INSTALLATION,
OPERATION AND MAINTENANCE MANUAL

AIR-HANDLING UNITS

ZASE SERIES

EUROVENT CERTIFIED PERFORMANCE
AHU -09.07.436
Range -EURO
www.eurovent-certification.com

TABLE OF CONTENTS

0. INTRODUCTION

This manual has been compiled by TCF Srl to provide the installer, Customer and User with instructions intended to ensure the proper management and use of the Air Treatment Unit mod. ZASE from delivery to commissioning.
The recommendations that follow are intended to ensure continuous operation of the Air Treatment Unit and long machine life .
The procedures described below should be followed by skilled personnel with a good working knowledge of air-conditioning, systems engineering and air treatment units, even though the unit can be operated by those unfamiliar with air treatment thanks to the machine's simplicity of design.

DESCRIPTION OF AIR TREATMENT UNIT

1.1. COMPOSITION

In its most complete version, the unit, in its monoblock or broken down configuration, comprises:
- One or more air lock intake section
- Filtration section
- Recovery section
- Heat exchanger section (heating, cooling, post-heating)
- Humidifier section
- Ventilation section (delivery, intake—outlet)
- Silencing section.

1.2. PERMITTED USE

TCF Air Treatment Units are designed exclusively for CIVIL AND INDUSTRIAL AIR TREATMENT
In the case of CORROSIVE and/or EXPLOSIVE air flows a number of special technical modifications must be made at the design stage which, together, adapt the machine for the treatment of special types of flow.
The Air Treatment Unit must at all times be used strictly in accordance with the design conditions established at the time of contract in agreement with the customer. ANY OTHER USE SHALL CONSTITUTE IMPROPER USE AND IS THEREFORE DANGEROUS.
THE MANUFACTURER MAY NOT BE HELD LIABLE FOR DAMAGE CAUSED BY NON—STANDARD USE OR ANY USE NOT ENVISAGED IN THE CONTRACT

2. CONTROL, PACKING, TRANSPORTATION

2.1. INSPECTION OF SUPPLY AT THE FIRM

Prior to shipping, each TCF Air Treatment Unit is subjected to all the functional tests listed on the attached UNIT INSPECTION SHEET (Form E.1.).
The checks performed regard:
- general machine dimensions
- correct assembly of the various parts and sections
- compliance with the various safety rules in force
- integrity of all the system's component parts
- application of the identification, operation and safety notices.

On completion of the Inspection, the Chief Inspector applies the EC mark demonstrating product compliance with prevailing European Union machine directives.

2.2. PACKING

The Air Treatment Units are usually supplied as fully-assembled monoblocks. Only if the customer expressly requests it can the units be broken down into several sections to facilitate transportation and carriage through narrow apertures, stairs or corridors. Transportation of the machines, both monoblock and broken down, can be:
- normal
- special.

In the former case, TCF Srl does not pack the machine. In the case of special transportation, the packing requested is agreed at the time of contract and is entirely for the customer's account.

Fragile components supplied separate from the Unit, such as humidifiers, exchangers, recuperators, filters, control boards, etc. are always delivered packed.

2.3. LOADING, TRANSPORTATION, UNLOADING

TCF Srl disclaims all liability for damage sustained by the Air Treatment Units during loading, unloading and transportation. We therefore recommend that special precautions be taken, including:
- The load must be firmly secured to ensure its integrity during transportation
- Handling must be performed without exerting force on projecting accessories (hydraulic attachments, handles, hinges, air locks, protection roof)
- Do not overturn the sections as you may otherwise break internal supports, components and dampers
- Do not subject the Unit to violent impacts as you may damage its integrity
- If a forklift truck is used during the loading, unloading and handling operations, the forks of the truck must be at least the same length as the unit to ensure stability (fig. 1)
- if the Air Treatment Unit is fitted with a continuous steel base, handling may be accomplished with a crane, using cables firmly secured to rods (sufficient for the stress involved) passing through the holes provided in the base.

If a crane is used, proceed as shown in the illustration, using spacers to protect the structure (fig. 2).
- During transportation, protect the unit from atmospheric agents. Special care must be taken if the unit is supplied disassembled or designed for internal use.

Fig. 1

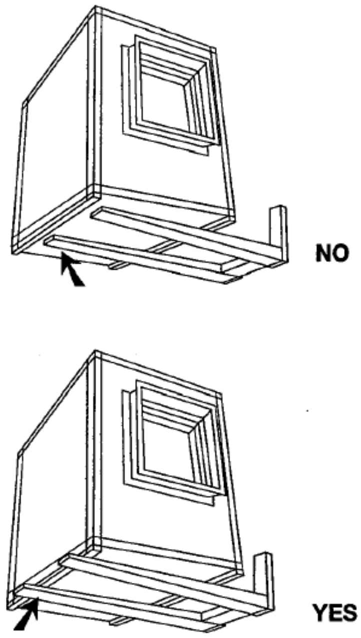
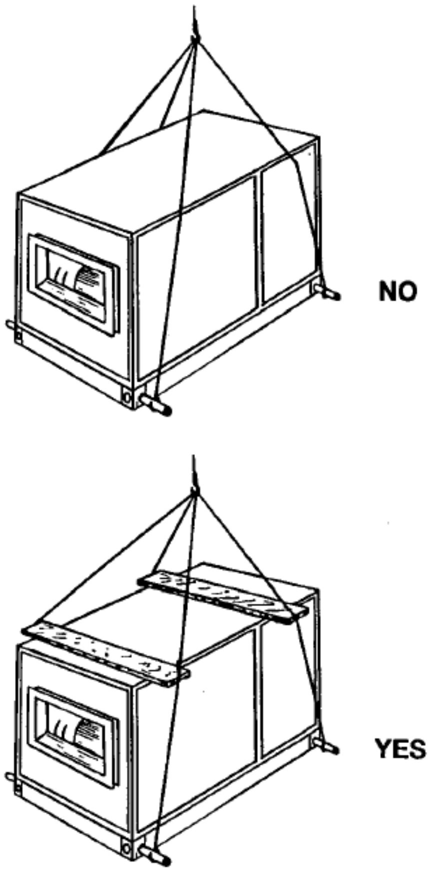


Fig. 2



3. ASSEMBLY ON SITE

3.1. POST-TRANSPORTATION CHECK

When the Air Treatment Unit arrives on site, we recommend you to make a careful inspection of the structure and the component parts of the unit.
Should you come across damage sustained during transportation, you must report it on the freight bill. The carrier must immediately tile a report of the accident to obtain compensation from the insurance company

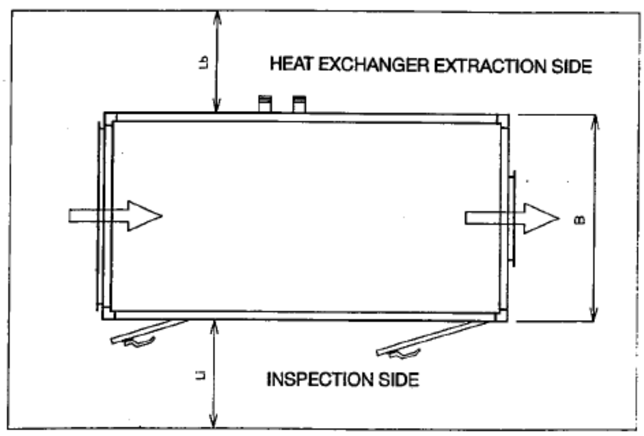
3.2. PRESERVATION ON SITE

In order to keep the Air Treatment Unit in good and efficient condition on site, the following steps must be taken first:
- Prior to installation, position the Unit and the accessories in a place affording the best possible protection against accidental knocks, dust and atmospheric agents
- Carefully cover the inlets and outlets to prevent foreign matter from entering the unit and damaging the internal components
- Extract the pre-filters from the Unit and put them in a protected place to preserve their filtration efficiency This is why the superior efficiency filters are delivered packed; they must be kept in their packages until the unit is put into service
- Check that the hydraulic connections are protected by the relevant caps as they were on delivery to the TCF plant. If they are not, plug them in order to protect the exchangers.

3.3. POSITIONING

3.3.1. Dimensions of installation room
The Air Treatment Unit installation room must be of sufficient size to permit easy inspection, maintenance and component replacement.
Accordingly, the following dimensions are recommended [fig. 3):

Fig. 3



- heat exchanger extraction side
  Minimum distance Lb = (B+O.2) m
  where B = machine width (m)
- inspection side e Minimum distance Li = 1.2 m

If you do not have the minimum space requirements as specified above, the Unit doors can, on request, be fitted using PVC clamps instead of hinges. In this case the minimum distance will be Li = 0.7 m

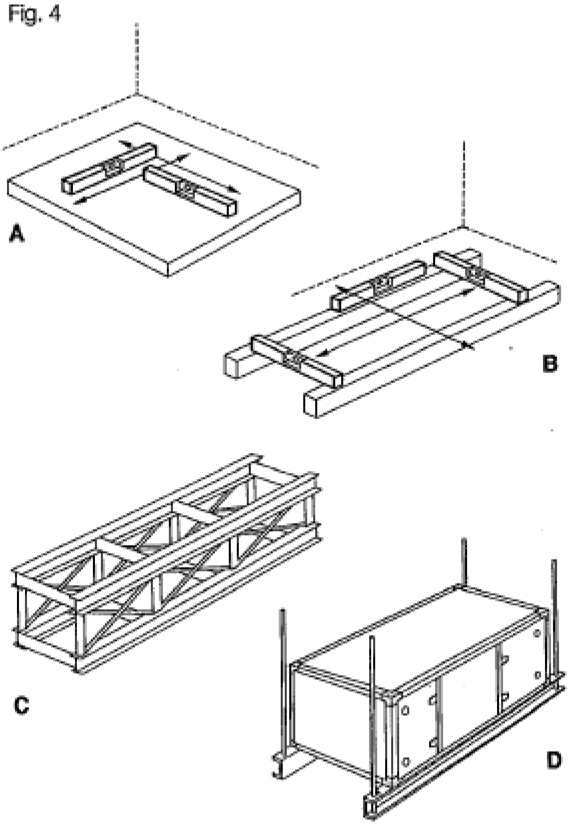
3.3.2. Base

The permanent installation of the Air Treatment Unit may be made:
- directly on the floor (Hg. 4a)
- on a concrete bed (fig. 4b)
- on a steel section bed (fig. 4c)
- on a suspended base (fig. 4d)

Both the floor and the beds must be capable of withstanding the machine weight to within the required safety margins.
The Air Treatment Unit must be positioned on a horizontal surface so as to prevent:
- damage to the fan motor units caused by uneven weights on the vibration dampers
- malfunctioning of the condensate drains
- difficulty in opening and closing the inspection doors.

The horizontal alignment of the support surface must be checked with a SPIRIT LEVEL; adjustments may be made using STEEL SHIMS.

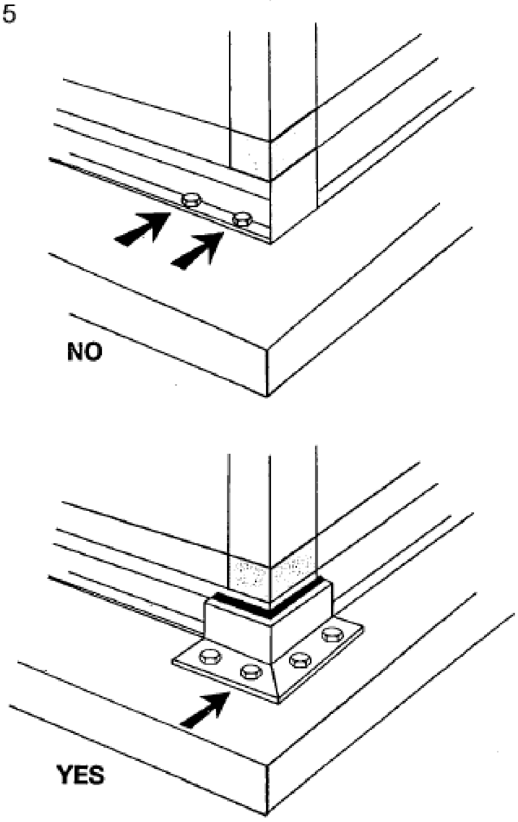
Fig. 4



3.3.3. Vibration damping

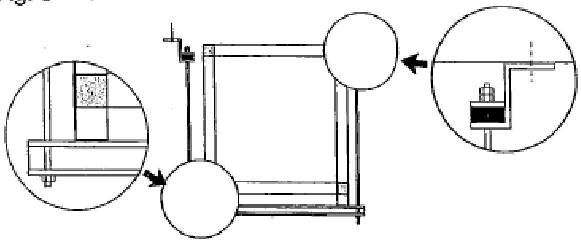
In order to ensure effective protection against vibrations, the Air Treatment Unit must be installed as follows:
- suitable DAMPERS in material designed to withstand the weight involved must be placed between the machine and the support surface
- the Unit must not be fastened directly with screws but by means of brackets (fig. 5).

Fig. 5



Even in the case of suspended installation of the Unit, the supports must not be screwed directly into the ceiling; vibration damping material must always be placed between the supports and the ceiling (fig. 6).

