BUREAU OF INDIAN STANDARDS

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भारतीय मानक **मसौदा**

घरेलू और समान इलेक्ट्रिकल साधित्र – सुरक्षा –

विद्युत ताप पंप, एयर कंडीशनर और डीह्यूमिडिफायर की विशेष अपेक्षाएँ

(IEC 60335-2-40 : 2022, का *संशोधित अधिग्रहण*)

Draft *Indian Standard*

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

PARTICULAR REQUIREMENTS FOR ELECTRICAL HEAT PUMPS, AIR-CONDITIONERS AND DEHUMIDIFIERS

(*Modified Adoption* of IEC 60335-2-40 : 2022)

ICS 23.120

Refrigeration and Air Conditioning Sectional Committee, MED 03	Last date for receipt of comments is **05 March 2025**

NATIONAL FOREWORD
(*Formal clause will be added later on*)

This standard was earlier published as IS/IEC 60335-2-40 : 2018 ‘Household and Similar Electrical Appliances — Safety Part 2-40 Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers’. The new standard has been taken up to adopt the standard IEC 60335-2-40 : 2022 ‘Household and similar electrical appliances – Safety – Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers’ with modifications.

This new standard supersedes IS/IEC 60335-2-40 : 2018 ‘Household and Similar Electrical Appliances — Safety Part 2-40 Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers’.

The IEC standard has been approved for publication as Indian Standard with modifications (*see* National Annex SS). Additionally, certain terminologies and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’; and
b) Comma (,) has been used as a decimal marker while in Indian Standards the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standard for which Indian Standard also exist. The corresponding Indian Standards, which are to be substituted in their respective places, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60079-0 Explosive atmospheres – Part 0: Equipment – General requirements	IS/IEC 60079-0 : 2017, Explosive atmospheres Part 0 Equipment — General requirements (*third revision*)	Identical
IEC 60079-7 : 2015 Explosive atmospheres − Part 7: Equipment protection by increased safety "e" IEC 60079-7 : 2015/AMD1 : 2017	IS/IEC 60079-7 : 2017, Explosive atmospheres Part 7 Equipment protection by increased safety 'e' (*second revision*)	Identical
IEC 60079-14 : 2013 Explosive atmospheres − Part 14: Electrical installations design, selection and erection	IS 16724 : 2018/IEC 60079-14 : 2013, Explosive atmospheres — Electrical installations design, selection and erection	Modified
IEC 60079-15 : 2017 Explosive atmospheres – Part 15: Equipment protection by type of protection "n"	IS/IEC 60079-15 : 2017, Explosive atmospheres Part 15 Equipment protection by type of protection 'n' (*second revision*)	Identical
IEC 60335-2-34 : 2021 Household and similar electrical appliances – Safety – Part 2-34: Particular requirements for motor-compressors	IS/IEC 60335-2-34 : 2021, Household and similar electrical appliances — Safety Part 2-34 Particular requirements for motor-compressors	Identical
IEC 60695-1-10 Fire hazard testing – Part 1-10: Guidance for assessing the fire hazard of electro-technical products – General guidelines	IS/IEC 60695-1-10 : 2016, Fire hazard testing Part 1 Guidance for assessing the fire hazard of electro-technical products Section 10 General guidelines	Identical
IEC 60695-10-2 : 2014 Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method	IS/IEC 60695-10-2 : 2014, Fire hazard testing Part 10 Abnormal heat Section 2 Ball pressure test method	Identical
IEC 62471 : 2006 Photo-biological safety of lamps and lamp systems	IS 16108 : 2012/IEC 62471 : 2006, Photo-biological safety of lamps and lamp systems	Identical
ISO 817 Refrigerants – Designation and safety classification	IS 16656 : 2017/ISO 817 : 2014, Refrigerants — Designation and Safety Classification	Identical
ISO 527-3 Plastics − Determination of tensile properties − Part 3: Test conditions for films and sheets	IS 13360 (Part 5/Sec 3): 2022/ISO 527-3 : 2018, Plastics — Method of testing Part 5 Mechanical properties Section 3 Determination of tensile properties — Test conditions for films and sheets (*second revision*)	Identical
ISO 2578 Plastics – Determination of time-temperature limits after prolonged exposure to heat	IS 13360 (Part 6/Sec 22) : 2006/ISO 2578 : 1993, Plastics — Methods of testing Part 6 Thermal properties Section 22 determination of time-temperature limits after prolonged exposure to heat	Identical

ISO 5149-1 : 2014 Refrigerating systems and heat pumps – Safety and environmental requirements – Part 1: Definitions, classification and selection criteria ISO 5149-1 : 2014/AMD1 : 2015 ISO 5149-1 : 2014/AMD2 : 2021	IS 16678 (Part 1) : 2018/ISO 5149-1 : 2014, Refrigerating systems and heat pumps — Safety and environmental requirements Part 1 Definitions, classification and selection criteria	Identical
ISO 5149-2 : 2014 Refrigerating systems and heat pumps – Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation ISO 5149-2:2014/AMD1:2020	IS 16678 (Part 2) : 2018/ISO 5149-2 : 2014, Refrigerating systems and heat pumps — Safety and environmental requirements Part 2 Design, construction, testing, marking and documentation	Identical
ISO 5149-3 : 2014 Refrigerating systems and heat pumps – Safety and environmental requirements – Part 3: Installation site ISO 5149-3 : 2014/AMD1:2021	IS 16678 (Part 3) : 2018/ISO 5149-3 : 2014, Refrigerating systems and heat pumps — Safety and environmental requirements Part 3 Installation site	Identical
ISO 7010 : 2019 Graphical symbols – Safety colours and safety signs – Registered safety signs	IS 16451 : 2023/ ISO 7010 : 2019, Graphical symbols — Safety colours and safety signs — Registered safety signs (*first revision*)	Identical
ISO 13355 : 2016 Packaging − Complete, filled transport packages and unit loads − Vertical random vibration test	IS 15763 : 2020/ISO 13355 : 2016, Packaging — Complete, filled transport packages and unit loads — vertical random vibration test (*first revision*)	Identical

The Committee has reviewed the provisions of the following International Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

International Standard	*Title*
IEC 60068-2-52	Environmental testing – Part 2: Tests – Test Kb: Salt mist, cyclic (sodium, chloride solution)
IEC 60335-2-51	Household and similar electrical appliances – Safety – Part 2-51: Particular requirements for stationary circulation pumps for heating and service water installations
IEC 60730-2-6	Automatic electrical controls – Part 2-6: Particular requirements for automatic electrical pressure sensing controls including mechanical requirements
ISO 21920-1:2021	Geometrical product specifications (GPS) — Surface texture: Profile Part 1: Indication of surface texture
ISO 5151:2017 ISO 5151:2017/AMD1:2020	Non-ducted air conditioners and heat pumps – Testing and rating for performance
ISO 13253	Ducted air-conditioners and air-to-air heat pumps – Testing and rating for performance
ISO 13256-1:2021	Water-source heat pumps — Testing and rating for performance Part 1: Water-to-air and brine-to-air heat pumps

ISO 13256-2:2021	Water-source heat pumps — Testing and rating for performance Part 2: Water-to-water and brine-to-water heat pumps
ISO 14903	Refrigerating systems and heat pumps – Qualification of tightness of components and joints
ISO 15042	Multiple split-system air-conditioners and air-to-air heat pumps – Testing and rating for performance

This standard also makes a reference of technical deviation to the IEC standard. The deviations are given in **National Annex RR**.

While formulating this National Annex RR, the following standard has also been reviewed:

UL 60335-2-40 :2022 Household and Similar Electrical Appliances - Safety - Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (second revision)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

NATIONAL ANNEX SS
(*National Foreword*)

LISTS OF TECHNICAL DEVIATIONS

SS-1 The text of the International Standard IEC 60335-2-40 : 2022 has been approved for publication as Indian Standard with agreed modifications as indicated below.

1) Substitute 'ISO 1302 : 2002, Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation" with 'ISO 21920-1:2021 Geometrical product specifications (GPS) — Surface texture: Profile Part 1: Indication of surface texture' under the clause 2.

2) Insert the following in clause **7** at the end:

If the refrigerant charge (m_c) of the appliance is greater than m_1 as specified in **GG.1.2, t**he minimum floor area of the room shall be specified on the appliance. The area in the marking shall be specified in m^2 in accordance with Annex GG.

The following warning shall also be applied to the non-fixed appliance when a flammable refrigerant is employed:

"WARNING

Appliance shall be installed, operated and stored in a room with a floor area larger than __ m^2."

The warning shall be placed on the outside of the appliance such that it is visible when in service.

3) Insert the following note after Para 4 of Clause **GG.1.1**:

NOTE 2 For general requirements about LFL and molar mass (M) *see* Clause **1.4**, Clause **4.1**, and Table BB.1.

4) Substitute the existing para 5 of Clause **GG.1.1** with the following:

Toxicity charge limits shall be determined per ISO 5149-1. If the toxicity based charge limits are less than the flammability based charge limits, the toxicity charge limits shall take precedence.

5) Substitute the existing para 8 of Clause **GG.1.1** with the following:

If releasable charge is determined by Annex 101 or **GG.10**:

- For releasable charge $m_{\text{rl}} \leq m_1$, there is no requirement for minimum room area (A_{min}) and Clause **GG.6** does not apply.
- For releasable charge $m_{\text{rl}} \leq m_1$, each operating state of the refrigerating system shall comply with at least one of the clauses: **GG.2**, **GG.3**, **GG.4**, **GG.7**, **GG.9**. The Refrigerant Charge (m_c) may be replaced by the releasable charge (m_{rl}) in the equations of Annex GG.

6) Substitute the existing Table GG.1 with the following table:

Table GG.1 Outline of Annex GG
(*informative*)

Sl No.	**Refrigerant Charge**	**Direct System[a,e]**		**Indirect System[b]**
		Indoor Space	Outdoors	

		Refrigerant Charge and Room Area	Refrigerant Charge, Room Area and Additional Requirements	Additional Ventilation		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	$m_c \leq m_1$ or $m_{rl} \leq m_1$	No room size restriction	—	—	No room size restriction	No room size restriction, **GG.2.1**; **GG.6**
ii)	$m_1 < m_c \leq 2 \times m_1$ (appliances which are not fixed appliances)	Not allowed	**GG.7**	Not allowed		
iii)	$m_1 < m_c \leq m_2$	**GG.2.1**	**GG.2.2**[c], **GG.2.3**[e], **GG.9**[c], **GG.10**[c,d]	**GG.3**, **GG.8**[c], **GG.10**[c,d]		
iv)	$m_2 < m_c \leq m_3$	Not allowed	**GG.9**[c], **GG.10**[c,d]	**GG.3**, **GG.8**[c], **GG.10**[c,d]		
v)	$m_c > m_3$	ITE Annex RR; Machinery room; **GG.2.1**				

[a] Direct system means a refrigerating system in which a single rupture of the refrigerant circuit results in a refrigerant release to an indoor space, irrespective of the location of the refrigerant circuit.
[b] Indirect system means a refrigerating system in which a single rupture of the refrigerant circuit does not leak into an indoor space, irrespective of the location of the refrigerant circuit.
[c] These clauses are only applicable to appliances with A2L refrigerant.
[d] Refrigerant charge is limited to $m_1 < m_c \leq m_3$.
[e] For ITE cooling appliances using A2L refrigerants with refrigerant charge, $m_c > m_1$, Annex RR shall apply as applicable.

7) Insert the following in Clause **GG.1.1** at the end:

In no case shall the refrigerant charge limit determined in accordance with Annex GG or Annex RR exceeds the refrigerant charge limit determined in accordance with ISO 5149.

NOTE 5 The refrigerant charge limit determined in accordance with ISO 5149 accounts for the flammability, toxicity, and oxygen depriving properties of the refrigerant.

8) Substitute the existing equation (GG.1) of Clause **GG.1.2** with the following:

$$m_1 = 3 \times LFL \qquad \text{(GG.1)}$$

10) Insert the following after para 2 of Clause **GG.1.2**:
For an appliance which is non-fixed sealed single package unit using A2L refrigerants, then for m_1 calculation, use equation (GG.1).

9) Modification of Clause GG.1.3 by substituting ‘Clause GG.2 or m2’ with ‘Clause GG.2.1.1 or m2’.

10) Substitute the para 1 of Clause **GG.1.3.2** with the following:

For units mounted higher than 1.8 m, and in compliance with **GG.2.2**, spaces divided by partition walls which are no higher than 1.6 m shall be considered a single space.

11) Insert the following after the last bullet of Para 3 of Clause **GG.1.3.2**:

- The room into which refrigerant can leak, plus the connected adjacent room(s) shall have a total area of not less than A_{min} per Clause **GG.2.1**; and
- The room area in which the unit is installed shall be not less than 20 percent A_{min} as determined in Clause **GG.2.1**.

