

New Refrigerant **R290** for Hot Water Heat Pump

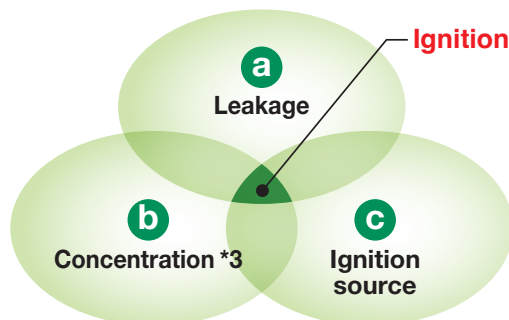
Summary of New Refrigerant R290 Handling Manual

- Refer to each product's installation manual and service manual in addition to this summary.
- In case there are regulations of each country, you must comply with the requirements in addition to this summary.

01 Safety Handling for R290 Refrigerant

1 R290 Refrigerant Properties

Under the conditions shown below, there is a possibility that R290 refrigerant could burn.



	R290	R454C	R407C
Chemical formula	C_3H_8	$CH_2F_2/C_3H_2F_4$	$CH_2F_2/CHF_2CF_3/CH_2FCF_3$
Global warming potential (GWP) *1	3	148	1770
Flammability *2	Higher Flammability (Class 3)	Lower Flammability (Class 2L)	No Flame Propagation (Class 1)
LFL (Vol%) Lower Flammable Limit	2.1	7.7	—
UFL (Vol%) Upper Flammable Limit	9.5	15.4	—

*1 IPCC 4th assessment report

*2 ISO 817:2014

*3 R290 refrigerant concentration is higher than LFL and lower than UFL.

2 Safety Precautions

As R290 refrigerant is classified into higher flammability, ignition conditions can be removed by following three points.

a Do not leak refrigerant.

- The work on refrigerant circuits can only be performed by certified or qualified personnel trained properly to handle R290 refrigerant in accordance with EN 378 Part 4 or IEC 60335-2-40 Annex HH.
- While the experts are handling R290 refrigerant and a unit, a portable Leak detector must be used. (Including when transport/storage and any case of entering the installation area where four surfaces are closed or into the protective zone)

b Prevent concentration.

- Besides during installation and servicing, when entering the installation area where four surfaces are closed or into the protective zone, make sure to ventilate the area with a fan.
- Follow "2. Installation Restrictions", "3. Protective Zone", and "6. Transportation of the Unit".

c Keep ignition source away from the unit.

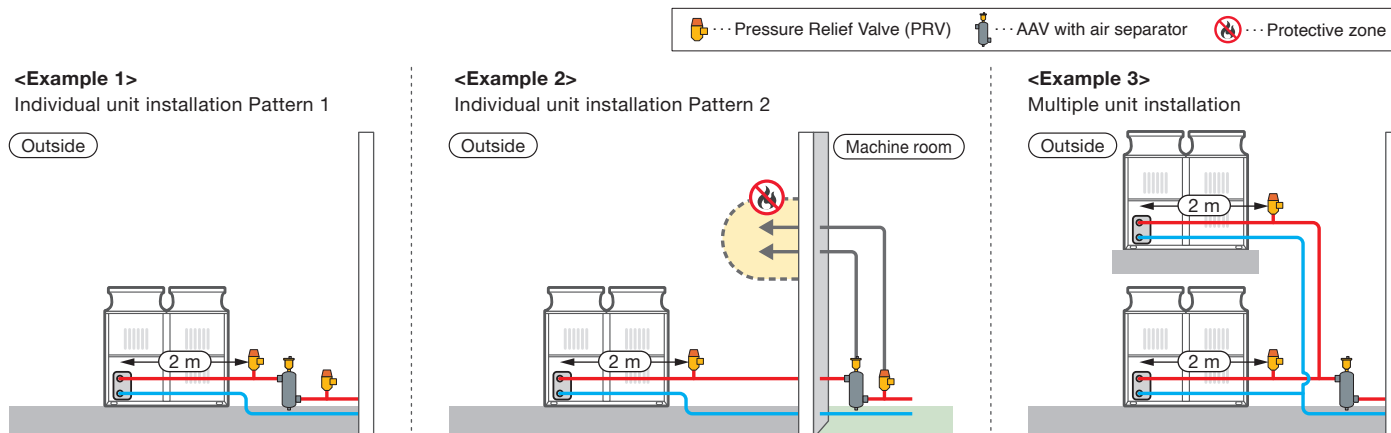
- Follow "4. Tools" and "5. Ignition sources".
- Note that static electricity is also an ignition source, so anti-static measures should be taken.
- When repairing the refrigerant parts, remove parts to be replaced by cutting with pipe cutter, NOT by flame nor by electric saw, etc..

