



INSTRUCTION MANUAL

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The following recommendations apply to all models and families of compressors manufactured by Tecumseh Europe under the trademark 'L'Unité Hermétique'. They cover safety and reliability and how to obtain optimum performance in different applications.

1 - SAFETY

In most cases any work done on a refrigeration system involves the use or handling of compressed gases (dry air, nitrogen, acetylene, oxygen, refrigerant), the use of a naked flame (blowtorch) and electrical work.

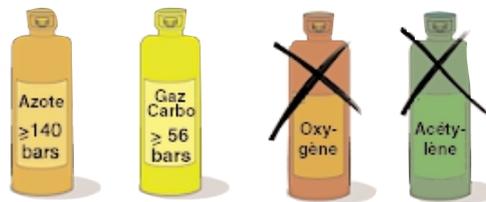
If the necessary precautions are not taken very serious accidents can occur.

Compressed gases are mainly used when testing, cleaning or charging with refrigerant.

For example, oxygen or acetylene must never be used to pressurise a circuit.



Nitrogen or carbon dioxide is preferable if certain rules are followed :

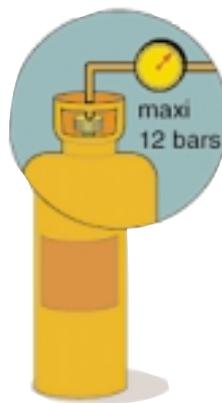


◆ The internal pressure of commercial nitrogen bottles is 140 bar or above, that of carbon dioxide bottles is 56 bars or above at a room temperature of 25-30 °C.

◆ Care must be taken not to drop or knock them against each other.

◆ They should be kept in an upright position and kept away from naked flames. If heating is necessary, the lower part of the bottle should be placed in water not more than +43 °C.

◆ Bottles must always be fitted with a pressure reducing and safety device to limit the pressure in the system to a maximum of 12 bars. In domestic applications (aluminium roll-bond evaporators), pressure should preferably be below 6 bars.



◆ For all methods of leak detection, we recommend that the system should not be pressurised above 10.5 bars.

◆ When cleaning or flushing out a contaminated system, great care must be taken to avoid getting any liquid refrigerant, oil or acids on the skin or in the eyes. All pressurised gases are potentially dangerous due to the latent energy associated with them.



◆ Some refrigerants can ignite spontaneously above a certain temperature:

R-22	635°C	R-407A	685°C
R-134a	743°C	R-407B	703°C
R-404A	728°C	R-407C	704°C

It is vital to check that no refrigerant is present before carrying out any repairs, which require the use of a blowtorch.

◆ The liquid receiver should never be filled to the top. The level should not exceed 80% of the maximum capacity.

◆ A sudden gush of liquid refrigerant can cause serious injury to eyes and skin.

1-a. Overcharging with refrigerant



Where a system has been dramatically overcharged with refrigerant, this may, in very rare cases, cause the compressor casing to rupture.

Immersion of the motor, piston and cylinder in refrigerant will have a hydraulic effect, preventing the compressor from starting i.e. locked rotor condition.

If for any reason the compressor protector does not operate, a high current in the motor windings will cause a rapid temperature rise, which rapidly causes excess pressure through vaporising liquid refrigerant.



When filling a refrigeration system with refrigerant **the cylinder should never be left connected to the system** even if the cylinder valve or manifold valve is closed. Any leakage from either of these valves will cause overcharging of the system, which can result in the hazards mentioned, above.



1-b. Vapour effect



This can occur in the case of a leak in a single walled evaporator between the water and refrigerant. The refrigerant leaks out and water gets into the system.



If there is no **shut down system** on the machine, the compressor will function as a steam generator and overheating of the motor and an excessive rise in pressure within the casing will occur.