12) Substitute the existing of clauses **GG.2.1 and GG.2.2** with the following:

GG.2.1 General

The refrigerant charge (m_c) in each refrigerating system employing A2 and A3 refrigerants shall not exceed m_1.

The refrigerant charge (m_c) in each refrigerating system employing A2L refrigerants shall not exceed m3 except in the following case:

For appliances installed in machinery rooms as defined in ISO 5149 with a refrigerant charge of $m_c > m_3$, the requirements of ISO 5149 shall apply. The subsequent clauses **GG.2.1.1** through **GG.13** shall not apply. All other requirements of this standard shall apply. For appliances in which leaked refrigerant cannot enter the space or the air-stream connected to the space, no additional active mitigation is required and **GG.6** shall apply.

The requirements of ISO 5149 shall apply when $m_c > m_3$.

For ITE cooling appliances with a refrigerant charge of $m_c > m_3$, the requirements of Annex 101 shall apply.

The refrigerant charge (m_c) in each refrigerant system for non-fixed factory sealed single package units using A2L refrigerants shall not exceed 2 × m_1. For charges of $m_1 < m_c \leq 2 \times m_1$, the requirements of Clause **GG.7** shall apply.

See Figure GG.1.

ITE cooling appliances using A2L refrigerants with charge $m_c \leq m_3$, shall comply with Annex GG or Annex RR as specified by the manufacturer.

For the determination of m_{max} as used in equation (GG.7) in Clause **GG.1.3** of the Part 2, clause **GG.2.1.1** applies.

For fixed appliances using A2L refrigerant with a refrigerant charge of $m_1 \leq m_c \leq m_2$, the requirements of Clause **GG.2.1.1** apply. If each space has room area more than A_{min}, no further measure is required. If the room area is less than A_{min}, additional mitigation is required.

For fixed appliances serving a single room using A2L refrigerant with a refrigerant charge of $m_2 \leq m_c \leq m_3$ or when additional mitigation is required by Clause **GG.2.1.1**, Clause **G.G.2.2** shall apply if applicable. For fixed appliances with a refrigerant charge of $m_1 \leq m_c \leq m_3$, Clause **GG.8**, Clause **GG.9**, or Clause **GG.10** shall apply if applicable.

For fixed appliances serving one or more rooms with an air duct system, using A2L refrigerant with a refrigerant charge of $m_1 < m_c \leq m_3$, the requirements of Clauses **GG.2.1.1** and **GG.9** shall apply if applicable. If the total conditioned space has an area more than TA_{min}, no further measure is required. If the total conditioned space is less than TA_{min}, Clause **GG.8** shall apply if applicable.

For non-fixed factory sealed single package units with a refrigerant charge of $m_1 < m_c \leq 2 \times m_1$, the requirements of Clause **GG.7** shall apply.

For enhanced tightness refrigerant system appliances, including non-ducted and those serving one or more rooms with an air duct system, using A2L refrigerants with a refrigerant charge of $m_1 < m_c \leq m_3$ that comply with the conditions in Clause **22.125**. the requirements of Clause **GG.10** can apply.

For appliances with a refrigerant charge of $m_c \leq m_1$ no mitigation is required. Appliances with a refrigerant releasable charge of $m_{rl} \leq m_1$ no additional mitigation is required.

GG.2.1.1 Charge limits for appliance in unventilated areas

The maximum refrigerant charge in a room shall be in accordance with the following:

$$m_{max} = 2.5 \times LFL^{5/4} \times h_o \times A^{1/2}, \text{ not to exceed } m_{max} = SF \times LFL \times h_o \times A \quad .... \text{(GG.8)}$$

Alternatively, the required minimum floor area A_{min} to install an appliance with refrigerant charge (m_c) in kg shall be in accordance with following:

$$A_{min} = \left[\left(m_c / 2.5 \times LFL^{5/4} \times h_o\right)\right]^2, \text{ not less than } A_{min} = m_c / SF \times LFL \times h_o \quad ...... \text{(GG.9)}$$

where

m_{max} is the allowable maximum refrigerant charge in a room, in kg;

m_c is the refrigerant charge in the appliance, in kg;

A_{min} is the required minimum room area, in m_2;

A is the room area, in m^2;

2.5 is a constant;

LFL is the lower flammability limit, in kg/m^3;

SF is a safety factor with a value of 0.50;

h_o is the release height, the vertical distance in meters from the floor to the point of release when the appliance is installed (*see* Figure GG.3) i.e. $h_o = (h_{inst} + h_{rel})$ or 0.6 m whichever is higher; and

h_{rel} is the release offset in meters from the bottom of the appliance to the point of release (*see* Figure GG.3). Cumulative openings smaller than 5 cm^2 and openings with a single dimension of not more than 0.1 mm are not considered as openings where leaking refrigerant can escape. Openings for routing of wires and tubing which are not sealed openings shall include the total area of the opening without consideration of the area occupied by the tubing or wire; and

h_{inst} is the installed height in meters of the unit (*see* Figure GG.3).

Reference installed heights are given below:

h_{inst} = 0.0 for floor mounted

h_{inst} = 1.0 m for window mounted

h_{inst} = 1.8 m for wall mounted

h_{inst} = 2.2 m for ceiling mounted

If the minimum installed height given by the manufacturer is higher than the reference installed height, then in addition A_{min} and m_{max} for the reference installed height shall be given by the manufacturer. An appliance may have multiple reference installed heights. In this case, A_{min} and m_{max} calculations shall be provided for all applicable reference installed heights.

For appliances serving one or more rooms with an air duct system, the lowest opening of the duct connection to each conditioned space or any opening or cumulative openings in the indoor unit greater than 5 cm^2, at the lowest position to the space, shall be used for h_{o}.

A_{min} shall be calculated as a function of the opening heights of the duct to the spaces and the refrigerant charge for the spaces where leaked refrigerant can flow to, considering where the unit is located. A_{min} shall be calculated for the spaces where a duct is connected, or an indoor unit is located. If all spaces have room area more than A_{min}, no further measure is required.

GG.2.2 Fixed appliances using A2L refrigerants with integral circulation airflow

GG.2.2.1 General

When the fan incorporated in an appliance is

- initiated by a refrigerant detection system with a sufficient circulation airflow rate; or
- continuous when the indoor releasable charge is greater than m_1;

the maximum refrigerant charge may be increased or minimum room area may be reduced according to following:

The minimum circulation airflow velocity shall be 1 m/s. The velocity shall be calculated as airflow divided by the nominal face area of the outlet. The grill area shall not be deducted.

The minimum circulation airflow shall be:

$$Q_{min} = 30 \times m_c/LFL \qquad \text{..… (GG.10)}$$

where

Q_{min} is the minimum circulation airflow in m^3/h (1 m^3/h = 1/3600 m^3/s);

m_c is the actual refrigerant charge amount in the system in kg; and

LFL is the lower flammability limit in kg/m^3.

The maximum refrigerant charge in a room shall be in accordance with the following:

$$m_{max} = SF \times LFL \times h_0 \times A \quad \text{....... (GG.11)}$$

Alternatively, the required minimum room area A_{min} of installed appliance with refrigerant charge m_c (in kg) shall be in accordance with following:

$$A_c = m_c / SF \times LFL \times h_0 \quad \text{....... (GG.12)}$$

where

m_{max} is the allowable maximum refrigerant charge in the system in kg;

m_c is the actual refrigerant charge in the system in kg;

A_{min} is the required minimum room area in m^2;

h_0 is the release height, the vertical distance from the floor to the point of release when the appliance is installed in;

A is the room area in m^2;

SF is a safety factor with a value of 0.50;

LFL is the lower flammability limit in kg/m^3; and

Compliance with Q_{min} shall be determined by the fan table for the unit.

GG.2.2.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be detected continuously or monitored continuously. Within 10 s in the event that the airflow is reduced below Q_{min}, the following actions shall be taken:

- provide an output signal such that airflow is reduced; and
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.2.2.3 Circulation airflow activated by a leak detection system

If a leak detection system is activated, the following actions shall be taken and continued for at least 5 minutes after the leak detection system has reset:

a) the fan shall be energized within 10 s following the input signal to turn on the fan;

b) Q_{min} shall be confirmed by fan curve analysis at 0.0 mm of water column or lowest listed external static pressure; and
c) disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

13) Substitute the last line in para 4 of Clause **GG.3** with the following:

The appliance enclosure shall have a ventilation system that produces airflow within the appliance enclosure and meets the requirements of Clause **GG.4**, or if installed in a machinery room meets the requirements of Clause **GG.5**.

14) Substitute the existing of Clause **GG.4** with the following:

GG.4 Requirements for mechanical ventilation within the appliance enclosure

Requirements for mechanical ventilation within the appliance enclosure. The refrigerating circuit is provided with a separate enclosure that does not allow flow from inside the enclosure to the room. The appliance enclosure shall have a ventilation system that produces airflow from the appliance interior to the outside through an exhaust ventilation duct. The manufacturer shall specify the exhaust ventilation duct dimensions, the maximum length and number of bends. The negative pressure measurement in the interior of the appliance enclosure shall be 20 Pa or more and the flow rate to the exterior shall be at least Q_{min}.

$$Q_{\text{min}} = 3\,600 \times 1/CF \times 24.5/M \times \dot{m}_{\text{leak}} \text{ (with a minimum of 2 m}^2\text{/h)} \quad \text{.... (GG.16)}$$

where

3 600 is a conversion of sec to h;

CF is a concentration factor with a value of 0.25;

M is the molar mass of refrigerant in kg/kmol;

Q_{min} is the minimum required volume flow of the ventilation in m^3/h;

24.5 is the universal gas constant *R* multiplied by temperature of 25 °C and divided by pressure of 101.325 kPa in l/mol; and

$\dot{m}_{\text{leak}}$ is the leak rate in kg/s.

For refrigerating systems which are not enhanced tightness refrigerating systems, the leak rate ($\dot{m}_{\text{leak}}$) shall be determined as follows:

$$\dot{m}_{\text{leak}} = m_{\text{c}}/240 \quad \text{..... (GG.17)}$$

where

m_{c} is the refrigerant charge in kg; and

240 is the 4 min release time in s.

For enhanced tightness refrigerating systems, the leak rate ($\dot{m}_{\text{leak}}$) shall be taken as 0.002 78 kg/s

Ventilation shall be to the outside or to a room with a minimum volume as specified in clause **GG.2**. The ventilation shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below Q_{min}, the following actions shall be taken:

a) provide output signal that airflow is reduced; or
b) disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released into the enclosure.

The ventilation is switched on by a refrigerant detection system and the following actions shall be taken and continued for at least 5 min after the refrigerant detection system has reset:

a) energize the fan(s) of the appliance to deliver airflow at or above the minimum airflow Q_{min}; or
b) disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the enclosure.

Compliance for the appliance ventilation system is checked by the following tests.

The appliance shall be installed in accordance with the instructions and the ventilation shaft shall not exceed the maximum length and number of bends specified by the manufacturer.

The room shall be at least 10 times the volume of the appliance and with sufficient make-up air to replace any air exhausted during the test. The air pressure differential is measured between the interior of the appliance enclosure and the room. The airflow rate shall be measured at the outside end of the ventilation shaft.

15) Substitute '*LFL* is the lower flammability limit in kg/m^3' with '*LFL* as referenced in Annex BB' in clause **GG.7.1**.

16) Substitute the existing para 3 and 4 of clause **GG.7.1** with the following:

The minimum circulation airflow velocity shall be 1 m/s. The velocity shall be calculated as airflow divided by the nominal face area of the outlet. The grill area shall not be deducted.

The appliance shall incorporate a fan to provide minimum circulation airflow of

$$Q_{\text{min}} = 30 \times m_{\text{c}}/LFL \qquad \text{….. (GG.20)}$$

where

Q_{min} is the minimum circulation airflow in m^3/h;

m_{c} is the actual refrigerant charge amount in the system in kg; and

LFL is the lower flammability limit in kg/m^3.

The fan shall either run continuously, even when the compressor is switched off by the thermostat, or the fan shall be activated by a refrigerant detection system per Annex LL.

If a refrigerant detection system is activated, the following actions shall be taken and continued for at least 5 min after the refrigerant detection system has reset:

a) the fan shall be switched on; and
b) disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

17) Insert the following para to clause **GG.7.2.4** at the end:

At the end of the test there shall be no refrigerant leak detected when checked with detection equipment with a capability of detecting 3 g per year of refrigerant, when measured in the off condition at ambient temperature.

