



SLOVENSKI STANDARD
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Železniške naprave - Ogrevalni, prezračevalni in klimatski sistemi za vozna sredstva - 4. del: Osnovni konstrukcijski parametri, preskusni in kontrolni elementi za enoto HVAC (ISO/DIS 19659-4:2024)

Railway applications - Heating, ventilation and air conditioning systems for rolling stock - Part 4: Basic design parameters, test and inspection items for the HVAC unit (ISO/DIS 19659-4:2024)

Bahnanwendungen - Heizung, Lüftung und Klimatisierung von Schienenfahrzeugen - Teil 4: Grundlegende Konstruktionsparameter, Messungen und Prüfungen für die HLK-Einheit (ISO/DIS 19659-4:2024)

Applications ferroviaires - Systèmes de chauffage, ventilation et climatisation pour le matériel roulant - Partie 4: Partie 4 : Paramètres de conception de base, éléments de test et d'inspection pour l'unité de conditionnement d'air (ISO/DIS 19659-4:2024)

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Railway applications — Heating, ventilation and air conditioning systems for rolling stock —

Part 4: Design parameters, test and inspection items for the HVAC unit

Applications ferroviaires — Systèmes de chauffage, ventilation et climatisation pour le matériel roulant —

Partie 4: Paramètres de conception, éléments de test et d'inspection pour l'unité de conditionnement d'air

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 2, *Rolling Stock*.

A list of all parts in the ISO 19659 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Since the HVAC unit is one of the main components of the HVAC system, its quality and performance is a key issue to improve thermal comfort and energy efficiency for rolling stock.

The purpose is:

- to develop a common international standard for the validation of a HVAC unit,
- to establish methodologies and requirements on a component basis to demonstrate compliance with the contractual technical specifications of the HVAC unit,
- to establish a clear scope of responsibility in case performance issues occur after mounting the HVAC unit on the rolling stock.

The justification is:

Currently, we have no common international standard for the validation of a HVAC unit,

Generally, existing national and regional HVAC unit standards are for air-conditioning systems in buildings and a few standards for rolling stock,

Therefore, there is a need to unify the methodologies of the HVAC unit standards into one single document.

This will not affect any existing national or regional standard.

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Railway applications — Heating, ventilation and air conditioning systems for rolling stock —

Part 4: Design parameters, test and inspection items for the HVAC unit

1 Scope

This document covers the following as a guideline:

- the design parameters to be provided to the HVAC unit manufacturer by the rolling stock manufacturer (“Customer”) and the railway operator,
- the test/inspection items, requirements and methods used by the HVAC unit manufacturer to verify that the HVAC unit complies with the design parameters.

This document is applicable to HVAC units for the passenger area and driver’s cabs in urban (metro, tramway), suburban, regional and main line vehicles.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 19659-1, *Railway applications — Heating, ventilation and air conditioning systems for rolling stock — Part 1: Terms and definitions*

ISO 19659-2, *Railway applications — Heating, ventilation and air conditioning systems for rolling stock — Part 2: Thermal comfort*

ISO 19659-3, *Railway applications — Heating, ventilation and air conditioning systems for rolling stock — Part 3: Energy efficiency*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19659-1 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

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3.2 Abbreviations

CMM	Coordinate Measuring Machine
DB	Dry Bulb
FEM	Finite Element Method
FFT	Fast Fourier Transform
FST	Fire, Smoke and Toxicity
GWP	Global Warming Potential
HF	High Frequency
PTU	Portable Testing Unit
RPM	Revolutions per Minute
TCMS	Train Control Monitor System
VOC	Volatile Organic Compounds
WB	Wet Bulb

4 Prerequisites (design parameters) for the HVAC unit

4.1 General

The design parameters shall be clearly specified in the contractual technical specification so that the HVAC unit manufacturer can design and build the HVAC unit to meet the customers requirements.

These shall meet the local laws and legislation requirements.

