

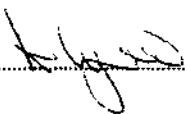
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Business Process Document

Guidance for the technical management of booster transformer outages

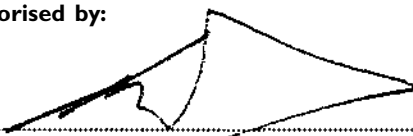
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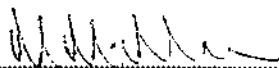
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Ref:	NR/GN/ELP/24015
Issue:	2
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Contents

1	Purpose	4
2	Scope	4
3	System overview	4
3.1	Arrangement of booster transformers with traction return conductors	4
3.2	Operation with an isolated booster transformer	5
4	Compliance with standards	5
5	Assessment of booster transformer outages	5
5.1	Factors that affect the severity of booster transformer outage(s)	6
5.2	Assessment of the severity of a booster transformer outage	8
5.3	Rail bonding within the vicinity of an isolated or failed booster	10
6	Abbreviations	10
7	Definitions	11
8	Reference documentation	11
Appendix A	13	
Appendix B	16	

Ref:	NR/GN/ELP/24015
Issue:	2
Date:	December 2005

1 Purpose

These guidance notes support the Network Rail Company procedure for managing the outages of booster transformers on 25 kV a.c. 50 Hz electrified lines and assist the assessment of actions required to be taken in the event of booster transformer outage(s).

2 Scope

These guidance notes apply to those parts of Network Rail's 25 kV a.c., 50 Hz electrified railway infrastructure, which includes the use of traction return conductors and booster transformers, in accordance with [NR/SP/ELP/21078](#) – *Design of earthing and bonding systems for 25kV a.c. electrified lines*.

The scope of these guidance notes is to provide assistance on the operation of Network Rail's 25 kV a.c., 50 Hz electrified railway, where there is an occurrence of booster transformer outage(s). These guidance notes provide a means of assessing the severity of each outage and hence the expected increase in the level of induced longitudinal voltage into lineside equipment.

The guidance notes do not include instructions for specification, approval, installation, commissioning, maintenance or day-to-day use of booster transformers.

3 System overview

In order to assess the actions required to be taken in the event of booster transformer outage(s), it is important to understand the booster transformer system. The following subsections provide a system overview of the operation of booster transformers in normal and abnormal conditions. Further information is provided in Appendix A.

3.1 Arrangement of booster transformers with traction return conductors

The general layout for the booster transformer system for Network Rail's 25 kV a.c. 50 Hz electrified railway is shown in figure 1 in Appendix A. The positioning of the overhead line conductors is such that significant magnitudes of e.m.f. may be induced into lineside conductors, the level of which is dependent on the actual arrangement of overhead line conductors.

3.2 Operation with an isolated booster transformer

The operation of the railway with an isolated booster transformer could affect the following parameters with a possible significant increase:

- the rail potentials;
- the level of 50 Hz longitudinal voltages induced into lineside equipment, in particular telecommunication conductors and metal fencing, positioned adjacent to the railway;
- the level of 50 Hz longitudinal voltage induced into non-railway systems, in particular telecommunications systems, within the vicinity of the railway.

The level of interference induced into lineside equipment is related to the following:

- a) the electrical feeding arrangement, including booster transformers;
- b) the level of traction load drawn by the system;
- c) the screening and type of lineside equipment (telecommunications, signalling);
- d) the traction return current system;
- e) the configuration of one or both running rails of each track, used for traction return.

4 Compliance with standards

The operation of the 25 kV a.c. 50 Hz electrified railway should ensure that accessible and touch potentials, inclusive of metallic equipment connected to remote earth, do not rise to a potential that will cause hazards to personnel operating or maintaining the system. For accessible voltages the total r.m.s. level of a.c. voltage is required to comply with the limits stated in the documents identified in the clause entitled “Reference documents”.

The limits of continuous and instantaneous induced voltage in telecommunications systems due to traction load are 60 V r.m.s. (normal service operation) and 430 V r.m.s. (fault current conditions) respectively, see section 2.1 of document [NR/SP/TEL/30003](#) - *The performance of telecommunications equipment under conditions of electrical interference*.

5 Assessment of booster transformer outages

In the event of booster transformer outage(s), the operation of the other booster transformers in the same electrical section will not be prevented. However, the level of rail potentials and induced voltages within the electrical section containing the failed booster transformer(s) will increase.

Ref:	NR/GN/ELP/24015
Issue:	2
Date:	December 2005

To assess the severity of booster outage(s), this identifies the increase in the levels of the longitudinal induced voltage and the interference into lineside equipment, in particular, telecommunications equipment when compared with that observed under normal operational conditions. This will vary from site to site and will primarily be determined by the site specific location and peak traction loads, see section 5.1.

This assessment is reliant upon information and data regarding the existing levels of induced voltages, due to the train power demands in both normal and abnormal peak time conditions.

By following Network Rail specification [NR/SP/ELP/24011](#), the severity of each outage and hence the expected increase in the level of induced voltage due to the outage of booster transformer(s) can be assessed.

5.1 Factors that affect the severity of booster transformer outage(s)

The severity of the interference and the magnitude of the longitudinal and transverse r.m.s. voltages at particular locations is determined by the following operational and design factors:

- a) number and location of the failed booster transformer(s);
- b) arrangement of the overhead line;
- c) traction load (worst case is during peak time);
- d) continuity of the traction return conductor;
- e) level of imbalance between the feeder and traction return circuits;
- f) screening applied to lineside equipment (in particular, telecommunications cables);
- g) length of the telecommunications cables.

5.1.1 Location of the failed booster transformer(s)

The location of the failed booster transformer(s) within the electrical feeding section will affect the level of induced voltage in lineside conductors, as well as geographical factors such as the vicinity of the nearest stations, freight depots, steep gradients etc., see Appendix A of this document.

5.1.2 Arrangement of the overhead line

The feeding arrangement of the overhead line will determine the traction load on each track feeding 'section'. The effect of emergency feeding arrangements with respect to the level of longitudinal induced voltages is described in Appendix A of this document.