INTEGRATION OF CAST RESULTS INTO SAFETY ASSESSMENT

PROBABILISTIC UNCERTAINTY/SENSITIVITY ANALYSIS OF C-14 RELEASE AND TRANSPORT

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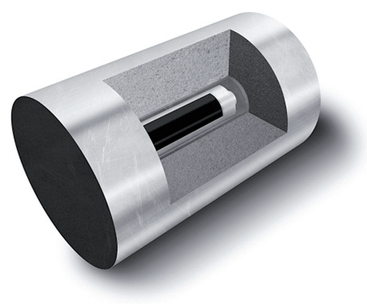
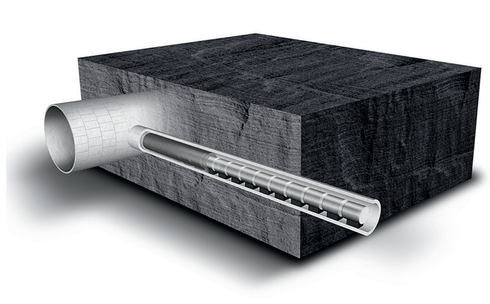
INTRODUCTION

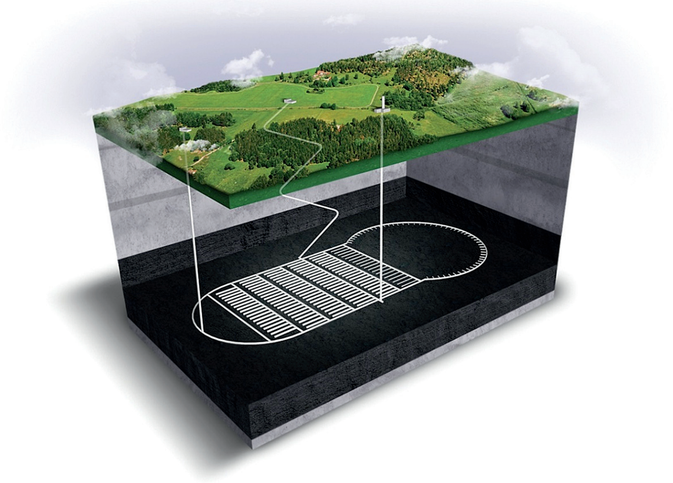
In 1984 the Netherlands has decided for a policy of long term interim surface storage of radioactive waste. This policy allows to develop a final disposal without undue hurry, and opens options that are less feasible for faster progressing countries, e.g. the long-term performance demonstration of safety-relevant elements of a disposal concept.

The Dutch research programme on the geological disposal of radioactive waste – OPERA (2011-2017) investigated the feasibility and the long-term safety of the OPERA disposal concept in Boom Clay host rock.

NRGS CONTRIBUTION TO CAST FOCUSED ON THE IMPACT OF C-14 IN THE OPERA DISPOSAL CONCEPT

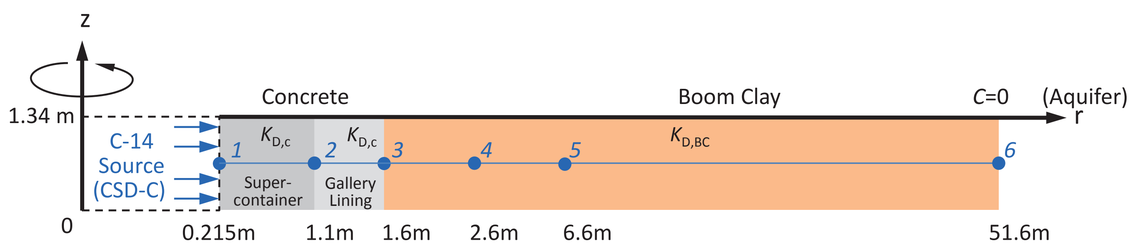






C-14 is present in Zircaloy hulls and end-pieces which are separated from spent fuel and compacted in standard waste containers: CSD-C Colis Standard de Déchets – Compactés. Upon their final disposal the CSD-C containers will be conditioned in concrete Supercontainers and emplaced in disposal galleries of the OPERA disposal concept in Boom Clay host rock.

Considering the OPERA disposal concept and related system parameters, a radial slice of the repository was modelled with ORCHESTRA, conceptualizing one CSD-C (C-14 source), surrounded by concrete (Supercontainer and gallery lining) and Boom Clay host rock. The initial C-14 inventory amounts 13.8 GBq.

