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VENTUS PRO AIR HANDLING UNITS

OPERATION, INSTALLATION AND MAINTENANCE MANUAL

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1 GENERAL INFORMATION AND SAFETY INSTRUCTIONS

In-depth familiarization with the content of this manual, assembly and operation of the air-handling unit in line with the instructions provided and obeying all safety regulations constitute the basis of efficient, safe and non-failure operation of the device.

Works related to unloading packages with AHU subassemblies, transportation of the packages, AHU blocks and elements, connecting AHU-related systems as well as maintenance and repair are carried out by qualified specialists or they are supervised by authorized staff.

The qualified technical personnel is understood as the trained specialists, who due to the professional experience, knowledge of the subject-related standards, documentation and regulations concerning operation and safety procedures, have been authorized to perform necessary operations and who are able to troubleshoot any potential problems.

This operation and maintenance manual does not cover all possible variants of the units configurations, examples of their assembly and installation as well as start-up, operating, repairing and maintenance. If the units are used for what they are intended, this documentation and any other materials provided with the unit contain information designed for the qualified technical personnel only.



- The air handling unit must be installed, checked, commissioned and maintained only by trained personnel in compliance with technical standards and local regulations.
- Warranty repairs must be performed only by an Authorized Manufacturer Service with appropriate certificates. It is recommended to employ an Authorized Manufacturer Service Center for installation, commissioning, maintenance and repair of AHU Manufacturer units as well.
- It is strictly forbidden to open the inspection panels when the device is operating or in the start-up phase. Before opening the inspection panel, turn off the unit and wait two minutes.
- Until the moving parts of the device stop, turn off the device and secure the power supply so as to prevent the device from being started accidentally.
- Before connecting the electric power supply, check the compliance of the mains voltage and frequency with the data on the name plate of the device. The admissible fluctuations in the supply voltage and its frequency in relation to the values given on the rating plate should not exceed ± 5%.



- For the units which are equipped with freon installation - before installing the device, check the applicable regulations related to the obligations of the heat pump or DX installation owner (an operator) in relation to the need to register the freon installation (see the F-Gas Act)
- The owner of the heat pump or DX installation owner (operator) is obliged to create a Product Card where all inspections, repairs or modifications to the device are recorded.



- The user (owner) of the device is obliged to keep the technical data sheets of the device, which were delivered with the device. The device card should be made available to the services servicing the device.
- VTS reserves the right to implement changes without prior notice.

2 TRANSPORT AND STORAGE

The VENTUS PRO can be delivered as fully assembled, assembled in sections or in packages, placed on closed palettes, containing elements to be assembled on-site by the Manufacturer Authorized Service. This manual does not contain instructions and guidelines on assembly of the unit.

Delivery of AHUs elements, in the closed, properly marked and not broken palettes is going to belong to customer after signing of consignment note by client representative.

Open of closed palettes by customer before arrival of Authorized VTS Service is connect with take-over of full responsibility for contents and completeness of delivery.

Right after delivery of the unit check the condition of the package and examine if all necessary elements have been delivered - according to the attached specification and consignment note.

Unloading packages with AHU subassemblies, transport of the packages to the assembly location

and transport of AHU blocks and elements to the assembly location should be carried out using special equipment and qualified staff.

Packages onsite must be stored on hardened, dry and protected against any precipitation place. Hardened surfaces are understood as flat, leveled and hard surface, which does not change its properties under influence of atmospheric conditions

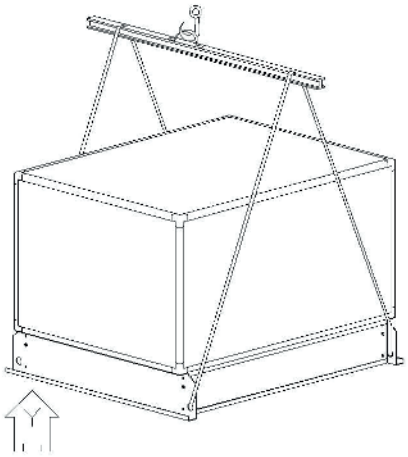
Packages containing AHU elements should be stored away from places where operate mechanical devices (vehicles, cranes and other construction machinery). They should be stored in places where they will not be subject to any mechanical damages, humidity, aggressive chemical agents, fluids, dusts and other external agents which may deteriorate their condition.

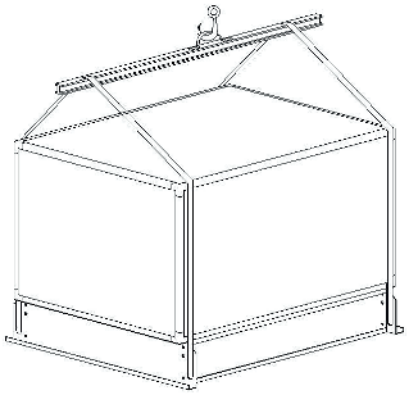
Air handling units are inspected prior to dispatch for good condition and carefully loaded. Special care must be taken while unloading the units.

Air handling units are generally damaged during transportation and loading / unloading, especially when being lifted by a crane. Small units can be transported by hand-powered pallet truck or by forklift truck. While hoisting or lowering, proper lifting equipment (slings and spreaders properly selected

on the ground of the size and weight of the section) should be used not to damage the unit. Safety precautions should also be taken not to tilt and not to drop the unit.

» TYPICAL LIFTING EQUIPMENT





! For the units which are equipped with freon installation - before installing the device, check the applicable regulations related to the obligations of the heat pump owner (an operator) in relation to the need to register the freon installation (see the F-Gas Act)

! The owner of the heat pump (operator) is obliged to create a Product Card where all inspections, repairs or modifications to the device are recorded.

3 FOUNDATION, ASSEMBLY, CONNECTION OF UNIT-RELATED SYSTEMS

3.1 AHU SUPPLIED IN SECTIONS

- ! Sections connection is out of the standard offer of VTS. It is possible to purchase additional option to connect to the section by Authorized Service VTS.
- ! When the customer connect the section by himself should follow the separate instructions, supplied with AHU in the mounting set.
- ! During connecting the section one should pay attention on the applying glue on the casing locks (section connection without using glue will result in a lack of casing tightness - warranty claims because of this will not be considered).
- ! Optionally, in the mounting set provided with AHU can be included butyl tape, to additional seal the connection of section. Additional seal at the connection of section is recommended especially for the external AHUs.

3.2 AHU SUPPLIED IN PACKAGES FOR ASSEMBLY ON SITE

In case of assembly on site:

- ! Assembly must be carried out on hardened and dry surface. Hardened surfaces are understood as flat, leveled and hard surface, which does not change its properties under influence of atmospheric conditions and is resistant to any damages relating to placing the AHU on it as well as regular operation.
- ! Assembly can be carried out in ambient temperature allowing to perform correctly all technical procedures of the assembly, i.e. within temperature range: from +5 to +35°C.
- ! In case of outdoor assembly, the procedure can be carried out in precipitation-free conditions.
- ! It is acceptable to start the assembly provided that all safety and security requirements are met.
- ! Minimum distance of an assembly location:
  - AHU width + 4 meters (2 meters on each AHU side),
  - AHU length + 4 meters (2 meters on each AHU side).

3.3 AMBIENT CONDITIONS FOR AHU INSTALLATION

The Ventus PRO air-handling can be installed as well as inside the building as the outside (except the unit with the humidity sections). Units can be installed and work on the external air with temperature from -40°C to +60°C.

AHUs installed outside the building should be equipped with roof, air intake and air outlet equipment.

The unit operated outdoor should be regularly cleaned from the snow. Such units should have barrier for protect against the snow, and base frame should be placed on the level not lower than height of snow level in that region and relevant regulations.

In condition of the low temperature, the heat lost is increased, It can affect rise of demand for heating.

Controls elements such as: a heat node of the heating capacity regulation, three-way valves, water pumps, thermo-manometers, valves, as well as frequency converters should be placed in the room with temperature higher than +5°C.

If a unit operates with the low inlet temperature of the air, it is recommended to use the mixture of the glycol (up to 45%) as the heating medium. All installation pipes of the water heating, condensate drying, hydraulic valves should be well isolated.

It is recommended to use the pre-heater before the heat recovery section.

The air damper actuators should be protected from the atmospheric conditions.

If the outdoor temperature is lower than -20°C, the air dampers actuators must be equipped with heating elements.

All equipment and components operating outside the unit must have the required IP.

Units, periodically stopped during periods of low outdoor temperatures, require special attention.

A unit shall be equipped with control system, that supports the flow of the liquid through water heaters to prevent it from freezing during AHU downtime.

If it is possible that temperature in the fan section fall below -30°C or lower, the sections should be equipped with an internal heating system to ensure reliable start of the motors after shutdown and downtime.

3.4 CONDITIONS FOR AHU ASSEMBLY CARRIED OUT BY VTS AUTHORIZED SERVICE

The following conditions apply to the delivery of AHUs in packages and orders for the assembly of devices on site by VTS.

» PREPARATION FOR ASSEMMBLING

Before starting AHU assembly VTS shall send to customer a document entitled ‚Confirmation of Readiness for Assembly' (enclosure no 1).

The document contains important information about the installation process. Having satisfied conditions specified in it the document should be signed in the indicated place and sent to the specified VTS office.

! Sending the ‚Confirmation of Readiness for Assembly' is indispensable to start the assembly process by Authorized Service. If real conditions do not correspond to the information given in confirmation VTS shall be entitled to demand reimbursement of the costs incurred due to service stoppages or additional actions performed by the service on site.

» ASSEMBLY SITE

An assembly place should meet the following conditions:

- The right surface – the surface should be hard, dry, protected from atmospheric influence, and damage resistant (placement of the unit, installation works).
- The required installation place area:
  - Width of the unit + 4 meters (two meters on each side of the unit),
  - Length of the unit + 4 meters (two meters on each side of the unit)
- The 230V AC power supply should not be located further than 20m from the installation place which should be properly lit.
- The place of installation shall provide a safe environment for the installation crew.
- The following should be provided:
  - availability of individual AHU elements or pallets including packages on the assembly place of a particular AHU. Ensured transport of AHU elements and AHU blocks to the place of installation,
  - possibility of service entering the site and starting assembly immediately after their arrival,
  - making the Warranty Card and Delivery documents supplied with a particular AHU available to the service

» ASSEMBLY COMPLETION

After the installation is completed the service is obliged to:

- notify the client's representative about the fact of finishing assembly,

- put into service a clean AHU labelled with provided pictograms and VTS labels, ready to be connected to a power source (wiring), utilities and control systems,
- hand control elements over to the client's representative if at his request they were not assembled in the AHU,
- hand a filled in Warranty Card of a VTS AHU over to the Client,
- hand the ‚Assembly Acceptance Protocol' documentation to be signed by the client and provide them with a copy of this document,
- put assembly waste in a place indicated by the client's representative not farther than 20 meters away from the place of assembly,
- leave the assembly place in the state from before the assembly.