1-c. Faulty electrical compressor terminal

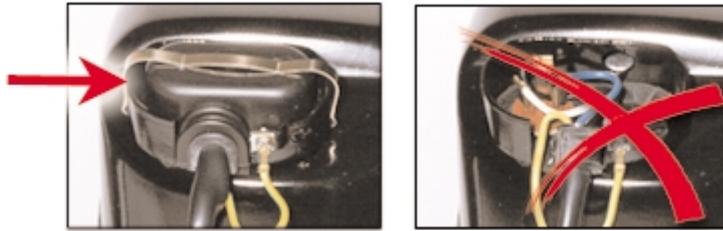
If the insulating material (glass pearls) on the electrical terminal of the compressor disintegrates as a result of physical damage or an electrical fault, a hole may occur through which gas and liquid refrigerant can escape.



If the terminal cover is missing or incorrectly fitted, the gas-oil mixture inside the shell can ignite if it comes in contact with a naked flame or electrical spark. The sudden burst of flames can be several metres high and is potentially very dangerous.



Whatever the type of repairs being carried out on the refrigeration system, it is vital to check that **the cover is in the correct position in order to prevent such accidents occurring.**



2- SYSTEM DESIGN

2-a. Selecting the type of application

The application of a compressor or a condensing unit can be classified according to use, and thus evaporating temperature.

There are three main types of application:

- ♦ **low temperature:**
evaporating temperature between $-35\text{ }^{\circ}\text{C}$ and $-10\text{ }^{\circ}\text{C}$
- ♦ **medium and high temperature:**
evaporating temperature between $-15\text{ }^{\circ}\text{C}$ or $-25\text{ }^{\circ}\text{C}$ and $+15\text{ }^{\circ}\text{C}$
- ♦ **air conditioning:**
evaporating temperature between $0\text{ }^{\circ}\text{C}$ and $+15\text{ }^{\circ}\text{C}$
This range of products can also be used for reversible heat pumps from $-25\text{ }^{\circ}\text{C}$.

Low temperature applications include both domestic (fridges and freezers) as well as various commercial applications.



The **medium and high temperature** range is the most diverse.

In some cases there may be an element of doubt as to which is the most appropriate choice: for example we usually advise high temperature compressors for ice makers; in this particular case operating conditions especially at the beginning of each cycle and or under low voltage conditions implies this compressor choice. This should not be confused with flake ice machines or ice cream cabinets.



Many other types of application present a similar problem :

The general rule is that **it is always preferable to choose a medium or high temperature model provided the lowest evaporating temperature, usually at the end of the cycle is less than 5°K below the lowest recommended level.**

Air conditioning applications have different requirements particularly where single-phase motors are concerned. There are therefore significant differences between these and high temperature applications.



2-b. Selecting the refrigerant



The refrigerant to be used must be the one for which the compressor has been designed.

For environmental reasons it is now strongly recommended to use only HFC refrigerants (R134a, R404A, R507 and R407C).



Note Additives :

No additives or colorants should be used for any TE L'Unité Hermétique model: the use of additives may cause accelerated ageing of the oil and/or compressor parts : This does not mean that these additives are unefficient on other systems or applications.

2-c. Selecting the capillary tube

In the attached selection program for compressors and condensing units you will find a calculation, which will enable you to select the appropriate capillary tube for a particular application on the basis of the model, and operating conditions selected.

2-d. Pipe sizing

Correct pipe sizing is an important factor in the design of an installation: the incorrect selection, particularly of the suction line can lead to malfunctioning of the compressor due to insufficient oil return especially where there is a long pipe run.

The return of oil to the compressor can only occur if the oil/refrigerant mixture is good and the velocity of the refrigerant is sufficient.

If, however, the velocity is too high the pressure drop within the system will be too high affecting the overall performance of the system.



The recommended velocities in the suction lines are as follows:

- ◆ **horizontal or suction** drops: 4 m/sec minimum (8 m/sec max.)
- ◆ **risers** : 8 m/sec minimum (12 to 13 m/sec max.)
- ◆ **do not exceed 15 m/sec to prevent refrigerant noise in the lines.**

Remote Installation

In some installations with long runs, it may be necessary to add oil in order to compensate for that permanently circulating in the system.