18) Substitute the existing of clause **GG.7.3** with the following:

Under normal operation, vibrations in refrigerant containing piping shall not exceed 0.30 g rms, when measured with a low pass filter at 200 Hz. The vibration acceleration shall be measured at critical points on the piping.

Compliance is checked by the following test.

The appliance is installed in accordance with the installation instructions. It is supplied at rated voltage or at the upper limit of the rated voltage range and operated at ambient temperature. The appliance shall be positioned in accordance with the manufacturer’s instructions. Testing shall be conducted in the fan-only mode and in the heating and cooling mode, if applicable.

Vibration levels shall be measured over the full range, + 5 percent of the maximum speed and - 5 percent of the minimum speed, of the compressor and indoor fan speeds as allowed by the controls at + 10 percent and - 10 percent input frequency, in consideration of the operation modes.

For compressors and fans with discrete steps in speed, the vibration shall be measured at each step, + 10 percent and - 10 percent. If the equipment trips on a protective device, the maximum speed and frequency may be reduced until the equipment stays on line as intended.

Care should be taken that the measurement sensors do not influence the line vibration level, and that the rate of change of speed is sufficiently slow that the maximum vibration is captured.

This test may be made on a separate sample.

19) Modify the title of Clause **GG.8.2** by inserting ‘requirements for appliances using A2L refrigerants’ at the end and

20) Renumber the equations (GG.20) to (GG.21) and (GG.21) to (GG.22) .

21) Modify the title of Clause **GG.8.3** by inserting ‘system’ after the word “ventilation”.

22) Substitute the existing of Clause **GG.8.3.1.1** with the following:

The mechanical ventilation system fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be detected continuously or monitored continuously. Within 10 s in the event that the airflow is reduced below, $Q_{\min}$, the following actions shall be taken:

a) Disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space; and
b) Provided an output signal that airflow is reduced.

Compliance is checked by inspection.

23) Substitute the existing of Clause **GG.8.3.1.2** with the following:

Mechanical ventilation system activated by a refrigerant detection system, if a leak detection system is activated, the following actions shall be taken and continue for at least 5 min after the refrigerant detection system has reset:

a) Energize the mechanical ventilation system of the appliance to deliver indoor airflow at or above the minimum airflow, Q_{min}; and
b) Disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

24) Substitute the existing of Clause **GG.8.3.2** with the following:

The airflow shall be calculated using the equation. Losses caused by ducts or other components in the air stream shall be considered.

$$Q_{\mathrm{min}} = \frac{m_{\mathrm{c}} - m_{\mathrm{max}}}{4 \times LFL} \times 2 \times 60 \qquad \text{……. (GG.23)}$$

where

Q_{min} is the required airflow volume in m^3/h;

m_{max} is the maximum refrigerant charge for the system in the room in kg according to equation (**GG.3**) or m_2, whichever is lower, or Clause **GG.9**, where applicable.

m_{c} is the actual refrigerant charge of a single refrigerating system in kg;

4 is the assumed leak time (4 min);

2 is a safety factor of 2;

60 is the conversion minutes to hours; and

LFL is the lower flammability limit in kg/m^3.

Mechanical ventilation shall be made to the outdoors or an indoor space where the room area is larger than the minimum area of the room to which the mechanical ventilation exhausts into (EA_{min}) calculated using the following equation:

$$EA_{\mathrm{min}} = (m_{\mathrm{c}} - m_{\mathrm{max}})/(CF \times LFL \times H) \qquad \text{……… (GG.24)}$$

EA_{min} is the minimum area of the room which the mechanical ventilation exhausts into in m2;
CF is the concentration factor with a value of 0.25;

m_{c} is the refrigerant charge in kg;

$m_{\max}$ is the allowable maximum refrigerant charge in the system in kg;

H is the height of the room = 2.2 m; and

LFL is the lower flammability limit in kg/m^3.

25) Substitute the existing of Clause **GG.8.3.3** with the following:

For mechanical ventilation as specified in Clause **GG.8.3**, the lower edge of openings extracting air from the room shall not be more than 100 mm above the floor.

The openings supplying makeup air to the room shall be located such that the supplied makeup air mixes with the leaked refrigerant.

When makeup air is supplied from the same space where the ventilation air extracted from the space is discharged, ventilation air discharge openings shall be separated by a sufficient distance, but not less than 3 m, from the makeup air intake openings to prevent re-circulation to the space.

26) Substitute the existing of Clause **GG.9.1** with the following:

GG.9.1 General

Clause **GG.9** is applicable for appliances with a refrigerant charge $m_1 < m_c \le m_3$. The maximum refrigerant charge can be increased or the minimum room area can be reduced if the following requirements are met:

a) The appliances shall be connected via an air duct system to one or more rooms, the supply and return air shall be directly ducted to the space;
b) Operation of circulation airflow shall comply with either **GG.9.2** or **GG.9.3**; and
c) $m_{\max}$ shall be determined based on the total area of the conditioned space (TA) connected by ducts taking into consideration that the circulation airflow distributed to all the rooms by the appliance integral indoor fan will mix and dilute the leaking refrigerant before entering any room. If no refrigerant detection system is provided then, spaces where the airflow may be limited by zoning dampers shall not be included in the determination of *TA*.

The minimum airflow shall be determined as:

$$Q_{\min} = 30 \times m_c / LFL \qquad \text{……… (GG.25)}$$

where

$Q_{\min}$ is the minimum circulation airflow circulated to the total conditioned space in m^3/h;

m_c is the actual refrigerant charge for a single refrigerating system in kg;

LFL is the lower flammability limit in kg/m^3; and

Compliance is checked by checking for ($Q_{\min}$) through confirmation using the fan curve analysis at 0.0 cm (0.0 in) of water or lowest listed external static pressure.

The maximum refrigerant charge based on the room area for the total conditioned space shall be in accordance with the following:

$$m_{\text{max}} = CF \times LFL \times H \times TA \qquad \text{……… (GG.26)}$$

The required minimum total conditioned room area TA_{min} of installed appliance with refrigerant charge m_{c} (in kg) shall be in accordance with following:

$$TA_{\text{min}} = m_{\text{c}}/(CF \times LFL \times H) \qquad \text{……… (GG.27)}$$

where

CF is the concentration factor with a value of 0.50;

m_{max} is the allowable maximum refrigerant charge in the system in kg;

m_{c} is the refrigerant charge in appliance in kg;

TA_{min} is the required minimum area of the total conditioned space in m^2;

H is the height of the room = 2.2 m;

TA is the area of the total conditioned space in m^2; and

LFL is the lower flammability limit in kg/m^3.

If *TA* is smaller than TA_{min}, additional ventilation according to **GG.8.3** shall be employed.

27) Substitute the existing of Clause **GG.9.2** with the following:

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below Q_{min}, the following actions shall be taken:

a) Provide an output signal that airflow is reduced; and
b) Disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

28) Substitute the existing of Clause **GG.9.3** with the following:

If a leak detection system is activated, the following actions shall be taken and continue for at least 5 min after the leak detection system has reset:

a) Energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow Q_{min};
b) Disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space;
c) Fully open all zoning dampers of the appliance and energize control signals to open any external zoning dampers if applicable; and
d) Activate additional mechanical ventilation, if required by Clause **GG.8.3**.

Compliance is checked by inspection.

Building fire and smoke systems may override this function.

29) Substitute the existing of Clause **GG.10** with the following:

GG.10 Allowable charge for enhanced tightness refrigerating systems using A2L refrigerant

GG.10.1 General

Clause **GG.10** is applicable to enhanced tightness refrigerating systems incompliance with **22.125** using A2L refrigerants with refrigerant charge of $m_1 < m_c \leq m_3$.

For appliances with more than one indoor unit, individual rated indoor unit cooling capacity shall not exceed 35 kW. For heating only appliances with more than one indoor unit, individual rated indoor unit heating capacity shall not exceed 35 kW.

The appropriate measures to be taken shall be ventilation (natural or mechanical), safety shut-off valves and the requirements of Clauses **GG.10.2** to **GG.10.4**. Appliances with enhanced tightness refrigeration systems that are ducted to one or more rooms may determine maximum refrigerant charge, m_{max} and minimum total conditioned room area TA_{min} in accordance with all requirements in Clause **GG.9** with the minimum airflow in Clause **GG.10.4**.

NOTE — Clause **GG.10** assumes a leak rate of not more than 10 kg/h.

GG.10.2 Required Measures for Allowable Refrigerant Charge

For indoor units where h_o as determined in Clause **GG.2.1** is less than 1.8 m, and for indoor units connected to one or more spaces by ducts which supply or return air from the space at a height less than 1.8 m, circulation airflow for the purpose of mixing the air in the room shall be provided in accordance with Clause **GG.10.4**. Where the refrigerant charge does not exceed maximum refrigerant charge in Clause **GG.10.3**, no additional measures are required.

Where the refrigerant charge exceeds the maximum refrigerant charge in Clause **GG.10.3**, one additional measure shall be taken in accordance with Clause **GG.10.4**, **GG.11** or **GG.12**.

GG.10.3 Maximum Refrigerant Charge

The maximum refrigerant charge m_{max} in a room and the minimum room area A_{min} of the installed appliance with refrigerant charge m_c shall be in accordance with the following:

$$m_{max} = CF \times LFL \times H_r \times A \qquad \text{……… (GG.28)}$$

$$A_{min} = m_c/(CF \times LFL \times H_r) \qquad \text{……… (GG.29)}$$

where

CF is the concentration factor with a value of 0.50;

m_{max} is the maximum refrigerant charge in kg;

m_c is the total refrigerant charge in the refrigerating system in kg;

LFL is the lower flammability limit in kg/m^3;

H_r is the effective height of the indoor unit in m;

A is the room floor area in m^2;

TA_{min} can be used in place of *A* as per Clause **GG.9**;

A_{min} is the required minimum room area in m^2;

A_{min} for appliances serving one or more rooms using ductwork shall be calculated for thespaces where a duct is connected, or an indoor unit is located. If all spaces have room area more than (A_{min}), no further measure is required.

The effective height (H_r), of the unit is determined as follows:

a) Where the release height (H_o), as determined in Clause **GG.2** is less than 2.2 m and equal to or greater than 1.8 m or the appliance has incorporated circulation airflow, in accordance with Clause **GG.10.4**, the effective height (H_r) is the room height in meters but not more than 2.2 m unless h_o is higher than 2.2 m; and
b) In all other cases, the effective height (H_r) is the release height (H_o) as determined in Clause **GG.2**.

For room areas exceeding 250 m^2, m_{max} shall be calculated with a room area (*A*) of 250 m^2.

GG.10.4 Requirement for units with incorporated circulation airflow to prevent stagnation

GG.10.4.1 *General*

The circulation shall operate continuously or be turned on by leak detection systems. The minimum air velocity and minimum airflow shall be as follows:

a) Minimum airflow = 240 m^3/h;
b) There is no minimum circulation airflow velocity requirement for downwards airflow or ducted units serving one or more rooms; and
c) Minimum air velocity for upwards airflow:

$$V_{min} = (-\,4.0 \times 10 - 5 \times M_2 + 0.010\,8\ \times M \times 1.42)/\sin\emptyset \qquad \text{......... (GG.30)}$$

where

V_{min} is the minimum air velocity in m/s;

M is the molar mass in kg/kmol; and

$\emptyset$ is the airflow angle above horizontal in degrees; an angle below 15° is considered to be 15°.

The unit air velocity (v) shall be calculated as airflow divided by the nominal face area of the outlet. The grille area shall not be deducted.

NOTE — The equation is based on appliances with a refrigerant release on floor level, which represents the most stringent situation.

As an alternative, for airflow angles between 15° and 90°, the minimum air velocity (V_{min}) can be determined by linear interpolation of the values included in Table GG.5.

