

International
Progress Report

IPR-00-18

Äspö Hard Rock Laboratory

Canister Retrieval Test

Temperature on the canister surface

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May 2000

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**Äspö Hard Rock
Laboratory**



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2001-09-03

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MATTER HANDLED BY
Ingela Månson

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To: Receivers of SKB International Progress Report IPR-00-18

We send you enclosed a new version of IPR-00-18, cancelling and replacing the first version. Please note two changes in the report.

1) To reach the temperature limit of 90°C on the canister surface a heat output of 2 600 W (instead of 3 000 W as indicated in the first version) will be required.

2) Figure 1 on page 5 is now readable.

We apologise for the inconvenience this change may cause you.

Yours faithfully,

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Communication Techniques

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Keywords: Canister retrieval test, temperature, thermal diffusivity, thermal conductivity, specific energy

This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the author(s) and do not necessarily coincide with those of the client.

Abstract

Thermal calculations have been done using FEM analysis in order to establish a base for the calibration of the electric heaters in the Canister Retrieval Test. It has been concluded that in the *one canister case* and with an initial heat output of 1 800 W, the maximum temperature on the canister surface would be 67°C after two years. After two months, the temperature will reach 59°C and after one year 66°C. To reach the temperature limit of 90°C a heat output of 3 000 W will be required. For the *two canisters case* the corresponding temperatures would be 73°C, 59°C and 70°C respectively and the heat output 2 300 W.

Sammanfattning

Temperaturberäkningar har gjorts med FEM-analys för att etablera en bas för kalibrering av de elektriska värmare som skall användas i återtagsförsöket. Slutsatsen blev att i fallet med *en kapsel* och med en initial effekt av 1 800 W blir maxtemperaturen på kapselytan 67°C och uppnås efter två år. Efter två månader blir temperaturen 59°C och efter ett år 66°C. För att uppnå 90°C krävs en effekt av 3 000 W. I fallet med *två kapslar* blir motsvarande temperaturer 73°C, 59°C och 70°C och effekten 2 300 W.

Canister Retrieval Test - Calculation of the Maximum Temperature on the Canister Surface

The aim of the Canister Retrieval Test is to demonstrate on a full scale basis a feasible technique for retrieving a canister that has been deposited and surrounded by a swelling bentonite buffer for some period of time. The heat output, simulating the future content of spent fuel, will be obtained by means of electric heaters. In order to meet requirements regarding a target temperature on the canister surface, thermal calculations were made to create a basis for the calibration of the heaters. This report presents the results of such calculations.

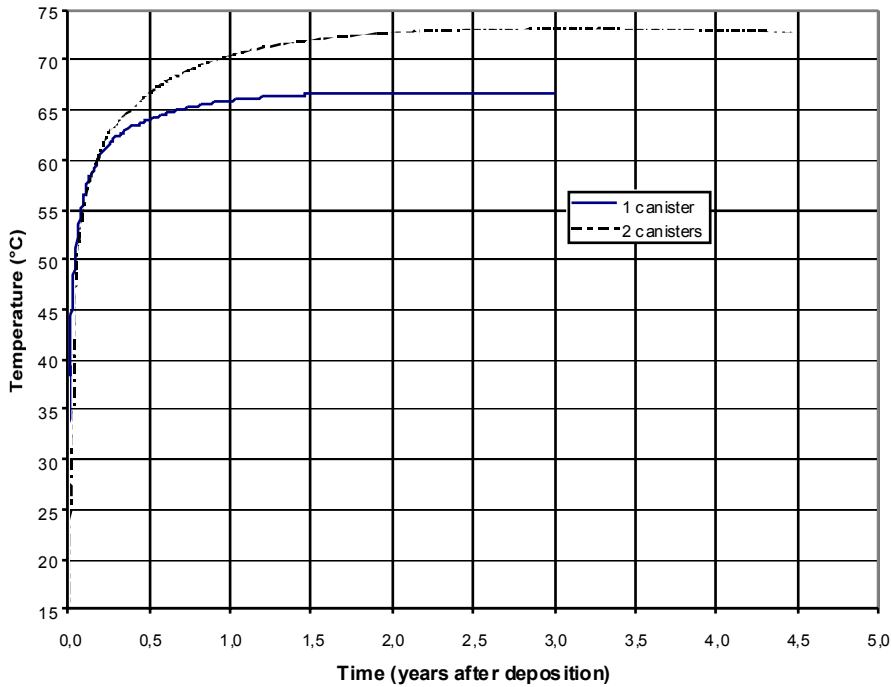
In the present stage of the preparation works for the test, only approximate predictions regarding the temperature distribution are required. Consequently it was deemed sufficient to use an existing FEM-model and slightly modify it with respect to the number of canisters. The model was originally made for the Prototype Repository Test. For more detailed model data and the source of thermal parameters, reference is made to the SKB Progress Report HRL-98-20.

