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Review of the Factory Acceptance Tests and Cold Tests of the W7-X Superconducting Magnets (P1-E-36)

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The W7-X magnet system consists of 50 non-planar coils of five different types and 20 planar coils of two different types. Factory acceptance tests of the non-planar coils are carried out at the manufacturer site of Babcock-Noell, Germany, and for the planar coils at Tesla Engineering, UK. They consist of electrical insulation checks, mass flow measurements and leak tests. In the test facility of CEA Saclay, France, each coil is cooled down to ~6 K and operated at nominal current. At least one coil of each type is quenched by increasing the inlet temperature. The characteristic parameters of the quench tests (temperature, pressure, speed of normal-conducting zone, etc.) will be presented. Coils of the same type show a uniform behavior. The occurrences of leaks during cool-down on planar coils revealed quality problems with aluminum welds and stress corrosion of stainless steel tubes at the soldered connections with copper heat sinks. AC tests (impulse and impedance tests) were applied to detect short circuits during the fabrication of the winding packs. High voltage DC tests under vacuum and low gas pressure (Paschen-minimum conditions) revealed electrical insulation defects, which had not been found using standard high-voltage tests. These were mainly due to voids and cavities present in the winding pack after vacuum impregnation, insufficient glass-epoxy wrapped insulation and inappropriate design of the Kapton insulated quench detection cables. The mass flow measurements of the superconductor showed that the deviation between individual double layers of the coils is within acceptable limits. Two winding packs were given up by the supplier because of a superconductor blockage with resin and a short circuited winding, respectively. All other quality issues could be resolved by repair or changes in the components. The coil instrumentation with temperature sensors seems to be adequate. The strain gauges need improvements in temperature compensation and gluing technique. The displacement transducers used temporarily during the cold tests showed reproducible results but a relatively high failure rate. In conclusion, the scope of the tests, augmented in due course by new elements as Paschen tests and dedicated AC tests, allows a very strict quality control. This experience is highly beneficial for the construction of similar components for future superconducting fusion experiments.