Table GG.5 Minimum Air Velocity
(*Clause* GG.10.4.1)

Sl No.	**Minimum Air Velocity, V_{min}** m/s							
	h_a m	M	Airflow angle above horizontal, Ø degrees					
			15	30	45	60	75	90
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	< 0.30	50	7.08	3.67	2.59	2.12	1.90	1.83
ii)		60	7.40	3.83	2.71	2.21	1.98	1.92
iii)		70	7.62	3.94	2.79	2.28	2.04	1.97
iv)		80	7.78	4.03	2.85	2.32	2.08	2.01
v)		90	7.90	4.09	2.89	2.36	2.12	2.04
vi)		100	8.00	4.14	2.93	2.39	2.14	2.07
vii)		110	8.07	4.18	2.96	2.41	2.16	2.09
viii)		120	8.14	4.21	2.98	2.43	2.18	2.11
ix)	< 0.60	50	6.47	3.35	2.37	1.93	1.73	1.67
x)		60	6.76	3.50	2.47	2.02	1.81	1.75
xi)		70	6.96	3.60	2.55	2.08	1.86	1.80
xii)		80	7.10	3.68	2.60	2.12	1.90	1.84
xiii)		90	7.21	3.73	2.64	2.16	1.93	1.87
xiv)		100	7.30	3.78	2.67	2.18	1.96	1.89
xv)		110	7.37	3.82	2.70	2.20	1.97	1.91
xvi)		120	7.43	3.85	2.72	2.22	1.99	1.92
xvii)	< 0.90	50	5.78	2.99	2.12	1.73	1.55	1.50
xviii		60	6.04	3.13	2.21	1.81	1.62	1.56
xix)		70	6.22	3.22	2.28	1.86	1.67	1.61
xx)		80	6.35	3.29	2.32	1.90	1.70	1.64
xxi)		90	6.45	3.34	2.36	1.93	1.73	1.67
xxii)		100	6.53	3.38	2.39	1.95	1.75	1.69
xxiii		110	6.59	3.41	2.41	1.97	1.77	1.71
xxiv		120	6.64	3.44	2.43	1.99	1.78	1.72
xxv)	< 1.20	50	5.01	2.59	1.83	1.50	1.34	1.30
xxvi		60	5.23	2.71	1.92	1.56	1.40	1.35
xxvi		70	5.39	2.79	1.97	1.61	1.44	1.39
xxvi		80	5.50	2.85	2.01	1.64	1.47	1.42
xxix		90	5.59	2.89	2.04	1.67	1.50	1.45
xxx)		100	5.65	2.93	2.07	1.69	1.52	1.46
xxxi		110	5.71	2.96	2.09	1.71	1.53	1.48
xxxi		120	5.75	2.98	2.11	1.72	1.54	1.49

xxxi	< 1.50	50	4.09	2.12	1.50	1.22	1.10	1.06
xxxi		60	4.27	2.21	1.56	1.28	1.15	1.11
xxxv		70	4.40	2.28	1.61	1.31	1.18	1.14
xxxv		80	4.49	2.32	1.64	1.34	1.20	1.16
xxxv		90	4.56	2.36	1.67	1.36	1.22	1.18
xxxv		100	4.62	2.39	1.69	1.38	1.24	1.19
xxxi		110	4.66	2.41	1.71	1.39	1.25	1.21
xl)		120	4.70	2.43	1.72	1.40	1.26	1.22
xli)	< 1.80	50	2.89	1.50	1.06	0.86	0.77	0.75
xlii)		60	3.02	1.56	1.11	0.90	0.81	0.78
xliii)		70	3.11	1.61	1.14	0.93	0.83	0.81
xliv)		80	3.18	1.64	1.16	0.95	0.85	0.82
xlv)		90	3.23	1.67	1.18	0.96	0.86	0.83
xlvi)		100	3.26	1.69	1.19	0.98	0.87	0.84
xlvii		110	3.30	1.71	1.21	0.99	0.88	0.85
xlvii		120	3.32	1.72	1.22	0.99	0.89	0.86
NOTE — h_a is the air delivery height in upper side in *m*.								

Compliance is checked by testing.

Operation of circulation airflow shall comply with either Clauses **GG.10.4.2** or **GG.10.4.3**. Where a remote refrigerant detection system refrigerant sensor is used in a room with multiple units, all of the detection system activated safety measures shall be applied to all units in the room which rely on the remote refrigerant detection system.

GG.10.4.2 *Continuous Circulation Airflow*

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be detected continuously or monitored continuously. Within 10 s the event that the airflow is reduced below $(Q_{\min})$, the following action shall be taken:

Compressor operation shall be disabled unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.10.4.3 *Circulation Airflow Activated by a Leak Detection System*

If a leak detection system is activated, the following actions shall be taken When any refrigerant detection system is activated per Annex LL in response to a detected leak into the space, all indoor units in the room that are served by the same outdoor unit shall take the following actions and continue for at least 5 min after the leak detection system has reset:

a) Energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $(Q_{\min})$;
b) Disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space; and
c) Fully open all zoning damper of the appliance and energize control signals to open any external zoning dampers if applicable.

Compliance is checked by inspection.

30) Substitute the existing of Clause **GG.11.1** with the following:

Ventilation shall be made to a place where sufficient air is available to dilute the leaked refrigerant such as outdoors or a large space.

Where ventilation is to an indoor space, the total area of that space and the space in which the appliance is installed shall have a total room area not less than (A_{min}) according to Equation (GG.31). If the total room area in Clause **GG.11.2** is not large enough, the measure of Clause **GG.11.3** shall be taken with ventilation to the outdoors.

$$A_{\mathrm{min}} = m_{\mathrm{c}}/(CF \times LFL \times H_{\mathrm{r}}) \quad \text{…….. (GG.31)}$$

where

CF is the concentration factor with a value of 0.50;

m_{c} is the total refrigerant charge in the refrigerating system in kg;

LFL is the lower flammability limit in kg/m^3;

H_{r} is the effective height of the indoor unit in m; and

A_{min} is the required minimum room area in m^2.

The effective height (H_{r}) of the unit is determined as follows:

a) Where the release height (H_{o}) as determined in Clause **GG.2**, is less than 2.2 m and the appliance has incorporated circulation airflow, the effective height (H_{r}) is the room height (in meters) but not more than 2.2 m; and
b) In all other cases, the effective height (H_{r}) is the release height (h_{o}) as determined in Clause **GG.2**.

31) Substitute the existing of Clause **GG.11.2** with the following:

If natural ventilation is applied, then the following shall be met:

a) Openings for natural ventilation shall comply with Clause **GG.1.4**;
b) Natural ventilation to the outdoors is not allowed below ground level; and
c) Natural ventilation from an occupied space shall not be made to the outdoors.

NOTE — User can block the natural ventilation to the outside if it is cold outside.

The minimum opening area for natural ventilation (A_{nv}) to an indoor space shall be:

$$A_{\mathrm{nv}} = \frac{1}{720 \times LFL} \times \sqrt{\frac{M}{LFL \times (M-29)}} \quad \text{……… (GG.32)}$$

where

A_{nv} is the required natural ventilation opening area in m^2;

M is the molar mass in kg/kmol;

LFL is the lower flammability limit expressed in kg/m^3;

720 is the coefficient resulting from calculating all the constants used to establish the equation; and

29 is the average molar mass of air in kg/kmol.

The minimum opening area for natural ventilation (A_{nv}) to an outdoor space shall be determined as follows:

$$A_{\mathrm{nv}} = 0.14 \times \sqrt{m_{\mathrm{c}} \times \frac{M \times 0.04}{LFL}} \quad \text{………………. (GG.33)}$$

where

m_{c} is the refrigerant charge of a system in kg;

m_{max} is the maximum refrigerant charge for a system in kg;

LFL is the lower flammability limit in kg/m^3;

A_{nv} is the minimum opening area in m^2;

0.14 is a constant derived from the gravity acceleration, flow coefficient, etc; and

0.04 is the conversion constant from hydrocarbon to other *LFL*.

32) Substitute the existing of clause **GG.12** with the following:

GG.12 Safety shut-off valves for enhanced tightness refrigerating systems using A2L refrigerants

GG.12.1 Location

Safety shut-off valves shall be located in a space with a room volume large enough so that the maximum refrigerant charge complies with **GG.10.4**, **GG.10.5**, or outside. Safety shut-off valve shall be positioned to enable access for maintenance by an authorized person.

GG.12.2 General

Safety shut-off valves shall be positioned to enable access for maintenance by an authorized person.

The releasable charge as determined by Clauses **GG.12.3**, **GG.12.4**, or **GG.12.7** shall be limited to:

$$m_{\mathrm{rl}} < CF < LFL < H_{\mathrm{r}} < A \quad \text{………… (GG.36)}$$

where

CF is the concentration factor with a value of 0.50;

m_{rl} is the releasable charge in kg;

LFL is the lower flammability limit in kg/m^3;

H_r is the effective height of the indoor unit as determined in Clause **GG.10.3** in m; and

A is the room floor area in m^2.

GG.12.3 Releasable Charge Calculation

GG.12.3.1 *Determination of Releasable Charge*

The releasable charge (m_rl) shall be determined in accordance with **GG.12.3.2** and **GG.12.3.3**.

GG.12.3.2 *Test Set-Up*

The appliance, including safety shut-off valves, shall be installed according to the instructions, in the smallest room as specified by the instructions, with the set-up that will create the largest releasable charge for that room.

NOTE **1** Tests set ups that give a larger releasable charge can be considered representative for setups that give a lower releasable charge. A test set-up with indoor units with a larger inner volume can be representative for units with a smaller inner volume. A test set set-up with piping with a larger inner volume can be representative for piping with a smaller inner volume.

NOTE **2** It is possible for the instructions to cover different room sizes for different set-ups, if so, each set-up will be considered separately.

The refrigerating system shall be evacuated prior to each test, and then charged with refrigerant equal to m_c, where m_c is the refrigerant charge in kg.

A calibrated leak opening shall be installed in the refrigerating on system that would result in the greatest amount of refrigerant released in the occupied space. A valve to enable opening and closing of the calibrated leak opening shall be installed between the appliance and the calibrated leak opening. The calibrated leak shall be at the point in the circuit that has the highest saturated pressure in the indoor unit during steady state operation.

The calibrated leak opening shall vent into a volume at atmospheric pressure.

NOTE **3** The volume can be a room, or a pressure vessel kept at atmospheric pressure, to avoid the refrigerant released into the atmosphere.

The calibrated opening shall be a capillary or orifice that leaks at 2.8 g/s from saturated liquid at a saturated pressure of 63 °C.

GG.12.3.3 Test Method

The refrigerating system shall operate according to the operating state until steady state is reached for at least 30 min, prior to opening the valve of the calibrated leak opening.

NOTE **1** The same applies for standstill condition.

The test shall be repeated at least three times, and the releasable charge shall be 2 standard deviations above the mean result.

NOTE **2** The calculation of the mean value and the standard deviations apply to each operating state separately.

The valve to the calibrated leak opening shall be opened.

The refrigerating system shall operate normally for t_{r1} time with the calibrated leak open, where t_{r1} is the time before the leak is detected as determined in **GG.12.5**.

After the t_{r1} time, the refrigerant charge limited system shall simulate a detected leak.

NOTE **3** This can be done by any method, for example, putting the refrigerant sensor in the refrigerant concentration above the output signal set point of the sensor, C_{set}.

After the safety shut-off valves are closed, the remaining charge m_{rm} contained in the part of the refrigerating system which is closed by the safety shut-off valves is measured. The releasable charge (kg) is determined as follows:

$$m_{rl} = m_c - m_{rm} \quad \text{………… (GG.37)}$$

where

m_c is the refrigerant charge in kg; and

m_{rm} is the remaining charge in kg.

GG.12.4 Determination of Releasable Charge by Calculation and Test

GG.12.4.1 *General*

The releasable charge (m_{rl}) shall be calculated as the sum of the refrigerant released inthe separate stages as follows:

$$m_{rl} = t_{r1} \times 0.002\,8 + m_{rl2} + m_{rl3} \quad \text{……… (GG.38)}$$

where

t_{r1} is the time before leak is detected as determined in Clause **GG.12.5** in s;

m_{rl2} is the charge between detection and closing the shut-off valves as determined in Clause GG.12.4.2 in kg;

m_{rl3} is the refrigerant released after closing the shut-off valves in part of thesystem that can leak into the occupied space as determined in Clause **GG.12.4.3**; and

0.002 8 is the assumed leak rate in kg/s.

GG.12.4.2 *Refrigerant Release between Detection and Closing the Safety Shut-Off Valves*

The refrigerant amount released between the leak detection systems sends an output signal and closing the safety shut-off valves (m_{rl2}) shall be determined as:

$$m_{rl2} = t_{cl} \times 0.002\,8 \quad \text{…………… (GG.39)}$$

where

t_{cl} is the time from the leak detection system gives an output signal to the shut-off valves closing in s;

0.002 8 is the assumed leak rate in kg/s; and

Compliance is checked by inspection and test to determine the value of t_{cl}.

GG.12.4.3.1 *General*

To determine the releasable charge after closing the shut-off valves (m_{rl3}) which can leak into the occupied space, determine the releasable charge for each part (unit or piping) (m_{rl3}) that can leak into the occupied space after closing the shut-off valves by one of the following methods:

a) Determine the apparent volumetric density $(\rho_{\mathrm{part,i}})$ by measuring the pressure according to Clause **GG.12.4.3.2**;
b) Determine the apparent volumetric density $(\rho_{\mathrm{part,i}})$ by applying default values according to Clause **GG.12.4.3.3**; or
c) Determine the apparent volumetric density $(\rho_{\mathrm{part,i}})$ according to Clause **GG.12.4.3.4**.

