Progress in Technology at JET

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JET has contributed strongly to the development of fusion technology over many years, and technical development continues in parallel with the operation of the Tokamak. These programmes are supported by the associated laboratories around Europe and elsewhere, including US support for a number of activities. A major shutdown extended through much of 2001 and the machine is currently shutdown for 11 months for the installation of many further enhancements.

JET operations have included both the study of ITER-like scenarios and of technical objectives in support of ITER, notably mitigation of ELMs and disruptions, investigation of tritium retention, development of burning plasma diagnostics, real time control of plasma parameters, and control of extreme plasma shapes to centimetre tolerance. Safe operation of high force ITER scenarios with disruptions up to 500 tonnes vertical force, and operation at 4 Tesla toroidal field, have been demonstrated in recent campaigns with low consumption of the fatigue life of the machine, less than 10% over the lifetime of JET. JET heating systems are being upgraded, with additional new NB power supplies and uprated ion sources having recently been brought into full operation, and an ITER-like ICRF antenna under manufacture. Coupling of LHCD over large distances to the separatrix has been demonstrated. Other enhancements have included installation of four external error field correction coils, and a quartz microbalance mounted in the divertor to monitor carbon film deposition.

During the present shutdown, around 20 new or improved systems are planned to be installed. These are mainly diagnostics, including various tritium retention diagnostics, magnetic and halo current probes, neutron and alpha particle detectors, and TAE antennae. Modifications to the divertor will enable increased triangularity ITER-like scenarios. The bulk of the in-vessel installation will be carried out using the extensive JET remote handling equipment to minimise the cumulative dose. Important up-grades of the RH tools have been implemented, notably the provision of force feedback to enable the remote installation of loads up to 260kg, and the extensive use of virtual reality methods for preparing and implementing the work.

Analysis of tritiated samples from the tritium campaign in 1997, including highly tritiated flakes from near the divertor, continues as does the development of methods for detritiation of hard and soft waste and of tritiated water. The unique JET capability to operate with tritium (and beryllium) has been maintained; a further trace tritium campaign was completed in autumn 2003 during which 5 grams of tritium were supplied to the machine, mainly to one of the NB injectors. The experience in the use of tritium over an extended period, and in implementing in-vessel enhancements on an active and tritiated machine, is a valuable input to the preparations for tritium burning Tokamaks. Notwithstanding the on-going use of tritium, it remains practical to implement important enhancements of JET to fully exploit its capabilities in the preparations for ITER operation.