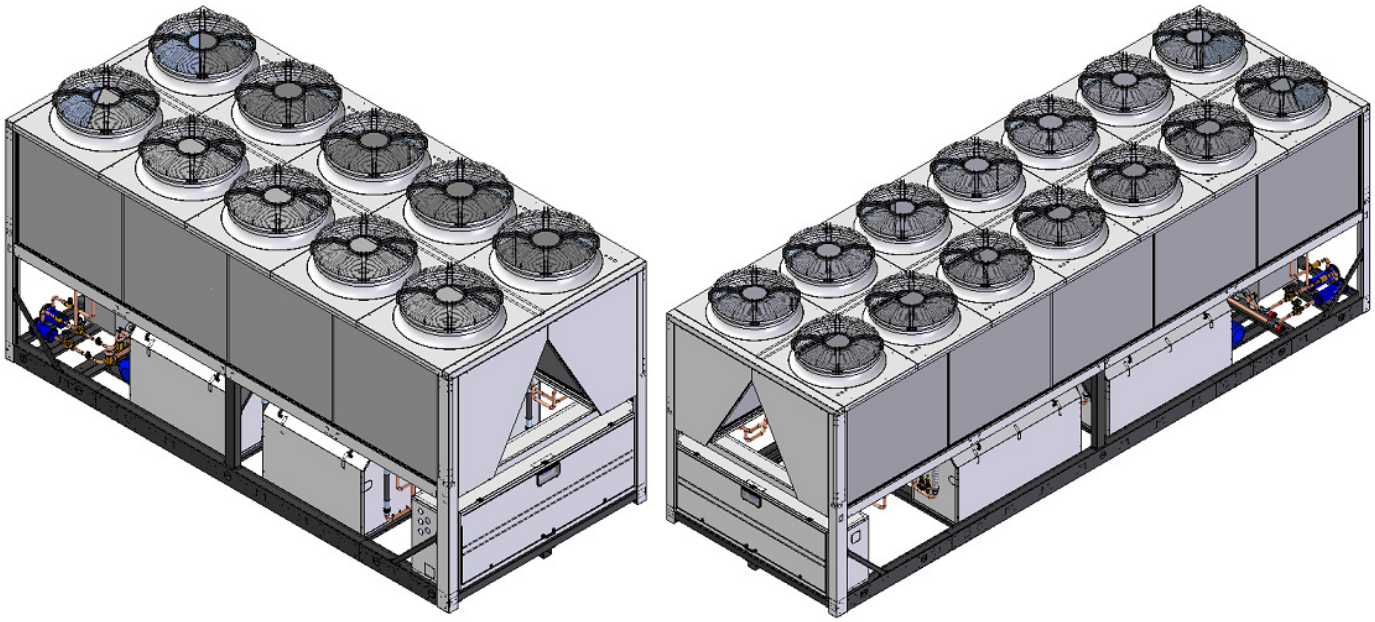
LSE water chillers

water chillers – CS/CL

heat pumps chillers – HS/HL

free-cooling chillers – FS/FL



Installation, use and maintenance manual

TABLE OF CONTENTS

Declaration of conformity

The declaration of conformity is attached to the documentation on board, usually put in the electrical panel.

1. GENERAL DESCRIPTION

1.1 The series

The **LSE** series of chillers, fluid coolers (CS-CL), heat pumps coolers (HS-HL) and Free Cooling coolers (FS-FL), covers a power range from 355 to 918 kW.
LSE industrial chillers are equipped with SCROLL compressors assembled in an heavy frame made in galvanized steel powder coated in black colour RAL9005 on the under part and in light colour RAL9002 on the top part. All panels are made in galvanized steel powder painted in RAL9002, to give better aesthetic impact of the unit.

- Wide range of hydraulic accessories
  - single or double pump (optional)
  - two (2) different levels of available pressure head (optional)
  - built in buffer tank (optional)
  - expansion tank (relative to hydronic kit)
  - safety valve (relative to hydronic kit)
- Plate heat exchangers
  - single water circuit
  - single or double independent refrigerant circuits for the maximum efficiency, mainly in partial load
- Large coil design
  - Double material for coil's endplates
  - Innovative concepts for coil's frame in order to avoid the pipe's stress
- Multibend base frame
  - High mechanical resistance
- Accessibility
  - There is high accessibility of all components and the possibility to use a crane for the compressors and pumps supported on the unit side, always well exposed.

1.2 Field of application

These machines are designed to cool-heat water and solutions containing up to 35% glycol (percentage by weight) in civil, industrial and technological air-conditioning systems.
They must be used in observance of the operating limits specified in this manual; failure to comply with said limits will invalidate the warranties provided in the contract of sale.

2. PRELIMINARY PROCEDURE

2.1 Inspection

On receiving the unit, check that it is perfectly intact: the machine left the factory in perfect conditions; immediately report any signs of damage to the carrier and note them on the Delivery Slip before signing it.
Lennox S.p.A. or its Agent must be promptly notified of the entity of the damage.
The Customer must submit a written report describing every significant sign of damage.

2.2 Lifting and transport

While the unit is being unloaded and positioned, care must be taken to avoid abrupt or violent manoeuvres.
The unit must be handled carefully and gently: avoid using machine components as anchorages when lifting or moving it.
The unit must be lifted using steel pipes inserted through the holes provided on the base frame.
Prior to being lifted, the unit should be harnessed as shown in the figure below: use ropes or belts of adequate length and strength and spacer bars to avoid damaging the sides and top of the unit.

Warning: In all lifting operations make sure that the unit is securely anchored in order to prevent accidental falls or overturning.

2.3 Unpacking

The packing must be carefully removed to avoid the risk of damaging the unit. Different packing materials are used: wood, cardboard, nylon etc.
It is recommended to keep them separately and deliver them to suitable waste disposal or recycling facilities in order to minimise their environmental impact.

I

TRASPORTO

Carico Posteriore tramite gru

Il carico/scarico posteriore è fortemente consigliato utilizzando una gru di adeguata portata e seguendo le istruzioni di seguito riportate - vedi fig.1 e 2. Una volta posizionato il carico sul pianale l'unità va fissata a questo con apposite cinghie.

* = Altezza minima luce di carico

GB

TRANSPORT

Rear loading by crane

Rear loading/unloading using a crane with an adequate lifting capacity and following the instructions given below – ref. figs. 1 and 2 - is strongly recommended. Once the load has been positioned on the flatbed the unit must be fixed by suitable belts.

* = Minimum clear loading height

D

TRANSPORT

Rückseitige Beladung mit Kran

Das Auf- und Abladen der Maschine auf den LKW sollte rückseitig mittels eines Kranes mit entsprechender Traglast erfolgen, siehe folgende Darstellungen (Abb. 1 und 2). Nach dem Positionieren der Maschine auf der Ladefläche wird diese mit entsprechenden Gurten an der Ladefläche gesichert.

