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Specification of d.c. Time Constants for Switchgear

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PUBLISHING AND COPYRIGHT INFORMATION

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Amendments since publication

Issue	Date	Amendment
Issue 1	September, 2016	This EREP represents a cosmetic revision of the original EREC G89 Issue 1. The original document has been subject to editorial changes necessary to comply with the conventions and formatting in the ENA engineering document template and Engineering Recommendation ER G0 rules, for structure, drafting and presentation of ENA engineering documents. There are no technical changes between this EREP and the original EREC G89 Issue 1.

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Foreword

This Engineering Report (EREP) is published by the Energy Networks Association (ENA) and comes into effect from the date of publishing. It has been prepared under the authority of the ENA Engineering Policy and Standards Manager and has been approved for publication by the ENA Electricity Networks and Futures Group (ENFG). The approved abbreviated title of this engineering document is "EREP 89", which replaces "Engineering Recommendation (EREC) G89, Issue 1".

EREC G89, *Specification of DC Time Constants for Switchgear* [N1], was first published in 2011 to disseminate the results and findings of an ENA Working Group which reviewed time constants found in typical UK DNO networks. The Working Group was formed because at the time, ENA members were concerned that the switchgear specification of a 45 ms d.c. time constant may be inadequate for the UK network at 132kV and below. The Working Group established the requirements of the network (via fault level studies) and developed recommendations which have subsequently been implemented into appropriate ENA switchgear specifications.

The recommendations from G89 have subsequently been added to ENA TS 41-36 [N2] and TS 41-37 [N3] respectively. After a review of EREC G89 Issue 1 in 2016 by ENA Members, it was decided that the results from the Working Group should published in an Engineering Report, and hence the basis of this EREP.

The 2016 review concluded that the original results were still valid there was no technical justification to amend the document. However, EREC G74 Issue 1 [N4] is under revision in 2016, and should any changes to the guidance for calculating X/R ratio be implemented, then the original G89 results may require updating. The completion of EREC G74 revision work should prompt whether this is required or not.

Introduction

Time constants contribute to the peak fault current that circuit-breakers see under fault conditions, and are determined by X/R parameters at a point where the fault takes place on the network. Electrical Engineers are often concerned that specified time constants are appropriate for circuit-breakers so they are capable of clearing a fault under make or break conditions. ENA members were concerned that the specification of a 45 ms d.c. time constant may be inadequate for the UK network at 132 kV and at voltages below.

International standards define circuit-breaker terminal fault making & breaking capability in terms of a rated a.c. r.m.s. current and a 100% d.c. component decaying with a single time constant. The standard value of d.c. time constant defined in circuit-breaker standard BS EN 62271-100 [N5] is 45 ms; a value which corresponds well to the d.c. time constant of overhead lines but which is significantly less than that of transformers (typically well in excess 100 ms). Special case alternative values of 75 ms and 120 ms which can be selected by users are also included in the standard as user defined options.

EREC G89 Issue 1 was published in 2011 to disseminate the results of an ENA Working Group, which considered time constant issues with circuit-breakers, from 2005 to 2011. G89 provided recommendations and associated justification to amend two ENA switchgear Technical Specifications referenced in Annex A. The recommendations applied to primary type circuit-breakers and did not include distribution type switchgear (e.g. Ring Main Units).

This EREP presents the findings, as published in the original 2011 document, which describe the:

- key elements of fault current for switchgear ratings;
- fault level studies undertaken by ENA members;
- analysis of the survey results;
- derivation of recommended ratings for inclusion within ENA Technical Specifications.

It is important to note that this report is presented on the basis of worst case, single phase fault conditions which result in the most onerous potential fault current interruption conditions for the circuit-breaker.

1 Scope

This Engineering Report applies to switchgear at UK primary DNO substations and above; it does not apply to UK distribution substations.

2 Normative references

The following referenced documents, in whole or part, are indispensable for the application of this EREP. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS EN 62271-100: 2009 & A1 2012, *High-voltage switchgear and controlgear. Alternating current circuit-breakers*

Other publications

[N1] ENA EREC G89, Issue 1: 2011, *Specification of DC Time Constants for Switchgear*

[N2] ENA TS 41-36, Issue 3: 2012, *Switchgear for Service up to 36 kV (Cable and Overhead Conductor Connected)*

[N3] ENA TS 41-37, Issue 2: 2015, *Switchgear for use on 66 kV to 132 kV distribution systems (Alternating current circuit-breakers)*

[N4] ENA EREC G74, Issue 1: 1992, *Procedure to meet the requirements of BS EN 909 for the calculation of short-circuit currents in three-phase AC power systems*

3 Terms and definitions

For the purposes of this EREP, the following terms and definitions apply.

3.1
a.c.
alternating current

3.2
d.c.
direct current

3.3
ENA
Energy Networks Association

3.4
r.m.s.
root mean square

3.5
SAP
switchgear assessment panel

3.6
X/R
ratio of reactance and resistance determining a d.c. offset asymmetrical fault current