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

**Part 1:
Terms and definitions**

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

Partie 1: Termes et définitions



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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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.

Introduction

The ISO 19659 series defines terms, thermal comfort, energy efficiency and system installation of heating, ventilation and air conditioning (HVAC) for rolling stock.

The purpose of this document is to standardize the terms, definitions, symbols and abbreviated terms used throughout trains systems for the cooling, heating and internal air circulation that are commonly known as heating, ventilation and air conditioning (HVAC). These can be broken down into multiples of these functions and as an example, ventilation and air conditioning (VAC), etc.

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

Part 1: Terms and definitions

1 Scope

This document is applicable to rail vehicles and specifies the terms, definitions, symbols and abbreviated terms to be used in the ISO 19659 series, heating, ventilation and air conditioning for rolling stock.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

3.1 HVAC system

3.1.1 Function

3.1.1.1 cooling

process which enables the interior temperature to be lowered or maintained

3.1.1.2

pre-cooling

process which enables the interior temperature to be lowered (without the presence of passengers)

3.1.1.3

dehumidification

process which removes water vapour from air to reduce the absolute humidity

[SOURCE: ISO/TR 16344:2012, 2.1.32, modified — “relative humidity” has been changed to “absolute humidity”.]

3.1.1.4

heating

process which enables the interior temperature to be raised or maintained

3.1.1.5

pre-heating

process which enables the interior temperature to be raised (without the presence of passengers)

3.1.1.6

supplementary heating

additional *heating* ([3.1.1.4](#)) which provides support for the HVAC system

Note 1 to entry: This can also be referred to as “auxiliary heating”.

3.1.1.7

ventilation

movement of fresh (outside) air to and/or recirculating air in an enclosed space

3.1.1.8

natural air ventilation

air circulation generated without a mechanical action

3.1.1.9

forced air ventilation

air circulation generated by a mechanical action

3.1.1.10

emergency ventilation

ventilation ([3.1.1.7](#)) if main power source has failed

3.1.1.11

filtering

process which removes particles from the air

3.1.1.12

purifying

process which removes non-particulate contaminants from the air

Note 1 to entry: Odours and pathogens are examples of non-particulate contaminants from the air.

3.1.1.13

heat recovery

process which transfers heat (latent/sensible) between *fresh air* ([3.4.1](#)) and *exhaust air* ([3.4.10](#))

3.1.2 Position

3.1.2.1

centralized system

system which consists of one set of *HVAC unit* ([3.1.3.1](#)) per car

3.1.2.2

decentralized system

system which consists of two or more sets of *HVAC unit* ([3.1.3.1](#)) per car

Note 1 to entry: This can also be referred to as “dispersed system”.

3.1.3 Equipment

3.1.3.1

HVAC unit

unit intended for *cooling* ([3.1.1.1](#)) and/or *dehumidification* ([3.1.1.3](#)) and/or *heating* ([3.1.1.4](#)), and/or *ventilation* ([3.1.1.7](#))

3.1.3.2

controller unit

unit which operates the HVAC system in a predetermined behaviour while exchanging data with external devices

3.1.3.3**cooling unit**

system which provides *cooling* (3.1.1.1)

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.1.3.4**heating unit**

system which provides *heating* (3.1.1.4)

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.1.3.5**supplementary heater**

heater that carries out a *heating* (3.1.1.4) function in a decentralized manner either associated with *forced air ventilation* (3.1.1.9) or not

Note 1 to entry: This can also be referred to as “auxiliary heater”.

Note 2 to entry: This can include floor heater, roof heater, body side heater, entrance heater, duct heater, etc.

Note 3 to entry: See [Figure 5](#).

3.1.3.6**total heat exchanger**

device using temperature and humidity difference to recover energy

3.1.3.7**ventilation unit**

system ensuring *ventilation* (3.1.1.7)

Note 1 to entry: See [Figure 3](#).

3.1.3.8**exhaust air fan****exhaust air unit**

device or unit providing the extraction of air by mechanical action to the outside

Note 1 to entry: See [Figure 4](#).

3.1.3.9**supplementary fan**

device installed outside of *HVAC unit* (3.1.3.1) to move the air locally

Note 1 to entry: See [Figure 3](#).