* = Minimale lichte Höhe der Last

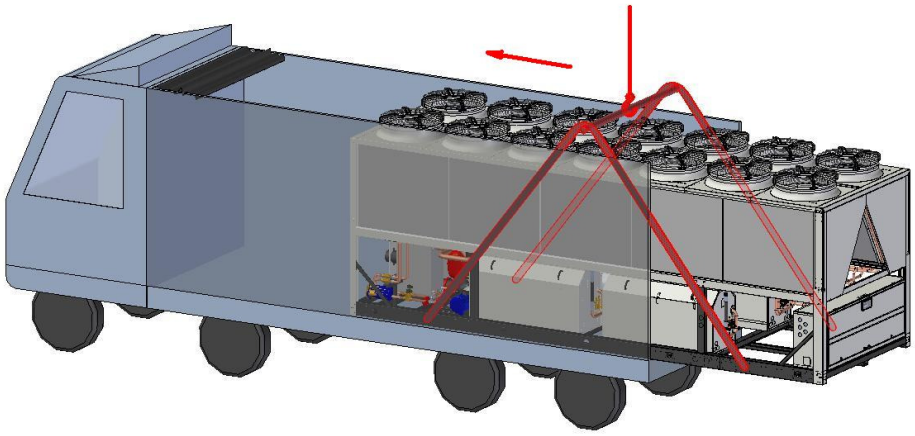


Fig. 1

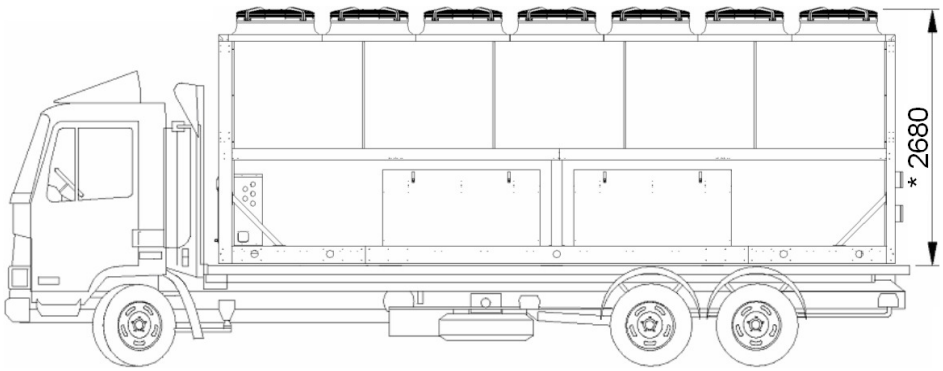


Fig. 2

I

SOLLEVAMENTO E MOVIMENTAZIONE

Va eseguita tramite sollevamento con gru e apposite tubazioni in acciaio ø2"1/2 (consegnate in dotazione - da inserire nel basamento attraverso gli appositi fori) dimensionate per far fronte al massimo peso dell'unità, alle quali assicurare funi o cinghie di adeguata portata, collegate al gancio di sollevamento.
N.B. La parte superiore ed i fianchi dell'unità devono essere protetti da una struttura rigida in legno, oppure da una tubazione in acciaio che distanzi le corde di sollevamento dalla macchina (vedi fig.3).

GB

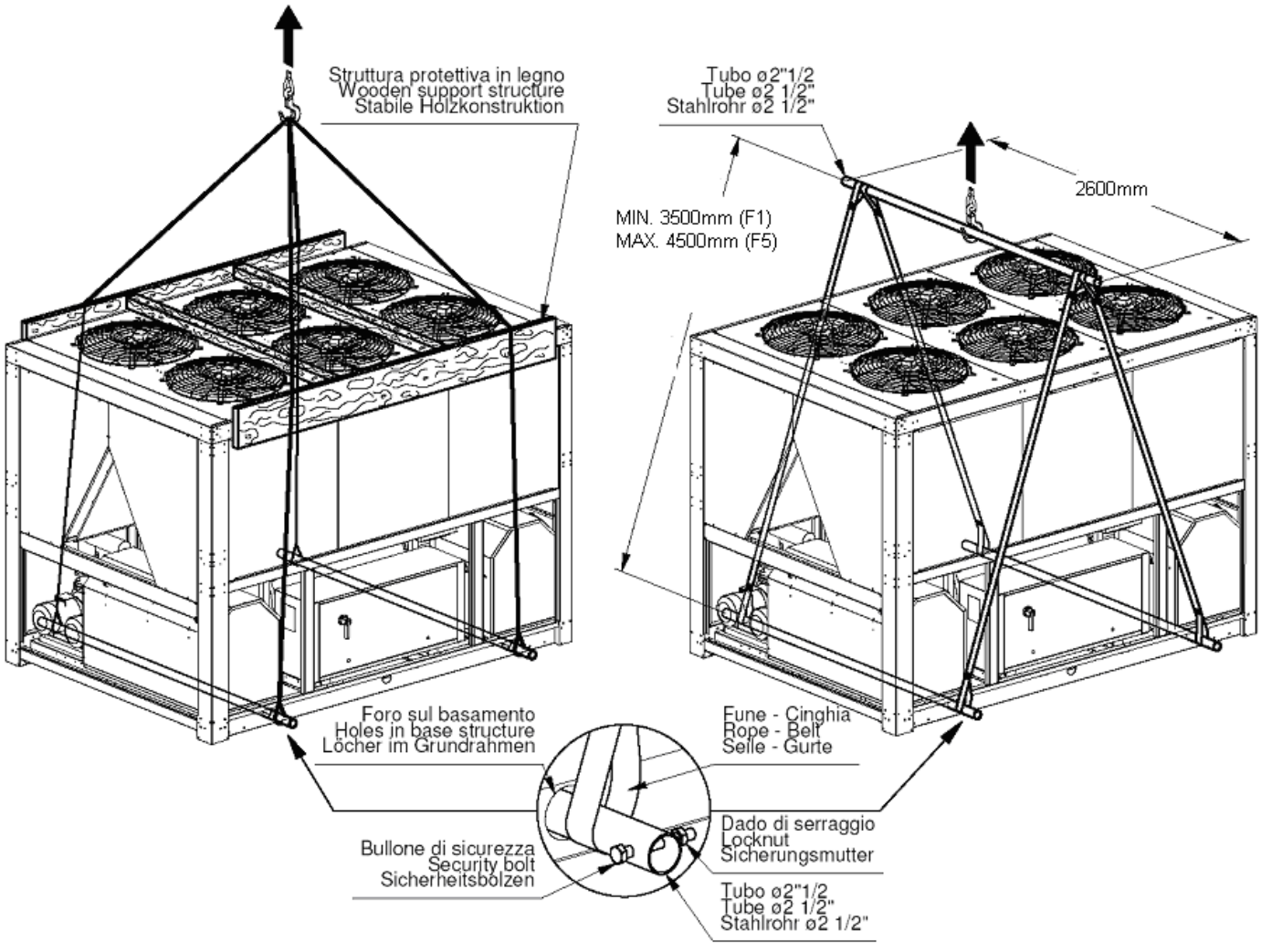
LIFTING AND HANDLING

The lifting and handling must be carried out by using a crane and 2"1/2 dia. steel pipes (as supplied – to be fitted in the base through the holes) designed to carry the maximum weight of the unit, connected by ropes or belts with an adequate lifting capacity to the lifting hook.
N.B.) The upper part and the sides of the unit must be protected by a rigid wooden support structure, or by steel pipes to keep the lifting ropes away from the machine (ref. fig. 3).

D

HEBEN UND BEWEGEN

Das Heben und Bewegen erfolgt mit einem Kran und entsprechenden Stahlrohren ø2"1/2 (mitgeliefert – sie werden in die entsprechenden Bohrungen im Grundrahmen gesteckt). Kran und Rohre sind entsprechend des maximalen Gewichts der Einheit dimensioniert, diese werden mit geeigneten Seilen oder Gurten verbunden und am Kranhaken eingehängt.
Hinweis: Der obere Teil und die Flanken der Einheit müssen durch eine stabile Holzkonstruktion oder Stahlrohre geschützt werden, die verhindern, dass die Hebegurte in Kontakt mit der Maschine kommen (siehe Abb. 3).



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TRASPORTO
Carico laterale tramite muletto

Il carico/scarico laterale tramite carrello sollevatore non è possibile se non utilizzando un camion a pianale ribassato (luce di carico minima pari a **3000mm**) completamente apribile di lato e non centinato - vedi fig.4.
Una volta posizionato il carico sul pianale l'unità va fissata a questo con apposite cinghie.

GB

TRANSPORT
Side loading by forklift truck

Side loading/unloading using a forklift truck is only possible if a depressed centre flatcar is used (min. clear loading height equal to **3,000 mm**) the side of which may be fully opened and is not ribbed – ref. fig. 4.
Once the unit is positioned on the flatbed it must be fixed by suitable belts.

D

TRANSPORT
Seitliche Beladung mit Gabelstapler

Das seitliche Auf-/Abladen mit einem Gabelstapler ist nur mit einem Tieflader (minimale Lasthöhe **3.000 mm**) möglich, der seitlich vollständig geöffnet werden kann und keine Plane besitzt – siehe Abb. 4.
Nach dem Positionieren der Maschine auf der Ladefläche wird diese mit entsprechenden Gurten an der Ladefläche gesichert.

