

Air-handling Units MANDÍK

INSTALLATION COMMISSIONING MAINTENANCE

MANDÍK[®]



ATEX II 2G IIB T4

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1 | GENERAL

This manual uses graphical symbols that point to important facts. They are:



This symbol indicates a potentially hazardous situation, which is immediately life-threatening or could cause damage to the unit or parts thereof.



This symbol indicates a risk of electric shock.



A symbol indicating important facts that relate to proper installation, commissioning and maintenance of the unit or parts thereof. It may also indicate a suggestion or comment for installation, commissioning and maintenance.

This manual includes regulations for proper execution of installation, commissioning and maintenance of Air-handling Units MANDÍK, series M/M+, P/P+, S/S+ and T/T+.



Prior starting any work on the unit, it is necessary to study these regulations and observe them subsequently. Compliance with these regulations is a requirement for proper operation, function and validity of warranty conditions. The manufacturer shall not be liable for any damage caused by improper use and all the risks shall be borne by the user.

This manual is intended for persons holding a valid license for servicing air-handling units. Air-handling Units MANDÍK may only be used in accordance with technical specifications TPM 088/12 and only for filtration, transport and treatment of air – heating, cooling, humidification and dehumidification. Any other use is not permitted.



Any unauthorized alterations to the unit, such as modifications, etc., that have not been agreed by MANDÍK, a. s., result in the termination of provided warranties and in the termination of guarantee of safe use and operation.

2 | RELATED DOCUMENTS

Each unit delivered is accompanied by the following documents:

- Warranty certificate
- Installation, operation and maintenance manual
- Technical specifications of the unit
- Certificate for the unit (Declaration of Conformity, TÜV-SÜD, hygienic report, EMC and LVD certification...)
- Documentation of an electric heater if supplied (Inspection Report, EC Declaration of Conformity, Installation and Operating Instructions, wiring diagram)
- List of used fasteners
- Drawings of the Measuring and Control System, if supplied
- Parameter settings of fan frequency converters or rotary regenerative exchangers
- Manual for the installation, operation and maintenance of the Measuring and Control System, if this system is included

Other documents on the web www.mandik.cz:

- Technical specifications for Air-handling Units Mandík – TPM 088/12
- Instructions for controlling and setting the SIEMENS Climatix controller
- Parameterisation from POL822 room device
- Manual for controlling AHU with wall-mounted control CP-M-B
- Manual for upload operating system of regulator Climatix with SD card
- Manual for controlling and setting with AMR-OP41 controller
- Manual for controlling and setting with AMR-OP70 controller
- Manual for controlling and setting with WRF04 controller
- Instructions for controlling and setting the SIEMENS – POL822 room and control device
- Instructions for controlling frequency converters DANFOSS, type FC 51
- Instructions for controlling frequency converters DANFOSS, type FC 101
- Instructions for controlling frequency converters DANFOSS, type FC 102
- Instructions for fast setting of frequency converters DANFOSS, type FC 51
- Instructions for fast setting of frequency converters DANFOSS, type FC 101

3 | SAFETY

The use of the units must comply with instructions contained herein.



When installing, wiring, commissioning, repairing and maintaining the units, it is necessary to observe the applicable standards, safety regulations and generally accepted technical rules!



Installation of the units, including connection of electrical installations, commissioning of the unit, repairs, maintenance and operation may only be carried out by a duly authorized natural or legal entity!

The following general instructions are considered as essential. Other recommended instructions are described in detail in the section on installation, commissioning and maintenance.

Prior starting the unit, the following items must be met:

- Installation of all safety devices of the unit, e.g. protective grilles of fans
- Firm closing of all service panels and doors of the unit
- Checking that there are no people inside the unit or within the dangerous area around the unit
- Instructions for initial start-up of the unit and commissioning and instructions for maintenance are given in the appropriate sections of this manual

The unit may be operated under the following conditions:

- The unit is located in an area with the risk of presence of explosive atmospheres (does not apply for ATEX units)
- The unit is located near magnetic fields
- The air entering the unit contains aggressive gases or chemical particles, or the air temperature is lower than -30 °C and higher than + 50 °C

The unit must not be entered or must not be worked on in any way if the following items are not met:

- The unit is disconnected from the power supply.
- All the rotating parts (fans, rotary regenerative exchangers, etc.) have stopped.
- Minimum waiting time of 15 minutes is required for fans and motors that are equipped with frequency converters due to residual voltage
- The unit is secured against accidental starting (e.g. with a service switch)
- The heat exchangers and components of the hydraulic system have cooled to the ambient temperature, max. surface temperature is +40 °C
- The pressure values of the pressure systems are at ambient pressure
- The operators must be equipped with appropriate protective equipment
- There is not explosive environment inside the unit

4| HANDLING, TRANSPORT AND STORAGE

- Units are delivered as individual chambers or compact blocks. The roof for the outdoor units are delivered as mounted with the unit
- The units are delivered wrapped in plastic film; larger chamber and units for export are wrapped and seated on pallets. Packaging methods can be arranged individually



CAUTION: the plastic film is transport packaging to protect the chambers during transport and must not be used for long-term storage of the chambers. Changes in temperature during transport may cause condensation of water vapour inside the packaging and thereby conditions may arise inside the packaging that are suitable for corrosion of materials used in the chambers (e.g. white corrosion on zinc-coated items). Therefore, it is necessary to remove the transport packaging immediately after the transport and allow air into the chambers to let the chamber surfaces get dry

- When transporting and relocating, the individual chambers must only be transported using forklift trucks or conveyor belts and the relevant safety regulations (ISO 8792) must be observed. The chambers must only be lifted from the bottom. When lifting with a crane, it is necessary to use belts led under the unit. With larger items, it is necessary to open the belts at the top or to reinforce additionally the points where the belt could cause deformation of the chambers. When transporting with a fork-lift, it is necessary to support a chamber along the entire width of the chamber to prevent damage to the chamber bottom.
- Permitted handling methods are shown in the following figures.
- Upon receipt, it is necessary to check whether the product has been delivered in the agreed design and scope and whether it has not been damaged during transport. In the event of damage during transport, the person receiving the product must record the extent of damage in the carrier's delivery note. Failure to do so will give rise to the risk of rejection of the claim for damage caused during transportation
- The units must be stored in dry, dust-free, spaces protected against rain and snow where the ambient temperature does not drop below +5 °C, and they must be protected against mechanical damage, contamination and corrosion caused by continuous condensation of water vapour on the unit surfaces



CAUTION: If the equipment is suspended during transport, it is necessary to stay away within a safe distance from the load, never under the load. Keep lifting acceleration and speed within safe limits. Never leave the equipment suspended for longer than is absolutely necessary!

Permitted handling methods:

1) TRANSPORTATION AND HANDLING USING A PALLET TRUCK



There are openings in the chamber base frame designed for this purpose. When using a pallet truck, the forks must always be under the entire chamber; see the figures.

2) TRANSPORTATION AND HANDLING USING A FORK-LIFT TRUCK

There are openings in the chamber base frame designed for this purpose. When using a fork-lift truck, the forks must always be under the entire chamber.



CAUTION: A chamber is not always balanced in terms of weight. Handling and lifting height must be adjusted accordingly!

3) TRANSPORTATION AND HANDLING ON A DISPOSABLE PALLET

When using a disposable pallet, the forks of a pallet/fork-lift truck must always be under the entire chamber.



CAUTION: A chamber is not always balanced in terms of weight. Handling and lifting height must be adjusted accordingly!

4) HANDLING WITH CHAMBERS WITHOUT A BASE FRAME USING SLINGS

Chambers without base frames are delivered on disposable pallets. The slings must always be led under the entire chamber length or width (in the direction of air flow). The slings must always be on the edges of the chamber because of weight balance. The chamber can be transported in the horizontal working position only.



To prevent deformation of the chamber at the points that are exposed to the pressure of the sling, the slings must be opened above the chamber as shown below, or the contact points must be provided with a sufficiently rigid items as shown above.





CAUTION: Only suitable and approved fastening devices must always be used for handling and transporting the chambers!
Observe all applicable technical and legal regulations of the country when handling. For example EN 13 155+A2, ISO 12480-1

If the chamber is equipped with a roof, the slings must always be opened sufficiently above the chamber so the straps do not deform the roof and chamber frame.

5) HANDLING WITH CHAMBERS WITH A BASE FRAME BY MEANS OF STEEL PIPES AND SLINGS



The pipes must be led through circular openings in the corner of the base frame along the entire chamber length or width. The minimum overhang of the pipe as compared to the slings is 100 mm. The pipe ends may be provided with clips to prevent slipping of the slings. The pipe diameter is 40–45 mm. The minimum pipe wall thickness is 5 mm. The minimum angle of the sling relative to the top edge of the chamber is 50 °. See the figure above. The chamber can be transported in the horizontal working position only. If the chamber is equipped with a roof, the slings must always be opened sufficiently above the chamber so the straps do not deform the roof and chamber frame. If the base frame is equipped with feet, as shown in the figure above, the process of passing through the pipe and tying the slings is the same as with the base frame without feet.



To prevent deformation of the chamber at the points that are exposed to the pressure of the sling, the strap must be opened above the chamber as shown below, or the contact points must be provided with a sufficiently rigid items as shown above.



CAUTION: For handling and transport of the chambers, only appropriate and permitted slings must always be used!

During handling, comply with all the applicable technical and legal regulations of the country, e.g. EN 13 155+A2, ISO 12480-1.

6) MANIPULATION OF THE CHAMBER WITH THE HELP OF A CRANE WHEN HANGING ON SEPARATE CRANE EYES



Separate crane eyes are designed only for chambers with a maximum weight of 400 kg or an even load of 100 kg per eye.

To lift the chamber with a crane, it is necessary to use suitable fastening means, which are mainly frame crossbeams with hooks, spacer crossbeams with hooks or chain hinges with hooks.



The crane may only be operated by a professionally qualified person with the appropriate authorization to operate the crane (crane operator).

Tying and untying of loads may be performed only by a binder with the appropriate authorization for this – a binding card.

We use it as a guide rope to prevent the load from swaying or rotating during transport and allows the load to be positioned correctly.



CAUTION: The tetherer must ensure that the load is not transported over persons and must not remain under the load. Passers must be alerted to movement in a timely manner.



The minimum clamping angle of the chain to the upper edge of the chamber is 60 °.

Separate crane eyes are only temporary elements, they should be removed from the chambers after handling. The crane eyes are attached to the ceiling of the chamber using 4 M8 screws. A size 13 key is required to enable them.

If it is an outdoor unit, then after dismantling the crane eyes, it is necessary to assemble and mount the roof of the unit on its ceiling.

7) MANIPULATION OF THE CHAMBER WITH THE HELP OF A CRANE WHEN HANGING ON CRANE EYES WITH A HIGHER LOAD CAPACITY



Separate crane eyes are designed only for chambers with a maximum weight of 2700 kg or an even load of 675 kg per eye.

To lift the chamber by crane, it is necessary to use suitable fastening means, which are mainly frame crossbeams with hooks, spacer crossbeams with hooks or chain hinges with hooks.



The crane may only be operated by a professionally qualified person with the appropriate authorization to operate the crane (crane operator).

Tying and untying of loads may be performed only by a binder with the appropriate authorization for this – a binding card.

We use it as a guide rope to prevent the load from swaying or rotating during transport and allows the load to be positioned correctly.



CAUTION: The tetherer must ensure that the load is not transported over persons and must not remain under the load. Passers must be alerted to movement in a timely manner.



The minimum clamping angle of the chain to the upper edge of the chamber is 60 °.



Separate crane eyes are only temporary elements, they should be removed from the chambers after handling.

The crane eyes are attached to the ceiling of the chamber using 2 M10 screws and one M10 threaded rod with two nuts. Two size 17 wrenches are required to loosen them. The two screws can be completely removed. The threaded rod is provided with a groove for the use of a screwdriver, by means of which it is possible to screw the threaded rod into the chamber shell. Make sure that the threaded rod is not screwed in too deep to allow it to be reused. After disassembly, we recommend storing the crane eyes with screws and nuts for later use.

If it is an outdoor unit, then after dismantling the crane eyes, it is necessary to assemble and mount the roof of the unit on its ceiling.



CAUTION: For handling and transport of the chambers, only appropriate and permitted slings must always be used!
During handling, comply with all the applicable technical and legal regulations of the country, e.g. EN 13 155+A2, ISO 12480-1.

5| ASSEMBLY AND INSTALLATION

5.1 GENERAL

- Installation of the units may only be performed by an authorized person. The person performing the assembly must meet technical and legal regulations of the country. E.g. EN 45004, Act 174/68 Coll.
- Connections and grounding of the electrical equipment of the electric motor and any electrical wiring must comply especially with EN 33 2190, EN 33 2000-4-41, EN 33 2000-5-51, EN 33 2000-5-54, applicable regulations, the actual environment with regard to safe operation.
- The unit and its accessories must be commissioned by an authorized and trained specialist technician only who is familiar with the equipment and the hazards associated with it
- Before installing the unit, it is necessary to check construction readiness, power supply system parameters, the temperature and pressure of cooling/heating media, completeness and condition of the unit's components
- defects must be removed prior installation
- The unit and its accessories must only be connected to the mains voltage of 230 V / 400 V, 50 Hz
- Access to the switchboard, to which the assemblies are connected, must be provided. Power components in the switchboard (breakers, contactors, switches, etc.) must be marked clearly with the device number under the HVAC project!
- The presence of the representatives of the installer and user at the operators' training is recommended



The unit can not perform any functions of the building, such as a static load of the building and its related components to the unit operation, place of installation for bridges and electric distribution, switchboards, etc., apart from exceptions consulted with Mandík, a. s. Failure to do so will void the warranty provided by Mandík, a. s.

- It is recommended to use protective gloves when installing and handling with the unit
- When handling and lifting, the chambers of the unit must be transported using forklifts and conveyor belts only and it is necessary to follow the relevant safety regulations. The unit will not be transported over people! See Section 4. Handling, Transport and Storage
- Before installation, it is necessary to remove all supports and reinforcements delivered with the unit for its transportation
- The gas heater burner must be adjusted after mounting it on the chamber



The overall transport pressure of the ventilator is designed to design external pressure losses – in front of and behind the fan, see the unit's technical specifications. Accordingly, it is necessary to observe the installation of the air-handling ducts – without any additional local pressure losses that may result, after adjusting, higher operating point of the fan and thus power consumption of the electric motors.

5.2 IDENTIFICATION OF UNITS

Each chamber of the unit is provided with a label, which lists the basic information for installation, maintenance and service; see the following figure:



① Location of label on the chamber

MANDÍK		MANDÍK, a.s. 267 24 Hostomice	Hostomice 550 Česká republika
① Prod.No	0701-997	Position	C M8 ④
VENTILATOR SECTION ⑤			
ER45Cpro, Vn=7490 m3/h, Pex=250 Pa ⑥			
3 kW, 400 V, 5.9 A, FOP=73 Hz ⑥			
② Weight: 156 kg		Cert.A0227 No 227/CS/2014/0552 ⑦	
③ k factor=197			

① Unit's serial no. (total HVAC assembly)



② Total weight of the chamber

③ Additional information, e.g. k-factor for calculating air-flow rate through the fan

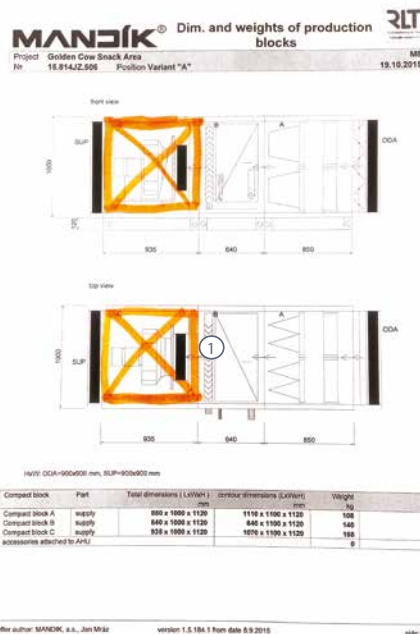
④ Chamber position within unit (F), type size of the unit (M75)

⑤ Type – chamber in-built device

⑥ Basic parameters of the chamber in-built device

⑦ Additional information, e.g. Product Construction Certificate

Each chamber is fitted with an overall view of the Air-handling Unit Mandík, in which the position of the chamber is highlighted; see the figure below:



① Layout marking of the given chamber in the assembly

5.3 GENERAL SEATING OF THE UNIT

- Minimum space for basic maintenance and servicing of 600 mm on the operators' side
- Minimum space for repair and replacement of equipment is the width of the unit + 200 mm
- Minimum distance of flammable objects from the unit is 200 mm
- Units for outdoor installation must be secured sufficiently to its foundations, due to stability, according to the expected climatic conditions

5.4 SEATING OF THE UNIT ON THE FLOOR

- Permitted handling with the chambers due to installation is described in Section 4.
- The units must be placed on a firm level surface, to which they may be anchored firmly. It is suitable to place damping material (e.g. rubber, cork) under the base frame of the unit at the place of installation
- The maximum permissible deviation from the horizontal plane is 0.5 % (0.3 °)
- When installing the unit outdoors, it is recommended to seat the unit on a steel frame (supplied by a building company). The maximum allowable deflection of the frame is 1/1000 of the frame beam length
- It is necessary to take into account the sufficient height of the unit above the floor/ground because of the sufficient height of the siphons fitted to the chambers with condensate draining; see Section 5.26 INSTALLATION OF SIPHONS.
- Units with chambers installed one above the other may be equipped with central frames for better handling. Installation of chambers with central frames is described in Annex A. INSTALLATION OF CHAMBER CENTRAL FRAMES



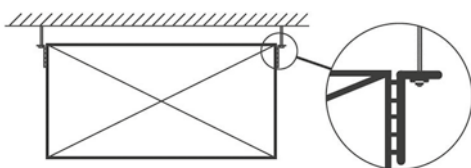
The unit must be supported (floor / steel frame) under the entire perimeter its base frame, including the inner frames - otherwise there is a risk of the bottom bending chambers and damage to internal structures!!!



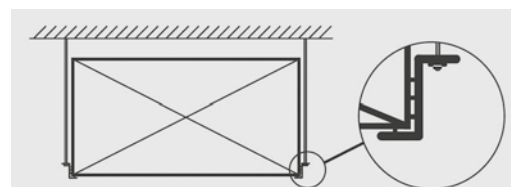
Failure to maintain stability or horizontality of the base may result in deterioration of the function of the unit or its damage, such as misalignment of the rotor of the rotary regenerative chamber, impossibility to close the door, misalignment of the chamber connection openings, etc.!

5.5 SEATING OF THE UNIT UNDER THE CEILING

- The operators' side of fan, filtration and other chambers, which are equipped with door or service panels, must be seated downwards
- To ensure proper function, the unit must be seated horizontally
- Chambers of units designed to be suspended from the ceiling are factory-equipped, as standard, with components designed as suspension L-profiles or Z-profiles fitted with rubber stabilizers to reduce the transmission of vibrations and noise into the building structure; see the figure



L-PROFILE



Z-PROFILE

- To suspend and support the units, it is possible to use conventional suspension technology designed for air-handling units, such as profiles or threaded rods. To reduce the transmission of vibrations and noise, it is recommended to use standard spring components!
- To lift the unit chambers, it is necessary to use suitable lifting equipment, such as a forklift truck, lifting transports, etc.
- When installing the unit to the ceiling, it is necessary to provide openings in the ceiling structure for maintenance and service

5.6 GENERAL ASSEMBLY OF THE UNIT

Prior assembling the unit, the following tasks must be performed:

- Checking the unit seating and the stability of the base surface – the unit chamber are seated/ supported across the entire floor area, the unit is seated horizontally with a maximum permitted tolerance, damping material is inserted between the unit and the base surface or the steel frame
- Removal of the packaging film from each chamber
- Removal of inserted parts in the unit (cardboard boxes of fasteners, frequency converters, control nodes, gas heater burners and other accessories) and placing them at a safe and dry place
- Checking the material for connecting the chambers. The types and quantities of materials are listed in the accompanying documentation provided with the unit



The material needed to connect the individual chambers is enclosed in a cardboard box which is housed in one of the chambers of the unit. In addition, the box is always marked with the order number (eg KFI60001) and the unit serial number (eg 0701-100) for identification.

To assemble the unit, the following fasteners are supplied (for assembly for see Section 5.7):



Seal 50 × 5 mm for the units of types M2-M18 or P1-P18



Seal 30 × 5 mm for the units of types M20-M100 or P20-P100



Assembly of straight eccenters



Assembly of rectangular eccenters



PU sealant for roof mounting

The rectangular eccenters and the PU sealant for roofs are supplied based on the configuration.

5.7 CONNECTION OF THE VERTICAL/HORIZONTAL AND CEILING UNIT

The procedure of connecting the unit chambers:

- Gluing on of the seal to the chamber flanges – always to one flange of the two adjacent chambers, as shown below.



