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C1Po1E-05: Presentation of the commissioning and testing of the hydrogen cryostat of the cryogenic moderator system at the ZEA-1 (Forschungszentrum Jülich) for the European Spallation Source ESS

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The European Spallation Source (ESS) is a multi-disciplinary research facility based on the world's most powerful neutron source. One key component of the target station is the cryogenic moderator system (CMS) which is designed and manufactured by the ZEA-1 of the Forschungszentrum Jülich. The cryostat of the CMS supplies liquid hydrogen in a closed loop at the temperature of around 18.5K and a pressure of 10 bar.abs to the moderator vessels, where neutrons interact with the hydrogen and get slowed down. The neutron moderation process can produce an average of 17.3 kW of heat, and considering the additional 5.9 kW of heat input from the pumps, the total heat that must be removed by a continuous stream of liquid hydrogen adds up to 23.1 kW. The flow is generated by two redundant hydrogens pumps which can circulate one kilogram of liquid hydrogen per second. At ESS the required cooling capacity is provided by helium refrigeration plant with ca. 30.2 kW cooling power at 15 K (Target Moderator Cryoplant TMCP) which interfaces to the Cryogenic Moderator System via two heat exchangers inside the cryostat. A major challenge during the factory acceptance test (FAT) in Jülich was the lack of a refrigeration system. In order to still be able to carry out the CMS cryostat cold test with liquid nitrogen instead of liquid hydrogen, gaseous nitrogen with a controlled temperature between 300K and 100 K is fed to the He side of the cryostat. A mixing plant was specially designed and built for this purpose, which mixes liquid nitrogen and gaseous nitrogen at room temperature in such a way that a gas flow with a PID-controlled temperature is produced. Above all, keeping the temperature stable at different pump speeds was a major but necessary challenge, because the temperature gradient across the heat exchanger between the secondary and primary side must not exceed a maximum of 40K. Finally, after the successfully completed FAT, the cryogenic moderator system was delivered to Sweden and integrated into the target station of the ESS.

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