VTS on-site assembly does not include:

- setting up of electrical wiring, connection to heating of freezing sources and assembly of exchanger valve,
- connection, assembly and start-up of control elements (except for damper actuators, pressure control and anti-frost thermostat) and engines zeroing,
- placing, balancing and anchoring of air handling units,
- connecting air handling units to ventilation ducts, utilities and electricity,
- start-up of air handling units,
- recycling of containers in which air handling units were delivered.

3.5 INSTALLATION



! During final installation the requirements of EN 60204-1 do apply.

! Before manufacturing air handling unit, the client should check the conditions at site to ensure that access routes are adequate for both size and weight of the unit sections. Air handling unit installation areas should also be checked.

! There should be sufficient space around the unit for servicing, maintenance and piping connections. Further, it must be ensured that the base is high enough from the floor to allow the condensate drain with necessary water trap.

! AHUs must be anchored to the foundation. Anchoring AHUs is out of VTS delivery.

! The AHU should be installed so that connections of any related systems (ventilation ducts, pipelines, cabling, etc.) do not collide with the inspection panels.

! It is forbidden to place any elements on the AHU as well as use the AHU as a support of ventilation ducts and other building components.

The AHU installation clearance is defined by:

- rear side of the unit - minimum space required allowing access and operations on connecting point
- front side of the unit - minimum space require allowing opening access door to position perpendicular to the AHU longitudinal axis
- minimum distance between the front side and existing construction elements in order to carry out the assembly, operation and maintenance successfully.

! In AHUs where the exchangers' connections are led to the side opposite to the access side an appropriate distance required for proper assembly of the power supply installation elements should be maintained.

! There is possible to install other systems, pipelines, pillars in the operation area only if they can be easily disassembled for the maintenance and service procedures.

The outlet condensate connections, led outside the AHU's casing are assembled in the drain plates of coolers, counter–flow heat exchangers (the diameter of drain pan connection pipe is 32mm).

To avoid damage drain pipe of the counter-flow heat exchanger section during transportation, they are not installed and attached separately in the package.

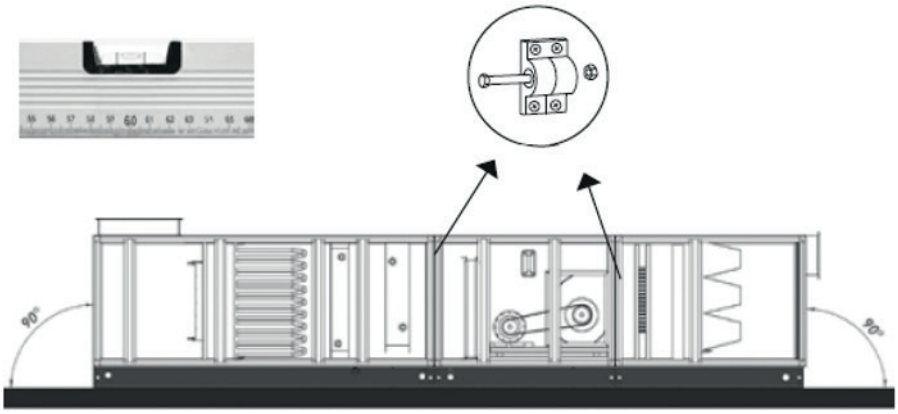
To mount the drain pipe one should unscrew the drilling screws and disassembly header connection glands (magnification (1) in the the below figure), install the pipe on the drain pan connection inside the casing and assembly bach the header glands (2).

Siphons, which are designed to drain out condensed water from the exchangers at different pressure of the section and environment, should be connected to the drain connections.

For proper drainage of condensate from the unit, the siphon on the drain pan connection pipe must be installed in the AHU sections, where negative pressure occurs. Drain siphons or siphon parts are not supplied as standard delivery. There is no need to apply drain siphons in section with overpressure. In order to minimize air blow–by, you can use a siphon on the system draining out condensate, assembling the siphon made in accordance with fig. 5 and table 1.

Siphons usable „H" height depends on the pressure difference between the AHU section, where condensate is drained from during operation and the ambient pressure. „H" dimension is provided in mm and must be higher than the pressure difference expressed in mmH_2O.

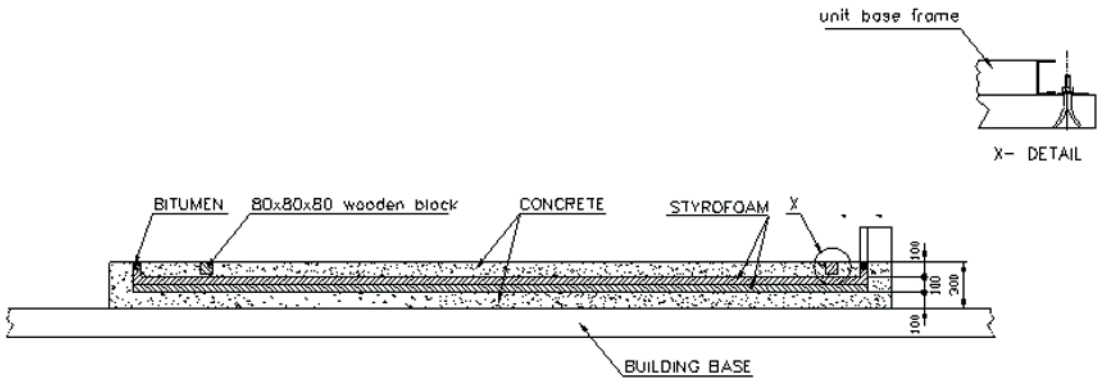
» FITTINGS



! First attach the bolts on the base frame, then section bolts and tighten both with the same order and same torque gradually. Do not use excessive force to align the sections, because it may deform the aluminum framework and casing.

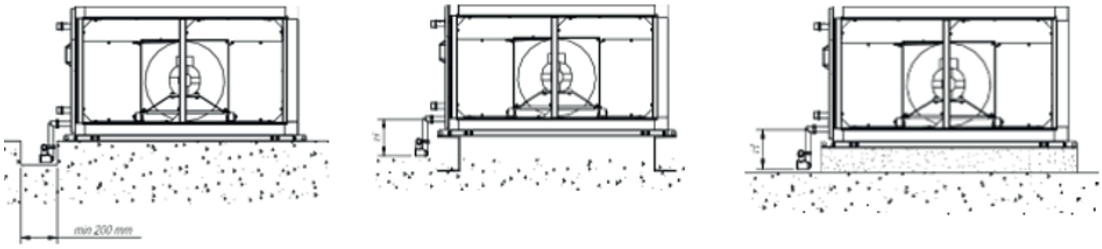
If the air handling unit is to be installed in a place where low vibration and noise is required such as hotels, hospitals etc. it is recommended to install the unit on a floating concrete base, around which is filled with Styrofoam

» TYPICAL AHU CONCRETE BASE



Height of the foundation slab or base frame must allow for assembly of the u-trap which drains the condensate out of the draining tray. In case of the drain plates installed in the lower AHU sections, the unit has to be mounted onto additional foundation slab or a special hollow must be made directly under the u-trap.

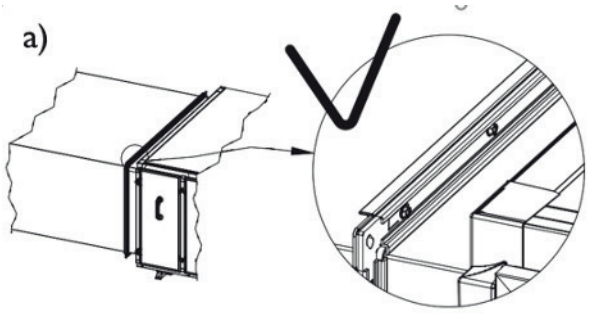
» EXAMPLES OF AHU FOUNDATION



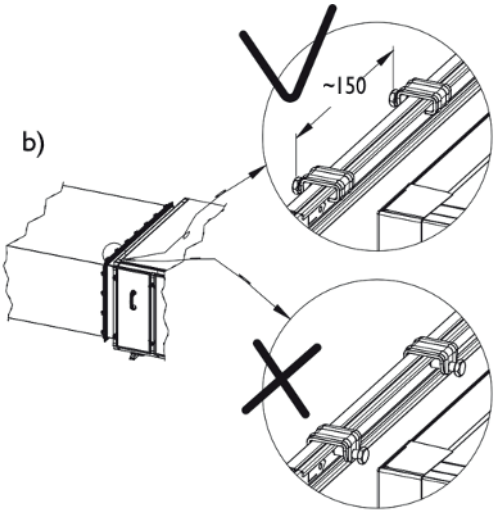
3.6 CONNECTIONS

The ventilation ducts should be connected to the AHU with the flexible connections (optional accessory) which suppress vibrations of the unit and level the coaxial deflection of the duct and the AHU outlets. Flexible connections are equipped with flanges with sealing. The flexible flanges should be connected with ducts with using drilling screws or additional clamping elements. Materials to connect ducts are not supplied as standard delivery.

» Flexible flanges connection using drilling screws



» Flexible flanges connection using clamping elements



! Appropriate operation of the flexible connection occurs if it is stretched to about 110 mm.

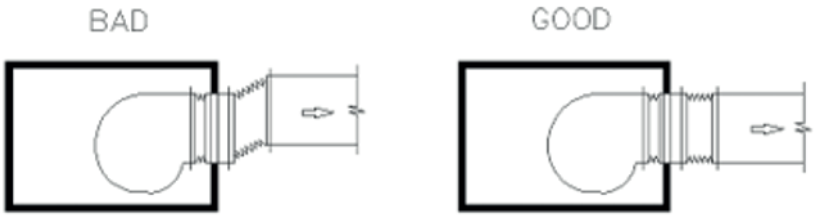
! The ducts connected to the AHU have to be suspended or underpinned with dedicated support elements. Conducting the ducts with the fittings should be done in a way to eliminate possible increase of noise level in the ventilation system.

! Air tightness should be maintained to achieve required air flow conditions. Poor ductwork connections to the unit and incorrect size, shape and arrangement of ductwork fittings can change airflow conditions.

3.6.1 DUCTED OUTLE CONNECTIONS

With the outlet connected to the discharge duct by a flexible connector, which is desirable for noise and vibration isolation, it is important that the connector is correctly fitted. The fan outlet and the duct should not be misaligned nor should the flexible connector be allowed to concertina. A smooth passage of air is desirable at all times.

