



To be attended only by qualified personnel

Vertical Refrigerator

NG4 / NG5 / NG6 / NG9
NG10 / NG11 / NG12 / NG13
NG26 / NG27 / NG43 / NG44
NG49 / NG50



These models may contain any of the following suffixes
in different order and combination:
C, H, M, N, O, S



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User Manual

FP11808
Rev. 3
English

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Inspections	Possible Causes	Procedure
Cooler does not turn on.	Electrical Power Failure.	Verify that the electrical outlet has power, connect some other device to make sure it turns on.
	Cooler not connected.	Check that the cooler power cord is properly connected.
	High or low voltage variations (Some electronic temperature controlled coolers has voltage protections to prevent further damage.)	Check the voltage of the installation site, if it is not stable, install an external voltage regulator (not supplied) with the appropriate capacity for your cooler.
	Poor voltage tap.	Change or repair the voltage tap. (Plug your cooler into a separate outlet).
Cooler does not cool.	Excess or poor distribution of the product.	Distribute the products allowing the free flow of air between them. Avoid introducing cardboard or plastic unrelated to the type of refrigerated product
	High opening frequency of the door(s).	Avoid opening the door(s) too far.
	Cooler installed incorrectly.	Observe the item "Installation place".
Noisy.	Cooler unlevel with respect to the floor.	Level the cooler with respect to the floor or change the installation location.
	Cooler with the rear part leaning against the wall.	Leave the cooler at least 15 cm from the wall.
	When connecting the cooler after a period of inactivity, it is normal for noise to be produced at the start of operation.	Wait 60 min and recheck the noise. If persists, consult customer service.
Cooler does not stop (compressor).	External heat sources affect temperature.	Do not install the cooler near heat sources such as stoves, or close to direct sunlight.
	Door open.	Verify that the door(s) are closed and that there are no air leaks.

Note / Nota:

Pictures & temperature control may vary depending on your cooler model.
 Imágenes y control de temperatura pueden variar dependiendo del modelo de su refrigerador.

SAFETY INSTRUCTIONS

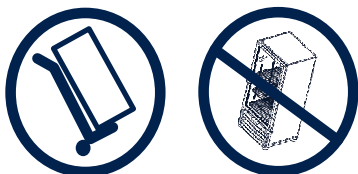
General Recommendations

- Read this manual carefully before beginning any procedure.
- Do not let your cooler be repaired by unqualified personnel. Whenever possible, the installation must be executed by the Technical Service Provider authorized by Metalfrío (Consult the current rates with your dealer or call the Metalfrío Customer Service).
- Follow the electrical installation instructions.
- Periodically check the state of electrical installations.

Safety of children and vulnerable people

This appliance is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for safety

Children should be supervised to ensure that they do not play with the appliance.



Installation Place

- When unpacking, do not tilt the cooler more than 45 degrees, to prevent contamination of compressor oil cooling system.
- Do not expose the cooler to heat sources such as stoves, ovens, greenhouses, hot walls & solar radiation (direct).
- The cooler should be installed in places with good air circulation that provide good ventilation to the condenser unit.
- We do not recommend the installation in places with high relative humidity. i.e. laundry rooms.
- A minimum distance of 15cm from the side and back walls must be maintained and a minimum of 1.3m from the cooler top.
- Cooler should be perfectly leveled for its proper operation.
- The cooler may not be installed in narrow corridors, only in secure locations with easy access.
- Your cooler is only for indoor use.
- If your cooler has top door, be careful when closing, we recommend to close it gently.

Electrical Installation

- Permissible voltage range:

Nominal Voltage	127V	220V
Min Voltage	100V	190V
Max Voltage	140V	250V

- Make sure the voltage taken corresponds to the cooler.
- Make sure that the plug is properly adjusted and connect it to dedicated outlet.
- Don't use electrical extensions cords.
- In case of needing an electrical extension cord, the installation should only be carried out if the socket has the nominal voltage output with a tolerance of $\pm 10\%$. The gauge of the wires must obey the following table:

Gauge	Distance	
	127V	220V
12 AWG	-----	Until 91m
10 AWG	Until 19m	92 to 145m
8 AWG	20m to 30m	146 to 218m
6 AWG	31m to 48m	-----

- The replacement of electrical power cables should be done by authorized technical service provider.
- If it's not possible to obtain the indicated nominal voltage with a variation of $\pm 10\%$ (power supply instability), install a voltage regulator according to your cooler power. (consult with service center)
- The automatic defrost is regulated by an electronic control or, when appropriate, by an electromechanic thermostat.
- Your cooler has a power cord with a ground terminal, make sure that in your facilities have a proper plug for this purpose. We do not recommend the use of adapters or the removal of the ground pin.

WARNING! Do not use electrical appliances inside the food/ice storage compartments unless they are of the type recommended by the manufacturer.

WARNING! Do not use mechanical devices or other means to accelerate the defrosting process, other than those recommended by the manufacturer.

WARNING! Keep clear of obstruction all ventilation openings in the appliance enclosure or in the structure for building-in.

WARNING! Do not damage the refrigeration circuit

Technical data of the device

- The rating plate is located on the inside of the appliance. It contains information on voltage, type and quantity of refrigerant and information on climatic classes.

LEVELING FEET INSTALLATION



The cooler is shipped with the leveling feet inserted.



Make sure base is flat against floor and measure the cooler leveling with a spirit level.



Adjust if necessary.

- Note: Make sure that the cooler is sealed to the floor or counter to establish proper sanitary operation

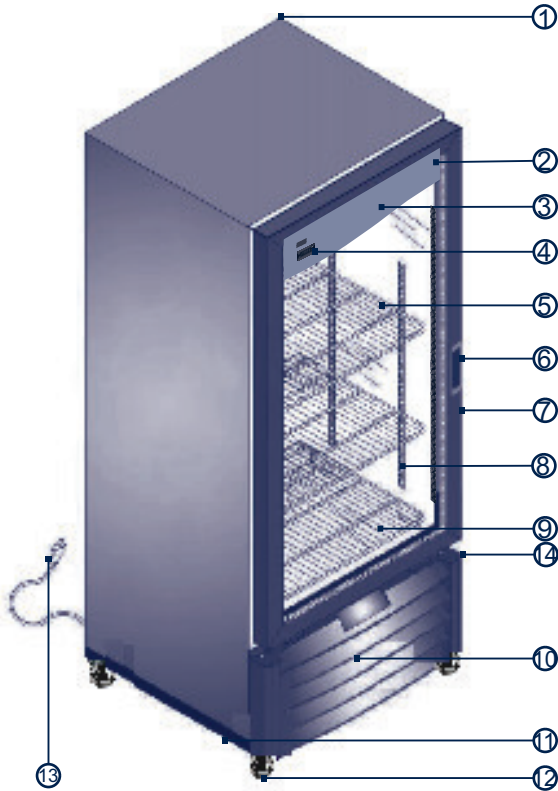


With the cooler completely on the floor, you need to place a strip of NSF approved sealant in the four sides, closing all around.

- The result is intended to prevent liquid spillages on adjacent floor or countertop surfaces from passing under inaccessible parts of the cooler.



Main Components



- 1. Cabinet.
- 2. LED Lamp on canopy, cabinet or door.
- 3. Display.
- 4. Electronic control or thermostat.
- 5. Adjustable shelves.
- 6. Handle.
- 7. Door (according with the model, right or left opening).
- 8. Pilaster.
- 9. Floor shelf. (where applicable)
- 10. Front grid.
- 11. Metal base.
- 12. Leveling feet.
- 13. Power cord.
- 14. Magnetic door switch.

Meaning of alphanumeric characters indicating the climate class of the device test room.

N G 10 C H N,S

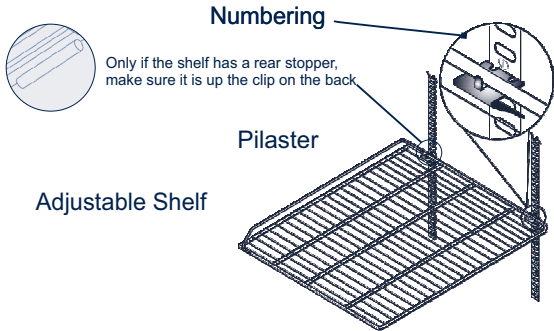
Operating condition

-C:32°C; 65% HR
-D:40.5°C; 75% HR

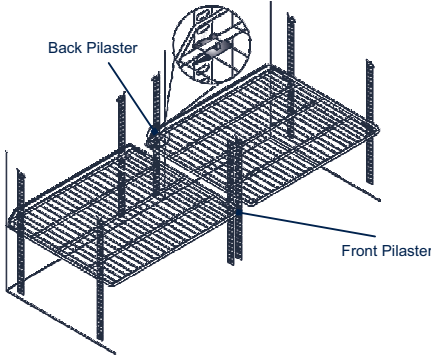
Hydrocarbon Refrigerant Gas

*Note: Image only for reference, it can change according with your real model.

Coolers with one door:



Cooler with two or more doors:



Shelf Support (CLIP)

Model.	Max Weight. FOR SHELVE Kg/Lb
NG5	23.3 / 51.3
NG6	15.56 / 34.3
NG9	23.3 / 51.3
NG10/NG11/NG12/NG13	32.6 / 71.8
NG26/NG27	63 / 138.8
NG43/NG44	43.5 / 96
NG43 SD	38.1 / 84
NG49/NG50	56 / 123.4
NG 4	27.96/61.6

Note:
The pilasters are provided with numbers wich are reference to accommodate the shelves supports aligned into the pilasters, so that, all shelves are level.

i.e.
If you selected the CLIP in the position #1, the other CLIPs must be in the position #1 too, for each level.