Fig. 6

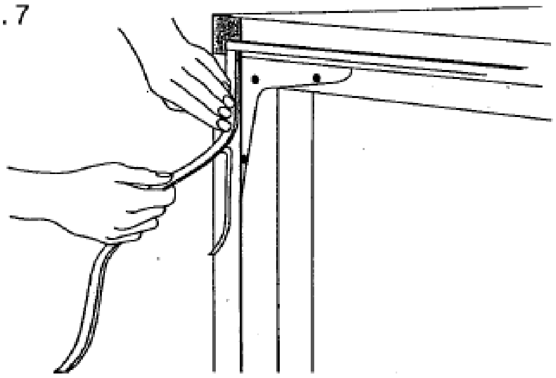


It, for reasons connected with increased protection, spring-operated or rigid rubber vibration dampers are required between the machine base and the support surface, the hydraulic connections must be fitted with appropriate JOINTS.

3.4 ASSEMBLY OF SECTIONS

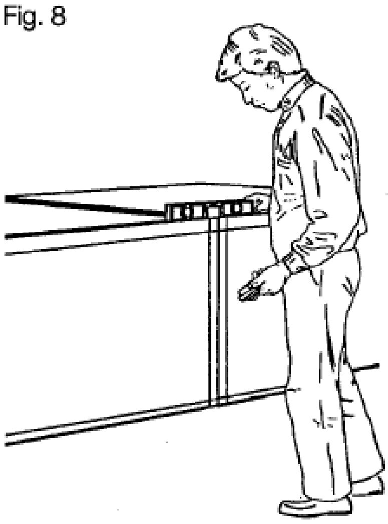
If the Air Treatment Unit is broken down into two or more sections. proceed as follows:
- Check the module assembly order on the TCF working drawing.
- Remove the material required for assembly, supplied on delivery, from the container located inside one of the inspection doors.
- Clean the steel sections at the point of connection of the modules and tit the SELF—ADHESIVE SEALING STRIP provided (fig. 7).

Fig. 7



The same strip must also be fitted to the duct connection flanges.
- Set the individual sections set by side, using a SPIRIT LEVEL to check that the assembled parts are perfectly aligned and level. (fig. 8)

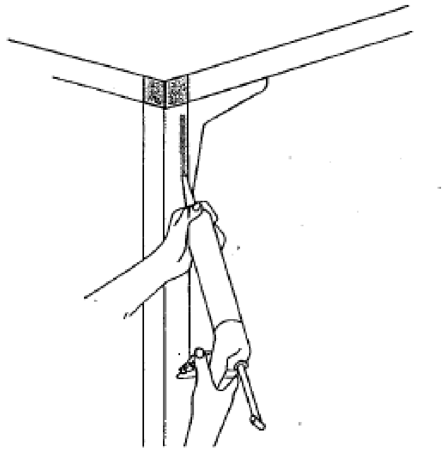
Fig. 8



- Fasten the sections together with screws in the holes provided.
The holes are located on the inside of the corners and, in the case of dimensions greater than 1.3 m, also in a midway position.
The screw-fastening areas can usually be accessed from the inspection doors. Otherwise, you must remove the panels next to the area involved.

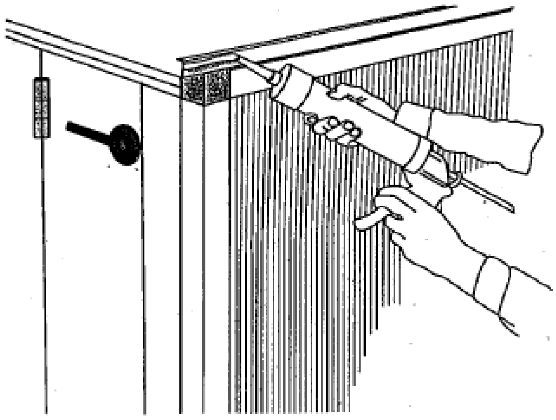
Should the Unit be installed outdoors, in addition to the steps listed above, the points of connection of the individual modules must also be sealed with waterproofing silicone (fig. 9).

Fig. 9



Special care must be taken with the roofing to afford protection against the elements: the two edges will be jointed by means of a bayonet system, assisted by silicone treatment or a specific seal (fig. 10).

Fig. 10



4. CONNECTION TO SYSTEMS AND START-UP

4.1. CONNECTION TO DUCTS

At the points of connection to the air ducts, the Air Treatment Units have a smooth or a flanged surface.
In order to optimise the connection with the ducts, you must:
- clean the connection edges between duct and unit
- fit a seal to the flanges in order to prevent air infiltration
- tighten the connecting screws firmly
- treat the joint with silicone to enhance the seal.

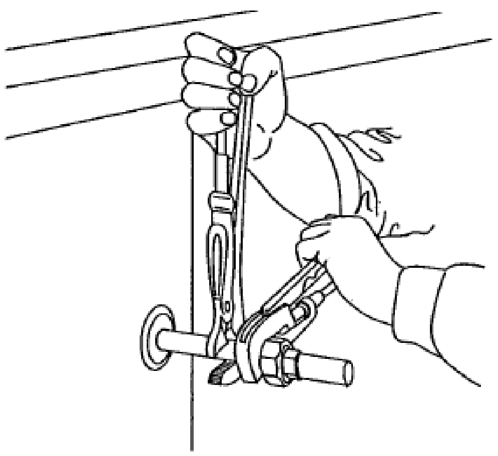
If the connection is made with rubberised canvas joints, make sure they are not taut on completion of assembly so as to prevent damage or the transmission of vibrations.

In order to ensure the tightness of the connections and the integrity of the unit structure, the weight of the ducts must under no circumstances bear down on the unit. The ducts must be supported by BRACKETS.

4.2. CONNECTION OF HEAT EXCHANGERS

In order to prevent damage to the exchanger at the joint between the steel manifold and the copper circuits, you must:
- Use a pipe wrench to apply force in the opposite direction when making the connection to the mains pipe (fig. 1.1)
- Fit brackets to support the connecting pipes.
The weight of the pipes must under no circumstances bear down on the manifold.

Fig. 11

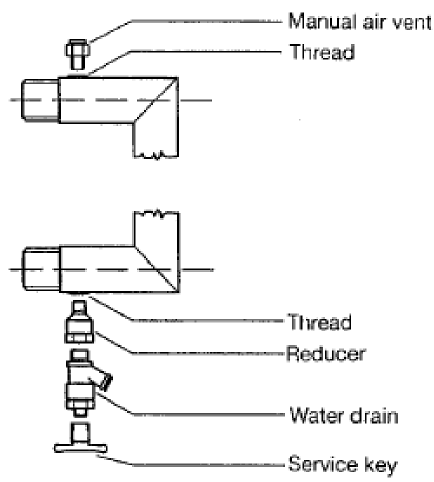


4.2.1. Water exchange

In order to ensure an optimum heat exchange, you must:
- WASH the heat exchanger before connecting it to the water mains
- once installed in a workmanlike fashion, any air present in the hydraulic circuit must be expelled using the relevant valve.

To allow easy extraction of the exchanger during maintenance:
- the connections to the mains must be made in such a way as to allow removal of the exchanger
- ON-OFF VALVES must be installed to exclude the heat exchanger from the hydraulic circuit
- A VALVE must be installed on the lower manifold to allow complete drainage, and a VALVE must be titled to the upper manifold to vent the air from the exchanger (fig. 12)

Fig. 12



The normal heat exchange in a heating or cooling water exchanger occurs in REVERSE CURRENT (fig. 13).

Fig. 13

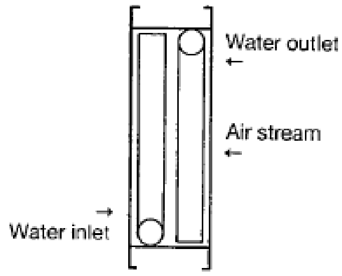
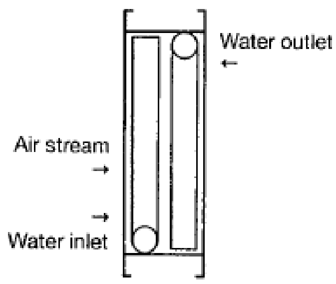
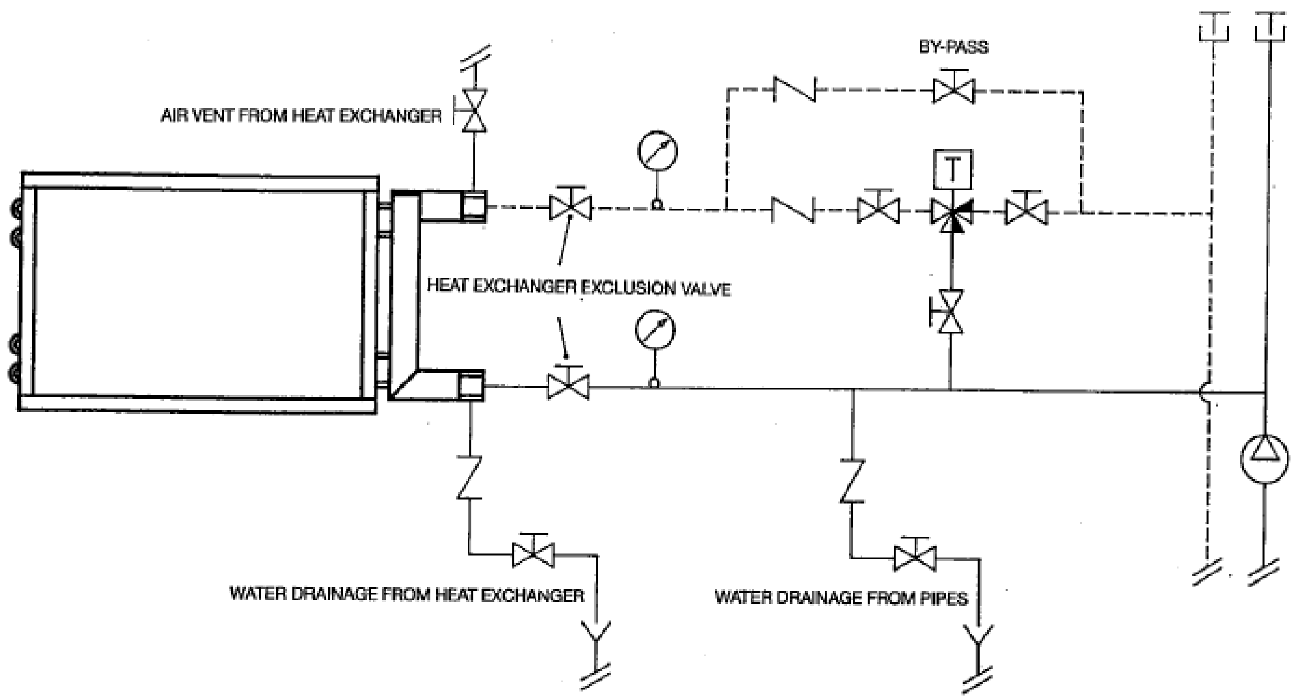


Fig. 14



In order to prevent the formation of ice in the heating units in the presence of particularly low outside temperatures, an EQUICURRENT heat exchange system may be provided (fig. 14).
This configuration must be determined at the design stage and not during installation, since an obvious reduction in efficiency will result if a heat exchanger sized for reverse current heat exchange is used for equicurrent operation.

Fig. 15

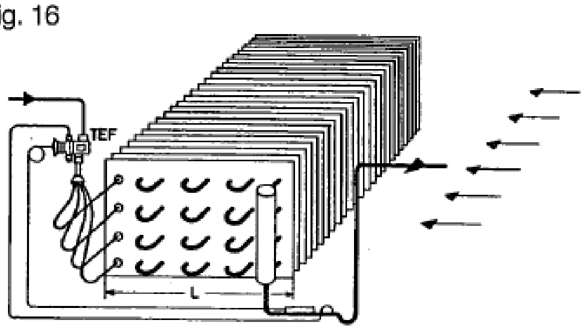


The diagram (Hg. 15) shows the "standard" installation of a water-type heat exchanger.

4.2.2. Direct expansion exchanger

In order to permit operation of the whole system, make sure that the heat exchange occurs in reverse current before)making the connections to the heat exchanger (fig. 16).

Fig. 16



The cooling circuit must be complete with all the necessary flow control, filtration and safety devices; the pipe must be sized to allow proper circulation of the compressor protection oil.
We recommend you protect the exchanger against vibrations to prevent the likelihood of rupture at the joint between manifolds and copper pipes.
In order to ensure correct operation of the thermal expansion valve, the bulb of the valve must be in perfect contact with the intake line and fitted on the outside of the air flow so as not to be affected by it.

Special care must be taken with the SIPHONING of these exchangers to ensure the maximum heat exchange and correct entrainment of the oil in the circuit. The diagram in fig. 16 shows a siphoning system without division of head.

Fig. 17 System siphoning example with division of cooling head.