This clause gives an overview of the design parameters that should be specified as good engineering practice including the parameters to calculate the total annual energy consumption and the total annual energy efficiency of the HVAC unit. The latter is important, as in most cases, after the traction system, the HVAC system is the second largest power consumer on the train.

4.2 Design parameters to be provided to the HVAC unit manufacturer

4.2.1 HVAC unit installation requirements

As a minimum, the following design parameters shall be provided:

- Type of the railway vehicle (high speed, commuter, Cat. 1, Cat. 2, Cat. 3 in ISO 19659-2);
- Type of the HVAC unit (compact, split in ISO 19659-1);
- HVAC unit location (roof mounted, roof embedded, ceiling mounted, on floor mounted, under floor mounted in ISO 19659-1);
- Number of the HVAC units per railway vehicle.

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4.2.2 Air flow requirements

4.2.2.1 Air Volume Flow Rates

The following items shall be considered for air flow requirements:

a) Fresh Air Volume Flow Rate

- Fresh air volume flow rate per person depending on operating conditions as defined in ISO 19659-2 or local standard
- Number of passengers (Normal/Maximum)

NOTE In case free cooling mode is required, fresh air volume flow rate could be higher. Free cooling mode is defined in ISO 19659-1.

b) Supply Air Volume Flow Rate based on following heat gains:

- Heat transfer (including glazing)
- Heat emission from person defined in ISO 19659-2
- Fresh air / outside air (defined in ISO 19659-1) (ventilation)
- Passenger door cycling air infiltration
- Solar radiation (glazing and opaque surfaces) defined in ISO 19659-2
- Heat emission of supply fans/motors and other equipment defined in ISO 19659-2
- Lighting and Miscellaneous internal heat gains defined in ISO 19659-2

c) Return Air Volume Flow Rate

d) Exhaust Air Volume Flow Rate

- Air Volume flow rate required to be exhausted from technical cabinets, WCs, galleys, etc. and to compensate the fresh air volume rates to maintain the required vehicle inside pressure

e) Infiltration Air Volume Flow Rate

4.2.2.2 Back pressure at air interfaces

The following items shall be considered for back pressure at air interfaces:

a) Fresh air inlet back pressure

- Pressure loss through the ducts
- Type and efficiency of air filters in [4.2.8](#)
- Filter condition (clean/dirty)
- External contamination
- Drip or mist separator
- Dampers action
- Back pressure due to train speed, especially in case of a high-speed train
- Back pressure due to other equipment

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- b) Supply air outlet back pressure
 - Pressure loss through the ducts
 - Dampers action
 - Mechanical parts friction
 - Diffusers
 - Vehicle internal pressure
- c) Return air inlet back pressure
 - Pressure loss through the ducts
 - Type and efficiency of air filters in [4.2.8](#)
 - Filter condition (clean/dirty)
 - Internal contamination
 - Dampers action
 - Vehicle internal pressure
- d) Exhaust air back pressure, if applicable
 - Pressure loss through the ducts
 - Back pressure due to train speed, especially in case of a high-speed train
 - Back pressure due to other equipment
 - Dampers action
 - Vehicle internal pressure

4.2.2.3 Air flow distribution

Air flow distribution (uniformity of air speed, temperature) e.g., at the supply air flow outlet(s) shall be considered.

4.2.3 Cooling/Heating performance requirements**4.2.3.1 Common requirements**

The design conditions shall be specified as described in ISO 19659-2:

- a) Exterior design conditions
 - Temperature and corresponding relative humidity
 - Solar radiation
 - Altitude
 - Train speed
- b) Extreme exterior conditions
- c) Fresh air volume flow rate

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d) Interior design conditions

- Temperature and maximum corresponding relative humidity
- Latent and sensible loads

The thermal impact of other systems on the train and / or of the infrastructure on the HVAC system shall be specified and taken into account.

NOTE Other systems are for example braking resistors, battery cooling system and traction converter. An example for the infrastructure would be recycling of expelled air due to tunnel or station platform.