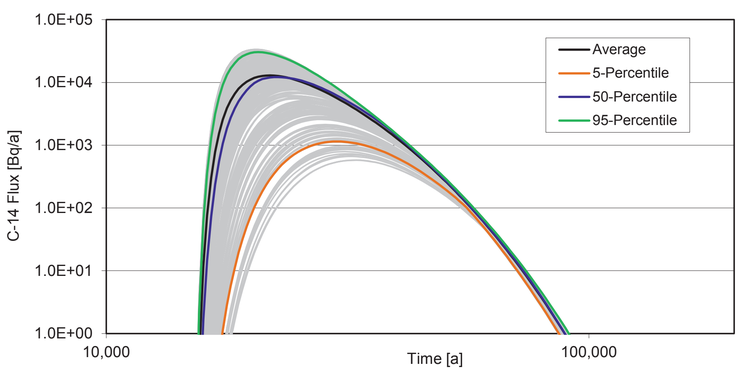


NRG performed a probabilistic uncertainty/sensitivity analysis for assessing the impact of C-14 on safety-related parameters of:

1) Instant Release Fraction (IRF) of C-14 from Zircaloy
2) Corrosion rate of Zircaloy
3) Adsorption coefficient $K_{D,c}$ of C-14 in concrete
4) Adsorption coefficient $K_{D,BC}$ of C-14 in Boom Clay

ORCHESTRA: Objects Representing CHEmical Speciation and TRAnsport - http://www.orchestra.meeussen.nl

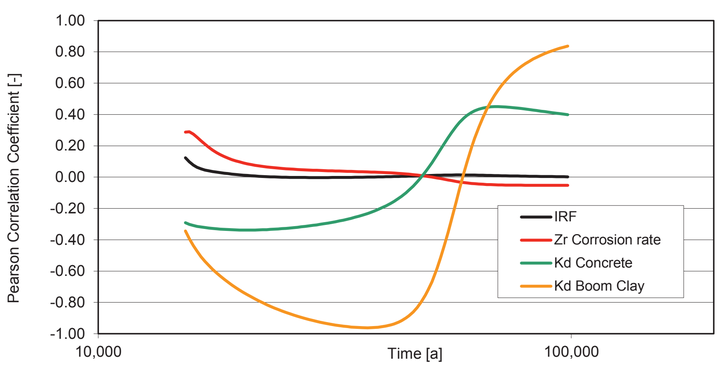
CAST Work Package 6 proposed ranges of parameter values for these quantities



C-14 flux at 5 m into the Boom Clay – Point 5

250 Simulations were performed, randomly varying the values of the four input parameters. Each combination of four parameters represents a different "state" of the disposal system

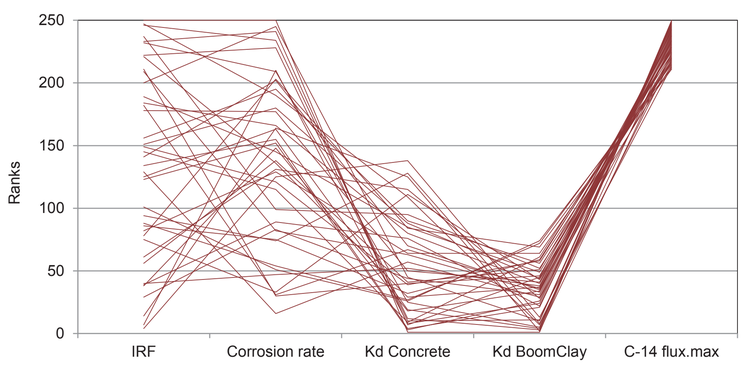
The plot shows the resulting variation of the C-14 flux, assuming a time of failure of the CSD-C container of 15'000 years



Pearson Correlation Coefficient for C-14 flux at 5 m into the Boom Clay – Point 5

The PCC indicates the strength of the linear relationship between input parameters and the calculated output

At 5 m into the Boom Clay the C-14 flux is strongly correlated with $K_{D,BC}$, moderately correlated with $K_{D,c}$, and uncorrelated with IRF and Zr corrosion rate



Cobweb plot for the maximum C-14 flux at 5 m into the Boom Clay – Point 5

Cobweb plots visualize qualitatively the dependency of output variables on multiple input variables

At 5 m into the Boom Clay the 40 largest values of the maximum C-14 flux are strongly correlated with the lower values of $K_{D,BC}$, and uncorrelated with IRF and Zr corrosion rate

MAIN FINDINGS OF THE UNCERTAINTY / SENSITIVITY ANALYSIS

- In all simulation cases and at all locations in the disposal system the calculated C-14 fluxes hardly depend on (prescribed) values of the IRF and the Zircaloy corrosion rate
- The K_D values of C-14 in concrete and Boom Clay do affect the C-14 fluxes throughout the disposal system. The influence of the K_D values of C-14 in Boom Clay increases further away from the C-14 source.
- Considering the half life of C-14 (5'700 years) compared to assumed CSD-C failure times and the C-14 transport rate through Boom Clay, an insignificant fraction of disposed C-14 may reach the outer Boom Clay boundary.
- The simulations performed in CAST are in line with the results of the OPERA safety assessment, indicating that the contribution of C-14 to various safety indicators (dose rate to biosphere, radiotoxicity fluxes / concentrations), is small compared to other radionuclides.
- The UA/SA analyses indicate that assessing the safety consequences of C-14 disposed in a deep geological repository in Boom Clay would benefit from enhancing the understanding of parameters and processes that determine the migration rate of C-14 in Boom Clay, and to a lesser extent in concrete.

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