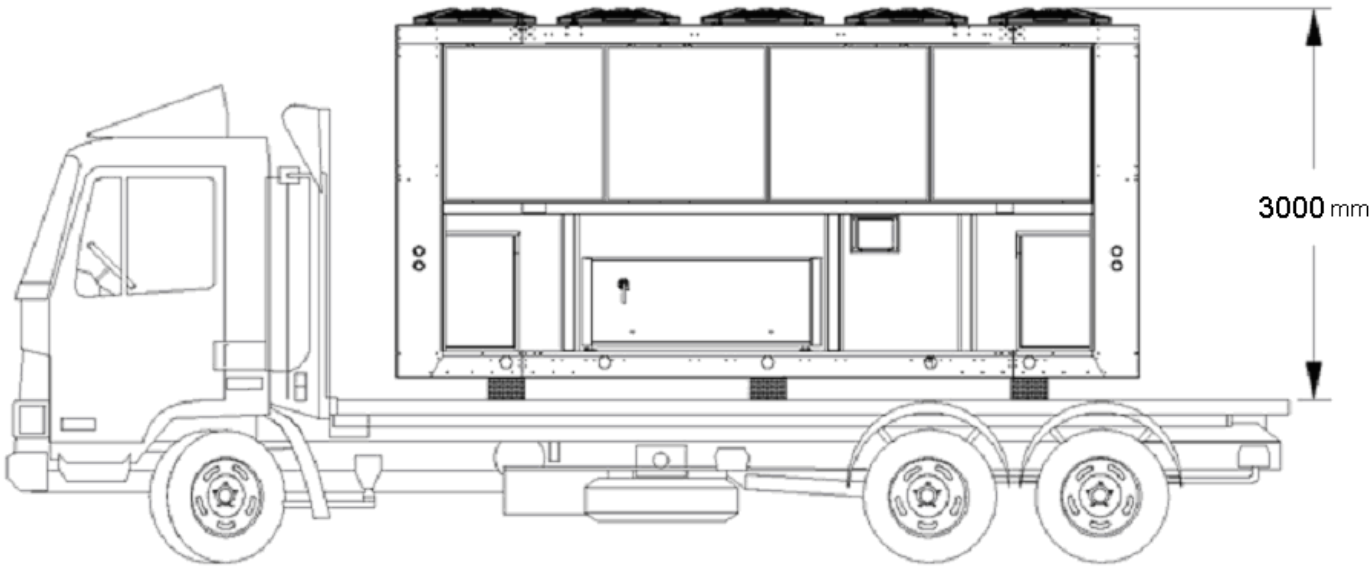


Fig. 4

3. INSTALLATION

3.1 Generalities

You should pay attention to the following aspects when choosing the best site for installing the unit and the relative connections:
- size and position of water pipes;
- location of power supply;
- accessibility for maintenance or repairs;
- solidity of the supporting base;
- ventilation of the air-cooled condenser and necessary free space;
- direction of prevalent winds: avoid positioning the unit in such a way that the prevalent winds favour the backflow of air to the condenser coils; a speed of 8 m/s (28.8 km/h) already generates a sufficient air pressure to guarantee 60% of the nominal air flow rate.[In situations where the action of air currents is inevitable and there is a simultaneous presence of temperatures below – 5°C, the control of condensation for low outdoor temperatures must be of the flooding type or with a device for choking the condensing exchanger -contact the technical department for further details]
- possible reverberation of sound waves.

All models belonging to the LSE series are designed and built for outdoor installation: avoid covering them with roof structures or positioning them near plants (even if they only partly cover the unit) which may interfere with the regular ventilation of the unit condenser.
It is a good idea to create a base of adequate dimensions to support the unit. This precaution becomes essential when the unit is to be sited on unstable ground (various types of soil, gardens, etc.).

It is advisable to place a rigid rubber strip between the base frame and the supporting surface or special rubber support [see on the price list for the right selection]
Whenever more effective insulation is required, it is recommended to use vibrating-damping spring supports.

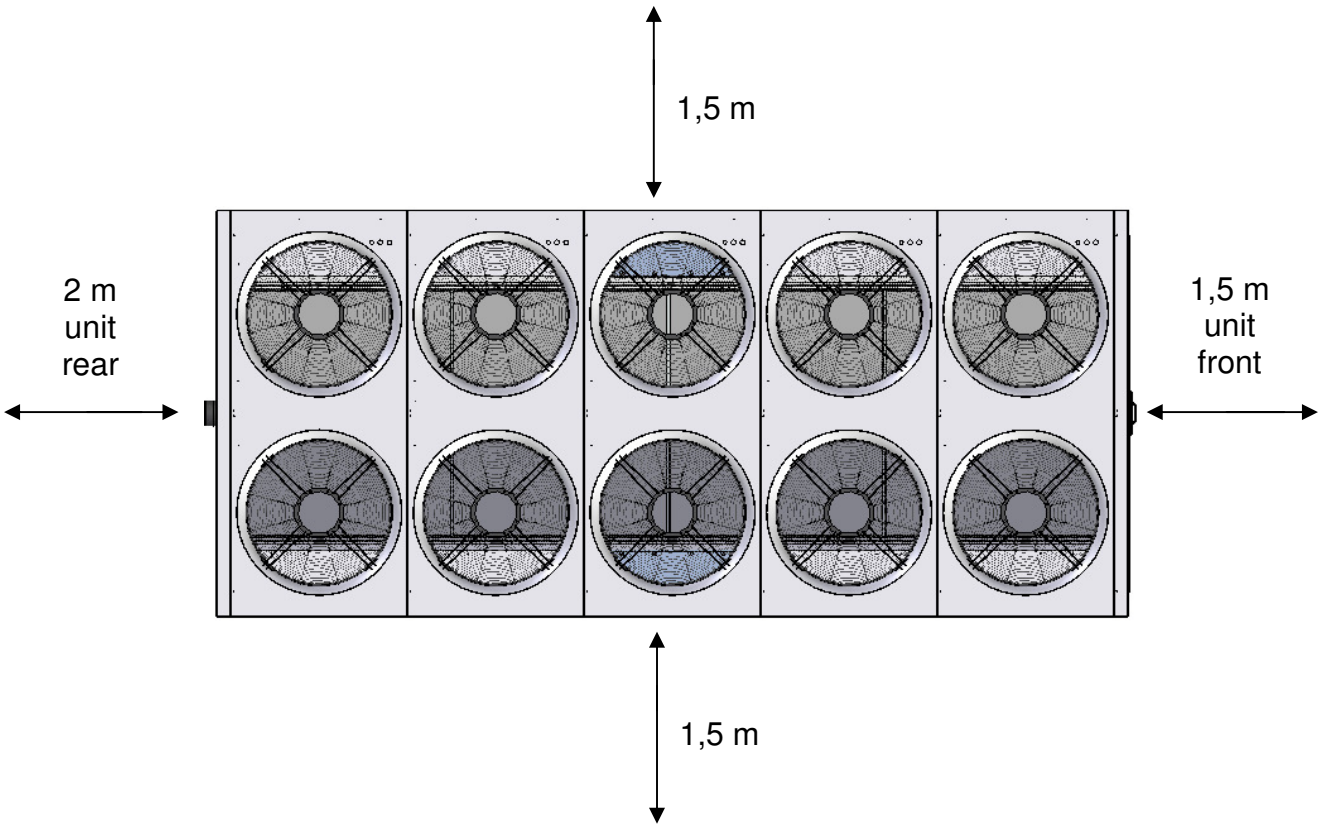
In the case of installation on roofs or intermediate storeys, the unit and pipes must be insulated from walls and ceilings by placing rubber joints in between and using supports that are not rigidly anchored to the walls.
If the unit is to be installed in proximity to private offices, bedrooms or areas where noise levels must be kept down, it is advisable to conduct an analysis of the sound field generated by the chiller and verify its compatibility with the local laws / situations.

Inside the unit, if it is provided with pump/s and/or tank, you can find the expansion tank packed, and it must be fixed upon suction piping of the pump where there is a retaining fixed "TEE", or upon the tank itself. Remove the cap and screw the expansion tank (only by qualified personnel) before filling the water circuit and starting up the machine.