02 Installation Restrictions

To prevent ignition of the refrigerant, follow these instructions* during installation.

*Established based on the Mitsubishi Electric's Risk Assessment Standards.

1 System configuration



In order to ensure that the safety measures function properly in the event of a refrigerant leakage, Pressure Relief Valve (PRV) and Automatic Air vent Valve with Air Separator (AAV with air separator) must be installed as defined. Mitsubishi Electric strongly recommends that these be installed outdoors to reduce the risk of ignition with the leakage. In that case, they must be located inside the protective zone around the unit, as these open components may discharge flammable refrigerant. Make sure to follow the points below;

<PRV>

All the conditions below must be followed;

- At least two PRVs that remain opened must be installed in the whole system. (It is acceptable for a greater number of them to be installed.)
- One of the two PRVs must be located within 2 m of the unit.

One efficiently discharges refrigerant outdoors while the other regulates the water pressure, in the event of rapid refrigerant leakage from the water heat exchanger.

<AAV with air separator>

The condition below must be followed;

- At least one AAV with an air separator must be installed in the whole system. It efficiently discharges refrigerant outdoors in the event of slow refrigerant leakage from the water heat exchanger.

*It is also acceptable to install an AAV with air separator equipped with a PRV. However, in this case, it must be installed within 2 m of the unit.

The PRV installed within 2 m of the unit and the AAV with air separator must comply with the following specifications:

<PRV>

Regarding the unit installation;

- Individual unit installation: Discharge capacity must be $\geq 2,700$ NL/min.
- Multiple unit installation: Each unit must be equipped with a PRV installed within 2 m of the unit (each PRV must be $\geq 2,700$ NL/min.).

Regarding the operating pressure;

- The PRV must be set at the appropriate point so that it operates first in the event of the refrigerant leakage.
- The operating pressure of the PRV must be set to the lowest value. Proper consideration of head difference and pressure loss is required to ensure correct operation.

<AAV with air separator>

Regarding the installation;

- Individual unit installation:
 - Discharge capacity must be ≥ 90 NL/min.
 - Gas-liquid separation efficiency must be $\geq 90\%$ at maximum water flow rate of $7 \text{ m}^3/\text{h}$.
- Multiple unit installation;
 - Discharge capacity must be ≥ 90 NL/min.
 - When installing it on the combined piping system, the gas-liquid separation efficiency must be $\geq 90\%$ at the water flow rate of $(7 \times \text{number of units}) \text{ m}^3/\text{h}$.
 - When installing it on the pipe of each unit, the gas-liquid separation efficiency must be $\geq 90\%$ at the maximum water flow rate of $7 \text{ m}^3/\text{h}$.

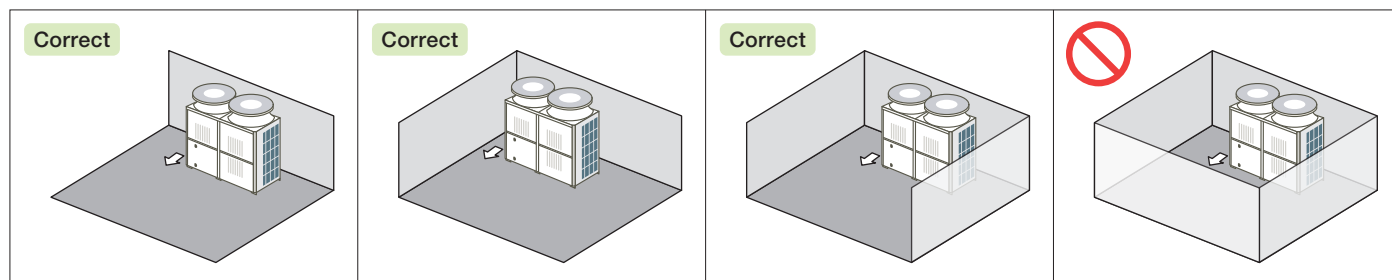
Even when PRVs and AAVs with air separator are installed indoors unavoidably, any leaked refrigerant must always be discharged outdoors. Make sure to follow the points below;

- If it is necessary to discharge from indoor PRVs or AAVs with air separator, the outlet piping must always be led outdoors because the indoor discharge is not permitted. The protective zone rule also applies to the discharge destination; therefore, no ignition sources should exist at that location. (See chapter 03. Protective Zone.)
- When the primary side is isolated from the secondary side by an indirect heat exchanger or a tank with coil, the restrictions above do not apply to the secondary side.