- ① Opposite chamber flange with seal
- ① Chamber flange without seal

There are two types of flanges or two procedures of fixing the seal as shown in the figures below:

- 1) 50MM FLANGE (SMALLER UNITS, CASING T3 TB2 / T2 TB1)



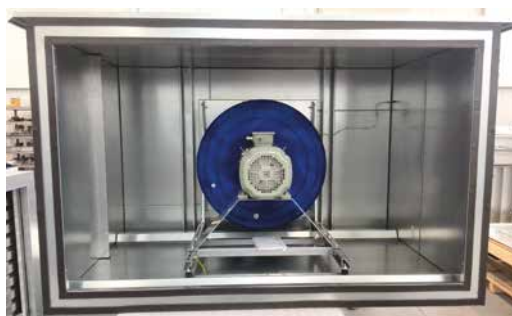
Use the 50 × 5 seal from the supplied fasteners.

For indoor placement of the unit is packed polyurethane gasket ST, for outdoor placement is packed from EPDM.



Glue on the seal in one row around the flange circumference. The connecting seals must adhere to each other and must not create a gap that causes untightness, as shown above.

- 2) 100MM FLANGE (BIGGER UNITS, CASING T3 TB2 / T2 TB1, ALL UNITS WITH CASING T1 TB1)



Use the 30 × 5 seal from the supplied fasteners.

For indoor placement of the unit is packed polyurethane gasket ST, for outdoor placement is packed from EPDM.

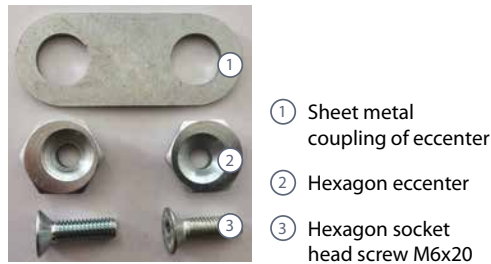


Glue on the seal in two rows around the flange circumference as shown in the figure. One row of the seal must be glued to the outside section of the flange and the other row must be glued to the inside section of the flange. The connecting seals must adhere to each other and must not create a gap that causes untightness.

■ Use of connecting eccentric pieces

To connect the chambers of vertical (chambers one above the other) or horizontal (chambers side by side) units, use connecting eccentric pieces. The types of eccentric pieces and their functions and assemblies are shown in the figures below.

1) Straight connecting eccentric piece – for outline-aligned chambers



Assembly for one connection.



'Loosened' position



'Tightened' position

2) Rectangular eccentric piece – for chambers with different outlines, e.g. the chamber of the rotary exchanger, the chamber of the gas heater



Assembly for one connection.



'Loosened' position



'Tightened' position

■ Connection of the chambers using connecting eccentric pieces

The casing of each chamber is fitted with vertical rows of pressing M6 nuts for mounting the connecting eccentric pieces; see the figure below.



① Pressing nut for connecting eccentric piece

The pressing nuts of the connections of adjacent chambers can be placed on the outer side of the chamber shell or on the inner side. It always depends on the configuration of the unit. The mounting procedures for the connecting eccentric pieces for both the location types are identical.



The final form of mounting the connecting eccentric pieces is shown below. To ensure the proper function of the eccentric pieces and the seals between the chamber flanges, it is important to tighten the bolts to the 'tightened' position; see the figure below.

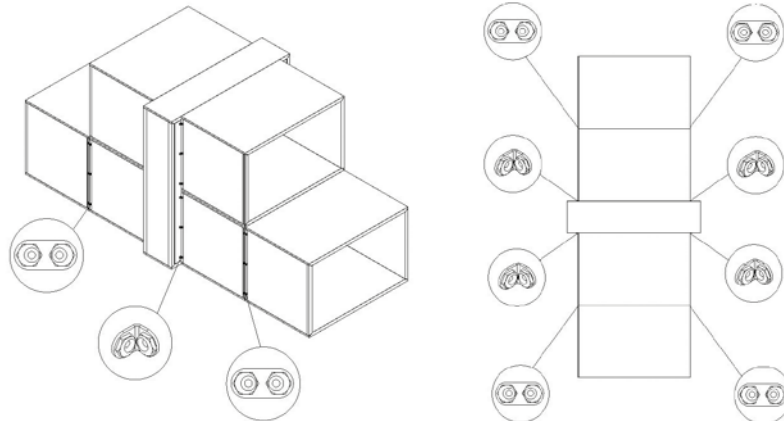


① Drawing of chambers together without gap
② 'Tightened' position of eccentric

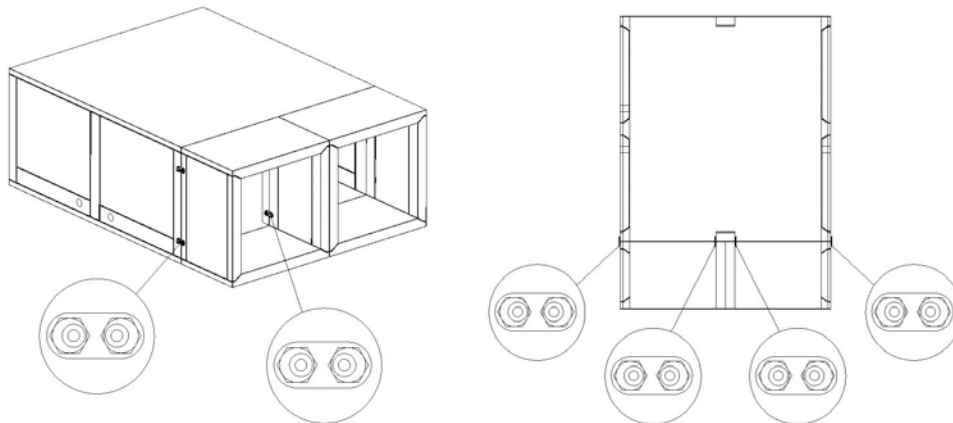


The eccentrics for connecting the chambers do not serve as an element for moving the chambers to the assembly position for final tightening of the eccentric !!! It is necessary to use a suitable tool such as a lever clamp, which can be pulled through the chambers through the side circular holes of the base frame or use tightening straps to pull adjacent chambers through the flanges.

According to the unit configuration, both the types of the connecting eccentric pieces (straight or rectangular) and both the types of pressing nut location (outer or inner) may be present in a single unit. The following figure shows an overview of the possible unit configurations:



Outer connection of the chambers. A combination of the straight and rectangular eccentric pieces. See the figure above. (an example of a vertical assembly with a rotary regenerative exchanger)



Outer and inner connection of the chambers (an example a horizontal assembly with a plate recuperative exchanger). The figure above.



This type of unit and the method of connecting the chambers are identical to the ceiling-mounted unit.

5.8 CONNECTION OF THE UNIT DESIGNED FOR EXTERIOR USE

The necessary chambers for the units designed for the exterior use are fitted with roofs. The roofs are factory-mounted on the given chambers. The correct procedure for connecting the roofs is shown in the figure below.

The chamber roof sides on the side of connecting with an adjacent chamber are always finished with two types of connections – 'Z' and 'U'; as shown below.



① 'U' connection

② 'Z' connection



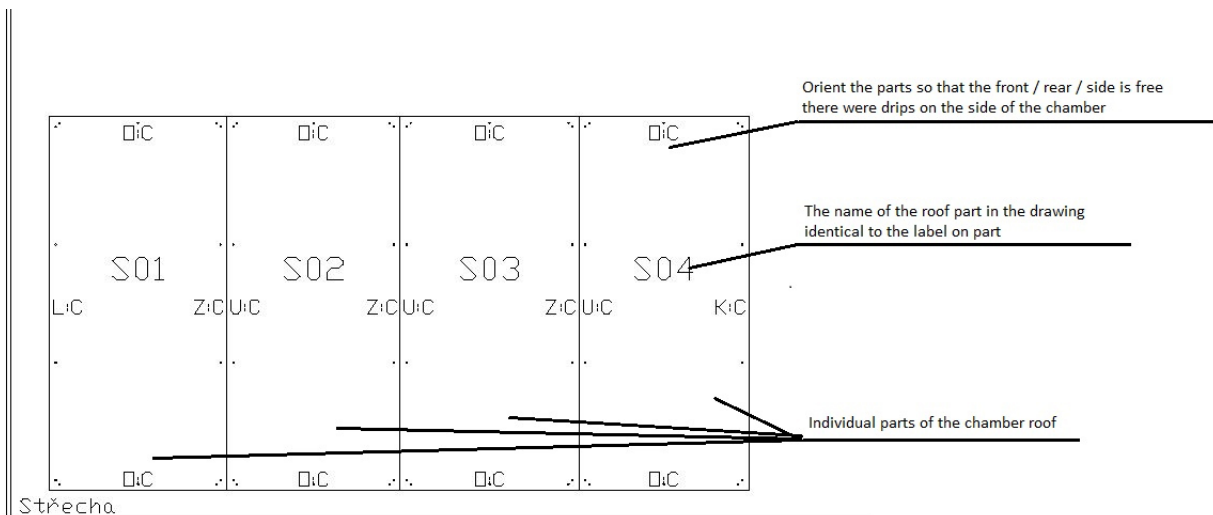
Prior connecting the chambers, it is necessary to apply PU sealant from mounting kit on the roof connections. Correct assembly of the chamber and the roof can be seen in the following figure.



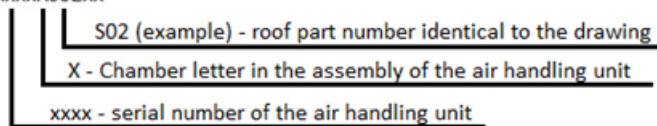
- ① Seal the roof connection with PU sealant
- ② Correct contact of roof pieces
- ③ Seal 50 × 5 mm or 30 × 5 mm
- ④ Eccentric pieces in the 'tightened' position



If the roofs are packed on a pallet, it is necessary to fit them and fasten them individually chambers. For each chamber, the roof parts are packed separately, including a drawing for correct fitting of individual roof parts on the given chamber. Each part of the roof is provided with a label with the name of the part according to the drawing. See the following figure.



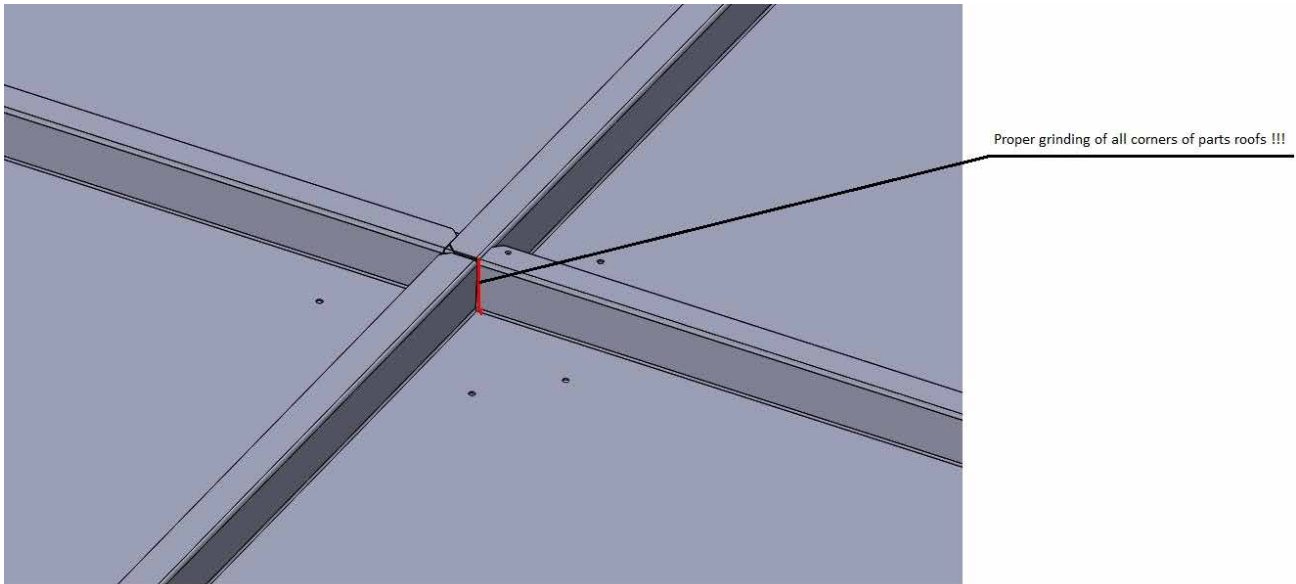
Název dílu na štítku: 701-xxxxXS02xx



(The image of the roof is located in the lower left corner of the drawing.)



Use self-tapping screws with a rubber washer to fasten the individual roof parts pre-prepared holes in the roof and chamber parts. The screws are included in the mounting kit. For the correct function of roofs, it is very important to properly grind the parts between each other and between the chambers, including corners!!! See the following figure.



5.9 CONNECTION AND ASSEMBLY OF THE CHAMBER OF THE SPLIT PLATE RECUPERATING EXCHANGER

The units of type M20 or P20 or higher can be designed and delivered in a split design. Detailed description of the assembly is given in Annex B. ASSEMBLY OF SPLIT RECUPERATION

5.10 CHAMBER OF FILTER G2–F9/GREASE

The chamber contains filter elements – type pre-filter (G2–G4), or pocket filter elements (G4–F9) or grease filters. The filter chamber is factory-fitted with filter elements as standard.

In another case, they are supplied in a cardboard box, which is located in one of the unit chambers or on a separate pallet. This depends on the size of the box.

The chamber grease filter can be fitted, on request, with a tray to trap smear and grease. Its outlet is fitted with a stainless steel DN32 pipe for mounting piping.



Based on request, the chamber, if supplied, is fitted with a differential pressure switch or a digital differential pressure gauge. In another case, the recommended assembly is described in the 'Manual for Installation, Operation and Maintenance of the Measuring and Control System'.

The recommended settings of end pressure losses of filters of each filtration class are specified in Annex H. RECOMMENDED END PRESSURE LOSSES OF FILTERS.

Based on request, the chamber, if supplied, is fitted with a liquid pressure gauge with an inclined tube for visual inspection. In another case, the recommended assembly is described at the end of this paragraph.

There are two types of mounting filter elements. The types and procedure of mounting filter elements into the filter chamber is as follows:

1) Downforce rail – for units up to 2500 mm clear width

- For gluing on of the EPDM seal, 12 × 10 mm, to one of the two adjacent elements see the figure below:



The seal is inserted into the box with the filters.

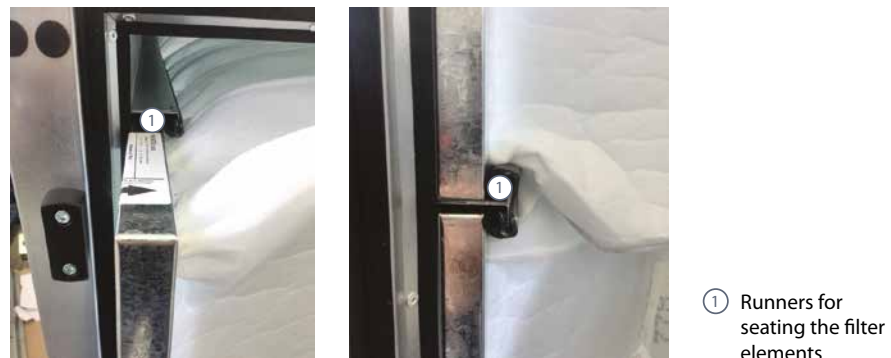


The filter,tridge gasket is already factory installed on the filter frame. Thus, it is not necessary to glue the seals to the filter cartridges themselves, even when replacing them



Release the filter elements with the slider -> pull towards you

- Gradual insertion of the elements into the runners.



The composition of the filters is shown at the end of paragraph 5.10

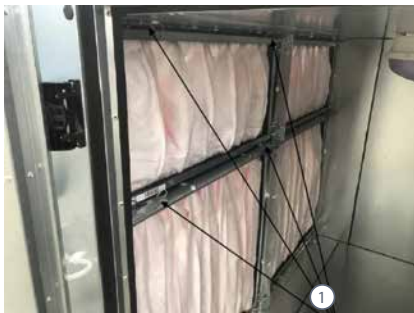
2) Mounting frames – for units above 2500 mm clear width or based on request from selection software

The inserts are always inserted from the dirty side and so that the insert frame pushes into the storage frame. See the following illustration for the bearing direction.

- Gradual mounting of the elements into the mounting frames using a clamping mechanism. The elements are always inserted from the dirty side and in such a way that the frame pushes the elements into the mounting frame. For the direction of mounting see the figure below.



The composition of the filters is shown at the end of paragraph 5.10



- ① The filter inserts are clamped into the storage frames using a clamping mechanism (in each corner of the storage frame)



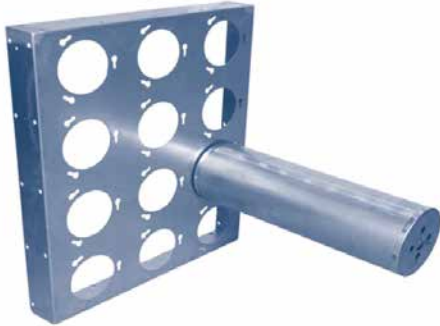
The filter cartridge gasket is already factory installed on the filter frame. Thus, it is not necessary to glue the seals to the filter cartridges themselves, even when replacing them.

Filter composition of M / M +, P / P + and T / T + sizes and dynamic (own) cross-sections are given in the order technical specification, in the filter section

Filter	air flow 5040 m ³ /h, pressure loss 116 Pa
Filter parts composition	1 × 592 × 402 mm, 1 × 592 × 287 mm, 1 × 490 × 402 mm, 1 × 490 × 287 mm
Pressure loss reserve	84 Pa
Filter class, length	(M6) ePM10 65 % – bag filter 630 mm
Type	KS PAK 62 – synthetic
Total filter surface	12.89 Pa
Filter area per m ² cross-section	16.74 m ² /m ²
Initial pressure loss	32 Pa
Max. allowed final pressure loss	450 Pa

5.11 CHAMBER OF ACTIVATED CHARCOAL FILTER

The chamber contains adsorbent cartridges filled with granular activated charcoal. Cartridge length may be 450 or 625 mm. The cartridges are mounted in a mounting frame by means of a bayonet system, as shown below.



The activated charcoal filtration cartridges are supplied separately. They are mounted into the chambers during final assembly after cleaning the entire air-handling facility.

5.12 CHAMBER OF FAN WITH FREE IMPELLER

The chamber includes a fan unit – a free impeller with backward curved blades and an electric motor. The fan chamber is factory-fitted with the unit as standard. The unit is statically and dynamically balanced (vibration intensity less than 2.8 mm/sec. according to DIN ISO 14694); therefore, it is not necessary to perform additional balancing.

Two types of electric motors are used for driving the fans:

- Three-phase asynchronous electric motors with a short-connected rotor are powered by voltage 3× 400 V / 50 Hz. At the nominal rating on the motor nameplate of 230 V D/ 400 V Y 50 Hz, the motor is wye-connected; at the rating of 400 V D/ 690 V Y 50 Hz, the motor is delta-connected. All the necessary information can be found on the motor nameplate and on the lid of the terminal board. It is recommended to power the motors from a frequency converter set according to the motor rating values with sufficient acceleration time. When the motor is powered from the frequency converter, electromagnetic interference can be generated in the supply cables. Therefore, to connect the motor and the frequency converter drive it is necessary to use shielded cables and follow the instructions contained in the technical documentation to the frequency converter.
- EC motors are electronically commutated three-phase synchronous motors. They contain an integrated voltage converter, which controls the motor speed with an electrical signal. All the control and protection functions are integrated in a control unit located in the fan motor – it connects only the power supply of 1~230 V / 50 Hz or 3~400 V / 50 Hz and the control signal of 0–10 V. All the necessary information can be found on the motor nameplate. EC motors achieve, despite having small dimensions, a relatively high output and dynamics, they have a quiet and smooth running.

When the electric motor is powered from a frequency converter, it is necessary to connect thermistor terminals to the appropriate terminals of the converter under the condition of correct setting of the frequency converter.



Setting the parameters of the frequency converter is specified in the accompanying documentation to the unit.

Wiring diagrams for the AC and EC electric motors are presented on the lids of electric motor terminal boards. Typical wiring of the AC and EC electric motors is specified in Annex C. WIRING OF ELECTRIC MOTORS.

In case of delivering a measurement and control system, the specific wiring of electric motors or frequency converters is specified in the accompanying documentation 'Measurement and Control System of Air-handling Units MANDÍK'.

Based on request, the chamber, if supplied, is fitted as standard with a service safety switch. In another case, the recommended installation is described in the document 'Manual for the Installation, Operation and Maintenance of the Measuring and Control System'.

In the event of a request for wiring of the measuring and control system under Directive 2004/108/EC – Electromagnetic Compatibility (residential environment – resistance and emissions, industrial environment – resistance and emissions), the recommended procedures are specified in Annex D. ELECTRICAL CONNECTIONS IN ACCORDANCE WITH DIRECTIVE 2004/108/EC – EMC to this manual.

The electrical wiring diagram of the service switch is given in ANNEX J. ELECTRICAL CONNECTION OF THE SERVICE SWITCH / SERVICE SWITCH WITH FREQUENCY INVERTER

The fan chamber is equipped as standard with cable bushings for leading power conductors to connect the electric motor and the frequency converter; their dimensions are according to the electrical power input of the electric motor.



