IEC/TR 61000-3-13

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TECHNICAL REPORT

BASIC EMC PUBLICATION

Electromagnetic compatibility (EMC) – Part 3-13: Limits – Assessment of emission limits for the connection of unbalanced installations to MV, HV and EHV power systems

IEC/TR 61000-3-13:2008(E)

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FOREWORD

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IEC/TR 61000-3-13, which is a technical report, has been prepared by subcommittee 77A: Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It has the status of a basic EMC publication in accordance with IEC Guide 107 [12][1].

This first edition of this technical report has been harmonised with IEC/TR 61000-3-6 [10] and IEC/TR 61000-3-7 [11].

1 Figures in square brackets refer to the bibliography.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
77A/577/DTR	77A/616/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

A list of all parts of the IEC 61000 series, under the general title *Electromagnetic compatibility (EMC)*, can be found on the IEC website.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

The contents of the corrigendum of April 2010 have been included in this copy.

INTRODUCTION

IEC 61000 is published in separate parts according to the following structure:

Part 1: General

General considerations (introduction, fundamental principles)

Definitions, terminology

Part 2: Environment

Description of the environment

Classification of the environment

Compatibility levels

Part 3: Limits

Emission limits

Immunity limits
(in so far as they do not fall under the responsibility of product committees)

Part 4: Testing and measurement techniques

Measurement techniques

Testing techniques

Part 5: Installation and mitigation guidelines

Installation guidelines

Mitigation methods and devices

Part 6: Generic standards

Part 9: Miscellaneous

Each part is further subdivided into several parts published either as International Standards or as technical specifications or technical reports, some of which have already been published as sections. Others will be published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

ACKNOWLEDGMENT

In 2002, the IEC subcommittee 77A made a request to CIGRE Study Committee C4 and CIRED study committee S2, to organize an appropriate technical forum (joint working group) whose main scope was to prepare, among other tasks, a technical report concerning emission limits for the connection of unbalanced installations to public supply systems at MV, HV and EHV.

To this effect, joint working group CIGRE C4.103/CIRED entitled ''*Emission Limits for Disturbing Installations*'' was appointed in 2003. Some previous work produced by CIGRE JWG C4.07/CIRED has been used as an input to the revision, in particular the planning levels and associated indices. Addition survey data was also collected by the Joint Working Group in the process of setting indicative planning levels.

Subsequent endorsement of the document by IEC was the responsibility of SC 77A.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 3-13: Limits – Assessment of emission limits for the connection of unbalanced installations to MV, HV and EHV power systems

1 Scope

This part of IEC 61000 provides guidance on principles which can be used as the basis for determining the requirements for the connection of unbalanced installations (i.e. three-phase installations causing voltage unbalance) to MV, HV and EHV public power systems (LV installations are covered in other IEC documents). For the purposes of this report, an unbalanced installation means a three-phase installation (which may be a load or a generator) that produces voltage unbalance on the system. The connection of single-phase installations is not specifically addressed, as the connection of such installations is under the control of the system operator or owner. The general principles however may be adapted when considering the connection of single-phase installations. The primary objective is to provide guidance to system operators or owners on engineering practices, which will facilitate the provision of adequate service quality for all connected customers. In addressing installations, this document is not intended to replace equipment standards for emission limits.

The report addresses the allocation of the capacity of the system to absorb disturbances. It does not address how to mitigate disturbances, nor does it address how the capacity of the system can be increased.

Since the guidelines outlined in this report are necessarily based on certain simplifying assumptions, there is no guarantee that this approach will always provide the optimum solution for all unbalanced load situations. The recommended approach should be used with flexibility and judgment as far as engineering is concerned, when applying the given assessment procedures in full or in part.

The system operator or owner is responsible for specifying requirements for the connection of installations which may cause unbalance on the system. The disturbing installation is to be understood as the complete customer's installation (i.e. including balanced and unbalanced parts).

Problems related to unbalance fall into two basic categories.

- Unbalanced installations that draw negative-sequence currents which produce negative-sequence voltages on the supply system. Examples of such installations include arc furnaces and traction loads (typically connected to the public network at HV), and three phase installations where the individual loads are not balanced (typically connected at MV and LV). Negative-sequence voltage superimposed onto the terminal voltage of rotating machines can produce additional heat losses. Negative-sequence voltage can also cause non-characteristic harmonics (typically positive-sequence 3rd harmonic) to be produced by power converters.
- Unbalanced installations connected line-to-neutral can also draw zero-sequence currents which can be transferred or not into the supply system depending on the type of connection of the coupling transformer. The flow of zero-sequence currents in a grounded neutral system causes zero-sequence unbalance affecting line-to-neutral voltages. This is not normally controlled by setting emission limits, but rather by system design and maintenance. Ungrounded-neutral systems and phase-to-phase connected installations are not, however, affected by this kind of voltage unbalance.

This report gives guidance only for the coordination of the negative-sequence type of voltage unbalance between different voltage levels in order to meet the compatibility levels at the point of utilisation. No compatibility levels are defined for zero-sequence type of voltage unbalance as this is often considered as being less relevant to the coordination of unbalance levels compared to the first type of voltage unbalance. However, for situations where a non-zero impedance exists between neutral and earth with the system still being effectively grounded (i.e., where the ratio between zero-sequence, X_0 and positive sequence reactance X_1 is $0 < X_0/X_1 \leq 3$), this type of voltage unbalance can be of concern especially when the type of connection of the coupling transformer allows zero-sequence path to flow from MV to LV and vice-versa.