Fig. 17

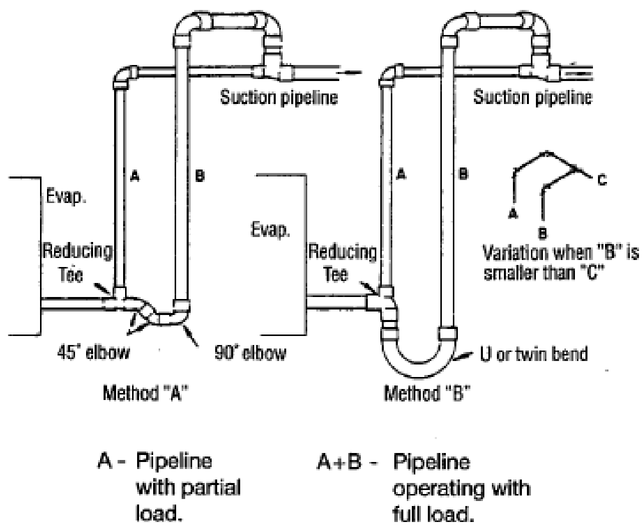
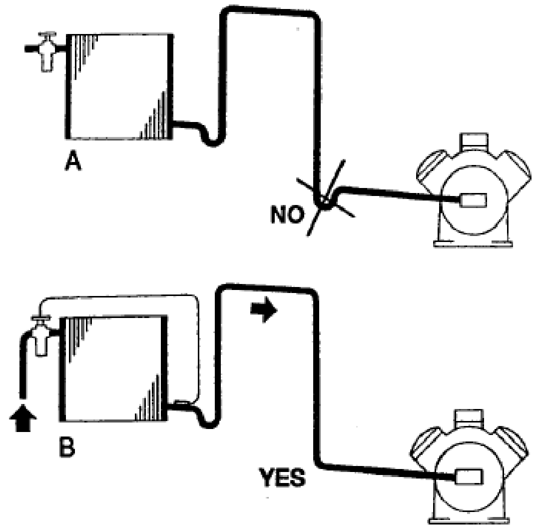


Fig. 18 shows an incorrect siphon system (a) and a correct one (b), in the case of installation of the compressors at a point below the evaporator.

Fig. 18



4.2.3. Steam exchanger

In order to prevent dangerous WATER HAMMERING that could rupture the exchanger and lead to the escape of steam under pressure, you must:
- make sure that the Air Treatment Unit is level on installation
- correctly size the flow control devices and the condensate drains
- ensure the correct angle of inclination of the pipes comprising the steam circuit.

Before starting up the system make sure that the heat exchanger is correctly connected to it (fig. 19)

TCF installs steam batteries with angled or vertical pipes (fig. 19) to ensure correct drainage of the condensate and prevent it from accumulating inside the system. In Air Treatment Units with this type of exchanger special care must be taken to ensure that the base is level (see section 3.3.2.).

The steam system must be complete with all the necessary regulating, filtration and safety devices, which must be correctly sized.

Each heat exchanger must be fitted with a condensate drain, which must be oversized to allow drainage of the greater quantity of condensate that is formed during system start-up.

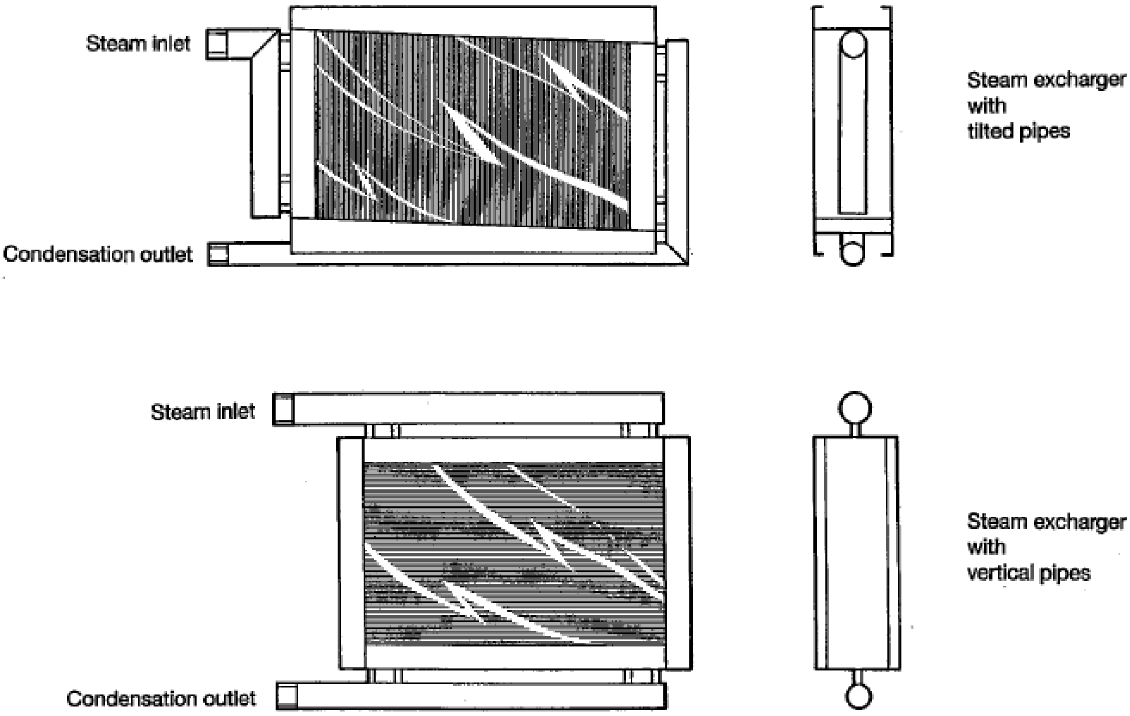
Provision must also be made for the automatic shut-off of the steam feed in the case of fan motor unit stop.

4.3. CONNECTION OF HUMIDIFIER SECTIONS

4.3.1 . Feed water

TCF recommends feeding the humidifier sections with water that has a TOTAL HARDNESS of between 15°F and 25°F. Below 15°F the aggressiveness of the water could damage the unit components, and the useful life of the resins in the softening system would be drastically shortened.
Over 25°F the efficiency of the humidifier system would quickly diminish due to the build-up of scale.

Fig. 19



4.3.2. Hydraulic connections for cell block or spray nozzle humidifiers

The hydraulic connections must be arranged so as to permit easy extraction of the evaporating block or the distribution ramp.

The drain and overflow must be fitted with a siphon a not connected directly to the drainage system pipe (section 4.4.). This operation is extremely important in order to prevent tank overflows and resulting flooding of the unit and the site of installation.

We recommend you install the following devices on the hydraulic connection to the mains:
- a filter
- a pressure gauge
- a flow control valve that also allows exclusion of the humidification system.

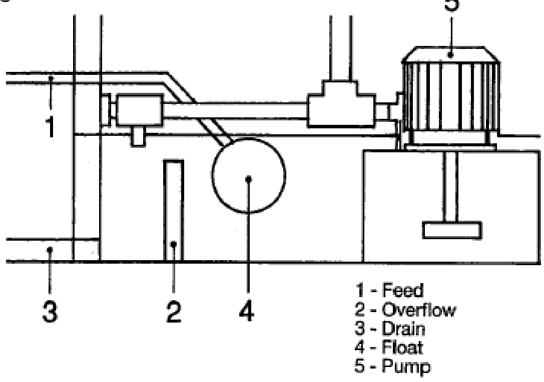
4.3.3. Humidification with cell block

Prior to start-up, check that the cell block is correctly installed (section 6.4.2.).

At first-time start-up, check that the cell block is evenly wetted; if you observe water jets on its surface, restore the regular water flow by means of the tap.

4.3.4. Humidification with circulating pump

Fig. 20



To avoid damaging the pump at first-time start-up, check that:
- The hydraulic connection has been made properly, in accordance with prevailing regulations
- The tank is clean and free of any residue resulting from installation that could cause its blockage
- The water level inside the tank is kept at 20-30 mm below the overflow.

Should a situation arise in which there is no water in the tank, the pump motor would overheat and be irreparably damaged. Conversely, if there is too much water in the tank, an overflow may result, leading to flooding of the unit and the installation room.

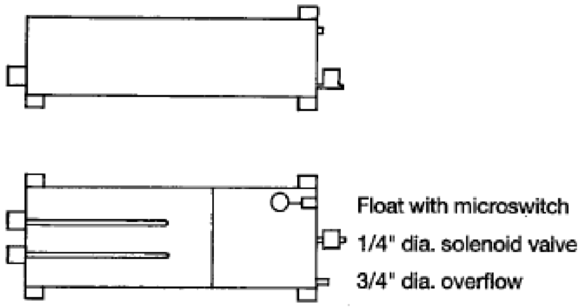
4.3.5. Ultrasonic, steam (submerged electrodes), compressed air humidification

For Air Treatment Units with the above-listed types of humidification, you should consult the MANUAL supplied with the humidifier.

4.3.6. Steams humidifier with submerged elements

In order to make the system operational, you must:
- Connect up the element electrically in accordance with prevailing standards
- Connect the humidifier to the mains network; an on-off valve must be included to exclude the humidification section from the line
- Connect the overflow to the drain to prevent flooding in the case of float malfunction.

Fig. 21



Before starting up the humidification system, you must:
- check the proper operation of the microswitch which, in order to protect the element, interrupts the flow of current when the water level drops below a permitted level.
- check the setting of the float to prevent the overflow of water from the tank.

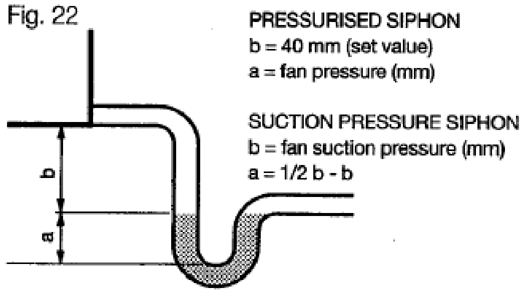
4.4 DRAINAGE AND SIPHONING

Before positioning the Air Treatment Unit make sure you have sufficient room to install the siphon and drainage pipe.

The humidification and cooling exchanger sections of the TCF Units are fitted with a threaded drain pipe projecting laterally about 80 mm.

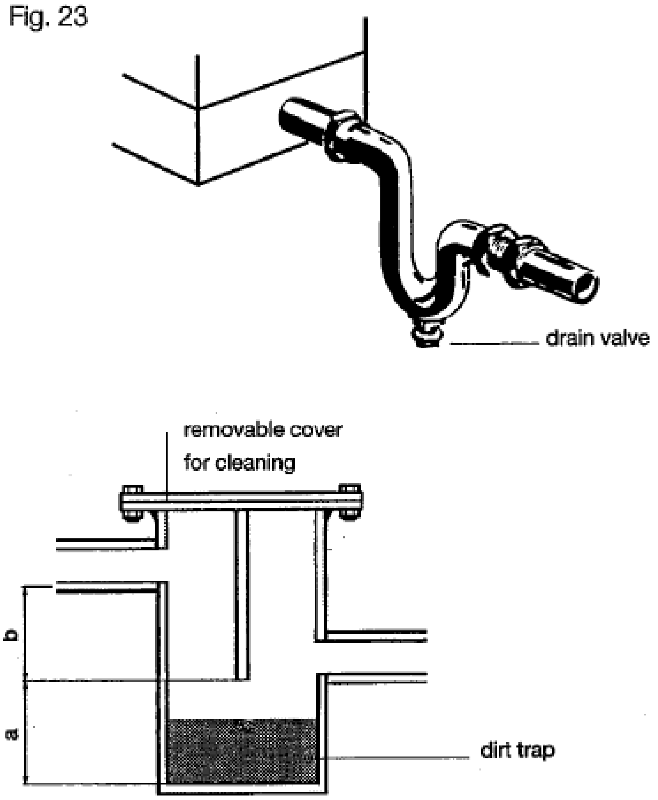
To allow the regular outflow of water every drain must be fitted with a correctly sized SIPHON (fig. 22).

Fig. 22



In order to prevent overflowing from the condensate collection tank and resulting flooding of the machine and the room in which it is installed, the siphon must be fitted with a DRAIN VALVE to permit the removal of impurities that settle on the bottom (fig. 23).

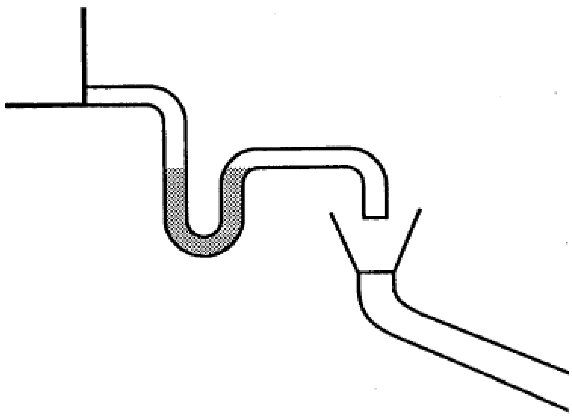
Fig. 23



In order not to undermine the operation of the drainage system, pressurised siphons and siphons operating under suction pressure must not be connected together.

THE WASTE PIPE (fig. 24) leading to the drainage network:
- Must not be connected directly to the siphon in order to absorb air or waste backflow and to permit direct visual control of the correct outflow of waste water
- Must have a diameter larger than the drain pipe and a minimum angle of 2% to ensure proper functioning.

Fig. 24



4.5. FILTRATION SECTIONS

Check the correct installation of the prefilters located in the relevant counter-frames with safety springs or guides.

The electrical connection and installation instructions for the rotary filtration section are provided in the specific manual provided. The instructions for introduction of the reconditionable filtration diaphragm are set out in the maintenance chapter (6.2.3.).

After removing the filters from the packing (in which they are supplied to prevent deterioration during transport and on site), place the bag, absolute and active carbon filters in the relevant section, taking care to ensure rigid assembly and perfect gasket tightness.
This operation must be performed about one hour after the unit has been started up for the first time, when dust and installation residue have been removed from the ducts. In this way the non-reconditionable filtration sections will be preserved.