The fan chamber, when configuring the unit type M40 / P40 and larger, must be fitted a safety feature to prevent excessive overpressure behind the fan chamber against damage to the chambers or endanger the health of persons moving in the vicinity of the fan chamber or other chambers behind the fan

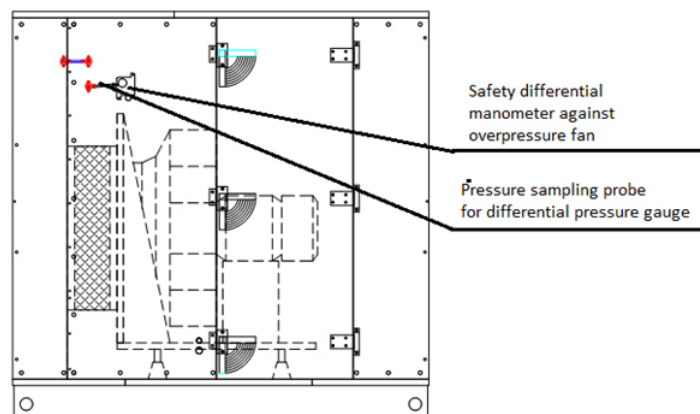
A differential pressure gauge, eg HK-Instruments PS4500, is recommended as a safety feature, in sufficient protection (IP65) if placed outdoors.



The differential pressure gauge must be connected to the MaR system in such a way that when the switching limit is exceeded value (open) the fan operation was switched off. The switching pressure value must be set to + 2000 Pa (ie overpressure behind the fan to atmospheric pressure). If the unit is ordered with the MaR Mandík system, a differential pressure gauge is included supplies and part of the drawing documentation of the MaR system. Depending on the choice attaching / fitting the components of the MaR system, the manometer is either packed with other elements MaR system or is mounted on a chamber.

The wiring diagram is given in ANNEX I. ELECTRICAL WIRING OF THE SAFETY FAN HIGH PRESSURE DIFFERENTIAL PRESSURE GAUGE

The fan chamber is equipped with a pressure intake as standard for easy installation differential pressure gauge. The mounting is shown in the following figure.



5.13 CHAMBER OF WATER HEATER

The chamber contains a plate exchanger designed for water or water-glycol mixture as the heat transfer medium. The heating chamber is factory-fitted with the exchanger as standard.

The heating chamber is factory-fitted, as standard, with a frame for a capillary anti-freeze thermostat.



The mixing junction for controlling the thermal output, if included, is supplied in a cardboard box in one of the unit chambers. The recommended installation of the mixing device is described in Section 5.25 INSTALLATION OF MIXING DEVICE. The wiring of the mixing junction is described in the document 'Manual for the Installation, Operation and Maintenance of the Measuring and Control System'.

The capillary anti-freeze thermostat, if supplied, is factory-fitted on request. In another case, the recommended installation is described in the document 'Manual for the Installation, Operation and Maintenance of the Measuring and Control System'.

Exchanger connections are marked INLET/OUTLET for proper connection of the mixing device or piping of the hydraulic system, as shown below.



Marking of exchanger inlet



Marking of exchanger outlet

The exchanger outlets are threaded for connecting the hydraulic system.

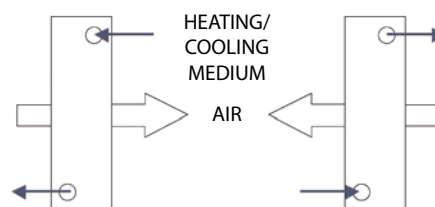


All the piping must be mounted independently of the exchangers. The weight and dilatation forces of the pipeline distribution of active fluids must not act on the unit blocks or on the heat exchangers. The connections must be made so that the dilatation of the pipes, caused by temperature, does not cause excessive loads on the mouths.

The connections must be tightened with two spanners. Otherwise, distortions of the thread may be caused!

An air-relief valve if not installed, must be mounted at the highest point of the hot water supply.

The exchanger is always connected in counter-flow! See the figure below.



Water for water exchangers must not contain impurities that cause clogging, especially the products of corrosion of steel and cast-iron parts. To prevent generation of these impurities, it is necessary to use chemically treated water – for its parameters see 07 7401.

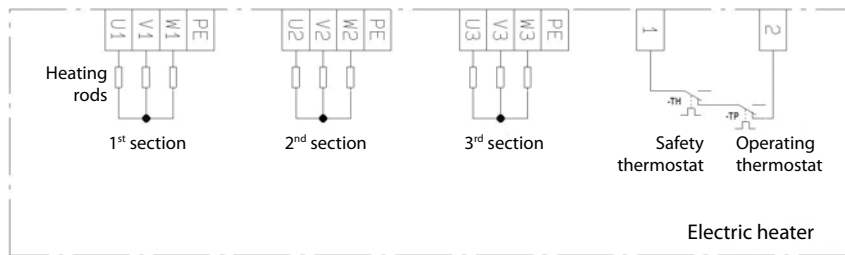
- Hydrogen exponent pH 7–9.
- Water hardness 1.0 mval.l⁻¹.
- Max. content of chlorides 30 mg.l⁻¹.
- Content of phosphates converted to P₂O₅, min. 15 mg.l⁻¹.

5.14 CHAMBER OF ELECTRIC HEATER

The chamber contains an exchanger with resistance elements, an operating thermostat and a safety thermostat with values fixed at +50 °C. The resistance rods are already factory-connected as standard; together with the thermostats they are wired to the terminal board. The terminal board is mounted on the operators' side of the exchanger.

The heating chamber is factory-fitted with the exchanger as standard.

The electric exchanger is rated for a voltage of 3~400 V / 50 Hz and it may include multiple sections, and the maximum power input of one section can be 48 kW. The diagram of the electric heater is in the figure:



Any interference with the electric heater may only be performed by personnel qualified according to valid regulations of the country in which the unit is put into operation!

Access to the terminal board is possible after removing the service panel with an Allen wrench – 5.0 mm. For connecting the power cables, the chamber is provided with screw-top PG cable bushings, which are located on a removable panel, as shown below.



Access to terminal board

- ① Panel removal is possible using Allen wrench 5.0 mm
- ② Cable bushings



Wiring of the heaters is described in the heater documentation or in the enclosed documentation 'Measurement and Control System of Air-handling Units MANDÍK' if the system is included.

Documentation of the heater (Initial Inspection Report, Quality Certificate, EC Declaration of Conformity, Installation and Operating Instructions, Wiring Diagram) is enclosed inside the heater.

The operating and safety thermostats must be connected properly to the control system. The thermostats are connected in a series and, at safe air temperatures inside the heater, their contacts are closed. Opening of the contact must switch off the electric heater. The operating thermostat is reset automatically at the moment when the heater has cooled down; the safety thermostat must be reset manually. The temperature must drop below the value set on the thermostat between the moment of thermostat overheating and the possibility of manual resetting. The condition for restarting the heater is to remove the cause of overheating. The operating thermostat is preset as standard to the temperature of about 50 °C in the air flow; the safety thermostat is preset to the temperature of about 50 °C in a suitable space of the heater that is affected by radiation of the heating elements.

The speed of the airflow in the unit's operating cross-section must not be less than 1 m/sec., otherwise the heating elements will overheat. In units with variable air output, this must be dealt with by setting increased minimum speed.

**Operation of the electric heater:****CAUTION: The heater must not be operated without the simultaneous operation of the fan!**

It is absolutely necessary to provide air flow through the heater, i.e. to start the fan first and to wait, according to its start-up time, until the normal operating point is reached. The heater may be started after reaching this state. Likewise, it is necessary to ensure run-out time of the fan of at least 5 minutes after turning off the heater to ensure sufficient cooling of the heating elements. Failure to observe this instruction relieves the manufacturer of any liability for damage caused by the heat accumulated within the body of the electric heater.

Surface temperature of the heating elements during operation exceeds highly the safe touch temperature of 60 °C. Prior starting any intervention or work in the chamber, it is necessary to wait until the exchanger cools down sufficiently!

The standard electric heater should not be installed in potentially explosive atmospheres; explosive or easily inflammable substances must be stored near the electric heater.

5.15 GHM GAS/OIL HEATER CHAMBER

The chamber contains an air heater with a flue gas-air exchanger. An overpressure gas/oil burner of corresponding power input is then mounted to the heater. On the operator's side, there are removable panels providing access for cleaning and checking the exchanger and for mounting an actuator of a bypass damper (if used). By default, the heating chamber is equipped during manufacture with a flue gas-air exchanger.

Furthermore, the heating chamber may be equipped with a bypass or a bypass damper to bypass excess air (as part of the design of the unit at a greater amount of supplied air as compared to an optimum amount of air flow through the gas exchanger). The bypass section can be located at the following positions:

- above the gas/oil exchanger in a common chamber (vertical position)
- next to the gas/oil exchanger in a common chamber (horizontal position)
- above the gas/oil exchanger in a separate chamber (vertical position)
- together above and next to the gas/oil exchanger (if there is excessive residual space around the exchanger)

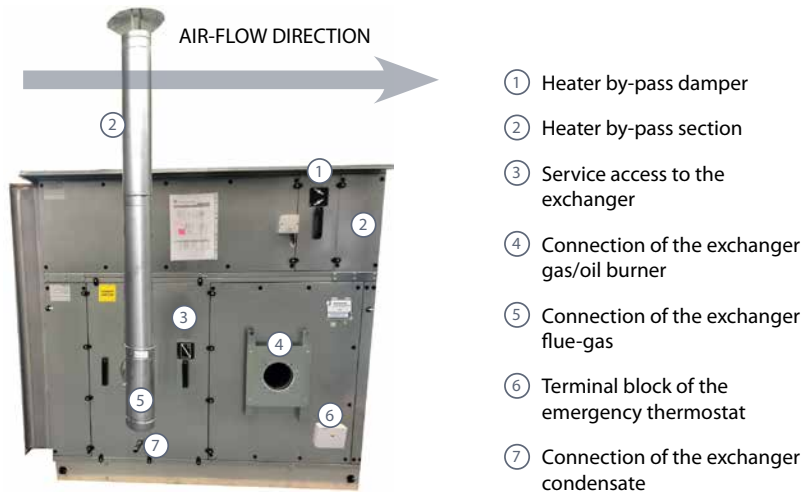
When installing, make sure that the chamber is oriented properly within the assembly (cold air first cools the tube plate carrying flue gas and then the combustion chamber itself). The exchanger is designed as a counter-flow one in order to utilize the maximum possible amount of thermal energy contained in waste gas, thus utilizing the heat component resulting from possible condensation of the vapour contained in flue gas. Consequently, the formation of condensate, under certain operating conditions, is desirable and common for higher boiler efficiency.

The heating chamber is also delivered with an emergency thermostat to provide thermal protection to the heater. The burners, including the gas/oil line fittings, are delivered separately in their original packaging and they are only mounted on the chamber at the site of final installation.

The delivery may also include flue-gas exhaust elements and bypass damper servo-drive (provided they are included and specified in a particular technical offer).

The GHM gas/oil heater chambers are by default equipped with all operating and connecting elements (flange for burner mounting, flue-gas exhaust mouth, service opening for checking and cleaning the exchanger tube-plate, condensate drain outlet), which are located on one (service) side of the heating chamber.

The front service side of the GHM heater is shown in the following figure.



- ① Heater by-pass damper
- ② Heater by-pass section
- ③ Service access to the exchanger
- ④ Connection of the exchanger gas/oil burner
- ⑤ Connection of the exchanger flue-gas
- ⑥ Terminal block of the emergency thermostat
- ⑦ Connection of the exchanger condensate

Dismantling the service panels of the bypass damper and the exchanger is possible with a 5.0-mm Allen key.

Correct operation of the gas/oil heater can only be guaranteed if the following operating conditions are met:

- maintaining of nominal thermal input [kW]
- maintaining of nominal air flow [m³/hour]
- correct orientation of the chamber during installation – counter-flow connection
- adequate gas pressure and flow (see the documentation)
- correct air inlet temperature (usually up to 40 °C for the standard version)
- ensuring proper bypass of the exchanger chamber (if bypass is used)
- preventing of chimney effect and back flow
- correct connection of an emergency thermostat

Before installation, check that the local fuel distribution conditions, fuel characteristics, overpressure and the current heater settings are compatible.



Final installation site procedure:

The location must be such as to permit cleaning of the tube space and, where appropriate, replacing the combustion chamber. Routine maintenance requires at least 600 mm of space from the burner on the operator's side.

The actual distance between an exchanger part and combustible material must not be less than the safety clearance, which is 200 mm.

Installation of the burner

On the operator's side, a corresponding flange for fitting the burner has been prepared and fitted in the factory to which the burner body is fixed by means of bolts. Only after the burner has been mounted on the chamber can the gas line fittings be mounted.

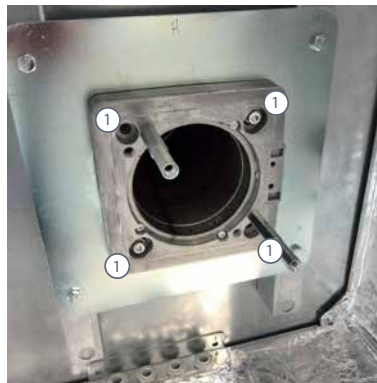


Detailed installation, setting and commissioning of the burner is described in the manufacturer's technical documentation delivered with the burner package.

Detailed installation, setting and commissioning of the gas line fittings is described in the manufacturer's technical documentation delivered with the burner package.

A recommended basic (only illustrative) burner installation procedure is shown in the following figures. Since the heater can be equipped with different types of burners made by several different manufacturers, the individual components or assemblies shown may differ in their appearance and mounting methods for different products. Therefore, before starting the installation, it is always necessary to get familiarized with the contents of the delivery and the instructions from the manufacturer of a particular delivered burner, which are included in the burner packaging:

1) MOUNTING OF THE BURNER FLANGE TO THE HEATER FLANGE



① Connection of the flange with 4 bolts from the burner package

2) MOUNTING OF THE BURNER TO THE BURNER FLANGE



① Connection of the burner with 2 bolts from the burner's package



The flange for mounting the burner is designed for the weight of a burner only. Care should be taken to ensure that the connected gas/oil piping does not load additionally both the burner and the heater chamber with its own weight!

When mounting the fuel, burner and gas heater connectors, follow the instructions contained in the manual and the installation and operating instructions for the burner included with each burner delivered.

Installation may only be carried out by a qualified technician authorized to work with gas-fired equipment and only in accordance with the manufacturer's instructions. Gas-fired equipment is subject, in accordance with applicable regulations, to both initial and subsequent periodic inspections. The gas connection must be inspected in advance, as part of the preparation for commissioning the installation and this should follow the physical connection of a burner to gas piping. The inspections must be carried out by a technician appropriately qualified and authorized; this inspection is not a part of commissioning or adjustments and it must always precede these processes!

The subsequent commissioning of a burner and its initial adjustment must be carried out by an authorized service technician of the burner manufacturer.

Installation of a burner cover (in case of outdoor installation)

In units designed for outdoor installation, a burner cover may be included. The burner cover consists of a standard sandwich chamber and any necessary equipment (doors, combustion air intake grille, openings for fittings, cable glands for power and control cables, roof and base frame).

This cover (chamber) is mounted on the heater chamber by using provided mounting items, which are included in the delivery of fasteners (standard quick-release couplings used to mount the chambers).

Before connecting the cover (of the chamber) to the heater chamber, the cover flange must be sealed along its perimeter with a seal or the gap must be sealed with putty to prevent water ingress.

The burner cover can be equipped with a heater for tempering the burner space. The convector is delivered with a socket.

Installation of the flue-gas exhaust (in case of outdoor installation)

The flue-gas duct must be designed in accordance with relevant regulations and it must be provided with inspection openings. The technical specification of the gas heater always indicates the required diameter of the flue-gas exhaust (depending on the boiler type and its heating performance) and the unit diagram indicates the position of the waste-gas outlet from the chamber. The pressure loss of the flue-gas duct should not exceed 100 Pa. Furthermore, condensate must be drained from the flue-gas duct.

The supplied chimney components are provided with mouth connections with an external clip and seal. The delivered components are connected to each other and the overall height is designed for a particular type of unit.



Flue-gas duct installation must comply with all applicable national standards and it must be carried out by a specialist company.

The outlet of the flue-gas duct must be at least 500 mm above the chamber roof and it must not be installed in such a way to prevent flue gas being sucked back into the unit! The condensate drain must be connected to a suitable collecting tank or, after suitable arrangements, to a sewer!

The recommended overall design of the waste-gas duct is shown in the following figures.



- ① A 90° flue-stack with a bottom condensate outlet and a Ni1000 sump for the flue-gas temperature sensor. Located on the exchanger
- ② Anti-rain head. It must always be a flue-gas duct termination item.
- ③ Straight parts. Delivered for a specific type of heater and unit.

Depending on the total weight and height of the flue-gas duct, the duct must be fixed with a static coupling at suitable points to the chamber or its supporting structure so as not to overload the flue-gas outlet mouth.

Condensate drain from the gas exchanger

The exchanger is equipped with a condensate drain whose G1/2" mouth is led out through the chamber casing. The condensate drainage from this mouth must be fixed in a suitable manner at the chamber installation site, preferably in a combined outlet with the condensate drain from the flue-gas duct. Care should be taken to ensure that the joint outlet is always lower than the condensate outlet mouth of the exchanger and that the condensate piping has sufficient slope away from the gas heater; only thus condensate drainage from the exchanger can be ensured!

Emergency thermostat

Delivery without the MANDÍK electronic control system:

- Gas-fired heating chambers are delivered without electrical control. A plastic box with an emergency thermostat is delivered for the chamber; the box is mounted on the air outlet of the exchanger chamber. The thermostat is factory-installed.
- The emergency disconnecting thermostat is non-return and requires a manual reset to reactivate it.

- The emergency thermostat contact must be connected to the power-supply phase of the burner to ensure that it is switched off in any (even failure) condition of the burner.
- The emergency thermostat is delivered in a plastic housing labelled RTH.

- The heater is equipped with a terminal for protective connection in accordance with EN 32 2000-4.41.
- In the emergency thermostat, it is imperative to connect the “ground” terminal to the PE conductor to prevent any induced voltages from affecting the thermostat sensor.

Delivery with the MANDÍK electronic control system:

- The function of an operating expansion return thermostat, which is provided by a controller using a flue-gas sensor, is connected to the safety equipment described above.
- The control ensures that the fan is switched on and run-out (combustion chamber cooling) after the burner has been switched off.



① Location of the RTH emergency



Description of operation:

- During operation it is especially necessary to monitor the failure of the emergency thermostat. If the maximum temperature set at the emergency thermostat, located behind the exchanger in the direction of the air flow, is exceeded to 90 °C, the burner is switched off and blocked. In order to allow a new automatic start of the burner, the emergency thermostat must be reset. Between the moment of blocking the burner and resetting the emergency thermostat, the temperature must drop below the value set on the emergency thermostat. The condition for restarting the heater is to remove the cause of overheating.
- If the mains supply voltage fails (during burner operation), the temperature increases due to accumulated heat in the heat exchanger chamber and because the fan is not working. If the temperature exceeds the value set on the emergency thermostat, it will open and disconnect the burner power supply. In the event of a short-term outage, it is necessary to wait until the fan has cooled the chamber before performing a manual reset.
- After specialist commissioning, the system settings can no longer be changed to ensure trouble-free operation.

Controlling air flow through the exchanger



If the heating chamber is equipped with a by-pass part, the optimum amount of air flow through the exchanger must be controlled. The nominal values of air flow and pressure losses of the exchanger are given in the unit's technical specification.

By default, the heater chamber is equipped with pressure taps and a controller for controlling the constant air flow through the exchanger (see the figure below). A differential pressure sensor with a 0–10 V digital output with a range of 0..500 Pa is used as the controller.

The by-pass damper servo-drive must have continuous control to ensure its smooth control by the pressure sensor on the heater. The sensor maintains the prescribed constant air flow according to the pressure loss on the boiler and passes any excess air through the by-pass. If a servo-drive is not installed or not included, it is necessary to ensure that the controller operates the by-pass damper as described above.



Electrical installation



Electrical installation must be carried out by a specialist company and electrical inspections must be carried out in accordance with applicable legal and technical regulations of the country in which the exchanger is put into operation.

Electrical connection of the heater burner, the emergency thermostat, the burner heater cover and the socket is given in Annex E. PECÍN GAS-FIRED HEATER ELECTRICAL CONNECTION or in the enclosed documentation "KJ MANDÍK Electronic Control System" if an electronic control system is part of the delivery.

Burner documentation is included in the burner package.

The by-pass damper servo-drive, if delivered, can be factory-installed on request. Otherwise, the recommended installation is described in section 5.28 INSTALLATION OF SERVO-DRIVES. The electrical connection of the servo-drives is described in the document "Manual for Installation and Operation of the Electronic Control System".



Operation of gas/oil heater:

The gas/oil heater must not be placed in a potentially explosive atmosphere.

CAUTION: The burner must not be switched on without simultaneous fan operation!

It is imperative to ensure the air flow through the gas heater, i.e. to switch on the fan first and wait for the normal operating point to be reached according to its starting time. Only when this condition is reached the burner can be switched on. It is also necessary to ensure that the fan runs-out for at least 5 minutes after the burner has been switched off to ensure sufficient cooling of the exchanger.