3.1.3.10**booster fan**

supplementary fan (3.1.3.9) used to compensate (part of) the pressure drop inside air ducts

3.1.3.11**pressure protection device**

device providing protection against undue vehicle interior tympanic pressure variations caused by exterior pressure variations

3.1.3.12**pressure protection fan**

device providing pressure protection while maintaining a certain degree of *ventilation* (3.1.1.7)

3.1.3.13**ducting**

installations that guide air flows

3.1.3.14

air diffuser

device for blowing the air in one or more directions while reducing the air velocity

3.1.3.15

air grille

device that provides physical protection, yet allows air to pass through

3.1.3.16

silencer

device to reduce air borne noise

3.1.4 Operation

3.1.4.1

automatic mode

automatic operating mode

operating mode of control in which the HVAC system operates in accordance with the programme data until stopped by the programme or the operator

[SOURCE: ISO 13041-1:2004, 3.3.4, modified and adapted to HVAC system]

3.1.4.2

cooling mode

operating mode in which the *HVAC unit* ([3.1.3.1](#)) provides *cooling* ([3.1.1.1](#))

3.1.4.3

forced cooling mode

mode which manually operates *HVAC unit* ([3.1.3.1](#)) *cooling mode* ([3.1.4.2](#))

3.1.4.4

pre-cooling mode

mode which enables the interior temperature to be lowered (without the presence of passengers)

3.1.4.5

free cooling mode

operating mode in which the HVAC system provides *cooling* ([3.1.1.1](#)) by only introducing *fresh air* ([3.4.1](#))

3.1.4.6

heating mode

operating mode in which the HVAC system provides *heating* ([3.1.1.4](#))

3.1.4.7

heat pump mode

mode which can heat the interior by altering the heat emission and removal from the *heat exchangers* ([3.2.3.5](#)) by changing the *refrigerant* ([3.2.3.3](#)) flow

3.1.4.8

forced heating mode

mode which manually operates *HVAC unit* ([3.1.3.1](#)) *heating mode* ([3.1.4.6](#))

3.1.4.9

pre-heating mode

mode which enables the interior temperature to be raised (without the presence of passengers)

3.1.4.10

ventilation mode

mode which provides *ventilation* ([3.1.1.7](#)) only

3.1.4.11**frost protection mode**

mode to raise temperatures and avoid interior freezing

3.1.4.12**degraded mode**

operation of the HVAC system with defined limitations in performance

3.1.4.13**power save mode**

mode which actively reduces its power consumption by allowing parameters to change

Note 1 to entry: Set point and *fresh air* (3.4.1) are examples of parameters.

3.1.4.14**standby mode**

mode under which a predetermined interior temperature range is maintained during non-operational activity of the vehicle

3.1.4.15**emergency mode**

mode which provides reduced *ventilation* (3.1.1.7), *heating* (3.1.1.4) and/or *cooling* (3.1.1.1) if the main power source has failed

3.1.4.16**maintenance mode**

mode used for the purpose of maintenance activities which calls up automatic predefined testing

3.1.4.17**test mode**

mode used for the purpose of test activities which calls up a specified routine or requires some specific testing during maintenance

3.1.4.18**washing mode**

mode for external cleaning of train

3.1.5 Performance**3.1.5.1****cooling capacity**

enthalpy reduction between the *fresh air* (3.4.1) and/or *return air* (3.4.11) on one hand and *primary air* (3.4.4) on the other hand in a defined interval of time

3.1.5.2**pre-cooling time**

time needed for lowering the interior temperature to *pre-cooling* (3.1.1.2) set point

3.1.5.3**heating capacity**

enthalpy elevation between the *fresh air* (3.4.1) and/or *return air* (3.4.11) on one hand and *primary air* (3.4.4) on the other hand which can be supported by the *supplementary heater* (3.1.3.5) in a defined interval of time

3.1.5.4**pre-heating time**

time needed for increasing the interior temperature to *pre-heating* (3.1.1.5) set point

3.1.5.5

design conditions

specified exterior/interior boundary conditions under which the *thermal comfort* (3.7.1) parameters need to be achieved

3.1.5.6

rated conditions

set of operating conditions specified in a contractual/technical specification

3.1.5.7

standard rating conditions

mandatory condition that is used for marking and for comparison or certification purposes

[SOURCE: ISO 13612-2:2014, 3.40]

3.1.5.8

extreme conditions

specified exterior/interior boundary conditions beyond the *design conditions* (3.1.5.5) under which the functionality of the HVAC system installation is maintained but *thermal comfort* (3.7.1) parameters do not need to be achieved

3.1.5.9

volume flow

volumetric air flow rate which passes per unit time

3.1.5.10

water tightness

ability of the closed test specimen to resist water penetration

[SOURCE: ISO 15821:2007, 3.6]

3.2 HVAC unit

3.2.1 Type

3.2.1.1

compact HVAC unit

unit where all *refrigerant* (3.2.3.3) components are installed in the same location

Note 1 to entry: This can also be referred to as “packaged” or “self-contained”.