In addition to the above, if there is any mechanism that releases gas throughout the entire system, it is not recommended to leave it open. If it is to be left open, ensure that the outlet piping is led outdoors. In case of heat exchanger failure, a small amount of flammable refrigerant could leak inside the building from it.

2 Surrounding Conditions for Outdoor Units

Install outdoor units in a place where at least one of the four sides is open or in a sufficiently large space without depressions.



If you unavoidably install a unit in a space where all four sides are blocked or there are depressions, confirm that one of these situations below (A or B) is satisfied.

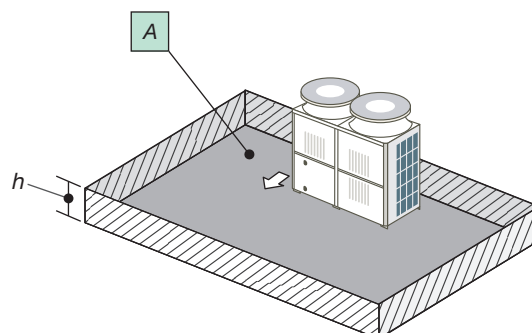
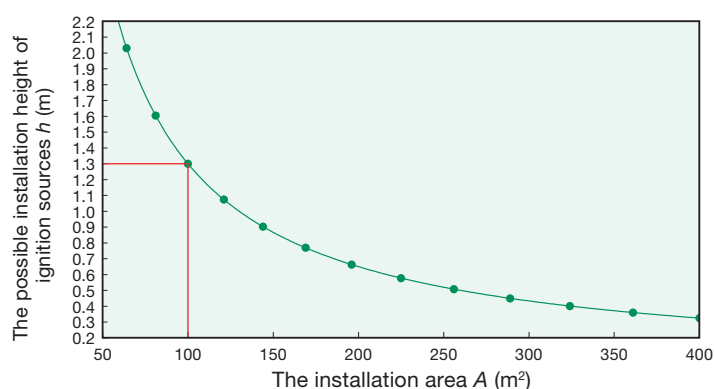
A Secure sufficient installation space and follow the restriction of the possible installation height regarding ignition sources.

Based on the size of the installation area A (X-axis), find the possible installation height of h (Y-axis) in which ignition sources must not exist (refer to the graph below). Make sure any ignition source must not be placed below h .

However, when h is higher than the height of parapet ^{*1}, h can be equivalent to the height of parapet.

^{*1} Definition of parapet: a low protective wall along the edge of a roof, bridge, or balcony

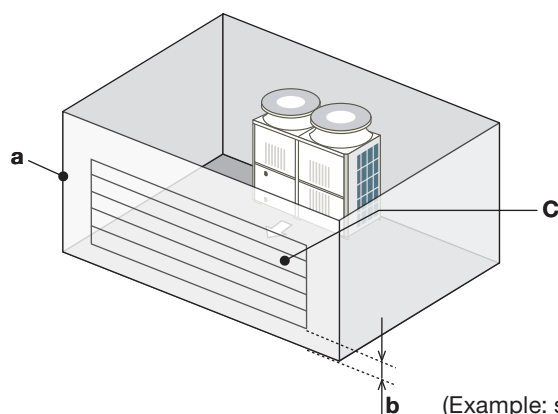
e.g., When A is 100 m², any ignition source cannot be installed below h 1.3 m. (the red line on the graph below)



B Create an appropriate ventilation open area.

The ventilation open area refers to those that meet all of the following conditions: it starts at a height of 0.125m or less from the ground (condition b), the vertical length of the sides is at least 80% of longitudinal direction of the wall on which it is placed (a), and the area must occupy more than 75% of the total area of the wall (condition c).

If one side of the walls out of four sides satisfies that, the installation rules of Fig. 3-6 are applied, and when 2 sides/3 sides of the walls satisfy that, that of Fig. 3-5/3-4 are applied.



