Introduction

A crucial part of the long term strategy for the reprocessing of spent nuclear fuel is the return of vitrified waste products to the country from which they originated. These waste forms, known as HAW (Highly Active Waste) are now being returned by International Nuclear Services (INS) using a fleet of dedicated ships.

Figure 1: The Pacific Grebe is one of the PNTL fleet used by INS to return HAW to its country of origin

Supporting the Safety Case

MMI Engineering used CFD to calculate the temperature of a flask transporting HAW in a ship cargo hold. The purpose of the calculations were to demonstrate that specific regions of the flask did not exceed critical temperatures during transport and to determine the ventilation conditions at which it would. These calculation were used to support the transport safety case.

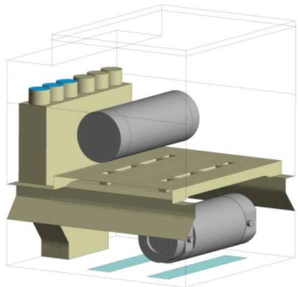

Figure 2: CFD model of one ship hold compartment storing 2 flasks

Verification & Validation

In order to verify the CFD model, a benchmark calculation of the package was created to determine the flask temperature under ambient conditions corresponding to those defined by IAEA Regulations.

These results were used to verify that the new model produced similar results to those provided in the original flask licensing documentation.

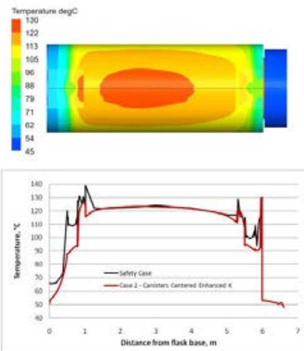

Figure 3: Benchmark model compared to the safety case temperature profile flasks

Conjugate Heat Transfer (CHT)

Once verified, a full CHT model of the ship ventilation hold was built, incorporating one complete flask, so that heat transfer was calculated from the canisters inside the package, through the solid walls of the flask and then by convection and radiation to the surrounding air. This allowed the distribution of heat flux to be calculated precisely around the outside of the flask.

Conclusions

The results demonstrated that the flask was maintained below the critical temperature during transport. From the results, a critical hold temperature could be defined, below which the average hold temperature should be maintained during transport.

Figure 4: Map of air temperature around the flasks in the ship hold showing regions of hottest air

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