This should be kept to a minimum as too much oil in the compressor can be just as damaging as to little.

For pipe work over 10 m use the following guidelines for the amount of oil to be added:

OD	Ø	1/2"	10 ml / m
		5/8"	20 ml / m
		3/4"	30 ml / m
		7/8"	40 ml / m
		1"	50 ml / m

After a complete oil change, use only the following oils or their direct equivalents:



- ◆ **R12 and R22** compressors: **2444RC mineral TE** code 685013
- ◆ **R502 (BP)** compressors: **akylbenzene TE** code 8685016
- ◆ **R134a or R404A** compressors: **polyolester TE** code 8685015

For top ups with R12 and R22 compressors it is possible to add up to 25% of the original charge with an equivalent oil e.g. SUNISO 3GS.

2-e. Oil

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The original oil charge is given in our general catalogue.

When oil is drained from the compressor via the suction port a residue is left in the compressor housing, ranging from 8 to 15% of the initial charge, depending on the oil temperature.

This should be taken into consideration when carrying out a full oil change.

Acidity

It is a good practice to test oil acidity as a precautionary measure during maintenance, particularly in the case of medium to large capacities (above 2HP i.e. compressor models FH's and up). The testing kits available in the trade are generally sensitive to levels above 0.5mg KOH/g.



However, our R12 and R22 models are factory charged with oils with an acidity level around 1mg/KOH when new. **The testing kits are not suitable for these types of oil.**

However 2444RC mineral oil sold in 2 litre containers for topping up, has an acidity level of less than 0.05mg KOH/g compared with the oil used in the original fill. Akybene oil used in LBP R502 compressors has the same level.

The normal acidity level for polyolester oils used in R134a and R404A or R507 is 0.04mg KOH for small domestic compressors and 0.3mg KOH/g for all others.

Note Additives :

No additives or colorants should be used for any TE L'Unité Hermétique model: the use of additives may to cause accelerated ageing of the oil and/or compressor parts : This does not mean that these additives are uneffiscient on other systems or applications.

2-f. Cooling



Compressors of 1/5HP and above generally require forced air circulation (or an oil cooler) to cool the electric motor and the discharge gas, to maintain reliability particularly in hot environments.

The temperature of the motor and discharge gas depends on operating conditions (e.g. pressure, return gas temperature) and airflow. **Above a certain capacity (about 1.5 HP), the suction gas mainly cools the compressor: on these models suction gases are responsible for 85% of cooling. It is therefore important to control superheat when there is no airflow across the compressor.**

In some cases the compressor can be insulated when the suction superheat at the compressor is low and there is no liquid present. In this case it is imperative that a safety switch be fitted to switch off the compressor if the suction superheat increases due to a system fault. (e.g. refrigerant leakage, expansion valve failure).

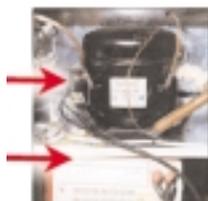
The application engineer should always focus on reliability as well as performance and design.

If the worst operating conditions are known, it is recommended to measure the **two parameters which directly affect the compressor's reliability: the temperature of the motor windings** and the **discharge temperature** which directly relates to the temperature at the discharge valve.

Motor temperature :

Leave the application switched off overnight or for an equivalent period in a constant temperature (longer for high capacity compressors). Measure the motor winding resistance R_1 at this temperature t_1 .

Run the application in the most difficult conditions foreseeable, switch off the machine and immediately measure the new resistance R_2 . The temperature t_2 can easily be calculated using the following equation:



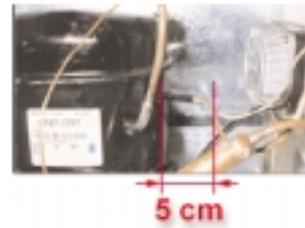
$$t_2 = \frac{R_2}{R_1} (234.5 + t_1) - 234.5$$

Discharge temperature :



Braze a thermocouple onto the discharge pipe 5cm from the compressor and insulate for a length of 10cm. In the worst conditions foreseeable, **the temperature should not exceed the following :**

AZ / THB :	135°C
AEZ / AE :	127°C
AJ (CAJ - TAJ) :	135°C
FH(TFH) / AH (TAH) :	143°C
TAG / TAN :	143°C
RK(TRK) / RG :	127°C



You have to take into consideration that a dusty condenser induces higher temperatures. Then, we advise you to take a safely margin or take system measures under a dusty condenser conditions.