3.2 Clearance requirements

It is of fundamental importance to ensure an adequate volume of air both on the intake and outlet sides of the condenser coils; it is highly important to prevent the air delivered from being re-aspirated as this may affect the performance of the unit or even cause an interruption in normal operation. For this reason it is necessary to guarantee the following clearances (see figure on this page):

- rear side/ connections: min. 2 metres to guarantee access to water connections, to the expansion valves, the refrigerant filters, and to allow the right air circulation fro the condensing coils
- front side/ electrical panel: min. 1,5 metres to guarantee access to electrical panel, to the pump(s), and to allow the right air circulation fro the condensing coils
- sides: min. 1.5 metres to ensure the access to the SCROLL compressors, to the heat recovery exchanger (option) and for air circulation.
- top side: there must be no obstacle because condenser air discharge.



3.3 General guidelines for hydraulic connections

When you are getting ready to set up the water circuit for the evaporator you should follow the indication given below and in any case make sure you comply with national or local regulations (use the diagrams included in this manual as your reference).

- Connect the pipes to the chiller using flexible couplings to prevent the transmission of vibrations and to compensate thermal expansions.

- It is recommended to install the following components on the pipes:

  - temperature and pressure indicators for routine maintenance and monitoring of the unit. Checking the pressure on the water side will enable you to verify whether the expansion tank is working efficiently and to promptly detect any water leaks within the equipment. **N.B.**: make sure that the water pressure on pump's suction side is at least 0,6 bar: if not, damages can occurs on the buffer tank.

  - traps on incoming and outgoing pipes for temperature measurements, which can provide a direct reading of the operating temperatures. Temperature readings can in any case be obtained from the microprocessor installed on the unit.

  - regulating valves (gate valves) for isolating the unit from the water circuit.

  - metal mesh filter (incoming pipes), with a mesh not to exceed 1 mm, to protect the exchanger from scale or impurities present in the pipes.

  - air vent valves, to be placed at the highest points of the water circuit for the purpose of purging air. [The internal pipes of the unit are fitted with small air vent valves for bleeding the unit itself: **this operation may only be carried out when the unit is disconnected from the power supply – mainly for Free-Cooling units, be sure that the circuit is completely full of water, then purge air from the water coils to avoid pumps cavitation events**].

- drainage valve and, where necessary, a drainage tank for emptying out the equipment for maintenance purposes or when the unit is taken out of service at the end of the season. [A 1" drainage valve is provided on the optional water storage reservoir: **this operation may only be carried out when the unit is disconnected from the power supply**].

- For FS-FL you must use glycolated solutions (max. 35% of weight) to prevent hardly repairable damages to the finned coil caused by freezing of the coil itself. Check carefully the minimum air T which the unit can be exposed to and then define the anti-freezing % to add.

3.4 Water connection to the evaporator

It is of fundamental importance that the incoming water supply is hooked up to the connection marked "Water Inlet".

Otherwise the evaporator would be exposed to the risk of freezing since the antifreeze thermostat would not be able to perform its function; moreover the reverse cycle would not be respected in the cooling mode, resulting in additional risks of malfunctioning and the flow switch doesn't works.
The dimensions and position of hydraulic connections are shown in the dimension tables at the back of the manual.

The water circuit must be set up in such a way as to guarantee that the nominal flow rate of the water supplied to the evaporator remains constant (+/- 15%) in all operating conditions.

The compressors work intermittently, since the cooling capacity of the users generally do not coincide with the compressor output. In systems containing little amount of water, where the thermal inertia of the water itself is lower, it is suggest to check that the water content in the cold section satisfies the condition listed below:

$$V = \frac{Cc \times \Delta\tau}{\rho \times Sh \times \Delta T \times Ns}$$

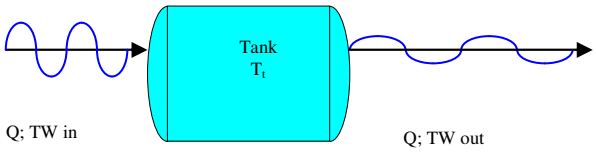
V	= water content in cold section	[m3]
Sh	= specific heat of the fluid	[J/(kg/°C)]
ρ	= fluid density	[kg/m3]
Dτ	= minimum time lapse between 2 compressor restarts	[s]
DT	= allowed water T differential	[°C]
Cc	= Cooling capacity	[W]
Ns	= N° of capacity steps	

Regardless of their own configuration, all groups have an only external hydraulic push (input + output). It is an important factor which allows to reduce connection times on place. Normally all groups are provided with a flow switch that immediately stops the unit in case of anomalies avoiding in this way that the thermal plate exchanger will freeze or damage. Moreover there is a water temperature probe mounted on evaporator drain side and connected to the anti-freeze thermostat.
For all groups various optionals are available to have different shapes with:

- single or double pumps for applications at –10°C and with maximum 35% of glycol [on demand, available for applications with more than 35% of glycol with special ceramic gaskets on pump board];
- gather tank on hydraulic circuit drain side. This solution makes the temperature unavoidable ripples trade-off easier for effect of the modulating action of the compressor.

The **Fig.6** shows the integrated and well-balanced effect of the gather tank. Its function supports an exact control of the temperature according to the ambient parameters of the connected groups.

Fig.6



A **standard** feature of LSE units is a device for controlling the flow rate (flow switch or differential pressure switch) in the water circuit close to the evaporator.

Any modification to this device will immediately invalidate the warranty.

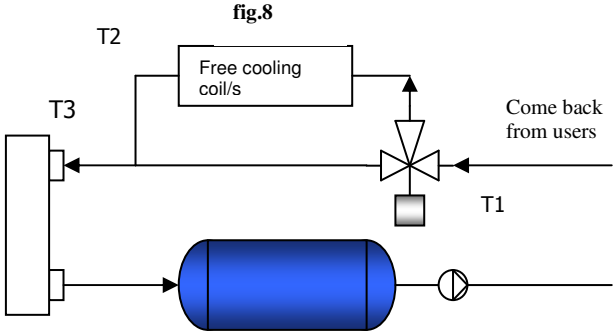
It is advisable to install a metal mesh filter on the inlet water pipe.

Warning: When making the hydraulic connections, make sure there are no open flames in proximity to or inside the unit.

3.5 Hydraulic circuit in Free-Cooling units

Free-Cooling units are provided with a 3-way valve to deviate the water flow in the Free-Cooling coils. The coils in Free-Cooling units are installed outside the condensing coils.
The valve is activated by the Microprocessor (type Advanced by series in FC version) by means of calculating the temperature difference between the water temperature set value (T1) and the external air (T2). [**fig. 8**]

fig.8

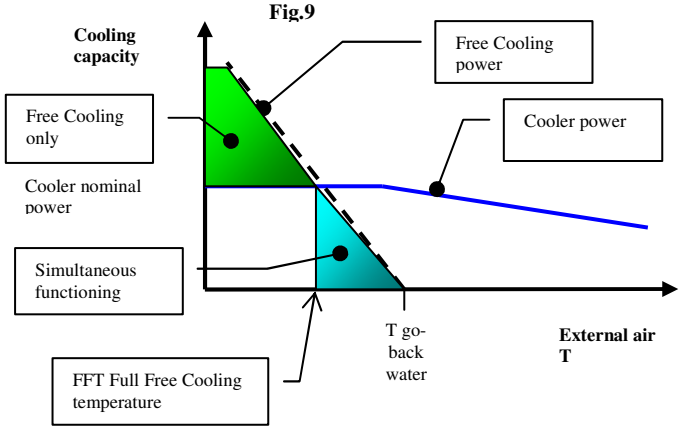


A sensor which provides for the compressors additional starting-up, when free-cooling operation is not sufficient to meet the requirements of total cooling, is installed at the evaporator inlet (T3). The temperatures T1 and T3 are always controlled by the unit microprocessor so that it detects possible anomalies of the free cooling 3-way valve. For example, if free-cooling operation is activated, the valve would be activated as a consequence, but T1 and T3 are equal. This fact means that the valve is blocked. You'll have to decide if simply creating an alarm or stopping the unit when there is an anomaly in free-cooling operating.

Among the several available options, the pumps can be choosen with several useful static pressure values. For Free-Cooling refrigerating groups it is suggested to choose pumps with high useful static pressure values in order to compensate the highest pressure drops due to the additional 3-way valve, the Free-Cooling coil and the use of glycolated blends. [see the technical card for glycol use]

The free-cooling configuration allows considerable savings in every situation in which the outdoor temperature is lower than the circulating fluid one (transformation industry, close control applications, data-transmission in general, convention halls, etc.). The free-cooling circuit performances depend on the difference between the outdoor air temperature and the circulating water temperature in the system, as shown in the **Fig. 9**.

