EXECUTIVE SUMMARY

This deliverable summarizes the work carried out in SCARLET's WP4 to prepare the cable components for the type test at SINTEF followed by the long-term test at Absolut System. It presents the selection of MgB_2 wires, the design and validation of the cable conductor, and the definition of voltage insulation for a 25 kV cable class. After a description of the cryogenic envelope, the designs of the terminations and joint are presented, followed by a detailed description of the cooling system. These final designs of the different elements will be completed with a realization report in the 1st semester of 2026.

Following an extensive characterization program of electrical and mechanical properties, a 36-filament MgB_2 wire with an overall diameter of 1.33 mm was selected for the project. A cable conductor operating at 20 kA is manufactured with 36 such wires arranged in a single layer. This simple wire arrangement was preferred over two other designs investigated, as it has reduced damage risks and manufacturing costs. The 36 wires are wound around a flexible copper core that acts as a thermal stabilizer and allows for very high fault currents without degradation. The resulting outer diameter of the cable conductor is 17.8 mm.

The voltage insulation has a thickness of 3.75 mm and consists of 28 lapped PPLP tapes that will be impregnated with liquid hydrogen (LH_2). An overall diameter of 27 mm is proposed for the insulated cable including all protection layers. Special attention was given to ensuring a reduced risk of voltage breakdown during the foreseen tests. After finalizing the insulated cable, a 39/66 mm flexible cryogenic envelope designed for LH_2 was selected for the project. This cryogenic envelope is compatible with the operational specifications of the two test loops.

Additionally, the final design of the terminations is presented, which integrates low-loss hybrid current leads, low-resistance connectors, and voltage management devices optimized to reduce the electric field in the outer parts. The proposed concept makes it easy to adapt the termination according to the grid requirements.

A design for the cable joint is also proposed, including sketches and assembly sequences. The design integrates a low-resistance joint for current management and voltage management devices based on the same principle as in the termination.

Finally, four designs of the cooling machine and liquefier for LH_2 were studied in the past 3 years and are detailed in the deliverable. The selected system is a Remote Helium Cooling Loop (RHCL) operated in a closed loop. This system facilitates LH_2 supply, minimizes LH_2 consumption, and simplifies the safety protocols on the test sites at SINTEF and Absolut System. However, the proposed system still needs to be confirmed by the HAZID / HAZOP analysis that will start in the 4th quarter of 2025.

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