2-g. Air flow

Apart from cooling the compressor, airflow is used to ensure efficient heat exchange in the condenser and therefore directly affects condensing temperature.

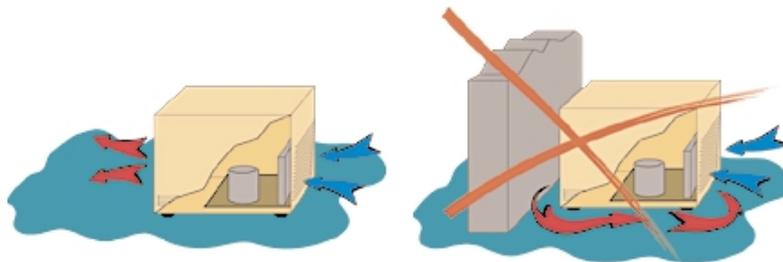


It is important to provide a good air supply to the condenser which should be as cool as possible.

◆ **Make sure that the unit does not become covered with dirt and that it is cleaned periodically.**

It is vital to maintain the free flow of air into and out of the condenser and to keep the two flows separate.

◆ **Remove any obstacles to the airflow.** The positioning of the unit may result in re-circulation of the exhausted hot through the condenser. This may lead to air passing through the condenser being several degrees (sometimes up to +10°C) hotter, which reduces the refrigerating efficiency and can activate safety devices as well as reducing the life of the compressor.



2-h. Liquid refrigerant

Liquid refrigerant is one of the major causes of compressor breakdown particularly for higher capacity compressors (AJ's and up). It can happen during both operation and the off cycle.

During operation:

Return of refrigerant to the compressor can occur accidentally as a result of overcharging, poor superheat control at the expansion valve or icing up of the evaporator. It can also be due to incorrect use of the equipment or even the design itself: e.g. reverse cycle or hot gas defrosting.



The most effective solution is to use an accumulator, which is large enough to hold at least 70% of the total charge of the system.

If the correct amount is not known, a rough estimate can be made according to the type of application:

- ◆ air conditioning or positive evaporating temperature:
380 g per kW of refrigeration output
- ◆ negative evaporating temperature (approx. -10°C to -15°C):
1000 g per kW of refrigeration output
- ◆ low temperature:
2700 g per kW of refrigeration output.



During the off cycle:

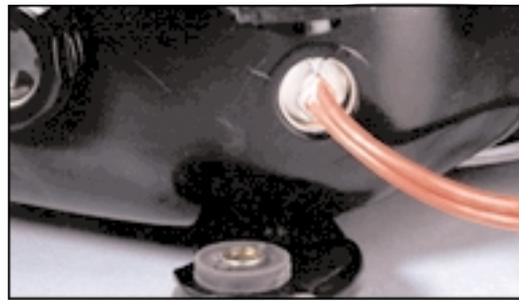
In cases where the compressor is colder than any other part of the system, there is a risk that refrigerant will migrate to the compressor (this can occur even when the evaporator and the compressor are at the same temperature).

The presence of liquid refrigerant in the compressor oil will reduce its lubricating capability.

It can also occur when cleaning the evaporator with hot water, or even by direct sunlight on the evaporator (heat pump).



The most usual solution is to use a crankcase heater to keep the compressor at a higher temperature.



It is also possible to initiate a pump-down cycle before switching off the compressor : the closing of a solenoid valve at the evaporator inlet makes it possible to hold almost all the charge in the liquid receiver, condenser and liquid line.