The surface temperature of the gas heater exchanger during operation exceeds highly the safe contact temperature of 60 °C. Wait until the exchanger has cooled down sufficiently before carrying out any work on the chamber!

If the heater is installed outdoors, it is recommended to equip it with suitable heating, such as with a heating cable, for proper operation of the condensate drain in winter.

5.16 CHAMBER OF 'MONZUN' GAS HEATER

The chamber contains a gas heater with or without a thermal bypass.

The heating chamber is factory-fitted with a combustion products-air heat exchanger or a bypass damper as standard.

The heating chamber is equipped with automatic control for the heater operation.

The chamber is always supplied with an atmospheric burner, including the fittings of the gas line.

On the operators' side, there is a door or removable panels providing access to the burner, igniting automatics and also for cleaning and checking the exchanger and for mounting the actuating mechanism of the bypass damper.

The delivery may also contain components of the exhaust of combustion products and the actuating mechanism of the bypass damper (assuming they are contained and specified in a specific technical offer).



- ① exhaust of combustion products
- ② burner intake cover
- ③ cable bushings
- ④ gas connection
- ⑤ fixed panel
- ⑥ service door

Operators' side of the "Monzun" gas heater (outdoor version)

Installation procedure at the site of final installation:

Installation of gas connection

On the operators' side, a gas connection is factory-prepared and fitted.

The gas connection on the chamber is not designed to bear the weight of the connected gas piping. It must be ensured that the connected components of the gas piping do not burden the connection as well as gas heater chamber by their own weight!

When installing the gas connection, it is necessary to follow the instructions contained in the 'Monzun' gas heater installation and operation manual, which is enclosed in the packaging of each delivered heater. The gas piping must be terminated with a gas ball valve installed before the heater inlet. It is recommended that the connection between this valve and the heater connection is made of a flexible gas hose.

The installation may be performed by a qualified technician authorized to work with gas equipment and solely in accordance with the manufacturer's instructions. In accordance with relevant regulations, gas appliances are subject to initial as well as subsequent periodic inspections. An inspection of the gas connection must be performed in advance, as part of preparations for commissioning the equipment and it should follow physical connection of the heater to the gas pipeline. The inspection must be performed by a technician with professional qualifications and appropriate authorization; this inspection is not a part of commissioning or adjustments and it must always precede them!

Commissioning of the burner and its initial adjustment must always be performed by a service technician of MANDÍK, a. s. or by an authorized service technician of MANDÍK, a. s.

Mounting of the exhaust of combustion products

The system of the exhaust of combustion products must be designed in accordance with relevant regulations. The technical specifications of the gas heater always specify the required diameter of the exhaust of combustion products (depending on the boiler type and heating output) and, in a diagram, the position of the mouth of the exhaust of combustion products from the chamber. The heating chamber has an exhaust fan, which ensures forced exhaust of combustion products. This fan is able to overcome the pressure loss of the exhaust system of max. 60 Pa. In case the combustion air for the burner is supplied through a coaxial chimney, the sum of pressure losses for the combustion air intake and in the chimney must not exceed 60 Pa. Draining of condensate from the exhaust system must also be provided. During normal operation, there is little condensation and only for a short period of time after switching on the heater; it is practically absent after the chimney has heated. However, make sure that the connection of the condensate drain is always lower than the lower edge of the mouth of the combustion product exhaust from the exchanger and thus prevent possible flooding of the exhaust fan. Possible condensate piping must have sufficient tilt away from the chimney for reliable condensate draining!



The wiring of the heater is specified in Annex F. ELECTRICAL WIRING OF 'MONZUN' GAS HEATER or in the enclosed documentation 'Measurement and Control System of Air-handling Units MANDÍK' if the system is included.

The actuating mechanism of the bypass damper, if included, can be factory-fitted on request. In another case, the recommended mounting is described in Section 5.28 MOUNTING OF ACTUATING MECHANISMS. The wiring of the actuating mechanisms is described in the document 'Manual for the Installation, Operation and Maintenance of the Measuring and Control System'.

For the actuating mechanism of the bypass damper it is necessary to adjust the stops defining the extreme positions of the damper so as to maintain the minimum prescribed air flow through the bypass. The minimum flow is always specified in the technical specifications for the supplied unit. It means that, in the closed position, the limit position of the damper actuating mechanism must nevertheless enable partial opening and thus the prescribed air flow through the bypass. In the event that the actuating mechanism is not installed or manual control is mounted, this minimum opening of the damper must again be ensured in an appropriate manner.

Interior installation and access to the actuating mechanism of the bypass is shown in the figure below.



- ① Combustion product exhaust fan
- ② Burner
- ③ Burner fittings
- ④ Damper shaft
- ⑤ Terminal board

**Operation of the gas heater:****CAUTION: The burner must not be operated without the simultaneous operation of the fan!****It is absolutely necessary to provide air flow through the gas heater, i.e. to start the fan first and to wait, according to its start-up time, until the normal operating point is reached. The burner may be started after reaching this state. Likewise, it is necessary to ensure run-out time of the fan of at least 5 minutes after turning off the burner to ensure sufficient cooling of the exchanger.****Surface temperature of the gas heater exchanger during operation exceeds highly the safe touch temperature of 60 °C. Prior starting any intervention or work in the chamber, it is necessary to wait until the exchanger cools down sufficiently!**

5.17 CHAMBER OF WATER COOLER

The chamber contains a plate exchanger designed for water or water-glycol mixture as the heat transfer medium. The cooling chamber is factory-fitted, as standard, with the exchanger or an eliminator of condensate droplets. The cooling chamber is factory-fitted, as standard, with a tray for draining condensate from the exchanger surface. Its outlet is fitted with a stainless steel DN32 pipe for mounting a siphon.

**The installation of a siphon to the overpressure or underpressure side is described in Section 5.26 INSTALLATION OF SIPHONS.****The mixing point for controlling the thermal output, if included, is supplied in a cardboard box in one of the unit chambers. The recommended installation of the mixing device is described in Section 5.25 INSTALLATION OF MIXING DEVICE. The wiring of the mixing device is described in the document 'Manual for the Installation, Operation and Maintenance of the Measuring and Control System'.**

Exchanger connections are marked INLET/OUTLET for proper connection of the mixing device or piping of the hydraulic system, as shown below.



Marking of exchanger inlet

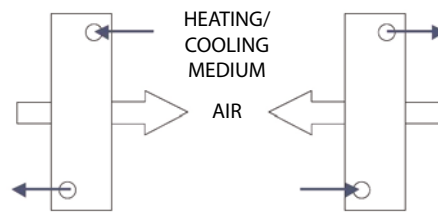


Marking of exchanger outlet

The exchanger outlets are threaded for connecting the hydraulic system.

**All the piping must be mounted independently of the exchangers. The weight and dilatation forces of the pipeline distribution of active fluids must not act on the unit blocks or on the exchangers. The connections must be made so that the dilatation of the pipes, caused by temperature, does not cause excessive loads on the mouths.****An air-relief valve, if not installed, must be mounted at the highest point of the cold water supply.****The connections must be tightened with two spanners. Otherwise, distortions of the thread may be caused!**

The exchanger is always connected in counter-flow! See the figure below.



5.18 CHAMBER OF EVAPORATOR

The chamber contains a plate exchanger designed for refrigerant (R-410A, R-407A and others) as the heat transfer medium.

The chamber is factory-fitted, as standard, with the evaporator or an eliminator of condensate droplets.

The evaporator chamber is factory-fitted, as standard, with a tray for draining condensate from the evaporator surface. Its outlet is fitted with a stainless steel DN32 pipe for mounting a siphon.



Mounting of a siphon to the overpressure or underpressure side is described in Section 5.26 MOUNTING OF SIPHONS.

Evaporator connections are marked, according to the number of circuits, IN1/OUT1, IN2/OUT2, etc. for proper connection of a condensation unit, as shown below.

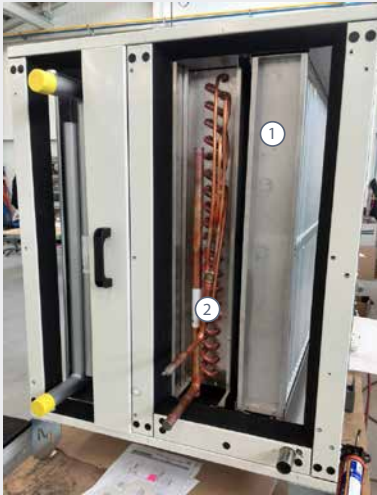


Example of marking of a 3-circuit evaporator.



The inlet and outlet connections of the evaporator are made of copper; they are soldered closed and ready for mounting cooling piping. The exchanger is factory pressure-tested and factory-filled with nitrogen.

The distributor for injecting refrigerant into the evaporator is located inside the chamber behind a fixed panel. Access to the distributor or piping for the installation of a temperature sensor, if required by the given condensation unit, is possible from the side of the droplet eliminator after removing its service panel and sliding the eliminator out, as shown below.



- ① Sliding-out droplet eliminator
- ② Coolant distributor behind the fixed panel
- ③ Evaporator fixed panel
Panel removal is possible after removing the cover caps a removing the screws using a Phillips PH2 bit
- ④ Droplet eliminator service panel
Panel removal is possible using Allen wrench 5.0 mm



The condensation unit is not included. The installation may be performed by a qualified refrigeration technician authorized to work with coolants and in accordance with the instructions of the condensation unit manufacturer.

Connection of the condensation unit to the measurement and control system is described in the enclosed documentation 'Measurement and Control System of Air-handling Units MANDÍK' if the system is included.

5.19 CHAMBER OF PLATE RECUPERATOR

The chamber contains a plate air-air exchanger with a thermal bypass.

The chamber is factory-fitted with the plate exchanger, a bypass damper or an eliminator of condensate droplets as standard.

If required, the chamber can contain a mixing damper. The damper is factory-fitted as standard.

The chamber is factory-fitted, as standard, with trays for condensate draining from the surface of the plate exchanger. Its outlets are fitted with stainless steel DN32 pipes for mounting a siphon.



Mounting of a siphon to the overpressure or underpressure side is described in Section 5.26 MOUNTING OF SIPHONS.

The actuating mechanism of the bypass damper, if included, can be factory-fitted on request. In another case, the recommended mounting is described in Section 5.28 MOUNTING OF ACTUATING MECHANISMS. The wiring of the actuating mechanisms is described in the document 'Manual for the Installation, Operation and Maintenance of the Measuring and Control System'.

The placement of the dampers (top left / top right / bottom left / bottom right) or of their actuating mechanisms can be seen in the data sheet to the unit in the figure of the total assembly or with help of stickers on the operators' side of the chamber.

Access to the actuating mechanisms is shown in the figure below.

1) Vertical design (the inlet and outlet branches above each other)



① Sticker showing layout location of the damper in the chamber



② Chamber service panels
Panel removal is possible using Allen wrench 5.0 mm



③ Actuating mechanism is always inside the chamber near the rear wall where there is a holder for its fixing

2) Horizontal design (the inlet and outlet branches next to each other)



① Chamber service panels (chamber front and rear wall)

Panel removal is possible using Allen wrench 5.0 mm

② Sticker determining the layout placement of the flap in the chamber

③ The actuator is always there placed inside the chamber.

5.20 CHAMBER OF ROTARY HEAT EXCHANGER

The chamber contains an air-air rotary heat exchanger.

The rotary heat exchanger is factory-fitted with the exchanger as standard.

The heating chamber is factory-fitted, as standard, with a geared drive and a rotor belt.



The motors can be started only with a frequency converter set according to the electric motor rating values with sufficient acceleration time. The setting of the frequency converter is described in detail in the document 'Manual for the Installation, Operation and Maintenance of the Measuring and Control System'.

If the frequency inverter is not included in the scope of delivery, follow the instructions of the frequency inverter manufacturer and the rotary heat exchanger manufacturer when connecting and commissioning. The operating frequency must be set so that the wheel speed is at the optimum power / gear ratio. The optimum is usually around 12 rpm, for this it is necessary to adapt the frequency of the drive. However, the frequency must be between 18–85 Hz, otherwise the motor and / or heat exchanger wheel may be damaged.

The wiring diagram of the electric motor and the frequency converter included in the delivery is listed in Annex G. ELECTRICAL CONNECTION OF THE ROTARY RECUPERATOR or in the enclosed documentation "Measurement and control of KJ MANDÍK", if the MaR system is a part supplies.

The optimum speed of rotation of the wheel-working frequency of the rotary heat exchanger is specified in the technical conditions or in the installation and operating instructions of the exchanger manufacturer.

The operating frequency is set from the production of Mandík, a. s. The parameter settings.

The frequency converter is specified in the enclosed documentation for the unit and on the name-plate chambers.



When operating the rotary heat exchanger, the flow velocity of the conveyed air on the heat exchanger must not exceed 4 m/s. The loss in the air inlet and outlet must not exceed 15% of the theoretical value, based on the technical specification created in the design program AHUMAN of Mandík a.s. Exceeding these recommended values may damage the exchanger rotor and the manufacturer does not warrant such a product.

The chamber is equipped as standard with cable bushings for leading power conductors to connect the electric motor and the frequency converter; their dimensions are according to the electrical power input of the electric motor. Access to the connections of the electric motor is shown in the figure below.

For conducting power wires, the chamber is equipped as standard with cable bushings for connecting the electric motor and frequency converter with dimensions according to the electric power input of the electric motor.

The following figure shows how to connect the electric motors



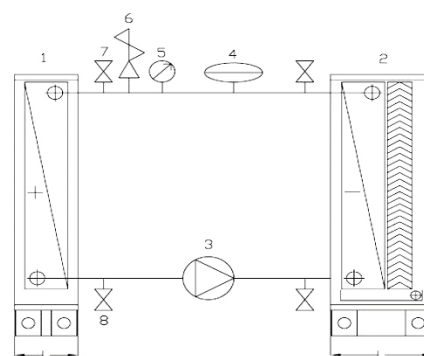
- ① Chamber service panel for access to the recuperator drive.
Panel removal is possible using Allen wrench 5.0 mm
- ② As standard the chamber is fitted with a cable bushing for connecting the recuperator drive.

5.21 CHAMBERS OF FLUID CIRCUIT – HEAT RECOVERY

The chambers are normally made as water heater chambers and water cooler chambers. They are subject to the same mounting instruction as those in Section 5.13 CHAMBER OF WATER HEATER and Section 5.17 CHAMBER OF WATER COOLER.

Components of the hydraulic circuit are not included.

The recommended connection is shown schematically in the figure below.



- 1 – heating exchanger in supply branch
- 2 – cooling exchanger in outlet branch with drop eliminator
- 3 – circulating pump
- 4 – expansion vessel
- 5 – pressure gauge
- 6 – safety valve
- 7 – relief valves
- 8 – discharge valves

5.22 CHAMBER OF STEAM HUMIDIFIER

The steam humidifier is not supplied with the chamber.

The chamber contains free space for connecting steam distribution pipes.

The humidifier chamber is factory-fitted, as standard, with a tray for draining condensate. Its outlet is fitted with a stainless steel DN32 pipe for mounting a siphon.



Mounting of a siphon to the overpressure or underpressure side is described in Section 5.26 MOUNTING OF SIPHONS.

On the operators' side, the chamber is equipped with a fixed panel for connecting distribution pipes and a removable service panel with a service visor.

The service panel can be removed with an Allen wrench – 5.0 mm.

5.23 CHAMBER OF SILENCER

The chamber contains silencing screens.

The chamber is factory-fitted with the screens as standard.

There are no requirements for mounting.

5.24 CHAMBER OF DAMPERS AND END WALL

The chamber of dampers or the end wall includes shutter dampers.

The chamber of dampers or the end wall is factory-fitted with the shutter dampers as standard.

The dampers can be placed inside or outside the chamber. Access to the dampers is shown in the figure below.



- ① Service panel of the chamber of damper/inner damper of the end wall
Panel removal is possible using Allen wrench 5.0 mm
- ② Chamber inner space
Inner dampers with holders for mounting the actuating mechanism
- ③ Outer damper of the end wall
Dampers with holders for mounting the actuating mechanism



The actuating mechanism of the damper, if included, can be factory-fitted on request. In another case, the recommended mounting is described in Section 5.28 MOUNTING OF ACTUATING MECHANISMS. The wiring of the actuating mechanisms is described in the document 'Manual for the Installation, Operation and Maintenance of the Measuring and Control System'.

5.25 INSTALLATION OF MIXING JUNCTION

This paragraph applies to a mixing junction for the water heater and the water cooler.
The installation and service manual is enclosed in the mixing device packaging.
This manual contains information necessary for safe mounting, commissioning and maintenance.



In case of installing the unit outdoors, it is recommended to locate the mixing device in an empty chamber behind the exchanger. This must be taken into account while designing the unit and free space is part of the exchanger chamber or as a separate chamber.

An example of installing the mixing device inside a chamber is shown in the figure below.



- ① Mixing device mounting to vertical holders using heating system collars. The working position of the circulating pump must be maintained acc. to the requirements in its manual
- ② Connecting outlets through the chamber shell. The outlets must be air-tight and thermal insulated.

5.26 INSTALLATION OF SIPHONS

The trays for draining condensate (chambers of the coolers and recuperators) are fitted with DN32 outlets. The siphons supplied are dimensioned for this size.
Marking of siphon connections to the tray outlet is shown in the figure below.



Condensate drain for plate recuperation



Condensate drain for the cooler (water/evaporator)



All the condensate drain pipes must be connected via a siphon with sufficient height of the water column, which guarantees flawless operation.

A siphon must be connected individually to each outlet. The piping behind a siphon can be connected to the outlet of another siphon.

A siphon connected to underpressure must always be filled with water prior commissioning or after a long inactivity so that condensate can drain.

The piping behind a siphon must not be connected directly to sewer piping.

The height of the unit above the floor/ground must always be adjusted to the required height of the siphons (base frame, feet, steel frame, etc.).

In the case of placing the siphon in an outdoor design, it is necessary to temper its route, e.g. electric heating cable. If the heating cable is included in the delivery, it is delivered 2 m long heating cable with built-in thermostat and plug + outdoor socket. In the MaR system, is only a circuit breaker for an outdoor outlet. The cable is regulated autonomously from built-in thermostat. It usually switches on at + 3 ° C and switches off when the temperature rises above +10 ° C. Therefore, the MaR system does not regulate the heating cable.

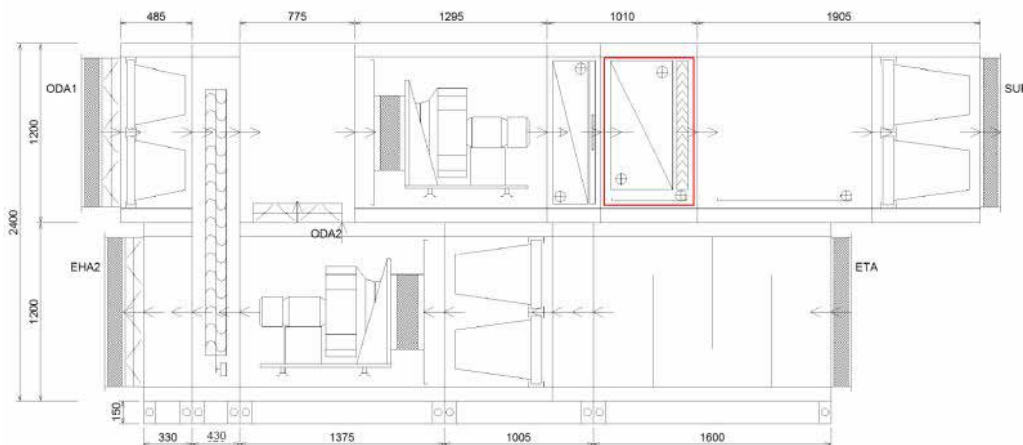
In case locating a siphon in the outdoor design, it is necessary to heat its route, e.g. with an electric heating cable. If the heating cable is included, its recommended mounting and connecting procedure is described in the document 'Manual for Installation, Operation and Maintenance of the Measuring and Control System'.

Siphons are distinguished by the pressure ratio at the outlet within the unit configuration – it can be negative (underpressure) or positive (overpressure) pressure. Depending on the type of the pressure ratio, an underpressure siphon or an overpressure one is delivered.

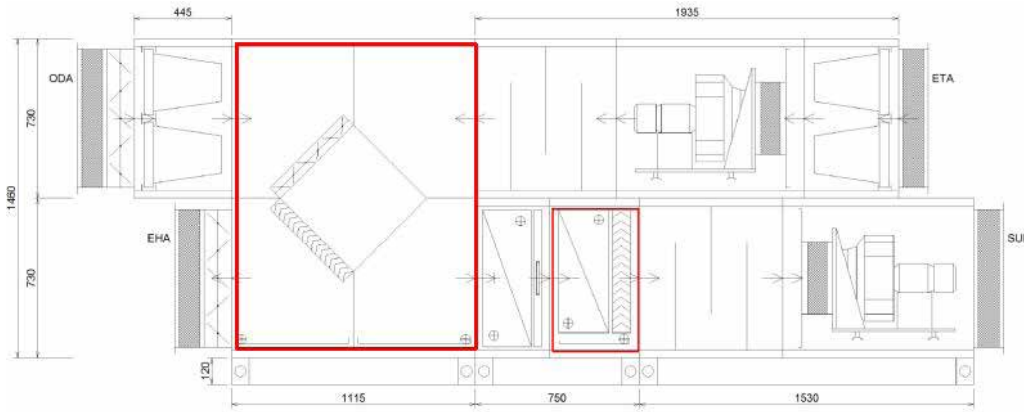
If the siphon is included, its correct positioning can be determined by its type (HL136NGG/HL136.2), which is consistent with the siphon type specified in the technical documentation to the unit, the section of a given in-built device (radiator, evaporator, recuperation, etc.).