NOTE The boundaries between the various voltage levels may be different for different countries (see IEV 601 01-28) [9]. This report uses the following terms for system voltage:

– low voltage (LV) refers to Un ≤ 1 kV;

– medium voltage (MV) refers to 1 kV < Un ≤ 35 kV;

– high voltage (HV) refers to 35 kV < Un ≤ 230 kV;

– extra high voltage (EHV) refers to 230 kV < Un.

In the context of this report, the function of the system is more important than its nominal voltage. For example, a HV system used for distribution may be given a "planning level" which is situated between those of MV and HV systems.

2 Normative references

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

IEC 60050(161), *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*

3 Terms and definitions

For the purpose of this part of IEC 61000, the following definitions apply as well as the definitions in IEC 60050(161).

3.1
agreed power
value of the apparent power of the disturbing installation on which the customer and the system operator or owner agree. In the case of several points of connection, a different value may be defined for each connection point

3.2
customer
a person, company or organisation that operates an installation connected to, or entitled to be connected to, a supply system by a system operator or owner

3.3
(electromagnetic) disturbance
any electromagnetic phenomenon which, by being present in the electromagnetic environment, can cause electrical equipment to depart from its intended performance

3.4
disturbance level
the amount or magnitude of an electromagnetic disturbance measured and evaluated in a specified way

3.5
electromagnetic compatibility (EMC)
ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

NOTE 1 Electromagnetic compatibility is a condition of the electromagnetic environment such that, for every phenomenon, the disturbance emission level is sufficiently low and immunity levels are sufficiently high so that all devices, equipment and systems operate as intended.

NOTE 2 Electromagnetic compatibility is achieved only if emission and immunity levels are controlled such that the immunity levels of the devices, equipment and systems at any location are not exceeded by the disturbance level at that location resulting from the cumulative emissions of all sources and other factors such as circuit impedances. Conventionally, compatibility is said to exist if the probability of the departure from intended performance is sufficiently low. See Clause 4 of IEC 61000-2-1 [7].

NOTE 3 Where the context requires it, compatibility may be understood to refer to a single disturbance or class of disturbances.

NOTE 4 Electromagnetic compatibility is a term used also to describe the field of study of the adverse electromagnetic effects which devices, equipment and systems undergo from each other or from electromagnetic phenomena.

3.6
(electromagnetic) compatibility level
specified electromagnetic disturbance level used as a reference level in a specified environment for co-ordination in the setting of emission and immunity limits

NOTE By convention, the compatibility level is chosen so that there is only a small probability (for example 5 %) that it will be exceeded by the actual disturbance level.

3.7
emission
phenomenon by which electromagnetic energy emanates from a source of electromagnetic disturbance

[IEV 161-01-08 modified]

NOTE For the purpose of this report, emission refers to phenomena or conducted electromagnetic disturbances that can cause voltage unbalance due to unequal currents on the three phases.

3.8
emission level
level of a given electromagnetic disturbance emitted from a particular device, equipment, system or disturbing installation as a whole, assessed and measured in a specified manner

3.9
emission limit
maximum emission level specified for a particular device, equipment, system or disturbing installation as a whole

3.10
generating plant
any equipment that produces electricity together with any directly connected or associated equipment such as a unit transformer or converter

3.11
immunity (to a disturbance)
the ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

3.12
immunity level
the maximum level of a given electromagnetic disturbance on a particular device, equipment or system for which it remains capable of operating with a declared degree of performance

3.13
normal operating conditions
operating conditions of the system or of the disturbing installation typically including all generation variations, load variations and reactive compensation or filter states (e.g. shunt capacitor states), planned outages and arrangements during maintenance and construction work, non-ideal operating conditions and normal contingencies under which the considered system or disturbing installation has been designed to operate

NOTE Normal system operating conditions typically exclude: conditions arising as a result of a fault or a combination of faults beyond that planned for under the system security standard, exceptional situations and unavoidable circumstances (for example: force majeure, exceptional weather conditions and other natural disasters, acts by public authorities, industrial actions), cases where system users significantly exceed their emission limits or do not comply with the connection requirements, and temporary generation or supply arrangements adopted to maintain supply to customers during maintenance or construction work, where otherwise supply would be interrupted

3.14
planning level
level of a particular disturbance in a particular environment, adopted as a reference value for the limits to be set for the emissions from the installations in a particular system, in order to co-ordinate those limits with all the limits adopted for equipment and installations intended to be connected to the power supply system

NOTE Planning levels are considered internal quality objectives to be specified at a local level by those responsible for planning and operating the power supply system in the relevant area.

3.15
point of common coupling (PCC)
point in the public supply system, which is electrically closest to the installation concerned, at which other installations are, or could be, connected. The PCC is a point located upstream of the considered installation

NOTE A supply system is considered as being public in relation to its use and not its ownership.

3.16
point of connection (POC)
point on a public power supply system where the installation under consideration is, or can be connected

NOTE A supply system is considered as being public in relation to its use and not its ownership.

3.17
point of evaluation (POE)
point on a public power supply system where the emission levels of a given installation are to be assessed against the emission limits. This point can be the point of common coupling (PCC) or the point of connection (POC) or any other point specified by the system operator or owner or agreed upon

NOTE A supply system is considered as being public in relation to its use and not its ownership.

3.18
short circuit power
a theoretical value expressed in MVA of the initial symmetrical three-phase short-circuit power at a point on the supply system. It is defined as the product of the initial symmetrical short-circuit current, the nominal system voltage and the factor √3 with the aperiodic component (DC) being neglected