- ◆ Check that the receiver is large enough to hold at least 90% of the charge
- ◆ and that there is not a vacuum in the compressor at start-up to avoid creating an arc at the terminals inside the casing.

This solution however does have disadvantages against crankcase heaters: when the compressor is pumping down the velocity of the gas is low, if the pipe diameter is too large the oil in the system will not return to the compressor.

There are two options, to keep pipe sizes as small as possible or secondly, to run the system for a short time at start up bypassing the expansion device at restart.

2-i. Start-ups per hour



The refrigeration system should be designed so that the compressor does not start more than **10 to 12 times per hour**.

A normal application usually has 7 to 8 cycles per hour. To allow for sufficient cooling of the motor (particularly the start winding), we recommend keeping the ON/OFF cycle to above 0,75.

Applications using a capillary, as an expansion device should allow some time to equalise pressures during the off cycle. With single cylinder compressors systems pressure equalisation may take 7 to 8 minutes due to the resistance of the capillary.

3- CONNECTING UP THE INSTALLATION

3-a. Connecting pipework.



Before installing the compressor or condensing unit, check that **the refrigeration system is clean and dry**.

◆ Carry out pipe cutting and bending operations carefully in order to prevent dust and swarf contaminating the system. Never use a saw to cut piping and use a bending tool of the correct diameter to avoid damage to the pipe.

◆ When installing a new compressor into an existing system, the filter drier in the liquid line must be replaced. It should always be fitted sloping in the direction of the fluid flow.

◆ If the compressor is being replaced due to a burn out, a burn out filter drier should be installed in the suction line. If the burn out is caused by a locked rotor most of the contamination will be within the compressor itself, and the filter can be removed after 1 or 2 hours running time.

◆ If burn out occurs while the compressor is running, traces of sludge or burnt oil may be visible inside the discharge line and in some cases in the suction line. The expansion valve, four way valve or any electronic valves fitted should be replaced or carefully cleaned. Filter driers in both the liquid and suction lines should be replaced several times.

◆ When brazing a pipe to a valve or a swivel connection remove the plastic joint and ensure that the material in the gland is not damaged.

◆ At start up check that there has been no leakage from the gland. If a leak has occurred tighten the screw while allowing the spindle to rotate freely.



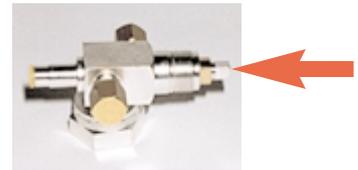
Tecumseh Europe recommends **the use of brazed connections** instead of flared connections to prevent leakage. Connections, which use an intermediate joint, are acceptable.

Brazing should be carried out using an inert gas (e.g. nitrogen at for 5 to 7 litres per minute) in order to prevent the formation of oxides inside the pipe system. This is particularly the case for compressors charged with synthetic oils (e.g. POE, PVE) and alkylbenzene which have more detergent properties than mineral oils.

3-b. Maximum torque settings

◆ Valve spindle

	Nm	(cm Kg)
- small valves	11.7	(115)
- 19mm square body	14	(138)
- 22mm square body	21	(207)
- 28mm square body	35	(344)



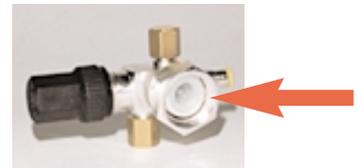
◆ Valve cap on Rotalock

- 1/4" (7/16" thread)	14	(138)
- 3/8" (5/8" thread)	30.5	(300)
- 1/2" (3/4" thread)	45	(442)
- 3/4" (7/8" thread)	59	(580)



◆ Rotalock valves on compressors and receivers (with joint)

- 3/4" thread	56.5	(553)
- 1" thread	84.5	(829)
- 1 1/4" thread	141	(1382)
- 1 1/2" thread	197	(1935)
- 1 3/4" thread	317	(3110)



◆ Connections on parallel mounted versions

- 1 3/4" thread	107	(1050)
- 5/8" thread	45	(442)



◆ Sight glass

- 1 1/8"	51	(500)
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3-c. External compressor anti-vibration mounting feet

All Tecumseh Europe compressors are delivered with external anti-vibration mounting feet comprising:

- ◆ 4 anti-vibration mounts (rubber grommets)
- ◆ 4 steel inserts

These anti-vibration mounts reduce the transmission of vibrations from the compressor to the chassis.