Cooling System
loaded with
R290 or R600a



Climate class 4 for refrigeration equipment are designed to operate optimally in environments with a maximum ambient temperature of 30°C and a relative humidity of 55%.

Table 3 — Climate classes

Test room climate class	Dry bulb temperature °C	Relative humidity %	Dew point °C	Water vapour mass in dry air g/kg
0	20	50	9,3	7,3
1	16	80	12,6	9,1
2	22	65	15,2	10,8
3	25	60	16,7	12,0
4	30	55	20,0	14,8
6	27	70	21,1	15,8
5	40	40	23,9	18,8
7	35	75	30,0	27,3
8	23,9	55	14,3	10,2

NOTE The water vapour mass in dry air is one of the main points influencing the performance and the energy consumption of the cabinets. See also Annex D to compare lab and store conditions.

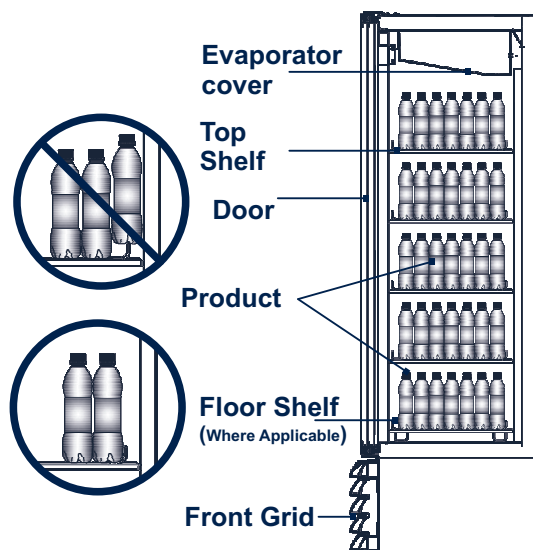
The red flame indicates the presence of very dangerous oxide gas particles in the pipe



USE & PRODUCT LOADING

- It is recommended to leave the cooler connected four hours before placing first product or make a defrost.
- Do not put hot product, it is recommended to previously cool to room temperature.
- Avoid leaving the door open for long periods.
- Avoid blocking air flow.
- It is recommended to load the cooler at night.
- This cooler is intended to be loaded with PET, glass bottles & aluminum cans.
- Do not store explosive substances such as aerosol cans with flammable propellant in this appliance.
- This equipment is intended for the storage and display of non-potentially-hazardous bottled or canned products only.

REFRIGERATION SYSTEM



All refrigerators are provided with a forced air cooling system, this means that the air is forced to flow through the coil (device that cools the air) by means of an internal micro motor.

To have an optimal air flow over the refrigerator, the following recommendations should be followed:

- Do not place cardboard or any airflow obstruction on the shelves.
- Do not saturate the refrigerator with product.

For exclusive use of prepackaged product only.

component parts shall be replaced with like components so as to minimize the risk of possible ignition due to incorrect parts.

CLEANING

External cleaning

- The external cleaning of the equipment shall be done with mild soap and water.
- Never use detergents, abrasive sponges or steel brushes.

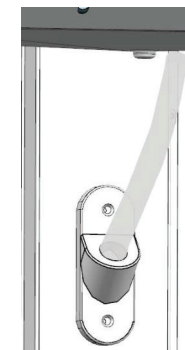


- Condenser cleaning is recommended once every 2 months. (Blown out and / or vacuum)
- Cleaning cloth (slightly wet)

Drain cleaning

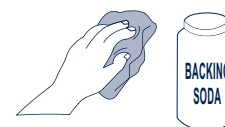
When cleaning, replacing or maintain apply silicone to around contour of the hose unions.

When installing, the hose must be completely inserted in the hopper drain.

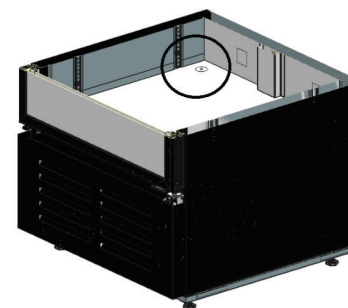


Internal cleaning

- Clean the inside with a wet cloth in a solution of water and baking soda (1 tablespoon per liter of water). Then dry.

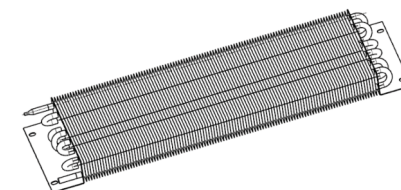


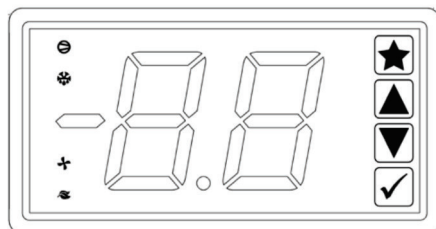
Do not use water stream that requires flush or drainage.



Evaporator Cleaning

- If your evaporator need to be clean, please call to an authorized service supplier.





SHUTTING DOWN EQUIPMENT

To turn off the equipment, hold and press for 6 seconds: ★ ✓

This two buttons

REFRIGERATION CONTROL

Temperature Control Method	Air or evaporator
Temperature Control Range	-40°C to +70°C (-40°F to +158°F)
Temperature Time Delay	1 - 255 s
Defrost Control	Timed, Active or Manual (via a display)
Advanced Defrost Mode	Pre and Post Defrost, Emergency Defrost
Energy Saving	Temperature Set-back, Fan Cycling, Lights OFF
Input Type	Temperature Sensor & Door Switch
Temperature Probe Type	100 KΩ NTC (B25/85: 4060 k)
Output Control	Compressor, Lights, Evaporator Fan, Reverse Fan or Heater (if fitted with 10 A relay)
Number of Relay	16A + 2 x 5A (Option 16A + 5A + 10A)
Compressor Relay	16A, 250 V
Relay #2	Fan: 5 A, 250 V
Relay #3	Light: 5 A, 250 V or Heater: 10 A, 250 V
Maximum Total Current Rating	18A
Intelligent Time Delay	0 - 600 s
Refrigerant Compatibility	CO2 & Hydrocarbon

POWER & VOLTAGE PROTECTION

Nominal Voltage	115 V / 230 V
Operating Voltage Range	85 / 265 V
Withstand Voltage	Up to 450 V
Working Frequency	Auto-sense 45 - 60 Hz
Type of Protection	High / Low, Spike / Surge & Frequency
High / Low Voltage Blind Time	0 - 255 s
Surge Protection	6.5 kA, <10 ns, 160 J
Over Voltage Category	Category II

CELLULAR CONNECTIVITY

Target Region	Global
Antenna	Internal
Type	LTE
Category	Cat-NB1
Frequency Band	850 / 900 / 1800 / 1900 B1, B2, B3, B4, B5, B8, B12, B13, B18, B19, B20, B25, B28, B39

BLUETOOTH CONNECTIVITY

Type/version	BLE 4.1
RF Power Output	-20 dBm to +4 dBm
Frequency	2.4 GHz ISM
Connectivity	Eddystone, iBeacon & connection to the Sollatek Smart Device Application
Bluetooth Standard	IEEE 802.15.1
Memory Size	32 Mb for data/image storing between transmission

WI-FI GEO-LOCATION

Frequency Range	2.4 GHz
Protocol	802.11 b/g/n

ACCELEROMETER

Measurement Direction	3-axis
Measurement Scale	High Sensitivity ±2g

BATTERY

Battery Type	Rechargeable Lithium Polymer
Nominal Voltage	3.7 V
Capacity	700 mAh
Typical Run Time	Approx. 4 months (depending on set transmission frequency)

USER INTERFACE

LEDs	1 x Controller Status ; 1 x Battery Status ; 2 x GSM Status
Display (Optional)	Connects to the FDM4 & FDM5 Display Range

CONNECTOR / INTERFACE

Input Connector	1 pair of 0.11" (2.80 mm) Faston Tabs, 1 triple 0.11" (2.80 mm) Faston Tabs
Output Connector	Up to 5 x 0.25" (6.35 mm) Faston Tabs (depending on model)
External Device Connector	6-way (3x2) Female Connector Block
Data / Programming	Micro USB-B for Programming
Sim Card	Push-Push Micro SIM holder





ES – Energy Saving On-Off
(up button)

Set-mute
(center button)

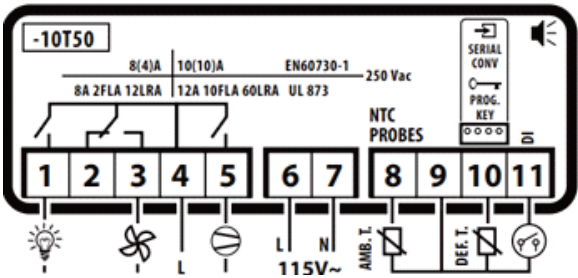
Light ON/OFF
(down button)



SHUTTING DOWN EQUIPMENT

To switch off, press the “ES” and Light ON/OFF buttons

Wiring Diagram



Error Messages:

- E0 Regulation Probe Fault.
- E1 Condenser Probe Fault.
- dF Defrost.
- dor Door Open Time Out.
- Err Refrigerant System Failure Alarm.
- ECO Energy Saving Mode Activated.
- CCP Cold Climate Protection Mode Activated.

Display Indicators

1. Day / Night Mode.
2. 3 digit Display LED.
3. Back Button -Abort / Night Mode Button.
4. UP Button.
5. Bluetooth Indicator.
6. Defrost Button / Enter
7. DOWN Button.
8. Alarm.
9. Compressor.
10. Defrost Mode.
11. Fan.