Fig.9



When the outdoor temperature (T2) goes down below the "return from users" water temperature (T1), thermal exchange could happen. In fact this happens free-cooling operation is activated, integrated with one or more mechanical cooling steps, depending on various cases.
For the whole free-cooling series, the cooling power is modulated by regulating the air speed in order to keep the outlet water temperature constant.
To avoid it blockes-off, the 3-way valve is automatically activated up to 30% every 140 hours of functioning while the cooler is operating. The 3-way valve is predisposed to be accessible in case of servo-motor anomalies which you can reach dismantling the appropriate metallic protection shown in the following figures (for LSE units correspondent to the 2 scheduled carpentry sizes).

3.6 Instructions for the filling up of the tank and/or the pump(s) *(if present)*

The tank is not planned to resist to a depression greater than -0,15 Bar, so pay attention to the fact that the suction pressure of the pump, where the expansion tank is positioned, has to be always greater than 0,5 Bar with the pump in operation: this fact also contributes to reduce any risks concerning the cavitation of the pump.

It is of fundamental importance for the installer to follow and check the instructions written below stepwise, so as to avoid every kind of risks concerning the implosion of the tank or the cavitation of the pump:

a) Empty the expansion tank until the pressure is 0,5 Bar
b) Charge the system and pressurize it until about + 1 Bar in suction, pump side (with pump not working)
c) Allow air to escape from the system
d) Check the suction pressure of the pump (about 1 Bar) and start the system
e) Stop the pump after 15-30 minutes and repeat from point **c)** until you don't hear noises, caused by air still present in the system, anymore.

4. ELECTRICAL CONNECTIONS

4.1 Generalities

Before carrying out any job on electrical parts, make sure the power supply is disconnected.

Check that the mains electricity supply is compatible with the specifications (voltage, number of phases, frequency) shown on the unit rating plate.
The connection to the power supply should be made with a three-pole + neutral cable and earthing wire.

The size of the cable and line protections must conform to the specifications provided in the wiring diagram.

The supply voltage may not undergo fluctuations exceeding ±5% and the unbalance between phases must always be below 2%.

The above operating conditions must always be complied with: failure to ensure said conditions will result in the immediate invalidation of the warranty.

The electrical connections must be made in accordance with the information shown in the wiring diagram provided with the unit and current regulations.
An earth connection is required by law. The installer must connect the earthing wire using the earthing terminal situated on the electric control board (yellow and green wire).
The power supply to the control circuit is shunted from the power line through an insulating transformer situated on the electric control board.
The control circuit is protected by suitable fuses or automatic switches.

- Electrical panel: the electrical panel is designed and cabled in according with the CEE directive 73/23, the Directive 89/336 for electromagnetic agreement and correlated laws. To access the electrical panel and its components it is necessary to open the external pane provided with lifting pneumatic pistons which keep it in lock status. However, before making an opening it is necessary to disconnect the unit from the power supply turning the red general the dissector. All remote and auxiliary controls are made with 24V tension supplied by an insulating transformer put in the electrical panel. In general, all electrical panels are designed with air-circulating active system. Moreover a temperature control kit (optional), including a thermostat, a self-adjusting electrical heater (type PTC) and an auxiliary fan, is available. The position of the general dissector is choosen in order to make wiring operations on the site easier and to avoid difficulties during cables passages and “3+1 power” cables bends. All components are protected by overload and short circuit. Like an option, it is possible to choose an arrangement for automatic thermal protections for all loads. Anyway a thermal protection, made up of a chain of thermal sensors on all connected electrical engines, is already scheduled. Moreover the compressors are managed by their own on-board electronic controls which check oil alarms and phases sequence too. Anyway all devices are provided with a phases sequence general relay that ensures the correct functioning of the compressor/s, when the phases correct hints are not respected, as well as internal protection. The unit protection level is IP54 and when the electric panel is open it continues to respect a protection level IP20, due to the plastic cover pane on the distribution electrical panel front side. Remote contacts are at low tension and mounted on sideburns. The sideburns also provide signals for remote functions such as:
  - Unit switching on/off - ON/OFF [light bulb at 24 V];
  - Alarm status [light bulb at 24 V].

4.2 Electric connections of flow switch or differential water pressure switch

It is standard and pre-wired in all LSE units; the paddle flow-switch (optional) for all these units is provided apart the unit itself, on demand.

4.3 Electric connections of the circulation pump *(if present)*

If selected on ordering, it/they is/are supplied pre-wired with all LSE units.

The pump must be started before the chiller and stopped after the latter (minimum recommended delay: 60 seconds). If included as an option, this function is already performed by the electric control board on the unit.

4.4 Remote controls

If you wish to include a remote control for switching the unit on and off, you must remove the bridge between the contacts indicated in the wiring diagram and connect the remote ON/OFF control to the terminals themselves [see annexed wiring diagram].

All remote controls work with a very low voltage (24 Vac) supplied by the insulating transformer on the electric control board.

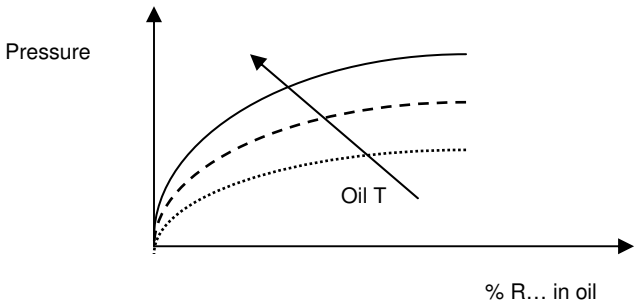
5. STARTING UP

5.1 Preliminary checks

- Check that all the valves in the cooling circuit are open (liquid line).
- Check that the electrical connections have been made properly and that all the terminals **are securely tightened**. This check should also be included in a periodic six-month inspection.
- Check that the voltage at the RST terminals is 400 V ± 5% and **make sure** the yellow indicator light of the phase sequence relay is on. The phase sequence relay is positioned in the middle right part of the electric control board; if the sequence is not duly observed, it will not enable the machine to start.
- Make sure there are no refrigerant leaks that may have been caused by accidental impacts during transport and/or installation.
- Check that the crankcase heating elements are properly connected to the power supply (present by series on FS-FL units).

The electrical heaters must be turned on at least 5-10 minutes before starting the unit. This operation is due to raise the oil Temperature in the sump, limiting the refrigerant percentage dissolved in the oil itself.

To verify whether the heating elements are working properly, check the lower part of the compressors: it should be warm or in any case at a temperature 10 - 15 °C higher than the ambient temperature.



The diagram above illustrates a specific property [Charles' Law] of gases, which are more soluble in liquids as the pressure increases but less soluble as the temperature increases: if the oil in the sump is held at a constant pressure, an increase in temperature will significantly reduce the amount of refrigerant dissolved in it, thus ensuring that the lubricating function desired is maintained.

- Check that the plumbing connections have been properly made according to the indications given on the plates to be found on the unit itself (proper inlet and outlet connections).

- Make sure that the water circuit is duly bled to completely eliminate the presence of air: load the circuit gradually and open the air vent valves on the top part, which the installer should have set in place.

5.2 Starting operation

Before starting the chiller, turn the main switch off, select the operating mode desired from the control panel [red button = heating, green button = cooling] and press the "ON" button on the control panel [see the "Firs Start Up Instruction" sent together with the unit].

The unit will start up if enabled:
- by the safety devices of the water circulation pump/s
- by the flow switch (or differential pressure switch)
- by the T sensor measuring the temperature of the water returning from the system [chiller inlet]
- no alarms have been triggered

If the unit fails to start up, check whether the service thermostat has been set according to the nominal values provided.

You should not disconnect the unit from the power supply during periods when it is inoperative but only when it is to be taken out of service for a prolonged period (e.g. at the end of the season). To turn off the unit temporarily follow the directions provided in the section "Stopping the Unit".

5.3 Checks during operation

- Check the phase sequence relay on the control board to verify whether the phases occur in the correct sequence: if they do not, disconnect the unit from power supply and invert two phases of the incoming three-pole cable. Never attempt to modify internal electrical connections: any undue modifications will render the warranty null and void.