To function correctly they must not be restricted: the washer should press on the steel inserts leaving 1 to 4mm between the washer and the top of the rubber grommets

To prevent overtightening, the recommended torque settings are as follows:

- ◆ 6mm diameter bolts = 5 to 10 Nm (50 to 100 cm Kg)
- ◆ 8mm diameter bolts = 8 to 13 Nm (80 to 130 cm Kg).

3-d. Start relay



As with the overload protector it is vital to use the relay which comes with the compressor or condensing unit, even if a different model seems to function satisfactorily at any given time:

- an incorrect relay can cause serious damage to the compressor motor and other electrical components.
- It can also cause contact flutter, supply voltage variations and longer start up times.

PTC relays

Some models of compressors are fitted with PTC relays: do not use electromagnetic relays on these compressors and do not use a PTC on motors designed for electromagnetic relays.

PTC relays require a cooling period of about 3 minutes before each start up and even longer if the compressor casing is very hot due to high ambient or difficult operating conditions.

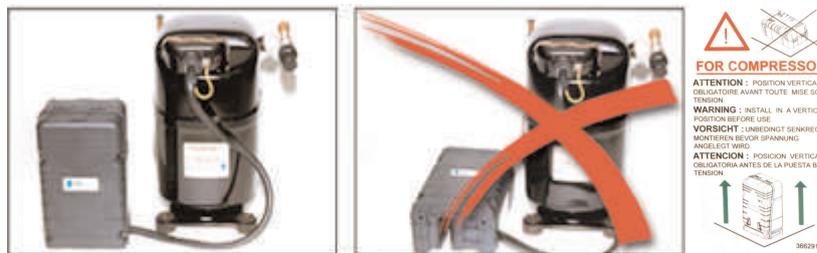


In the case of a remote relay (voltage or current types) mounted in an electrical box, it is essential that the box is mounted in a vertical position.

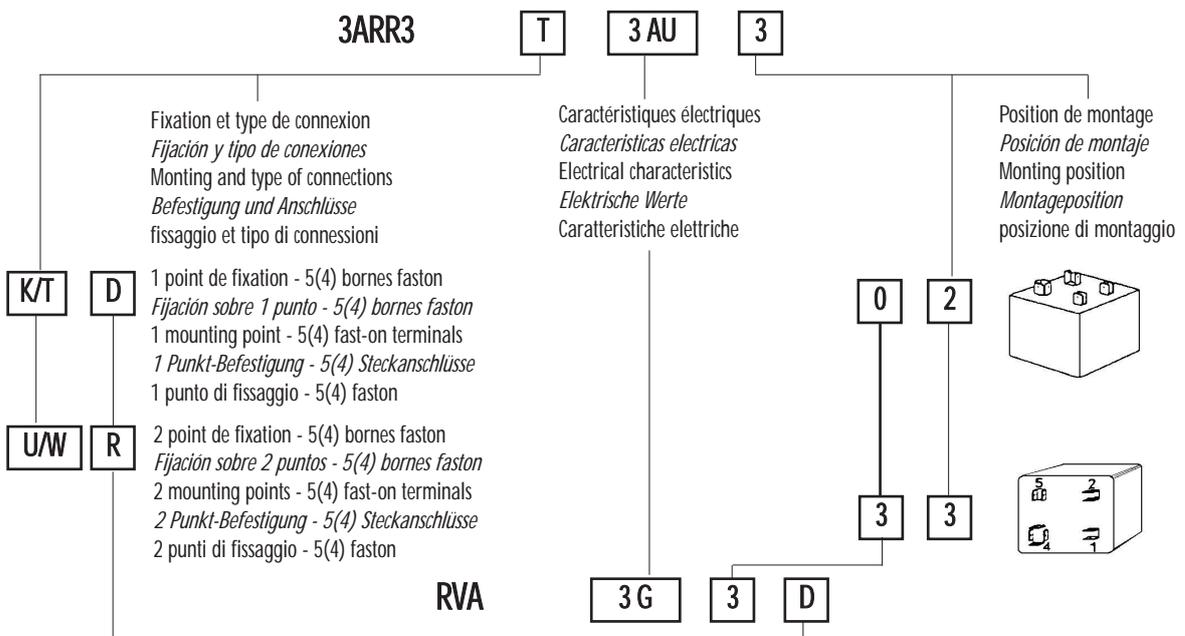
Anything over 15 degrees off the vertical will affect the start capacitor and/or the start winding of the motor.