SHUTTING DOWN EQUIPMENT

To perform shutdown, you have to press the Back Button -Abort/Night Mode Button and Defrost Button / Enter



An early alarm will minimize refrigerator downtime
A fault code should always be supplied when reporting an alarm.

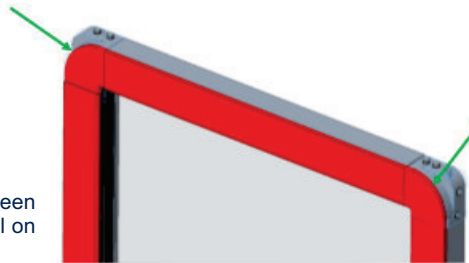
Code	Meaning	Possible causes
dor	Door Open	The door is open or the door sensor is out of adjustment.
15	Excessive condenser heating	Check that no objects blocked the condenser, for example boxes or some other device. Restore power, if fault continues, check condenser fan operation.
17	Main sensor or condenser sensor failure.	The temperature sensor needs to be replaced. The system will not work while the fault is present.
19	Refrigeration failure The compressor works for the specified time without reaching the set temperature.	Multiple possibilities that prevent the system from reaching its temperature. The fault will not be removed by restarting the refrigerator, you will need to consult a specialized technical service.
20	Low return air temperature. The temperature dropped below the set point	The set temperature keeps getting colder even when the compressor is off. Check compressor connections and check that the compressor status parameter is correct. It can also stem from a secondary failure of the compressor itself.
21	Excessive compressor starts ** The compressor has had repeated overtemperature readings for similar periods of time.	The condenser sensor is reading high temperature. Check that the condenser is not blocked and that there is good air circulation, with the fan on.
22	Triac S1 Overcurrent	A high current component such as the compressor has been incorrectly connected to output S1. Check the wiring.
23	Triac S2 Overcurrent	
27	Other temperature sensor faults **	The sensor needs to be replaced. The system will continue working ignoring the error.
28	No blocking due to low temperature trend **	Multiple possibilities that make the system reach the desired temperature. The most common causes are ice blocked evaporator, low refrigerant or low evaporator fan speed.
** Firmware 1580 or UP		



The "Full Glass" models have the characteristic of door exchange (moldings) and procedure replacement is as follows:

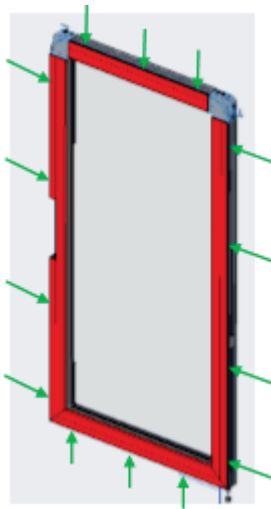


- Step 1: With a flat screwdriver or spatula remove the plastic rivets from the handle in order to remove it from the door.



- Step 2: Using the spatula, push it between the flat trim and the door frame and pull on the corner to remove it completely.

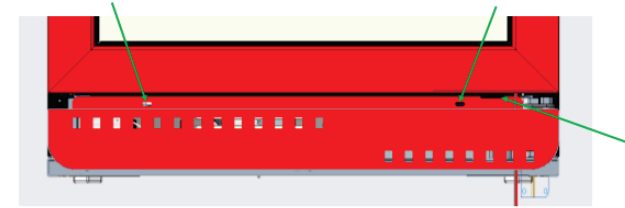
Step 3: Repeat Step 2 along the rest of the trim (top, bottom, and sides) until completely removed.



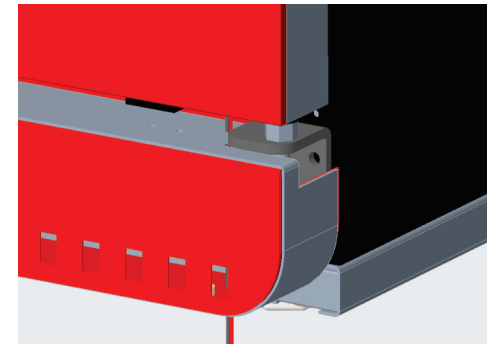
- Step 4: Position the new moldings and their corners, pushing them manually along the door frame, install the handle, the plastic rivets and the screws that you removed at the beginning.



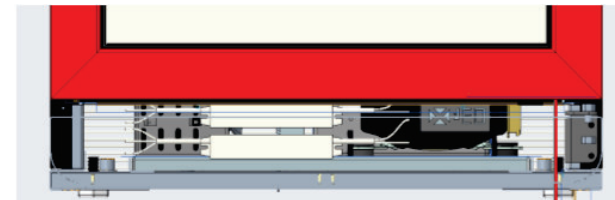
Drivers LED / Fan & Control Acces



- Step1 : Remove the front grid screws with a 1/4" hex box screwdriver, remove magnet screws with a Phillips head screwdriver and pull the grid up gently and retrieve.



- Control, drivers for LEDs and fans will be available for inspection or replacement.



LIGHT REPLACEMENT

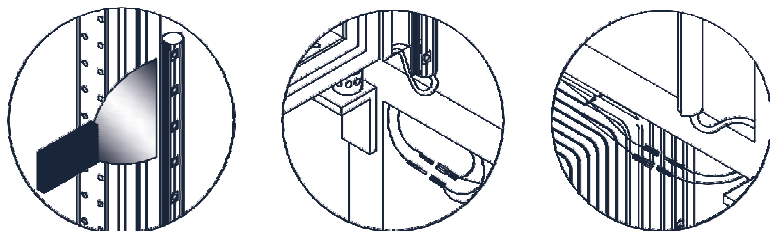
Depending on the model of your refrigerator, there are several light configurations with LED lamp, the main ones are:

- a) Display.
- b) Door.
- c) Cabinet.

(See page 5)

To make a replacement:

- 1.- Turn off the cooler.
- 2.- Disconnect the power cables from the lamp.
- 3.- If the lamp is screwed, use a screwdriver to remove it. (screen).
- 4.- If the lamp is in the door or cabinet, support it with a spatula-type tool to remove it, in this case the lamps are inserted in the plastic cavity and it is required to remove them under pressure. (be careful not to damage them).
- 5.- Replace the lamps you removed with new ones.
- 6.- Connect the cables of the lamps.
- 7.- Connect the refrigerator and check the correct lighting.



If you have questions about the lamp replacement procedure, consult Metalfrio Customer Service.

SUPPLY CORD REPLACEMENT

If the supply cord is damaged, it must be replaced by the manufacturer, its service agent or similarly qualified person in order to avoid a hazard.”

SAFETY STANDARD FOR COMMERCIAL REFRIGERATION

The appliance is to be installed in accordance with the Safety Standard for Refrigeration Systems, ANSI/ASHRAE 15.

“If appliance has a refrigerant charge of more than 114g for R290 or 129g for R600a, the appliance shall not be installed in public corridors or lobbies”

WARRANTY

each new refrigerator indicating the warranty period and the conditions it covers, see its documentation.

TO MAKE YOUR WARRANTY VALID

At the time of any damage, the buyer or end user must provide the following information:

- 1.- Model
- 2.- Serial number
- 3.- Copy of the invoice
- 4.- Purchase date
- 5.- Description of the fault

The warranty service will be provided by the network of authorized Metalfrio service centers.

If it is necessary to transfer the refrigerator to our plant, it must be approved by the commercial area in writing, and it must be delivered to the carrier; The refrigerator must be shipped in the original packaging to avoid further damage.

THE WARRANTY DOES NOT APPLY IN THE FOLLOWING CASES

- A) The warranty is limited to the repair of the refrigerator and includes the replacement of defective parts. In no case will the refrigerator be replaced during the repair time, which will not be longer than 30 business days. Except products that require manufacture of special pieces.
- B) In no case will repairs of damage to problems be paid for handling in transfers or in facilities outside the norm, overload of refrigerator capacity, voltage variations or misuse of the same.
- C) The purchaser or end user is obliged to follow the installation and operating instructions, and the premises where the refrigerators are used must fully comply with the recommended electrical installation requirements described in this manual. Failure to do so will void the warranty.
- D) In the event of accidents such as fires, floods, earthquakes, or other natural events that are unrelated to the operation of the refrigerator, the warranty does not cover it.

INSTRUCTIONS FOR HANDLING AND/ DISPOSAL OF THE APPLIANCE

- For handling, follow the recommendations in this manual.
- For responsible final disposition please follow your local regulations.
- Recycling and final disposition centers are an option for final disposition when compliant with local regulations.

For details, check with our service staff
Tel +52 800 006 4380



The symbols referred to in Clause 7.6 (without colours is permitted) and the information of the warning marking shall be provided as follows:

WARNING

Do not use means to accelerate the defrosting process or to clean, other than those recommended by the manufacturer.

The appliance shall be stored in a room without continuously operating ignition sources (for example: open flames, an operating gas appliance or an operating electric heater.

Do not pierce or burn.

Be aware that refrigerants may not contain an odour.

In Canada, the French translations for the warnings in Clause 101.DVS.2 are as follows

MISE EN GARDE

Ne pas utiliser de moyens autres que ceux recommandés par le fabricant pour accélérer le processus de dégivrage ou pour nettoyer l'appareil.

L'appareil doit être entreposé dans un local ne contenant pas de sources d'inflammation permanentes (flammes nues, appareil à gaz ou dispositif de chauffage électrique en fonctionnement, par exemple).

Ne pas percer ou brûler.

Attention, les fluides frigorigènes peuvent ne pas dégager d'odeur.

The manufacturer may provide other suitable examples or may provide additional information about the refrigerant odour..