On request, TCF supplies differential analogue pressure gauges (fig. 25) or oil-column, gauges (fig. 26) of the types shown.

Fig. 25

Fig. 26

4.6. FAN MOTOR UNIT

4.6.1. Electric motors

Before start-up:

- Inspect the motor control board and check that the motor protection devices are sized for the maximum amperage. corresponding to the rated value on the plate.

If the protection devices are sized for an amperage in excess of the rated value, you must make sure that the working range is sufficient.

- The thermistors (operating voltage 1 V) must not be connected to the electric motor power supply line, as otherwise they would be irreparably damaged
- Check that the mains supply voltage is suited to that of the motors as indicated on the relevant plates.

4.6.1.1. Connection for direct starting

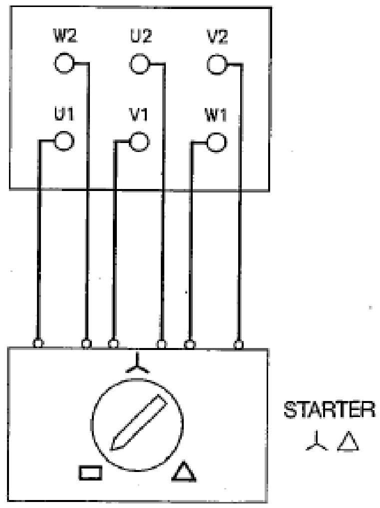
The simplest electric motor start—up system is obtained by connecting the motor direct to the power supply.
However, this method has limitations due to the high start-up current (pick-UD); this type of start-up is recommended for power ratings of up to 5.5 KW at which TCF installs 4 pole, 220/380 V three—phase motors as standard.

The wiring diagrams are shown in fig. 27.

4.6.1.2. Connecting with delta—star starter

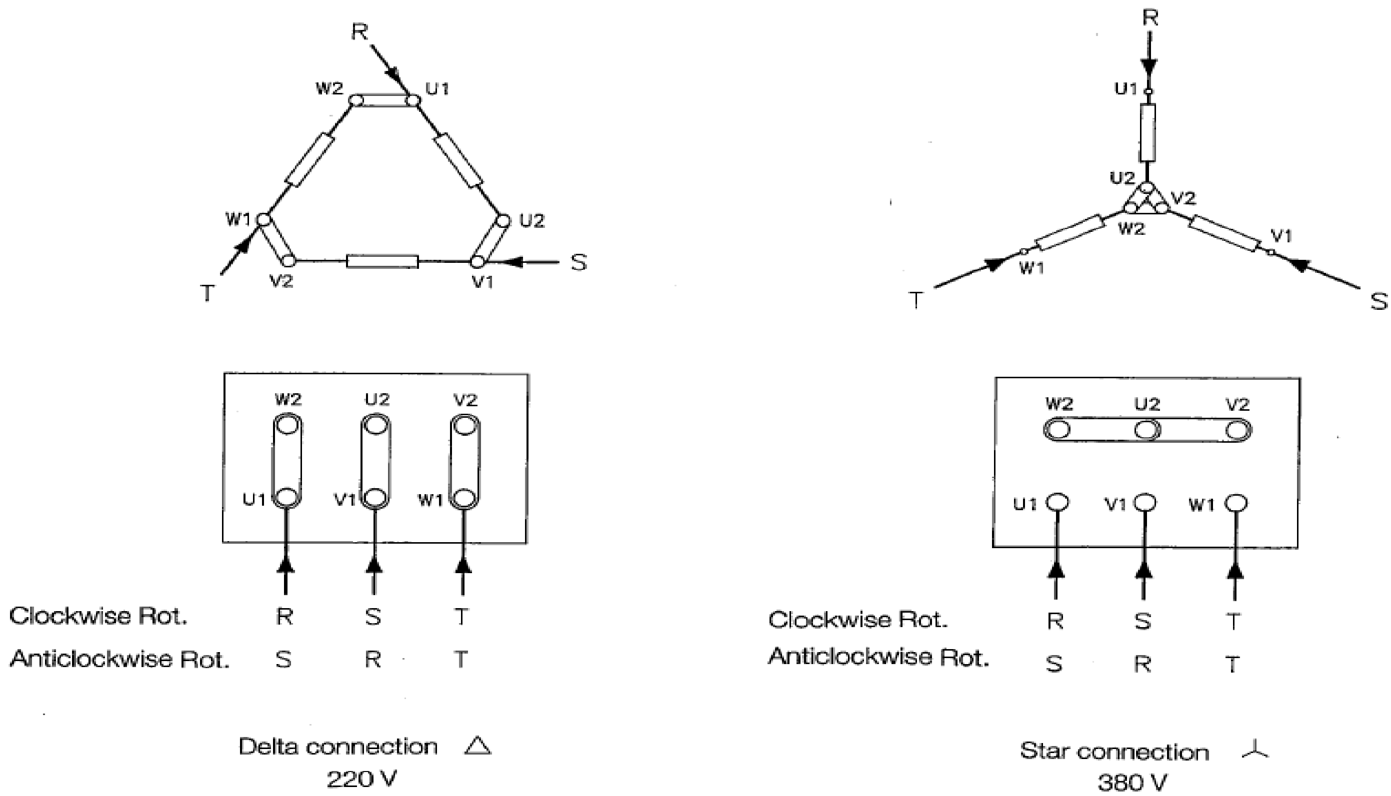
If the motor start-up current exceeds the value permitted by the power supply you may decide to opt for delta-star starting.
For this purpose TCF installs dual voltage 380/660 V motors on its Air Treatment Units starting from an output of 7.5 KW, thereby allowing the motor to function normally at 380 V (delta connection) and to start-up at 660 V (star connection).
This arrangement reduces the starting current to approximately 30% of the current involved in the case of direct starting.

Fig. 28



Wiring diagram for delta-star starter with three-phase motor, single speed, dual voltage.

Fig. 27



4.6.1.3. Dual speed three-phase motors

The diagram in fig. 29 shows the connection of a TWO-SPEED MOTOR with two separate windings to the power supply. TCF installs motors of this kind on its Units:
- 220/380 V for power ratings up to 5.5 kW
- 380/660 V for power ratings over 7.5 kW.
This type of electric motor permits delta-star connection with starter.

The two-speed motors with a single DAHLANDER commutable winding (fig. 30) (side connection) offer the advantage of generating greater power than motors of the same size but with separate windings.

4.6.1.4. Permitted start time

With regard to the temperature increase. the start-up time of a motor may not exceed the value shown in table 1. In the case of repeated starts with unchanging rated power the temperature of the motor must be the same as it was before the first start. Therefore, in order for the values in the table to be valid. it is assumed that the motor is cold.

TABLE 1

Motor size	Starting method	Max start time in seconds for single start Number of poles 2	4	6	8
63	Direct starting	25	40	—	40
71	Direct starting	20	40	40	40
80	Direct starting	15	20	40	40
90	Direct starting	10	20	35	40
100	Direct starting	10	15	30	40
112	Direct starting	12	15	20	25
	Delta-star start.	36	45	60	75
132	Direct starting	12	12	20	25
	Delta-star start.	36	36	60	75
160-250	Direct starting	15	15	20	20
	Delta-star start.	45	45	60	60

4.6.1.5. Recommended connection and protection accessories

Table 2 recommends, depending on the electric motor installed in the Unit:
- the cross-section of the connecting cable, in copper or aluminium
- the overload cut-out
- the fuse
Isp = starting current intensity
IN = rated current intensity

Fig. 29

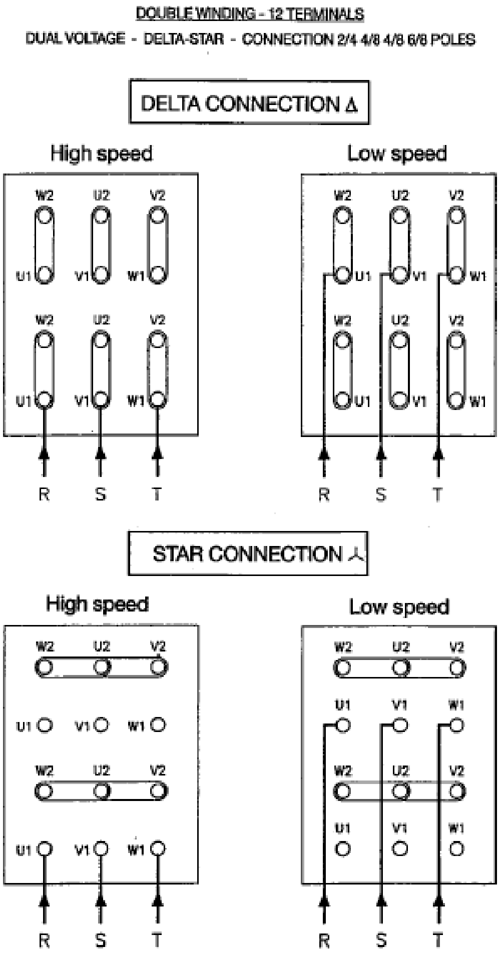


Fig. 30

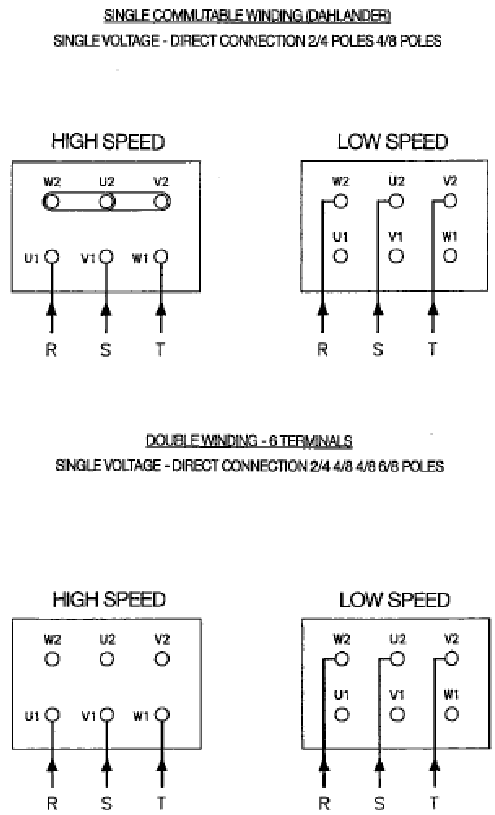


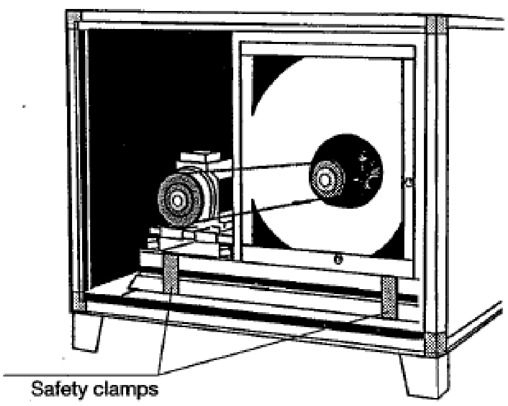
TABLE 2

Motor			Cable		Ov. cutout	Fuse
Power kW	380 V current A	Size	Pose A Cu mm^2	Al mm^2	Overload thermal cutout Scale A	Recommended fuse for direct starting I/IN S7. Max start time max 10 s. A
0.18	0.7	63 B	1.5		0,6-1.0	6/4
0.25	0.85	71 A	1.5		0.6-1.0	6/4
0.37	1.15	71 B	1.5		1.0-1.5	6/4
0.55	1.55	80 A	1.5		1.6-2.5	10/6
0.75	2	80 B	1.5		1.6-2.5	10/6
1.1	2.9	90 S	1.5		2.5-4.0	16/10
1.5	3.7	90 L	1.5		2.5-4.0	16/10
2.2	5.2	100 LA	2.5		4-6	20/20
3	6.9	100 LB	2.5		6-9	25/20
4	9	112 M	2.5		6-9	35/25
5.5	12	132 S	2.5		9-13	35/35
7.5	18	132 M	6		13-16	50/50
11	23	160 M	6		18-23	63/63
15	30	160 L	10	16	28-42	80
18.5	37	180 M	10	16	28-42	80
22	44	160 L	10	16	40-52	100
30	59	200 L	16	25	52-65	125
37	74	225 S	25	35	60-75	160
45	88	225 M	35	50	72-100	200
55	108	250 M	50	70	72-100	200

4.6.2. Fan

Before start-up, carry out the following checks:
- make sure that the fan wheel is functioning correctly by turning it manually
- check that any safety clamps fitted to prevent damage during transportation have been removed from the dampers (fig. 31).

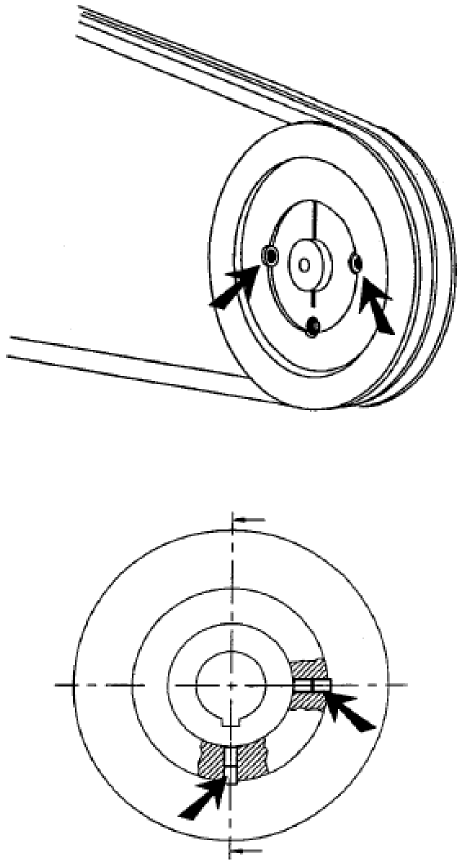
Fig. 31



4.6.3. Drive

Before starting the Air Treatment Unit, check:
- the tension of the “V“ belts (section 5.5.4.)
- that the pulleys are aligned (section 5.5.4.)
- that the dowels, shown in fig. 32 in their possible installation positions, are doing their job of securing the pulleys to the hubs.