- a** Longitudinal direction
- b** Height from the ground to an opening ≤ 0.125 m
- c** Opening:
 - Must occupy 80% of the longitudinal side of a space.
 - Must have an opening ratio of 75% or higher.

b (Example: space with a louver)

Note

- These countermeasures (A or B) are for keeping safety not for specification guarantee.
- In addition to the restriction of ignition sources, people are not allowed to enter the installation area where four surfaces are closed. In case qualified personnel enter for maintenance/removal, they must follow 01-2 Safety Precautions.

03 Protective Zone

In the event of a refrigerant leakage, it must be ensured that no one is endangered outdoors or in adjacent buildings, and no refrigerant can get into the building. For this purpose, safety-relevant protective zone are specified below.

- There must not be any building openings, entrance to the basement, grooves, or into the wastewater system in this area.
- The protective zone must not extend to adjacent buildings or public traffic areas.
- Ignition sources must not be present in this area, either permanently or for a short period of time.
- When the unit is installed in an open area (e.g., on the ground), prepare a fence around the unit so that people cannot enter easily. The unit is not accessible to the general public.
- When the unit is installed on the roof, make sure to lock the entrance so that only authorized personnel can enter.

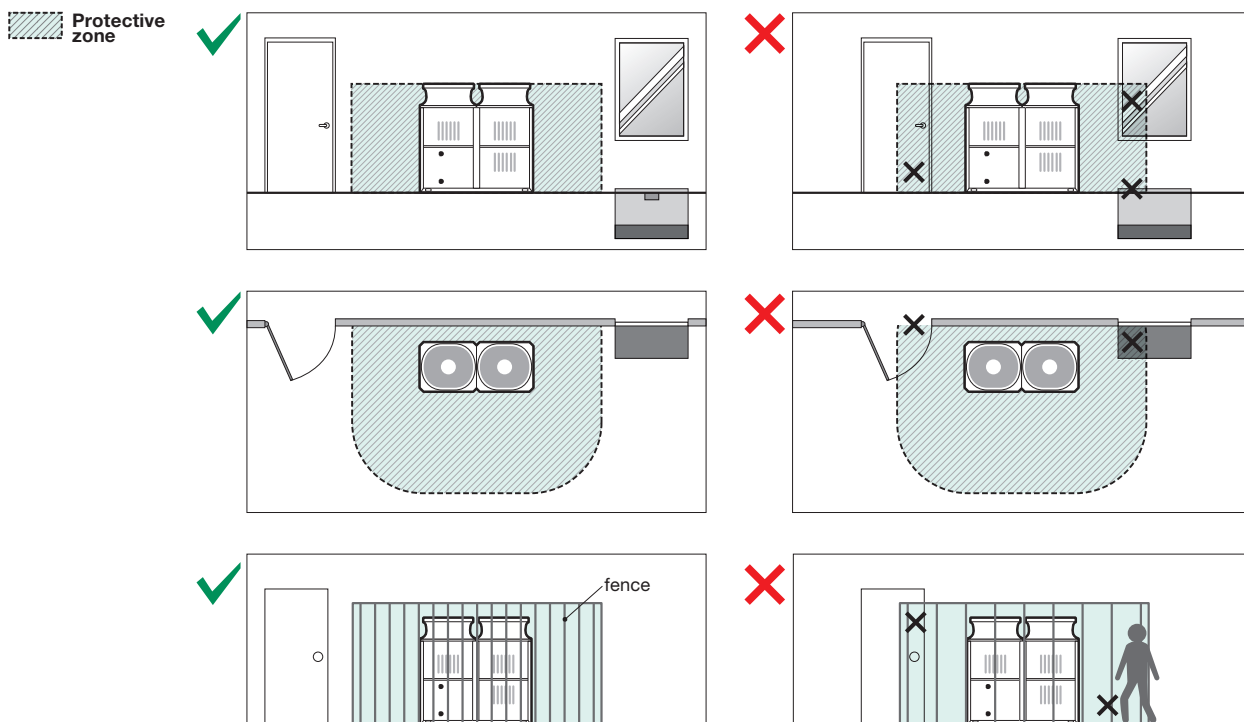


Fig. 3-1

Note In case qualified personnel enter for maintenance/removal, they must follow 01-2 Safety Precautions.

Specific dimensions of the protective zone are specified for each installation condition. Refer to the figures for each case.

