ECCD requirements for the NTM suppression

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A heuristic criterion for the full NTM suppression was formulated as $\eta_{NTM} \equiv j_{CD,max}/j_{BS} \geq 1.2$. In this work we subject this criterion to a theoretical analysis on the basis of the generalized Rutherford equation. An analytical expression for η_{NTM} is obtained, accounting for the effects of CW and modulated j_{CD} inside the island, the effect of j_{CD} outside the island on the quasi-linear mode stability and the effect of the localized heating inside the island. A numerical analysis of η_{NTM} requirement is performed over the parameter space defined by the saturated island size, $\bar{w}_{sat}$, and on the power deposition width, $\bar{w}_{dep}$, both normalized to the marginal island size w_{marg}. Taking into account only the effect of j_{CD} inside the island, a new criterion for full NTM suppression is obtained in the form of a joint criterion on the maximum value for $\bar{w}_{dep}$ and the minimum for $\bar{w}_{dep}\eta_{NTM}$. For a given value of $\bar{w}_{dep}\eta_{NTM}$ the requirement on the maximum $\bar{w}_{dep}$ can be considerably relaxed when the favourable effects from either the equilibrium profile modifications or a power modulation are accounted for. The inclusion of the effect from the localized heating inside the island is found to provide a possible reduction of the required value of $\bar{w}_{dep}\eta_{NTM}$. The power requirements for the preemptive ECCD are also presented. Optimization of the ITER ECRH Upper Port Launcher design is performed minimizing the required power for full NTM suppression by a moderate change in the toroidal injection angle.