

1st edition:
Version:

June 2022
Original

**Technical Support to the IC&HS Committee International Railways
Standards Working Group**

Design of a high-speed railway - Energy



© International Union of Railways, 2022. All rights reserved.
This document may not be reproduced – even in part – without the written authorisation of UIC.

IRS to be classified in volumes of UIC:

6 - Traction

Complete reference in case of citation:

IRS-60682:2022, Ed. 1: Design of a high-speed railway - Energy

Approbation date:

10 April 2021

With effect from:

10 April 2021

Application recommended to:

10 April 2021

Keywords:

High-speed railway; Design; Energy

Warning

No part of this publication may be copied, reproduced or distributed by any means whatsoever, including electronic, except for private and individual use, without the express permission of the International Union of Railways (UIC). The same applies for translation, adaptation or transformation, arrangement or reproduction by any method or procedure whatsoever. The sole exceptions - noting the author's name and the source - are "analyses and brief quotations justified by the critical, argumentative, educational, scientific or informative nature of the publication into which they are incorporated".
(Articles L 122-4 and L122-5 of the French Intellectual Property Code).

© International Union of Railways (UIC) - Paris, 2022

Published by the International Union of Railways (UIC)

16 rue Jean Rey, 75015 Paris - France, June 2022

Dépôt Légal June 2022

ISBN 978-2-7461-3185-9



Record of updates:

1st edition, June 2022

First edition.

CONTENTS

Foreword	1
Executive summary	3
Field of application	4
Reference documents	5
Abbreviations and Symbols	6

General Application

1 – Introduction	8
1.1 – Context.....	8
1.2 – Objectives	8
1.3 – Prior knowledge	8
2 – Basic requirements	9
3 – Traction power supply and traction substation	10
3.1 – Traction power supply	10
3.1.1 – Traction power supply system.....	10
3.1.2 – Feeding mode of traction network	10
3.1.3 – Power supply plan	12
3.1.4 – Arrangement of traction substations.....	12
3.1.5 – Configuration of traction transformers	12
3.1.6 – Sectioning of OCS feeding	13
3.1.7 – Traction return current.....	13
3.2 – Traction substation.....	14
3.2.1 – Location of traction substations.....	14
3.2.2 – Main circuit	14
3.2.3 – Power distribution unit.....	15
3.2.4 – Surge protection	15
3.2.5 – Return current and earthing	16

3.2.6 – Relay protection and automatic device	16
3.2.7 – Auxiliary power supply and operational power supply.....	17
4 – Overhead contact line system (OCS)	18
4.1 – Environmental characteristics	19
4.1.1 – Spatial environment.....	19
4.1.2 – Climatic environment.....	19
4.1.3 – Operational environment.....	19
4.1.4 – Earthquakes	19
4.2 – OCS pole and foundation.....	20
4.3 – Bracket and registration assembly	20
4.4 – Overhead contact line	21
4.4.1 – Suspension.....	21
4.4.2 – Wires	22
4.4.3 – Main technical specifications.....	24
4.4.4 – Installation design.....	25
4.5 – OCS longitudinal structure and equipment	26
4.5.1 – Span length	26
4.5.2 – Tensioning section and overlap.....	26
4.5.3 – Midpoint anchor.....	27
4.5.4 – End anchor and tensioning device	27
4.5.5 – Overhead crossing	28
4.5.6 – Electrical sectioning device and phase break device	28
4.5.7 – Disconnecter	28
4.6 – Structural design	28
4.7 – Electrical insulation	29
4.8 – Lightning protection.....	29
4.9 – Return current and earthing	29
5 – Electric power system	30
5.1 – Electric power supply requirements	30
5.2 – Means of electric power supply.....	31
5.3 – Transformer substation, distribution substation and transformer substation at the power load end33	
5.3.1 – Transformer substation or distribution substation	33
5.3.2 – Transformer substation at power load end.....	33

5.4 – Electric power line	33
5.5 – Lightning protection and earthing.....	34
5.5.1 – Lightning protection	34
5.5.2 – Earthing	34
6 – Supervisory control and data acquisition (SCADA) system	35
6.1 – System composition	35
6.2 – Functions	36
Regulatory listing	37
Bibliography	39

Foreword

An International Railway Solution (IRS) is a document drawn up by consensus and applied on a voluntary basis which aims to facilitate and harmonise railway operation.

IRSs are gradually replacing UIC leaflets.

Members of the International Union of Railways (UIC) participate in the creation of IRSs, of which they benefit in full. Furthermore, marketing to railway stakeholders contributes to the sharing and harmonisation of good practices, in accordance with UIC's primary goal.

While IRSs do not have the force of law, they are created and published in a professional manner and with technical approval on the basis of UIC procedures, and have full technical legitimacy in the railway sector.