An object is considered to indicate the presence of a surface (or wall) when all of the following criteria are met:

- Its height is greater than 0.125 m and its width exceeds that of the unit.
- The opening ratio is less than 75%.
- It is within 5 m of the nearest side of the product enclosure.

1 When installed in a location with an open around (Fig.3-2/3-3)

Define the protective zone as follows:

- 2 m around of the unit

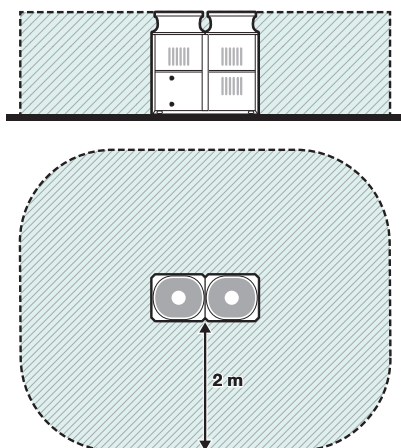


Fig. 3-2

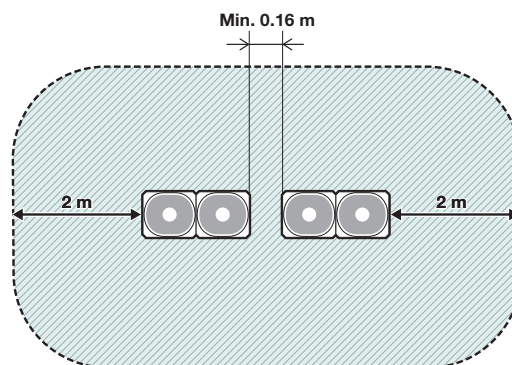


Fig. 3-3

2 When installed in a location with 3 surfaces opened

- The open side distance from the unit x_l and x_r must be above 2 m.
- Calculate the forward distance y_{f1} and backward distance y_b to the unit with the table below.

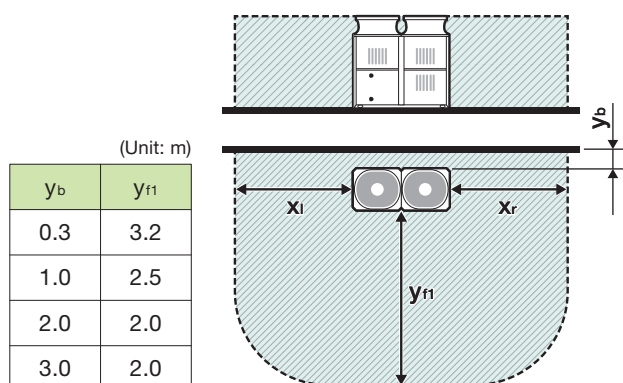


Fig. 3-4

3 When installed in a location with 2 surfaces opened (where the distance between one side of the unit and the wall is 0.3 m or more but less than 5 m)

- The open side distance from the unit x_l must be above 2 m.
- The forward distance from the unit y_{f2} must follow the table below. It depends on the distance l , which is defined by the smaller of the distances between x_r and y_b .

(Unit: m)	
$l = \min(x_r, y_b)$	y_{f2}
0.3	5.0
1.0	3.4
2.0	2.0
3.0	2.0

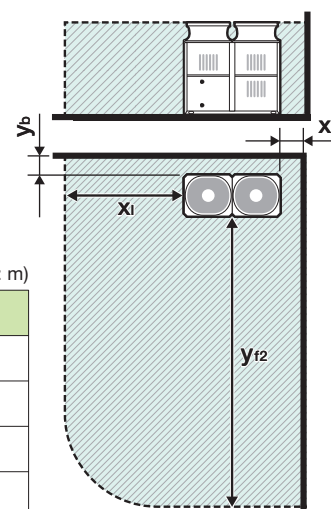


Fig. 3-5

4 When installed in a location where only the front opened

- The backward distance from the unit y_b must be above 0.3 m.
- The forward distance y_{f3} must follow the table below depending on the total side distance $x_l + x_r$.