The maximum total annual energy consumption and maximum power consumption of the HVAC unit should be specified.

Based on the above and the car data, the information for the design and testing of the HVAC unit shall be derived.

4.2.3.2 Cooling performance requirements

The following design parameters in [4.2.3.1](#) shall be provided:

- a) Exterior condition (air temperature and relative humidity)
 - Design point, maximum operating point, minimum operating point
- b) Mixed air condition or interior condition (air temperature and relative humidity)
 - Design point, maximum operating point, minimum operating point
- c) Cooling capacity (total cooling capacity/sensible cooling capacity) or supply air condition (in combination with supply air volume flow rate from [4.2.2](#)). If different cooling capacity will be required for pre-cooling mode, degraded mode, free cooling mode or other condition, cooling capacity and condition should be specified.
- d) Local air temperature (in case that they are different from exterior value)
 - Fresh air inlet
 - Outdoor heat exchanger air inlet
- e) Information if the system has reheat conditions to control inside maximum humidity level
- f) Filter condition (clean/dirty), e.g. 20 % of surface covered, 10 % reduction in air volume flow rate
- g) Heat exchangers condition (clean/dirty), e.g. 20 % of surface covered, 10 % reduction in air volume flow rate
- h) Pressure drop caused by outside air flow speed or other factors affecting the total pressure drop of outdoor heat exchanger area in the HVAC unit

In addition, the following information shall be provided:

- i) Additional operating point to calculate the total annual energy consumption for the HVAC unit, if any (refer to ISO 19659-3)

4.2.3.3 Heating performance requirements (electric heater type)

The following design parameters in [4.2.3.1](#) shall be provided:

- a) Exterior condition (air temperature)
 - Design point, maximum operating point

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- b) Mixed air condition or interior condition (air temperature)
 - Design point, maximum operating point
- c) Heating capacity or supply air condition (in combination with supply air volume flow rate from [4.2.2](#))

If different heating capacity will be required for pre-heating mode, degraded mode, or other condition, heating capacity and condition should be specified.

NOTE Heating capacity can be provided by other equipment such as electric heater installed under passenger seat. The heating capacity for design of HVAC unit is the capacity required for HVAC unit only.
- d) Local air temperature (in case that they are different from exterior value)
 - Fresh air inlet
- e) Filter condition (clean/dirty)
- f) Maximum allowable duct temperature

In addition, the following information shall be provided:

- g) Additional operating point to calculate the total annual energy consumption for the HVAC unit, if any (refer to ISO 19659-3)
- h) Information about exhaust heat recovery system (system schematic, operation, etc.) to cooperate with the HVAC unit, if exist

4.2.3.4 Heating performance requirements (heat pump type)

The following design parameters in [4.2.3.1](#) shall be provided:

- a) Exterior condition (air temperature and relative humidity)
 - Design point, maximum operating point, minimum operating point

NOTE Relative humidity is only relevant for outdoor heat exchanger.
- b) Mixed air condition or interior condition (air temperature)
 - Design point, maximum operating point, minimum operating point
- c) Heating capacity or supply air condition (in combination with supply air volume flow rate from [4.2.2](#))

NOTE 1 Heating capacity may be provided by other equipment such as electric heater installed under passenger seat. Heating capacity for design parameter of HVAC unit should be specified as capacity required for HVAC unit only.

NOTE 2 If different heating capacity will be required for pre-heating mode, degraded mode, or other condition, heating capacity and condition should be specified.
- d) Local air temperature (in case that they are different from exterior value)
 - Fresh air inlet
 - Outdoor heat exchanger air inlet
- e) Filter condition (clean/dirty)
- f) Maximum allowable duct temperature
- g) Heat exchangers condition (clean/dirty)
- h) Pressure drop caused by outside air flow speed or other factors affecting the total pressure drop of outdoor heat exchanger area in the HVAC unit