In another case (self supply), it is possible to determine the type of the pressure ratio and to determine the proper siphon type by the data in the accompanying technical documentation to the unit, the section of a given in-built device, that contains data on the type of the pressure ratio (overpressure/underpressure) and its value in [Pa]. The pressure value is calculated on the basis of local pressure losses of the unit part, including external pressure losses. External pressure losses are divided on a suction side and a discharge one (in relation to the fan) during the design and technical approval of the unit. However, it is always necessary to take into account specific installation conditions, or to establish a new division of external pressure losses and thereby correct height adjustment of the siphon.

Furthermore, for determining the pressure ratio at the point of the siphon, it is possible, for example, to be guided by the unit image in the accompanying technical documentation. The following figures show examples of determining the pressure ratio.



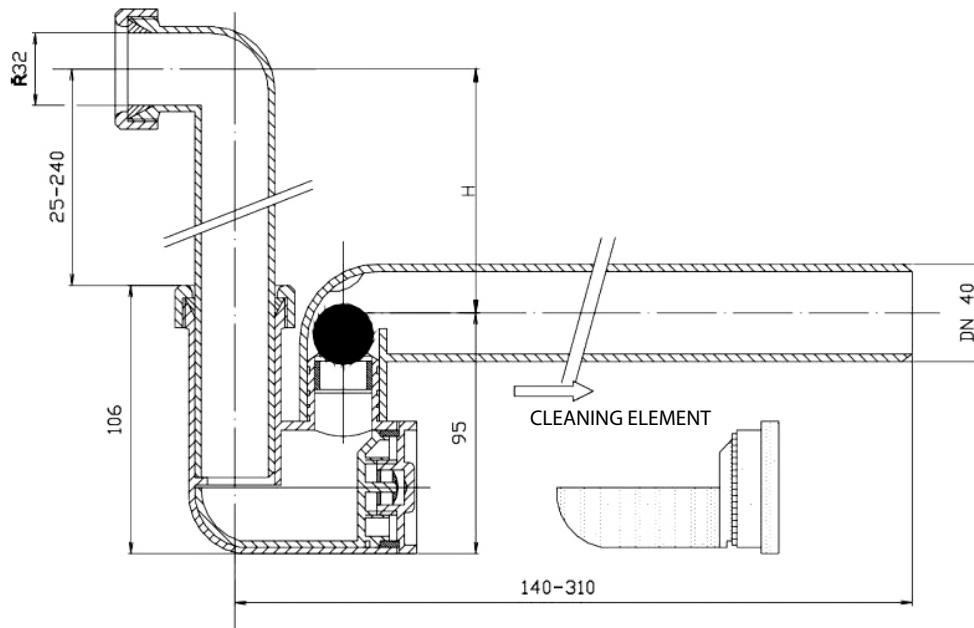
The cooler is located in overpressure behind the fan (overpressure siphon).



The cooler is located in underpressure in front of the fan (underpressure siphon). The inlet portion of the recuperator is located in underpressure in front of the fan (underpressure siphon). The outlet portion of the recuperator is located in overpressure behind the fan (overpressure siphon).

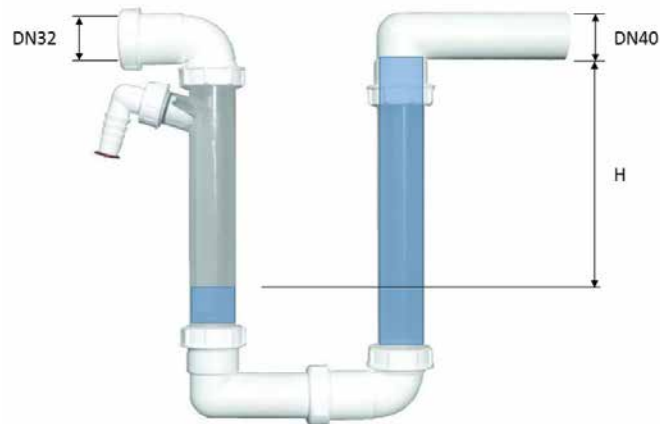
Proper height adjustment of the siphon by the pressure value is as follows:

- 1) Underpressure siphon with a ball HL136NGG
It can be used for underpressure to 2.300 Pa.
It can also be used for overpressure to 500 Pa.



$H = P / 10$ ($P =$ pressure value specified in the technical documentation of the in-built device [Pa])

- 2) Transparent overpressure siphon HL136.2
It can be used for overpressure to 2,000 Pa.
The siphon is supplied, as standard, with an adapter from DN40 to DN32 for connecting to the condensate drain.



$H = P / 10$ (P = pressure value specified in the technical documentation of the in-built device [Pa])

5.27 MOUNTING OF UNIT TO AIR-CONDITIONING DUCTS



Mounting of the unit to the air-conditioning ducts is only possible by means of flexible connection that are fitted to each terminating flange of the unit chamber (they prevent the transmission of vibrations).

The air-conditioning ducts must be connected without tension, i.e. so that its weight is not borne by the flexible connection and thus also the chamber or the unit.

Flanged connections of the air-conditioning ducts and the flexible connection must always be sealed properly.

When connecting the air-conditioning ducts, it is necessary to note the following permitted mounting limits of the unit's flexible connection:

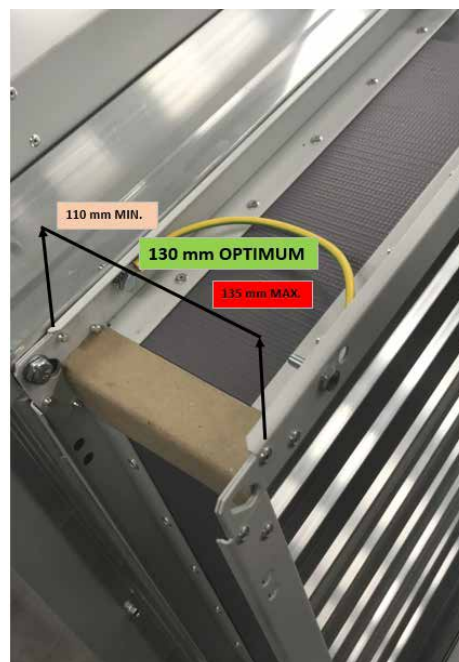
1) Dotted flexible connection:

1) Standard flexible connection

2) Riveted flexible connection (painted)



Optimal moutage lenght = 135 mm



Optimal moutage lenght = 130 mm

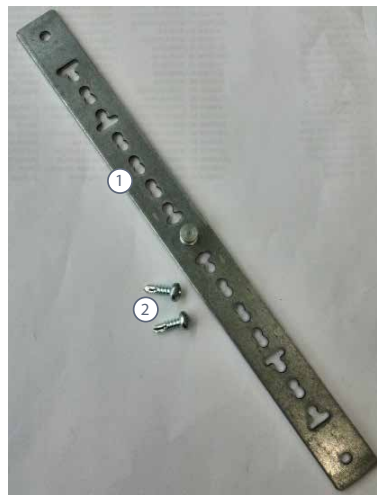
5.28 MOUNTING OF ACTUATING MECHANISMS

The actuating mechanisms, on request when ordering, can be factory-fitted, including their electrical connections to a cable junction box. In another case, the recommended mounting is described in the following paragraphs. All the dampers are factory-fitted with standard sheet metal holders for mounting the actuating mechanisms. The dampers can be:

- End-wall damper – exterior (on the chamber flange)/interior
- Damper-chamber damper – exterior (on the chamber flange/on walls)/interior
- Plate-recuperation bypass damper – exterior/horizontal – interior
- 'Pecín' gas heater bypass damper – interior
- 'Monzun' gas heater bypass damper – interior

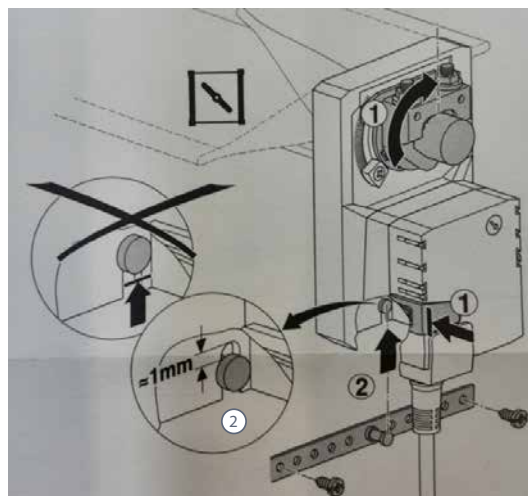
The recommended mounting of the actuating mechanism is as follows (for more information regarding mounting and wiring of the actuating mechanism see the manufacturer's instructions enclosed in the packaging):

1) Adjustment of the actuating mechanism holder



- ① Cut the holder behind the mandrel for mounting the actuating mechanism
- ② Actuating mechanism packaging contents: 1 actuating mechanism holder, 2 screws

2) Mounting of the actuating mechanism



- ① Place the shortened holder vertically in the axis actuator mounting point. Fasten the bracket with two screws to the metal holder on the damper.
- ② Place the holder mandrel to the actuating mechanism mounting opening acc. to a detailed manual in the mechanism manual. The figure shows another possible method of holder mounting – horizontal.

3) Setting of the actuating mechanism stops



① The act. mechanism stops are used to set the angle of damper opening/closing. As standard, the stops are set to damper full opening/closing.

4) Mounting of the cable junction box



① For connecting the actuator to the switchboard of MaR system is needed, due to the short length, bring the actuator cable to junction box. The junction box can be placed outdoors or inside the chamber, depending on the length actuator cable.

② As standard, the chamber is factory-fitted with a cable bushing for mounting the cable to the junction box.

5) Testing of the actuating mechanism for free movement and rotation direction

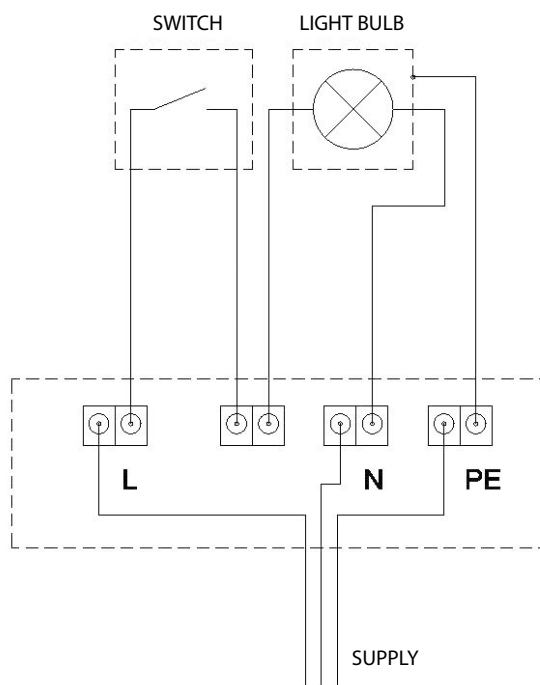


① Switch for turning the act. mechanism opening direction (checking is possible after making electrical connections and a run command from the measuring and control system)

② Button for checking the free movement of the damper independently on the act. mechanism. (press towards inside)

5.29 CONNECTING OF CHAMBER LIGHTING SWITCH

The chambers that are equipped with internal lighting are factory-fitted, as standard, with a switch that is connected according to the following diagram.



6 | OPERATIONS PRIOR COMMISSIONING

6.1 GENERAL



- **The unit may be commissioned only by a properly educated and trained person and in compliance with all the relevant safety regulations and standards**
- **Prior putting the unit into operation for the first time, it is necessary to complete each previous step of the installation instructions**
- **Prior putting the unit into operation, it is necessary to go through each step of the following paragraphs and to record these actions in the appropriate protocols, which will be filed with the operational documentation and a copy will be sent to the address of MANDÍK, a. s. or by e-mail to the service centre at service@mandik.cz.**
- **When checking the individual components of the unit, it is possible to use the following paragraphs containing step by step instructions, which have been created as protocols and which can serve as a useful tool for commissioning**

6.2 UNIT IN GENERAL

LIST OF SERVICING OPERATIONS PRIOR COMMISSIONING AIR-HANDLING UNIT MANDÍK

Order number:	User:
Date:	Commissioning party:
Project name:	Serial number:
Address:	Position:
Date of first start-up:	

OPERATIONS FOR THE UNIT IN GENERAL					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.01.	Check the seating order of the chambers within the unit acc. to the documentation.				
1.02.	Check each chamber for external or internal damage.				
1.03.	Check the seating of the unit – on the floor/ceiling acc. to installation instructions.				
1.04.	Check connecting eccentric pieces between the chambers – in the “tightened” position.				
1.05.	Check the tightness of chamber connections – visually, acc. to installation instructions.				
1.06.	Check the total tightness of the unit – visually (the door, service panels, fixed panels, etc.).				
1.07.	Check the mounting of the roof on outdoor units acc. to installation instructions.				
1.08.	Check the cleanness of the chamber interior – without foreign bodies and construction debris.				
1.09.	Check closing of the unit – the door, service panels.				
1.10.	Check the connection of HVAC piping to the damping inserts acc. to installation instructions.				
1.11.	Check the legibility and cleanness of manufacturing and safety plates. Clean if necessary.				
1.12.					
1.13.					
1.14.					
1.15.					
1.16.					
1.17.					
1.18.					
1.19.					

OPERATIONS FOR THE UNIT IN GENERAL – ELECTRICAL AND MEASURING AND CONTROL					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.20.					
1.21.					
1.22.					
1.23.					
1.24.					
1.25.					
1.26.					
1.27.					
1.28.					
1.29.					
1.30.					

SPECIAL OPERATIONS:					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.31.					
1.32.					
1.33.					
1.34.					

In date

Stamp and signature of service technician

Stamp and signature of authorised representative of the facility operator

Surname and number of service technician in capital letters

Surname of the operator's authorised representative in capital letters

* Record the value only when a value needs to be measured.

6.3 CHAMBERS OF FILTERS

LIST OF SERVICING OPERATIONS PRIOR COMMISSIONING AIR-HANDLING UNIT MANDÍK

Order number:	User:
Date:	Commissioning party:
Project name:	Serial number:
Address:	Position:
Date of first start-up:	

OPERATIONS FOR FILTER CHAMBERS – G2-F9/GREASE (POCKET AND FRAME) – RUNNERS

Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.01.	Check the fitting with filter elements with an equal filtration class according to the technical specification of the unit.				
1.02.	Check the fitting with filter elements according to the required composition according to mounting instructions.				
1.03.	Check the seal between the filter elements according to the mounting instructions.				
1.04.	Check the firm mounting of the filter elements in their holders.				
1.05.	Check the cleanness and integrity of the filter elements.				
1.06.					

OPERATIONS FOR FILTER CHAMBERS – G2-F9/GREASE (POCKET AND FRAME) – MOUNTING FRAMES

1.07.	Check the fitting with filter elements with an equal filtration class according to the technical specification of the unit.				
1.08.	Check the fitting with filter elements according to the required composition according to mounting instructions.				
1.09.	Check the seal between the frame contact surface and the filter element frame.				
1.10.	Check the firm mounting of the filter elements in their mounting frames.				
1.11.	Check the cleanness and integrity of the filter elements.				
1.12.					

OPERATIONS FOR FILTER CHAMBERS – ACTIVATED CHARCOAL

1.13.	Check the fitting with filter cartridges according to the technical specification of the unit.				
1.14.	Check the firm mounting of the filter cartridges.				
1.15.					

OPERATIONS FOR FILTER CHAMBERS – MEASURING AND CONTROL SYSTEM

Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.16.	Check the mounting of the pressure differential switch/digital pressure gauge according to mounting instructions.				
1.17.	Check the wiring and setting of the pressure differential switch/digital pressure gauge according to mounting instructions – in particular the setting of the filter pressure loss.				
1.18.					
1.19.					
1.20.					
1.21.					
1.22.					
1.23.					

SPECIAL OPERATIONS:

Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.24.					
1.25.					
1.26.					
1.27.					

In date

Stamp and signature of service technician

Stamp and signature of authorised representative
of the facility operatorSurname and number of service technician
in capital lettersSurname of the operator's authorised representative
in capital letters

* Record the value only when a value needs to be measured.

6.4 CHAMBERS OF FANS

LIST OF SERVICING OPERATIONS PRIOR COMMISSIONING AIR-HANDLING UNIT MANDÍK

Order number:	User:
Date:	Commissioning party:
Project name:	Serial number:
Address:	Position:
Date of first start-up:	

OPERATIONS FOR FAN CHAMBERS – FREE IMPELLER					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.01.	Check the fitting with an equal device according to the technical specification of the unit.				
1.02.	Check the correctness of mechanical installation (tightening of all bolts, etc.).				
1.03.	Check the condition of the device's rubber pad – without deformation, offset, etc.				
1.04.	Check the integrity of the flexible connection of the fan.				
1.05.	Check the impeller for free rotation.				
1.06.	Check the cleanness of the impeller and the chamber.				
1.07.	Check the condition of grounding connections.				
1.08.	Check the correct rotation direction according to arrow through starting the electric motor for a short time.				
1.09.	Check the fan operation for excessive vibrations. In the event of vibrations, the device must be balanced statically and dynamically.				
1.10.	"The assembly of a motor and a fan must not be operated within the range of resonance speed and its multiples. This resonance speed must be determined during commissioning and operation at it must be eliminated subsequently by setting the frequency converter."				
1.11.					
1.12.					
1.13.					

OPERATIONS FOR FAN CHAMBERS – MEASURING AND CONTROL SYSTEM

Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.14.	Check the correct wiring of the electric motor of the device according to the attached documentation and rating of the electric motor.				
1.15.	Prior the first starting of the fan, it is necessary to measure isolating resistance of the electric motor to prevent possible damage to it.				
1.16.	Check the connection of the frequency converter, if included, according to the attached documentation.				
1.17.	Check the setting of the frequency converter according to the nameplate rating of the electric motor.				
1.18.	Check the setting of the working frequency of the frequency converter according to the technical specification of the unit.				
1.19.	Check, if required, the wiring according to the requirements of electromagnetic compatibility according to the attached documentation.				
1.20.	Check the connection of pressure probes for measuring differential pressure according to the mounting instructions.				
1.21.	Kontrola zapojení a ověření funkčnosti bezpečnostního diferenčního manometru proti nadměrnému přetlaku.				

SPECIAL OPERATIONS:

Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.21.					
1.22.					
1.23.					
1.24.					

In date

Stamp and signature of service technician

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of the facility operatorSurname and number of service technician
in capital lettersSurname of the operator's authorised representative
in capital letters

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6.5 CHAMBERS OF EXCHANGERS – HEATERS, COOLERS

LIST OF SERVICING OPERATIONS PRIOR COMMISSIONING AIR-HANDLING UNIT MANDÍK

Order number:	User:
Date:	Commissioning party:
Project name:	Serial number:
Address:	Position:
Date of first start-up:	

OPERATIONS FOR EXCHANGER CHAMBERS – WATER HEATER

Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.01.	Check the tightness of the connections of working fluid/mixing device to the exchanger.				
1.02.	Check the exchanger for deaeration.				
1.03.	Check the cleanness and integrity of the exchanger heat-transfer surface.				
1.04.	Check the connections whether thermal dilatation of the pipes does not cause excessive load on the connections.				
1.05.	Water for the water exchanger must not contain dirt causing clogging of the pipes.				
1.06.	Check stress on the exchanger mouths – no components of the heating water source (piping, mixing device, etc.) may load the exchanger mouths.				
1.07.	Check the exchanger connection in counter flow – according to the mounting instructions.				

OPERATIONS FOR EXCHANGER CHAMBERS – WATER COOLER

1.08.	The same operations as for the water heater.				
1.09.	Check the integrity of the droplet eliminator, if included.				
1.10.	Check the mounting of the siphon, according to the mounting instructions, if it is part of the chamber – wet cooling.				
1.11.					
1.12.					
1.13.					
1.14.					
1.15.					

OPERATIONS FOR EXCHANGER CHAMBERS – MEASURING AND CONTROL SYSTEM					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.16.	Check the mounting and connection of the mixing device/three-way valve according to the mounting instructions – for the heater as well as the cooler, if included.				
1.17.	Check the mounting and connection of the capillary anti-freeze thermostat of the heater according to the mounting instructions.				
1.18.	Check the function of the capillary anti-freeze thermostat of the heater, e.g. with special freezing gas or by shutting off the heating water at a sufficiently high temperature of the air supplied to the exchanger.				
1.19.					
1.20.					
1.21.					

SPECIAL OPERATIONS:					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.22.					
1.23.					
1.24.					
1.25.					