» DUCTED OUTLET CONDITIONS

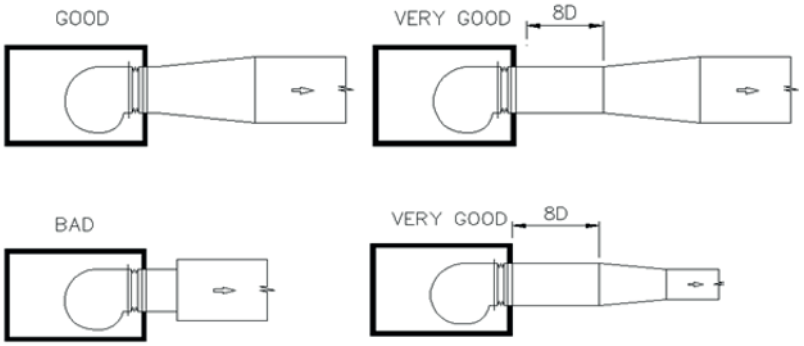


When discharging into a duct of larger cross-sectional area than the fan outlet, an expansion section with an included angle of 7-20º should be used. The ideal configuration is with parallel length

of ducting prior to the expansion section, allowing the air to become less turbulent before expanding. The fan should never discharge directly into a duct with larger cross- section.

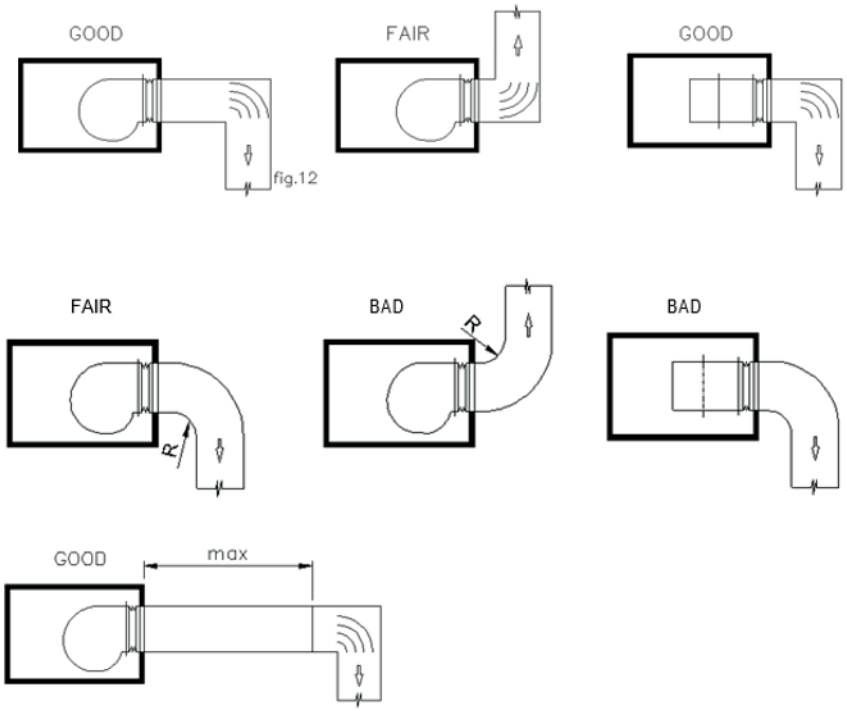
The same criteria apply when discharging into a duct of smaller cross-sectional area then the fan outlet. A ducting section with an included angle of up to 45º should be used. Losses will again be minimized if a parallel section of ducting is used prior to the reducing section. To achieve ideal conditions the length of parallel ducting in both cases should be equal to 8 impeller diameters. However, parallel ducting of considerably shorter lengths can be used to advantage.

» RULES DUCTED OUTLET CONNECTIONS



Extremely high losses occur when attempts are made to change the direction of the airflow close to the fan discharge. If this is necessary the installation should be carried out as in and ever as in. A better solution is to have a parallel section of ducting prior to changing direction and it should be as long as can be accommodated.

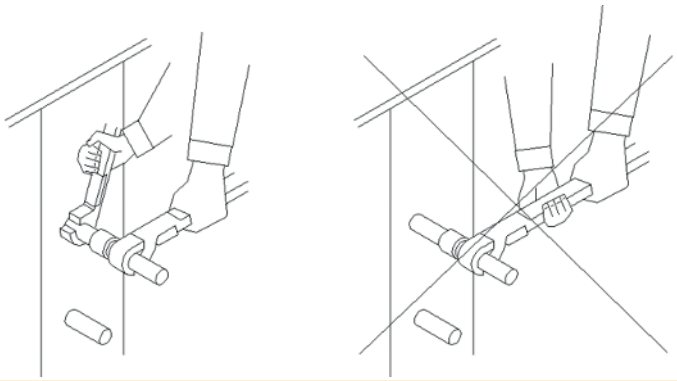
» RULES DUCTED OUTLET CONNECTIONS WITH DIRECTION CHANGE



3.6.2 PIPING CONNECTIONS

Coils should be piped in counter flow arrangement to achieve required capacity. This arrangement requires that the entering heating or cooling fluid contacts the air leaving the coil.

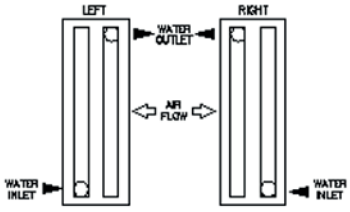
- ! The diameter of the connection and the type of connection of the exchanger are available in the technical parameters sheet delivered with the device and at the customer's request.
- ! Do not exceed allowed maximum pressure what is mentioned in AHU tech data and on the coils.
- ! All coils connecting piping should be thermally insulated.
- ! All coils connecting piping should be independently supported not to impose strain on the coil connections or circuitry.
- ! Use a pipe wrench to restrain the pipe connections of the coil when tightening the external pipe connections.



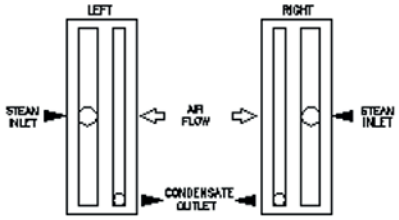
Water heating and cooling coils should be arranged with inlet connection at the lowest level on one side of the coil near downstream and water outlet connection on the same side but at high level near the upstream. This arrangement drives any air in the system into the upper part of the coil, where a manual air release valve should be fitted.

» COIL CONNECTION RULES

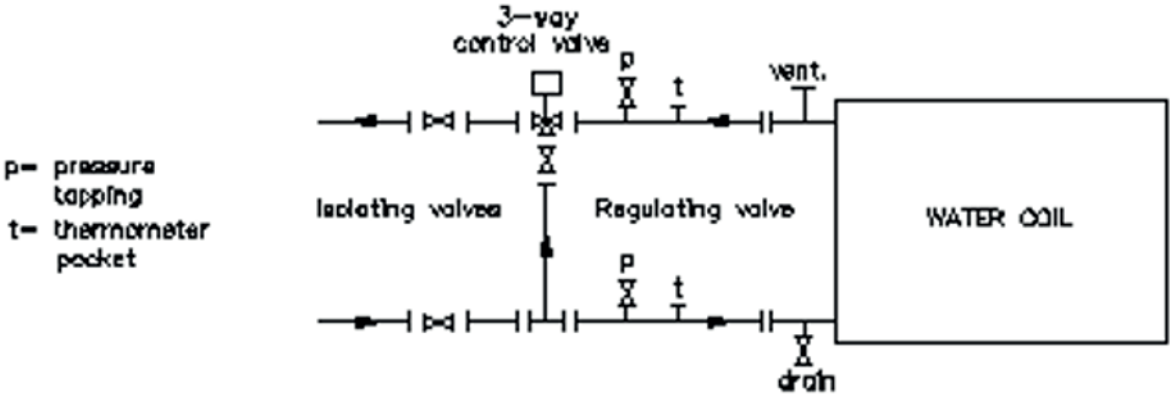
- Hydronic



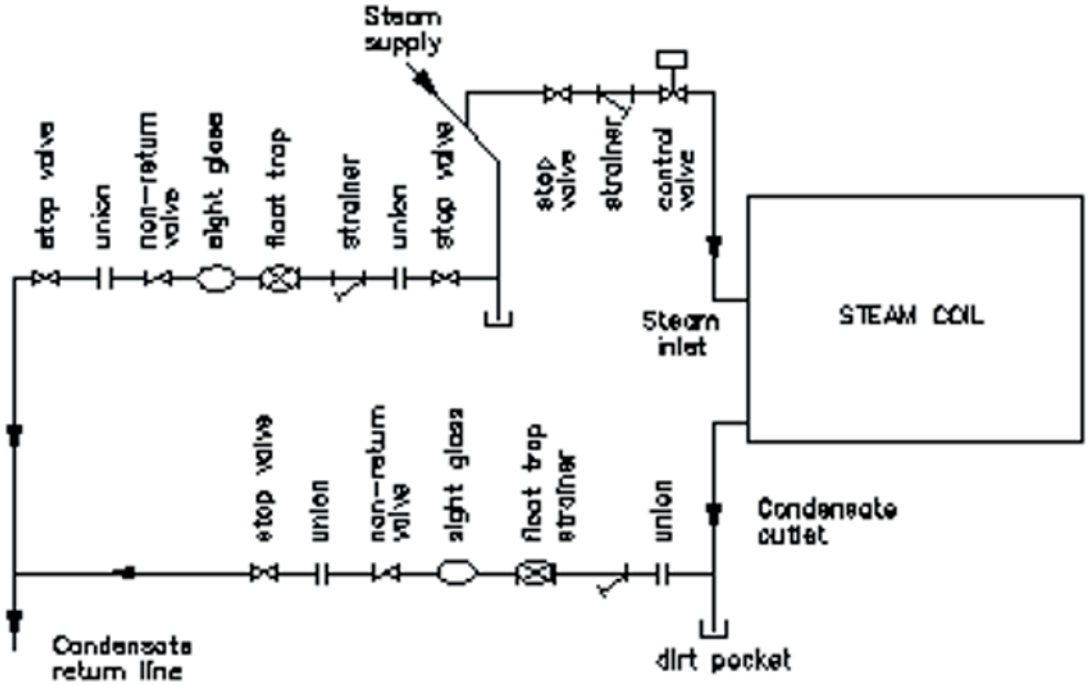
- Steam



» COIL INSTALLATION – HYDRONIC COILS



» COIL INSTALLATION – STEAM COILS



3.6.3 CONDENSATE DRAIN LINES

Moisture condensed out of the airstream on cooling or dehumidifying coils should be drained out from the unit in order to sustain the proper use of the air handling unit and the ductwork system. Following precautions should be observed in piping of condensate drain lines.

- ! The bore size of the pan outlet connection should not be less than the pipe connection of the drain pan.
- ! A union or pipe coupling should be fitted at the drain pan pipe connections to permit easy disconnection for cleaning any dirt sediments.
- ! The siphon (for positive and negative pressure applications) which is sent separately in the unit should be assembled according to the installation instructions given below.