3.2.1.2

split HVAC unit

unit where *refrigerant* (3.2.3.3) components are installed in different locations

3.2.2 Location

3.2.2.1

roof mounted

mounted on the roof

Note 1 to entry: See [Figure 1](#) a).

3.2.2.2

roof embedded

installed in the roof

Note 1 to entry: See [Figure 1](#) b).

3.2.2.3**ceiling mounted**

installed between the ceiling and the roof

Note 1 to entry: See [Figure 1](#) c).

3.2.2.4**on floor mounted**

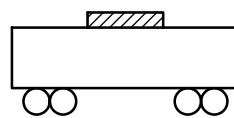
mounted on the floor

Note 1 to entry: See [Figure 1](#) d).

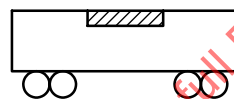
3.2.2.5**under floor mounted**

installed within the underframe

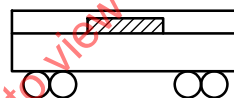
Note 1 to entry: See [Figure 1](#) e).



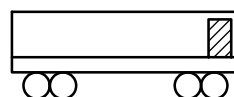
a) roof mounted ([3.2.2.1](#))



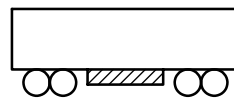
b) roof embedded ([3.2.2.2](#))



c) ceiling mounted ([3.2.2.3](#))



d) on floor mounted ([3.2.2.4](#))



e) underfloor mounted ([3.2.2.5](#))

Figure 1 — Diagram explaining the HVAC unit location

3.2.3 Components and parameters**3.2.3.1****air handling unit**

group of components designed to move, filter and/or mix, heat and/or cool the air

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.2.3.2**compressor condenser unit**

part of the *HVAC unit* ([3.1.3.1](#)) where heat is dissipated

3.2.3.3

refrigerant

fluid used for heat transfer in a refrigerating circuit

[SOURCE: ISO 817:2014, 3.1.35, modified — “system” has been replaced by “circuit”.]

3.2.3.4

compressor

device for mechanically increasing the pressure of a refrigerant vapour

[SOURCE: ISO 5149-1:2014, 3.4.2]

3.2.3.5

heat exchanger

device designed to transfer heat between two physically separated fluids

[SOURCE: ISO 5149-1:2014, 3.4.3]

3.2.3.6

condenser

heat exchanger ([3.2.3.5](#)) in which refrigerant vapour is liquefied by removal of heat

[SOURCE: ISO 5149-1:2014, 3.4.4]

3.2.3.7

evaporator

heat exchanger ([3.2.3.5](#)) in which liquid *refrigerant* ([3.2.3.3](#)) is vaporized by absorbing heat

[SOURCE: ISO 5149-1:2014, 3.4.6, modified — “from the substance to be cooled” has been deleted.]

3.2.3.8

gas cooler

heat exchanger ([3.2.3.5](#)) in which refrigerant vapour is cooled by removal of heat

3.2.3.9

condenser fan

device providing air flow across the *condenser* ([3.2.3.6](#)) to remove heat

3.2.3.10

supply air fan

device providing air circulation and transfer air to the interior

Note 1 to entry: This can also be referred to as “evaporator fan” or “evaporator blower”.

3.2.3.11

leak detector

sensing device which responds to a pre-set concentration of *refrigerant* ([3.2.3.3](#)) in the environment

[SOURCE: ISO 5149-1:2014, 3.6.9]

3.2.3.12

hermetic system

refrigerating system in which all *refrigerant* ([3.2.3.3](#)) containing parts are made tight by welding, brazing, or a similar permanent connection

Note 1 to entry: This can also be referred to as “sealed system”.

[SOURCE: ISO 5149-1:2014, 3.1.11, modified — Original Note 1 to entry has been replaced.]

3.2.3.13

semi-hermetic system

refrigerating system in which some or all refrigerant-containing parts are made tight by non-permanent connections such as compression fittings, push connectors or flange connections

3.2.3.14**high-pressure side**

part of a refrigerating system operating approximately at the *compressor* (3.2.3.4) output pressure

Note 1 to entry: This can also be referred to as “condensing pressure side” or “discharge pressure side”.