In date

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6.6 CHAMBERS OF 'PECÍN/MONZUN' GAS HEATERS

LIST OF SERVICING OPERATIONS PRIOR COMMISSIONING AIR-HANDLING UNIT MANDÍK

Order number:	User:
Date:	Commissioning party:
Project name:	Serial number:
Address:	Position:
Date of first start-up:	

OPERATIONS FOR 'PECÍN' GAS HEATER CHAMBERS					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.01.	Check the cleanness and integrity of the gas heater and tighten the service cover of the exchanger.				
1.02.	Check the free movement of the bypass damper.				
1.03.	Check stress on the mouths of all connections – no components may load the connection mouths.				
1.04.	Check the execution and completeness of the combustion products exhaust system; check the execution of the condensate drains.				
1.05.	Check the mounting of the burner to the heater flange.				
1.06.	Check the burner nameplate – the burner output must correspond with the heater output range.				
1.07.	Check the burner and the gas connection according to the list of necessary checks from the burner manual.				
OPERATIONS FOR 'MONZUN' GAS HEATER CHAMBERS					
1.08.	Check the cleanness and integrity of the gas heater; check the function of the service door.				
1.09.	Check the free movement of the bypass damper (if part of the heater).				
1.10.	Check stress on the mouths of all connections – no components may load the connection mouths.				
1.11.	Check the execution and completeness of the combustion products exhaust system; check the execution of the condensate drain.				
1.12.	Check the unobstructed passability of the combustion air suction grille on the chamber panel.				
1.13.	Check the nameplate of the 'MONZUN' heater and compliance of the data with the heater tech. specification.				
1.14.	Check the burner and the gas connection according to the list of necessary checks from the manual of the heater TPM043-/05 MONZUN-KLIM.				

OPERATIONS FOR GAS HEATER CHAMBERS – MEASURING AND CONTROL SYSTEM					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.15.	Check the switch of power supply and the required protection.				
1.16.	Check the correct wiring of the burner electrical connection according to the attached documentation and nameplate rating.				
1.17.	Check the connection and the function of the safety thermostat of heat protection of the 'PECÍN' heater.				
1.18.	Check the correct wiring of electrical connection of the 'MONZUN' heater according to the attached documentation, TPM043/05 MONZUN KLIM and nameplate rating.				
1.19.	Check the connection and the function of the safety thermostat of heat protection of the 'MONZUN' heater.				
1.20.	Check, if required, the wiring according to the requirements of electromagnetic compatibility.				
1.21.					
1.22.					

SPECIAL OPERATIONS:					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.23.					
1.24.					
1.25.					

In date

 Stamp and signature of service technician

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 in capital letters

 Stamp and signature of authorised representative
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6.7 CHAMBERS OF EVAPORATORS

LIST OF SERVICING OPERATIONS PRIOR COMMISSIONING AIR-HANDLING UNIT MANDÍK

Order number:	User:
Date:	Commissioning party:
Project name:	Serial number:
Address:	Position:
Date of first start-up:	

OPERATIONS FOR EVAPORATOR CHAMBERS					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.01.	Check the cleanness and integrity of the exchanger heat-transfer surface.				
1.02.	Check the correct connections of the inputs/outputs according to the marking on the chamber.				
1.03.	Check the circuit tightness through a pressure test.				
1.04.	Check the connections whether thermal dilatation of the pipes does not cause excessive load on the connections.				
1.05.	Check stress on the exchanger connections – no components of the cooling source (piping, expansion valve, etc.) may load the exchanger connections.				
1.06.	Check the integrity of the droplet eliminator, if included.				
1.07.	Check the mounting of the siphon, according to the mounting instructions, if it is part of the chamber – wet cooling.				
1.08.					
1.09.					
1.10.					
1.11.					
1.12.					
1.13.					
1.14.					
1.15.					
1.16.					

OPERATIONS FOR EVAPORATOR CHAMBERS – MEASURING AND CONSTROL SYSTEM					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.17.	Check the mounting and/or wiring of the expansion valve.				
1.18.	Check the wiring of the condensation unit according to the attached documentation.				
1.19.	Check the mounting and connection of the heat or pressure sensors of the evaporator according to the requirements of the condensation unit manufacturer.				
1.20.					
1.21.					
1.22.					

SPECIAL OPERATIONS:					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.23.					
1.24.					
1.25.					
1.26.					

In date

Stamp and signature of service technician

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Surname and number of service technician in capital letters

Surname of the operator's authorised representative in capital letters

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6.8 CHAMBERS OF RECUPERATORS – PLATE/ROTARY

LIST OF SERVICING OPERATIONS PRIOR COMMISSIONING AIR-HANDLING UNIT MANDÍK

Order number:	User:
Date:	Commissioning party:
Project name:	Serial number:
Address:	Position:
Date of first start-up:	

OPERATIONS FOR RECUPERATION CHAMBERS – PLATE					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.01.	Check the cleanness and integrity of the exchanger heat-transfer surface.				
1.02.	Check the free movement of the bypass damper or the mixing damper.				
1.03.	Check the integrity of the droplet eliminator, if included.				
1.04.	Check the mounting of the siphons according to mounting instructions.				
1.05.					
1.06.					
1.07.					
OPERATIONS FOR RECUPERATION CHAMBERS – ROTARY					
1.08.	Check the cleanness and integrity of the rotor heat-transfer surface.				
1.09.	Check the correct setting of the rotor sealing profiles – circumferential and along the rotor dividing plane.				
1.10.	Check the tensioning of the drive belt.				
1.11.	Check the rotor for free rotation.				
1.12.	In case the rotor is secured for transport, remove the securing items.				
1.13.	Check the cleanness of the rotary and fixed components that are in contact (remove very carefully metal chips and iron dust).				
1.14.					

OPERATIONS FOR RECUPERATION CHAMBERS – MEASURING AND CONTROL SYSTEM					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.15.	Check the mounting and connection of the actuating mechanism of the damper (bypass/mixing) of the plate recuperation according to mounting instructions.				
1.16.	Check the mounting of the pressure differential switch/digital pressure gauge according to mounting instructions – plate/rotary recuperation.				
1.17.	Check the wiring and setting of the pressure differential switch/digital pressure gauge according to mounting instructions – in particular the setting of the filter pressure loss (plate/rotary recuperation).				
1.18.	Check the correct wiring of the electric motor of the rotor according to the attached documentation and rating of the electric motor.				
1.19.	Check the connection of the frequency converter, if included, according to the attached documentation.				
1.20.	Check the setting of the frequency converter according to the nameplate rating of the rotor electric motor.				
1.21.	Check the setting of the working frequency of the frequency converter according to the technical specification of the unit.				
1.22.	Check, if required, the wiring according to the requirements of electromagnetic compatibility according to the attached documentation.				

SPECIAL OPERATIONS:					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.23.					
1.24.					
1.25.					

In date

Stamp and signature of service technician

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6.9 CHAMBERS OF FLUID CIRCUIT, STEAM HUMIDIFIER, SILENCER

LIST OF SERVICING OPERATIONS PRIOR COMMISSIONING AIR-HANDLING UNIT MANDÍK

Order number:	User:
Date:	Commissioning party:
Project name:	Serial number:
Address:	Position:
Date of first start-up:	

OPERATIONS FOR FLUID CIRCLE – RECUPERATION					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.01.	The same operations as for the water heater.				
1.02.	The same operations as for the water cooler.				
1.03.	Check the mounting and tightness of the hydraulic circuit (not included).				
1.04.					
1.05.					
OPERATIONS FOR STEAM HUMIDIFIER CHAMBERS					
1.06.	Check the correct sealing of openings after mounting of distribution tubes.				
1.07.	Check of the location of the distribution tubes above the tray with condensate outlet.				
1.08.	The mounting of the siphon according to mounting instructions.				
1.09.					
1.10.					
OPERATIONS FOR SILENCER CHAMBERS					
1.11.	Check the cleanness and integrity of the silencer screen fabric.				
1.12.	Check the fitting of the silencer screen fabric.				
1.13.					

OPERATIONS FOR RECUPERATION CHAMBERS – MEASURING AND CONTROL SYSTEM					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.14.	Check the wiring of the hydraulic circuit according to the attached documentation (the hydraulic part is not included). If the delivery contains the measuring and control system MANDÍK, if is equipped with an output signal for controlling the circuit circulating pump.				
1.15.	Check the wiring of the hydraulic circuit according to the attached documentation (the steam humidifier is not included). If the delivery contains the measuring and control system MANDÍK, if is equipped with signals for controlling the humidifier.				
1.16.					
1.17.					
1.18.					
1.19.					

SPECIAL OPERATIONS:					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.20.					
1.21.					
1.22.					

In date

Stamp and signature of service technician

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6.10 CHAMBER OF DAMPERS AND END WALL

LIST OF SERVICING OPERATIONS PRIOR COMMISSIONING AIR-HANDLING UNIT MANDÍK

Order number:	User:
Date:	Commissioning party:
Project name:	Serial number:
Address:	Position:
Date of first start-up:	

OPERATIONS FOR DAMPER CHAMBERS AND END WALLS					
Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.01.	Check the location of dampers according to the unit technical specification – internal/external.				
1.02.	Check the fitting of the dampers to the supporting structure.				
1.03.	Check the dampers for free rotation.				
1.04.	Check the dampers for complete closing.				
1.05.					
1.06.					
1.07.					
1.08.					
1.09.					
1.10.					
1.11.					
1.12.					
1.13.					
1.14.					
1.15.					
1.16.					
1.17.					

OPERATIONS FOR DAMPER CHAMBERS AND END WALLS – MEASURING AND CONTROL SYSTEM

Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.18.	Check the mounting and connection of the actuating mechanisms according to the mounting instructions.				
1.19.					
1.20.					
1.21.					
1.22.					
1.24.					
1.25.					

SPECIAL OPERATIONS:

Operation number	Description of servicing operation	Completion of operation		Measured or set value *	Comment
		YES	NO		
1.26.					
1.27.					
1.28.					
1.29.					

In date

Stamp and signature of service technician

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7 | COMMISSIONING

7.1 OPERATIONS PRIOR FIRST START

The following must be performed prior the first start:

- Operations prior commissioning pursuant the previous Section 6.
- Initial inspection of electrical installations
- Initial inspection of gas installations if the supply includes a gas heater
- Setting of the fan operating point (speed/frequency) in accordance with the values from the technical specifications of the unit

Prior starting the unit for the first time, the following must be checked:

7.2 OPERATIONS DURING FIRST START



The fan must not be run when the closing or control dampers are closed. It is necessary to avoid pressure shocks arising during testing the functionality of fire dampers or other dampers a short time of repositioning to the closed position.

The first test run of the unit should not exceed 30 minutes. After that, it is necessary to checked again completely all its sections.

After initial commissioning, it is necessary to clean all the input filters or to replace them with new ones.

During the first start, in particular the following is checked:

Unit in general:

- Whether abnormal mechanical sounds can be heard or not
- Check for excessive vibration of the unit
- Tightness of joints of each chamber and tightness of all subsequently made passes through the unit shell
- All the dampers on the end walls of the unit are open

Fans:

- Measuring of current consumption of the electric motor – it must not exceed the data on the nameplate

Water exchangers (heater/cooler):

- Tightness of connections of the hydraulic system with the exchanger
- Proper function of the condensate siphon (height, flooding with water)

Evaporator:

- Tightness of the cooling circuit
- Check of the circuit parameter values (pressures, temperatures) in each section (high-pressure section, low-pressure section)
- Check of functionality of each circuit devices (compressor, expansion valve, fan of the condensing unit, etc.)
- Measuring of current consumption of the compressor – it must not exceed the data on the nameplate
- Check of the coolant level
- Proper function of the condensate siphon (height, flooding with water)

Electric heater:

- The speed of air flow must not drop below 1 m/sec.
- Measuring of current consumption at all the power stages on all the phases – it must not exceed the data on the nameplate

'Pecín' gas heater:

- Correct setting and operation of the burner (the amount of combustion air, the amount of supplied gas, tightness of the connection of the burner to the exchanger, tightness of the fittings of the gas line and gas connection, etc.) – always carried by a qualified service technician of the burner manufacturer
- The optimal temperature of combustion products – it should not exceed 200 °C
- The air behind the exchanger does not exceed +45 °C
- The correct direction of rotation of the bypass damper, or the turning of the switch of the actuating mechanism, see Section 5.28 MOUNTING OF ACTUATING MECHANISMS

'MONZUN' gas heater:

- Commissioning of the heater must only be performed by a service technician of MANDÍK, a. s. or by a person authorized by MANDÍK, a. s. to perform servicing
- The air behind the exchanger does not exceed +45 °C
- The correct direction of rotation of the bypass damper, or the turning of the switch of the actuating mechanism, see Section 5.28 MOUNTING OF ACTUATING MECHANISMS

Plate heat-recuperation exchanger:

- Proper function of the condensate siphon (height, flooding with water)
- The correct direction of rotation of the bypass/mixing damper, or the turning of the switch of the actuating mechanism, see Section 5.28 MOUNTING OF ACTUATING MECHANISMS

Rotary heat exchanger:

- Free movement of the rotor
- The correct direction of rotation according to a directional arrow, or swapping two phases in the motor terminal board
- The flow velocity of the conveyed air on the exchanger must not exceed the speed of 4 m/s.
- Sufficient tension of the belt and whether the pulley does not slip
- Rotor sealing profiles for proper function
- Measuring of current consumption of the electric motor – it must not exceed the data on the nameplate
- The air inlet or outlet loss must not exceed 15 % of the theoretical value stated in the technical specification

Chamber of dampers and end walls:

- The correct direction of rotation of the dampers, or the turning of the switch of the actuating mechanism, see Section 5.28 MOUNTING OF ACTUATING MECHANISMS

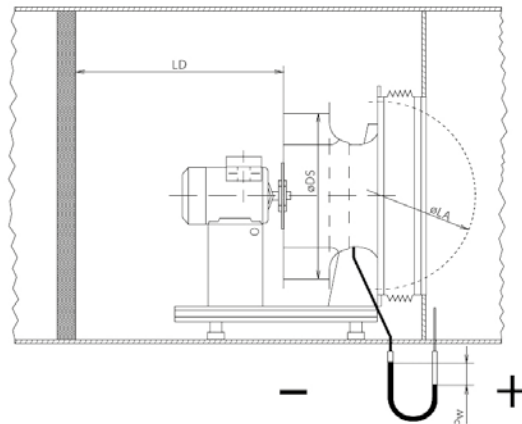
7.3 ADJUSTING AIR OUTPUTS OF THE UNIT

During the start and after performing the operations of the previous Section 7.1, it is necessary to check the air output of the unit according to the technical specifications or to change the speed/frequency of the fans. The fan chamber is equipped with sampling probes, shown below, for measuring air output of the fan, or the differential pressure.



- ① Sticker with k-factors of individual fan impellers for calculating the air output [m³/hour] based on the measured differential pressure [Pa]
- ② Probes for measuring differential pressure of the fan

After measuring the differential pressure [Pa], the air output [m³/hour] is calculated by the k-factor of the given fan and a formula, which appears on the fan sticker. In another case, the air output can be calculated as follows:



Connection of the meter

RH22C	47	RH45C	197	RH90C	789	RH35Cpro	121
RH25C	60	RH50C	252	RH10C	999	RH40Cpro	154
RH28C	75	RH56C	308	RH11C	1233	RH45Cpro	197
RH31C	95	RH63C	381	RH25Cpro	60	RH50Cpro	252
RH35C	121	RH71C	490	RH28Cpro	75	RH56Cpro	308
RH40C	154	RH80C	620	RH31Cpro	95	RH63Cpro	381

K-factors of the van free impellers. Applies to the for air density of 1.2 [kg/m³]

$$\dot{V} = k \cdot \sqrt{\Delta p_w}$$

Formula for the calculation of air output .

k = k -factor (table above), Δp_w = measured pressure difference [Pa]

To remove the deviations of the measured air output and the required air output specified by the project (technical specifications), adjusting of the fan operating frequency [Hz] on the frequency converter is performed. Increase in the frequency = increase in the air output and vice versa.

When the load increases, it is necessary to check the current consumed by the fan electric motor. Measuring of current consumption of the electric motor must not exceed the data on the nameplate

When performing these adjustments, all the dampers must be in a maximum open position.



If the required air output cannot be reached or the operating frequency is increased/decreased very significantly, this is impetus for inspecting the unit (internal clogging, foreign local pressure resistances) or piping lines (foreign local pressure resistances, the designed external pressure loss is not identical to the real execution of the piping), etc.

A record on adjusting the unit must be written in a relevant protocol.

The results of the measured values are satisfactory if the deviation of the measured values with the values in the unit technical specifications does not exceed ± 10 %.

In an inlet-outlet unit, it is always necessary to adjust air outputs by the pressure conditions specified by the project or by the type of operation in the conditioned space – equal-pressure/overpressure/underpressure ventilation.

The protocol on these adjustments must contain the following information:

- Device identification (order number, serial number, position in the project)
- Details of the person performing the adjustment, including their signature or stamp
- Nominal parameters of the device (air outputs, current load of the fan electric motors – nameplate values)
- Used measuring instruments
- Functional diagram of the device, including the diagram of pipe lines with the dimensions and description of their components (embedded devices – silencers, filters, regulation dampers, turns, bends, etc.).
- List and values of measuring points
- Timetable of the adjusting process (start/stop of the unit)
- Weather conditions during operation (input/output temperatures and humidity of the supplied and discharged air)
- Records of the operation and status of individual components of the unit referred to in Section 7.1
- Records of detected faults
- Record of the test evaluation (result, date, etc.)
- Table of the measured and set values of each fan (frequencies, air outputs, currents)

7.4 OPERATOR TRAINING AND UNIT HANDOVER

The following steps must be followed during training:

- User training for operation and maintenance of the unit
- Making a record of the training. A copy will be sent to the address of MANDÍK, a. s. or by e-mail to the service department at service@mandik.cz.
- Training on operation and setting of user parameters of the Climatix measuring and control system
- Making a record of the training in the measuring and control system. A copy will be sent to the address of MANDÍK, a. s. or by e-mail to the service department at service@mandik.cz.
- Making a record of the unit adjustment. A copy will be sent to the address of MANDÍK, a. s. or by e-mail to the service department at service@mandik.cz.
- Handover of the unit to the user
- Making a record of handover of the unit to the user. A copy will be sent to the address of MANDÍK, a. s. or by e-mail to the service department at service@mandik.cz.
- Starting of an operational logbook of the equipment
- Handover of the documentation to the user (the manufacturer's instructions, inspection of the electrical installations, inspection of the gas installations, protocol of the training for operation and maintenance, protocol of the training in the measuring and control system, protocol of handover of the unit, protocol of the unit adjustment).

7.5 CONDITIONS FOR COMMISSIONING OF AIR HANDLING UNITS BY SERVICE TECHNICIANS OF MANDÍK, a.s.

If this service is ordered, the customer must unconditionally meet the following points (**otherwise, if the conditions stipulated below are not met, the commissioning-related costs shall be charged!**):

- 1) Send a regular order of this service in written to e-mail: service@mandik.cz, stating in the e-mail heading: „**ORDER – COMMISSIONING, order number (e.g. KSI40000)**“.
- 2) The order shall specify, among other things: the exact address of the unit location and the contact person (name, phone, e-mail) who:
 - a) Will notify the service engineer of the requirements on operation and functions of the HVAC unit for the purpose of its correct settings.
 - b) Will accept the HVAC unit by signing the commissioning report.
 - c) Will be trained for operation and maintenance of the HVAC unit.
 - d) Will sign the service report to the service engineer.
- 3) Before starting the commissioning service, the customer shall submit a report of the initial inspection of general wiring (MaR system and electrical devices) and the report of the initial inspection of the gas device, if the HVAC unit is equipped with it, to the service engineer.
- 4) The customer shall arrange the access to the place of installation – parking close to the place of installation, free access to the unit to be commissioned.
- 5) The customer shall arrange adequate working conditions – workplace safety, lighting, elimination of any other activities that would complicate or make impossible the work at the HVAC unit to be commissioned, and provide for the necessary assembling equipment (lifting platforms, etc.).
- 6) The customer shall arrange the building preparation to be made by the customer for the HVAC unit commissioning, i.e.
 - a) The HVAC unit shall be installed and completely assembled according to the accompanying technical documentation and the installation manual of Mandík, a. s.
(see <https://mandik.cz/product-line/air-handling-units/air-handling-units-mandik>, "AHU - Control and Commissioning guide).
 - b) The HVAC unit shall be connected to the piping network with all integrated items (fire dampers, regulating flap valves, ...) and with all end elements (induction units, air distribution elements, louvers, ...).
 - c) The HVAC unit shall be connected to the necessary technological piping – heat and cold sources for water heaters/coolers, evaporators/capacitors, glycol circuits, ..., including regulation items (mixing nodes of heaters/coolers, pumps and valves of glycol circuits, ...) and to the gas piping, respectively.
 - d) The MaR components (sensors, servo drives, manostats, anti-freeze thermostats, remote controls, ...), electrical equipment (fans, frequency convertors, electric heaters, drives of rotary regeneration heat exchangers, ...) and piping items (fire dampers, ...) shall be connected by cables with the switchboard box of the HVAC unit according to the drawing documentation of the MaR project.
 - e) There shall be a functional main power supply to the switchboard box of the HVAC unit.

Note:

All service actions, extra works, surcharges and travel costs shall be billed according to the valid price list of service works, unless agreed otherwise.