Fig. 32



4.6.4. Noise level

The computation and control of noise emissions has today become particularly important, both during the design and installation phases.
The sound pressure values of our machines are indicated In our technical catalogues or can be supplied directly by our Technical Department according to the requested air moving characteristics.
Being therefore aware of the sound emissions produced by the Unit, the Designer must make sure that, in treated environments, maximum values laid down by current regulations are not exceeded.
It must however be stressed that every environment has its own acoustic characteristics which can considerably affect sound pressure values of mechanical ventilation systems. THE NOISE LEVEL DATA SUPPLIED BY US SHOULD CONSEQUENTLY BE CONSIDERED AS A CALCULATION BASE FOR MORE IN-DEPTH CONSIDERATIONS WHICH TAKE INTO ACCOUNT THE SYSTEM AND BUILDING STRUCTURE AS A WHOLE.

5. INSPECTION

5.1. PRELIMINARY CHECKS

- THE DELIVERY AND OUTLET HYDRAULIC CONNECTIONS must be completed. Check the pressure seal of the various circuits and the free passage they afford to the carrying fluid
- THE INTAKE AND DELIVERY AIR-MOVING CONNECTIONS must be completed. Check the tightness of the lines against air leaks in both the main sections and the various branches leading to the utilisation points
- THE EXTERNAL AIR INTAKES AND OUTLETS must present entirely free passages. If the Units remain on site for some time prior to inspection, make sure that the passages have not become obstructed by foreign matter and that the flow control locks are not in the fully or partly closed position. TCF fits standard on outdoor installations special "RAIN-SHIELDS" complete with leaf-collection net with a mesh size of 10 mm x 1 mm. It is however advisable to check that these air intakes are free of obstructions.

Similarly you must make sure that there are no air locks in the closed position in the AIR DISTRIBUTION CIRCUITS and that any safety systems installed, such as lire or smoke gates, are not activated and blocking the air passage
- THE CARRIER FLUIDS such as hot or superheated water; steam, cooled water glycol mixtures or cooling gases must be available in the actual conditions (temperature and pressure) considered at the design stage
- THE POWER AND CONTROL BOARDS must be supplied with the normal operating voltage
- OUTSIDE WEATHER CONDITIONS, DIFFERENT FROM THOSE CONSIDERED ATTHE DESIGN STAGE, must be assessed and made allowance for so as to ensure that the inspection is reliable.

5.2. INSPECTION PROCEDURES

5.2.1. Power board

Inspect the motor control board and check that the motor protection devices are sized for the maximum amperage corresponding to the rated value.

If the protection devices are sized for an amperage in excess of the rated value, you must make sure that the working range is sufficient.

5.2.2. Flowrate check

- Using an oil or water column pressure gauge or an analogue and/or digital gauge, check the FLOW RESISTANCE in the various filtration sections and consequently their fouling factor. The TREATED AIR FLOW can be determined with a good degree of precision on the basis of the filters' operating curve and the working life considered at the design stage.

To make this check you must first take pressure readings at the PRESSURE POINTS in front of and behind each filtration section (on request, TCF can provide the relevant attachments during manufacture)
- Compare the flow rate value obtained as described above with the value obtained from the following formula:

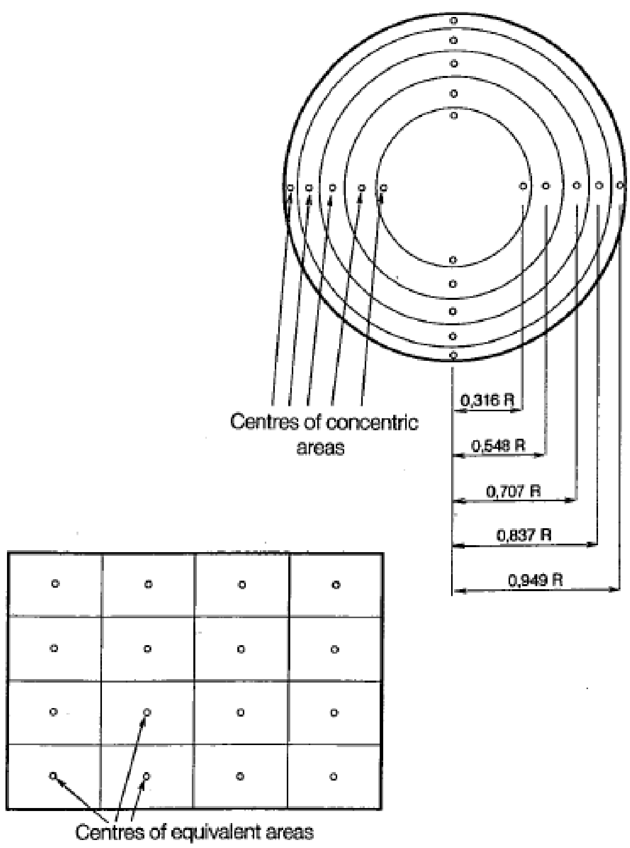
Q = 3600xSxV where:
Q = flow rate in m“/h
V = air velocity in Ws
S = passage area in m^2
The velocity value "V" can be measured with hot-wire or revolving-vane anemometers.

You must deduct from the front area of the grilles or inlets the area lost through the presence of the conveying fins in order to consider just the NET PASSAGE SECTION. The area occupied by the fins can be obtained from the technical specifications and is, on average, approximately 15% of the total area.

In order to take VELOCITY MB\SUREMENTS with the HOFWIRE ANEMOMETER, holes of sufficient diameter to allow the introduction of the telescopic probe must be made in the ducts.

You should select straight duct sections at least 2.5 equivalent diameters in length or as far away as possible from obstructions or points of probable turbulence. In order to obtain reliable flow rate measurements, a PERFORATED GRID must be made in the duct according to the "point sampling" method shown in fig. 33.

Fig. 33



The more turbulent the air flow in the duct (evaluated by broad deviations between one measurement and the next) the denser the meshes in the sampling grid will be.
The REFERENCE MEASUREMENT is the arithmetic mean of the measurements taken.

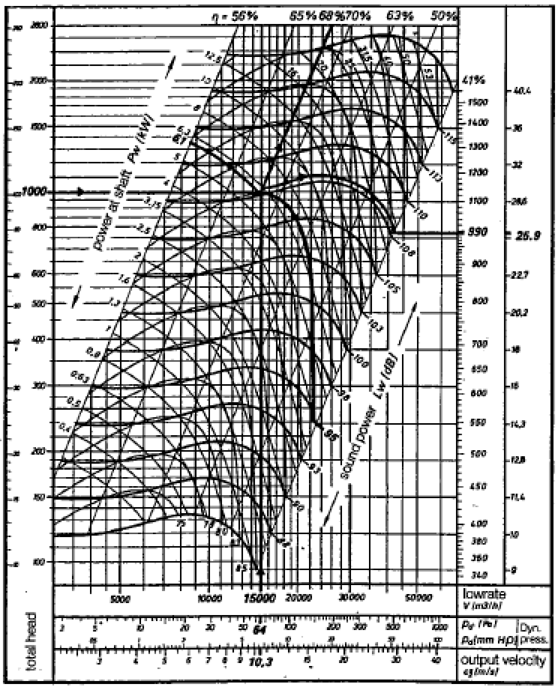
Using a REVOLVING-VANE ANEMOMETER a series of VELOCITY MEASUREMENTS must be taken on the external air intakes (if the Unit is configured for outside air only) or at the intake grilles or delivery inlets.
The revolving-vane anemometer is not reliable for measurements related to anemostatic or high-induction diffusers.
The revolving-vane anemometer is recommended when measurements are taken on a maximum of 2 or 3 intake grilles so as to avoid summing together measurement errors that would lead to an unacceptable calculation of the hourly flow. It is therefore clear that, for measurements on 4 or more diffusion inlets, the reliability of the measurement is compromised and may only be used as an approximate reference or as a rough check on more accurate measurements made at one or two positions on the intake duct

- The TCF Technical Department recommends you double-check the flow rate results obtained as described above, using the characteristic curve of the fan wheel used (graph 1 shows an example):
- identify the curve corresponding to the fan's rpm.
- identify the curve corresponding to the absorbed power at the shaft (P), previously calculated using the formula:

$$P\,(KW) = \frac{V \times I \times \eta \times \cos\rho \times \sqrt{3}}{1000}$$

V = potential difference [V]
η = current intensity [A]
ρ = efficiency
r = phase angle

GRAPH 1



The CURRENT INTENSITY measurement of the fan motor units under operating conditions should be made on the remote control power switches inside the control board, using an amperometer clamp.
Under no circumstances must the measurements be made directly on the motor terminals since this is possible only with the inspection door open, a condition that would alter the length of the air circuit and therefore the working point of the fans.

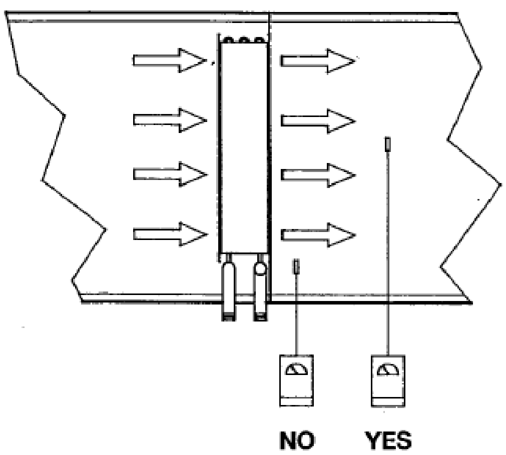
- Descend vertically from the point of intersection of the power and rpm curves to obtain the FLOWRATE value on the x-axes.

5.2.3. Checking heat exchanger efficiency

Check the EFFICIENCY OF THE HEAT EXCHANGERS by measuring the temperature of the air and the carrier fluid at the inlet and outlet with temperature gauges fitted with telescopic contact probe. These measurements may be made only after you have checked:
- correct connection to the distribution circuits (section 4.2.
- complete de-aeration of the circuits
- compliance of fluid temperature values with the design values
- proper operation of the electronic adjustment
- correct opening and closing of the mixing valves and the other exchanger control devices installed (diverter and check valves, ON/OFF or modulating servomotors on air locks, etc).

The AIR TEMPERATURE MEASUREMENTS must be made with a telescopic temperature gauge through holes made in the unit ducts or panels upstream and down-stream of the exchangers to be checked.
The sensitive element of the temperature gauge must be placed inside the duct or the Unit so that it is directly in the path of the air flow, avoiding "dead zones" (e.g. by the walls on the heat exchanger manifolds) which would falsify the measurements (fig. 34).

Fig. 34



On completion of the operation CLOSE THE HOLES made with plugs.

5.2.4. Humidification system check

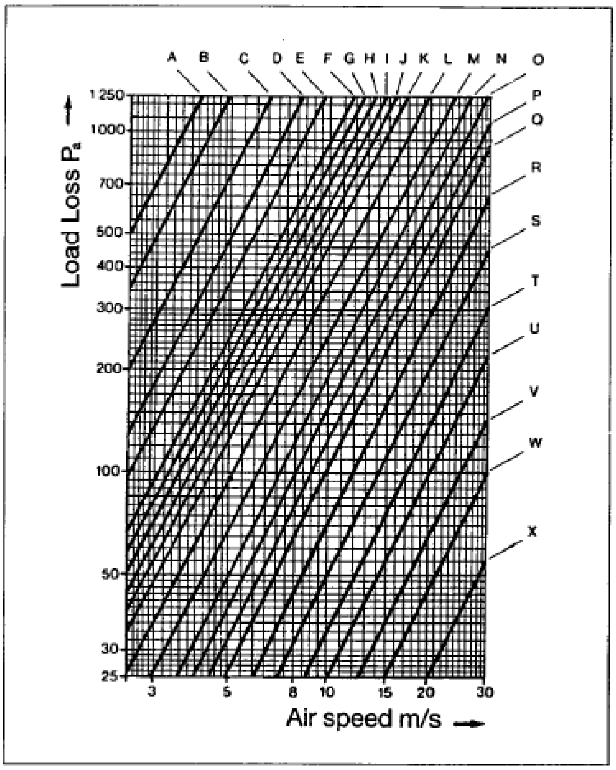
- Check that the humidification system is functioning correctly, and particularly the exact humidistat or regulator electrical connection to ensure that the system comes into operation if the relative humidity in the environment drops in relation to the set-point, and vice versa. As with every other control feature, you must therefore simulate different values on the regulators or humidistats to check the activation of the pump, the submerged electrode steam generator or any other component involved in the treatment
- Check the correct siphoning of the drains (section 4.4.).