101.DVS.3.1.1 The following information shall be specified in the manual where the information is needed for the function of the manual and as applicable to the appliance:

a) information for spaces where refrigerant pipes are allowed, including statements that

i) piping material, pipe routing, and installation shall include protection from physical damage in operation and service, and be in compliance with national and local codes and standards, such as ANSI/ASHRAE 15, IAPMO Uniform Mechanical Code, ICC International Mechanical Code, or CSA B52. All field joints shall be accessible for inspection prior to being covered or enclosed;

ii) the installation of pipe-work shall be kept to a minimum;

iii) pipe-work in the case of flammable refrigerants shall not be installed in an unventilated space, if that space is smaller than Amin in Annex 101.DVU, except for A2L refrigerants where the installed pipes comply with Clause 22.115DV. In case of field charge, the effect on refrigerant charge caused by the different pipe length shall be quantified;

iv) mechanical connections made in accordance with Clause 22.115DV shall be accessible for maintenance purposes;

v) provision shall be made for expansion and contraction of long runs of piping;

vi) protection devices, piping, and fittings shall be protected as far as possible against adverse environmental effects, for example, the danger of water collecting and freezing in relief pipes or the accumulation of dirt and debris;

vii) piping in refrigeration systems shall be so designed and installed to minimize the likelihood of hydraulic shock damaging the system;

viii) steel pipes and components shall be protected against corrosion with a rustproof coating before applying any insulation;

ix) flexible pipe elements shall be protected against mechanical damage, excessive stress by torsion, or other forces, and that they should be checked for mechanical damage annually;

x) precautions shall be taken to avoid excessive vibration or pulsation;

xi) for appliances containing flammable refrigerants, the minimum floor area of the room shall be mentioned in the form of a table or a single figure without reference to a formula;

xii) after completion of field piping for split systems, the field pipework shall be pressure tested with an inert gas and then vacuum tested prior to refrigerant charging, according to the following requirements:

1) The minimum test pressure for the low side of the system shall be the low side design pressure and the minimum test pressure for the high side of the system shall be the high side design pressure, unless the high side of the system cannot be isolated from the low side of the system in which case the entire system shall be pressure tested to the low side design pressure.

2) The test pressure after removal of pressure source shall be maintained for at least 1 h with no decrease of pressure indicated by the test gauge, with test gauge resolution not exceeding 5 % of the test pressure.

3) During the evacuation test, after achieving a vacuum level specified in the manual or less, the refrigeration system shall be isolated from the vacuum pump and the pressure shall not rise above 1500 microns within 10 min. The vacuum pressure level shall be specified in the manual, and shall be the lessor of 500 microns or the value required for compliance with national and local codes and standards, which may vary between residential, commercial, and industrial buildings.



- xiii) field-made refrigerant joints indoors shall be tightness tested according to the following requirements: The test method shall have a sensitivity of 5 grams per year of refrigerant or better under a pressure of at least 0,25 times the maximum allowable pressure. No leak shall be detected.
- b) instructions how to determine the additional REFRIGERANT CHARGE and how to complete the REFRIGERANT CHARGE on the label provided by the manufacturer considering the requirements in Clause 7.1DV.5.2;
- c) the minimum rated airflow, if required by Annex 101.DVU;
- d) information for handling, installation, cleaning, servicing and disposal of refrigerant;
- e) for appliances using FLAMMABLE REFRIGERANTS, instructions shall include the REFRIGERANT CHARGE mc and minimum room area of the space A_{min} . All dimensional data shall be provided in both SI and IP units;
- f) a warning to keep any required ventilation openings clear of obstruction;
- g) a notice that servicing shall be performed only as recommended by the manufacturer;
- h) a warning that ducts connected to an appliance shall not contain a potential ignition source;
- i) for appliances relying on safety measures according to Annex 101.DVU, instructions for wiring to external ventilation;
- j) when a remote located refrigerant sensor is specified by the manufacturer, the instructions shall state when it is required and how to install and connect the sensor;
- k) for appliances using A2L REFRIGERANTS, connected via an air duct system to one or more rooms, the supply and return air shall be directly ducted to the space. Open areas such as false ceilings shall not be used as a return air duct;
- l) the following information requirements apply for connecting piping in field erected systems:
 - i) Equipment piping in the occupied space shall be installed in such a way to protect against accidental damage in operation and service.
 - ii) Precautions shall be taken to avoid excessive vibration or pulsation to refrigerating piping.
 - iii) Protection devices, piping, and fittings shall be protected as far as possible against adverse environmental effects, for example, the danger of water collecting and freezing in relief pipes or the accumulation of dirt and debris.
 - iv) Provision shall be made for expansion and contraction of long runs of piping.
 - v) Piping in REFRIGERATING SYSTEMS shall be so designed and installed to minimize the likelihood hydraulic shock damaging the system.
 - vi) Solenoid valves shall be correctly positioned in the piping to avoid hydraulic shock or pressure.
 - vii) Steel pipes and components shall be protected against corrosion with a rustproof coating before applying any insulation.
- viii) Insulation shall be suitable for use with the material being insulated.

- ix) Flexible pipe elements shall be protected against mechanical damage, excessive stress by torsion, or other forces. They should be checked for mechanical damage annually.
- x) The indoor equipment and pipes shall be securely mounted and guarded such that accidental rupture of equipment cannot occur from such events as moving furniture or reconstruction activities.
- xi) Where safety shut off valves are specified, the minimum room area may be determined based on the maximum amount of refrigerant that can be leaked as determined in Annex 101.DVU.
- xii) Where safety shut off valves are specified, the location of the valve in the REFRIGERATING SYSTEM relative to the occupied spaces shall be as described in Annex 101.DVN and Annex 101.DVU.
- xiii) Field-made refrigerant joints indoors shall be tightness tested to applicable codes and requirements.

m) For mechanical ventilation as specified in Annex 101.DVU, the air extraction opening from the room shall be located equal or below the refrigerant release point. For floor mounted units, it shall be as low as practicable. The air extraction openings shall be located in a sufficient distance from the air intake openings to prevent re-circulation to the space.

All installation instruction information required to comply with Annex 101.DVU shall be provided in the form of a table or a single figure without reference to a formula;

n) For mechanical ventilation as specified in Annex 101.DVU, the lower edge of the air extraction opening where air is exhausted from the room shall not be more than 100 mm above the floor.

The location where the mechanical ventilation air extracted from the space is discharged shall be separated by a sufficient distance, but not less than 3 m, from the mechanical ventilation air intake openings, to prevent re-circulation to the space.

101.DVS.3.1.2 The following additional information shall be specified in the manual for remote systems using safety shut off valves in installation of appliances using A2L refrigerants where the information is needed for the function of the manual and as applicable to the appliance:

- a) Safety shut off valves installation shall avoid hydraulic shock.
- b) Safety shut off valves shall not block in liquid refrigerant unless adequate relief is provided to the refrigerant system low pressure side.
- c) Where safety shut off valves are specified, the minimum room area may be determined based on the maximum amount of refrigerant that can be leaked as determined in Annex 101.DVU.1.2.
- d) Where safety shut off valves are specified, the location of the valve in the REFRIGERATING SYSTEM, relative to the occupied spaces shall be as described in Clause 101.DVU.1.4.2.

101.DVS.3.1.3 For appliances with REFRIGERANT DETECTION SYSTEMS, the instructions shall include the following:

- a) For REFRIGERANT DETECTION SYSTEMS, the function and operation and required servicing measures.
- b) For LIMITED LIFE REFRIGERANT SENSORS used in REFRIGERANT DETECTION SYSTEMS, the specified end of life and instructions for replacement.
- c) REFRIGERANT SENSORS for REFRIGERANT DETECTION SYSTEMS shall only be replaced with sensors specified by the appliance manufacture.
- d) Instruction to verify actuation of mitigation actions per Annex 101.DVU



101.DVS.3.2 Unventilated areas

For appliances containing more than m1 for any refrigerating circuit, the manual shall include a statement advising that an unventilated area where the appliance using FLAMMABLE REFRIGERANTS is installed shall be so constructed that in the event of any refrigerant leak, it will not stagnate so as to create a fire or explosion hazard. This shall include:

- a) a warning that the non-FIXED APPLIANCE shall be stored in an area where the room size corresponds to the room area as specified for operation;
- b) a warning that the non-FIXED APPLIANCE shall be stored in a room without continuously operating open flames (for example an operating gas appliance) or other potential ignition sources (for example an operating electric heater, hot surfaces).

101.DVS.3.3 Qualification of workers

The manual shall contain specific information about the required qualification of the working personnel for maintenance, service, and repair operations. Every working procedure that affects safety means shall only be carried out by competent persons according to Annex 101.DVT.

Examples for such working procedures are

- a) breaking into the refrigerating circuit;
- b) opening of sealed components;
- c) opening of ventilated enclosures.

101.DVS.4 Information on servicing

101.DVS.4.1 General

The manual shall contain specific information for service personnel according to Clauses

101.DVS.4.2 to 101.DVS.4.10.

101.DVS.4.2 Checks to the area

Prior to beginning work on systems containing FLAMMABLE REFRIGERANTS, safety checks are necessary to ensure that the risk of ignition is minimised. For repair to the REFRIGERATING SYSTEM, Clauses 101.DVS.4.3 to 101.DVS.4.7 shall be completed prior to conducting work on the system.

101.DVS.4.3 Work procedure

Work shall be undertaken under a controlled procedure so as to minimise the risk of a flammable gas or vapour being present while the work is being performed.

101.DVS.4.4 General work area

All maintenance staff and others working in the local area shall be instructed on the nature of work being carried out. Work in confined spaces shall be avoided.

101.DVS.4.5 Checking for presence of refrigerant

The area shall be checked with an appropriate refrigerant detector prior to and during work, to ensure the technician is aware of potentially toxic or flammable atmospheres.

