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Manufacture of the ITER Central Solenoid components

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The ITER Central Solenoid (CS) components are now being manufactured. This superconducting magnet will provide the magnetic flux swing required to induce up to 15 MA as plasma current. It includes six identical coils, called modules, stacked on top of each other to form a solenoid, enclosed inside a structure that has nine subsets, to provide vertical pre-compression and mechanical support. Using a 45 kA Nb₃Sn superconducting conductor requires a long heat treatment at 650 °C to form the Nb₃Sn alloy. The conductor lengths wound into multiple pancakes are connected with each other before heat treatment and electrically insulated afterwards. High mechanical stresses in materials and high voltages call for the use of high mechanical resistance structural materials and high dielectric strength insulating materials. The pulsed operation imposes materials with high fatigue resistance at cryogenic temperatures. The unique requirements derived from the operating conditions impose specific materials, manufacturing routes and dedicated working stations for the different steps in the manufacture of the components to achieve the required quality. Whereas for the structure, large existing manufacturing tools are required, the modules required construction of a dedicated manufacturing line. Qualification of the different manufacturing procedures is of prime importance to ensure that the magnet will meet the requirements during operation. A comprehensive qualification programme is being performed at the manufacturers before applying procedures for the production of the CS components. The paper describes the main characteristics of the CS components, their manufacturing routes and the different elements of the qualification programme. The overall plan for the manufacture is reported, including the identified risks and the mitigation items. The status of the first components manufactured is shown as well as the planned delivery schedule to the ITER site.

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