» Drainage U-trap connection

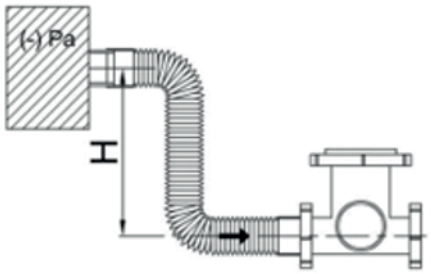
- Negative pressure

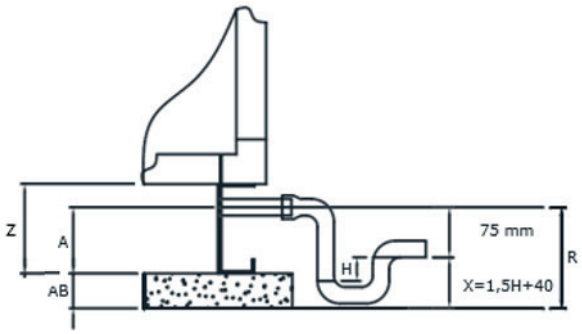
H= [(-)Pa / 10] + X

PVS 3-6	-> X =50 mm
PVS 6-6 - 15-15	-> X= 40 mm
PVS 15-18 – 37-40	-> X = 30 mm

- Positive pressure

H= (Pa / 10)	X= (1,5 x H) + 40
R= X + 75	AB= R - A
Z = 80 mm	-> A = 40 mm
Z = 120 mm	-> A = 60 mm
Z =200 mm	-> A = 140 mm





3.6.4 ELECTRIC CONNECTIONS

Connection of electric AHU elements should be carried out by qualified personnel and should be done in accordance with any standards and regulations being in force in a country where the unit is installed. Cross-section and type of cables (e.g. shielded cable) feeding individual functional segments should be selected basing on nominal current and specific operation conditions (e.g. ambient temperature, way of cabling, distance from the power supply).

All connections which are field made by a contractor shall be conducted in accordance with delivered together with ahu diagrams.

Before starting connecting power supply, check conformity of the voltage and frequency of a supply network with the data shown on the device's rating plate. Permissible fluctuation of the supply voltage and its frequency to the values shown on the rating plate is ±5%. If discrepancy exists, the device cannot be connected.

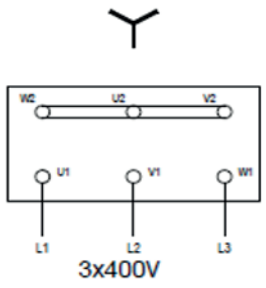
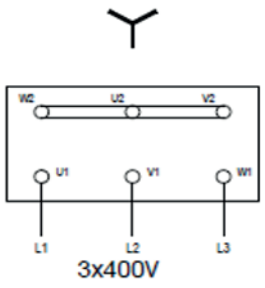
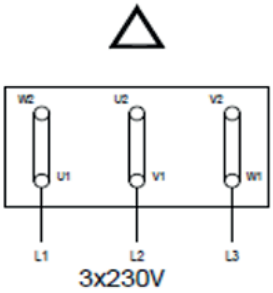
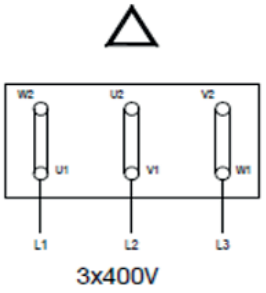
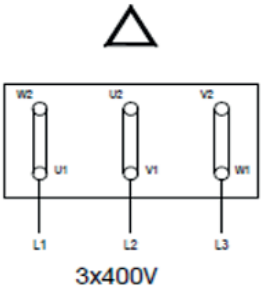
! Electrical installation and wiring works should be carried out by qualified and competent electricians.

! In case of the humidifier, frequency converter, electric heater, EC motor applications their own installation and connection manuals should be used. For the other equipment the installation instructions and the wiring diagrams which stuck in the terminal box should be followed.

» Typical connections – inverter powered ac motors

Direct Driven Fans' motors are adapted to operation in dusty and humid environment (IP55) and their insulation (F-class) is adapted to cooperation with the frequency converter. No additional means inuring the motor against conditions of the AHU fans' section are required.

Motors used in our AHUs are by default motors with their own cooling system and with fans built into a shaft. Supply cabling must be led to the fan's motor via rubber passes located in the back panel of the AHU casing.

Connecting power cables and clamps in a cable box of one-speed motors			
Marking on the engine rating plate	Motor power supply 3x400V/50Hz	Supplying power to the motor through frequency converter	
		Converter power supply 3x400V/50Hz	Converter power supply 1x230V/50Hz
230/400V D/Y			
400/690V D/Y			X

One should connect the fan set by means of fault protection appropriate for the applied frequency converter. In the case of use EC motors or AC motors powering with the use of a converter it is not necessary to connect the motor's PTC protection.

Overload protection is realized on the frequency converter by means of activating specified parameters and introducing the motor's rated data in accordance with the manual provided together with the frequency converter.

- Before connecting the fan set one should check carefully the rated parameters of both power supply and the converter's output.
- In fan sections equipped with more than one fan synchronous operation of fans should be ensured. The fan control system should be prepared in such a way so as to provide simultaneous start- up, rotary speed control and stoppage.
- In case of a breakdown and stoppage of one fan the fan set does not fulfil its function and should be disabled.
- In the inspection door of the fan section is installed limit switch, which cause the fan to stop in case of unauthorized opening of the door. The switch must be connected to the frequency converter, accordance with the wiring diagram attached in the VFD separate manual.

In case of powering the motor from a frequency converter, high-frequency currents or voltage harmonic components in wiring powering the motor can generate some electromagnetic interferences. Connection between the frequency converter and motor should be done using shielded cables, in accordance with guidelines outlined in the operation and maintenance manual of the frequency converter.

Before putting into service and after long time of storage or standstill, the resistance of insulation between the casing and winding should be determined, applying direct current. **Minimal value of insulation resistance for a new, renewed or repaired winding should be 10 MΩ in relation to the ground.**

» TYPICAL CONNECTIONS – INTERMEDIATE FAN DRIVE (AC MOTORS)

Fans' motors with belt drive are powered by 3x400V/50Hz voltage. The connection should be done through the overload and short-circuit protection suitable for rated current of the motor.

- Fan motors with the power of 4kW can be started directly. Motors with the power of 5.5 kW and more should be started in a ‚star - triangle' start-up system.

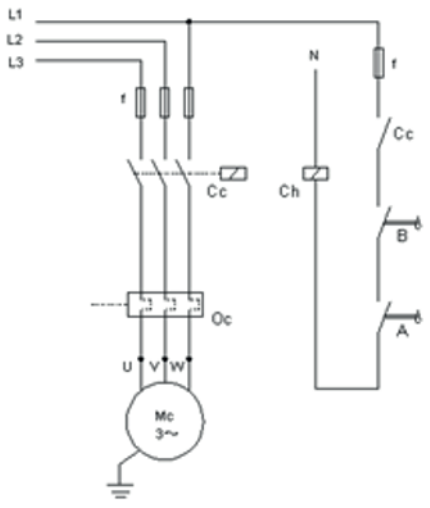
Electric motor, starters, interconnecting cabling and any associated controls should be properly designed and selected to be suitable for the driven equipment or other electrical apparatus, to be safe and to comply with the requirements of Electricity Supply Authority.

Starter for centrifugal fans in the air handling units for single speed motors driving through V-belts are normally of the direct-on-line type. However, the customer or Electric Supply Authority may require motors above 3kW to be operated by a star-delta starter, to reduce starting current.

» Reset way

To avoid the electric heater keep on running while the fan is not rotating, the wiring should be done similar to diagram shown at the right

A – manual reset
B – automatic reset



» THERMAL OVERLOAD RELAY SETTING

Fans' motors with belt drive are powered by 3x400V/50Hz voltage. The connection should be done through the overload and short-circuit protection suitable for rated current of the motor.

- direct-on-line starting: The thermal overload really should preferably be set to the motor full load current shown on the motor rating plate.
- star-delta starting: The thermal overload really should preferably be set to the 0.58 x motor full load shown on the motor rating plate.

After thermal overload relay settings is done it should be checked that thermal overload relay works properly at normal operating conditions, by operating motor on two phases.

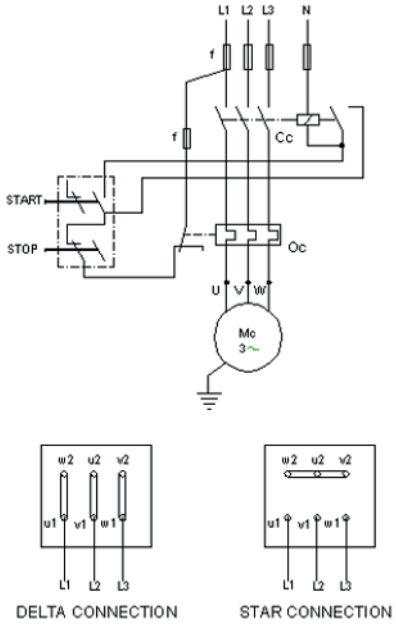
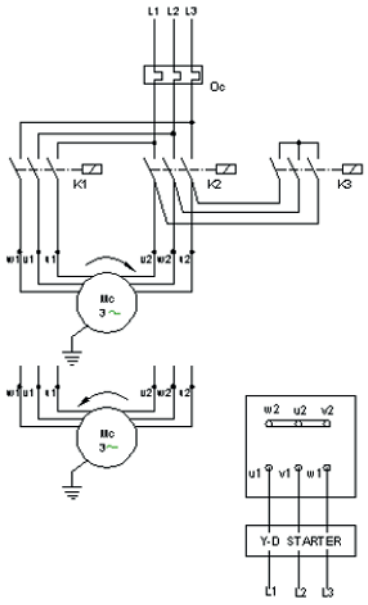
» MOTOR TERMINAL MARKINGS:

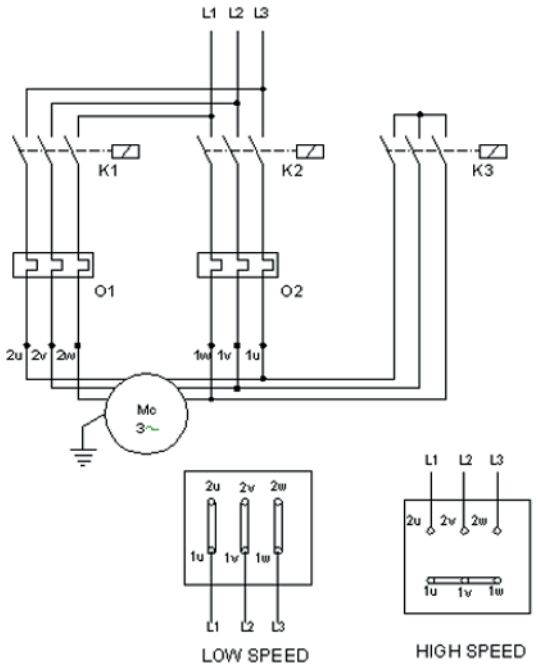
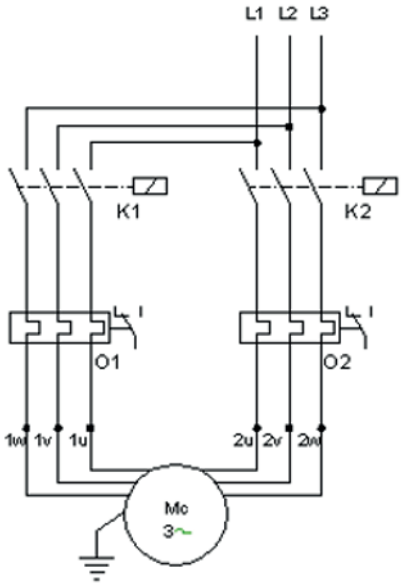
- the terminal markings of motors conform to the international standards. Stator terminals are marked, U.V.W and the neutral terminal N,
- please check data on the rating plate. The voltage marked on the rating plate must be in agreement with the mains voltage.
- the terminal board is normally equipped with 6 terminals. Details concerning the connection are given on the inside cover of the terminal box and / or on a diagram placed inside by the manufacturer.