Ensure that the leak detection equipment being used is suitable for use with all applicable refrigerants, i.e., nonsparking, adequately sealed, or intrinsically safe.

101.DVS.4.6 Presence of fire extinguisher

If any hot work is to be conducted on the refrigerating equipment or any associated parts, appropriate fire extinguishing equipment shall be available on hand. A dry chemical or CO2 fire extinguisher should be adjacent to the charging area.

101.DVS.4.7 No ignition sources

No person carrying out work in relation to a REFRIGERATING SYSTEM which involves exposing any pipe work shall use any sources of ignition in such a manner that it may lead to the risk of fire or explosion. All possible ignition sources, including cigarette smoking, should be kept sufficiently far away from the site of installation, repairing, removing and disposal, during which refrigerant can possibly be released to the surrounding space. Prior to work taking place, the area around the equipment shall be surveyed to make sure that there are no flammable hazards or ignition risks. "No Smoking" signs shall be displayed.

101.DVS.4.8 Ventilated area

Ensure that the area is in the open or that it is adequately ventilated before breaking into the system or conducting any hot work. A degree of ventilation shall continue during the period that the work is carried out. The ventilation should safely disperse any released refrigerant and preferably expel it externally into the atmosphere.

101.DVS.4.9 Checks to the refrigerating equipment

Where electrical components are being changed, they shall be fit for the purpose and to the correct specification. At all times, the manufacturer's maintenance and service guidelines shall be followed. If in doubt, consult the manufacturer's technical department for assistance.

The following checks shall be applied to installations using FLAMMABLE REFRIGERANTS:

- a) the actual REFRIGERANT CHARGE is in accordance with the room size within which the refrigerant containing parts are installed;
- b) the ventilation machinery and outlets are operating adequately and are not obstructed;
- c) if an indirect refrigerating circuit is being used, the secondary circuit shall be checked for the presence of refrigerant;
- d) marking to the equipment continues to be visible and legible. Markings and signs that are illegible shall be corrected;
- e) refrigerating pipe or components are installed in a position where they are unlikely to be exposed to any substance which may corrode refrigerant containing.

components, unless the components are constructed of materials which are inherently resistant to being corroded or are suitably protected against being so corroded.

101.DVS.4.10 Checks to electrical devices

Repair and maintenance to electrical components shall include initial safety checks and component inspection procedures. If a fault exists that could compromise safety, then no electrical supply shall be connected to the circuit until it is satisfactorily dealt with. If the fault cannot be corrected immediately but it is necessary to continue operation, an adequate temporary solution shall be used. This shall be reported to the owner of the equipment, so all parties are advised.

Initial safety checks shall include:

- a) that capacitors are discharged: this shall be done in a safe manner to avoid possibility of sparking;
- b) that no live electrical components and wiring are exposed while charging, recovering or purging the system;
- c) that there is continuity of earth bonding.

101.DVS.5 Repairs to sealed components

101.DVS.5.1 During repairs to sealed components, all electrical supplies shall be disconnected from the equipment being worked upon prior to any removal of sealed covers, etc. If it is absolutely necessary to have an electrical supply to equipment during servicing, then a permanently operating form of leak detection shall be located at the most critical point to warn of a potentially hazardous situation.

101.DVS.5.2 Particular attention shall be paid to the following to ensure that by working on electrical components, the casing is not altered in such a way that the level of protection is affected. This shall include damage to cables, excessive number of connections, terminals not made to original specification, damage to seals, incorrect fitting of glands, etc.

Ensure that the apparatus is mounted securely. Ensure that seals or sealing materials have not degraded to the point that they no longer serve the purpose of preventing the ingress of flammable atmospheres. Replacement parts shall be in accordance with the manufacturer's specifications.

101.DVS.6 Repair to intrinsically safe components

Do not apply any permanent inductive or capacitance loads to the circuit without ensuring that this will not exceed the permissible voltage and current permitted for the equipment in use.

Intrinsically safe components are the only types that can be worked on while live in the presence of a flammable atmosphere. The test apparatus shall be at the correct rating. Replace components only with parts specified by the manufacturer. Other parts can result in the ignition of refrigerant in the atmosphere from a leak.

NOTE The use of silicon sealant can inhibit the effectiveness of some types of leak detection equipment. Intrinsically safe components do not have to be isolated prior to working on them.



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NOTE The use of silicon sealant can inhibit the effectiveness of some types of leak detection equipment. Intrinsically safe components do not have to be isolated prior to working on them.

101.DVS.7 Cabling

Check that cabling will not be subject to wear, corrosion, excessive pressure, vibration, sharp edges, or any other adverse environmental effects. The check shall also take into account the effects of aging or continual vibration from sources such as compressors or fans.

101.DVS.8 Detection of flammable refrigerants

Under no circumstances shall potential sources of ignition be used in the searching for or detection of refrigerant leaks. A halide torch (or any other detector using a naked flame) shall not be used.

The following leak detection methods are deemed acceptable for all refrigerant systems.

Electronic leak detectors may be used to detect refrigerant leaks but, in the case of FLAMMABLE REFRIGERANTS, the sensitivity might not be adequate, or might need recalibration. (Detection equipment shall be calibrated in a refrigerant-free area.) Ensure that the detector is not a potential source of ignition and is suitable for the refrigerant used.

Leak detection equipment shall be set at a percentage of the LFL of the refrigerant and shall be calibrated to the refrigerant employed, and the appropriate percentage of gas (25 % maximum) is confirmed.

Leak detection fluids are also suitable for use with most refrigerants but the use of detergents containing chlorine shall be avoided as the chlorine can react with the refrigerant and corrode the copper pipe-work.

NOTE Examples of leak detection fluids are

– bubble method,

– fluorescent method agents.

If a leak is suspected, all naked flames shall be removed/extinguished.

If a leakage of refrigerant is found which requires brazing, all of the refrigerant shall be recovered from the system, or isolated (by means of shut off valves) in a part of the system remote from the leak. Removal of refrigerant shall be according to Clause 101.DVS.9.

101.DVS.9 Removal and evacuation

When breaking into the refrigerant circuit to make repairs – or for any other purpose – conventional procedures shall be used. However, for flammable refrigerants it is important that best practice be followed, since flammability is a consideration. The following procedure shall be adhered to:

a) safely remove refrigerant following local and national regulations;

b) purge the circuit with inert gas;

c) evacuate (optional for A2L);

d) purge with inert gas (optional for A2L);

e) open the circuit by cutting or brazing.

The refrigerant charge shall be recovered into the correct recovery cylinders if venting is not allowed by local and national codes. For appliances containing flammable refrigerants,

the system shall be purged with oxygen-free nitrogen to render the appliance safe for flammable refrigerants. This process might need to be repeated several times.

Compressed air or oxygen shall not be used for purging refrigerant systems.

For appliances containing flammable refrigerants, refrigerants purging shall be achieved by breaking the vacuum in the system with oxygen-free nitrogen and continuing to fill until the working pressure is achieved, then venting to atmosphere, and finally pulling down to a vacuum (optional for A2L). This process shall be repeated until no refrigerant is within the system (optional for A2L). When the final oxygen-free nitrogen charge is used, the system shall be vented down to atmospheric pressure to enable work to take place.

Ensure that the outlet for the vacuum pump is not close to any potential ignition sources and that ventilation is available.

101.DVS.10 Charging procedures

In addition to conventional charging procedures, the following requirements shall be followed.

a) Ensure that contamination of different refrigerants does not occur when using charging equipment. Hoses or lines shall be as short as possible to minimise the amount of refrigerant contained in them.

b) Cylinders shall be kept in an appropriate position according to the instructions.

c) Ensure that the REFRIGERATING SYSTEM is earthed prior to charging the system with refrigerant.

d) Label the system when charging is complete (if not already).

e) Extreme care shall be taken not to overfill the REFRIGERATING SYSTEM.

Prior to recharging the system, it shall be pressure-tested with the appropriate purging gas. The system shall be leak-tested on completion of charging but prior to commissioning. A follow up leak test shall be carried out prior to leaving the site.

101.DVS.11 Decommissioning

Before carrying out this procedure, it is essential that the technician is completely familiar with the equipment and all its detail. It is recommended good practice that all refrigerants are recovered safely. Prior to the task being carried out, an oil and refrigerant sample shall be taken in case analysis is required prior to re-use of recovered refrigerant. It is essential that electrical power is available before the task is commenced.

a) Become familiar with the equipment and its operation.

b) Isolate the system electrically.

c) Before attempting the procedure, ensure that:

i) mechanical handling equipment is available, if required, for handling refrigerant cylinders;

ii) all personal protective equipment is available and being used correctly;

iii) the recovery process is supervised at all times by a competent person;

iv) recovery equipment and cylinders conform to the appropriate standards.

d) Pump down refrigerant system, if possible.

e) If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.

f) Make sure that cylinder is situated on the scales before recovery takes place.

g) Start the recovery machine and operate in accordance with instructions.

h) Do not overfill cylinders (no more than 80 % volume liquid charge).

i) Do not exceed the maximum working pressure of the cylinder, even temporarily.

j) When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.

k) Recovered refrigerant shall not be charged into another REFRIGERATING SYSTEM unless it has been cleaned and checked.



101.DVS.12 Labelling

Equipment shall be labelled stating that it has been de-commissioned and emptied of refrigerant. The label shall be dated and signed. For appliances containing FLAMMABLE REFRIGERANTS, ensure that there are labels on the equipment stating the equipment contains FLAMMABLE REFRIGERANT.

101.DVS.13 Recovery

When removing refrigerant from a system, either for servicing or decommissioning, it is recommended good practice that all refrigerants are removed safely.

