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Guideline

EDH Part 1: Introduction

Part 1 of the revised ITER Cadarache relevant Electrical Design Handbook

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Change Log			
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v1.0	In Work	16 May 2008	Part 1 of the revised ITER Cadarache relevant Electrical Design Handbook
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v1.2	Signed	20 Jul 2009	Issued on present document template, addition of voltage classed
v1.3	Signed	29 Jul 2009	Includes text on reclassification of former EDH Parts into Standardisation Guides
v1.4	Approved	15 Sep 2009	This is an initial version of this document that has been reviewed in accordance with the ITER MQP. Review comments have in part been addressed and others will be considered in detail and addressed at the next revision.

Electrical Design Handbook

Part 1: Introduction

Abstract

This manual is provided for the use of all Departments of the ITER Organization and is addressed to system specifiers, designers and users of electrical components in otherwise non-electrical plant systems.

This is an initial version of this document that has been reviewed in accordance with the ITER MQP. Review comments have in part been addressed and others will be considered in detail and addressed at the next revision.

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Contents

List of Tables

1 Introduction

This document replaces the now obsolete ITER **Electrical Design Handbook** (EDH) (ITER_D_222QF5 v1.0). In particular this new version is Cadarache site specific.

It will be published in the Baseline documentation folder of the ITER Document Management (IDM) System and will be the subject of continual review and revision throughout the lifetime of the ITER project.

This handbook is provided for the use of all Departments of the ITER Organization and is addressed primarily to system specifiers, designers and users of electrical components in otherwise non-electrical plant systems, rather than to designers of the power supply systems. The latter shall in addition comply with many other standards, instructions and industrial practices that are beyond the scope of this handbook..

This document comprises four parts, each of which *will be* published separately, and 3 guides on component standardisation for electrical installations:

1. Introduction (this document)
2. Table 1.7 IEC Standard Current Ratings
3. Terminology and Acronyms
4. Codes and Standards Applicable to Electrical Components and Systems on the ITER Project
5. Requirements for Earthing and Electromagnetic Compatibility

Standardisation Guides

A.

Guide A on Standardisation of Components in Electrical Installations for SSEN

B. Guide B on Standardisation of Components in Electrical Installations for PPEN Systems

C. Guide C on Standardisation of Components in Electrical Installations for EPS Systems

All electrical components and plant systems used or installed at ITER shall comply with the requirements set out in this EDH.

In particular, voltage and current ratings must be selected for connection to the ITER standard nominal system voltages that have been selected from the IEC standards as given in the Section on Standard Voltages.

The related test voltages are given in the Section on Standard Test Voltages.

1.1 Standard Voltages

1.1.1 Applicable IEC standards

IEC 60038 IEC Standard Voltages

International Standard **IEC 60038** defines a set of standard voltages for use in low voltage and high voltage AC electricity supply systems.

The definition of voltage levels is as follows:

IEC voltage range	AC	DC	defining risk
Extra-low voltage	< 50 V_{rms}	< 120 V	low risk
Low voltage	50–1000 V_{rms}	120–1500 V	electrical shock
High voltage	> 1000 V_{rms}	> 1500 V	electrical arcing

Table 1.1 IEC Definition of Voltage Levels

1.1.2 Low Voltage, single & 3 phase, 50Hz

The 230V/400V level (in bold text) is that adopted for use by ITER:

	rms voltage between a phase and the neutral connector	Corresponding rms voltage between two phases. Four-wire (with neutral) or three-wire (without neutral) systems
LV	**230 V**	**400 V**
	400V	690V
	1000V	-

Table 1.2 Low Voltage (LV) used at ITER

1.1.3 High Voltage, 3 phase, 50 Hz

Whilst defined by IEC as being **High Voltage**, i.e. > 1000 V_{rms}, the following voltage levels shall be referred to within ITER as **Medium Voltage (MV)**, i.e. 1 kV < V_r ≤ 35 kV, **Intermediate Voltage (IV)**, i.e. 35 kV < V_r ≤ 230 kV or as **High Voltage (HV)**, i.e. 230 kV < V_r ≤ 800 kV.

The levels in bold are those adopted for use by ITER:

	Highest voltage for equipment *V_m kV	Nominal system voltage ☒V_r kV (± 10%)
MV	3.6	3.3
	7.2	**6.6**
	12	11
	17.5	-
	24	**22**
IV	**72.5**	**66**
	123	110
	145	132
HV	245	220
	420	**400**

Table 1.3 Medium Voltages (MV), Intermediate Voltage (IV) and High Voltage (HV) used at ITER

1.2 Standard Test Voltages

1.2.1 Applicable IEC standards

IEC 60060 High-Voltage Test Techniques

International Standard **IEC 60060** defines a set of tests on equipment having its highest voltage for equipment V_m above 1kV, i.e. in the case of components and plant systems used or installed at ITER, any that are to be connected to a supply voltage higher than that classed as low voltage, must be subjected to testing.

This standard is applicable to:

- dielectric tests with direct voltage;
- dielectric tests with alternating voltage;
- dielectric tests with impulse voltage;

* V_m represents the dielectric strength of an equipment, device or system for which it is designated
☒ V_r represents the nominal or rated system voltage at which an equipment, device or system shall usually operate

- tests with impulse current;
- tests with combinations of the above.

Highest voltage for equipment V_m kV	Standard short-duration power frequency withstand voltage kV (rms value)	Standard lightning impulse withstand voltage
7.2	**20**	**40/60**
24	**50**	**95/125/145**
36	70	145/170
72.5	**140**	**325**
245	(275)/(325)/360/395/460	(650)/850/950/1050

Note: If values in brackets are considered insufficient to prove that the required phase-to-phase withstand voltage are met, additional tests are needed.