5.3. CORRECTION OF FLOW RESISTANCE VALUES IN CIRCUITS AND ADJUSTMENT OF FAN AIR-MOVING PERFORMANCE

MODIFICATIONS TO THE AIR-MOVING CIRCUIT may sometimes be necessary during installation as a result, for example, of dimensional or routing requirements that cannot be anticipated at the design stage.
These modifications frequently result in increasing the number and type of factors that affect fan performance. Hence the need to approximate as realistically as possible the SYSTEM CHARACTERISTIC CURVE, accurately recalculating the new flow resistance values and introducing e correction factor.
On the basis of its thirty years' experience in the field, TCF Technical Department uses and recommends the SE (SYSTEM EFFECTS) ADDITIONAL FLOW RESISTANCE SYSTEM based on the charts developed by AMCA (AIR MOVING AND CONDITIONING ASSOCIATION).
To calculate the additional flow resistance a graph is used which presents a family of straight lines on logarithmic velocity/flow resistance coordinates. Each line, which is identified by a different letter of the alphabet, represents an abnormal situation that determines an additional flow resistance.

AMCA lists the adverse installation situations and indicates the letter corresponding to the straight line in the SE graph with which to determine the additional loss factor. The flow losses Pa are calculated on the SE graph as follows:
- enter the x-axis
• with the fan output velocity V if the obstruction is on the delivery side
• with the fan input velocity V if the velocity refers to the intake side

GRAPH 2
Graph taking account of the System Effect (SE) (AMCA)



- ascend vertically to the straight line representing the abnormal installation situation
- move horizontally to the y- axis to read off the Pa value.

5.3.1. Insufficient length of diverging duct section between unit delivery inlet and obstruction

In the event that a given accessory has been installed at such a distance from the delivery inlet as not to allow the complete expansion of the air flow in the duct, abnormal conditions quantifiable using the SE METHOD may arise. In order for the air flow to expand and occupy the entire duct section, a straight line distance is required equal to:
L>= 2.5 equivalent diameters (low/medium velocity ducts
L >= 6 equivalent diameters (high velocity ducts with V >= 30 ITT/S)

Table 3 shows the value of the equivalent diameters for rectangular ducts.

TABLE 4
Rectangular ducts - Equivalent diameters with the same friction loss and air flow

a \ b	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1200	1400	1600	1800
150	210	230	245	260	275	290	300	310	320	Equivalent diameters										
200	245	265	285	305	320	340	350	365	380	390	400	415								
250	275	300	325	345	365	380	400	415	430	445	455	470	480	495	505	520				
300		330	365	370	400	425	440	460	475	490	505	520	535	550	560	575	620			
350			380	410	435	455	475	495	515	535	550	565	585	600	615	625	680	725		
400				440	465	490	515	535	555	575	590	610	625	645	660	675	730	780	830	870
450					490	520	545	565	590	610	630	650	670	685	705	720	780	835	885	935
500						545	575	600	625	645	665	685	710	725	745	780	830	880	940	990

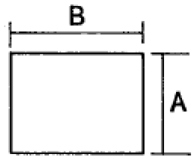


Table 4 shows the LETTER TO BE USED IN THE SE GRAPH to determine the additional loss Pa in the case in question.

TABLE 5

«System Effect» (SE) due to the connector fitting between delivery inlet and duct.					
	No fitting	PLN=12%	PLN=24%	PLN=50%	PLN=100%
Dynamic pressure recovery	0%	50%	80%	90%	100%
Se/Sp	Corresponding line on SE graph				
0,4	P	R-S	U	W	–
0,5	P	R-S	U	W	–
0,6	R-S	S-T	U-V	W-X	–
0,7	S	U	W-X	–	–
0,8	T-U	V-W	X	–	–
0,9	V-W	W-X	–	–	–
1,0	–	–	–	–	–

PLN: Represents the percentage of the straight line length required for complete expansion of the air flow leaving the fan unit

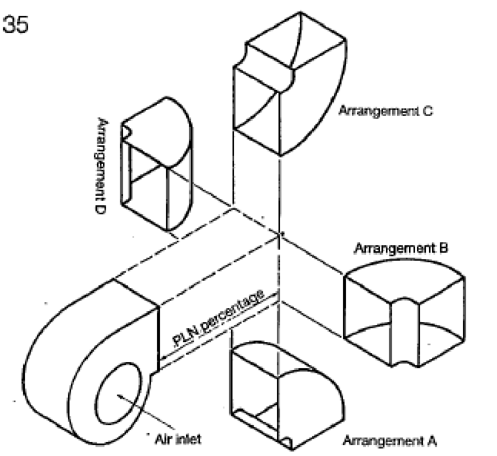
Se: Area of the fan delivery inlet actually affected by the air flow (value specified in manufacturer's catalogue)

Sp: Area of fan delivery inlet.

5.3.2. Elbows

The FLOW RESISTANCE connected with the presence of elbows in the ducting depends:
- on their arrangement
- on the PLN value
- on the fan unit installed

Fig. 35



The proposed typology refers to a simple suction fan

Table 5 shows the letter corresponding to the straight line in the SE graph to be used to obtain the additional flow resistance value Pa, depending on:
- the Se/Sp ratio
- the arrangement of the elbow (fig. 35)
- the PLN value.

TABLE 6

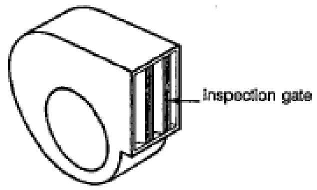
«System Effect» (SE) due to the installation of an elbow on the delivery inlet of a fan.						
Se/Sp	Elbow arrangement	No fitting	Fitting with PLN=12%	Fitting with PLN=25%	Fitting with PLN=50%	Fitting con PLN=100%
0,4	A	N	O	P-Q	S	No System Effect
	B	M	M-N	O	R	
	C	L-M	M	N	Q	
	D	L-M	M	N	Q	
0,5	A	P	Q	R	T	
	B	N-O	O-P	P-Q	S	
	C	M-N	N-O	O-P	R-S	
	D	M-N	N-O	O-P	R-S	
0,6	A	Q	Q-R	R-S	U	
	B	P	Q	R	T	
	C	N-O	O-P	P-Q	S	
	D	O	P	Q-R	S-T	
0,7	A	S-T	T	U	W	
	B	R-S	S	T	V	
	C	Q-R	R	S	U-V	
	D	R	R-S	S-T	U-W	
0,8	A	S	S-T	T-U	V-W	
	B	R	R-S	S-T	U-V	
	C	Q	Q-R	R-S	U	
	D	Q-R	R	S	U-V	
0,9	A	S-T	T	U	W	
	B	R-S	S	T	V	
	C	R	R-S	S-T	U-V	
	D	R-S	S	T	V	
1,0	A	R-S	S	T	V	
	B	S-T	T	U	W	
	C	R-S	S	T	V	
	D	R-S	S	T	V	

5.3.3. Control air locks

Table 6 shows the MULTIPLIERS TO BE APPLIED TO THE AIR LOCK FLOW RESISTANCE VALUES according to the Se/sp ratio, should the locks be installed on the delivery inlet. If the air locks are supplied by TCE consult the "SAL" air lock technical bulletin.
Abnormal situations in relation to the reference standard may also occur on the intake and are basically connected with;
- the possible formation of eddies caused by curves in the inlet conduit in conflict with the fan wheel rotation
- choking on the intake elbows
- the installation of containment housings around the fans
- more generally, the installation of accessories such as drive protection guards, flow rate control locks, etc.
For all these evaluations and any others, all the AMCA PUBLICATION 201 FANS AND SYSTEMS technical documentation is available from the TCF Technical Department. However, we would advise customers to contact cur specialist personnel for a rapid, expert service during inspection. The fan units will be adapted to the new requirements by adjusting the drive ratios. In this respect our Customer Service is always on hand to carry out the necessary jobs.

TABLE 7

Multipliers to be applied to the flow resistance values indicated by the manufacturer in the event of installation of the control air locks on the ventilator delivery inlet.



Se/Sp ratio	Flow resistance multiplier
0,4	7,5
0,5	4,8
0,6	3,3
0,7	2,4
0,8	1,9
0,9	1,5
1,0	1,2

6. MAINTENANCE

6.1. FOREWORD

TCF recommends that its customers carry out preventive maintenance on the Air Treatment Units in order to ensure long-term efficiency. These units require little maintenance and have been designed to make each operation as easy and safe as possible.

6.2. FILTRATION SECTIONS

The filtration sections require the most frequent maintenance in order to:
- ensure that the air is filtered with the required efficiency in the conditioned environment
- to prevent unit components from being damaged.

6.2.1. Reconditionable synthetic filters

These are cells measuring 50 or 1 O0 mm in thickness, also known as PREFILTERS, which offer the advantage of being reconditionable. The RECONDITIONING can be performed using two different methods, depending on the type of dust treated:
- In the case of DRY DUSTS, a compressed air jet is directed against the filter in the opposite direction to normal operation.
- In the case of WET DUSTS, the filtration diaphragm is washed (without removing it from the frame), if necessary using domestic detergents.

To avoid damaging the filter the temperature of the water must not exceed 50°C. Do not use solvents or caustic soda. Let the diaphragm dry by evaporation and refit it only when it is perfectly dry.

TCF advises you to CHECK THE CONDITION OF THE FILTERS ON A WEEKLY BASIS.

THE PREFILTERS MUST BE RECONDITIONED EVERY 7-20 DAYS depending on the type of environment being conditioned. After 7-10 reconditioning operations, the diaphragm deteriorates and its original characteristics will be impaired; it should therefore be replaced.

6.2.2. Metal filters

These are filters of considerable strength and long service life (especially if the mesh is stainless steel). You should inspect them visually to decide when they need replacing. THESE FILTERS MUST BE RECONDITIONED AT LEAST ONCE A WEEK since they generally treat extremely impure air (greasy and highly laden with particles).

The RECONDITIONING consists in washing the filters, if necessary with solvents and caustic soda mixtures.

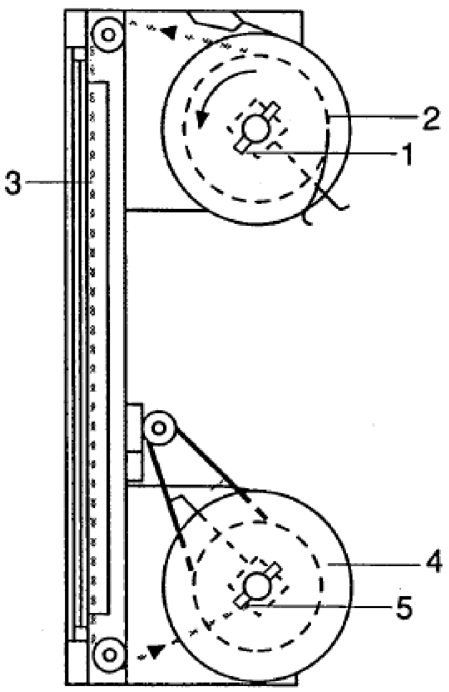
The filtration diaphragm may be dried with warm air or compressed air.

6.2.3. Rotary filters

The rotary filters installed in the TCF Air Treatment Units come complete with control board and differential pressure switch.
The MAINTENANCE OPERATIONS to be performed periodically are as follows:
- cleaning and lubrication of the gears: every 6 months
- drive chain tension check: every week
- replacement of fouled filtration diaphragm: if the equipment spare has been consumed.

To replace the diaphragm, proceed as follows (fig. 35):
- stop the system by turning off the control board master switch:
- after retrieving the check pin (1). extract the empty clean filter roller (2) and replace the filtration diaphragm (3)
- refit the full clean filter roller (2), check the correct direction of air flow and make sure that the pin (1) has been reintroduced on the reduction gear motor side
- roll out the clean filtration diaphragm until the end of the dirty diaphragm hooks onto it
- using the manual control, rewind the whole of the dirty filter onto the relevant roller (4)
- after retrieving the check pin (5), extract the dirty filter miler (4) and remove the diaphragm
- after replacing and blocking the empty dirty filter roller (4), fasten the clean diaphragm (3) to it using the spring
- make sure that the system functions correctly using the manual control. If it does not, check the operations performed
- lastly. set the control panel switch to automatic.

Fig. 35



6.2.4. Reconditionable bag filters

These are non-rigid filters with EU3-EU4 efficiency THEY CAN BE RECONDITIONED using two different methods.
- With a vacuum cleaner, after removing the filter from the Unit on the air inlet side.
- If this method is used the filter can be reconditioned from 7 to 1 O times, after which the filter's efficiency and accumulation capacity is impaired
If this method is not sufficient to remove impurities from the filters, proceed as follows:
- extract the filters from the unit and, holding them with the aperture uppermost, rinse them with a weak jet of warm water (50°C max), letting the impurities run out at the bottom through the filtration diaphragm
- let the filters dry thoroughly by evaporation before refitting them. Do not use air jets to dry them.
In this way the filters can be cleaned 2-3 times, after which the filter's characteristics will be compromised and it will have to be replaced.

6.2.5. Non-reconditionable medium-high efficiency filtration sections

This category includes BAG FILTERS with efficiency equal to or in excess of EU5, and ABSOLUTE FILTERS.
They are characterised by an initial, clean filter loss and by a final loss beyond which the filter loses its accumulation capacity and original efficiency and must be replaced. The filter must be replaced when it reaches a loss level between the two points specified above. This loss is fixed at the design stage on the basis of the following considerations:
- it must not be high so as to prevent imbalances in the system
- it must not be low to give the filters a sufficient service life
THE REPLACEMENT LOSS CAN BE MEASURED WITH A DIFFERENTIAL PRESSURE SWITCH. The recommended values are shown in table 8.