NOTE **1** The apparent volumetric density is the total mass of refrigerant in the part being evaluated divided by the total free internal volume of that part.

NOTE **2** These methods can be combined for evaluating each part. A part shall be the piping or the indoor unit between the field connection points.

NOTE **3** The apparent volumetric densities that are determined in a part can be used to calculate the releasable charge after closing the shut-off valves for different configurations. For instance, the apparent volumetric density determined in the piping can be used for the calculation with different piping lengths that operates under the same condition.

The releasable charge after closing the shut-off valves (m_{rl3}) shall be the sum of the charge of each part that can leak into the occupied space after closing the shut-off valves:

$$m_{\mathrm{rl3}} = \sum V_{\mathrm{part,i}} \times \rho_{\mathrm{part,i}} \quad \text{.................. (GG.40)}$$

where

$V_{\mathrm{part,i}}$ is the free internal volume in the evaluated (part,i) in m^3;

$\rho_{\mathrm{part,i}}$ is the apparent volumetric density internal volume of the evaluated (part,i) in kg/m^3;

GG.12.4.3.2 *Determine apparent volumetric density $(\rho_{\mathrm{part,i}})$ by measuring the pressure*

To determine the apparent volumetric density $(\rho_{\mathrm{part,i}})$ of the releasable charge after closing the shut-off valves for the evaluated part of the system by measuring the pressure, the following procedure shall be applied.

The appliance shall be installed according to the manufacturer's instructions. The most unfavorable combination of test samples shall be chosen.

NOTE — The most unfavorable combination is the set-up that will create the highest apparent volumetric density.

For the test in cooling or heating mode, the system is operated according to the condition specified in Clause **GG.12.6**. The refrigerating system shall operate according to the operating state until steady state is reached for at least 30 min.

For the test in standby mode, the system shall be stopped for 8 h after the cooling operation according to the condition specified in Clause **GG.12.6** for 30 min.

The refrigerant state (liquid, gas or mixture) for the evaluated part of the system shall be determined as follows.

The pressure shall be measured at the refrigerant entering side for units and piping.

The apparent volumetric density for the evaluated part of the system $(\rho_{\mathrm{part,i}})$ shall be determined as:

a) For liquid piping: the density of saturated liquid at the pressure that is measured;
b) For gas piping: the density of saturated gas at the pressure that is measured;
c) For piping containing a mixture of gas and liquid: the density of saturated liquid at the pressure that is measured; and
d) For indoor units: the density of saturated liquid at the pressure that is measured.

GG.12.4.3.3 *Determine apparent volumetric density* $(\rho_{part,i})$ *by default values*

When no test is executed, the following method shall be applied.

The refrigerant state (liquid, gas or mixture) for the evaluated part of the system shall be determined.

The apparent density for the evaluated part of the system $(\rho_{part,i})$ shall be determined as:

a) *For liquid piping* — the density of saturated liquid at 10°C;
b) *For gas piping* — the density of saturated gas at 42 °C;
c) *For piping containing mixture of gas and liquid* — the density of saturated liquid at10 °C; or
d) *For indoor units* — the density of saturated liquid at 10°C.

GG.12.4.3.4 *Determine apparent volumetric density* $(\rho_{\mathrm{part,i}})$ *by measuring the recovered refrigerant amount from the unit or piping*

To determine the apparent volumetric density $(\rho_{\mathrm{part,i}})$ of the releasable refrigerant after closing the shut-off valves for the evaluated indoor unit or piping by measuring the recovered refrigerant amount, the following procedure shall be applied.

The appliance including safety shut-off valves shall be installed according to the manufacturer's instructions. The most unfavorable combination of test samples shall be chosen.

NOTE **1** If in doubt, multiple samples can be measured.

Shut-off valves for testing shall be installed upstream and downstream of the part where the apparent volumetric density is measured. Shut-off valves for testing shall be of the same type of as the safety shut-off valves used for the appliances. The action to shut-off shall be made in accordance with the normal operation of the safety shut-off valves.

For the test in cooling or heating mode, the system is operated according to the condition specified in Clause **GG.12.6**. The refrigerating system shall operate according to the operating state until steady state is reached for at least 30 min prior to closing the shut-off valves for testing.

For the test in standby mode, the system shall be operated in cooling mode according to the condition specified in Clause **GG.12.6** for 30 min, and then stopped for 8 h.

The refrigerant containing part of the unit which is to be evaluated is shut off completely from upstream and downstream by shut-off valves. The shut-off valves used for testing shall close simultaneously when the last safety shut-off valve closes during the safety shut-off sequence.

The part being evaluated shall then be evacuated and the recovered refrigerant amount (m_{rm}) shall be measured.

The test shall be repeated at least three times and the measured refrigerant amount (m_{rm}) releasable charge shall be 2 standard deviations above the mean result.

NOTE **2** The calculation of the mean value and the standard deviations apply to each operating state separately.

The apparent volumetric density $\left(\rho_{\mathrm{part,i}}\right)$ of the evaluated $\left(\rho_{\mathrm{part,i}}\right)$ is determined as follows:

$$\rho_{\mathrm{part,i}} = \frac{m_{\mathrm{rm}}}{V_{\mathrm{part,i}}} \quad \text{................ (GG.41)}$$

where

m_{rm} is the measured refrigerant amount in the evaluated (part i) in kg; and

$V_{\mathrm{part,i}}$ is the internal free volume in the evaluated (part i) in m^3.

GG.12.5 Time before the Leak is Detected (t_{r1})

GG.12.5.1 *General*

Each operating state as indicated in Clause **GG.12.6** shall be considered separately, as applicable.

The time before a leak is detected (t_{r1}) in seconds (s) is determined by one of the following:

a) Where the refrigerant sensor location is in compliance with Annex MM when tested at the maximum airflow for the operating state;
b) Where the leak detection system is in compliance with Annex PP, Clause **GG.12.5.2** applies; or
c) For all other cases where the refrigerant sensor location is not in compliance with Annex MM when tested at maximum airflow for the operating state, or the refrigerant sensor is remotely located, then Clause **GG.12.5.3** applies.

GG.12.5.2 *Determination of* (t_{r1}) *by default time*

The time for the leak detection system to give an output signal (t_{r1}) shall be 120 s.

NOTE — The time 120 s = 90 s + 30 s. 90 is the time delay in seconds as specified in Annex MM, and 30 is the maximum response time of the refrigerant sensor in seconds as specified in Clause **LL.3**. The time delay in seconds specified in Annex PP is 90 s, which is less than the 120 s time.

GG.12.5.3 *Determination of* (t_{r1}) *based on effective room concentration*

The time for the refrigerant detection system to give an output signal (t_{r1}) in seconds shall be determined as follows:

$$t_{\mathrm{r1}} = (H_{\mathrm{r}} \times A_{\mathrm{min}} \times LFL \times C_{\mathrm{set}}/0.002\,8) + 30 \quad \text{.............. (GG.42)}$$

where

H_r is the effective height of the indoor unit as determined in Clause **GG.10.3** in m;

A_{min} is the required minimum room area in m^2;

LFL is the lower flammability limit in kg/m^3;

C_{set} is the alarm set point of the sensor in percent of LFL, including the sensor tolerances that results in the highest (C_{set});

0.002 8 is the assumed leak rate in kg/s; and

30 is a constant.

NOTE **1** The constant 1 000 is a conversion from g to kg, 0.002 8 is the release rate in g/s for the enhanced tightness refrigerant system under Clause **GG.10** and 30 is the maximum response time of the refrigerant sensor in seconds specified in Clause **LL.4**.
NOTE **2** Detection is assumed when the room concentration reaches the alarm set point of the refrigerant detection system. Installing the appliance in a room larger than (A_{min}) will result in an overall safer situation, even though (t_{r1}) will be underestimated.
NOTE **3** This calculation method is typically used for remote refrigerant sensors and for appliances where there is too much airflow to detect a leak during the tests of Annex MM or Annex PP.
NOTE **4** It is assumed that the refrigerant sensor is able to detect the refrigerant concentration in the room where it is installed, for instance by being installed in the airstream of the unit or close to the floor.

GG.12.6 Test Conditions

For releasable charge limited system, the following operating states and conditions specified in the instructions shall be applied as applicable:

a) Compressor off with indoor temperature 27 °C and outdoor temperature 35 °C, with indoor fan ON;

b) Compressor off with indoor temperature 27 °C and outdoor temperature 35 °C, with indoor fan OFF;

c) Cooling mode with:

i) The compressor running at maximum speed allowed by the controls at the specified temperature;
ii) The highest outdoor air temperature and highest airflow allowed by the controls, or the highest entering fluid temperature and highest fluid flow rate; and
iii) The highest indoor air temperature and highest indoor fan airflow allowed by the controls, or the highest entering fluid temperature and highest fluid flow rate; and

d) Heating mode with:

i) The compressor running at the maximum speed allowed by the controls at the specified temperature;
ii) The highest outdoor air temperature and highest airflow allowed by the controls, or the highest entering fluid temperature and highest fluid flow rate; and
iii) The highest indoor air temperature and highest indoor fan airflow allowed by the controls, or the highest entering fluid temperature and highest fluid flow rate.

NOTE — The fan can have a different maximum speed depending on the operating state and working temperature, the highest speed in that condition is relevant.

GG.12.7 Alternative Method for Determination of Releasable Charge

GG.12.7.1 *General*

Releasable charge shall be the largest value of calculation results determined by Clauses **GG.12.7.2**, **GG.12.7.3** and **GG12.7.4**.

GG.12.7.2 *Releasable Charge in Heating Mode*

The releasable charge in the heating mode ($m_{\mathrm{REL-H}}$) shall be calculated per the following:

$$m_{\mathrm{rl-H}} = L_{\mathrm{VAP}} \times TD_{\mathrm{VAP}} \times \rho_{\mathrm{VAP-H}} + L_{\mathrm{LIQ}} \times TD_{\mathrm{LIQ}} \times \rho_{\mathrm{LIQ-H}} + IV_{\mathrm{UNIT}} \times \rho_{\mathrm{MIX-H}} + 6.8\frac{g}{s} \times T_{\mathrm{RESP}}/1\ 000 \quad \text{..... (GG.42)}$$

where

L_{VAP} is total length of vapor interconnecting tubing from safety shut-off valves to each indoor section, m;

TD_{VAP} is tube volume per length for tube diameter (L_{VAP}) from Table GG.6 in m^3/m;

$\rho_{\mathrm{VAP-H}}$ is the density of superheated vapor refrigerant at 40.6 °C saturation temperature with a degree of superheat equal to 33.3 K in kg/m^3;

L_{LIQ} is the total length of liquid interconnecting tubing from safety shut-off valves to each indoor section in m;

TD_{LIQ} is the tube volume per length for tube diameter (L_{LIQ}) from Table GG.6 in m^3/m;

$\rho_{\mathrm{LIQ-H}}$ is density of saturated liquid refrigerant at 40.6 °C in kg/m^3;

IV_{UNIT} is the total internal volume of all indoor sections including coil, headers, tubing andall refrigerant containing parts of the units that are downstream of the safety shut-off valve as determined by the manufacturer in m^3;

$\rho_{\mathrm{MIX-H}}$ is the refrigerant density assuming 40 percent liquid and 60 percent vapor by volume $(= 0.40 \times \rho_{\mathrm{LIQ-H}} + 0.60 \times \rho_{\mathrm{VAP-H}})$, in kg/m^3; and

T_{resp} is response time for refrigeration detection system in sec, which shall be 30 sec.

