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Development of ultra-high voltage insulation technology for the power supply components in neutral beam system on ITER

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Dc ultra-high voltage insulation technologies in oil, gas and vacuum have been newly developed to fabricate dc 1MV power supply components in the neutral beam (NB) system on ITER. In the ITER NB system, a 1 MV power supply with output pulse duration of 3600 s is required, which is twice higher in the voltage and two orders longer in the pulse than those of the existing NB system in the world. To fulfill the requirements, R&D of the insulation technologies has carried out for a dc 1MV generator (step-up transformer and rectifier), a 1 MV transmission line and a 1 MV high voltage (HV) bushing. One of the issues for the dc generator is a long pulse dc high voltage insulation on the pressboard immersed in oil. Electric field on the pressboard is increased with time, and this could generate flashover. To lower the electric field strength in the pressboard, a new design with considering the dc long pulse effect has been developed. A thickness of the pressboard has optimized to reduce the electric field concentration. Also barrier configuration for the pressboard at the connection points of the insulators has been adopted. For the 1 MV transmission line, an issue is to make a compact transmission line about 2 m in diameter since it penetrates tokamak building. To make the compact transmission line, all feeders at different voltages from 0.2 MV to 1 MV are designed within a single pressure vessel filled with SF6 gas. The layout of the feeders is designed with 3D electrical analysis to reduce electric field to an allowable level. For a HV bushing, vacuum insulation in the multistage gaps has been found to be characterized by a total cathode area. On the basis of the result, a configuration of the five layered screens in the HV bushing was determined. Based on these insulation technologies, manufacturing three of five dc generators, the transmission line and the HV bushing has been completed. These components have showed the sufficient voltage holding to be required by ITER. They have been delivered to the site of NB Test Facility and installation has started since Dec, 2015 on schedule.

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Author: Mr UMEDA, Naotaka (Japan Atomic Energy Agency)

Co-authors: Dr KOJIMA, Atsushi (Japan Atomic Energy Agency); Mr YAMANAKA, Haruhiko (Japan Atomic Energy Agency); Dr TOBARI, Hiroyuki (Japan Atomic Energy Agency); Dr WATANABE, Kazuhiro (Japan Atomic Energy Agency); Dr HANADA, Masaya (Japan Atomic Energy Agency); Mr DAIRAKU, Masayuki (Japan Atomic Energy Agency); Dr KASHIWAGI, Mieko (Japan Atomic Energy Agency); Mr SHIBATA, Naoki (Japan Atomic Energy Agency); Mr MAEJIMA, Tetuya (Japan Atomic Energy Agency)

Presenter: Mr UMEDA, Naotaka (Japan Atomic Energy Agency)

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