The service of commissioning by the service engineers of Mandík, a. s. can be ordered only in case of simultaneous delivery of the HVAC unit and the MaR system from Mandík, a. s.

8 | OPERATION AND MAINTENANCE



The following prescribed maintenance and servicing intervals for the individual components of the unit must be observed to keep the manufacturer's warranty of MANDÍK, a. s. and for trouble-free and safe operation of the unit.

These intervals are intended for standard units with normal operating conditions. In units that are operated differently (24-hour operation, higher operating temperatures, higher dust content in the surrounding air, etc.) intervals for maintenance and servicing must be shortened by at least one level below. It always depends on the actual operating conditions for which the intervals are determined at commissioning, training and handover of the unit.



All the performed maintenance operations, maintenance, inspections must always be recorded in an operational logbook of the unit. The obligation to start and maintain an operational logbook lies on the person who puts the unit into operation. Entries for individual events are made by the unit operator.

SAFETY DURING MAINTENANCE:

- **CAUTION:** ALL THE OPERATIONS, MAINTENANCE AND INTERVENTIONS ON THE EQUIPMENT MUST BE PERFORMED BY A QUALIFIED PERSON WITH RELEVANT AUTHORISATIONS (E.G. GAS INSTALLATIONS, ELECTRICAL INSTALLATIONS, ETC.)!
- **CAUTION:** ANY SERVICING AND MAINTENANCE ON THE EQUIPMENT MAY BE PERFORMED ONLY WHEN SWITCHED OFF (IT MUST BE SECURED AGAINST ACCIDENTAL STARTING OR STARTING BY ANOTHER PERSON)!
- **CAUTION:** PRIOR ENTERING THE EQUIPMENT, ALL THE ROTATING COMPONENTS (FANS, ROTARY EXCHANGERS, ETC.) MUST BE STOPPED!
- **CAUTION:** MINIMUM WAITING TIME OF 15 MINUTES IS REQUIRED FOR FANS AND ELECTRIC MOTORS THAT ARE EQUIPPED WITH FREQUENCY CONVERTERS DUE TO RESIDUAL VOLTAGE!
- **CAUTION:** THE HEAT EXCHANGERS, COMPONENTS OF THE HYDRAULIC SYSTEM, COMPONENTS OF THE COOLING CIRCUIT MUST BE COOLED TO THE AMBIENT TEMPERATURE, THE MAX. SURFACE TEMPERATURE IS +40 °C!
- **CAUTION:** THE PRESSURE VALUES OF THE PRESSURE SYSTEMS ARE AT AMBIENT PRESSURE!

8.1 SERVICE AND MAINTENANCE INTERVALS

Detailed instructions for operation and maintenance/servicing procedures are provided in the following paragraphs of Section 8.2 and various components of the unit.

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
1. UNIT IN GENERAL							
1.01.	Overall check of cleaning, damage and corrosion on all components of the unit (outside/inside).	N	cleaning and repair		✓		
1.02.	Overall check of the tightness of the doors, service and fixed panels on all components of the unit.	Y	repair			✓	
1.03.	Overall check of the tightness of connections between the unit chambers.	Y	repair			✓	
1.04.	Check the tightness of the connections of HVAC ducts and the condition of the damping inserts.	Y	repair			✓	
1.05.	Check the unit for excessive vibrations.	Y	repair	✓			
1.06.	Check the air output of the unit (when the unit and filters are clean inside).	Y	measuring				✓
1.07.	Check the function of the roof of an exterior unit.						✓

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
2. FILTERS G2-F9, GREASE							
2.01.	Check the filter pressure losses.	Y	value from the measuring and control system	✓			
2.02.	Check the integrity of the filtration medium of the filter elements.	N	replacement		✓		
2.03.	Check the integrity of the seals on the filter frame	N	repair			✓	
2.04.	Check the setting and function of the differential pressure gauge (switches, digital, sloping tube).	Y	repositioning/ replacement		✓		
2.05.	Check the fitting of pressure probes for measuring filter differential pressure.	N	repair	✓			

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
3. FILTERS WITH ACTIVATED CHARCOAL							
3.01.	Check the integrity of the filter cartridges.	N	replacement				✓
3.02.	Check the fitting of the filter cartridges in their frames.	N	repair			✓	
3.03.	Check the condition of the filtration medium – activated charcoal through a weight method.	N	reactivation		✓		

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
4. FANS WITH FREE IMPELLERS							
4.01.	Check the cleanness and condition of the impeller and the chamber inside.	N	cleaning			✓	
4.02.	Check the integrity of the damping insert of the fan.	N	replacement			✓	
4.03.	Check the impeller for free rotation.	N	repair			✓	
4.04.	Tighten the cables in the electric motor terminal board.	N	repair			✓	
4.05.	Check the assembly for excessive vibrations – the assembly must not show any visible vibrations.	Y	repair	✓			
4.06.	Check the condition of the assembly vibration insulator.	N	repair		✓		
4.07.	Checking the function of the safety differential manometer against excessive overpressure (if any fan equipped)	N	repair		✓		

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
5. WATER HEATER							
5.01.	Check the integrity of the exchanger heat-transfer surface.	N	repair/replacement			✓	
5.02.	Check the cleanness of the exchanger heat-transfer surface.	N	cleaning			✓	
5.03.	Check the tightness of the exchanger on the side of working fluid.	N	repair			✓	
5.04.	Check the function of the exchanger anti-freeze protection (always prior a heating season).	N	repair/measuring and control system			✓	
5.05.	Check the condition of connection of the exchanger hydraulic circuit.	N	repair			✓	
5.06.	Check the condition and function of the mixing device according to the manufacturer's instructions.	N	repair			✓	

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
6. ELECTRIC HEATER							
6.01.	Check the heating rods for damage.	N	replacement			✓	
6.02.	Check the cleanness of the terminal board.	N	cleaning			✓	
6.03.	Check the heating rods for cleanness.	N	cleaning			✓	
6.04.	Check the condition of the wiring of the heating rods and protection (condition of the cables, tightening of the cables, etc.).	N	repair			✓	
6.05.	Check the function of the operating and safety thermostats.	N	value from the measuring and control system			✓	

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
7. 'PEČÍN' GAS HEATER							
7.01.	Check the condition of the exchanger (damage, corrosion).	N	repair/ replacement			✓	
7.02.	Check the outside of the exchanger for contamination.	N	cleaning			✓	
7.03.	Check the inside of the exchanger for contamination – combustion product exhaust system.	N	cleaning				✓
7.04.	Check the gas connection,	N	repair/ replacement		✓		
7.05.	Check the burner for its condition and correct function – always performed by a service technician of the burner manufacturer.	N	repair/ replacement				✓
7.06.	Check the burner cover heating for its function in case of exterior installation.	N	repair/ replacement				✓
7.07.	Check the function of the safety thermostat.	N	repair/ replacement				✓
7.08.	Check the condition and passability of the heater combustion product exhaust.	N	repair/ replacement				✓
7.09.	Check the function of condensate draining from the combustion product exhaust.	N	repair/ replacement				✓
7.10.	Check the free turning of the bypass damper.	N	repair/ replacement			✓	
7.11.	Check the bypass damper for contamination.	N	cleaning			✓	

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
8. 'MONZUN' GAS HEATER							
8.01.	Check the condition of the exchanger (damage, corrosion).	N	repair/replacement			✓	
8.02.	Check the outside of the exchanger for contamination.	N	cleaning			✓	
8.03.	Check the gas connection,	N	repair/replacement		✓		
8.04.	Check the condition and passability of the heater combustion product exhaust.	N	repair/replacement				✓
8.05.	Complete check of the condition and function of the heater (burner, automatics, exchanger, bypass, etc.) must be always performed by a service technician of MANDÍK, a.s. or by a service technician authorised by MANDÍK, a.s.	N	repair/replacement				✓

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
9. WATER COOLER							
9.01.	Check the integrity of the exchanger heat-transfer surface.	N	repair/replacement			✓	
9.02.	Check the cleanness of the exchanger heat-transfer surface.	N	cleaning			✓	
9.03.	Check the tightness of the exchanger on the side of working fluid.	N	repair			✓	
9.04.	Check the condition and cleanness condensate droplet eliminator.	N	repair/cleaning			✓	
9.05.	Check the condition of connection of the exchanger hydraulic circuit.	N	repair			✓	
9.06.	Check the condition and function of the mixing device according to the manufacturer's instructions.	N	repair			✓	
9.07.	Check the cleanness and passability of the condensate drain.	N	cleaning/repair			✓	
9.08.	Check the condition and flooding with water of the condensate drain siphon.	N	repair			✓	

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
10. EVAPORATOR							
10.01.	Check the integrity of the exchanger heat-transfer surface.	N	repair/replacement			✓	
10.02.	Check the cleanness of the exchanger heat-transfer surface.	N	cleaning			✓	
10.03.	Check the condition and cleanness condensate droplet eliminator.	N	repair/cleaning			✓	
10.04.	Complete checks of the condition and function of the cooling circuit (tightness, expansion valve, condensation unit, coolant condition, etc.) must always be performed by a qualified refrigeration technician authorized to work with coolants.	N	repair/replacement				✓
10.05.	Check the cleanness and passability of the condensate drain.	N	cleaning/repair			✓	
10.06.	Check the condition and flooding with water of the condensate drain siphon.	N	repair			✓	

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
11. PLATE RECUPERATOR							
11.01.	Check the integrity of the exchanger heat-transfer surface.	N	repair/replacement			✓	
11.02.	Check the cleanness of the exchanger heat-transfer surface.	N	cleaning			✓	
11.03.	Check the free turning of the bypass/mixing damper.	N	repair/replacement			✓	
11.04.	Check the dampers for contamination.	N	cleaning			✓	
11.05.	Check the condition and cleanness condensate droplet eliminator.	N	repair/cleaning			✓	
11.06.	Check the cleanness and passability of the condensate drain.	N	cleaning/repair			✓	
11.07.	Check the condition and flooding with water of the condensate drain siphon.	N	repair			✓	

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
12. ROTARY HEAT RECUPERATOR							
12.01.	Check the integrity of the rotor heat-transfer surface.	N	repair/replacement			✓	
12.02.	Check the cleanness of the rotor heat-transfer surface.	N	cleaning			✓	
12.03.	Check the free turning of the rotor.	N	repair/replacement			✓	
12.04.	Check the tensioning of the rotor drive belt.	N	repair/cleaning			✓	
12.05.	Check the condition and correct setting of the rotor seals – circumferential and cross-sectional seals.	N	repair/replacement			✓	
12.06.	Check the condition of the wiring of the driving electric motor – tighten the cables in the terminal board.	N	repair			✓	
12.07.	Check the condition and function of the device at its minimum and maximum speeds.	N	repair/replacement			✓	
12.08.	Check of max. Velocity of air flow 4 m/s through exchanger	A	repair/replacement		✓		
12.09.	Check the maximum pressure drop of the exchanger 250 Pa or max. + 15 % against the stated value in the technical specification	A	repair/replacement		✓		

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
13. FLUID CIRCUIT – HEAT RECUPERATION							
13.01.	The same instructions as for the water heater.	N					
13.02.	The same instructions as for the water cooler.	N					
13.03.	Check the condition and function of the fluid circuit.	N	repair/replacement			✓	

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
14. STEAM HUMIDIFIER							
14.01.	Check the condition and fitting of the distribution tubes inside the chamber.	N	repair/replacement			✓	
14.02.	Check the condition and function of the steam humidifier circuit.	N	repair/replacement			✓	
14.03.	Check the cleanness and passability of the condensate drain.	N	cleaning/repair			✓	
14.04.	Check the condition and flooding with water of the condensate drain siphon.	N	repair			✓	

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
15. SILENCER							
15.01.	Check the silencer screens for damage – in particular to the screen fabric	N	repair/replacement			✓	
15.02.	Check the fitting of the silencer screens.	N	repair			✓	

* status of unit operation while performing the checks

SERVICING AND MAINTENANCE OPERATIONS							
	Check operation	Unit in operation Y/N*	Service/rectification method	Intervals (months)			
				1	3	6	12
16. DAMPER CHAMBER AND END-WALL DAMPER							
16.01.	Check the dampers for free movement.	N	repair/replacement			✓	
16.02.	Check the dampers for contamination.	N	cleaning			✓	

* status of unit operation while performing the checks

8.2 UNIT OPERATION AND MAINTENANCE IN GENERAL



All the persons performing maintenance of air-handling units must be familiar with the contents of the maintenance instructions, and they must follow the recommendations set out in them. These instructions are only a complementary source of information and the knowledge is expected of mounting and operating regulations for air-handling units MANDÍK, a. s., series M/M+, P/P+, S/S+ and T/T+, and complying with all the requirements contained therein. The manufacturer cannot be held liable for any damage arising from failure to observe the mounting and operating regulations and these instructions.

Air-handling units are devices for transport and treatment of air and they require regular maintenance and cleaning. According to the scope and purpose of air-conditioning facility whose part they are, as well as the composition and equipment of air-handling units themselves, the operator is advised to develop local operation and maintenance regulations respecting the requirements of mounting and operating regulations and instructions for maintenance of air-handling units MANDÍK, a. s., M/M+, P/P+, S/S+ a T/T+.

Any time intervals for maintenance, mentioned in the text below, are for informative purposes only and they are valid for air containing normal amounts of pollutants. These time intervals can be lengthened or shortened, depending on the local operating conditions, the nature of the facility and pollution of the transported air. These intervals also cannot relieve the operators of their responsibility to ensure daily the correct and safe operation of their air-handling unit.

All the items whose nature determines them to be ejected, opened or disassembled easily must be put into such a position to allow as thorough cleaning of the unit interior as possible. Remove coarse dirt with a vacuum cleaner or, if necessary, use a damp cloth. In case of greasy dirt, use a neutral cleaner; then wipe the surface again with a damp cloth. Any damage to painted surfaces or traces of corrosion must be treated and repaired with a suitable coat. The moving components (hinges, handles, etc.) must be treated, if necessary, with a lubricant spray. All the inspection doors must be seated properly and checked for free opening. According to the conditions of unit seating, it may be necessary to align the doors within the adjustment play of bolts of the handles and hinges. Check proper fitting-in of the doors to the sealed surfaces. The door seals should be checked and repaired or replaced in the event of untightness.

8.3 FAN CHAMBER



Prior starting any intervention or work on the chamber, it is necessary to wait until the fan impeller stops completely! It is also necessary to prevent unintentional or accidental start of the fan by another person!

In fans, check the cleanness of the free impeller; remove any coarse dust with a vacuum cleaner and wipe fine dust with a damp cloth.

Keeping the fan impeller clean is very important, especially in terms of maintaining the best possible balance. Any damage to painted surfaces or traces of corrosion must be treated and repaired with a suitable coat.

Check regularly for any unbalance (vibrations), mounting of the impeller to the hub and of the hub to the motor shaft. Furthermore, check the width of the gap between the free impeller and the fan suction mouth and tighten all the bolts on the motor unit and the fan. Check the electric motor for vibrations, noise of the bearings, any excessive heating, tightening the terminals in the terminal board and the integrity of the conductors connected to the chamber frame.

Measure the motor current, check the voltage and phase symmetry during maintenance. Any surface damage must be repaired. Check the proper mounting of the electric motor to the base as well as all the bolting on the fan unit base. Check also the functionality of rubber vibration dampers under the unit and their anchoring. The periodic checks also include checking for leaks and integrity of the elastic collar on the fan intake and its cleaning.

If the fan is equipped with a safety differential pressure gauge, we check its correct function by a verification test with a suitable overpressure in the chamber.

8.4 FILTER CHAMBER



Dust deposited on the filter element can cause allergic reactions on the skin, mucous membranes and eyes or difficulty in breathing. Therefore, avoid any contact with the collected dust. During maintenance and when replacing the filter elements, it is necessary to wear protective clothing and, if necessary, protective equipment (breathing mask, etc.)!

In filter chambers, check the cleanness of the chamber; remove any coarse dust with a vacuum cleaner and wipe fine dust with a damp cloth. Furthermore, check clogging and tightness of the entire filter element. When changing the filters, avoid contamination of the chambers or new filter elements by deposited dust.

■ Pocket and frame filters

According to the filtration class and filters used and their replacement interval, it is always necessary to have a supply of at least one set of replacement filters and to ensure that their prescribed maximum shelf life is not exceeded. It is recommended to set the filter replacement interval on the basis of the results of observations during a trial run of the unit. This interval can then be, depending on the local conditions, shorter or longer than the interval for regular maintenance. In no case must the maximum allowable terminal pressure loss for the used type of filter element and the time interval of 12 months between changes (this applies to the first stage of filtration) be exceeded. For second and subsequent stages of filtration and also for filters of drainage components of the units, this time may be determined individually but it should not be longer than 24 months. All the filters across a filter element are usually replaced at the same time; the replacement of individual filters is allowed only if they are damaged.

■ Filters with activated charcoal

In plants where activated-charcoal filter are used to separate non-hazardous odours, the functionality of the filters can be checked using olfactory sensory perception. In cases of separation of odourless, toxic and other hazardous substances, the saturation of the charcoal and the remaining filter life can only be found through a laboratory test that can be carried out by the manufacturer of filter cartridges. On the basis of this test, the interval of replacing cartridges with activated charcoal may be determined. When determining the replacement interval it is always necessary to take into account the characteristics and nature of the substances to be separated, especially with regard to their potential health harmfulness or other hazards.

When disposing of used filter cartridges, it is necessary to observe the general and local regulations on environmental protection. In filters where it is technologically possible and available, it is preferred to use the possibility of recycling and regeneration of organic filtering materials.



Recommended end pressure losses of the filters are listed in Annex F.

8.5 END PANELS WITH DAMPERS AND DAMPER CHAMBERS



The shutters of the open damper must be secured against accidental or unintentional closing. Never put your limbs through the shutters of an opened damper – there is a risk of serious injury!

Check contamination, potential damage, free movement of the damper shutters and especially the correctness of damper closing. Remove any deposited dust with a vacuum cleaner; clean the damper shutter surfaces with a damp cloth. Plastic gears of the dampers are made of a material that does not require additional lubrication. In dampers with leverage, lubricate the necessary points of the leverage with lubricant spray. If a damper is followed by an elastic collar, check its tightness and integrity or clean it.

8.6 HEATING WATER OR STEAM CHAMBER, WATER COOLING CHAMBER



Surface temperature of the heater and medium connections during operation may exceed the safe touch temperature of 60 °C. Prior starting any intervention or work on the chamber, it is necessary to wait until the exchanger and the connections cool down sufficiently!

When filling, draining and deaerating the exchanger, avoid contact of unprotected skin and the heat-transfer medium. In the event of using of additives or complete ready mixtures in heating/cooling systems, it is necessary to observe the manufacturer's information for the use and handling of these substances.

Check exchangers for contamination, tightness and any damage. Remove any contamination by blowing air, steam or using a hot-water pressure cleaner against the air flow. In any case, care should be taken to prevent deformation of the exchanger plates. For this reason, high-pressure equipment, whether it water or air, should not be used for cleaning.

Check regularly the tightness of the connection threads and the functionality air-relief valves. In independently specified maintenance intervals and always prior the cold seasons of the year, check the functionality of anti-freeze protection or check the anti-freeze mixture concentration. Drain the medium from the coolers prior winter, from all the exchangers prior prolonged shutdown (if they are not filled with an antifreeze mixture of a sufficient concentration). The actual draining of the medium does not guarantee emptying of all the fluid from the exchanger, it is imperative also to blow compressed air through the exchanger!

In addition, the coolers must be checked for the condition and function of the trays for condensate draining, passability of the drain from the tray, and the condition and function of the siphon. Clean and add water if necessary. Prior winter, check the functionality of anti-freeze measures for the condensate drain (if they are in operation even in winter and there is a risk of freezing). Furthermore, check the droplet eliminator for the presence of any deposits, the condition and cleanliness and, if necessary, pull it out and clean.

8.7 HEATING CHAMBER WITH A CONDENSER, COOLING CHAMBERS WITH A DIRECT EVAPORATOR



Surface temperature of the heater and medium connections during operation may exceed the safe touch temperature of 60 °C. Prior starting any intervention or work on the chamber, it is necessary to wait until the exchanger and the connections cool down sufficiently!

During any work on the cooling circuit, avoid contact of the skin, mucous membranes or eyes with the coolant charge. In the event of coolant leakage, use personal protective equipment and a breathing apparatus when entering the plant room. Coolants and compressor oil may be toxic or cause allergic reactions. Mixtures of coolants with air may be explosive; coolant components may be heavier than air and displace oxygen from the space where persons are present. Always proceed in accordance with the instructions in the MSDS of the substance used!



Servicing of the cooling circuit, such as adding or replacing the coolant, replacing the circuit components (filter drier, expansion valves, pressure sensors, etc.) may only be performed by a qualified refrigeration technician authorized to work with coolants and in accordance with the instructions of the condensation unit manufacturer.

Check exchangers for contamination, tightness and any damage. Remove any contamination by blowing air, steam or using a hot-water pressure cleaner against the air flow. In any case, care should be taken to prevent deformation of the exchanger plates. For this reason, high-pressure equipment, whether it water or air, should not be used for cleaning. Check regularly the tightness of the circuit.

