



## Project FORTE - Nuclear Thermal Hydraulics R&D for BEIS

### Aerosol Dynamics in the Cover Gas Region of a LMFR

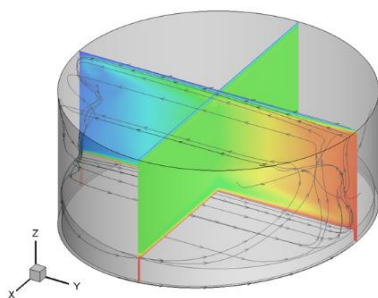
#### THE CHALLENGE

A design feature of Liquid Metal Fast Reactors (LMFRs) is the presence of an inert (e.g. argon) gas cover layer above the liquid metal pool to isolate it from the surroundings. The heat transfer from the free surface of the pool to the roof of the core is of significant interest to the understanding of the overall behaviour of the reactor and the deposit of metal aerosol particles on the components above the pool may be a safety concern. Additionally, the free surface is a major source of argon gas entrainment into the liquid metal, causing various adverse effects. Despite the importance of the aerosol dynamics and heat transfer in the cover gas region, there is little knowledge documented in the open literature. It is therefore imperative for the development of LMFR technologies to understand and reliably predict the complex multi-physics processes present in the cover gas region, including aerosol formation, growth and deposition on solid surfaces as well as heat and mass transfer of the argon gas and liquid metal vapour mixture.

#### OUR SOLUTION

Our activities include:

- ▶ Retrieval of the unique historic sodium experimental data produced in the Manchester Nuclear Research Laboratory in the 1990's, which provide a valuable validation database in support of the numerical simulation of the cover gas region dynamics.
- ▶ Development of a multi-physics cover gas dynamics engineering model based on conventional CFD which simulates aerosol dynamics, natural convection of mixture gases, mass transfer and thermal radiation.
- ▶ In the future, high fidelity numerical simulations are planned using a physics model based on Large Eddy Simulation (LES) to advance the understanding of the physics of the cover gas region.



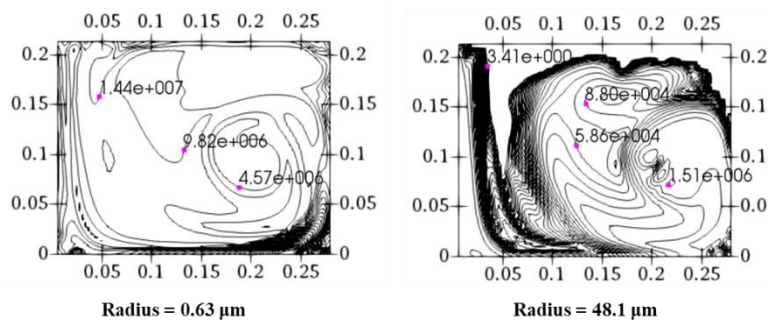
Temperature distribution and streamlines in test rig

#### OUR INNOVATION

The simulation of aerosol dynamics and radiation within the cover gas region is achieved by making use of a standard CFD solver and is hence transferrable to different CFD packages.

#### THE BENEFITS

- ▶ Improved predictive capability of the behaviour of the cover gas region in the upper sections of sodium and lead cooled fast reactors.
- ▶ Exploitation of currently under-used and potentially internationally valuable UK test data. Developing and maintaining the UK's leading position in this area, and creating opportunities for international collaborations.
- ▶ Improved methods for the modelling of large volumes with complex heat transfer mechanisms, including the influence of thermal radiation, applicable to a range of reactor technologies.



Aerosol droplet number density distributions

#### Contact

Richard Underhill, Frazer-Nash Consultancy, [r.underhill@fnc.co.uk](mailto:r.underhill@fnc.co.uk)  
Professor Shuisheng He, University of Sheffield, [s.he@sheffield.ac.uk](mailto:s.he@sheffield.ac.uk)  
Dr Xiaoxue Huang, University of Sheffield, [xiaoxue.huang@sheffield.ac.uk](mailto:xiaoxue.huang@sheffield.ac.uk)  
Other contributors: Professor Derek Jackson (UoS)



The University  
Of  
Sheffield.