[SOURCE: ISO 5149-1:2014, 3.1.7, modified — “condenser” has been replaced by “compressor output” and Note 1 to entry has been added.]

3.2.3.15**low pressure side**

part of a refrigerating system operating approximately at the *compressor* (3.2.3.4) input pressure

Note 1 to entry: This can also be referred to as “evaporating pressure side” or “suction pressure side”.

[SOURCE: ISO 5149-1:2014, 3.1.8, modified — “evaporator” has been replaced by “compressor input” and Note 1 to entry has been added.]

3.2.3.16**design pressure**

gauge pressure chosen for the strength calculation of each component

[SOURCE: ISO 5149-1:2014, 3.3.1, modified — Note 1 to entry has been deleted.]

3.2.3.17**maximum working pressure**

maximum gauge pressure which a system or component is operated as specified by the manufacturer

3.2.3.18**rated static pressure of the HVAC unit**

difference of the static pressure between the *return air* (3.4.11) port and the *conditioned air* (3.4.3) discharging port at the rated airflow

3.2.3.19**pressure relief device**

pressure relief valve or bursting disc device designed to relieve excessive pressure automatically

[SOURCE: ISO 5149-1:2014, 3.6.7]

3.2.3.20**safety switching device for limiting the pressure**

pressure activated device that is designed to stop operation of the pressure generator

[SOURCE: ISO 5149-1:2014, 3.6.10, modified — “type-approved” has been deleted.]

3.2.3.21**shut-off device**

device to shut off the flow of the *refrigerant* (3.2.3.3)

[SOURCE: ISO 5149-1:2014, 3.5.12, modified — “fluid” has been replaced by “refrigerant”.]

3.2.3.22**expansion device**

orifice or regulating valve through which the *refrigerant* (3.2.3.3) expands to a lower pressure

[SOURCE: ISO 13043:2011, 3.3.8, modified — “vapour prior to entering the evaporator” has been deleted.]

3.3 Vehicle space

3.3.1

comfort envelope

compartment or saloon area normally occupied by passengers

3.3.2

comfort zone

subset of the *comfort envelope* (3.3.1) such as compartments or other areas

3.3.3

local annexes

places where passengers stay temporarily
EXAMPLE Toilets, washrooms, corridors, telephone booths, etc.

3.3.4

catering service area

space or compartment reserved for staff specializing in the preparation and/or the sale of goods

3.4 Air classification

3.4.1

fresh air

outside air
air taken from outside the vehicle

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.2

mixed air

combination of fresh/outside air and *return air* (3.4.11)

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.3

conditioned air

treated air

air that can have been filtered and/or had energy exchanged as it passed through the *air handling unit* (3.2.3.1)

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.4

primary air

conditioned air (3.4.3) entering the ducts from the *HVAC unit* (3.1.3.1)

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.5

induced air

interior air (3.4.7) taken locally and added to the *primary air* (3.4.4) without additional conditioning

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.6

supply air

primary air (3.4.4) that can be combined with some *induced air* (3.4.5), supplied to a specified space

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.7**interior air**

air contained in a specified space

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.8**transfer air**

air moving from a specified interior space to another interior space

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.9**extract air**

air leaving an interior specified space to be fed into the *exhaust air* ([3.4.10](#)) or *return air* ([3.4.11](#))

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.10**exhaust air**

air rejected outside the vehicle

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.11**return air**

air taken from the interior of a specified space and returned to *HVAC unit* ([3.1.3.1](#)) to be reused

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.12**supplementary air****secondary air**

air taken from the interior of a specified space, treated locally and returned to the same space

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

Note 2 to entry: By *supplementary fan* ([3.1.3.9](#)) or *heating* ([3.1.1.1](#)) are examples of local treatment.