When transferring refrigerant into cylinders, ensure that only appropriate refrigerant recovery cylinders are employed. Ensure that the correct number of cylinders for holding the total system charge is available. All cylinders to be used are designated for the recovered refrigerant and labelled for that refrigerant (i.e., special cylinders for the recovery of refrigerant). Cylinders shall be complete with pressure-relief valve and associated shut-off valves in good working order. Empty recovery cylinders are evacuated and, if possible, cooled before recovery occurs.

The recovery equipment shall be in good working order with a set of instructions concerning the equipment that is at hand and shall be suitable for the recovery of all appropriate refrigerants including, when applicable, FLAMMABLE REFRIGERANTS. In addition, a set of calibrated weighing scales shall be available and in good working order. Hoses shall be complete with leak-free disconnect couplings and in good condition. Before using the recovery machine, check that it is in satisfactory working order, has been properly maintained and that any associated electrical components are sealed to prevent ignition in the event of a refrigerant release. Consult manufacturer if in doubt.

The recovered refrigerant shall be returned to the refrigerant supplier in the correct recovery cylinder, and the relevant waste transfer note arranged. Do not mix refrigerants in recovery units and especially not in cylinders.

If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that FLAMMABLE REFRIGERANT does not remain within the lubricant. The evacuation process shall be carried out prior to returning the compressor to the suppliers. Only electric heating to the compressor body shall be employed to accelerate this process. When oil is drained from a system, it shall be carried out safely.

Annex 101.DVT (informative)

Competence of service personnel

Annex 101.DVT DR Add Annex 101.DVT as follows:

101.DVT.1 General

Information of procedures additional to usual information for refrigerating appliance installation, repair, maintenance, and decommission procedures is required when an appliance with FLAMMABLE REFRIGERANTS is affected.

The training of these procedures is carried out by national training organisations or manufacturers that are accredited to teach the relevant national competency standards that may be set in legislation.

The achieved competence should be documented by a certificate.

101.DVT.2 Information and training

101.DVT.2.1 The training should include the substance of the following:

101.DVT.2.2 Information about the explosion potential of FLAMMABLE REFRIGERANTS to show that flammables can be dangerous when handled without care.

101.DVT.2.3 Information about potential ignition sources, especially those that are not obvious, such as lighters, light switches, vacuum cleaners, electric heaters.

101.DVT.2.4 Information about the different safety concepts:

Unventilated – Safety of the appliance does not depend on ventilation of the housing. Switching off the appliance or opening of the housing has no significant effect on the safety. Nevertheless, it is possible that leaking refrigerant may accumulate inside the enclosure and flammable atmosphere will be released when the enclosure is opened.

Ventilated enclosure – Safety of the appliance depends on ventilation of the housing. Switching off the appliance or opening of the enclosure has a significant effect on the safety. Care should be taken to ensure sufficient ventilation before.

Ventilated room – Safety of the appliance depends on the ventilation of the room. Switching off the appliance or opening of the housing has no significant effect on the safety. The ventilation of the room should not be switched off during repair procedures.

101.DVT.2.5 Information about refrigerant detectors:

a) Principle of function, including influences on the operation.

b) Procedures, how to repair, check, or replace a refrigerant detector or parts of it in a safe way.

c) Procedures, how to disable a refrigerant detector in case of repair work on the refrigerant carrying parts.

101.DVT.2.6 Information about the concept of sealed components and sealed enclosures according to IEC 60079-15

101.DVT.2.7 Information about the correct working procedures:

a) Commissioning

i) Ensure that the floor area is sufficient for the REFRIGERANT CHARGE or that the ventilation duct is assembled in a correct manner.

ii) Connect the pipes and carry out a leak test before charging with refrigerant.

iii) Check safety equipment before putting into service.

b) Maintenance

i) Portable equipment is to be repaired outside or in a workshop specially equipped for servicing units with FLAMMABLE REFRIGERANTS.

ii) Ensure sufficient ventilation at the repair place.

iii) Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.

iv) Discharge capacitors in a way that won't cause any spark. The standard procedure to short circuit the capacitor terminals usually creates sparks.

v) Reassemble sealed enclosures accurately. If seals are worn, replace them.

vi) Check safety equipment before putting into service.

c) Repair

i) Portable equipment is to be repaired outside or in a workshop specially equipped for servicing units with FLAMMABLE REFRIGERANTS.

ii) Ensure sufficient ventilation at the repair place.

iii) Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.

iv) Discharge capacitors in a way that won't cause any spark.

v) When brazing is required, the following procedures shall be carried out in the following order:



- 1) Safely remove the refrigerant following local and national regulations. If the recovery is not required by national regulations, drain the refrigerant to the outside. Take care that the drained refrigerant will not cause any danger. In doubt, one person should guard the outlet. Take special care that drained refrigerant will not float back into the building.
 - 2) Purge the refrigerant circuit with oxygen free nitrogen.
 - 3) Evacuate the refrigerant circuit.
 - 4) Purge the refrigerant circuit with nitrogen for 5 min (not required for A2L refrigerants).
 - 5) Evacuate again (not required for A2L refrigerants).
 - 6) Remove parts to be replaced by cutting or brazing.
 - 7) Purge the braze point with nitrogen during the brazing procedure required for repair.
 - 8) Carry out a leak test before charging with refrigerant.
- vi) Reassemble sealed enclosures accurately. If seals are worn, replace them.
- vii) Check safety equipment before putting into service.
- d) Decommissioning
- i) If the safety is affected when the equipment is put out of service, the REFRIGERANT CHARGE is to be removed before decommissioning.
 - ii) Ensure sufficient ventilation at the equipment location.
 - iii) Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.
 - iv) Discharge capacitors in a way that will not cause any spark.
 - v) Remove the refrigerant. If the recovery is not required by national regulations, drain the refrigerant to the outside. Take care that the drained refrigerant will not cause any danger. In doubt, one person should guard the outlet. Take special care that drained refrigerant will not float back into the building.
 - vi) When FLAMMABLE REFRIGERANTS except A2L REFRIGERANTS are used,
 - 1) Evacuate the refrigerant circuit.
 - 2) Purge the refrigerant circuit with nitrogen for 5 min.
 - 3) Evacuate again.
 - 4) Fill with nitrogen up to atmospheric pressure.
 - 5) Put a label on the equipment that the refrigerant is removed.
- e) Disposal
- i) Ensure sufficient ventilation at the working place.
 - ii) Remove the refrigerant. If the recovery is not required by national regulations, drain the refrigerant to the outside. Take care that the drained refrigerant will not cause any danger. In doubt, one person should guard the outlet. Take special care that drained refrigerant will not float back into the building.
 - iii) When FLAMMABLE REFRIGERANTS are used,
 - 1) Evacuate the refrigerant circuit.
 - 2) Purge the refrigerant circuit with oxygen free nitrogen.
 - 3) Evacuate again (not required for A2L refrigerants).
 - 4) Cut out the compressor and drain the oil.
 - iv) Cut out the compressor and drain the oil

Annex 101.DVU

(normative)

A2L Refrigerant Requirements

Annex 101.DVU DR Add Annex 101.DVU as follows:

101.DVU.1 General

When an A2L flammable refrigerant is used in a field-erected system made up of partial units, the requirements for installation space of appliance and/or additional requirements are determined according to the following and as required by Annex 101.DVG.

- a) The refrigerant charge (mc) used in the appliance;
- b) The releasable charge (mrel) of the appliance;
- c) The maximum charge (mmax) allowed in the space;
- d) The minimum area of the space (Amin);
- e) The Lower Flammability limit (LFL) as given by the value based on the WCF – Worst Case Formulation as defined in ISO 817;
- f) The installation location;
- g) The type of ventilation of the location or the appliance;
- h) Construction;
- i) Refrigerant detection and mitigation means (air circulation, ventilation, shut-off valves, etc.).

Symbol mc denotes the refrigerant charge of a single refrigerating system or single refrigerating circuit. Where multiple refrigerating systems or refrigerating circuits are servicing the same space, each refrigerating system or circuit refrigerant charge shall be evaluated independently.

Symbol mrel denotes the releasable charge of a single refrigerating appliance or refrigerant circuit defined as Clause 101.DVU.1.3.

101.DVU.1.1 Additional construction requirements of partial system and piping with A2L refrigerants

101.DVU.1.1.1 The compressor, pressure-relief device, or pressure vessel type refrigerant containing components of the refrigerating system shall be in locations other than the occupied space or in compliance with charge limits given by Clauses 101.DVU.1.5 and 101.DVU.1.6.

NOTE Pressure vessel means any refrigerant-containing part of a REFRIGERATING SYSTEM other than

- a) Compressors;
- b) pumps;
- c) component parts of sealed absorption systems;
- d) evaporators, each separate section of which does not exceed 15 L of refrigerant containing volume;
- e) coils.
- f) piping and its valves, joints, and fittings;
- g) control devices; and
- h) pressure-containing components (including headers) having an internal diameter or largest cross sectional dimension not greater than 152 mm.

101.DVU.1.1.2 Refrigerant distribution assemblies and associated piping shall meet all applicable requirements of this Standard.

101.DVU.1.1.3 Refrigeration systems shall use only permanent joints indoors, except for site-made joints directly connecting the appliance to the refrigerant piping, or factory mechanical joints in compliance with ISO 14903 that at pressure of no less than the refrigerant saturation pressure at 25 °C have no leak when checked with an instrument having a sensitivity of 3g/y or less.

101.DVU.1.1.4 Refrigerant containing parts in the appliance shall be protected from damage in the event of catastrophic failure of moving parts, e.g., belts on belt drive fans. Fan assemblies in compliance with Clause 101.DVU.1.1.7, other than belts on belt drive fans, do not need to be guarded against catastrophic failure.



