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Plasma disruption management in ITER

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Successful operation of ITER and a timely achievement of its objectives require an accurate disruption management as the significant disruption loads can have severe impact on the availability of the device and the lifetime of the in-vessel components. Target values for the disruption rate and the mitigation success rate will have to be defined for each of the different operational phases. This paper will present a disruption management plan including such target values from the start of ITER operation at low current in H/He until the end of the first DT campaign. The loads that determine the target disruption and mitigation rates for the different phases of ITER operation are surface heat fluxes during the thermal quench, electro-magnetic loads and halo driven thermal loads during the current quench, and runaway electron impact. To quantify the impact of these events, disruption budget consumption (DBC) will be associated with them for the individual operational phases with different plasma currents (magnetic energy) and thermal energies. The DBC is based on the allowable number of mitigated and unmitigated load cycles, which is limited by a) the fatigue lifetime of components, b) the impact of electro-magnetic loads on mechanical structures, c) the erosion of plasma facing components (PFCs) by heat fluxes from the thermal quench, from the radiation flash during mitigation, from the halo during vertical displacements and from runaway electrons, and d) the achievable mitigation success rate. The DBC used for the disruption plan presented here is based on present knowledge on the impact of loads and on the effectiveness of their mitigation. In particular, it is found that very high mitigation rates are required for current quenches during high current operation to avoid excessive heat loads and halo current amplitudes. The present ITER strategy with respect to runaways is two-fold: a) avoidance of runaway generation by an appropriate mitigation scheme resulting in very low runaway generation rates and b) mitigation by runaway energy dissipation through collisions with high-Z impurities before its deposition on PFCs. The paper will assess the ability of the present design of the ITER disruption mitigation system to provide the required efficiency and reliability.

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