The analysis took into account material properties and geometrical data that are specific for the Äspö site and for the test setup. Of special importance to the outcome of the calculations are the number of canisters involved (one or two) and the fact that the saturation process of the bentonite buffer will be boosted by artificial addition of water. The addition of water will have the effect that the thermal conductivity of the buffer will be maintained at a relatively high level and that a gap between canister and buffer is not likely to open up again after initially being closed by the swelling of the bentonite.

The existing model, comprising six canisters along the centre line of a tunnel, was modified by the exclusion of the innermost four or five canisters. The voids were given properties corresponding to rock. The tunnel space above the one or two remaining canisters was given the properties of air and the thermal exchange constant at the tunnel wall was set to 0.01 W per m² and °C (roughly corresponding to stationary air conditions). It was verified that the sensitivity with respect to the latter parameter is very low.

Geometrical and thermal parameters applied are listed in Table 1 below. The heat conductivity of the bentonite was given a relatively high value due to the artificial saturation mentioned above. It should be emphasised that the heat conductivity of the bentonite has a strong influence on the canister temperature. Should there in the future become evident that the assumed values can not be reached, the results of the calculations have to be reconsidered.

Test setup details, such as plugs, fixtures, pipes or electric wiring were not considered. The simplified model geometry is shown in the attached plots: Plot 1 (one canister) and Plot 2 (two canisters).



Figur 1 Maximum temperature on the canister surface as a function of time

Case 1, One canister

The maximum temperature on the canister surface will be approximately 67°C reached after approximately two years. After two months, the temperature will be 59°C and after one year 66°C.

The effect of applying a different initial heat output can be estimated by proportioning against the rise of the temperature from its initial state (14°C). In Case 1 the rise was 53°C (67 minus 14). This gives us, for instance, a maximum temperature of 90°C at an initial heat output of approximately 3 000 W.