(Unit: m)	
$x_l + x_r$	y_{f3}
2.0	12.0
4.0	7.5
6.0	5.3
8.0	4.0
10.0	3.1

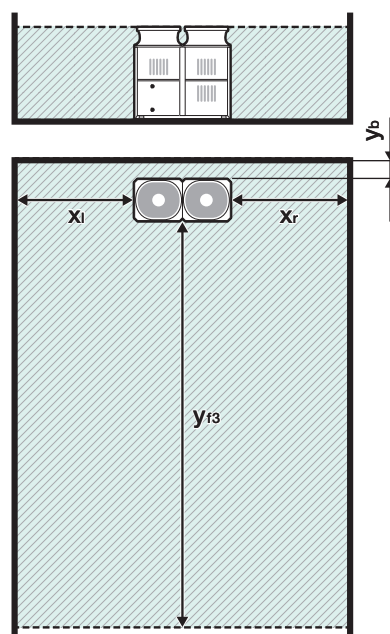
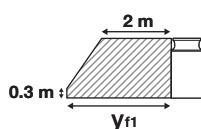
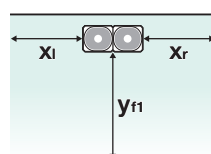


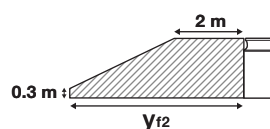
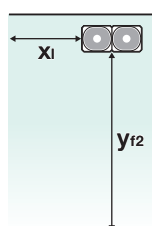
Fig. 3-6

Protective zone (Side view)

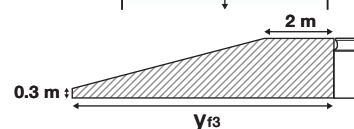
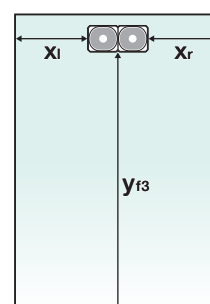
3 surfaces opened



2 surfaces opened

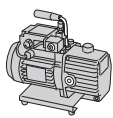


1 surface opened



04 Tools

✕ : Use the tools exclusive for R290. △ : Tools for other refrigerants can be used under certain condition. ○ : Tools for other refrigerants can be used.

Tool name Image	Specifications	Can other refrigerant tools be used?							
		R454C	R407C						
Gauge manifold 	•Be sure to use a gauge manifold compliant with R290 refrigerant since the saturated temperature is different depending on the refrigerant. •You should select it that can be used in the operating range of 3.85MPaG or higher. •Port size:<table><tr><td></td><td>R290</td><td>R454C</td></tr><tr><td>Cap size</td><td>7/16-20 UNF</td><td>1/2-20 UNF</td></tr></table>		R290	R454C	Cap size	7/16-20 UNF	1/2-20 UNF	✕	✕
	R290	R454C							
Cap size	7/16-20 UNF	1/2-20 UNF							
Charge hose 	•Be sure to use a charge hose compliant with R290 refrigerant. •You should select it that can be used in the operating range of 3.85MPaG or higher. •Cap size:<table><tr><td></td><td>R290</td><td>R454C</td></tr><tr><td>Manifold port size</td><td>7/16-20 UNF</td><td>1/2-20 UNF</td></tr></table>		R290	R454C	Manifold port size	7/16-20 UNF	1/2-20 UNF	✕	✕
	R290	R454C							
Manifold port size	7/16-20 UNF	1/2-20 UNF							
Charge valve 	•The charge valve prevents gas escaping from the hose and air conditioner when removing the charge hose. •Be sure to use a charge valve compliant with R290 refrigerant. Connection diameter: 7/16-20 UNF × 7/16-20 UNF	✕	✕						
Electronic refrigerant charging scale 	—	○	○						
Leak detector 	Before use, confirm that the leak detector can be used with R290 refrigerant. *Do not use a combustion-based leak detector with R290 refrigerant.	△	△						
Usable if the specifications on the left are satisfied									
Vacuum pump 	•Be sure to use a vacuum pump compliant with R290 refrigerant that has been specially designed and tested not to be an ignition source of itself. It is deeply better to use the vacuum pump that complies with explosion-proof standards, such as ATEX and IECEx. •Additionally, if vacuum pump oil (mineral oil) is mixed into the refrigerant circuit, sludge will be generated and damage the air conditioner. *Use a reverse-flow prevention adapter.	△	△						
Usable if the specifications on the left are satisfied									
Vacuum pump adapter 	•Be sure to use a vacuum pump adapter compliant with R290 refrigerant that has been specially designed and tested not to be an ignition source of itself. It is deeply better to use the vacuum pump adapter that complies with explosion-proof standards, such as ATEX and IECEx. •It is necessary to install an electromagnetic valve to prevent the flow of vacuum pump adapter oil back into the charge hose. •If the vacuum pump adapter oil (mineral oil) is mixed into the refrigerant circuit, sludge will be generated and damage the air conditioner.	△	△						
Usable if the specifications on the left are satisfied									
Cutter/Reamer	Do not use the tool that generates sparks due to tool friction, such as a saw.	△	△						
Usable if the specifications on the left are satisfied									
Refrigerant cylinder	Be sure to use the cylinders labeled according to the type of refrigerant.	✕	✕						
Adapter for refrigerant cylinder	Use an adapter that is appropriate for a connection of refrigerant cylinder and charge port. Connection of refrigerant cylinder: depends on the refrigerant or the country. Charge port: 7/16-20 UNF	✕	✕						
Refrigerant recovery equipment 	•Be sure to use a recovery equipment compliant with R290 refrigerant that has been specially designed and tested not to be an ignition source of itself. It is deeply better to use the recovery equipment that complies with explosion-proof standards, such as ATEX and IECEx.	△	△						
Usable if the specifications on the left are satisfied									
Refrigerant recovery cylinder 	Be sure to use the cylinders labeled according to the type of refrigerant.	✕	✕						
Electrical tools	•Do not use the electrical tools that generate sparks due to tool friction, such as an electrical cutter electrical saw and a grinder. •In case of using the electrical tools that drive with motor, such as an electrical driver, be sure to use one with brushless motor.	△	△						
Usable if the specifications on the left are satisfied									
Fan	•Be sure to use a fan compliant with R290 refrigerant that has been specially designed and tested not to be an ignition source of itself. It is deeply better to use the fan that complies with explosion-proof standards, such as ATEX and IECEx.	△	△						
Usable if the specifications on the left are satisfied									

