

NATIONAL GRID PROTECTION APPLICATION AND SETTING **AT RAILWAY SUPPLY POINTS**

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PURPOSE AND SCOPE

This Technical Guidance Note (TGN) provides the necessary guidance on application and setting policy for National Grid protection at Railway supply points. It should be read in conjunction with PS(T)063.

PART 1 – GUIDANCE

1 PROTECTION APPLICATION

1.1 Transformer Main Protection

Overall differential protection should be provided for the three winding (HV + LV1 + LV2) phase to phase transformer. The differential protection application should be suitable for both Booster Transformer (BT) and Auto Transformer (AT) modes of operation. An acceptable application on a typical three phase numerical protection relay is the six CTs on HV and LV (HV – 2 phases, LV – Auxiliary, Catenary and two neutral conductors) assigned to two of the three phase differential functions.

It is acceptable to extend the differential protection to protect the LV copper work up to the post CT, to overlap with the LV Feeder (or LV Connections) protection.

Restricted Earth Fault (REF) protection should be applied separately on each of the three transformer windings (HV + LV1 + LV2) to provide sensitive protection for earth faults. The transformer bushing CTs are typically used for REF protection application. The algorithm should avoid the need for vector subtraction of the phase currents as this can lead to non-operation for faults near the centre point of the HV winding.

Note - LV REF could be integrated into the transformer overall protection provided the sensitivity requirements given in PS(T)063 are not compromised (due to load biasing) under full load conditions.

1.2 Transformer HV (400kV or 275kV) Protection

1.2.1 The Instantaneous backup protection (High Set Overcurrent) and time delayed IDMT backup protection functions can be combined in a numerical relay and shall be provided for all transformers.

1.2.2 Different primary system configurations will require different application of clause 2.2.1 and 2.2.2 of PS(T)063. For example, the transformer may be connected to a mesh substation, double busbar arrangement, transformer feeder, or may be part of a banked transformer connection. It will be necessary to consider the location of CTs for these protection functions. The protection of three phase transmission system equipment associated with the alternative transformer HV connection arrangements above should be in accordance with PS(T)010 requirements.

Where the Railway Supply transformer is directly associated with a feeder (i.e. Teed transformer feeder), the feeder protection zone shall not include faults on the transformer HV bushings. Separately mounted post CTs shall be provided for the feeder protection.

- 1.2.3 Where the length of the transformer HV connections exceeds 15m a separate numerical HV Connections protection shall be provided with integral CT supervision.

For installations where the HV Connections is not protected by the transformer backup protection, a separate backup protection for the HV Connections shall be provided.

1.3 Protection of LV Connections (including any Cable Sections)

Since Railway supply sections are invariably supplied with one high source impedance transformer, fault current on the LV side of the transformer is determined predominantly by the transformer impedance and Tap position, and Neutral Series Reactor Tap (if present). The high impedance of this equipment results in relatively low fault levels on the LV side, between 3kA (BT mode, max neutral reactor tap) to 12kA (AT mode, reactorless transformer). The maximum (short term) load current for the transformer is 3200A (100% overload). This similarity in the minimum fault and maximum load imposes constraints on LV Connection and Two-stage back-up protection.

- 1.3.1 Where the length of the LV Connections cable exceeds 50m a separate numerical LV Connections protection or Feeder Unit protection shall be provided

- 1.3.2 The unit protection for the LV Connections cannot be set to the SGT full load current, as is the practice with other SGTs (400/132kV and 275/132kV) and specified in PS(T) 010, section 2.10.1. The recommendation for Railway supply transformers is to set to PS(T)063 section 3.7.

- 1.3.3 LV Two-Stage Back-up Protection

For the transformer incorporating fault limiting reactors, the load and fault currents are similar and standard overcurrent protection for the backup function cannot be used. Voltage controlled overcurrent is one method which can be used in this situation. This technique takes advantage of the voltage disturbance (drop), caused by faults, to distinguish between faults and load.

- 1.3.4 Cable thermal overload protection is to be enabled on a contract specific basis when the cable thermal capacity is lower than that of the transformer. Ref PS(T)063 section 3.8

- 1.3.5 Note: Broken Neutral Protection is only required when NG is the asset owner of the LV cable from transformer to ATFS. In this case, an optical fibre should run down one of the neutral cable pair and loop back up the remaining. The monitoring equipment should alarm only.

Current based Broken Neutral protection is also required and protects against a break in the neutral connection at the ATFS which is beyond the optical fibre.

Narrative: The 25kV supply to the Railway ATFS invariably has alternative paths for the neutral return current. Each Supergrid Transformer should have two neutrals in parallel, arranged in a manner to provide alternative paths for the return current in the event of loss of one neutral.

In AT mode, the auxiliary pole would assist to balance out the neutral return current, with little returning through the body of the earth. There is no requirement to trip the circuit on loss of one neutral, although an alarm should be generated. The alternative path mentioned may, in some cases (particularly under light loads) by-pass most of the current and cause false alarms if the relay is not correctly set.