OUT-OF-STEP PROTECTION STUDY FOR THE LARGE COMPLEX EHV INTERCONNECTED SYSTEM

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EHV interconnected system operation is essential to maintain the grid reliability for larger power systems. The interconnection between different operating regions may consist of long transmission lines which results in a weak interconnection. The power transfer via such long lines will result in a relatively large voltage phase difference. The synchronizing effect due to a disturbance on one part of the interconnected system will thus be compromised. This could lead to an 'Out-of-step' condition where the two areas lose synchronism. It is essential to identify an impending out-of-step condition and take measures to 'split' the two systems to avoid undesirable system conditions.

An out-of-step situation can damage critical system elements as well as lead to wide area system stability problems. This can also impair the ability to restore power quickly in the event of a system restart from a black start state. Out-of-Step situations occur when the voltage drops to a point where it is not possible to maintain synchronism between the two subsystems. This is normally caused by a large power swing which can be caused by a sever disturbance, for example a three-phase fault at peak loading or a very large generation loss.

Out-of-step relays must be provided to identify the onset of such conditions and issue trip signals to isolate the power system into independent areas. The location for such relays and their settings should be determined through careful system studies. An Out-of-Step protection study is a very sensitive study in that there are risks in deploying Out-of-Step protection following a disturbance where an Out-of-Step situation is not likely to develop. It is essential that the normal system operation points are outside the Out-of-Step protection relay blinders so as to not limit the power transfer capability of the transmission lines.

The out-of-step relay settings, once determined and implemented should be periodically reviewed in view of system expansions over time as addition of new equipment, new load levels and characteristics, system inertia can all impact the out-of-step situations. In addition to the out-of-step relay settings, the out-of-step blocking features in the rest of the system should also be reviewed.

Large interconnected power systems consist of complex load characteristics (Example Air-conditioning loads), long and heavily loaded lines, flexible AC transmission system devices (FACTS-Example SVC) and series compensated lines. Tie-lines' may interconnect strong system to weaker systems. All the above should be adequately represented and considered during the out-of-step relay setting study.

Generally, an Out-of-Step study is based on a Transient Stability assessment (Angular stability study). In the grid system studied, the load during the summer period is dominated by induction motor characteristics. This is a special situation and the load modeling for the study had to be selected accordingly. A number of different credible system configurations, generation scenarios, load conditions as well as different power transfer levels on the tie-lines were investigated.

If the normal operating conditions and typical system contingencies do not result in out-of-step conditions, then it is necessary to identify 'stressed system conditions' and extreme contingencies that would result in out-of-step situations. Such conditions will be used to determine

- The 'Electrical Centre' and hence the most appropriate location to implement the relays. In addition, maintain the power balance in different areas once they are separated was also a consideration.
- Appropriate settings for the relays

Once the settings are determined, further simulations are carried out to verify the acceptable operation of the relays with the proposed settings.

This paper presents the important considerations, outline of study methodology and key findings of an out-of-step study for a tie-line in a major grid system.

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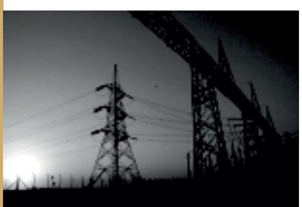

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