! Specifications require that all motors to be earthen properly. Special terminal in the terminal box should be used for this purpose.

! To avoid the danger of overloading and operation on two phases, the motors should be protected either with fuses and thermal/thermo magnetic switches or electronic circuits.

! If the electric heater will be used, electrical connections should be done according to the information on the heater label.

INTERMEDIATE FAN DRIVE – 1-SPEED AC MOTOR	
Direct-on line starter with control circuit	Star-Delta starter
	

INTERMEDIATE FAN DRIVE – 2-SPEED AC MOTOR	
Dahlander pole changing motor – switch (2-speed)	Pole chnager with two separate windings (2-speed)
	

3.7 SETTING UP OF COMPONENTS

3.7.1 CONTROL SYSTEM

! Complete automatic control which should be an integral part of each air-conditioning system, enables continuous operation of a device, in many cases it is an indispensable element and lack of it may lead to serious operational problems or failures.

3.7.2 AIR DAMPERS

! In the case of AHUs equipped with water heat exchangers (heaters, coolers, glycol recovery) air damper's actuators of supply units should be equipped with a return spring ensuring its spontaneous closure in case of power cut.

Dampers shall be equipped with the motor. Check that the blades turn back in closed position in case of power supply failure during operation. Care must be taken to ensure that the actuator does not attempt to push the damper blades beyond fully open or fully closed positions. All damper blades must be checked for free movement and for fully open and fully closed positions.

3.7.3 AIR FILTERS

Panel filters and zigzag filters are normally fitted within the unit prior to shipping.

Bag filters are normally shipped in closed carton boxes to avoid any collection of dust and loss of efficiency prior to commissioning. Each bag filter is housed within a special holding frame with necessary locking spring to ensure proper sealing.

Automatic roll filters consist of basic frame dispensing unit for clean media, rewind unit for dirty media, drive system, roll filter media and control system. Normally filter media and control system are supplied loose for site installation. For assembly, filter media roll is mounted on the dispensing unit taken along the guide channel through working section and locked to the rewind unit.

Differential pressure switch must be installed and connected to the control panel.

Absolute filters are shipped in sealed carton boxes. While assembly, special care must be taken to ensure that each filter cell is properly sealed within the assembly frame with no possibility of air leakage.

Other types of filters such as active carbon filters, sand filters etc. are supplied with manufacturer's instructions along with the units.

Filters that are shipped separately in the unit should be assembled after cleaning the inner surface by operating the fan. Before start-up, make sure that filters are properly installed.

3.7.4 COIL HEAT EXCHANGERS

All coils are leak tested and checked prior to assembly. Fins are checked for proper condition. However, they must be checked once more and combed out if necessary, because they might be damaged during handling and installation. Do not remove plastic covers from coil pipe connections until the unit is ready for piping connectors. Connections should be checked according to the project and the leakage should be taken in to account. System layout should take into consideration of possible coil withdrawal.

It is recommended that the water flow is shut off when the fan is switched off. To avoid the overheating of the heating coil, the hot water pump and water / steam valves should only be opened during the operation of fan.

Supply air control: The supply air temperature of the coil at the suction side should be max. 40˚C, otherwise the overheating danger will occur.

Check the concentration ratio of the antifreeze before the start-up of the cooling coil. It should be enough for the claimed operating temperature range. It should be taken in to account that the increasing concentration ratio of the antifreeze decreases the performance of the coil.

The minimum temperature of the chilled water should be +20C, at lower temperatures freezing danger will occur.

Antifreeze is a dangerous chemical. The safety regulations of the antifreeze manufacturer should be taken in to account.

Direct expansion coils will be supplied with a refrigerant distributor suitable for brazed connections. Refrigerant pipe work must include necessary shut off devices, dehydrators, solenoid valves, oil traps etc. Selection, sizing, installation and setting of thermostatic expansion valve should be in accordance with the recommendation of condensing unit manufacturer.

Steam coils: Special care should be taken for collection and disposal of condensate within the coils and to prevent entry of the condensate in the main into the coil by trapping it independently on a coil bypass. Condensate connections to the stream trap must be of the same size as the coil outlet.



! Do not operate coils above the maximum temperature and pressure specified on the capacity label.

! If not otherwise stated on the capacity label, maximum operating temperature and pressure:

- for water coils (type:1) : 90ºC, 10 bar,
- for water coils (type:2) : 150ºC, 15 bar,
- for steam coils: 160ºC, 6 bar

3.7.5 HUMIDIFIERS

Mat type or steam type humidifiers may be assembled in the unit. For the piping and wiring instructions please refer to humidifier manufacturer's manual.

The supply water, overflow / drain piping should be done before the start-up of mat type. The supply piping should have a valve for cutting off during the maintenance. Before start-up clean the water sump, close the drain valve and fill the sump with water. The float adjusts the water level. The distance between the water level and overflow pipe should be 5cm. The water level in the sump is very important that if the water height is usually at low level the humidification performance will decrease. Check the rotation of the pump, the direction should be at clockwise. Change the connection of the 2 phases if the direction is opposite. Not to damage the pump do not operate dry.

Before the start-up of the steam humidifier, wiring and piping should be done, steam supply and drain hose should be connected to the steam distribution pipe.

For further information about the humidifiers please refer to the humidifier manufacturer's manual.

3.7.6 SUPPLY AND RETURN FANS

Vibration isolators, on which fan + motor assembly is mounted, are locked prior to shipping to avoid damage during transport. Once the unit is in position and duct connections are made, isolators must be released. It should be guaranteed that the fan move hasn't locked.

Wiring work must be carried out in accordance with local standards. Type of start (direct-on-line or star/delta) should met with local electrical standards. Starters, controls, overload protecting devices, interlocks etc. should be provided as required. (See page 34) After the start-up, check that direction of rotation of the fan is correct.

3.7.7 ELECTRIC HEATER

The electric heater should be protected against humidity and water. Be sure that the electric heater automatically cuts off, if the air flow stops.

3.8 SAFETY

KLS air handling units can be considered as safe machinery. By means of the compliance statement of the EEC and of the symbol "CE" on the unit, it is guaranteed that KLS air handling units fulfil the provisions for the safety and health, on the ground of Machinery Directive 98/37/EC and the European standards. The "CE" mark appears on every identification label of the unit

In spite of all that, the unit can represent a danger, if it is utilized or serviced not properly or by staff not sufficiently trained, or if it is used not in conformity with general provisions. For this reason, we intend to explain to the user the concept of safety referring air handling units and to inform him of possible danger and consequent measures.

Internal area of the units near to the moving parts (fans, motors, pumps etc.) end electrical parts, hot sections (hot water and steam coils, piping, fittings and control devices) are considered as "danger zone". In order to be able to access to these areas, it is necessary to provide oneself with the proper key tools. The operators are responsible for transport, installation, start up, service and maintenance including cleaning and repairing.

Possible hazards regarding to the air handling units are:

- danger to the operator's safety,
- damages to the unit,
- possibility to affect the efficiency of the unit work

3.8.1 USE OF THE UNIT

KLS air handling unit are used for heating, ventilating and air conditioning purposes. Any other use is considered not in conformity with general provisions. The manufacturer is not responsible for damages resulting; the user will be the only responsible.



- Air handling units can be used between -30˚C and +60˚C ambient temperatures. If the unit is to be used at special locations such as tropical regions, indoor pools etc. the operational limits must be ascertained from the manufacturer.
- Standard units must not be used for handling of flammable gases. Spark-proof versions of rotating parts (fans, motors etc.) must be selected for this kind of applications, so air handling unit manufacturer should be informed while ordering the unit.
- In order to use the unit according to general provisions, proper instructions of transport, installation and use must be observed. Installation and start-up of the unit must conform to the national standards having legal course in the country of the user. **The user is responsible for compliance with standards**. Besides it must be avoided any type of work that may compromise safety.



- Arbitrary changes on the unit made by the user or operator are not allowed and exclude the warranty of the manufacturer for the damages to things and persons.
- The unit can be started up only by authorized persons and by the means of proper safety devices
- The installer is obliged to install the unit according to installation plans and conditions.
- The staff in charge is obliged to signal immediately to the user any changes that may compromise safety. For this reason it is necessary to inspect the unit for eventual anomalies or damages at least once a week.
- The user or operator never must dismount and deactivate safety devices; if these would be removed for extra maintenance, at the end of the operations they must be reinstalled.
- For all operations of extra maintenance, the power source must be locked out and protected against unlock by anybody else.

3.8.2 OBSERVATION OF WARNING SIGNS

Warning signs should be placed on the unit, showing:

- prohibition to repair or adjust while the unit is running,
- obligation to turn off the power before opening the access door,
- warning of coming into contact with electrical parts etc.

3.8.3 STAFF TRAINING

Installation, start up and maintenance works can be executed only by authorized and trained staff. This staff or people who, on behalf of the user, attend to control and make maintenance of the unit must be informed about possible hazards regarding:

- electrical connections,
- piping connections,
- ducting connections,
- start up,
- maintenance.

It is necessary to establish and to respect the responsibilities for the control and maintenance to guaranty safety.