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This recommendation concerns systems fitted with potential relay as well as current relay.



For compressors that are usually delivered with non fitted electrical accessories (for instance air conditioning compressors), please look at the joined mounting instructions or read below:



NOTA : Bien respecter la position de montage donnée par le dernier chiffre de la référence.
 NOTA : Respétese la Posición de montaje marcada por la ultima cifra de la referencia.
 NOTE : The mounting position must be respected. This is given by the last digit of reference.
 AMNERKUNG : Montageposition, gegeben durch die letzte Ziffer der Typenbezeichnung.
 NOTA : Bisogna rispettare la posizione di montaggio data per l'ultimo numero della referenza

3-e. Vacuum pumping

Pumping a vacuum in the system using a correctly functioning vacuum pump (preferably with double or triple stages) until a residual pressure of approximately 200 microns is achieved.

It is recommended that a vacuum be created simultaneously in both high and low-pressure sides of the system. It is not possible to obtain a sufficient vacuum in the high-pressure section by evacuating the low-pressure section alone, particularly when an expansion valve is installed in the system. Evacuating from both sides also helps reduce the amount of time required to have an adequate vacuum.



The compressor should never be used to create the vacuum.

If there is uncertainty as to the degree of moisture in a system, dry nitrogen can be used in conjunction with a deep vacuum to remove excess.

N.B.:

A vacuum pump must be correctly serviced. The oil should be replaced once or twice a year according to the pump service manual.

3-f. Charging

Vacuum Pumping



Never switch on a compressor when under vacuum: an arcing may occur (corona effect) between the terminals or a terminal and earth. This arcing causes deposits of conductive carbon that can affect the insulation of the terminal. It may even cause it to disintegrate with the accompanying risk of gas and oil leakage. Always check that the terminal cover has been properly fitted.

Never carry out an electrical safety test when the compressor is under vacuum. The same phenomenon as described before may occur.

Charging



The system should only be charged with the appropriate refrigerant indicated on the compressor's identification plate.

- ◆ When **azeotropic refrigerants** (pure refrigerants) are being used charging can be carried out in the **vapour phase of the suction line or in the liquid phase on the liquid line** between the condenser and the filter drier.
- ◆ With **non-azeotropic refrigerants** (blends) charging must be carried out only **in the liquid phase** in order to keep the correct proportions of the blend.

When charging in the vapour phase in the suction line it is advisable to break the vacuum by charging slowly until the pressure in the system reaches 4 to 5 bars with R22, R404A (R507) or approximately 2 bars with R12 and R134a.



Starting Up

Before starting the compressor check that:

- ◆ all valves on the compressor or the condensing unit are open
- ◆ the correct electrical equipment (relay, protector, and capacitor) is being used
- ◆ the supply voltage is correct and that the supply cables are sufficient to avoid a large voltage drop
- ◆ the start relay (mounted in a separate electrical box) is in the vertical position.

Continue charging slowly until reaching the manufacturer's recommended charge quantity or until the operating conditions are obtained (pressure) according to the type of equipment.

Diagnostic



Do not leave the charging cylinder connected to the installation even when the valves are closed.

Leave the system running for some time.

