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Fundamental points for efficient and successful risk based planning

Risk-based planning with reliability analysis is a fastidious task. Therefore some fundamental points, which are listed in the following, should be considered for an efficient and successful risk based power system planning.

1) The reliability analysis tool should be based on the Markov method, because Monte Carlo simulations lead to very long computation times.
2) All network structures (AC, DC, radial and meshed networks, all voltage levels) should be handled in one project. This way the influences of different network parts on each other is exactly modeled.
3) Because substations have a large influence on the reliability results, it should be possible to define substations freely (without any restrictions on pre-defined substation types and switch bays).
4) It should be easy to add to the already existing load flow network model the additional network information, needed for reliability studies, (e.g. disconnectors, circuit breakers, switching times, etc.).
5) The program should support different system state analysis methods (AC load flow, DC load flow, connection check). The AC load flow should be used for calculation of the final results. The DC (linear) load flow and the connection check methods are very useful in the beginning of a reliability study, in order to get a first quick overview.
6) For distribution systems a detailed simulation of the fault finding procedure can be useful. The following features should be included:
    - Local and remote indicated short circuit indicators
    - Accuracy of relays with automatic fault locating
    - Detailed time model (station access time, travel times, durations for switchings, measurements and emergency power supply)
7) The following results should be calculated:
    - load point indices: interruption frequency, interruption mean duration, unavailability, interrupted power, EENS, interruption cost
    - System indices (SAIDI, SAIFI, CAIDI, ASAI, …)
8) A risk based module is not just a fixed algorithm like a Newton-Raphson for load flow calculation. A lot of know how which is integrated in such a module (e.g. restoration algorithm) comes from the previous use of the module (it is like an expert system). Therefore it is important to know how many studies have been successfully performed (references and customer satisfaction should be checked).
9) Beside the default results evaluation the program should offer the possibility to perform user defined results evaluations.

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10) Modules should be available which may directly use results of the reliability analysis (e.g. importance of the components –> for how many costs is a specific component responsible for the energy cost not served) for optimal reinvestment and reinforcement strategies and optimal maintenance planning strategies (RCM).

11) The Failure Modes and Effects Analysis (FMEA) is a key point of the reliability calculation, because it calculates the interruption times for each load and each generator for every failure or failure combination. Sophisticated methods are indispensable. The following features should be included:
    - Protection operation (including special protection concepts, e.g. differential protection)
    - Fault isolation
    - Power restoration
    - Load shedding / load transfer
    - Maintenance cut-off
    - Generation re-dispatch
    - Backup equipment / cold reserve
    - Different network state analysis methods (connection check, DC load flow, AC load flow)
    - All results of the FMEA should be visible for the user.

12) Different failure modes of the same component may have different effects on the system. Therefore various failure modes should be handled (e.g. permanent fault, manual disconnection, ground fault and multiple ground faults in isolated or compensated systems, protection overfunction, protection failure, spontaneous unwanted protection operation, failures during scheduled outages, common mode failures, multiple failures).

13) If no own component reliability data is available (failure rates, repair times, etc.), an extensive component reliability data library should be available.

Applications which should imperatively use risk based analysis

- Mid- and long term network planning
- Optimal reinvestment strategies
- Optimal reinforcement strategies
- Optimal substation configurations
- Penalty payments for different contracts
- Scenario comparisons for automation in distribution networks
- Strategies for asset allocations
- Optimal maintenance scheduling, reliability centered maintenance (RCM)
- Connection of wind parks
- Calculation of SAID and SAIFI for the system regulator