3.8.4 PREVENT OF COMMON DANGERS AND RISKS

Air handling units are supplied with locked access doors as an option. So, unauthorized persons are not permitted to enter the sections which represent a danger. The most important potential dangers for life and health are described below. The units are manufactured in conformity with machinery normative 98/37/EC. If the user thinks to take further measures to restrict every possible remaining danger, he will be able to recognize them by the general description below.

PREVENT OF COMMON DANGERS AND RISKS		
KIND OF DANGER OR RISK	SOURCE OF DANGER OR RISK	DANGER OR RISK
Danger caused by moving parts	Fans, electric motors, pumps	Danger of hurting
Danger produced by electric contacts	Electrical parts, electric wires	Danger of loosing one' s life
Danger caused by hot surfaces.	Hot water and steam coils, steam humidifiers	Danger of burning
Danger caused by pipe or hose damage	Water and steam coils Water and steam humidifiers	Danger of burning from hot water or steam Danger of electric shock caused by water contacting electrical parts and cables. Risk of corrosion.
Risk caused by overspeed of fan	External frequency converter	Risk of damage of motor, fan and ductwork Risk of excessive noise.
Risk caused by mechanical resonance	Vibration isolators	Risk of damage or destruction of air handling unit.
Risk of fail function or programming	External frequency converter	Risk of overspeed of fan (see section above "risk caused by overspeed of fan") Risk of mechanical resonance (see section above "risk caused by mechanical resonance").

3.8.5 RECOMMENDED SAFETY PRACTICES

This publication explains the proper use and installation of centrifugal fans in order to warn operating and maintenance personnel of the commonly recognized dangers associated with this equipment.

In addition to follow the manufacturer's installation instructions, care must be taken to ensure compliance with federal, state and local rules, regulations and standards.

Centrifugal fans in air handling units are located inside a casing, so accessibility to the fan is occasional or infrequent. For this reason, protective devices are offered as optional accessories only at specific user's request. However as in case with other machinery involving moving parts, common sense and caution will preserve personnel safety.

The available optional guarding devices are:

- fan inlet and outlet guards: Centrifugal fans in air handling units are usually connected directly to ductwork which will prevent the contact with the internal moving parts. In case there is an exposed inlet or outlet which could represent a danger, suitable guards can be installed,
- drive guards: Safety guards should be used when drive systems are accessible by the personnel,
- limit switch: Cuts off the power supply of the fan motor when door opens. As the fan keeps on rotating, do not attempt to enter the unit within minimum 2minutes, after opening the door.

Also, lockout switches and suitable warnings should be used. Maintenance personnel should engage the lockout switch before starting any maintenance and repairs; do not forget to protect against unlock by anybody else.

3.8.6 THE HIDDEN DANGER

In addition to the dangers of rotation machinery, fans present another potential danger by virtue of their ability to draw in loose material. Solid objects passing through a fan represent potentially dangerous projectiles. Solid objects can cause fan failure by physically damaging the impeller blades. If the guard is removed for any reason, the fan must be disconnected and locked out. Where fans are installed over an occupied area, safety guards should be provided to prevent dropped objects from entering this area during installation and maintenance.



! Access doors to a fan or duct system must not be opened when the fan is running or coasting to a stop.

! After the unit is switched off, the impeller continues to run for approximately 1-3 minutes. The fan section is therefore still under pressure and the door must not be opened.

! The impeller must never be slowed down by hand or by other objects. Power must be locked out prior to access into the fan section or ductwork. Even when locked out electrically, fans may cause injury or damage if the impeller is subject to “windmilling”. The impeller should be secured to physically restrict rotational movement.

On the downstream or pressure side of the system, attempting to open the access door while the system is in operation, may result in an explosive opening. On the upstream or suction side, the inflow may be sufficient to draw in tools and clothing etc. and create a danger.

The stroboscopic effect of certain lights in combination with certain fan speeds may cause a rotating assembly to appear stopped.

Noise

At normal operating conditions, noise emission of air handling units does not (with duct connections made and service doors closed) exceed 70dB (A). At extreme operating conditions and depending on room acoustics, noise emission may be dangerous for health. Prolonged exposure at or above 85 dB(A) requires the use of hearing protection (ear plugs, ear muffs etc.).

3.9 START UP

Before operating fans for the first time (or after an annual maintenance) the manufacturer’s instructions must be followed. In addition, the following check list must be completed:

- ensure that all the sections of the unit are thoroughly cleaned. There is a possibility of collection of debris such as duct insulation materials, tapes, etc.,
- ensure all electrical wiring is carried out in accordance with local standards,
- ensure all components are provided with safety, protecting and isolating devices,
- remove all filters, install low efficiency filters such as gauze bags or throw away type filters, to keep the filters clean,
- check water/steam/refrigerant coils and pipe connections for any leaks. Ensure that all the air in the system and in the coil is vented out. Check coil face free from debris,
- ensure all panels, if removed during installation, are in position and all service doors are closed,
- ensure that minimum water level is maintained in the humidifier.

» OPERATIONS OF FANS

- check that pulleys are secure on shafts,
- check tightness of belts,
- check that all moving parts of the fan and motor are free to rotate,
- check that no loose materials are left near the fan inlet,
- check that direction of impeller rotation is correct. For this, momentarily energize the fan and see the direction of rotation,
- check that fan and motor pulleys are aligned,
- check that fan and motor are fixed tightly,
- one of the most common causes of motor failure with forward curved blade fans is excessive air flow, due to overestimated system resistance. To overcome this type of failure, first start-up should be with the main system damper partially closed and to be opened when correct proportional air flow has been achieved by system regulation,
- check that flexible connections are firmly fixed and undamaged, duct connections are designed in accordance with acceptable engineering practices and with the manufacturer' s recommendations,
- check that thermal overload relay setting is correct,
- switch on the electric supply and allow fan to reach full speed. Check carefully for:
  - excessive vibration,
  - unusual noise,
  - proper belt alignment Proper lubrication,
  - motor current and voltage values.

If any problem is indicated, switch of immediately. Lock out the electrical supply, secure fan impeller if there is a possibility of "windmilling". Check carefully for the cause of the problem and correct as necessary.

After ensuring that there is not any problem, no leaks between joints and system is clean, stop the fan. Dispose low efficiency filters; install panel/bag/absolute filters as supplied. Restarts the fan:

- adjust damper position to obtain required air volume. Ensure that the air volume is within specified limits,
- check the motor current and ensure that it is in accordance with the motor rated data (on motor nameplate),
- check inlet-outlet temperatures across coils and adjust water/steam flows accordingly. Check the functioning of control devices,
- check the functioning of humidifier by adjusting the humidistat control,
- check the operation of heating coils by adjusting thermostat. Check the functioning of controls. (air flow switch, fan interlock, overheat protection, etc.),
- check the pressure drop across the filters and ensure that it is within limits.

During the first eight hours of running, operation of fan should be periodically observed and checked for excessive vibration and noise. Motor input current and motor and bearing temperatures should also be checked to ensure that they do not exceed manufacturer's recommendations. Then the fan should be shut down to check the following items and to adjust, if necessary:

- belt drive alignment and belt tension,
- bearing housing temperature,
- fan and motor fixing bolts.

» AFTER TWO WEEK OPERATION

After start up and initial satisfactory operation of two weeks, it is recommended to have the following checks:

- belt drive alignment and belt tension,
- motor running current,
- bearing temperature immediately after stop. Bearing temperature should not exceed 70°C,
- lubricate if necessary,
- condition of filters,
- condensate and drain, to see flow,
- operation of control devices.

Investigate any changes to the fan. You may have more detailed explanation of problems and possible causes in “troubleshooting” section. Consult your manufacturer or other qualified consultant for questions concerning changes observed during periodic inspections.

If excessive vibration is observed, stop the fan until the cause is corrected. Check for material build up on the impeller which causes an imbalance and leads to the fatigue failure or impeller.

Changes in the sound level of the fan may indicate troubleshooting is required.

If the motor temperature is high check cooling fan of the motor. It may be blocked or broken. Also check the input current. An increase in current may indicate that some major changes have been made in system.

High bearing temperatures usually caused by improper lubrication. If the cause of the problem is not easily seen, experienced personnel must examine the equipment before running it again.

3.10 MAINTENANCE

A preventive maintenance program is an important aspect of an effective safety program. Maintenance works should be performed by experienced and trained personnel. Do not attempt maintenance unless electric supply has been locked out and the impeller has been secured. Before the maintenance operation, the safety precautions should be taken by locking out the main and maintenance switch and protecting against unlocking by anybody else.

Especially at the hygienic air handling units, filters, coils, (by disconnecting the flange connections), droplet eliminator and sound attenuators can be taken out from the service doors. Besides, all components can be taken out from the unit for cleaning and disinfection processes.

In general air handling unit do not require special attention other than routine cleaning and maintenance work. Frequency of maintenance depends on operating conditions. Following is the recommended schedule maintenance.

Periodic checks should be made for thermal and acoustic lining and electrical insulation of the unit sections. Also connecting cables and control panels should be checked. Any metal surface which shows signs of deterioration should be cleaned.

Bols, nuts and other assembling elements should be checked. Any missing bolts, nuts and screws should be replaced.

To clean the damper compressed air can be used. Do not lubricate the shaft of the damper.

Impurities on the droplet eliminator blades should be cleaned regularly. The period changes according to the operating conditions and the air quality. As cleaning media any de-scaler available on the market can be used.

For the best cleaning process of the droplet eliminator at the hygienic air handling units it should be taken out from the unit and disassembled by unscrewing.

To clean the inner surface of the unit (after necessary components taken out) water / steam spray and cotton or directly wet cotton can be used by wiping.

MAINTENANCE
ONCE A WEEK
Check the conditions of filters every week. Clean, wash or replace if necessary.
ONCE A MONTH
Check belt drive alignment and tension, adjust if necessary. Check the condition of float and valve in humidifier. Check the condition of drain for free flow. Check the condition of access door hinges and seals lubricate hinges if necessary.
ONCE IN SIX MONTHS
Check the motor running current. Check fan and motor bearings for high temperature and noise. Check function of control devices. Clean condensate drain pan, trap and drain line. Check air washer circulating pump and motor. Check the condition of inlet strainer of air washer. Check the condition of piping system for chilled/hot water or steam Add chemicals if necessary.
ONCE A YEAR
Check the filter frame for proper sealing Replace synthetic filter media in panel filters. Check the controls and operation of automatic roll filters Check the coils and fins. Wash with water spray, if necessary. Check the coils for any leakage Went the water coils Replace belts Check the tightness of the fan and the motor fixing bolts Check motor and fan bearing lubrication Check the operation of dampers Check the condition of access door for easily opening and proper locking Check the condition of valves and fittings on the piping system Check all wiring, control and isolating devices, terminal connections, etc.

After inspection and replacements, if necessary proceed in accordance with operation instructions, before running the unit again.