05 Ignition sources

The following are the ignition sources in R290. Keep them away from the R290 unit.

Ignition sources	Refrigerant	security class
Flame	R290	A3
Electric arc		
Hot surface (R290:370°C)		
Electrical switch contacts (pressostats, relay, etc.)		
Discharge of capacitors		
Electrical potential differences		
Mechanical impact of friction sparks (by tools)		
Static charge on non-earthed components (e.g. refrigerant hose)		
Static charge of work clothes		
Use of electric devices (smartphone, notebook, tablet, etc.)		

Examples of ignition sources:

Open flames, smoke, gas boiler/heater, electrical equipment, sockets, lamps, switches, electrical wiring, sparking tools, objects with a surface temperature of 370°C or higher, etc.

- Sparks due to tool friction also could be a source of ignition. Works that generate sparks should be done away from the unit.
- Be sure to use the electrical tools compliant with R290. Follow "4. Tools".
- Do not install a unit while leaving its power on. Make sure to turn it off and check with a multimeter before installing the R290 unit.
- Static electricity is also an ignition source, so anti-static measures should be taken.
- Do not braze a pipe and a unit which contains refrigerant. Before brazing, refrigerant must be removed.
- When repairing the refrigerant parts, remove parts to be replaced by cutting with pipe cutter, NOT by flame nor by electric saw, etc..

06 Transportation of the Unit



WARNING:

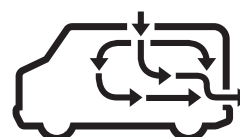
- Refrigerant must be recovered and disposed properly only by an authorised personnel.
- Be sure to observe the following safety requirements when transporting the unit.

- 1** Do not use ignition sources during transportation, including naked flames, sparks, static electricity, objects with high surface temperature (>370°C), etc.

- Do not smoke.
- Do not use the electric devices, heater, lights, etc.



- 2** Vehicles for unit transportation should have a ventilation function in the cargo area (see illustration below).



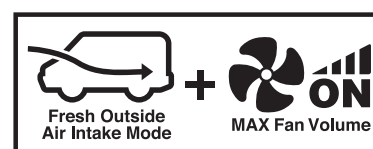
- If vehicles are not equipped with a special ventilation system, fresh outside air intake mode and MAX fan volume operation are mandatory.

- 3** Be sure to carry a R290 detector and keep it working properly.



- 4** Do not open the packaging of the unit that is charged with R290 during delivery.

CAHV-Z450YA-HPB(-BS) is not charged with R290 refrigerant when shipping from factory.



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