GG.12.7.3 *Releasable Charge in Cooling Mode*

The releasable charge in the cooling mode ($m_{\mathrm{rl-C}}$) shall be calculated per the following:

$$m_{\mathrm{rl-C}} = L_{\mathrm{VAP}} \times TD_{\mathrm{VAP}} \times \rho_{\mathrm{VAP-C,LP}} + L_{\mathrm{LIQ}} \times TD_{\mathrm{LIQ}} \times \rho_{\mathrm{LIQ-C,HP}} + IV_{\mathrm{UNIT}} \times \rho_{\mathrm{MIX-C}} + \left[6.8\frac{g}{s} \times T_{\mathrm{RESP}}\right]/1\ 000 \quad \text{........ (GG.43)}$$

where

L_{VAP} is total length of vapor interconnecting tubing from safety shut-off valves to each indoor section, m;

TD_{VAP} is tube volume per length for tube diameter (L_{VAP}) from Table GG.6 in m^3/m;

$\rho_{\mathrm{VAP-C,LP}}$ is the density of saturated vapor refrigerant at 10 °C in kg/m^3;

L_{LIQ} is the total length of liquid interconnecting tubing from safety shut-off valves to each indoor section in m;

TD_{LIQ} is the tube volume per length for tube diameter (L_{LIQ}) from Table GG.6 in m^3/m;

$\rho_{\mathrm{LIQ-C,HP}}$ is the density of saturated liquid refrigerant at 43.3 °C in kg/m^3;

$\rho_{\mathrm{VAP-C,LP}}$ is the density of saturated liquid refrigerant at 10 °C in kg/m^3;

IV_{UNIT} is the total internal volume of all indoor sections including coil, headers, tubing and all refrigerant containing parts of the units that are downstream of the safety shut-off valve as determined by the manufacturer in m^3;

$\rho_{\mathrm{MIX-C}}$ is the refrigerant density assuming 20 percent liquid and 80 percent vapor by volume $(= 0.20 \times \rho_{\mathrm{LIQ-C,LP}} + 0.80 \times \rho_{\mathrm{VAP-C,LP}})$ kg/m^3; and

T_{RESP} is response time for refrigeration detection system in sec, which shall be 30 sec.

GG.12.7.4 *Releasable charge in off/standby mode*

The releasable charge in the off/standby mode $(m_{\mathrm{rl-S}})$ shall be calculated per the following:

$$m_{\mathrm{rl-S}} = L_{\mathrm{VAP}} \times TD_{\mathrm{VAP}} \times \rho_{\mathrm{OFF}} + L_{\mathrm{LIQ}} \times TD_{\mathrm{LIQ}} \times \rho_{\mathrm{OFF}} + \left[6.8\frac{g}{s} \times T_{\mathrm{RESP}}\right]/1\ 000 \quad \text{..... (GG.44)}$$

where

L_{VAP} is total length of vapor interconnecting tubing from safety shut-off valves to each indoor section, m;

TD_{VAP} is tube volume per length for tube diameter (L_{VAP}) from Table GG.6 in m^3/m;

$\rho_{\mathrm{VAP-OFF}}$ is the density of saturated vapor refrigerant at 23.9 °C, kg/m^3;

L_{LIQ} is the total length of liquid interconnecting tubing from safety shut-off valves to each indoor section in m;

TD_{LIQ} is the tube volume per length for tube diameter (L_{LIQ}) from Table GG.6 in m^3/m;

$\rho_{\mathrm{LIQ-OFF}}$ is the density of saturated liquid refrigerant at 23.9 °C, kg/m^3;

IV_{UNIT} is the total internal volume of all indoor sections including coil, headers, tubing andall refrigerant containing parts of the units that are downstream of the safety shut-off valve as determined by the manufacturer in m^3;

ρ_{OFF} is the refrigerant density assuming 20 percent liquid and 80 percent vapor by volume at 23.9 °C saturation conditions $(= 0.20 \times \rho_{\mathrm{LIQ-OFF}} + 0.80 \times \rho_{\mathrm{VAP-OFF}})$, kg/m^3; and

T_{RESP} is response time for refrigeration detection system in sec, which shall be 30 sec.

Table GG.6 Tube Volume Per Unit Length

Sl No.	Tube Outer Diameter mm	Tube Outer Diameter inch	Tube Internal Volume Per Unit Length m^3/m
(1)	(2)	(3)	(4)
i)	6.35	0.25	1.77E−05
ii)	7.94	0.313	3.10E−05
iii)	9.53	0.375	4.80E−05
iv)	12.7	0.5	9.29E−05
v)	15.9	0.625	1.49E−04
vi)	19.1	0.75	2.14E−04
vii)	22.2	0.875	2.96E−04
viii	25.4	1	3.89E−04
ix)	28.6	1.125	5.03E−04
x)	31.8	1.25	6.23E−04
xi)	38.1	1.5	9.10E−04
xii)	41.3	1.625	1.08E−03
xiii	54	2.125	1.88E−03
xiv	66.7	2.625	2.89E−03

33) Delete the clause **GG.13** and renumber the subsequent clauses.

34) Substitute Figure GG.1, Figure GG.2, Figure GG.3 and Figure GG.4 with the following figures:

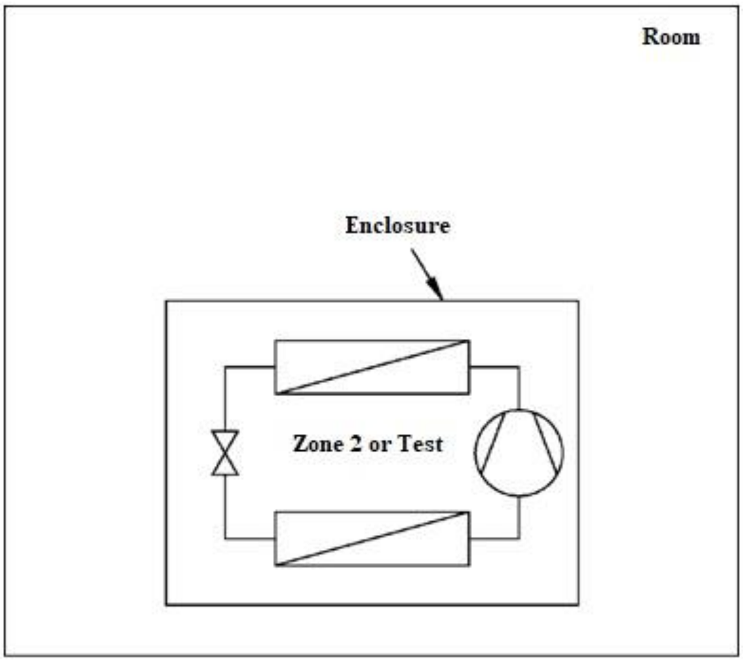


Figure GG.1 — Unventilated Area

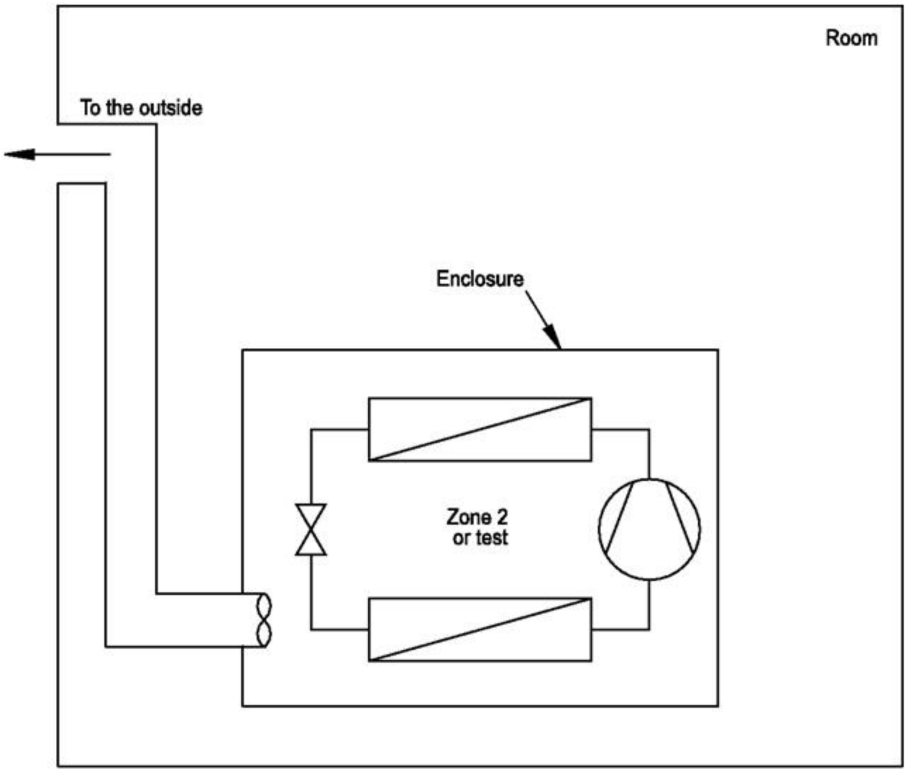


Figure GG.2 – Mechanical Ventilation

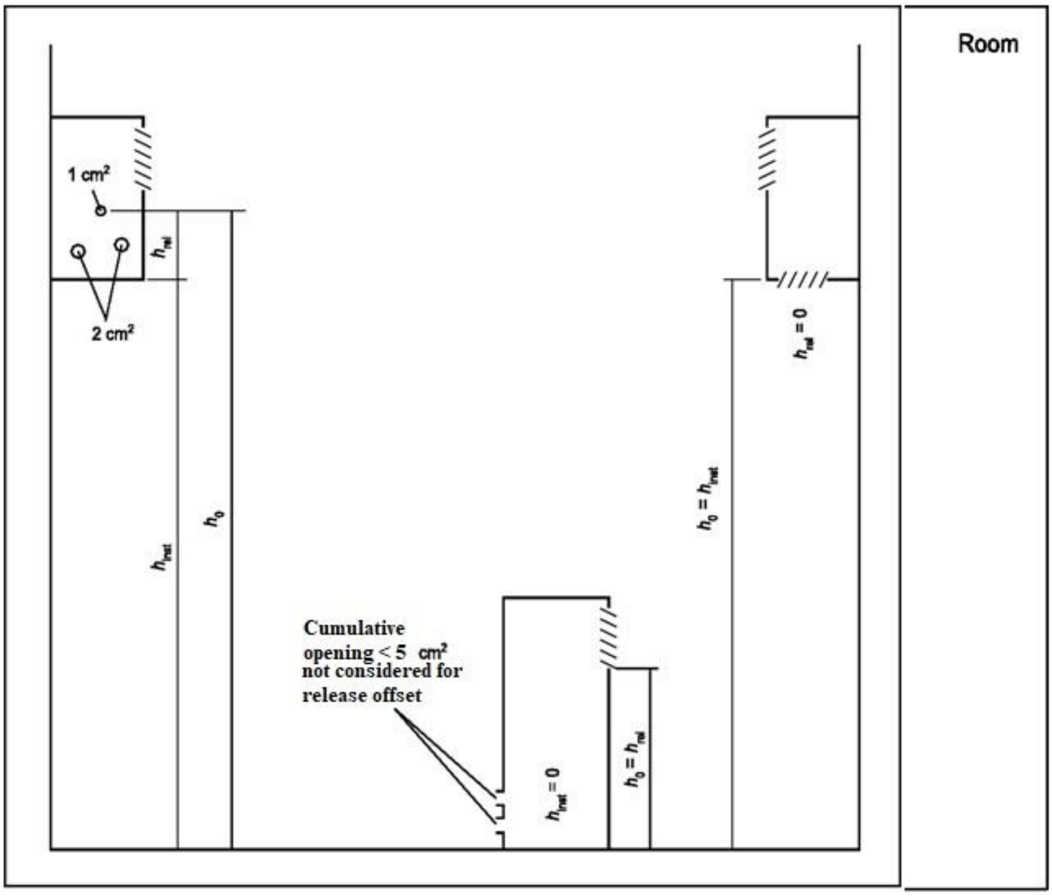
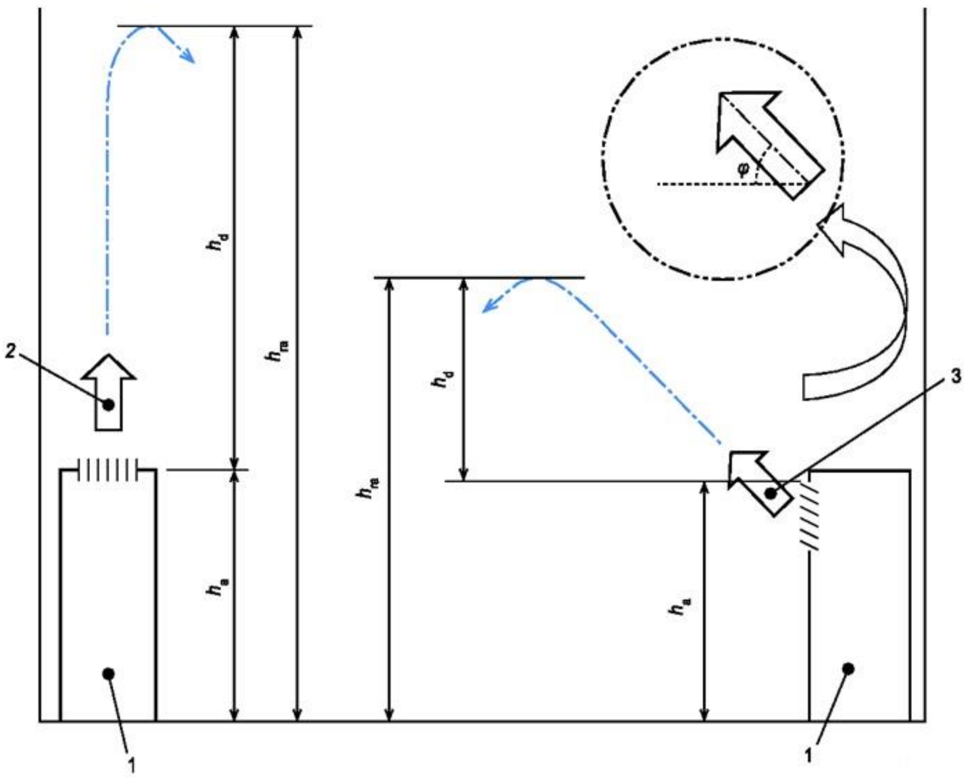