Case 2, Two canisters

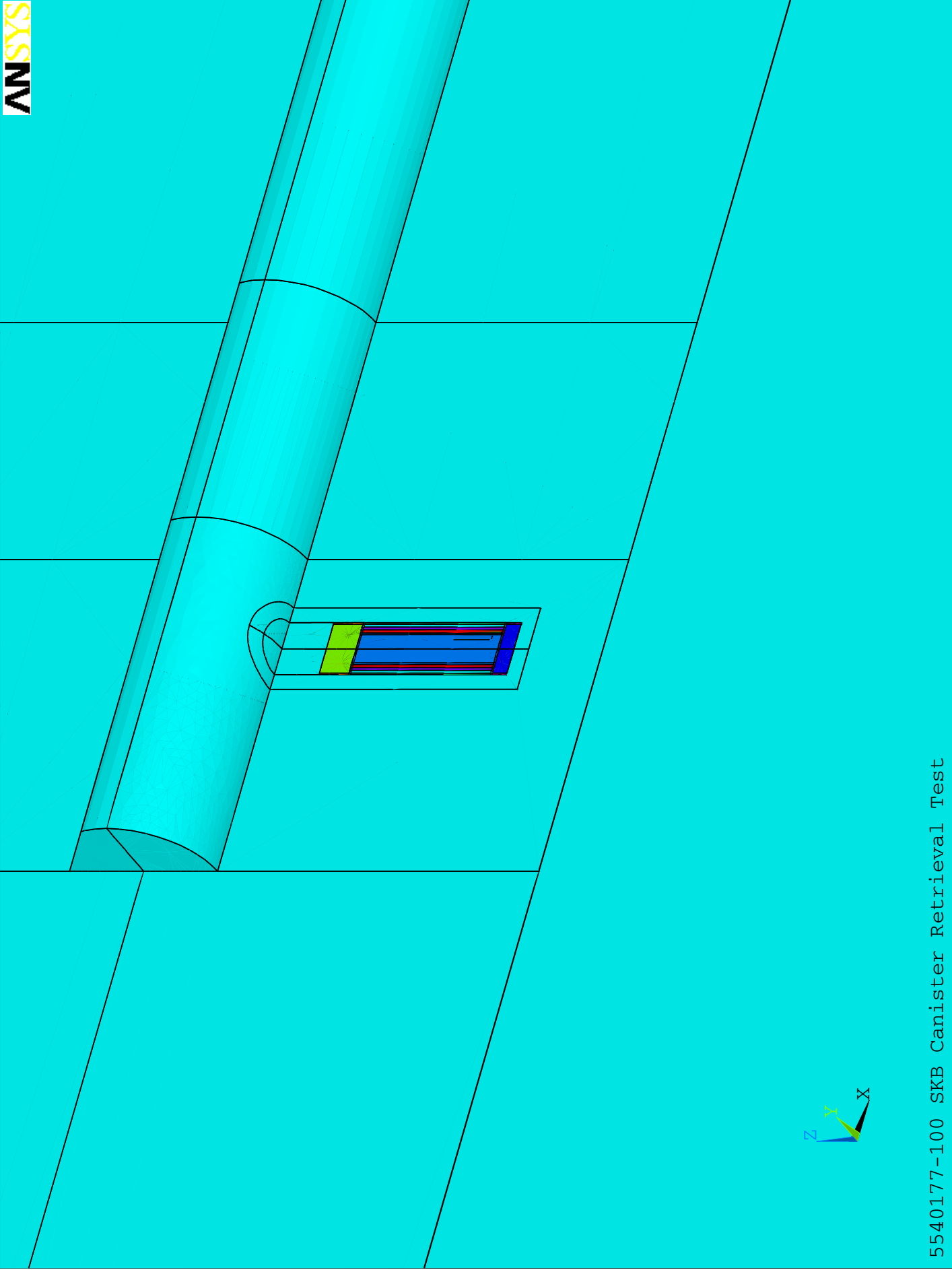
The maximum temperature on the canister surface will be approximately 73°C reached after approximately three years. After two months, the temperature will be 59°C and after one year 70°C.

In the same way as in Case 1 above, a maximum temperature of 90°C can be estimated. The required initial heat output will then be approximately 2 300 W per canister.