101.DVU.1.1.5 Systems where the appliance interconnecting pipes are installed in the occupied space, piping shall be designed and installed in such a way that these pipes are protected against accidental damage.

101.DVU.1.1.5.1 Interconnected piping shall comply with ANSI/ASHRAE 15 installation requirements.

101.DVU.1.1.5.2 Piping in the occupied space shall have a charge mc or mrel as calculated by Clause 101.DVU.1.1.3 and no more than mmax calculated per Clause 101.DVU.1.6.

factory. There shall be no leak when checked with an instrument having a sensitivity of 3g/yr or less when tested at 75 % of the maximum allowable pressure.

101.DVU.1.1.7 The maximum evaporator, condenser, or mitigation fan operating speed shall be less than 90 % of the maximum allowable fan speed as specified by the manufacturer of the fan wheel.

If a maximum allowable fan speed has not been established, the fan wheel shall be tested as follows:

a) The fan wheel shall be operated continuously at 120 % of maximum speed allowed by the controls for 10 d. There shall be no structural failure of the fan.

b) If non-metallic fans have a thermal index rating of 65°C or greater in accordance with UL 746B, preconditioning is not required.

c) If non-metallic fans have a thermal index rating less than 65°C in accordance with UL 746B, or no thermal index rating for the materials is available, specimens shall be preconditioned by aging at 90°C for 168 h. The samples shall not have more than a 50-percent reduction of the unconditioned property values for items 1 – 4 below when tested in accordance with CAN/CSA-C22.2 No 0.17 and UL 746A:

- 1) tensile strength;
- 2) flexural strength;
- 3) Izod impact; and
- 4) tensile impact..

101.DVU.1.2 Releasable charge (mrel) determination

101.DVU.1.2.1 General

The maximum releasable charge shall be considered to be the largest value as calculated by Clauses 101.DVU.1.2.2 to 101.DVU.1.2.3 multiplied by 1.30. The maximum releasable charge shall be calculated using the internal volume of all interconnecting tubing and all refrigeration appliances “downstream” of the safety shut-off valves. Internal volume of tubing shall be determined by multiplying the length of tubing times the internal volume per length specified in Table 101.DVU.1.

Table 101.DVU.1
Tube volume per unit length

Tube OD		Tube internal volume per unit length	
mm	in	m ³ / m	ft ³ / ft
6.35	0.250	1.77E-05	2.05E-04
7.94	0.313	3.10E-05	3.59E-04
9.53	0.375	4.80E-05	5.55E-04
12.7	0.500	9.29E-05	1.08E-03
15.9	0.625	1.49E-04	1.73E-03
19.1	0.750	2.14E-04	2.48E-03
22.2	0.875	2.96E-04	3.43E-03
25.4	1.000	3.89E-04	4.50E-03
28.6	1.125	5.03E-04	5.82E-03
31.8	1.250	6.23E-04	7.21E-03
38.1	1.500	9.10E-04	1.05E-02
41.3	1.625	1.08E-03	1.25E-02
54.0	2.125	1.88E-03	2.18E-02
66.7	2.625	2.89E-03	3.35E-02

NOTE Values in IP units are for reference only.

101.DVU.1.2.2 Releasable charge in cooling mode

The releasable charge in the cooling mode shall be in accordance with the following:

$$M_{rel} = (L_{vap} \times TD_{vap} \times \rho_{vap}) + (L_{liq} \times TD_{liq} \times \rho_{liq}) + (IV_{unit} \times \rho_{mix}) + (6,8g / s \times T_{resp} / 1000)$$

where

Lvap is the total length of vapor interconnecting tubing from safety shut-off valves to each refrigerating appliance in m;

Lliq is the total length of liquid interconnecting tubing from safety shut-off valves to each refrigerating appliance in m;

TDvap is the tube volume per length of tube diameter of the vapor interconnecting tubing determined from Table 101.DVU.1 in m3 /m;

TDliq is the tube volume per length of tube diameter of the liquid interconnecting tubing determined from Table 101.DVU.1 in m3/m;

pvp is the vapor refrigerant density in the cooling mode when operating at 35 °C ODDb (Out Door Dry Bulb Temperature) and DB/WB established from the evaporator leaving air temperature, if not given use of 0 °C/–10 °C for Medium Temperature Appliance and –20 °C/–30 °C for Low Temperature Appliance in kg/m3;



ρ_{liq} is the liquid refrigerant density in the cooling mode when operating at 35 °C ODDB (Out Door Dry Bulb Temperature) and DB/WB established from the evaporator leaving air temperature, if not given use of 0 °C/–10 °C for Medium Temperature Appliance and –20 °C/–30 °C for Low Temperature Appliance in kg/m³;
 ρ_{mix} is the refrigerant density assuming 80 % liquid and 20 % vapor. $\rho_{mix} = 0,8 \cdot \rho_{liq} + 0,2 \cdot \rho_{vap}$ in kg/m³;

IV_{unit} is the total internal volume of the refrigeration appliance including coil(s), headers, tubing and all refrigerant containing parts of the unit that is downstream of the safety shut-off valve as determined by the manufacturer, m³;

T_{resp} is the assumed response time for refrigeration detection system and associated mitigation measures in s, which shall be 30 s.

101.DVU.1.2.3 Releasable charge in off/standby/defrost mode

The releasable charge in the cooling off mode m_{off} , shall be in accordance with the following:

$$m_{rel} = (L_{vap} \times TD_{vap} \times \rho_{vap}) + (L_{liq} \times TD_{liq} \times \rho_{liq}) + (IV_{unit} \times \rho_{off}) + (6,8g/s \times T_{resp} / 1000)$$

where

ρ_{off} is the refrigerant density assuming 80 % liquid and 20 % vapor at 21C saturation conditions in kg/m³;

L_{vap} is the total length of vapor interconnecting tubing from safety shut-off valves to each refrigerating appliance in m;

L_{liq} is the total length of liquid interconnecting tubing from safety shut-off valves to each refrigerating appliance in m;

TD_{vap} is the tube volume per length of tube diameter of the vapor interconnecting tubing determined from Table 101.DVU.1 in m³/m;

TD_{liq} is the tube volume per length of tube diameter of the liquid interconnecting tubing determined from Table 101.DVU.1 in m³/m;

ρ_{vap} is the vapor refrigerant density in the cooling mode when operating at 35 °C ODDB (Out Door Dry Bulb Temperature) and DB/WB established from the evaporator leaving air temperature, if not given use of 0 °C/–10 °C for Medium Temperature Appliance and –20 °C/–30 °C for Low Temperature Appliance in kg/m³;

ρ_{liq} is the liquid refrigerant density in the cooling mode when operating at 35 °C ODDB (Out Door Dry Bulb Temperature) and DB/WB established from the evaporator leaving air temperature, if not given use of 0 °C/–10 °C for Medium Temperature Appliance and –20 °C/–30 °C for Low Temperature Appliance in kg/m³;

ρ_{mix} is the refrigerant density assuming 80 % liquid and 20 % vapor. $\rho_{mix} = 0,8 \cdot \rho_{liq} + 0,2 \cdot \rho_{vap}$ in kg/m³;

IV_{unit} is the total internal volume of the refrigeration appliance including coil(s), headers, tubing and all refrigerant containing parts of the unit that is downstream of the safety shut-off valve as determined by the manufacturer, m³;

T_{resp} is the assumed response time for refrigeration detection system and associated mitigation measures in s, which shall be 30 s.

101.DVU.1.3 Additional Instructions for partial systems with A2L refrigerants

101.DVU.1.3.1 The following additional information shall be specified in the instruction manual for partial units using A2L refrigerants.

101.DVU.1.3.2 Instructions for positioning of Solenoid Valves in the field-installed interconnecting refrigerant piping

101.DVU.1.3.2.1 Solenoid valves shall be correctly positioned in the piping to avoid hydraulic shock.

101.DVU.1.3.2.2 Solenoid valves shall not block in liquid refrigerant unless adequate relief is provided to the refrigerant system low pressure side.

101.DVU.1.3.3 Where safety shut-off valves are specified for use in the field-installed interconnecting refrigerant piping, instructions for calculating the minimum room area based on the maximum amount of refrigerant that can be leaked as determined in Clause 101.DVU.1.5 or 101.DVU.1.6 whichever is applicable.

101.DVU.1.3.4 Where safety shut off valves are required in the field-installed interconnecting refrigerant piping, the installation location of the valve in the REFRIGERATING SYSTEM, relative to the occupied spaces shall be provided.

101.DVU.1.3.5 Instructions for installation and protection of field-installed Interconnecting refrigerant piping shall be provided for compliance with Clause 101.DVU.1.1.5.

101.DVU.1.3.6 Instructions for operation, positioning, and use of refrigerant sensor or detector as specified in Annex 101.DVP or 101.DVQ.

101.DVU.1.3.6.1 Factory installed refrigerant sensors or detectors shall not be disconnected.

101.DVU.1.3.6.2 Field installed refrigerant sensors shall be correctly positioned and tested per Annex 101.DVQ.

101.DVU.1.4 Safety shut-off valves for direct systems

101.DVU.1.4.1 Installation and operation

101.DVU.1.4.1.1 Safety shut-off valves, if required on PARTIAL UNITS by Annex 101.DVG, shall be factory-installed, except as noted in Clause 101.DVG.10.4 for evaporator units installed in walk-in cooler/freezers.

101.DVU.1.4.1.2 When safety shut-off valves are activated by the refrigerant detection system, the valves shall close and remain closed until corrective action is taken.