6.2.5.1. Non-reconditionable bag—filters

These are filters with an efficiency of between EU5 and EU9. THEY CANNOT BE RECONDITIONED as this would damage their accumulation capacity and efficiency.
In order to preserve the filtration diaphragm for as long as possible, the condition of the pre-filters must be monitored carefully. Moreover, TCF recommends you check the state of the gaskets on the frames and the springs every week to prevent air passing the bag without being filtered.

6.2.5.2. Absolute filters

These have an efficiency of between EU1O and EU14.
In order not to harm the very fine filtration capacity that the filter in question is required to ensure, you must check, on at least a weekly basis, the condition of the gasket between filter and frame as well as the rigidity of the assembly. ABSOLUTE FILTERS CANNOT BE RECONDITIONED and must be replaced when the preset loss has been reached.

6.2.5.3. Replacement loss chart

TABLE 7. Replacement loss

FILTER TYPE	INITIAL dH (mm)	FINAL dH (mm)	RECOMMENDED REPLACEMENT (mm)
— SYNTHETIC BAG FILTERS			
EU 4	15	30	25
EU 5	9	20	15
EU 7	11	23	15
EU 9	14	30	20
— RIGID BAG FILTERS			
EU 6	10	45	30
EU 7	10	60	30
EU 9	13	80	30
— SEMI-ABSOLUTE FILTERS			
EU 12	25	100	50
— CHANNELLED FLOWS			
EU 13	25	60	40
— LAMINAR FLOW			
EU 14	20	60	40
— MULTIDIHEDRAL			
EU 13	25	100	60

6.2.6. Active carbon filters

The degree of deterioration of active carbon filters is difficult to determine since it depends on the concentration and type of aerosol in the air to be deodorised. In order to maintain efficient deodorisation, TCF recommends that the filters be replaced every 30-40 days.

TABLE 8
Capacity of active carbon filters to adsorb certain substances

CLASS 1	CLASS 2	CLASS 3	CLASS 4
Ethyl acetate	Acetone	Acetaldehyde	Acetylene
Acrylic acid	Hydrocyanic acid	Hydrochloric acid	Hydrogen
Lactic acid	Hydrogen iodide	Nitrogen dioxide	Carbonic acid
Butyl alcohol	Methyl alcohol	Propane	Methane
Acetic anhydride	Sulphur dioxide	Hydrobromic acid	
Benzol	Methyl bromide	Hydrofluoric acid	
Camphor	Ethyl chloryde	Ammonia	
Decane	Hexane	Butane	
Gasoline	Pentane	Sulphurous gases	
Heptane	Carbon sulphide		
Iodine	Methyl acetate		
Kerosene	Formic acid		
Naphthalene	Nitric acid		
Nitrobenzene	Chlorine		
Nitromethane	Methyl chloride		
Octane	Toxic gases		
Toluene	Hydrogen sulphide		
Butyl acetate	Sundry solvents		
Acetic acid			
Sulphuric acid			
Ethyl alcohol			
Aniline			
Bromine			
Chloroform			
Butyl chloride			
Cyclohexane			
Hydroform			
Menthol			
Nicotine			
Ozone			
Xylene			

CLASS 1 - GOOD ADSORPTION
CLASS 2 - AVERAGE ADSORPTION
CLASS 3 - POOR ADSORPTION
CLASS 4 - NO ADSORPTION

6.3. HEAT EXCHANGERS

6.3.1. Water exchanger

In order to maintain an optimum water/air heat exchange, the following MAINTENANCE OPERATIONS must be performed regularly on the exchangers:
- At the beginning of each operating season, remove the air present in the exchanger circuit using the relevant air valve.
- At the beginning of each operating season, remove dust and deposits from the finned block. Proceed as follows:
• use a jet of compressed air in the opposite direction to the air flow during normal unit operation
• or wash the finned block with water, non-corrosive components and a wire brush
- Remove any deposits from the condensate and drain trap. This operation must be repeated every month in order to prevent flooding of the machine and the room in which it is installed.

To avoid causing irreparable damage to the heat exchangers, you must make sure that the primary fluid will not risk freezing with the arrival of winter. For this purpose TCF recommends the following steps:
- In the case of prolonged idleness of the heat exchanger circuits, they should be completed drained
- Where an anti-freeze system based on heating elements is provided to protect the exchanger, make sure that the control board is constantly powered up
- On systems operating with anti—freeze, check its efficiency and top up or replace as necessary.
ANTI-FREEZE LIQUID MUST NEVER BE INTRODUCED INTO A CIRCUIT NOT SPECIFICALLY SIZED FOR THE PURPOSE as it would impair pump operation and heat exchanger efficiency.

6.3.2. Extraction of heat exchangers

Because there is frequently insufficient room for the operator, it is not always possible to carry out the necessary maintenance on the heat exchanger while it is installed in the Air Treatment Unit.
In these cases the exchanger must be extracted and this operation calls for the greatest care. To remove the exchanger you must:
- make sure you have enough room for the removal and temporary accommodation of the heat exchanger
- consider that an ordinary Cu/Al heat exchanger has a mass of approximately 10 kg/m2 of frontal area per rank; therefore, prepare supports if you think it necessary
- completely drain the heat exchanger
- remove the Unit panel covering the hydraulic connections and the panel through which the exchanger will be removed
- release the heat exchanger by undoing the relevant clamps and extract it
- on completion of maintenance, restore the ideal exchanger operating conditions.

6.3.3. Steam exchanger

With regard to general maintenance operations, follow the steps described in 6.3.1.
In order to perform maintenance work on an Air Treatment Unit with steam heat exchanger in absolute safety, you must make provision for the automatic shut-off of the steam supply in the case of motor fan unit stop.

6.3.4. Direct expansion exchanger

With regard to general maintenance operations, follow the steps described in 6.3.1.
TCF recommends you check, on at least a weekly basis, that there are no gas leaks from the distribution heads. In the event of gas leaks, the COOLING CHARGE would be lost and the whole system compromised.

6.4. HUMIDIFIER SECTIONS

An efficient humidification system has a limited life that depends on various factors, including:
- the type of operation (expendable, with circulation, cell block, spray nozzles, steam, compressed air)
- the total hardness of the feed water (section 4.3.1)
- the dust concentration in the treated ain i.e. the Unit's filtration efficiency.

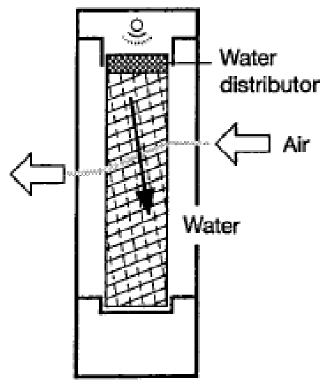
6.4.1. Humidification with spray nozzles

It is advisable to CHECK EVERYWEEK THAT THE SPRAY NOZZLES FORM A REGULAR GONE-SHAPED JET.
In the case of scale you must:
- remove the malfunctioning nozzles from the distribution ramp
- clean the nozzles on if they are damaged, replace them with others that have the same characteristics
- restore proper working conditions prior to restarting the humidification system.

6.4.2. Humidification with cell block

BEFORE EACH WORKING SEASON, in order to avoid interruptions, you must visually check that the cell block is evenly wetted; if you observe water jets on its surface you must restore an even water flow by adjusting the valve.
THE CELL BLOCK CANNOT BE RECONDITIONED.
When it is fouled you must replace it as follows:
- stop the electrical pump
- cut off the water feed using the relevant gate
- let the block dry completely, keeping the fan in operation
- remove the frame housing the block by undoing the securing screws and lift it out of the unit through the inspection door
- extract the fouled block from the housing and replace it with another of the same size. Take care with the direction of fluid flow: the water which runs along the veins of the block must intersect the air flow in reverse current (fig. 36)
- Check the condition of the distributor tube and, if necessary, replace it
- Restore proper operating conditions before restarting the humidification system.

Fig. 36



6.4.3. Humidification with circulating pump

- AT THE START OF EACH WORKING SEASON, in order to keep the humidification system in efficient condition, you must check that the pump is working properly. If it is not, remove and clean it. If the pump still does not work properly after cleaning, you must replace it.
- Make sure that the water level inside the tank is 20-30 mm below the overflow to avoid flooding and ensure the pump has a sufficient water head. If the pump sucks in air, it will overheat and sustain irreparable damage. If necessary, adjust the float to maintain the correct water level
- To prevent flooding of the machine and the installation room, remove any scale and sludge that might obstruct the drain every month.

6.4.4. Ultrasonic, steam (submerged electrodes), compressed air humidifiers .

For Air Treatment Units with these types of humidification system, consult the TECHNICAL MANUAL supplied with the humidifier

6.4.5. Steam humidification with submerged heating elements

In order to preserve the heating elements, maintain the efficiency of the humidification system and prevent over-flows and flooding of the installation site, you must perform the following steps at least once a month:
- check that the microswitch is working properly
- remove any deposits from the elements and the tank.

6.5. FAN SECTION

6.5.1. Fan

In order to keep the fan in perfect working order WE RECOMMEND YOU CHECK THE FOLLOWING AT LEAST ONCE A MONTH:
- The cleanliness of the screw and wheel; remove any deposits
- Damage and corrosion to the fan components; remedy with zinc-powder paint
- The tightness of the parts comprising the fan section
- Seal of the vibration-damping joint fitted to the fan delivery inlet
- Cleaning and lubrication of any DAPO' control air locks.
Lubrication of this part must be performed every six months.
- Absence of abnormal noise due to deterioration of the bearings. if necessary, replace them. The fans mounted on the TCF Units are fitted either with oilless bearings (design life 2000 hours) or pedestal bearings. depending on the operating conditions. The pedestal bearings require periodic lubrication. THE LUBFIICATION INTERVALS shown in Table 1 0 are subject to the environmental conditions and the maximum temperature range during operation.

TABLE 9
LUBRICATION OF FAN PEDESTAL BEARINGS

ENVIRONMENTAL COND.	TEMP. RANGE °C	LUBRICATION INTERVALS
CLEAN	UP TO 50	6 ÷ 12 MONTHS
	50 ÷ 70	2 ÷ 4 MONTHS
	70 ÷ 100	2 ÷ 6 WEEK
	100 AND OVER	1 WEEK
DIRTY	UP TO 70	1 ÷ 4 WEEKS
	70 ÷ 100	1 ÷ 2 WEEKS
	100 AND OVER	1 ÷ 7 DAYS
MAXIMUM HUMIDITY		1 WEEK

RECOMMENDED GREASE:
MOBILUX3 (MOBIL), ALVANIA GREASE3 (SHELL), BEACON3 (ESSO)

6.5.2. Motor

In order to maintain the motor in perfect working order, TCF recommends the FOLLOWING MONTHLY CHECKS:
- Cleanliness; remove any deposits
- Absence of abnormal noise due to deterioration of the bearings.
Powerful motors fitted with grease nipples require periodic lubrication. The greasing intervals, under normal operating conditions, are shown in Table 11.

TABLE 10
Greasing of motor bearing

MOTORE RPM	—	3000	1500	1000	750
GREASE EVERY (HOURS)	—	5000	10000	20000	25000

NOTE: The bearings must be greased more frequently in harsh operating conditions.

6.5.3. Drive

In order to ensure optimum drive efficiency and to avoid damaging the fan motor unit, the drive must be kept in perfect working order.
The following must be CHECKED EVERY MONTH:
- The operating condition and dirtiness of the drive; remove any deposits
- Damage to the drive (cracks on belts and pulleys, frayed belt edges, worn belts and pulleys). If necessary replace the damaged part(s)
- Perfect alignment of the drive
- Belt tension (see section 6.5.4.).

6.5.3.1. Determining belt tension

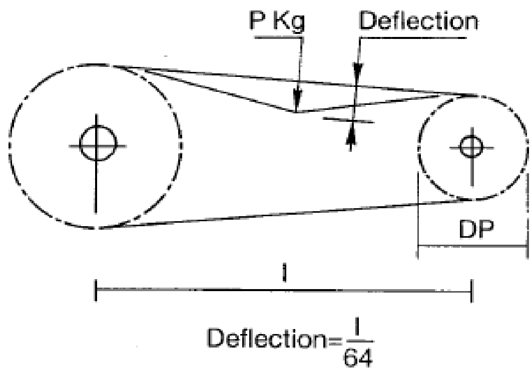
To alter the tension of the driving belts you must move the motor. To facilitate this operation the motors are positioned on;
- guides
- belt-tensioning slides.
In both cases it is easy to tighten or slacken the driving belt by means of the lock nuts and adjusting screws.

In order to determine DRIVING BELT TENSION, you must:
- establish a centre distance (I) and block the drive
- using a spring-operated torque wrench, apply a force (P) on the midway point of the belt (perpendicular to it) to obtain a deflection equal to 1/64 of the centre distance (approximately 16 mm/m)
- check that the force applied is within the values indicated in table 12. Otherwise, set a new centre distance and repeat the test.