3.4.13**exfiltration air**

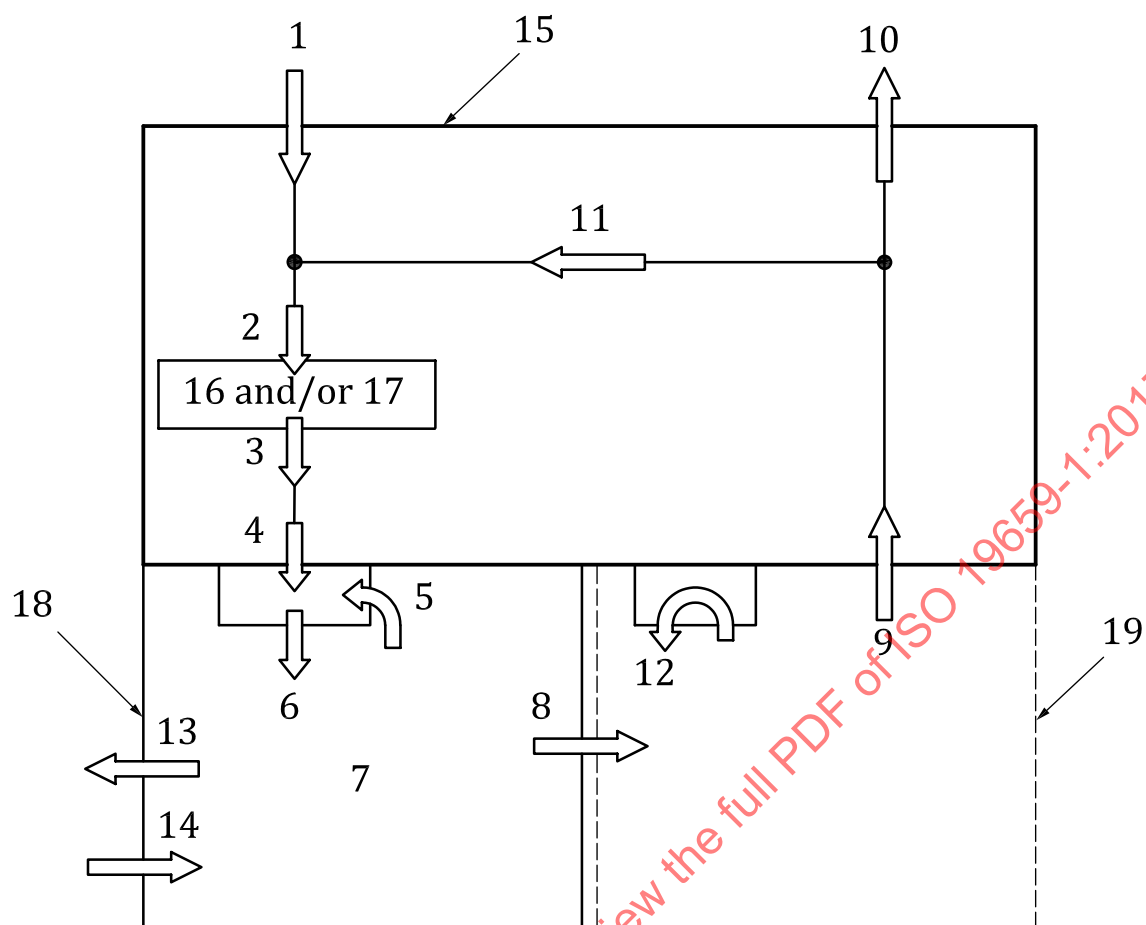
air movement caused by leakage from interior to exterior depending on *pressure differential* ([3.6.1](#))

Note 1 to entry: See [Figure 2](#) to [Figure 5](#).

3.4.14**infiltration air**

air movement caused by leakage from exterior to interior depending on *pressure differential* ([3.6.1](#))