101.DVU.1.4.2 Location

Safety shut-off valves shall be located in such a way such that leaks upstream of the safety shut off valve shall not enter the internal volume of the partial unit and in a space with a room volume large enough so that the maximum refrigerant charge complies with Clause 101.DVU.1.7 or shall be located outside. Safety shut off valves shall be positioned to enable access for maintenance by an authorized person.

101.DVU.1.4.3 Design

101.DVU.1.4.3.1 General

Safety shut-off valves shall be evaluated for use with the appliance.

Safety shut-off valves shall comply with Clauses 101.DVU.1.4.3.2 to 101.DVU.1.4.3.7. Seat leakage rates shall be determined in accordance with Clause 101.DVU.1.4.3.3. Safety shut-off valves shall be normally closed and shall be electronically controlled.

101.DVU.1.4.3.2 The safety shut-off valve control system shall be non-self-resetting. The safety shut-off valve control system shall require a manual reset operation. Remote reset without verification of corrective action shall not be allowed.

101.DVU.1.4.3.3 Seat leakage test

The safety shut-off valve shall have a maximum seat leakage at all test conditions of less than or equal to 0,01 kg/hr.
 Compliance is checked by test.



Through-the-seat leakage shall be measured, at the valve outlet port, at 2, 50, 100, and 125 percent of the maximum allowable system pressure as determined in Annex 101.DVJ applied to the valve inlet for 5 min at each test pressure. The maximum leakage rate over the 5 min duration shall be measured and recorded for each test pressure. The test shall be performed for both liquid state and vapour state. The inlet pressure shall be applied with a test medium corresponding to the intended fluid service of the sample valve. The vapour state working fluid during test may be air. The liquid state working fluid during test may be water. If the test working fluid is refrigerant, at least 3 °C superheat shall be used for vapour and at least 2 °C subcooling shall be used for liquid.

101.DVU.1.4.3.4 Safety shut-off valve requirements

Electrical contacts, terminals, and solenoids shall be adequately protected from damage and expected atmospheric conditions. Safety shut-off valves shall be capable of operating in a temperature range from at least 10 °K below the minimum design evaporator temperature to 60 °C. Safety shut-off valves shall be capable of fully closing within 30 s of being energized, at any normal operating pressure or condition.

101.DVU.1.4.3.5 Body leakage test

A pressure equal to 150 percent of the maximum rated pressure shall be applied through the safety shut-off valve, with the valve body open, and maintained for 5 min minimum, with no external leakage or damage to the safety shut-off valve, when checked with an instrument having a sensitivity of 3g.yr or less. No permanent distortion of any valve component shall be allowed after the pressure is released. The test working fluid may be refrigerant, water, or any suitable hydraulic fluid.

101.DVU.1.4.3.6 Marking

Safety shut-off valves shall be marked with the following, and all markings shall be legible and durable:

- manufacturer's name or trade name;
- model designation;
- type of fluid service;
- approved direction of flow;
- electrical ratings; and
- rated working pressure.

101.DVU.1.4.3.7 Manufacturing and production test

All production safety shut-off valves shall be tested to confirm rated seat leakage is not exceeded.

101.DVU.1.5 Maximum refrigerant charge

$$m_{\max} = 0,25 \times LFL \times H \times A$$

For spaces exceeding 250 m², room area (A) shall be 250 m², or the required minimum room area $A_{\min}$ of the installed appliance with the refrigerant charge m_c shall be in accordance with the following:

$$A_{\min} = m_c / (0,25 \times LFL \times H)$$

where

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

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

LFL is the lower flammability limit in kg/m³;

H is the room height in m but not more than 2,2 m

A is the room area in m²;

$A_{\min}$ is the required minimum room area in m².

If safety shut-off valves in compliance with Clause 101.DVU.1.4 are applied to limit the releasable charge, the releasable charge (m_{rel}) as determined in Clause 101.DVU.1.2 shall be used to determine the minimum room size $A_{\min}$ by replacing (m_c) in the equation for $A_{\min}$ with (m_{rel}).

101.DVU.1.6 Maximum refrigerant charge when employing circulation or ventilation

The maximum refrigerant charge of the installed appliance shall be in accordance with the following:

$$m_{\max} = 0,5 \times LFL \times H \times A$$

For spaces exceeding 250 m², room area (A) shall be 250 m², or the required minimum room area $A_{\min}$ of the installed appliance with the refrigerant charge m_c shall be in accordance with the following:

$$A_{\min} = m_c / (0,5 \times LFL \times H)$$

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

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

LFL is the lower flammability limit in kg/m³;

H is the room height in m but not more than 2,2 m;

A is the room area in m²;

$A_{\min}$ is the required minimum room area in m².



If safety shut-off valves in compliance with Clause 101.DVU.1 are applied to limit the releasable charge, the releasable charge (m_{rel}) as determined in Clause 101.DVU.1.2 shall be used to determine the minimum room size A_{min} by replacing (m_c) in the equation for A_{min} with (m_{rel}).

101.DVU.1.7 Mechanical ventilation – General

101.DVU.1.7.1 When the mass of the refrigerant in the entire refrigeration system is $> m_2$ and $\leq m_3$, COMPRESSOR UNITS, CONDENSING UNITS, and CONDENSER UNITS to be installed indoors shall be marked "Ventilation shall be provided as indicated in the installation instructions".

101.DVU.1.7.2 When the mass of the refrigerant in the entire refrigeration system is $> m_2$ and $\leq m_3$, COMPRESSOR UNITS, CONDENSING UNITS, and CONDENSER UNITS to be installed indoors shall be provided with installation instructions that indicate the following (through Clause 101.DVU.1.7.5):

Ventilation shall be made to a place where sufficient air is available to dilute the leaked refrigerant, such as outdoors or a large space. An indoor space used to exhaust the ventilation air shall have sufficient volume, including the volume of the room in which the appliance is installed, to ensure that the maximum refrigerant charge specified in Clause 101.DVU.1.6 is not exceeded.

When ventilation is activated by the refrigerant detection system, the following actions shall be taken:

a) For all appliances equipped with a fan, the fan shall be switched on to provide the minimum circulation airflow in accordance with Clause 101.DVU.1.8.2.

b) The compressor operation shall be disabled, unless the compressor operation reduces the leak rate or in the case of a multiple circuits, when the leak circuit is isolated by shut-off valves and the operation of the system is not affected.

The mechanical ventilation and appliance air circulation shall continue for a minimum of 5 min after the refrigerant detection system resets.

101.DVU.1.7.3 Required ventilation airflow

$$Q_{min} = 30(m_c - m_{max}) / LFL, \text{ not to exceed } Q_{min} - 486 / LFL$$

Where:

Q_{min} is the minimum mechanical ventilation in m³/h;

m_c is the refrigerant system charge in kg;

m_{max} is the maximum charge as determined in Clause 101.DVU.1.6;

LFL is the lower flammability limit in kg/m³;

30 is a constant

NOTE the limit of 486/LFL is based on an 35 kW system with 0,45 kg/kW charge = 15,8 kg charge. For appliances without air circulation fans, m_{max} shall be set to zero.

101.DVU.1.7.4 Mechanical ventilation openings

For mechanical ventilation, the lower edge of the air extraction opening where air is exhausted from the room shall not be more than 100 mm above the floor.

The location where the mechanical ventilation air extracted from the space is discharged shall be separated by a sufficient distance, but not less than 3 m, from the mechanical ventilation air intake opening to prevent re-circulation to the space.

101.DVU.1.7.5 Operation of mechanical ventilation

Mechanical ventilation shall be operated continuously or shall be switched on by a refrigerant detection system.

If the mechanical ventilation is operated continuously, other than for short periods of maintenance on service, the airflow shall be detected continuously or monitored continuously. Within 10 s in the event that the airflow is reduced, the following actions shall be taken:

- The compressor operation shall be disabled, unless the compressor operation reduces the leak rate or in the case of a multiple circuits, when the leak circuit is isolated by shut-off valves and the operation of the system is not affected.
- The user shall be warned if the airflow is reduced.

101.DVU.1.8 Circulation airflow

101.DVU.1.8.1 General

Where mechanical ventilation is required, circulation airflow for the for the purpose of mixing the air in the room shall also be provided.

The circulation airflow shall operate continuously or be turned on by a refrigerant detection system. The minimum air velocity and the minimum air flow shall be as follows:

$$Q_{min} = 135 \times CAP$$

$$v_{min} = 2$$

Where:

Q_{min} is the minimum airflow in m³/h;

CAP is the nominal capacity specified by the manufacturer in kW of cooling of the appliance;

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

135 is a constant m³/h per kW cooling capacity (CAP)

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

Compliance shall be checked by testing.



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 action.

101.DVU.1.8.2 Continuous circulation airflow

The 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 the following actions shall be taken:

- a) the compressor operation shall be disabled, unless the compressor operation reduces the leak rate or in the case of a multiple circuits, when the leak circuit is isolated by shut-off valves and the operation of the system is not affected;
- b) the user shall be warned that airflow is reduced—

Special instructions for appliances employing flammable refrigerant:d.

101.DVU.1.8.3 Circulation airflow initiated by a refrigerant detection system

When any refrigerant detection system is activated in accordance with Annex 101.DVP (Refrigerant Detector annex) in response to a detected leak into the space, all appliances in the space containing the refrigerant detection system, that are served by the same compressor(s) all take the following actions and continue for at least five minutes after the REFRIGERATION DETECTION SYSTEM has reset:

- a) The fan(s) shall be switched on.
- b) The compressor operation shall be disabled, unless the compressor operation reduces the leak rate or in the case of a multiple circuits, when the leak circuit is isolated by shut-off valves and the operation of the system is not affected.