TABLE 11

BELT SECTION	MINOR PULLEY DIAMETER (mm)	FORCE P (daN)
A	70 ÷ 120 125 ÷ 180	9 ÷ 15 13 ÷ 18
B	112 ÷ 140 150 ÷ 225	18 ÷ 26 23 ÷ 30
C	180 ÷ 225 250 ÷ 400	36 ÷ 53 48 ÷ 70
SPZ	67 ÷ 90 95 ÷ 150	11 ÷ 20 17 ÷ 25
SPA	90 ÷ 132 140 ÷ 224	20 ÷ 35 30 ÷ 45
SPB	140 ÷ 224 236 ÷ 355	35 ÷ 50 43 ÷ 65

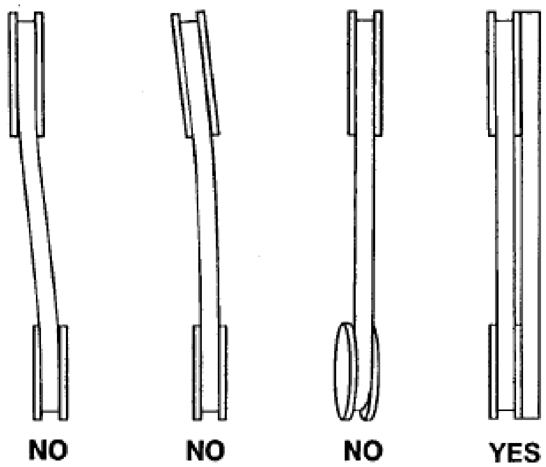
Fig. 37



if the tension is not correct, the following will occur:
- if the belt is slack, it will wear rapidly and the drive system will be inefficient
- if the belt is too taut, the motor and fan bearings will be damaged.

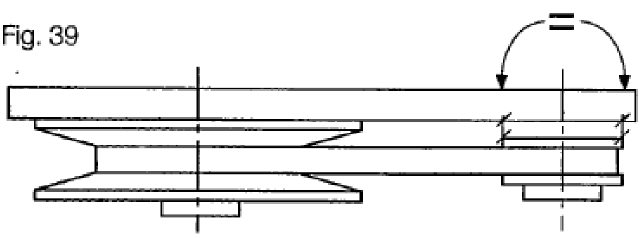
Whenever the belts are tensioned, you must check that the drive belts are aligned using an ordinary RULER. (fig. 38).

Fig. 38



If the pulleys are of different thickness, you must check their equivalence as shown in fig. 39 to ensure correct installation.

Fig. 39



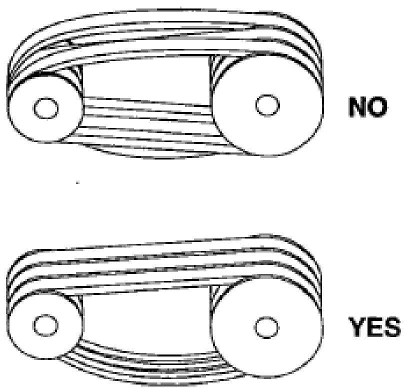
6.5.3.2. Driving belt replacement

To replace THE DRIVING "V" BEL`T:
- Loosen the drive and remove the worn belt
- Check the condition and wear of the pulleys and replace them if necessary
- introduce the new belt without forcing; any forcing could impair the drive and shorten its service life
- align the drive and tension the belt
- check the belt tension after about 10 hours in service.

6.5.3.3. Drive with multiple race pulleys

- In the case of drives with several belts, the belts must be replaced at the same time. This means that there must not be belts presenting different states of wear in the same drive system
- the number of belts must always match the number of races
- in this type of drive system, the belt slack must be on the same side, as shown in Hg. 40, before they are tensioned.

Fig. 40



6.6. Heat recuperator

6.6.1 . Crossover flow static recuperator

Maintenance on this type of recuperator is confined to CLEANING since it does not have any moving parts. To clean the recuperator:
- remove the dust from the exchanger using a compressed air jet and a wire brush
- remove grease deposits from the finned block with warm water or steam and liposoluble household detergents if necessary
- check the condensate drain every month and remove any deposits.

6.6.2. Rotary recuperator

The heat exchange surface is self-cleaning. However, TCF recommends:
- removing any residue with a compressed ai rjet or steam
- removing any deposits
- replacing the belt, if worn
- checking the physical condition and cleanness of the drive every month.

6.6.3. Heat tube recuperator

Maintenance on this type of recuperator is confined to CLEANING since it does not have any moving parts. Proceed as follows:
- every month check drain operation drain and remove any deposits V
- clean the finned block using either warm water with liposoluble detergents if necessary, or a compressed air jet in the opposite direction to the airflow during normal Unit operation.

6.7. ACCESSORIES

6.7.1. Control air locks

TCF "SAL" control air locks do not require any particular maintenance.
However, we recommend you check the alignment of the gears and the movement of the fins, which must not in any circumstance be deflected by the weight of the ducts.

6.7.2. External air intake grilles

These must be cleaned frequently to remove any deposits obstructing the air passage which would comprise the efficiency of the entire system.

6.7.3. Drip separator

Every month check that there are no deposits of dust or scale that would impair separation efficiency Clean the separator as follows:
- extract the drip separator from the Air Treatment Unit, removing the panel and the screws
- completely dismantle the drip separator and clean each single fin
- restore normal operating conditions, taking care not to bend the fins during separator removal and reassembly.

6.7.4. Silencer

The silencers installed on TCF machines are of the SOUNDPROOFED PANEL type.
They do not require any particular maintenance. Any dust that forms on them should be removed with an ordinary vacuum cleaner.

6.8. TROUBLESHOOTING

The most common MALFUNCTIONS in Air Treatment Units are:
- reduced flow rate
- increased flow rate
- reduction in heat exchanger efficiency
- reduction in heat recuperator efficiency
- reduction in humidifier efficiency
- abnormal noise

6.8.1 . Reduced flow rate

This is the result of an uncontrolled increase in resistance in the air moving circuit which alters the fan's operating point. The most frequent causes are:
- excessively clogged filters
- formation of frost or ice on the front surface of the prefilters in particularly damp and cold climates on Units operating entirely with external air
- blockage of the intake grille(s) (especially external air intake)
- fully or partially closed control air locks
- activation of the dampers
- deposits on cell blocks and heat exchangers
- inefficient fan motor unit drive.

6.8.2. Increased flow rate

If the sum of the resistances in the air-moving circuit is less than the value considered at the design stage, the most common causes are:
- incorrect setting of any mechanical flow controls or zone air locks
- non-replacement of filters after ordinary maintenance operations
- open or partially closed inspection doors.

6.8.3. Reduction in heat exchanger efficiency

The most common causes are:
- clogging of finned block
- formation of air bubbles inside the exchanger
- feed fluids at temperatures lower than the design temperature
- malfunction or breakdown of control valve actuators
- water flow rate below design values.

For steam-operated exchangers:
- malfunctioning of condensate drains
- reduced supply steam pressure.

For cooling gas-operated exchangers:
- malfunctioning of expansion valve
- reduced cooling capacity due to working temperatures different from those envisaged.

6.8.4. Reduction in heat recuperator efficiency

For crossover flow recuperators the causes may be:
- dust and dirt on the heat exchanger block
- clogging due to the presence of foreign matter between the heat exchanger fins
- abnormal bypass of air on recuperator

For two-phase gas recuperators the causes may be:
- dust and dirt on the heat exchanger block
- clogging due to the presence of foreign matter between the heat exchanger fins
- abnormal bypass of air on recuperator
- loss of cooling capacity due to accidental failure

For rotary recuperators the causes may be:
- dust and dirt on the heat exchanger block
- abnormal bypass of air on recuperator
- formation of frost on enthalpic recuperator in particularly damp and cold climates
- broken rotor driving belt or blocked reduction gear motor.

For twin exchanger recuperators the causes may be:
- dust and dirt on exchangers
- formation of air in the circuit
- blocked circulating pump.

6.8.5. Reduction in humidifier efficiency

Depending on the system used, the cause may be:
- scale clogging the spray nozzles
- scale on the cell block
- clogged lifting pump rotor and resulting reduction in water flow rate
- clogged water filter
- malfunction of float.

6.8.6. Abnormal noise

With regard to the fan, the causes may be:
- worn or defective bearings
- fan off-balance
- foreign matter in fan wheel.

With regard to the electric motor; the causes may be:
- worn or defective bearings
- loose cooling fan and/or fan guard
- magnetic noise during frequency reductions with inverter (applications below 22 Hz are not recommended as a rule).

With regard to the drive system, the causes may be:
- slipping of belt
- worn belt
- misaligned pulleys
- pulley with play on key.

In order to remedy the malfunctions listed above (and not the entire conditioning system), CONSULT CHAPTER 6 - MAINTENANCE OR, IF THE PROBLEM PERSISTS, CONTACT OUR TECHNICAL DEPARTMENT

6.9. MAINTENANCE AGREEMENT

On request, TCF Srl is willing to study preventive and annual maintenance agreements on its Air Treatment Units so as to provide the customer with excellent efficiency, purity and hygiene throughout the machine's working life.

7. SAFETY

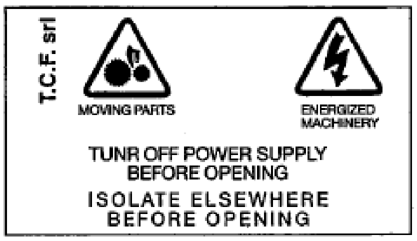
7.1. SAFETY-RELATED FEATURES OF AIR TREATMENT UNIT

TCF Srl has fitted its Air Treatment Units with every possible safety feature to prevent accidents, especially during start-up and maintenance.
Some of these SAFETY FEATURES are listed below:
- INSPECTION DOORS THAT CAN ONLY BE OPENED WITH A KEY are installed in the sections housing rotating parts and drives
- the GRATES and HOUSINGS protecting rotating parts and drives can only be removed with a key
- on Units larger than our model 20, in which the operator can enter the ventilation section for inspection purposes, an ELECTRICAL KNIFE SWITCH is fitted standard inside it. The purpose of the switch is to prevent the fan motor assembly from being activated when someone is inside the Unit
- the outside of the structure has ROUNDED EDGES
- elimination of sharp-edged steel sheet parts inside and outside the Unit
- use of SELF·TAPPING SCREWS WITH NON-PROJECTING TIP inside sections and panels.

7.2. SAFETY NOTICES APPLIED TO THE UNITS

The inspection doors of the Air Treatment Unit carry SAFETY NOTICES drawing the operator's attention to the danger connected with moving parts and warning him to disconnect the system power before opening the inspection doors (Hg.41).

Fig. 41



7.3. Practical accident-prevention tips

- Open the inspection doors only when the fan is at a standstill
- Before carrying out maintenance work on the fan motor unit, make sure that the motor cannot be restarted by accident
- Before working on the motor; make sure that it has cooled completely
- in order to protect your hands, use a lever to remove the belts
- Block the fan wheel before carrying out maintenance work on it, since (especially when the belt is removed) the updraft caused by the ducting could make it turn and cause injury

	CE DECLARATION OF COMPLIANCE	***Mod. 03/13/08***
		Page 01/01
		Date: 20/09/2015

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The undersigned Daniele Negrini,
in quality of legal representative (managing partner) of Company
T.C.F. s.r.l. - via G. Di Vittorio, 5 - 40057 Cadriano di Granarolo E. (BO)
Declares that the following products:

AIR HANDLING UNIT Mod. ZASE

Customer :

Reference :

Order n° :

Construction year :

is in compliance with the following Directives:

2004/108/CE*
2006/42/CE
91/368/CEE
93/68/CEE
2006/95/CE

* IT IS NECESSARY HOWEVER TO VERIFY THAT THE INSTALLATION AND THE DRIVE ARE CARRY OUT TO YOU CORRECTLY AND IN THE RESPECT OF DIRECTIVES EMC 2004/108/CE AND 2006/42/CE.

and to the following Norms:

CEI EN 60204-1
EN 60335-1

and, in application to the Directives cited, has been equipped of CE mark.
The correspondent Technical Dossier is available in our headquarters.

Cadriano, DD/MM/YYYY

STAMP AND COMPANY OF DECLARING

T.C.F. S.R.L.
Via G. Di Vittorio n. 5
40057 CADRIANO di GRANAROLO E. (BO)
Tel. 051 76.50.02 - Fax 051 76.53.17
Partita I.V.A. 00535681209

8. WARRANTY

TCF Srl guarantees its products for 12 months as of the delivery date.
The warranty covers the normal operation of the individual components installed on our units, such as motors, fans, heat exchangers, humidifiers and other parts.
It should be stressed that the warranty covers manufacturing defects in these parts, while their efficiency is categorically excluded since this is determined by the characteristics of the air-moving and hydraulic systems and by the design, and does not therefore fall within our sphere of responsibility.
TCF therefore undertakes to replace any individual component that malfunctions as rapidly as possible and subject to stocks. The part should be sent prepaid to our headquarters and the replacement will be sent carriage forward.
Please note too that the warranty does not include the services of our personnel for the replacement of the part on site; this cost is entirely for the installer's account.
On receipt of the returned material deemed to be defective, an inspection will be carried out to establish whether the part reveals abnormalities justifying application of the warranty lf it is established that the defect is attributable to external factors, it will be charged to the customer.
It should further be noted that the warranty shall not apply in the case of tampering or if the failure results from incorrect installation or connection.
In this regards, reference will be made to the instructions contained in this installation, Operation and Maintenance Manual which accompanies each of our machines.

T.C.F. Srl

TERMOVENTILATORI
CONDIZIONATORI
FELSINEA

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