System Operators in many countries are required to maintain contingency plans for critical N-2 contingencies. Huge number of possible N-2 contingencies makes their direct assessment computationally prohibitive forcing the operators to rely on engineering judgement or uncontrollable heuristics. We present a novel algorithm for identification of critical N-2 contingencies that result in line overloads in post-contingency equilibrium. High computational efficiency of the algorithm is achieved via effective certification of safety for the majority of contingencies. Unlike many common heuristics, the algorithm is guaranteed to have zero missing rate in DC approximation models. Performance of the algorithm is validated by simulation of several IEEE case scenarios which demonstrate 30 - 1000 fold acceleration of contingency selection process in comparison with naïve brute-force approach. Various possible applications of the approach in the problems of security assessment, transmission topology control and planning are discussed in the end of the manuscript.