One page: Plot 1

Title: The geometrical model representation of the case with one canister

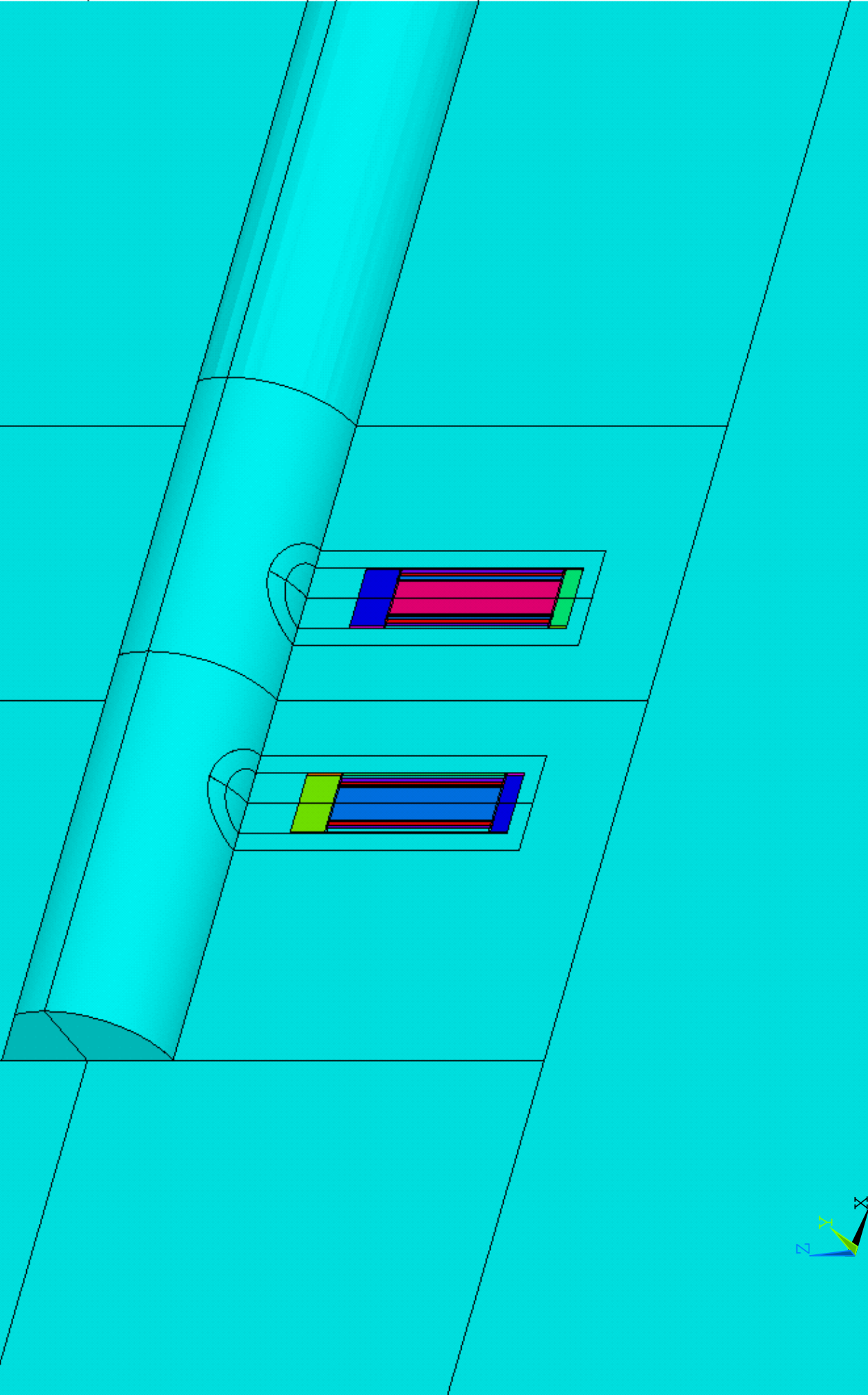
Postscript file: *Plot 1.eps*



One page: Plot 2

Bildtext: The geometrical model representation of the case with two canisters

Postscript file: *Plot 2.eps*

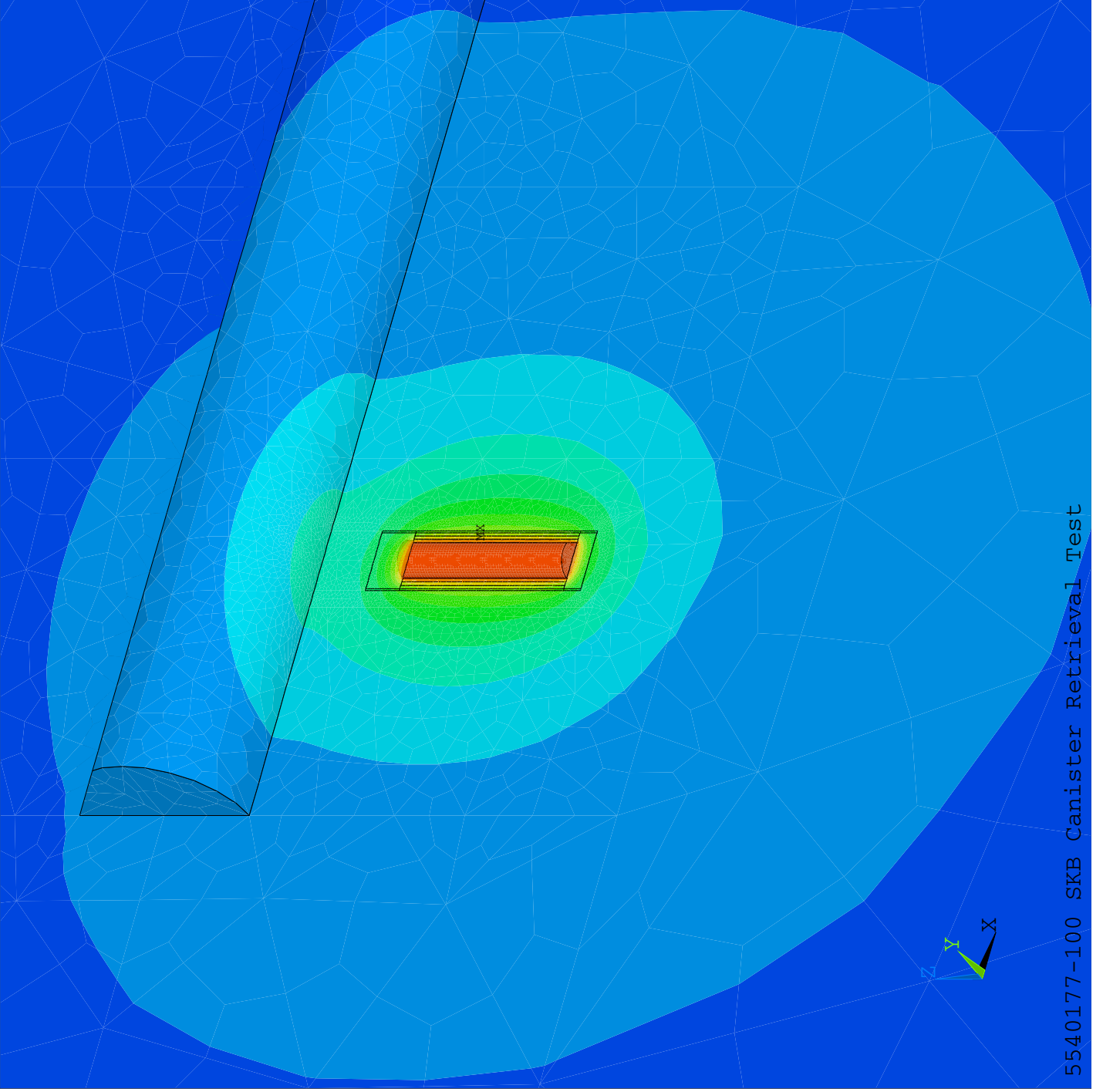
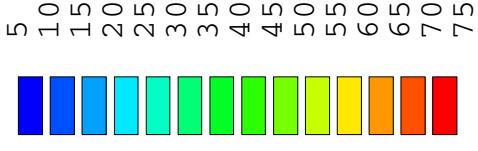


One page: Plot 3

Bildtext: Heat distribution around the canister in the case with one canister. Time equal to two years.

Postscript file: *Plot 3.eps*

ANSYS 5.6
MAY 4 2000
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PLOT NO. 1
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SMX =66.678



One page: Plot 4

Bildtext: Heat distribution around the canister in the case with two canisters. Time equal to three years.

Postscript file: *Plot 4.eps*

ANSYS 5.5.3
AUG 27 1999
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EFACET=2
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