All the three-phase devices on the unit, compressor, water pump and fans have a set direction of rotation and were harmonized in the factory.

- Check that the temperature of the water entering the evaporator is close to the value set on the service thermostat.

5.4 Checking the refrigerant level

- After a few hours of operation, check whether the liquid level indicator has a green crown: a yellow colour indicates the presence of humidity in the circuit. In such a case the circuit must be dehumidified by qualified personnel.

- Large quantities of bubbles should not appear through the liquid level indicator. A constant passage of numerous bubbles may indicate that the refrigerant level is low and needs to be topped up. The presence of a few bubbles is however allowed, especially in the case of high-glide ternary mixtures such as HFC R410A.

- Check that the end-of-condensation temperature shown on the pressure gauge (refer to the pressure gauge scale for the refrigerant R410A, is 4 °C lower than the temperature of the water outlet of the evaporator.

-Make sure the superheating of the suction gas is limited to between 5 and 8 °C: to this end:
1) read the temperature indicated by a contact thermometer placed on the compressor intake pipe;
2) read the temperature indicated on the scale of a pressure gauge likewise connected to the intake side; refer to the pressure gauge scale for the refrigerant R410A.
   The degree of overheating is given by the difference between the temperatures thus determined.

- Make sure that the subcooling of the liquid refrigerant is limited to between 4 and 6°C: to this end:
1) read the temperature indicated by a contact thermometer placed on the condenser outlet pipe;
2) read the temperature indicated on the scale of a pressure gauge connected to the liquid inlet at the condenser outlet; refer to the pressure gauge scale for the refrigerant R410A.
   The degree of subcooling is given by the difference between the temperatures thus determined.

Warning: all LSE units are charged with R410A: any top-ups must be made by specialised personnel using the same type of refrigerant, exclusively in the liquid phase.

Warning: the refrigerant R410A requires “POE” polyolester oil of a type approved by the compressor manufacturer.
For no reason should a mineral oil be introduced into the oil circuit.

5.5 Stopping the unit

To stop the unit press the "OFF" unit on the front panel.

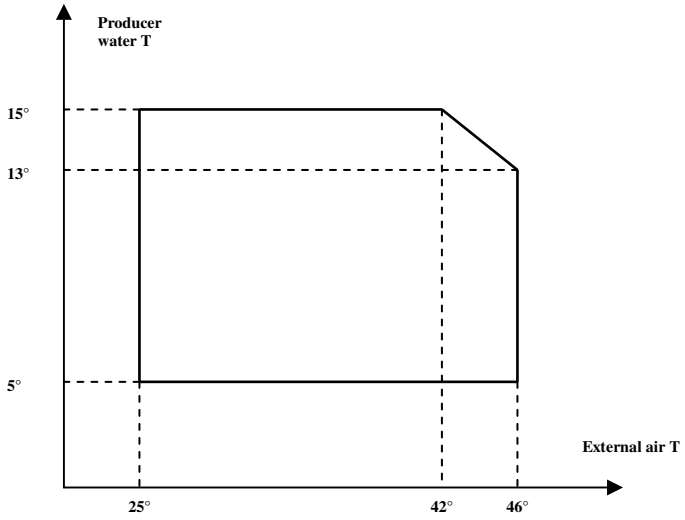
Warning: do not stop the unit using the main switch: the latter device serves to disconnect the unit from the electricity supply when there is no passage of current, i.e. when the unit is already turned OFF.
Moreover, if you completely disconnect the unit from the electricity supply, the crankcase heating elements will receive no power, thereby jeopardising the integrity of the compressor the next time the unit is started.

6. OPERATING LIMITS

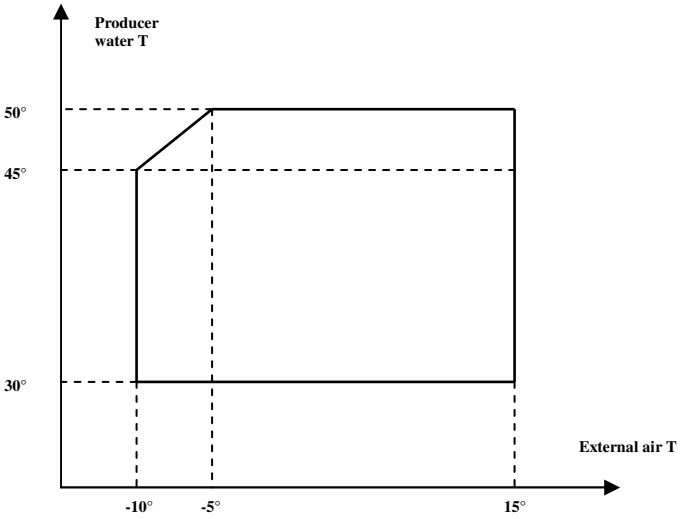
Operating limits of LSE units in relation with outlet water temperature and outdoor air temperature:

	Min.	Max.
Evaporator outlet water temperature [°C]:	**5 (30)**	**12 (45)**
External air temperature [°C]:	**-10**	**45**

- *Limits of the Chiller versions CS/CL*



- *Limits of the Heat pump versions HS/HL*



6.1 Water flow to the evaporator

The nominal flow rate is based on a thermal differential of 5° C between inlet and outlet water, in relation to the cooling capacity provided at the nominal water (12/7 °C) and air (35°C) temperatures.

The maximum allowed flow rate is associated with a thermal differential of 3 °C: higher flow rates cause very high pressure drops.

The minimum allowed flow rate is associated with a thermal differential of 8 °C or a minimum pressure drop of 10 kPa: lower flow rates cause a reduction in heat exchange coefficients and excessively low evaporation temperatures, which may trigger the safety devices and cause the unit to stop.

6.2 Chilled water temperatures

The minimum temperature of the water leaving the evaporator is 5 °C: lower temperatures are possible, but for such applications the Manufacturer should be consulted at the time the order is placed.
The maximum temperature of the water entering the evaporator is 20 °C. To allow higher temperatures specific equipment solutions must be adapted (split circuits, three-way valves, bypasses, buffer tanks): other applications, out of the mentioned range, may be allowed by Lennox S.p.a. after an official verification and a written communication.

6.3 Outdoor air temperature

The units are designed and built to work with outdoor temperatures ranging from -10 (with condensation control) to 45 °C. Contact the Manufacturer in the event of outdoor temperatures beyond this range.
On request, the units may be equipped with an electric heating element serving to heat the evaporator in cases where the unit is exposed to rigid temperatures during wintertime periods of quiescence.
The heating element is activated whenever the temperature of the water leaving the evaporator falls below the temperature set on the antifreeze heating element.

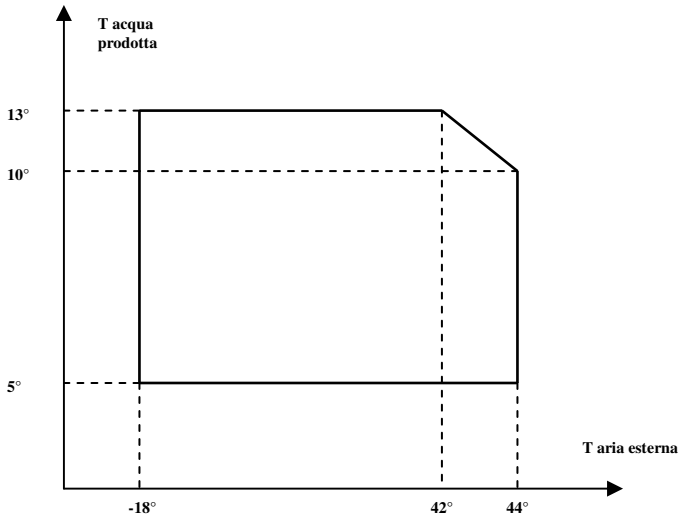
6.4 Operation with water at low temperatures

The standard units are not designed to work with chilled water temperatures below 5 °C at the evaporator outlet. In order to work below this limit, the unit requires specific technical adjustments: in such cases contact the Manufacturer.

6.5 Limits of the Free-Cooling versions FS/FL

Free-Cooling option is available for all models operating with only cooling. This function cannot be matched with heat pump operating. Due to the particular kind of application, all units are provided with a condensation control device and a microprocessor control, type ADVANCED, mounted by series.