Table 1.4 Test Voltages

1.3 Voltage Classes

The voltage class of a power circuit defines the degree of availability of the power delivery. The following classification of the power delivery circuits have been adopted at ITER:

Class I	Uninterruptible DC (up to 250 V)	DC battery supplies; batteries charging when AC supply is available. AC supply may be Class III or Class IV depending on Safety Level
Class II	Uninterruptible AC (230/400 V)	Provided from UPS systems, will switch to alternate supply. Alternate AC supply may be Class III or Class IV depending on Safety Level
Class III	Temporarily interruptible AC (230/400 V and 6.6 kV)	Provided from diesel motor generators, interruption for 30 s while generators start up
Class IV	Indefinitely interruptible AC (230/400 V and 6.6 kV).	Directly provided from the electrical supply network

Table 1.5 Voltage Classes

1.4 Insulation Coordination

1.4.1 Applicable IEC standards

IEC 60071 IEC Insulation Coordination

The following table shows standard insulation levels for range I (1kV < V_m = 245 kV)

Highest voltage for equipment (V_m) kV (rms value)	Standard rated short- duration power-frequency withstand voltage kV (rms value)	Standard rated lightning impulse withstand voltage kV (peak value)
7.2	20	40 60
24	50	95 125 145
36	70	145 170
72.5	140	325
245	(275) (325) 360 395 460	(650) (750) 850 950 1050

Note: If values in brackets are considered insufficient to prove that the required phase-to-phase withstand voltage are met, additional tests are needed.

Table 1.6 Insulation Withstand Voltages

1.5 Standard Current Ratings

1.5.1 Applicable IEC standards

IEC 60059 IEC Standard Current Ratings

This standard specifies standard current ratings for electrical devices, apparatus, instruments and equipment and should be applied to the designing or utilisation of systems or equipment as well as to operating characteristics. This standard does not apply to current ratings of components and parts used within electrical devices or items of equipment.

Standard current ratings in amperes have been fixed by the IEC as follows:

1	1.25	1.6	2	2.5	3.15	4	5	6.3	8
10	12.5	16	20	25	31.5	40	50	63	80
100	125	160	200	250	315	400	500	630	800
1000	1250	1600	2000	2500	3150	4000	5000	6300	8000
10000	12500	16000	20000	25000	31500	40000	50000	63000	80000
100000	125000	160000	200000						

Table 1.7 IEC Standard Current Ratings

2 Terminology and Acronyms

This part of the EDH is provided as a reference document for common terms used in electrical engineering, and for acronyms in both common use and ITER specific.

Most defined terms are those set down in IEC or other relevant standards.

The title of this part is **EDH-2 Terminology & Acronyms** and is available in IDM (ITER_D_2E8QVA)

3 Codes and Standards Applicable to Electrical Components and Systems on the ITER Project

This part of the EDH provides a detailed list of applicable standards for manufacturing, installation, testing, etc. of electrical components and plant systems used or installed at ITER.

The title of this part is **EDH-3 Codes & Standards** and is available in IDM (ITER_D_2E8DLM)

4 Requirements for Earthing and Electromagnetic Compatibility

This part of the EDH details the requirements for, and recommendations on the earthing of all electrical components and plant systems used or installed at ITER. Earthing is the connection of equipment to earth or ground for the purpose of limiting fault currents and high voltages under fault conditions.

It also covers requirements for, and recommendations on, the need for electromagnetic compatibility, i.e. the limiting of electromagnetic radiation and need for immunity to electromagnetic radiation.

Finally this part covers lightning protection, e.g. immunity to lightning strike or other high voltage/current impulses under external fault conditions

The title of this part is **EDH-4 Earthing, EMC and Lightning Protection** and is available in IDM (ITER_D_2ELREB)

5 Guide A on Standardisation of Components in Electrical Installations for SSEN Systems

This guide details the requirements for, and recommendations on, all electrical components and plant systems to be used or installed at ITER and to be connected to the SSEN.

In general, SSEN loads are not ITER pulse related but of a continuous nature, e.g. cryogenics plant, vacuum plant, heating, cooling, ventilation and lighting systems, etc.

The title of this guide is **Guide A: Electrical Installations for SSEN Systems** and is available in IDM (ITER_D_2EB9VT)

6 Guide B on Standardisation of Components in Electrical Installations for PPEN Systems

This guide details the requirements for, and recommendations on, all electrical components and plant systems to used or installed at ITER and to be connected to the PPEN.

In general, PPEN loads are ITER pulse related and thus of an on/off nature, i.e. they are energised and de-energised according to ITER pulse requirements. Furthermore they are likely to be interlocked or intertripped and de-energised automatically in the event of abnormal events being detected.

The title of this part is **Guide B: Electrical Installations for PPEN Systems** and is available in IDM (ITER_D_2EY57B)

7 Guide C on Standardisation of Components in Electrical Installations for EPS Systems

This guide details the requirements for, and recommendations on, all electrical components and plant systems to be used or installed at ITER and to be connected to the Emergency Power Supply Network (EPS).

The purpose of the EPS is to supply safety critical loads in the event of general power loss or power cut. Safety critical loads are those that are required to protect personnel or plant investment under such conditions.

The need for connection to the EPS, which may sometimes be referred to as an uninterruptable power supply (UPS), will need to be properly justified, e.g. specified in a safety case, as the additional cost of supplying and maintaining such supplies is significant.

The title of this part is **Guide C: Electrical Installations for EPS Systems** and is available in IDM (ITER_D_2F6BBN)