Following must also be noted about maintenance works:

3.10.1 FAN SECTIONS

For detailed information about lubrication of bearings, belt tension and alignment controls, changing of pulleys, see related sections in this manual.

3.10.2 COIL SECTIONS

Coils should be cleaned to remove any accumulation of dust between the fins and tubes should be checked for any leakage. Cleaning process can be done in 3 ways:

- vacuum,
- compressed air,
- water or steam spray (opposite to the air flow direction).

During the application the water / steam / air pressure should not exceed 5 Bar.

To clean the cooling coil at the hygienic air handling units, the coil can be reached from both sides by taking out the droplet eliminator from the service door by disassembling the by-pass sheet metal. With the same principle as there's no droplet eliminator, the heating coil can be cleaned by reaching both sides from the service doors.

If it is required to withdraw the coil for cleaning and repairing, proceed as follows:

- drain the water inside the coil,
- disconnect the coil from piping connections,
- remove the side panel,
- remove the bolts by which coil is fixed,
- withdraw the coil.

To check for leakage in the tubes:

- clean and dry the coil,
- fill water inside the tubes,
- see where the leakage is,
- drain the water inside the coil,
- repair the small holes or cracks on the copper tubes by oxyacetylene welding.

Check with water if the welding is successful or not.

After cleaning the coil, drain should be checked and the siphon should be cleaned.

3.10.3 FILTER SECTIONS

Condition of the filters should be checked once a week. Dirty filters reduces the air flow and hence the capacity. A manometer, measuring filter pressure drop should be fitted to filter section. If other not stated on the unit, please use the recommended maximum pressure differentials for different kind or filters that are given on below table. When manometer reading shows these values, filters should be cleaned or replaced, and these values should not be exceeded. Synthetic or metallic filter media can be cleaned or washed. However, it is recommended to replace synthetic media in every two years. New filters should be assembled in the right position that the rough and open side looks to the dirty air, smooth face to the clean air side.

If there's gasket on the previous filter frame, to achieve the necessary tightness do not forget to apply the same media (absolutely same way) on the new filter after renewal.

Other type of filters such as throw away media, bag, absolute and roll filters must be replaced with new filters of same type, size and efficiency.

PREVENT OF COMMON DANGERS AND RISKS			
FILTER GRADE	FILTER GRADE	INITIAL PRESSURE DIFFERENTIAL	RECOMMENDED MAXIMUM PRESSURE DIFFERENTIAL
Panel Filter	G-2 (65% ≤ Am ≤ 80%)	25 Pa	150 Pa
	G-3 (80% ≤ Am ≤ 90%)	40 Pa	150 Pa
	G-4 (90% ≤ Am)	50 Pa	150 Pa
Bag Filter	G-4 (90% ≤ Am)	65 Pa	150 Pa
	M-5 (40% ≤ Em ≤ 60%)	55 Pa	250 Pa
	M-6 (60% ≤ Em ≤ 80%)	60 Pa	250 Pa
	F-7 (80% ≤ Em ≤ 90%); 0.4 µm - 35%	115 Pa	250 Pa
	F-8 F8 (90% ≤ Em ≤ 95%); 0.4 µm - 55%	165 Pa	350 Pa

After opening the service door, the filters can be taken out by pulling aside.

Synthetic bag filter can be cleaned by vacuumed or compressed air besides can be washed with the sensitive detergent and warm water.

3.10.4 HUMIDIFIER SECTIONS

Humidifier should be cleaned regularly. The period changes according to the operating conditions, air specifications and water quality. During periodic maintenance of humidifier, checks mentioned in its own manual should be performed.

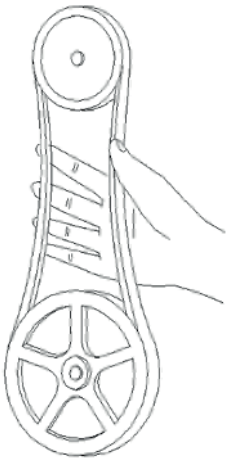
3.10.5 SOUND ATTENUATORS

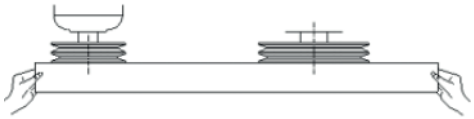
Sound attenuators can be taken out from the service door by unscrewing the components from the top and bottom panels. Attenuators can be cleaned by vacuumed or compressed air.

3.10.6 BELT TENSION AND ALIGNMENT CONTROL

BELT TENSION AND ALIGNMENT CONTROL

- A simple “Rule of thumb” for checking belt tension is illustrated at right.
- When the belt is grasped as shown, a total deflection of approximately 25mm (1”) should be easily attained.
- Excessive deflection is an indication that the belt is not tight enough, and if not corrected, could result in slippage causing loss of blower speed and belt failure through wear.
- Too small deflection indicates that the belt is too tight, and if not slackened somewhat could cause noise from excessive vibration, premature bearing failure and shorter belt life.
- Efficiency is another reason to properly adjust belt tension. Excessive belt tension can create such a power demand as to actually overload a motor that otherwise would be quite adequate.
- It goes without question however, that like all “Rules of thumb” some judgement is necessary on the part of person doing the adjusting.
- A belt should be just tight enough to avoid slippage.
- Before locking the motor is position, check the alignment of pulleys with a straight edge to conserve belt life as well as to eliminate the possibility of unnecessary noise.



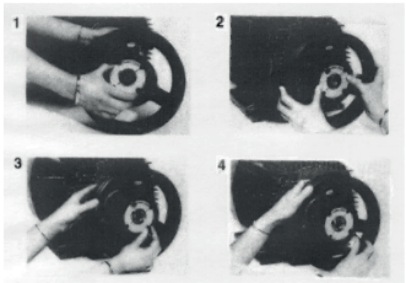


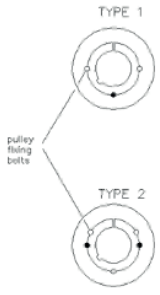
3.10.7 CHANGE OF PULLEYS

CHANGE OF PULLEYS

MOUNTING OF PULLEYS

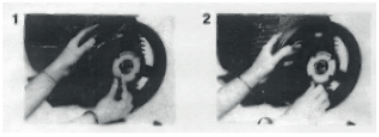
- A simple “Rule of thumb” for checking belt tension is illustrated at right.
- When the belt is grasped as shown, a total deflection of approximately 25mm (1”) should be easily attained.
- Excessive deflection is an indication that the belt is not tight enough, and if not corrected, could result in slippage causing loss of blower speed and belt.

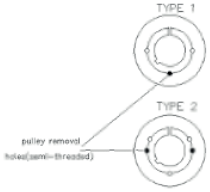




REMOVAL OF PULLEY

- Remove tightening screws.
- Insert one of the screws in the semi-threaded hole and tighten until bushing becomes loose on shaft.





Don’t use hammer or puller to remove the pulley. Don’t change pulleys without written consent of KLS; otherwise we take no responsibility for the consequences

3.10.8 LUBRICATION OF BEARINGS

Bearings have to be controlled and cleaned regularly; have to be lubricated adequately to prevent direct metallic contact between rolling elements, to prevent wear and to project bearing surfaces against corrosion.

The fans with low shaft power are equipped with bearings in a rubber housing which absorbs a part of vibration. When you change the bearing it is very important to change the rubber housing too. These bearings don't need to be lubricated.

The fans with higher shaft power are equipped with bearings with cast iron support. The lubricant filled in a bearing gradually loses its lubricating properties during operation. Therefore, it is necessary for grease to be replenished or renewed from time to time. The grease used is always lithium soap type suitable for all temperatures within the operating range.

Excess grease will cause the operating temperature to rise rapidly, particularly when running at high speeds. Therefore, only the bearing should be completely filled, whilst the free space in the housing should be partly filled (between 30% and 50 %) Where bearings are to operate at very low speeds and must be well protected against corrosion, it is advisable to completely fill the housing.

Relubrication interval depends on the fan speed and bearing internal diameter and is calculated by the following formula:

$$t = 10 \times \{14x106 / (n \times \sqrt{d}) - 4 \times d\}$$

where:

t = relubrication interval (h),

n = fan speed (rpm),

d = bearing inner diameter (mm)

FAN SPEED (rpm)	BEARING INNER DIAMETER (mm)							
	20	25	30	35	40	45	50	60
250	124 420	111 000	101 040	93 250	86 940	81 680	77 190	69 890
500	61 810	55 000	49 920	45 920	42 670	39 940	37 600	33 740
750	40 940	36 330	32 880	30 150	27 910	26 020	24 400	21 700
1000	30 500	27 000	24 360	22 260	20 530	19 070	17 800	15 670
1250	24 240	21 400	19 250	17 530	16 100	14 890	13 840	12 060
1500	20 070	17 660	15 840	14 370	13 150	12 110	11 200	9 650
1750	17 080	15 000	13 400	12 120	11 040	10 120	9 310	7 920
2000	14 850	13 000	11 580	10 430	9 460	8 630	7 900	6 630
3000	9 630	8 330	7 320	6 480	5 770	5 150	4 600	3 620
4000	7 020	6 000	5 190	4 510	3 930	3 410	2 950	2 110
5000	5 460	4 600	3 910	3 330	2 820	2 370	1 960	1 210

If the fan works in particular conditions, relubrication intervals have to be corrected concerning the temperature and surrounding factors, according to the following formula:

$$tc = t \times kT \times kS$$

where,

tc = corrected relubrication interval,

kT = temperature correction factor,

kS = surrounding correction factor

Temperature correction factor kT takes into account the reduction of relubrication interval when bearing temperature raised over 70°C.

Temperature correction factors kT (for lithium soap grease)								
Temperature of bearings (°C)	70	70	80	90	100	110	120	130
Temperature correction factor, kT	1	1	0.6	0.35	0.2	0.12	0.07	0.04

! Surround factor kS considers in particular the external influences such as humidity, shocks and vibrations

GREASE STRESS	SURROUNDING FACTOR, kS
Low	0.8
Medium	0.5
High	0.2

3.10.8.1 RELUBRICATION PROCEDURES

If the relubrication intervals are shorter than 6 months, then it is recommended that the grease fill in the bearing arrangement be replenished at intervals corresponding to 0.5 times the relubrication intervals., the complete grease fill should be replaced after three replenishment at the latest.

If the relubrication intervals are longer than 6 months it is recommended that all used grease be removed from the bearing arrangement and replaced by fresh grease.

The 6 months limit represents a very rough guideline recommendation and may be adapted to particular applications.

3.10.8.2 REPLENISHMENT

By adding small quantities of fresh grease intervals the used grease in the bearing arrangement will be partially replaced.

Suitable quantities to be added are calculated by the following formula and are listed on following table.