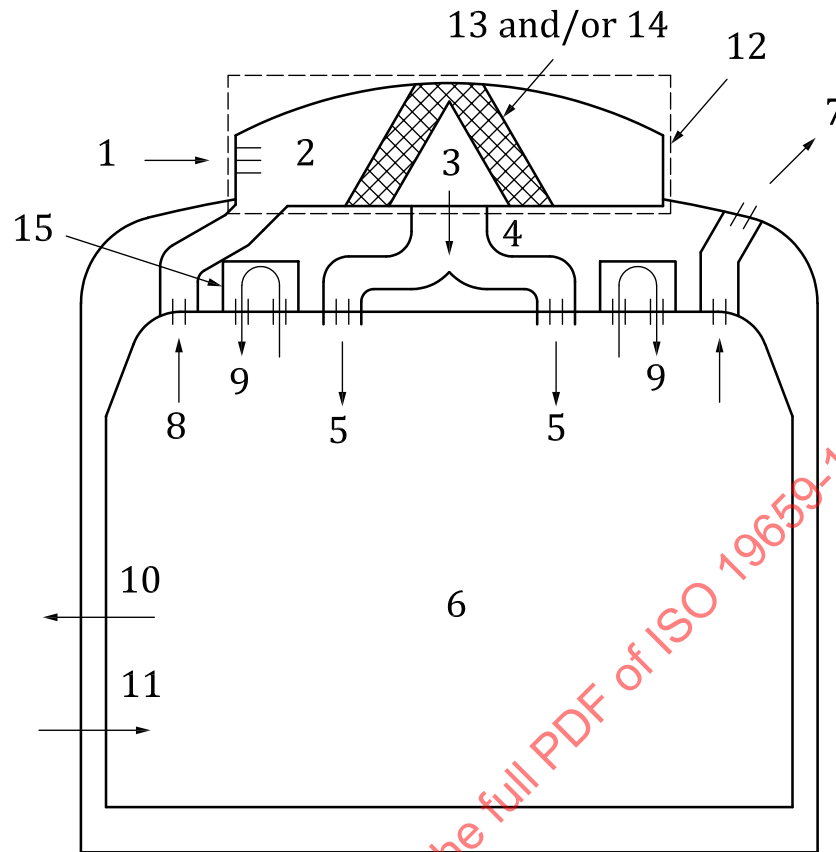
Note 1 to entry: See [Figure 2](#) to [Figure 5](#).



Key

- | | |
|---|---|
| 1 fresh air/outside air (3.4.1) | 11 return air (3.4.11) |
| 2 mixed air (3.4.2) | 12 supplementary air/secondary air (3.4.12) |
| 3 conditioned air/treated air (3.4.3) | 13 exfiltration air (3.4.13) |
| 4 primary air (3.4.4) | 14 infiltration air (3.4.14) |
| 5 induced air (3.4.5) | 15 air handling unit (3.2.3.1) |
| 6 supply air (3.4.6) | 16 cooling unit (3.1.3.3) |
| 7 interior air (3.4.7) | 17 heating unit (3.1.3.4) |
| 8 transfer air (3.4.8) | 18 compartment 1 |
| 9 extract air (3.4.9) | 19 compartment 2 |
| 10 exhaust air (3.4.10) | |

