FP. Two planning meetings were held in Brussels for this conference and preparation work was also discussed at the exchange meeting between the two projects, in conjunction with the annual plenary meeting of THERESA project (Dec.11-12, 2008).

Three PhD students are involved in the project (at KTH, TUC and CU), and they have contributed significantly to the progress of the progress of the project.

Two international journal papers were submitted and four international conference papers were published in this period.