

TRANSPORT CONCEPT FOR THE BALDER PROJECT AT PSI

Copenhagen Atomics Molten Salt Experiment

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Synopsis

Copenhagen Atomics has entered a collaboration agreement with the Paul Scherrer Institute (PSI) to initiate the BALDER project for licensing, construction, and operation of molten salt experiments at the Villigen site in Switzerland. The Copenhagen Atomics Molten Salt Experiment (MSE) is the first planned experiment, to be conducted within a purpose-built Nuclear Test Facility (NT).

The MSE, a self-contained criticality experiment, uses low-enriched uranium fluoride molten fuel salt and heavy water as a moderator to generate heat through fission. As a short-term criticality experiment based on Molten Salt Reactor (MSR) technology, it is planned to generate 1 MW of thermal power for 30 days. The design incorporates inherent and passive safety features, including negative reactivity feedback for temperature, low-pressure operation, and significant margins to prevent fuel salt boiling. Comprehensive autonomous control and monitoring systems ensure robust management of key parameters to prevent incidents and accidents.

All MSE systems, structures, and components (SSCs) will be shipped from the Copenhagen Atomics facility in Denmark to the PSI Villigen site. These SSCs are not classified as dangerous goods and can therefore be transported conventionally. In contrast, the fuel and blanket salts will require appropriate packaging and arrangements in fresh fuel transport casks due to their radioactivity. These packages and arrangements require approvals from relevant authorities, as well as the transport of heavy water.

After the operational phase, the MSE will undergo a period of safe shutdown to allow for substantial radioactive decay prior to dismantling and subsequent transport. End-of-life transport of SSCs and materials will follow a similar process, but with additional measures to address increased radioactivity. Most notably, the irradiated fuel and blanket salts will require spent fuel transport casks. Once the MSE has been shut down, decontaminated, and released at PSI Villigen site, SSCs and materials are planned to be reused under regulatory control at the Copenhagen Atomics facility.

Copenhagen Atomics is engaging with suppliers to define technical solutions, including license extensions for the cask to contain a package of a storage tank with solid salt, transport routes, safety assessments, and final storage options. Appropriate packages have been identified based on the activity and inventory of the irradiated materials. All salt material handling and transport are performed with the salt solidified and near ambient temperature to facilitate operations. The solidified salt is contained in custom stainless steel tanks that are used to melt and transfer the content during the MSE operation. The selected transport cask requires re-licensing of the package, demonstrating that the package fulfills the requirements for packages containing fissile materials including package arrays under accident conditions for transport. Different approaches to fulfilling this requirement are being considered.

Beyond these preparations, compliance with international regulations for the transport of radioactive materials will require additional effort. Anticipated challenges include securing approvals for novel fuel salt compositions, demonstrating package performance under regulatory testing, and coordinating authorizations across several national authorities. Addressing these aspects will be critical to ensure safety and avoid delays in project implementation.

Copenhagen Atomics will initiate a series of feasibility studies with established European suppliers to address all aspects of MSE transport, supporting the BALDER project's licensing applications. These studies will be led by established suppliers within the nuclear transport domain in ongoing collaboration.

At the appropriate stage, permits will be sought from the Swiss Federal Office of Energy, the Danish Health Authority, and the competent authorities of the relevant transit states. These applications will be supported by the necessary safety-related assessments.

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