Figure 2 — Generic diagram explaining certain air classification terms

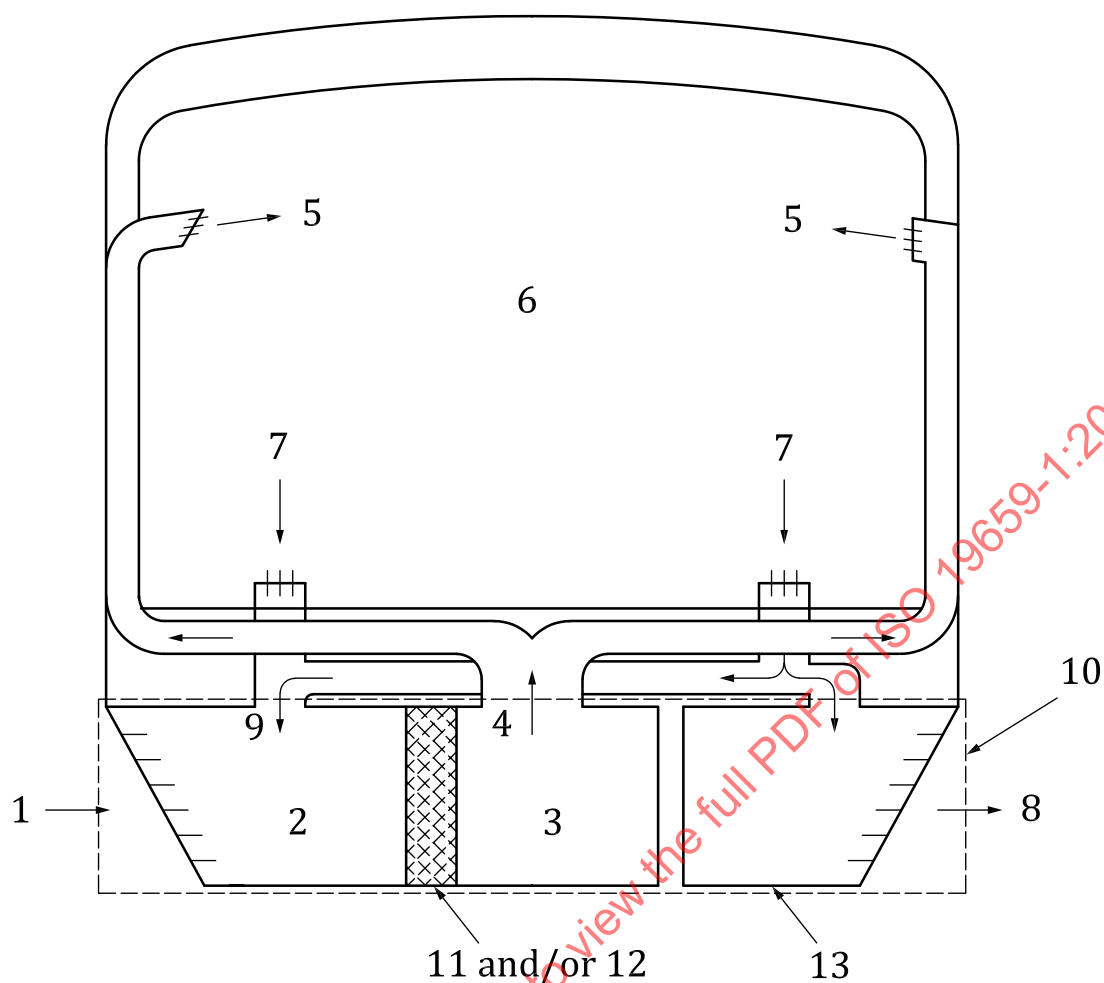


Key

- | | |
|---------------------------------------|--|
| 1 fresh air/outside air (3.4.1) | 9 supplementary air/secondary air (3.4.12) |
| 2 mixed air (3.4.2) | 10 exfiltration air (3.4.13) |
| 3 conditioned air/treated air (3.4.3) | 11 infiltration air (3.4.14) |
| 4 primary air (3.4.4) | 12 air handling unit (3.2.3.1) |
| 5 supply air (3.4.6) | 13 cooling unit (3.1.3.3) |
| 6 interior air (3.4.7) | 14 heating unit (3.1.3.4) |
| 7 exhaust air (3.4.10) | 15 supplementary fan (3.1.3.9) |
| 8 return air (3.4.11) | |

NOTE This figure is only given as an example and does not prejudice the design of the installations.

Figure 3 — Diagram explaining certain air classification terms (example of a HVAC system with roof mounted units)