The following graphic shows the field of normal applications for Free-Cooling units.



The lower limit is determined by freeze threshold of solutions containing glycol at 35% in weight, maximum allowed value for gaskets used for pumps. On request, ceramic special gaskets for pumps that allows to operate with temperatures lower than the specified ones (use of solutions containing up to 50% of glycol in weight) can be provided.

Etylenic glycol percentage %	0 %	10 %	15%	25 %	30 %	35 %
Freezing point temperature	0	- 3	- 5	-11	-14	-18

Free-Cooling and heat pump units are available with a heater put in the compressor frame.
The problem of inadequate lubrication can occur when the frame is not warmed-up correctly, mainly after long non use periods. In fact, because of the compressor suction actions, a hard pressure decrease happens inside the frame with consequent abundant evaporation of the refrigerant previously melt in the oil. This event causes 2 problems, when there are no electrical heaters:

- Oil dilution and so inadequate lubrication;
- Oil migration toward the cooling circuit due to refrigerant dragging effect.

Use of electrical heaters (std. for LSE) is capital mainly during the first starting-up; in this case we suggest to let them inserted at least 12 hours before starting-up the compressors.
When outdoor T decreases considerably, water T inside the system is checked by fans modulating action and in extreme cases (predominant strong winds) by 3-way valve modulating further action. Only on request, for borderline cases, 3-way valve joint modulating action is available.

7. CONTROL DEVICE SETTINGS

7.1 Generalities

All the control devices are set and tested in the factory before the unit is dispatched. However, after the unit has been in service for a reasonable period of time you can perform a check on the operating and safety devices. The settings are shown in Tables II and III.

The control devices may be serviced SOLELY BY QUALIFIED TECHNICIANS: incorrect settings may cause serious damage to the unit and injury to persons.

Many of the operating parameters and system settings are configured by means of the microprocessor control and are protected by passwords.

Table I - Setting of control devices

CONTROL DEVICE		SET POINT	DIFFERENTIAL
Service thermostat [C - F]	°C	12	4
Service thermostat [H]	°C	40	4

Table II- Setting of safety - control devices

CONTROL DEVICE		ACTIVATION	DIFFERENTIAL	RESETTING
Antifreeze thermostat	°C	+4	1	Automatic
Safety maximum pressure switch	bars	45	-13,5	Manual
Safety maximum pressure switch	bars	40.5	-12.2	Manual
High pressure relief valve	bars	-	-	-
Minimum pressure switch	bars	1,5	+1,3	Automatic
Modulating condensation control device	bars	18	10	
Time lapse between two starts of the same compressor	s	450	-	-
Delay in flow switch alarm	s	20	-	-
Delay in low pressure alarm	s	60	-	-
Pump rotation [optional]	h	6		
End-of-defrost pressure	bars	29	-	-
Maximum defrost time	s	360	-	-
Minimum time lapse between two defrosting operations	s	1800	-	-

NB: due to internal decisions some units may have a 44bar-safety-valve installed together with a 42bar-pressure-switch.

7.2 Maximum pressure switch

The high pressure switch is of the manually reset type and classifiable as category IV under EEC 97/23. It directly stops the compressor when the discharge pressure exceeds the set value.

Warning: do not attempt to change the setting of the pressure switch: should the latter fail to trip in the event of a pressure increase, the pressure relief valve will open.

To verify its efficiency, while the compressors are running, close off the passage of air into the condensers and check by referring to the compressor outlet pressure gauge (previously installed) whether the pressure switch trips (i.e. the compressors stop) when the set value is reached.
The high pressure switch must be **manually rest**; this is possible only when the pressure falls below the set differential (see Table II).

7.3 Minimum pressure switch

The low pressure switch stops the compressor when the intake pressure falls below the set value for more than 180 seconds.

The switch is automatically reset when the pressure rises above the set differential (see Table II); however, the unit will not resume operation until the alarm memory on the microprocessor control is cleared.

7.4 Service thermostat

The function of this device is to start and stop the compressors according to the demand for chilled water, as determined by a sensor placed at the evaporator inlet [water returning from the circuit].
This device is a function included in the microprocessor control and works with a proportional bandwidth that may be set as desired.

7.5 Antifreeze thermostat

The antifreeze sensor situated at the evaporator outlet detects the presence of excessively low temperatures and stops the unit. Together with the water differential pressure switch and low pressure switch, this device protects the evaporator from the risk of freezing as a result of faults in the water circuit.
This device is a function included in the microprocessor control.

7.6 Anti-recycle timer

The function of the timer is to prevent excessively frequent compressor starts and stops.
This device is a function included in the microprocessor control.
It imposes a minimum time lapse of 300 seconds between two successive starts.

Never attempt to change the delay set in the factory: wrong settings could cause serious damage to the unit.

7.7 Oil differential pressure switch

LSE units are equipped with SCROLL compressors: the both compressor types have not a lubricant pump and therefore no oil differential pressure switch is provided.

8. ROUTINE MAINTENANCE AND CHECKS

The only tasks to be performed by the end user are turning the chillers on and off and switching them between the cooling and heating functions as the seasons change.

All other operations are to be considered maintenance work and must thus be carried out by qualified personnel trained to do their job in observance of current laws and regulations.

8.1 Warnings

All the operations described in this chapter MUST ALWAYS BE PERFORMED BY QUALIFIED PERSONNEL.

Before carrying out any work on the unit or accessing internal parts, make sure you have disconnected it from the mains electricity supply.

The upper part and outlet pipe of the compressor may reach temperatures as high as 110°C. Be especially careful when working in the surrounding area while the unit is running.

Be especially careful when working in proximity to finned coils since the 0.11 mm-thick aluminium fins can cause superficial injuries due to cuts.

After completing maintenance jobs, always replace the panels enclosing the units and secure them with the fastening screws provided.

8.2 Generalities

It is a good idea to carry out periodic checks to ensure that the unit is working properly:

- Check the efficiency of all the control and safety devices as previously described.
- Check the terminals on the electric control board and compressor terminal boards to ensure that they are securely tightened. The movable and fixed contacts of the circuit breakers must be periodically cleaned and replaced whenever they show signs of deterioration.
- Check the refrigerant level by means of the liquid level indicator (every 6 months).
- Check the oil levels through the windows provided on the compressor crankcases (every 6 months).
- Check the water circuit for leaks (every 6 months).
- If the unit is to remain out of service for a long time, drain the water from the pipes and heat exchanger, from the pump/s (option), from the gather tank (option) and water coil if they are FREECOOLING units (if you don't use glycolated solutions). This is indispensable if during the period of quiescence the ambient temperature is expected to fall below the freezing point of the fluid used (routine seasonal operation).
- Check whether the water in the circuit needs to be replenished, breathing the circuit by the small valves put in the upper points.
- Check the efficiency of the flow switch or differential pressure switch
- Check the heating elements, where present, of the compressor crankcases.
- Clean the metal mesh filters mounted externally on the water pipes.
- Check the humidity indicator on the liquid level indicator (green=dry, yellow=humid); if the indicator is not green as shown on the indicator sticker, replace the filter (every 6 months).
- Check that the noise emissions of the unit are regular (every 6 months) and more specifically that no vibrations and/or knocking can be detected.

8.3 Repairing the cooling circuit

Warning: while performing repairs on the cooling circuit or maintenance work on the compressors, make sure the circuit is left open for as little time as possible. Even if briefly exposed to air, ester oils tend to absorb large amounts of humidity, which results in the formation of weak acids.

If the cooling circuit has undergone any repairs, the following operations must be carried out:

- tightness test;
- emptying and drying of the cooling circuit;
- charging with refrigerant.

If the system has to be drained, always recover the refrigerant present in the circuit using suitable equipment; the refrigerant should be handled exclusively in the liquid phase.

8.4 Tightness test

Fill the circuit with anhydrous nitrogen supplied from a tank with a pressure-reducing valve until the pressure rises to 10 bars.

During the pressurisation phase, do not exceed the pressure setting of the safety valves; otherwise you will cause the latter to open.

The presence of any leaks must be determined using special leak detectors. Should any leaks be detected during the test, empty out the circuit before repairing the leaks with suitable alloys.