Figure GG.3 — Relevant heights h_{inst}, h_{o} and h_{rel} for calculation of A_{min} and m_{max}



Key

1 Appliance

2 Airflow direction: Upwards (vertical φ = 90°)

3 Airflow direction: Upwards

Figure GG.4 – Airflow Direction

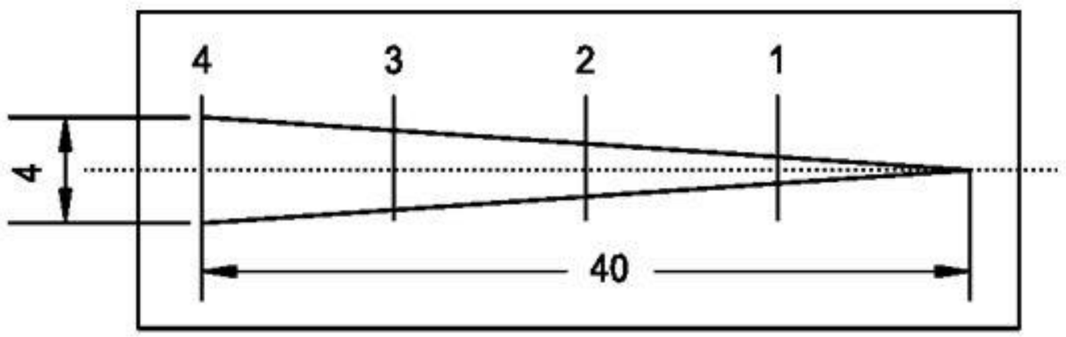


Figure GG.5 — Isosceles Triangle Arrow Test Gauge

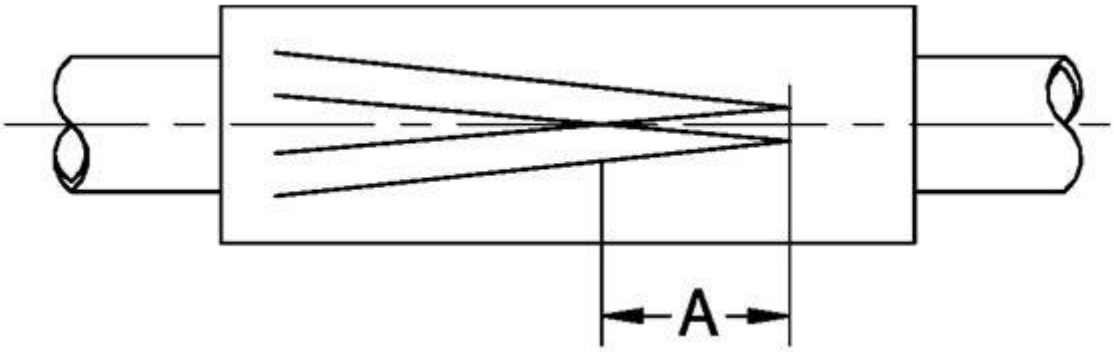


Figure GG.6 — Measurement of Vibration Amplitude

35) Insert Annex RR after Annex QQ:

Annex RR
(*Normative*)

ADDITIONAL REQUIREMENTS FOR APPLIANCES INTENDED FOR INFORMATION TECHNOLOGY EQUIPMENT (ITE) APPLICATIONS AND UTILIZING A2L REFRIGERANTS

RR-1 SCOPE

This Annex and its requirements only apply to refrigerant bearing appliances and their constituent parts and assemblies, designed specifically for the purposes of cooling information technology equipment (ITE) and ITE areas.

Additionally, this annex's requirements only apply to the above referenced appliances in which:

a) refrigerant of use, is classified as an A2L;
b) total refrigerant charge of the largest refrigerant circuit in the appliance is greater than m_1, as classified in Annex GG; and
c) rating is as per the following:
1) Not accessible to the general public; and
2) Fixed appliance or stationary appliance.

This annex's requirements are in addition to, or modification of, the applicable clauses of this standard, for the above referenced appliances and as specifically called out herein.

RR-2 APPLICATION

In the event that a conflict exists between the general requirements of this standard (Part 2) and the requirements of this annex, this annex shall take precedence over the general requirements for appliances within its scope.

If this annex explicitly references another section or clause of the Part 1 or Part 2, and that referenced section refers to other portions of this standard, the requirements of this annex shall take precedence in the event of a conflict.

The requirements of Annex GG are not applicable to ITE cooling appliances or systems except as explicitly referenced within this annex.

For ITE cooling appliances complying with clause **22.116**, the source of air shall not be from the effective dispersal volume.

For equipment using a group controller, the group controller shall comply with the requirements in clause **24.1**.

NOTE 1 — There will be multiple manners allowed for information technology equipment facilities (ITEFs) to safely apply A2L refrigerant cooling systems to information technology equipment (ITE). All ITE refrigerant cooling appliances, systems, and the individual system components will comply with at least one of the general methodologies as laid out within this annex and the appropriate sections of this Part 2.

NOTE 2 — ITEF means data centers and computer rooms which are used primarily to house information technology equipment.

NOTE 3 — ITE means equipment which includes computers, data storage, servers, and network/communication equipment.

For all systems and applications, the primary means of control against the unintended creation of a flammable mixture shall be:

a) the appropriate limitation of the amount of an A2L refrigerant that could be potentially released into an enclosed volume of space; and
b) the constant mixture and circulation of air to prevent a stagnant volume from existing, and in the event an unintended A2L refrigerant release occurs, to ensure that the mixture will have full access to the total volume of the space and remain below the lower flammability limit (LFL).

In addition to the control measures above, the facility can employ additional means and methods to remove or mitigate any hazardous mixture within the space if an unintended release of refrigerant occurs.

RR-3 ADDITIONAL CONSTRUCTION REQUIREMENTS OF ITE COOLING APPLIANCES

ITE cooling appliances shall comply with the following constructional requirements in addition to the applicable construction requirements elsewhere in this Part 2.

RR-3.1 ITE cooling appliances, which include internal compartments with refrigerant containing components other than piping (for example, compressors, condensers, etc), the compartment or section shall:

a) not be isolated from the circulation airflow; or
b) be mechanically ventilated from the compartment to the circulation airflow or to the outdoors in accordance with clause **GG.4**.

Compliance may be verified by test, if not readily apparent by design and construction.

When partial units with refrigerant containing components (other than piping), that are intended for indoor applications, away from the systems circulating air fans, the unit may be located in the circulation airflow of the space to connect the refrigerant containing components to that space. If the refrigerant containing components are within an enclosure, or otherwise isolated from the circulation airflow, mechanical fans shall be used to connect the components to the circulation airflow.

Mechanical ventilating fans intended to provide a connection between the appliance or a compartment of the appliance, and the circulation airflow, shall operate continuously in accordance with clause **RR-**

6 or activated by a leak detection system or refrigerant detection system in accordance with clause **RR-7**.

If the partial unit is not located in the space with the circulation airflow, it shall be connected to the outdoors by mechanical ventilation. Natural ventilation shall not be utilized for indoor equipment. The partial unit may also be located in a room that is mechanically ventilated in accordance with clause **RR-11**.

Compliance of the connection shall be verified by the appropriate test of Clause **GG.4** when mechanical fans are additionally employed for the creation of the connection. If not rated for connection to the outdoors the approved length of the venting shaft, may be 0 cm (0 in).

RR-3.2 The circulation air fans, for cooling appliances shall operate in accordance with the intended compliance path of the equipment.

RR-3.2.1 Circulating air fans intended for use in continuous circulation applications shall:

a) start to deliver air upon the application of power to the unit;
b) deliver at least $Q_{\min}$ airflow within 10 s of the initial application of power to the fans;
c) not be reliant upon the other unit controls for their start-up;
d) not stop their operation if power is available and other unit controls fail; and
e) be able to safely restart their operation within 60 s if power is briefly lost to the appliance.

RR-3.2.2 ITE cooling appliances shall be constructed such that they can perform all of the mitigation actions in accordance with clause **RR-6** or clause **RR-7** as applicable.

Compliance is checked by inspection and testing.

RR-3.3 ITE cooling appliances employing secondary heat exchangers shall comply with clause **GG-6**.

Compliance shall be verified by inspection.

RR-3.4 When equipment is intended for use with a refrigerant detection system to comply with this annex, the refrigerant sensor shall be located within the unit and supplied by the manufacturer. The refrigerant detection system controller for the appliance, if separate from the detector(s), shall be supplied as an integral component with the partial unit containing the compressor controls.

NOTE — This requirement does not prohibit manufacturer’s from providing additional remote sensors.

Compliance shall be verified by inspection.

The appropriate number and location of refrigerant sensors supplied shall be determined by the applicable clauses of this Part 2.

Compliance shall be verified by the tests of Annex MM or Annex PP as appropriate.

When a leak detection system or refrigerant detection system is supplied with a unit or partial unit, then the unit shall be capable of communicating the state of the leak detection system or refrigerant detection system to other external controllers, such as a group controller. There shall be a set of electrical input and output connection(s) available for this use. At a minimum, the communication signal for these inputs shall be 1-bit.

Compliance shall be verified by inspection and simulation tests on the electrical system.

RR-3.5 ITE cooling appliances and partial units, intended for indoor applications and A2L refrigerants shall comply with the following subclauses of clause **RR-3.5**.

RR-3.5.1 When pressure relief devices are required by the other parts of this Part 2 and specifically the subclauses of clause **22.112**, fusible plug type devices shall not be utilized. The means and design of pressure relief shall have the ability to control the flow of refrigerant to a safe location, either outdoors or to a portion of the system volume intended for this purpose.

When safety shut-off valves are, applied to the ITE cooling appliances or system, the pressure relief means shall not connect different portions of the system, which are isolated by the safety shut-off valves.

Compliance may be verified by test, if not readily apparent by design, instruction, and construction.

RR-3.5.2 When safety shut-off valves are installed in an appliance, liquid containing piping and components shall not be isolated from its expansion volume. The hydraulic expansion of intentionally trapped liquid refrigerant shall be determined by calculation based on the total mass of trapped liquid, and from its density change between following two state points:

a) The minimum rated operating condition minus 23 °C; and
b) The maximum allowable ambient temperature of the trapped liquid minus 12 °C.

The appliance shall provide an expansion volume of at least 10 percent greater amount than the calculated requirement.

This expansion volume may be contained within the normally available components of the refrigerant system, which are filled by a gaseous volume during normal operation, and not isolated from the liquid mass by safety shut-off valves.

When hydraulic expansion volumes are evaluated with the above statements, the total mass of trapped liquid refrigerant shall be evaluated at its maximum overcharged condition which allows the equipment to operate normally and to not trip other devices provided for its safe operation. The calculated amount of the systems overcharged condition shall not exceed 10 percent of the rated charge.

The requirements for the application of pressure relieving means shall be evaluated separately from hydraulic expansion.

Compliance may be verified by test, if not readily apparent by design, instruction, and construction.

RR-3.5.3 When safety shut-off valves are installed in an appliance, the tubing and components located upstream of the valves shall be evaluated to determine if the valves closing action will produce a hydraulic shock in the system per Clause **22** and modified as below.

If during, or immediately following the closing of a safety shut-off valve, the pressure of the system immediately upstream of the valve, and operating at its maximum capacity, increases by more than 5 percent of its normal operating value, then the tubing and components shall account for the forces generated due to the change in the refrigerant’s momentum.

Alternately, when evaluated at an appliances maximum operating conditions the forces expected to be generated by the closure of a safety shut-off valve may be calculated based on the mass, density and velocity of the refrigerant that would be expected by the engineering equations standardly applied to the hydraulic shock phenomenon.

Compliance may be verified by test or calculation.

RR-3.5.4 When safety shut-off valve are applied to standby or redundant appliances, the valves shall be commanded closed for this operational mode.

Compliance shall be verified by inspection.

RR-3.5.5 Safety shut-off valves shall be positioned to enable access for maintenance by an authorized person.