G = 0.005 x D x B

G = Grease quantity to be added when replenishing (g) D = bearing outside diameter (mm)

B = total bearing width (mm)

Temperature correction factors kT (for lithium soap grease)												
FRAME CONTRUCTION TYPE	FAN SIZE											
	250		280 315		355 400		450 500		560 630 710 700		900 1000	
K	G	d	G	d	G	d	G	d	G	d	G	d
	3.9	25	5.6	30	6.8	35	8.4	40	9.9	50	13.2	60

Suitable quantities of intervals adding fresh grease (K2)						
FRAME CONTRUCTION TYPE	FAN SIZE					
	560 630		710 800		900 1000	
K2	G	d	G	d	G	d
	3.9	25	5.6	30	6.8	35

3.10.8.3 RENEWING THE GREASE FILL

When the end of the relubrication interval t, has been reached, the used grease in the bearing should be completely removed and replaced by fresh grease. As stated before, under normal conditions, the free space in the bearing should be completely filled and the free space in the housing filled to between 30 and 50 % with fresh grease. Great care should be taken to see that contaminants are not introduced into the bearing or housing when relubrication.

3.11 TROUBLESHOOTING

Before checking the fan system, it will be necessary to shut down the fan. During inspection, the unit must be isolated electrically and all disconnected switches and other controls must be locked in the “off” position. Also, a prominent “DO NOT START” sign should be placed on control panel.

To find out the problem is an important step to correct it. By following the procedures outlined in this section, cause of the problem should be found.

Procedure for troubleshooting:

- Look at the troubleshooting chart to find the problem. Check probable causes.
- If the cause of the problem can not be found proceed through the “system checklist”
- If the problem still can not be solved, it is recommended to contact the “unit manufacturer”

System checklist

A systematic check of items listed below may identify the problem. See that:

a) impeller rotation is correct,
b) pulley are aligned,
c) belts are not loose or too tight,
d) belts and/or pulley are not worn,
e) flow surfaces of fan (impeller blades, housing and passages between inlets) are clean,
f) impeller and housing are not damaged,
g) coils, filters, ducts are clean.
h) fan outlet connections are correctly designed and installed,
i) variable inlet vanes are synchronised. If inlet vanes are not synchronised, there will be an unbalance flow between inlets causing thrust on bearing and low performance, inlet vanes are correctly positioned for the designed operating conditions,
j) there is no leak in the unit and ductwork. Some common leak sources are access doors, coil, duct joints, fan outlet connections etc.

If the cause of the problem still can not be found, consult air handling unit manufacturer. Manufacturer may need following information:

k) complete drawings including unit location, ductwork detail, model and size of the unit,
l) measured and design performance figures,
m) system design calculations,
n) measured fan performance figures such as fan static pressure, air volume, current drawn, fan speed, air temperature and altitude etc.

TROUBLESHOOTING			
PROBLEM	**SYMPTOMS**	**POSSIBLE CAUSE**	**OTHER CAUSES OR ACTION**
NOISE	Impeller hits inlet ring	Damaged impeller	Correct or change impeller
		Damaged inlet ring	Correct or change inlet ring
		Impeller not centered on shaft	Center the impeller
		Shaft loose in bearing	Tighten shaft
		Impeller loose on shaft	Tighten impeller
	Noise from drive system	Belts too loose	Adjust belt tension
		Belts too tight	Adjust belt tension
		Belts wrong section	Install correct section belts
		Belts worn	Change belts
		Belts oily or dirty	Clean belts
		Belts length different (multi-belt drives)	Install correct belts.
		Drive systems hits drive guard	Check drive system and drive guard.
		Fan, motor or motor base fixing bolts loose	Tighten bolts
		Pulleys misaligned.	Align pulleys
		Variable speed pulleys not adjusted so each groove has different diameter.	Adjust each groove to same diameter for required air flow
		Fan shaft bent	Correct or change shaft
		Motor bearings damaged	Change bearings
	Noise from bearings	Loose on support	Tighten bearings
		Loose on shaft	Tighten shaft
		Bearings worn or damaged	Change bearings
		Bearings need lubrication	Lubricate bearings
		Foreign material inside bearing	Clean bearings
		Corrosion between shaft and bearings	Clean corrosion, if the shaft worn change shaft
	High air velocity	Ductwork undersized for application	Check duct size and revise if necessary
		Fan size is too small for application	Change size of equipment, revise if necessary
		Coil with insufficient face area	
		Registers and/or grilles undersized for application	
		Worn or damaged impeller	Change impeller
		Unbalanced impeller	Balance impeller
		Foreign material in fan housing or inside the unit	Clean fan housing
		Vibrating ductwork	Stiffen ductwork
		Vibrating casing parts	Isolate vibrating parts properly
		Vibrating parts not isolated from building	
		Obstruction in dampers, registers, grilles	Check and remove any obstructions
		Leaks in casing and ductworks	Seal leaks
		Sharp elbows	Remove sharp elbows, install elbows with proper radius and turning vanes
		Sudden expansion or reduction in ductwork	Install expansion/reduction sections with proper expansion/reduction angles

TROUBLESHOOTING (cont.)			
PROBLEM	**SYMPTOMS**	**POSSIBLE CAUSE**	**OTHER CAUSES OR ACTION**
NO AIR FLOW Motor is not running	Current is not reaching motor	Electric power failure	Locate fault and restore power
		Starter overload tripped	Faulty wiring motor. Loose terminals.
		Control panel fault	Locate and correct fault.
		Isolating switches off	Time clock error
	Current available to motor	Motor bearing seized	Lack off correct lubrication
		Incorrect wiring to terminals	Motor internal wiring fault
		Faulty motor windings	Overheating or overloading incorrect electric supply
	Fan is not running	Impeller loose on shaft	Tighten impeller, check the belts
	Fan is running	Duct blockage	Rubbish blocking duct
		Impeller loose on shaft	Tighten impeller
LOW AIR FLOW		Filters are dirty or clogged	Change or clean filters
		Coils are dirty or clogged	Change or clean coils
		Fan rotation is not correct or impeller installed backwards	Correct fan rotation, check that impeller is properly installed
	Drive belts are slipping	Belts are not tight or are greasy	Tighten belts, clean the grease
		Duct resistance exceeds design criteria. Poor duct design	Check duct pressure losses and duct design
		Dampers/registers closed	Adjust dampers/register for required air flow conditions
		Drive system is wrong. Fan speed is low	Consult manufacturer to check whether drive system is properly selected or not
	High leakage on pressure side of the system	Access doors are loose. Duct joints are unsealed. Outlet duct system is not completed	Check access doors and duct joints. Seal leaks. Complete duct system.
HIGH AIR FLOW		Ducts are oversized or duct resistance overestimated.	Close balancing dampers or slow down fan by changing pulleys
	High leakage on suction side of the system	Access doors are loose. Duct joints are unsealed. Suction duct system is not completed.	Check access doors and duct joints. Seal leaks. Complete duct system
		Drive system is wrong. Fan speed is high	Consult manufacturer to check whether drive system is properly selected or not
	Motor current is excessive	Supply voltage is low	Motor overloads. Check current drawn by motor
		Registers/grilles not installed	Install registers/grilles
		Filters are not installed	Install filters
		Filters are clean so low initial pressure differential	Regulate on dampers
HEATING COIL No heating	Boiler plant is off	Power failure	Pump failure. Thermostat failure. Time clock error. Fuel blockage.
	Heating fluid is off or cold	Air lock	Blockage in coil or pipes
		Automatic valve is closed	Thermostat failure, valve motor failure
		Isolating valves are closed	Circuit valves are closed.
	Heating mains is cold	Boiler flow temperature is low	Thermostats should be adjusted. Boiler power is in adequate
HEATING COIL Low heating	Heating fluid flow rate is low	Regulating valves are partially closed	Pumping power is not sufficient.
AIR WASHER Low humidifying		Low water flow	Blockage in system. Valves are closed. Leakage in piping
		Low water level in water pan	Float valve is off. Supply water is off.
		Water distribution system is clogged	Clean the system.
		Strainer is clogged	Clean the strainer
		High air flow	Refer to “high air flow” section

TROUBLESHOOTING (cont.)			
PROBLEM	**SYMPTOMS**	**POSSIBLE CAUSE**	**OTHER CAUSES OR ACTION**
COOLING COIL No cooling	Cooling fluid temperature is high	Refrigeration plant cycles on- off	Refrigeration plant capacity is insufficient. Circulating pump or compressor fault. Excessive heat gain in piping system.
	Insufficient coolant flow	Valves are partially closed or blockage in the system	Circulating pump or compressor fault
	Cooling coil is partially frozen	Low load	Refer to “no cooling, safety device stops compressor” section
		Low suction temperature	
		Low air flow	Refer to “ low air flow” section
		Entering air temperature is too low	Apply reheat or preheat
		Poor distribution on cooling coil	Unequal air velocity. Poor duct connections
No cooling	Chilled water isolating valves are closed	Thermostatic valve is closed	Thermostatic failure. Circulating pump failure
	No air flow		Refer to “no air flow” section
	Faulty thermostatic gear	Cooling thermostat setting is high	Locate and correct fault
	Safety devices stops compressor	High pressure cut-out disconnects	Fault in condenser. Fans or pumps stopped. Condenser blocked. Heat rejection is not taking place.
	Safety devices stops compressor	Solenoid valve closed. Low pressure cut-out disconnects	Suction temperature is too low. Low airflow. Entering air temperature is too low. Oversized coil or compressor.
ELECTRONIC STEAM HUMIDIFIER No humidifying	Electronic power failure	Power is not reaching elements or control valve	Thermostatic gear fault
	Heater elements faulty	Safety cut-out tripped	Water make-up failure or insufficient water level in cylinder. Water treatment is required to avoid scaling.
	Humidistat setting is not correct	Control fault	Reset humidistat correctly
	Water is not available in cylinder		Check supply system
ELECTRONİC STEAM HUMIDIFIER Low humidifying	Heater elements faulty	Safety cut-out tripped	Water make-up failure or insufficient water level in cylinder. Water treatment is required to avoid scaling.
	Steam cylinder and heating elements are scaled	Water treatment is insufficient	Carry out maintenance or replacement
	Faulty thermostat gear	Humidistat calibration is not correct	Control valves are not opening fully. Manual valves or partially closed
	Steam supply rate is low	Steam-trap faulty	Manual valves or partially closed
ELECTRICAL HEATER			Locate fault and restore power
	Power is not available at controller	Main contactor de- energized	Safety cut out tripped / poor duct design adjacent to heater causes areas of uneven air velocity and overheating of casing
	Power available at controller	Thermostat set is too low	Step controller faulty
Low heat	Element failure	Elements down to earth	Elements disconnected / elements incorrectly wired / wrong voltage
	Thermostat set is too low	Step controller is sticking	Controller cams faulty / wiring fault / equipment fault