Do not use oxygen in the place of nitrogen as a test agent, since this could cause a risk of explosion as well as the certainty of extensive oxidisation in high-temperature areas.

8.5 Hard vacuum and drying of the cooling circuit

To achieve a hard vacuum in the cooling circuit it is necessary to use a pump capable of generating a high degree of vacuum, i.e. 15 Pa of absolute pressure.
If there is no suitable vacuum pump available, or whenever the circuit has remained open for long periods of time, you are strongly recommended to adopt the triple evacuation method. This method is also recommended when there is a presence of humidity within the circuit.
The vacuum pump should be connected to the inlets.
The procedure to be carried out is as follows:

- Evacuate the circuit until you reach an absolute pressure of at least 35 Pa: at this point inject nitrogen into the circuit until you reach a relative pressure of about 1 bar.

- Repeat the step described above.

- Carry out the step described above for the third time, but in this case attempting to reach the hardest vacuum possible.

Using this procedure you can easily remove up to 99% of pollutants.

8.6 Charging with R410A refrigerant

- Connect the cylinder of refrigerant gas to the male 1/4 SAE inlet situated on the liquid line after discharging a little gas to eliminate air in the connection pipe.

- **Carry out the charging operation with the refrigerant in liquid form** until you reach 75% of the total charge.

- Then connect to the inlet on the intake line and complete the charging process with the refrigerant **in liquid form** until no more bubbles can be seen on the liquid level indicator and the operating parameters specified in the section "Checking the refrigerant level" have been reached.

Introduce refrigerant through the inlet in the liquid line.

A unit that was originally charged with R410A in the factory cannot be charged with R22 or other refrigerants.

8.7 Environmental protection

The law implementing the regulations [reg. EEC 2037/00] which govern the use of ozone-depleting substances and greenhouse gases bans the dispersal of refrigerant gases in the environment and requires whoever is in their possession to recover them and, at the end of their useful life, either to return them to the dealer or take them to a suitable waste disposal facility.
The refrigerant HFC R410A is not harmful to the ozone layer but is included among the substances responsible for the greenhouse effect and thus falls within the scope of the aforesaid regulations.

Therefore, special care should be taken when carrying out maintenance work to minimise refrigerant leaks.

9. TROUBLESHOOTING

On the next pages you will find a list of the most common causes that may cause the chilling unit to fail or malfunction. These causes are broken down according to easily identifiable symptoms.

You should be extremely careful when attempting to implement any of the possible remedies suggested: overconfidence can result in injuries, even serious ones, to inexpert individuals. Therefore, once the cause has been identified, you are advised to contact the manufacturer or a qualified technician for help.

FAULT	Possible causes	Corrective actions
The unit does not start	No power supply.	Check that power is being supplied both to the primary and auxiliary circuits.
	The electronic card is cut off from the power supply.	Check the fuses.
	Alarms have been triggered.	Check whether any alarms are signalled on the microprocessor control panel, eliminate the causes and restart the unit.
	The phase sequence is wrong.	Invert two phases in the primary power line after disconnecting them upstream from the unit.
The compressor is noisy	The compressor is rotating in the wrong direction.	Check the phase sequence relay. Invert the phases on the terminal board after disconnecting the unit and contact the manufacturer.
Presence of abnormally high pressure	Insufficient flow of air to the condenser.	Check whether all the fans are turning properly.
		Check the air T at the condenser inlet and make sure no back suction occurs.
		Check whether the effective RMS voltage to the fans is the maximum. If necessary, check the pressure transducers controlling the revolution regulator, where present [optional].
		Check the cleanliness of the finned coils.
	Presence of air in the refrigerant circuit, as revealed by the presence of bubbles in the flow indicator also with subcooling values exceeding 5 °C.	Drain and pressurise the circuit and check for leaks. Generate a slow vacuum [longer than 3 hours] until reaching a pressure of 15 Pa and then recharge in the liquid phase.
	Unit overcharged, as revealed by an subcooling of more than 8 °C.	Drain the circuit.
	Thermostatic valve and/or filter obstructed. These symptoms may also occur in the presence of an abnormally low pressure.	Check the temperatures upstream and downstream from the valve and filter and replace them if necessary.
	Insufficient flow of water in the case of heat pump operation.	Check the water circuit for pressure drops and/or whether the pump is working properly [direction of rotation]. Check the outgoing water T and make sure it less than or equal to 45°C.

FAULT	Possible causes	Corrective actions
Low condensation pressure	Transducer fault.	Check the transducers and the efficiency of the needle pusher on the schrader valves they are connected to.
	Outdoor T too low and/or presence of strong winds.	Install the condensation control device and/or protect the unit from prevalent winds.
	Low water T, in the case of heat pump operation.	Check whether the thermal load is compatible with the unit's capacity.
Low evaporation pressure	Insufficient flow of water.	Check whether the pumps are rotating in the right direction. Check the water system for pressure drops. Check the efficiency of the pump system check valve (optional).
	Malfunctioning of thermostatic valve.	Warming the bulb with your hand, check whether the valve opens and adjust it if necessary. If it does not respond, replace it.
	Filter clogged.	Pressure drops across the filter should not exceed 2°C (saturated temperature): if it occurs, replace the filters.
	Low condensation T.	Check the efficiency of the condensation control device [if present].
	Low level of refrigerant.	Check the refrigerant level by measuring the degree of subcooling; if it is below 2°C charge with refrigerant.
	Coil covered with frost, in the case of heat pump operation.	Check whether the defrost parameters have been properly set. Check the efficiency of the 4-way valve.
	Low outdoor T, if the unit is operating with the heat pump on.	Check compliance with the operating limits and eliminate any bypasses and back flow of air.
The compressor doesn't start	The internal thermal protection device has tripped.	In the case of compressors equipped with a protection module, check the thermal contact. Identify the causes after restarting.
	The circuit breakers or line fuses have been tripped by a short circuit.	Pinpoint the cause by measuring the resistance of the individual windings and the insulation from the casing before restoring power.
	One of the high or low pressure switches has tripped.	Check on the microprocessor, eliminate the causes.
	The phases have been inverted in the distribution compartment.	Check the phase sequence relay.
High evaporation pressure	Water T too high.	Check the thermal load and/or efficiency of the thermostat function.
		Check the efficiency of the thermostatic valve.
Free Cooling Malfunctioning (units FS-FL)	Failure to exchange the 3-way valve in activation.	It is possible to hand-force the valve to open, but it is advisable to leave the unit working only mechanically.
	Failure to exchange the 3-way valve in deactivation.	It is necessary to hand-force the valve to close, replacing its servo-motor as soon as possible.

10. TECHNICAL FEATURES

Model		LSE360	LSE400	LSE470	LSE540	LSE860
Refrigerant		R410A	R410A	R410A	R410A	R410A
Cooling capacity(1)	[kW]	355.5	394.4	468.0	539.1	861.1
Heating capacity(2)	[kW]	406.4	451.9	509.3	602.0	-
Total absorbed power(1)	[kW]	132.4	149.4	176.4	189.6	322.0
Total absorbed power(2)	[kW]	127.7	142.4	169.0	193.5	-
Water flow(1)	[l/h]	61.141	67.831	80.532	92.731	148.106
Water pressure drops(1)	[kPa]	39	48	54	46	63
No. Scroll Compressors / Circuits	[-]	6/2	6/2	6/2	8/4	11/4
Buffer tank	[dm^3]	600	600	600	1040	1040
		STANDARD				
Height	[mm]	2650	2650	2650	2650	2650
Length(3)	[mm]	3060	3060	4060	5060	7060
Depth	[mm]	2260	2260	2260	2260	2260
Sound pressure @ 10 m Q=2	[db(A)]	62	62	63	64	65
		LOW NOISE				
Height	[mm]	2650	2650	2650	2650	2650
Lenght	[mm]	3060	3060	4060	5060	7060
Depth	[mm]	2260	2260	2260	2260	2260
Sound pressure @ 10 m Q=2	[db(A)]	54	55	56	56	57

(1) Data referred to the Standard Version, chilled water 12/7°C – external air 35°C
(2) Data referred to the Standard Version, hot water 40/45°C – external air 7°C R.H. 90%
(3) In the FREE- COOLING version add 350 [mm]