RR.3.5.6 The requirements of clause **GG.7**, other than the charge limitations of clause **GG.7.1**, shall apply to ITE cooling appliances and partial units which are non-fixed factory sealed single package units.

Compliance shall be verified by the tests and inspections of clause **GG.7**.

RR-4 ALLOWABLE CHARGE FOR ITE COOLING APPLIANCES USING A2L REFRIGERANTS

The requirements of Clause **GG.1.1** shall apply.

The reference charge amounts, m_1, m_2, etc., shall be determined in accordance with the equations of clause **GG.1.2** and their national differences.

The requirements of clauses **GG.1.3** and **GG.1.4** shall apply to units which reside in spaces not connected to the circulation airflow.

The requirements of clause **GG.2** shall be replaced by those requirements in this annex for ITE cooling appliances.

For ITE cooling appliances with a refrigerant charge of $m_c > m_3$, some requirements of ISO 5149 may apply if required by the AHJ. All other requirements of this annex shall additionally apply.

In this Annex, the term, 'system charge', refers specifically to the refrigerant charge (m_c) in the largest refrigerant circuit regardless of if it is a single circuit or multi-circuited equipment.

For appliances with multiple refrigerant circuits, all refrigerant circuits with greater than (m_1) charge shall comply with the same requirements as specified for the refrigerant circuit with the largest system charge.

Compliance with the above clause **RR-4** is verified by inspection of the manufacturer's literature and instructions.

RR-5 INDOOR CIRCULATION AIRFLOW REQUIREMENTS

Circulation airflow shall be provided continuously in accordance with clause **RR-6** or operation shall be initiated by a leak detection system or refrigerant detection system in accordance with clause **RR-7**.

The indoor ITE cooling appliance or partial unit, intended for providing the circulating air of the unit, shall have a factory set point for the rated minimum circulation airflow. The factory set point shall not be allowed to be reduced below the units rated value.

The minimum allowable rated set point of the circulation airflow for an appliance shall be determined as follows:

$$Q_{\mathrm{min}} = 30 \times m_{\mathrm{c}}/LFL \quad \ldots\ldots \text{ (RR.1)}$$

where

Q_{min} is the minimum circulation airflow in m^3/h;

m_{c} is the actual refrigerant charge amount in the system in kg; and

LFL is the lower flammability limit in kg/m^3.

Compliance with Q_{min} shall be determined by the fan table for the unit.

The determination and set point of Q_{min}, shall be applicable at the maximum allowable fan or system static pressure. Fan assemblies incorporating torque, speed and/or other controls may reduce their speed to account for the actual system static in its delivery of Q_{min}, so long as the failure of that control results in the delivery of Q_{min} at the maximum allowed static.

The minimum circulation airflow velocity shall be 1 m/s. The velocity shall be calculated as airflow divided by the nominal face area of the outlet. The grill area shall not be deducted.

For equipment that complies with clause **RR-10**, the refrigerant charge (m_{c}) may be replaced by the releasable charge (m_{rl1}) value for the equations input. Values larger than (m_{rl}) may be allowed.

Compliance shall be checked by inspection and testing.

RR-6 CONTINUOUS CIRCULATION AIRFLOW REQUIREMENTS

When equipment is intended for the continuous application of circulation airflow, the following requirements shall apply:

a) The circulating air fans within the appliance shall always be active, delivering an airflow rate equal to, or greater than, the minimum required for the proper mixing of air and any leaked A2L refrigerant; and
b) Regardless of the equipment’s intended operational state, the circulation air fans shall not be prevented from delivering the minimum required airflow rate if power is applied to the equipment. Standby or redundant cooling appliances and/or fan systems devoted to the circulation of air within the ITE area shall always maintain their airflow rate at or above the minimum required.

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below Q_{min} the following actions shall be taken:

a) provide an output signal notifying the group controller or user that the airflow is reduced below Q_{min}; and
b) disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Appliances that only employ continuous circulation airflow as its mitigation, shall be able to accept input from a group controller and shall mitigate in accordance with clause **RR-7** when commanded to do so.

Compliance shall be checked by inspection and testing.

RR-7 CIRCULATION AIRFLOW INITIATED BY A LEAK DETECTION SYSTEM OR REFRIGERANT DETECTION SYSTEM

When ITE cooling appliances do not utilize the continuous application of circulation airflow in accordance with clause **RR-6**, the circulation airflow shall be monitored and activated by a leak detection system or refrigerant detection system.

RR-7.1 ITE Cooling Appliances

When an ITE cooling appliances is commanded to activate circulation airflow, the following actions shall be taken:

a) the unit's refrigerant detection system shall provide an output signal notifying the group controller or user that the mitigation actions have been activated;
b) energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow. The fan(s) shall be energized within 5 s following the input signal to turn on the fan(s);
c) if applicable, fully open all zoning dampers of the appliance and energize control signals to open any external zoning dampers;
d) de-energize supplementary heat or any other potential ignition source, unless the unit complies with clause **22.117.2**;
e) if a pump down routine is used in minimizing the releasable charge, it shall be initiated in the mitigation actions unless overridden by an external, remote detection sensor that would indicate it would create an unsafe condition in an occupied space. The termination of any pump down cycle shall be automatically controlled;
f) disable the compressor operation unless a pump down routine is occurring that reduces the leak rate or the total amount released to the indoor space;
g) when safety shut-off valves are utilized, they shall be initiated in the mitigation actions, and in accordance with clause **RR-9**, in accordance with any pump down routines employed; and
h) activate additional mechanical ventilation, if required.

The above-mentioned actions shall continue for at least 5 min after the leak detection system or refrigerant detection system has reset, unless overridden by a group controller.

Compliance shall be checked by inspection and testing.

When a multi-circuit appliance has the ability to detect and mitigate a leak in a specific refrigeration circuit, only that refrigeration circuit is required to undergo the mitigation actions above.

Compliance shall be checked by testing in accordance with Annex MM or Annex PP as applicable, unless apparent by design.

RR-7.2 Refrigerant Detections Systems and Group Controllers

Refrigerant detections systems for use in ITE cooling appliances shall be allowed to be overridden by a group controller.

NOTE — A non-operational, stand-by unit need not respond to a refrigerant leak occurring from an operational unit within the same circulation airflow. (Unless commanded to by a group controller.)

An ITE cooling appliance or partial unit's refrigerant detection systems shall command the mitigation actions to occur when it's internal or remote refrigerant sensors command it to activate or when an input signal from a group controller commands it to activate.

If a group controller can determine that a specific refrigerant circuit, appliance, or group of appliances is responsible for the leak, the group controller shall command those appliances to mitigate as follows:

a) Only the appliance with the first output signal is initially required to act in mitigating manner. However, in the event that multiple refrigerant detection system output signals occur within 10 s of the initial output signal, then each of those cooling systems shall be considered as an individual leak source and each of those systems shall act in a mitigating manner; and
b) If after the completion of the first system(s) mitigation actions and the other ventilation or facilities other mitigation actions have occurred, the detection alarms reset to a safe condition, then the unintended leak source shall be considered to be contained and controlled.

When the group controller no longer has any RDS output signals from any connected appliances for at least 15 min time, it may reset the mitigation actions to appliances it has commanded to do so.

A group controller shall not be allowed to automatically reset activated safety shut-off valves.

A group controller may utilize its own remote sensor. When a group controller cannot determine that a specific appliance is causing a leak, it shall command all appliances under its command to mitigate.

Where a single remote refrigerant detection system sensor is used in a room with multiple units, all units in the room which do not have a dedicated refrigerant detection system shall take the same actions.

When an ITE cooling appliance or partial unit's refrigerant detection systems for an appliances refrigerant circuit resets to a safe condition the unit shall not be allowed to initiate normal operations until all refrigerant detection system systems in the circulation airflow have been reset.

Compliance shall be checked by inspection and testing.

RR-8 DETERMINATION OF ALLOWABLE SYSTEM CHARGE FOR ITE COOLING APPLIANCES

RR-8.1 How to Calculate Effective Dispersal Volume

RR-8.1.1 *General*

Volume Calculations shall be based on the overall volume of space available to which the refrigerant disperses within the circulation airflow in the event of a refrigerant leak. This overall volume shall be modified with the appropriate deductions.

RR-8.1.2 For the purposes of determining the effective dispersal volume of an ITE area in calculations, and for determination of the maximum allowable refrigerant charge, the following shall apply:

a) The effective dispersal volume shall only include the circulated airflow of the system;
b) The effective dispersal volume shall initially include the ITE area enclosed by the floor, walls, and ceiling of that space; and
c) When the circulation airflow includes underfloor spaces, suspended ceiling spaces, or other partitioned spaces, such as equipment galleries, the volume of those spaces may be included.

RR-8.1.3 *Requirements for Deductions from The Overall Space Volume*

In general, the volume of equipment, piping, wiring, or other apparatus that consume space within and are isolated from the circulation airflow shall be deducted from the effective dispersal volume.

The following deductions shall be applied:

a) When the circulation airflow has been fully contained on both hot and cold sides of the aisle, via ducts or other apparatus, any room volume outside of that containment shall not be included when calculating the effective dispersal volume;
b) When the overall volume of space available, or a partitioned portion of that volume includes ducted openings from partially ducted systems, some volume of that space may require a deduction. No volume greater than 1.2 m away in height from the upper most duct opening in the space may be included when calculating the effective dispersal volume, unless an analysis of the airflow has been conducted to show that the volume of air has effective movement for the mixing of a leaked refrigerant.

NOTE 1 — Refer to example Figure RR.1 for clarifying details of Item 2.

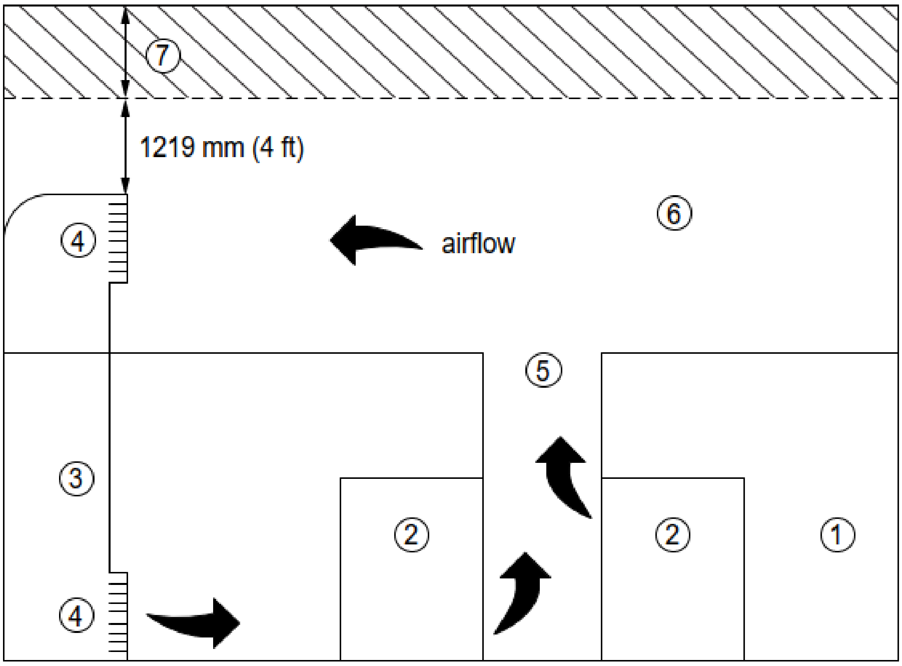


Figure RR.1 – Example for Determination of Effective Dispersal Volume

Key
1 ITE Room
2 IT Equipment
3 ITE Cooling appliance
4 Supply or return openings
5 Hot aisle containment
6 Volume of space excluded from effective dispersal volume

NOTE 2 — Hot aisle containment may or may not be present.

NOTE 3 — The appliance may be located within the ITE room or outside the ITE room and ducted to the space.

NOTE 4 — Direction of airflow may be reversed.

c) Obstructions of tubing, piping, wiring, etc., consuming more than 0.007 1 m^3 (0.25 ft^3) of space shall be included in the deductions from the overall volume;
d) The ITE within the circulated airflow shall be evaluated for their deduction from the effective dispersal volume. The deducted volume of the ITE shall be based on the designed maximum capacity or fill of the servers.

As a maximum value, no more than 75 percent of the ITE's volume shall be included as circulating air space in the effective dispersal volume. The total volume of the ITE shall be defined by the overall dimensions of its ITE enclosure. Small gaps in-between individual server racks shall not be included in the effective dispersal volume; and

e) Any other volume within the circulation airflow that is otherwise enclosed or partitioned off from the airflow shall be deducted in the calculation of the effective dispersal volume.