Check that there is no abnormal noise and that the bottom of the compressor housing is normally hot.

If the top of the compressor is sweating, liquid refrigerant is returning to the compressor: adjust the charge or increase the super-heat of the expansion valve.

Leak Detection

Use an appropriate electronic leak detector suitable for the type of refrigerant.



Check flared connections and the glands of all valves. The gland nut may need tightening.

Replace the valve covers, which provide additional security in the case of leakage from the valve gland.

4- ELECTRICAL SAFETY STANDARDS

All our compressors and condensing units are designed and manufactured in accordance with CEI 335-2-34.



The electrical supply must be disconnected before carrying out any work on a refrigeration system.

Before switching on again check that the earth has been connected and that the terminal cover is in place.

4-a. Insulation classification

The motors used in hermetically sealed compressor units must operate in the presence of refrigerant and oil. International standards organisations state that these motors do not have to comply with insulation class requirements contained in CEI 335-1.

However, these are replaced by tests on compressors at maximum operating conditions (CEI 335-2-24 and CEI 335-2-34). If used as conventional motors, they would be classified grade B (130 C) and the enamel used on the windings could be classified at least grade H.

4-b. Voltages

Electricity supply networks throughout the world are very varied both in nominal voltage and frequency used. Each model in the TE-L'Unité Hermétique range is available in different voltages, frequency and single or three phase versions.

Voltages shown on the compressor or condensing unit identification plate are nominal values or nominal voltage ranges. The guaranteed voltage range represents a variation of + or - 10% of nominal values:

♦ e.g.: 220v - 240v / 50 Hz => guaranteed range: 198v - 264v.

Code		A	C	F	G	H	K	M	Q	S	T
Phases		1 ~	1 ~	1 ~	1 ~	1 ~	3 ~	1 ~	3 ~	1 ~	3 ~
Rated	50 Hz	100V	208V	220-240V	208-220V	-	220V	100V	200V	240V	400V
	60 Hz	115V	230V	-	-	208-220V	220V	100V	200V	-	440V
Approved Range	50 Hz	90-110V	187-230V	198-264V	180-242V	-	180-253V	90-110V	180-220V	225-254V	340-440V
	60 Hz	103-127V	207-253V	-	-	180-242V	187-264V	90-110V	180-220V	-	396-499V

The actual voltage range is always larger than the guaranteed voltage range and it depends largely on the operating conditions of the application.

Whilst complying with the current norms, each manufacturer of compressors or condensing units has his own criteria for defining the guaranteed range. Differences are therefore quite normal.

4-c. Electrical safety

All compressors and condensing units manufactured by Tecumseh Europe are individually tested before dispatch. Apart from operating tests, the following electrical safety checks are carried out:

- ♦ High voltage : single phase : 1800 volts applied for 2 seconds
 three phase : 2300 volts applied for 2 seconds
- ♦ current leakage during operation = < 0.8 mA
- ♦ earth continuity = max impedance < 0.2 ohm.

Protection

All compressors made by Tecumseh Europe are protected either by an internal or external safety device, which operates on the principle of sensing both temperature and current.

Like all safety devices, it cuts the electrical supply when asked to function outside of its normal range: this should not be considered as a fault.



Where compressors or condensing units are fitted with an external safety device, **always use the device provided.**

With units fitted with an internal safety device, it may be necessary to wait over an hour after cutout before switching on again.

4-d. Maximum working pressures

Tecumseh Europe certifies that the complete range of compressors in the following families:

◆ AZ - THB - AEZ - CAEZ - AE - CAE - AJ - CAJ - TAJ - AH - CAH - TAH - FH - TFH - TAG and TAN

Have a maximum safety pressure of

- low pressure: 22 bar
- high pressure: 40 bar.

Tecumseh Europe also certifies that the following condensing units

◆ AZ - AEZ - CAEZ - AE - CAE - CAJ - TAJ - CAH - TAH - FH - TFH - TAG and TAN

- low pressure: 22 bar
- high pressure: 28 bar.