



CIGRE Study Committee A3

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP (JWG)

WG* N° A3/B5/C4.37	Name of Convenor : Anton Janssen (the Netherlands) E-mail address: anton.janssen@alliander.com
Technical Issues # (2): 6, 10	Strategic Directions # (3): 1, 2
The WG applies to distribution networks (4): No	
Title of the Group: System conditions for and probability of Out-of-Phase	
Scope, deliverables and proposed time schedule of the Group :	
Background :	
<p>With respect to power plants, Out-of-Phase or Out-of-Step conditions may occur during many different conditions, such as during system disturbances, nearby transmission faults or other problems within the power plant.</p> <p>Further, Out-of-Phase may occur in the transmission system, leading to system separation, due to system instabilities, during large system disturbances, or during system restoration. Mal-operation of protection and automatic control systems may also lead to system separation. Compared to meshed networks, the probability of Out-of-Phase conditions is larger with radial network topologies, which are typically used for long distance bulk power transmission. But, even in meshed networks, the probability increases, as systems are operated closer to the limits of the transmission capability and become more complicated by the introduction of dispersed generation, HVDC, phase shifters, mixed cable-overhead lines, more complex protection and control systems. Nevertheless there is hardly any information available about Out-of-Phase conditions under service conditions: its occurrence, its causes, its probability, the actual conditions, the out-of-phase angles, currents and voltages.</p> <p>For power plants and generators, protection experts design out-of-step protection. Besides generator bays and crucial coupling bays are equipped with synchro-check equipment (often in addition to synchronization equipment). Line and transformer protection is provided with out-of-phase blocking functions. In many countries network wide protection systems are in operation to detect, predict and hopefully prevent system separation. Is it because of all these systems that out-of-phase conditions have become less serious and/or the probability has been reduced dramatically? The questions, however, remain “are the conditions still very severe?” and “are Out-of-Phase conditions hidden among the large amount of information available under system collapse and restoration circumstances?”.</p> <p>In terms of primary equipment, circuit-breakers have to offer the last line of the defence, but the specifications for the Out-of-Phase switching duty have been established a long time ago and the background information has been lost. Still, the transient recovery voltage requirements put forward the highest peak values, albeit at 25% of the rated short-circuit current. Meanwhile the present peak values are used as a reference for other fault clearing circumstances, such as long line fault switching and clearing faults on series compensated lines. To the international IEEE Standard for generator circuit-breakers¹, the Out-of-Phase duty is limited to angles as large as 90°, although many users require type testing with an angle as large as 180°.</p>	

This joint WG will investigate service experience with out-of-phase and out-of-step conditions, and will describe the circumstances under which out-of-phase occurs, develop models and methods to estimate the out-of-phase angles, out-of-phase currents, out-of-phase voltages, and its development over time.

Together with protection experts and circuit-breaker experts, the system behavior will be investigated and compared with the background information as applied by these experts.

Those conditions that may be regarded as risky will be presented and recommendations for detection, prediction, prevention, protection and switching requirements will be given.

Scope :

1. Investigation of service experience with out-of-phase conditions and probable circumstances, leading to out-of-phase conditions. Investigation of the relevant system parameters and how these develop during the disturbance. Investigation of the influence of the fore-mentioned protection functions and protection systems.

2. Define the probability and risk of out-of-phase conditions and the consequential need for primary and secondary equipment to cope with it.

3. Addressing requirements for protection and automatic control equipment as well as HV equipment to prevent out-of-phase or function properly under out-of-phase conditions.

4. The WG will actively cooperate with related SCs (e.g. A1, A3, B5 and C4) and IEC TCs, and build on the work of, for instance, WG B5.14, A3.13, and A3.22/28. Presumably, the information on out-of-phase conditions is scarce and a survey among utilities and TSO's may be required to collect relevant cases.

Deliverables : Technical brochure with summary in Electra (or Report to be published in Electra). Tutorial on Out-of-Phase Conditions.

Time Schedule : start : Autumn 2014

Final report : Late 2017

Comments from Chairmen of SCs concerned :

Approval by Technical Committee Chairman :

Date : 09/05/2014



- (1) Joint Working Group (JWG) - (2) See attached table 1 – (3) See attached table 2
(4) Delete as appropriate

Table 1: Technical Issues of the TC project “Network of the Future” (cf. Electra 256 June 2011)

1	Active Distribution Networks resulting in bidirectional flows within distribution level and to the upstream network.
2	The application of advanced metering and resulting massive need for exchange of information.
3	The growth in the application of HVDC and power electronics at all voltage levels and its impact on power quality, system control, and system security, and standardisation.
4	The need for the development and massive installation of energy storage systems, and the impact this can have on the power system development and operation.
5	New concepts for system operation and control to take account of active customer interactions and different generation types.
6	New concepts for protection to respond to the developing grid and different characteristics of generation.
7	New concepts in planning to take into account increasing environmental constraints, and new technology solutions for active and reactive power flow control.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics.
9	Increase of right of way capacity and use of overhead, underground and subsea infrastructure, and its consequence on the technical performance and reliability of the network.
10	An increasing need for keeping Stakeholders aware of the technical and commercial consequences and keeping them engaged during the development of the network of the future.

Table 2: Strategic directions of the TC (cf. Electra 249 April 2010)

1	The electrical power system of the future
2	Making the best use of the existing system
3	Focus on the environment and sustainability
4	Preparation of material readable for non technical audience

References:

- ¹ IEEE Standard C37.013-1997, *Standard for High-Voltage Generator Circuit-Breakers Rated on a Symmetrical Current Basis*
- CIGRE TB xxx, WG B5.14, "Wide Area Protection & Copntrol Technologies", to be published soon
- CIGRE TB 336, WG A3.13, "Changing Network Conditions and system requirements, Part II"
- CIGRE TB 362, WG A3.22, "Technical Requirements for Substation Equipment exceeding 800 kV"
- CIGRE TB 456, WG A3.22, "Background of Technical Specifications for Substation Equipment exceeding 800 kV AC"
- CIGRE SC B5 Session 2006, Rep. 207, "Maintaining System Integrity to Prevent Cascading Blackout"
- CIGRE SC B5 Session 2006, Rep. 205, "Loss of Synchronism Detection, a Stratgeic Function for Power System Protection"
- CIGRE SC 34 Colloquium 2001, Rep. 106, "Failure Extension Protection Systems in Japan (No.1)"
- CIGRE SC B5 Colloquium 2007, Rep. 308, "Coordination Experiences in Japanese Transmission System Protection"
- CIGRE Symposium 2013, Rep. 253, "Visualizing the risk of black-out in smart transmission grids"
- CIGRE Symposium 2013, Rep. 255, "Feasibility Check of the P-V-Analysis for Voltage Stability Assessment in a Control Center Environment"
- UCTE Final Report System Disturbance on 4 November 2006 (published at ENTSEO/UCTE website, 30 January 2007)