The "General application" section constitutes the heart of the IRS and contains the working group's expertise applicable in the broadest manner. The addition of a "Specific application" aims to cover factors specific to a region, a type of service, etc.

Some provisions shall be implemented in all cases to ensure correct application and maintain the system's cohesiveness. Certain operational circumstances require that specific provisions be systematically applied by all users of the document.

For the purposes of understanding, the user acknowledges that the expression of:

- obligation indicates requirements to be respected in order to comply with the expertise expressed in the document (usually "shall");
- recommendation indicates options that are favourable but not essential (usually "should");
- permission indicates options that are recognised but without consequence (usually "may");
- capacity indicates possibilities from a technical standpoint and not permissions or probabilities (usually "can").

Obligation, recommendation and capacity can be expressed in the negative to indicate prohibiting, non-recommendation and incapacity.

If applicable, notably for the purposes of compliance with a UIC approval, passages that are recommended or mandatory for the cohesiveness of the system will be accompanied by the letters "R" and "MCS" respectively.

This IRS reflects the following UIC working group expertise:

IRS High-Speed Working Group - Intercity & High-Speed Committee (ICHSC)

It integrates in full or in part the following UIC leaflets:

- none

It complements the following standards:

- *IRS 60672: Implementation of a high-speed railway - Feasibility phase*
- *IRS 60673: Implementation of a high-speed railway - Design phase*

The following IRSs constitute a complementary series:

- *IRS 60680: Design of a high-speed railway - Infrastructure*
- *IRS 60681: Design of a high-speed railway - Communication and Signalling*
- *IRS 60682: Design of a high-speed railway - Energy*
- *IRS 60683: Design of a high-speed railway - Interface*

Executive summary

This IRS deals with the design of energy for high-speed railways. It contains guidelines to provide a global vision of the design of high-speed systems.

It contains information on the design of basic requirements, the traction power supply and traction substation, the overhead contact line system (OCS), the electric power system, and the supervisory control and data acquisition (SCADA) system.

It integrates in full or in part the following UIC leaflets:

- none

It complements the following standards:

- *IRS 60672: Implementation of a high-speed railway - Feasibility phase*
- *IRS 60673: Implementation of a high-speed railway - Design phase*

Field of application

This IRS applies to the design of HSR (see Abbreviations and Symbols - page 6) energy systems.

It provides information on basic requirements, the traction power supply and traction substation, the overhead contact line system (OCS), the electric power system, and the supervisory control and data acquisition (SCADA) system.

This IRS provides information on the main design concepts and requirements based on experience. However, in order to accommodate future technological developments in different countries, the main design concepts outlined in this IRS may be adjusted in accordance with specific circumstances.

This IRS focuses on high-speed passenger rail networks. HSR lines for freight transport should be designed in accordance with the specific circumstances.

Reference documents

The following documents are cited in this IRS or strongly support its requirements and recommendations:

1. International Standards

International Electrotechnical Commission (IEC)

- [1] *IEC 60850:2014: Railway applications - Supply voltages of traction systems*
- [2] *IEC 62128-1:2013: Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - part 1: Protective provisions against electric shock*

Abbreviations and Symbols

AC	Alternating current
AT	Autotransformer
EMC	Electromagnetic compatibility
HSR	High-speed railway
OCS	Overhead contact line system
PW	Protective wire
RAMS	Reliability, availability, maintainability and safety
SCADA	Supervisory control and data acquisition
SPD	Surge protection device
TSP	Track sectioning post

Design of a high-speed railway - Energy

General Application

1 – Introduction

This IRS contains guidelines to provide a global vision of the design of high-speed rail systems and outlines the HSR (see [Abbreviations and Symbols - page 6](#)) experience of various countries.

1.1 – Context

High-speed railway (HSR) is a safe and efficient mode of transport with a high level of competitiveness in terms of safety, speed, capacity and sustainability, assuming an important position in the transport system.

When it comes to the construction of railways worldwide and the application of new technologies, HSR drives a great part of the momentum and consequently boosts the development of the railway industry.

HSR is a complex system that incorporates advanced technologies for infrastructure, communications and signalling, energy, and rolling stock.

The design of the HSR is the basis for achieving the desired system functions; therefore, in order to guarantee safety, it shall balance technological innovation and reliability, coordinate passenger comfort with economy, and reconcile high speed with short intervals.

This IRS applies to the design of HSR energy systems.

1.2 – Objectives

The objectives of developing the "IRS for design of a high-speed railway" series are as follows:

- Guiding the construction of HSR
- Reflecting the performance of HSR systems
- Disseminating advanced technologies worldwide
- Promoting sustainable ecological and environmental development.

1.3 – Prior knowledge

This IRS provides information on the main design requirements and parameters based on experience. However, in order to accommodate future technological developments in different countries, the main design parameters outlined in this IRS may be adjusted in accordance with specific circumstances.