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C2Or1A-01: Design status of the ESS cryogenic moderator system

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The European Spallation Source ERIC (ESS) is going to provide long-pulsed cold and thermal neutron fluxes at very high brightness. They are produced by a linear proton accelerator with an average beam power of 5 MW, which is directed onto a tungsten target at a pulsed repetition rate of 14 Hz.
Two cryogenic hydrogen moderators, to which subcooled liquid hydrogen is supplied at 17 K and 11 bar, are designed to cool high-energy neutrons down to cold neutrons. At 5 MW proton beam power, an estimated nuclear heating of 6.7 kW is generated in the moderators. The Cryogenic Moderator System (CMS) has been designed to satisfy the ESS goals of providing high quality cold neutrons for science. The subcooled liquid hydrogen is circulated by two pumps arranged in series with a mass flow rate of 1 kg/s, to maintain the average temperature rise over each moderator below 3 K. The total heat load of 12.6 kW, including a static heat load of 5.9 kW on top of the nuclear heating of 6.7 kW, is removed through a helium-hydrogen plate fin heat exchanger by a helium refrigerator with a cooling capacity of 30.2 kW at 15 K, which is called the Target Moderator Cryoplant (TMCP). The ESS moderator vessel is optimized for maximum cold neutron brightness and pure parahydrogen, requiring a para concentration of > 99.5 %. To achieve this, an ortho-para hydrogen convertor is included into the loop and an online para-hydrogen measurement system is also integrated. The pressure fluctuation of the CMS caused by the abrupt nuclear heating will be mitigated using a pressure control buffer with a volume of 65 l. The fabrication, installation and commissioning will be completed by October 2021 to accomplish beam-on-target in 2022.

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