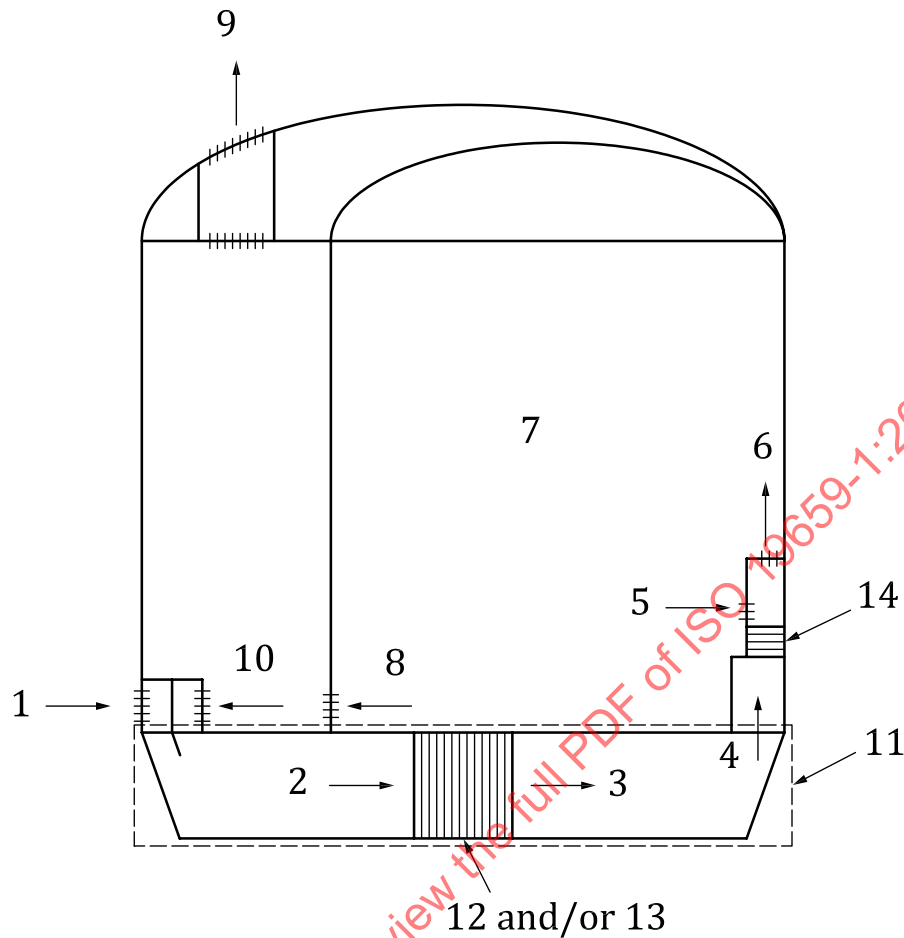


Key

- | | | | |
|---|-------------------------------------|----|--------------------------------|
| 1 | fresh air/outside air (3.4.1) | 8 | exhaust air (3.4.10) |
| 2 | mixed air (3.4.2) | 9 | return air (3.4.11) |
| 3 | conditioned air/treated air (3.4.3) | 10 | air handling unit (3.2.3.1) |
| 4 | primary air (3.4.4) | 11 | cooling unit (3.1.3.3) |
| 5 | supply air (3.4.6) | 12 | heating unit (3.1.3.4) |
| 6 | interior air (3.4.7) | 13 | exhaust air fan/unit (3.1.3.8) |
| 7 | extract air (3.4.9) | | |

NOTE This figure is only given as an example and does not prejudice the design of the installations.

Figure 4 — Diagram explaining certain air classification terms (example of a HVAC system with under floor mounted units)



Key

- | | | | |
|---|---|----|--|
| 1 | fresh air/outside air (3.4.1) | 8 | transfer air (3.4.8) |
| 2 | mixed air (3.4.2) | 9 | exhaust air (3.4.10) |
| 3 | conditioned air/treated air (3.4.3) | 10 | return air (3.4.11) |
| 4 | primary air (3.4.4) | 11 | air handling unit (3.2.3.1) |
| 5 | induced air (3.4.5) | 12 | cooling unit (3.1.3.3) |
| 6 | supply air (3.4.6) | 13 | heating unit (3.1.3.4) |
| 7 | interior air (3.4.7) | 14 | supplementary heater (3.1.3.5) |

NOTE This figure is only given as an example and does not prejudice the design of the installations.

Figure 5 — Diagram explaining certain air classification terms (example of a HVAC system of compartmented coach/car: with under floor mounted units)

3.5 Thermal load

3.5.1

mean exterior temperature

T_{em}

arithmetic mean of the exterior air temperatures

3.5.2

mean interior temperature

T_{im}

arithmetic mean of the *interior air* ([3.4.7](#)) temperatures of one comfort zone

3.5.3

horizontal temperature range

ΔT_h

difference of the maximum to minimum *interior air* (3.4.7) temperatures at a defined height in a horizontal section

3.5.4

vertical temperature range

ΔT_v

difference of the maximum to minimum *interior air* (3.4.7) temperatures for a seated or standing position in a vertical direction

3.5.5

interior temperature setting

T_{ic}

target *interior air* (3.4.7) temperature

3.5.6

heat load

P or $\dot{Q}$

quantity of heat per unit time which flows in or out and generated at the vehicle interior

3.5.7

overall heat transfer coefficient

k

ratio between the density of the heat flow rate per unit of surface area and the prevailing difference in temperature (T_{im}) and (T_{em}) across the relevant walls of the vehicle

3.5.8

solar load

P_s or $\dot{Q}_s$

heat load (3.5.6) by solar radiation

3.5.9

equivalent solar load

E_n

total heat received by 1 m² surface perpendicular to the radiation emitted by a luminous source (solar equivalent) when inclined at an angle identified by X degree to the horizontal axis

Note 1 to entry: X can be defined by country.

3.5.10

total solar energy transmittance

g

ratio between the overall energy flow transmitted to the interior of the vehicle through the window and the incident solar radiation

Note 1 to entry: Full reference for transmittance is described in ISO 9050.

Note 2 to entry: This can also be referred to as "solar factor".

3.5.11

heat load per person

P_p or $\dot{Q}_p$

heat load (3.5.6) that a passenger and/or train staff emits

3.5.12

fresh air heat load

heat load (3.5.6) required to cool or heat the *fresh air* (3.4.1) to the required interior condition