In addition, the coolers must be checked for the condition and function of the trays for condensate draining, passability of the drain from the tray, and the condition and function of the siphon. Clean and add water if necessary. Prior winter, check the functionality of anti-freeze measures for the condensate drain (if they are in operation even in winter and there is a risk of freezing). Furthermore, check the droplet eliminator for the presence of any deposits, the condition and cleanliness and, if necessary, pull it out and clean.

In addition, check direct evaporators for any icing of the exchanger during cooling.

When disposing of coolants and compressor oils, it is necessary to observe the applicable regulations on environmental protection.

8.8 CHAMBER WITH ROTARY HEAT EXCHANGER



Prior starting any intervention or work on the chamber, it is necessary to wait until the exchanger impeller stops completely. It is also necessary to prevent unintentional or accidental start of the fan by another person!

Check the impeller for condition and contamination, free movement and its backlash, bearing noise, belt tensioning and condition of the recuperator wheel.

Furthermore, check the condition of the electric motor and the gearbox. Remove contamination from the chamber (burrs from the belt, abrasion from the pulleys, dust) with a vacuum cleaner and wipe the surfaces with a damp cloth.

Remove any accumulated contamination from the impeller by blowing air, steam or using a hot-water pressure cleaner. In any case, care should be taken to prevent deformation of the exchanger plates. For this reason, high-pressure equipment, whether it water or air, should not be used for cleaning. Always direct water or air stream perpendicular to the exchanger accumulation surface.

Check any slippage of the belt for the exchanger wheel drive.

Check the position and condition of the movable recuperator wheel seal and make any necessary corrections at the places where the seal is more distant from the wheel. In any case, avoid direct contact between the wheel and the seal.

Check the gearbox and the electric motor for vibrations, noise of the bearings, any excessive heating, vibrations and the integrity of the conductors connected to the chamber frame. Measure the motor current and check the voltage during maintenance. Check the proper mounting of the electric motor to the tensioning base as well as all the bolting on the belt tensioning device.

8.9 CHAMBER WITH PLATE RECUPERATOR



The shutters of the open damper must be secured against accidental or unintentional closing. Never put your limbs through the shutters of an opened damper – there is a risk of serious injury!

Check the recuperator for its condition and contamination, function of the dampers, condensate drain and droplet eliminator.

Remove any contamination of the recuperator by blowing air, steam or using a hot-water pressure cleaner. In any case, care should be taken to prevent deformation of the plates of the exchanger.

Check the damper shutters for contamination, potential damage, free movement. Remove any dust deposits with a vacuum cleaner. Clean the damper shutter surfaces with a damp cloth. Plastic gears of the dampers are made of a material that does not require additional lubrication. In dampers with leverage, lubricate the necessary points of the leverage with lubricant spray.

In addition, check the function of the trays for condensate draining, passability of the drain from the tray, and the condition and function of the siphon. Clean and add water if necessary. Prior winter, check the functionality of anti-freeze measures for the condensate drain (if there is a risk of freezing).

Furthermore, check the droplet eliminator for the presence of any deposits, the condition and cleanliness and, if necessary, pull it out and clean.

8.10 SILENCING CHAMBER

Check the silencing screens for their condition and any contamination and, if necessary, cleaned them with a vacuum cleaner. Protect the absorption material of the screens against mechanical damage during cleaning.

8.11 GAS HEATING CHAMBER



Surface temperature of the heater and the exhaust system during operation exceeds highly the safe touch temperature of 60 °C. Prior starting any intervention or work on the chamber, it is necessary to wait until the exchanger, the exhaust system and chamber cool down sufficiently!

The shutters of the open damper must be secured against accidental or unintentional closing. Never put your limbs through the shutters of an opened damper – there is a risk of serious injury!

Check the exchanger for its condition and, if necessary, clean it with a vacuum cleaner.

Check the damper shutters for contamination, potential damage, free movement. Remove any deposited dust with a vacuum cleaner; clean the damper shutter surfaces with a damp cloth. Plastic gears of the dampers are made of a material that does not require additional lubrication.

In dampers with leverage, lubricate the necessary points of the leverage with lubricant spray.

In addition, check the function of the trays for condensate draining from the exchanger and the exhaust system, passability of the drain and of the siphon behind. Clean and add water if necessary. Check the gas connections and the exhaust system for leaks and functionality in addition to the exactly prescribed inspection dates.

■ 'Pecín' gas heater



To apply warranty, servicing of the burner may be performed only by a service technician of the burner manufacturer or an authorised service technician of the burner manufacturer.

To apply warranty, servicing of the exchanger (cleaning of the tube plate, etc.) may be performed only by a service technician of MANDÍK, a. s. or an authorised service technician of MANDÍK, a. s.

To apply warranty, servicing of the chimney system of the exhaust system may be performed by a specialist company.

Maintenance of the burner and the gas line fittings must follow the instructions in the manual and technical documentation enclosed in the packaging of the burner and stored subsequently at the place of installation of the equipment. When maintaining an exchanger component, check the tightening of the burner flange and the burner itself always at least prior the start of the heating season. After removing the tube plate cover, rotate the combustion product swirling generator to loosen any deposits and, if necessary, remove the swirling generators and sweep the tubes. After inspection and possible replacement of the cover seal, replace it and tighten the bolts.

■ 'MONZUN' gas heater



To apply warranty, servicing may be performed only by a service technician of MANDÍK, a. s. or an authorised service technician of MANDÍK, a. s.

When maintaining the heater, check the strength of the bolted joints in the area of the burner and test the functionality of the combustion product exhaust, thermostats and lights on the control panel. Furthermore, check the electrical connection and tighten cable clamps. If necessary, vacuum any dust and check the passability of the suction inlet of the combustion air for the burner.

8.12 ELECTRIC HEATING CHAMBER



Surface temperature of the heating elements during operation exceeds highly the safe touch temperature of 60 °C. Prior starting any intervention or work on the chamber, it is necessary to wait until the heating rods and the chamber cool down sufficiently!



Any interference with the electric heater may only be performed by personnel qualified according to valid regulations of the country in which the unit is put into operation.

Check the heating rods for its condition and, if necessary, clean them with a vacuum cleaner.

Furthermore, it is necessary to check the functionality of the equipment for controlling air flow and the operating and safety thermostats. With an electric heating chamber, it is always necessary, under all operating conditions and modes, to observe the minimum cross-sectional air speed of 1 m/sec. to ensure that heat is removed from the heating rods.

ANNEX A. INSTALLATION OF CHAMBER CENTRAL FRAMES

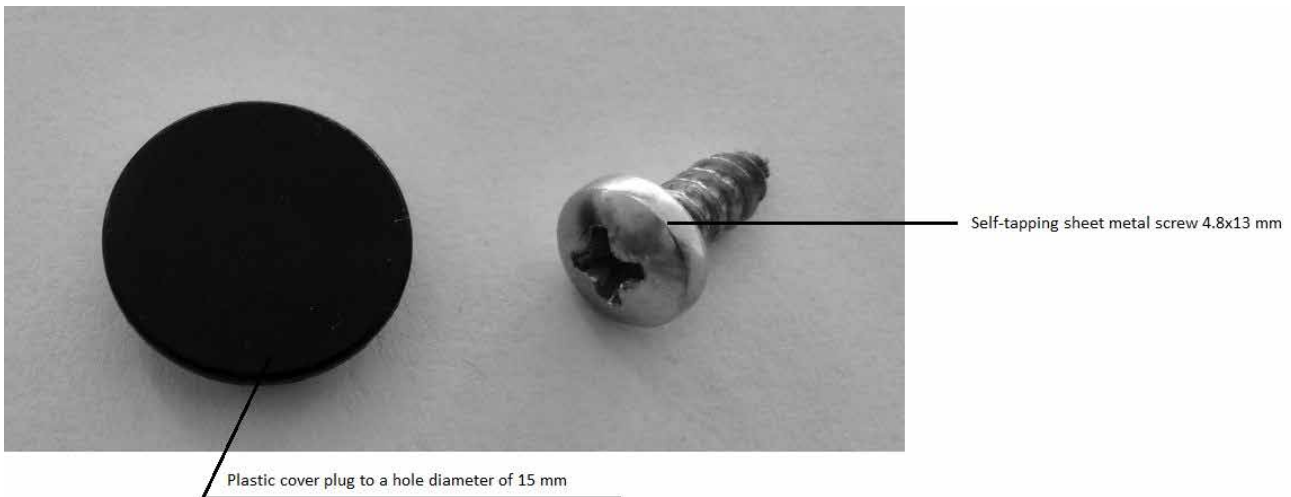
Valid for units of the type sizes of M20/P20 and above.

Chambers with central frames can be handled in the same manner as described in Section 4. HANDLING, TRANSPORT AND STORAGE.

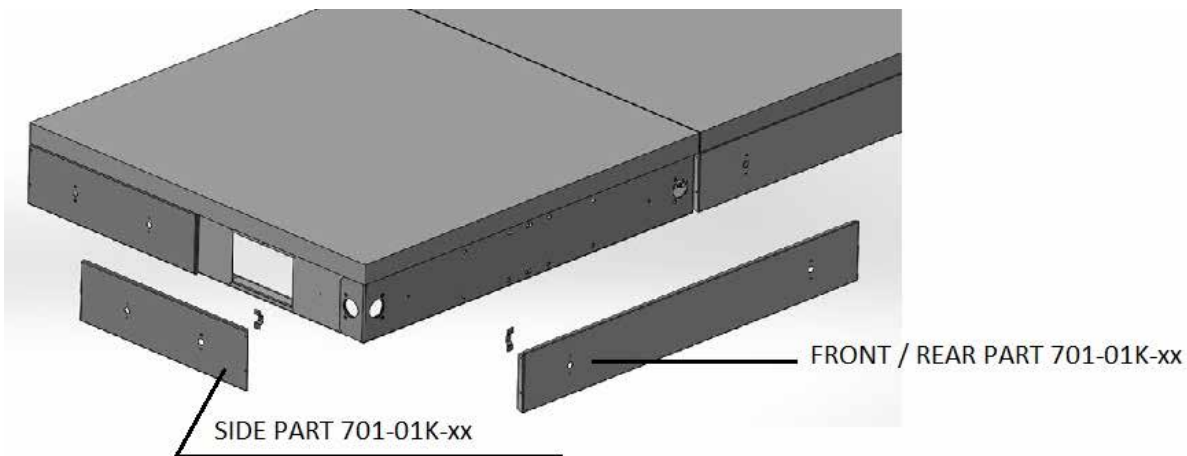
After seating the chambers, the frames must be covered according to the following method:



The following connecting material is supplied for assembly (it is placed in a cardboard box fasteners).



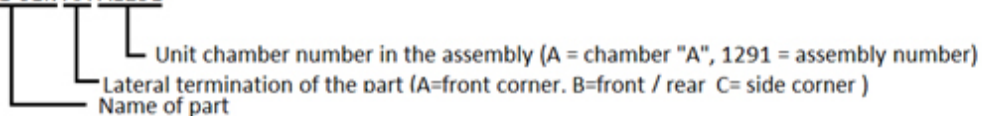
OVERALL VIEW:



Sheet metal parts of the cover 701-01K-xx are marked with labels at the factory.

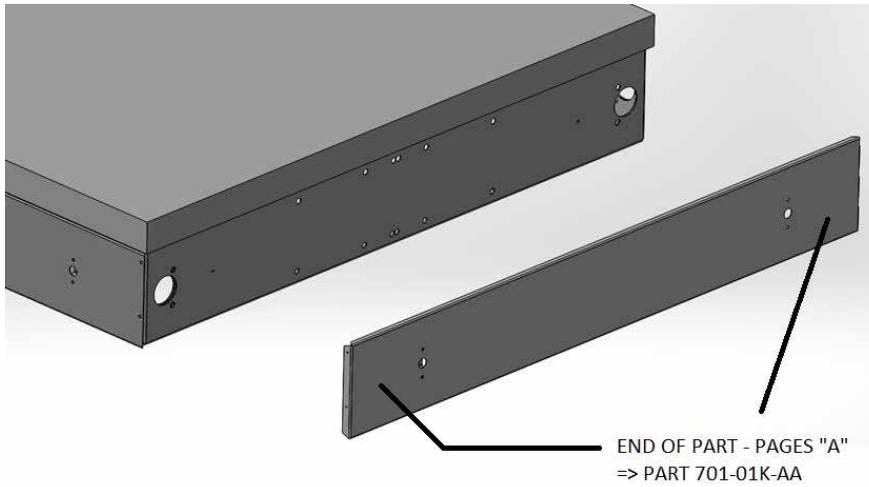
NAME OF COVER PARTS:

Full name = 701-01K-AA-A1291

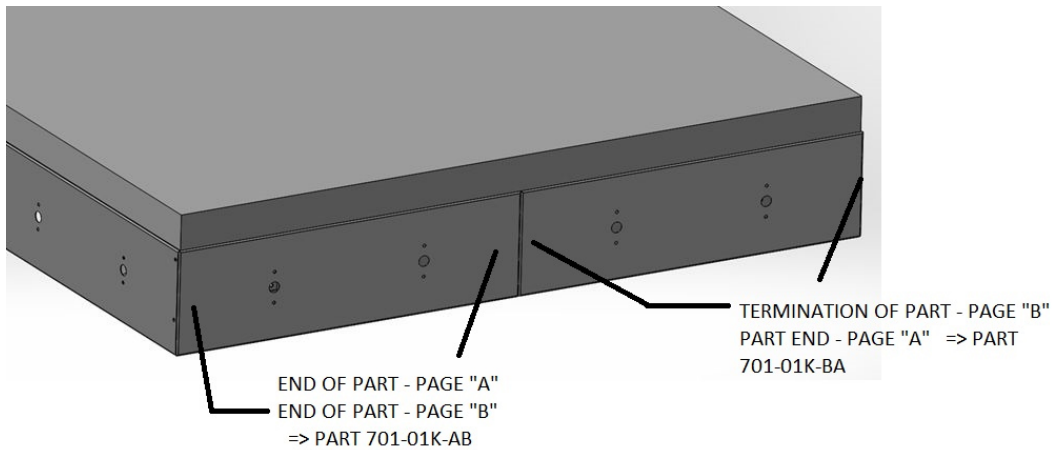


PARTS TYPES 701-01K:

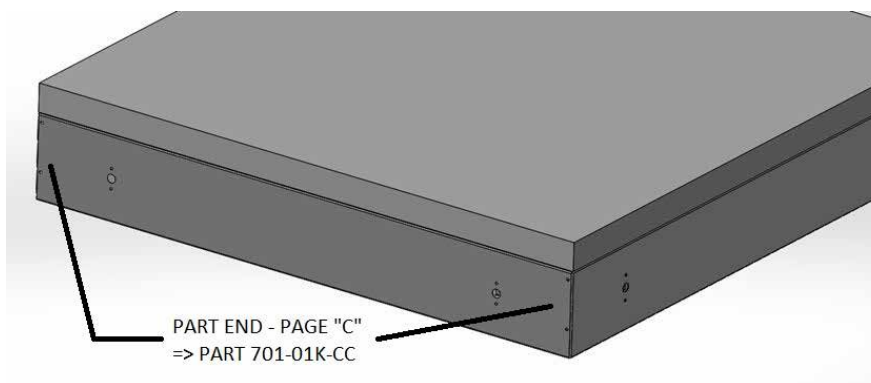
1) FRONT / REAR PART – IN PIECE (one-piece base frame)



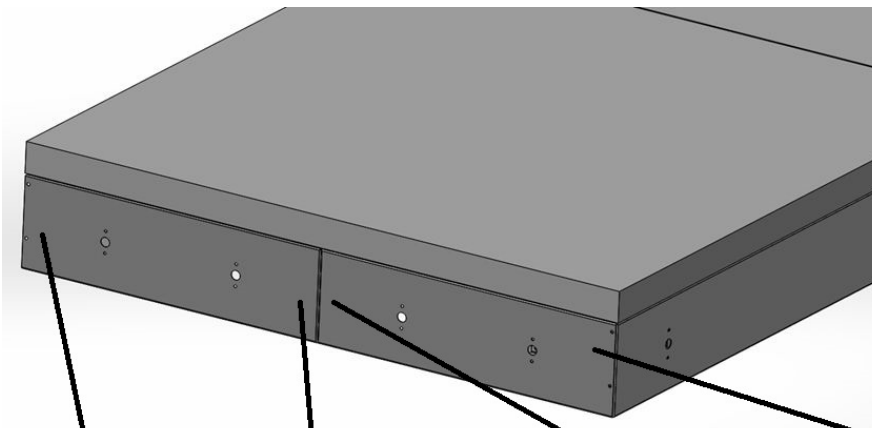
2) FRONT / REAR PART – TWO PIECES (two-piece base frame)



3) SIDE PART – IN PIECE (one-piece base frame)



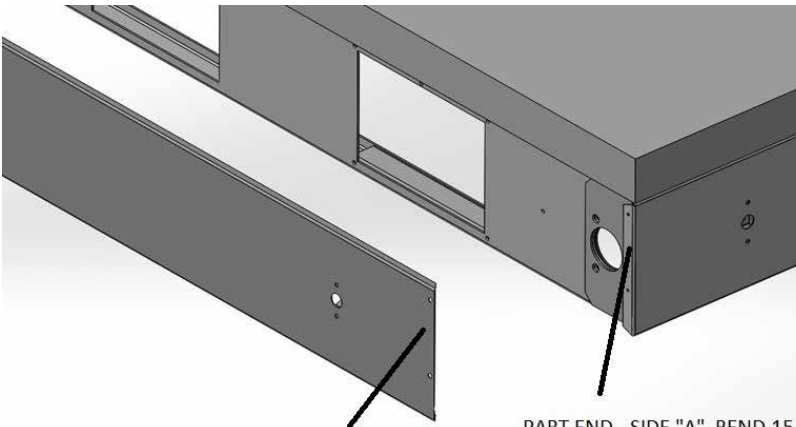
4) SIDE PART – TWO PIECES (base frame of two pieces)



TERMINATION OF PART - PAGE "C" END OF PART -
PAGE "B" => PART 701-01K-CB

PART END - PAGE "B" PART END - PAGE "C"
=> PART 701-01K-BC

5) DETAILS OF PARTY TERMINATIONS



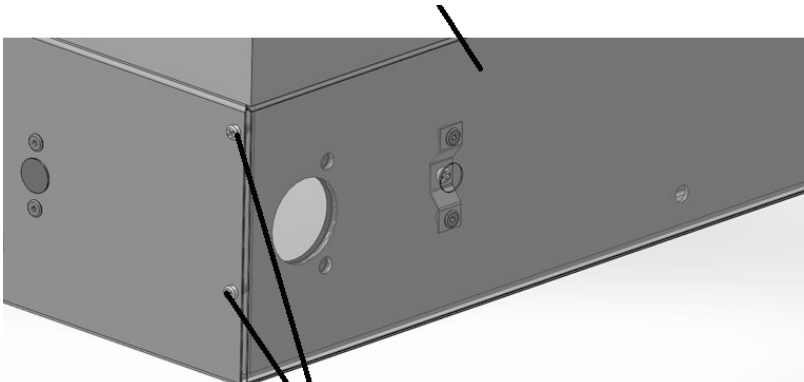
PART END - PAGE "C", BEND FREE

PART END - SIDE "A", BEND 15 mm
PART END - SIDE "B", BEND 9 mm
(SAME SHAPE AS "A")

ATTACHMENT OF PARTS TO THE FOUNDATION FRAME

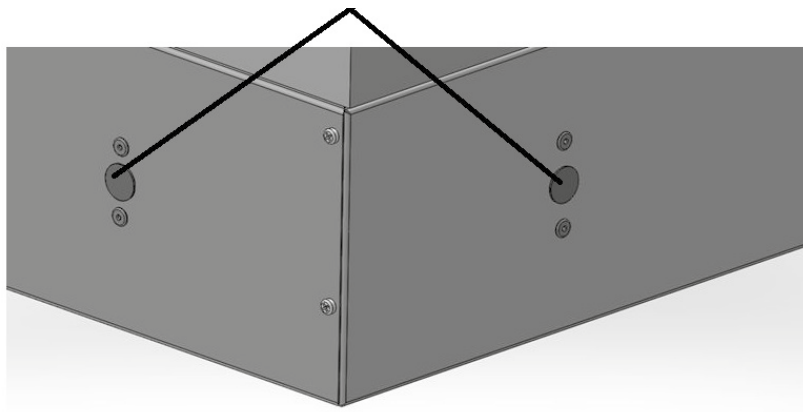
(applies to front / rear / side parts)

- 1) SCREW ALL PARTS 701-01K USING 4.8x13 SELF-CUTTING SCREWS AND HOLDERS IN PARTS 701-01K TO BASE FRAME PARTS, IN ASSEMBLY KIT (IN BASE PART THE FRAME IS A PREPARED HOLE WITH A DIAMETER OF 3 mm)



- 2) SCREW CORNER CONNECTION OF PARTS 701-01K USING SELF-CUTTING SCREWS 4.8x13

1) ZAKRYTOVAT VŠECHNY OTVORY KRYCÍMI ZÁTKAMI Z MONTÁŽNÍ SADY



ANNEX B. ASSEMBLY OF SPLIT VERTICAL RECUPERATION

This design of the recuperation chamber is intended for units with air flow greater than 20,000 [m³/hour]. The split design of this chamber facilitates transport and installation.

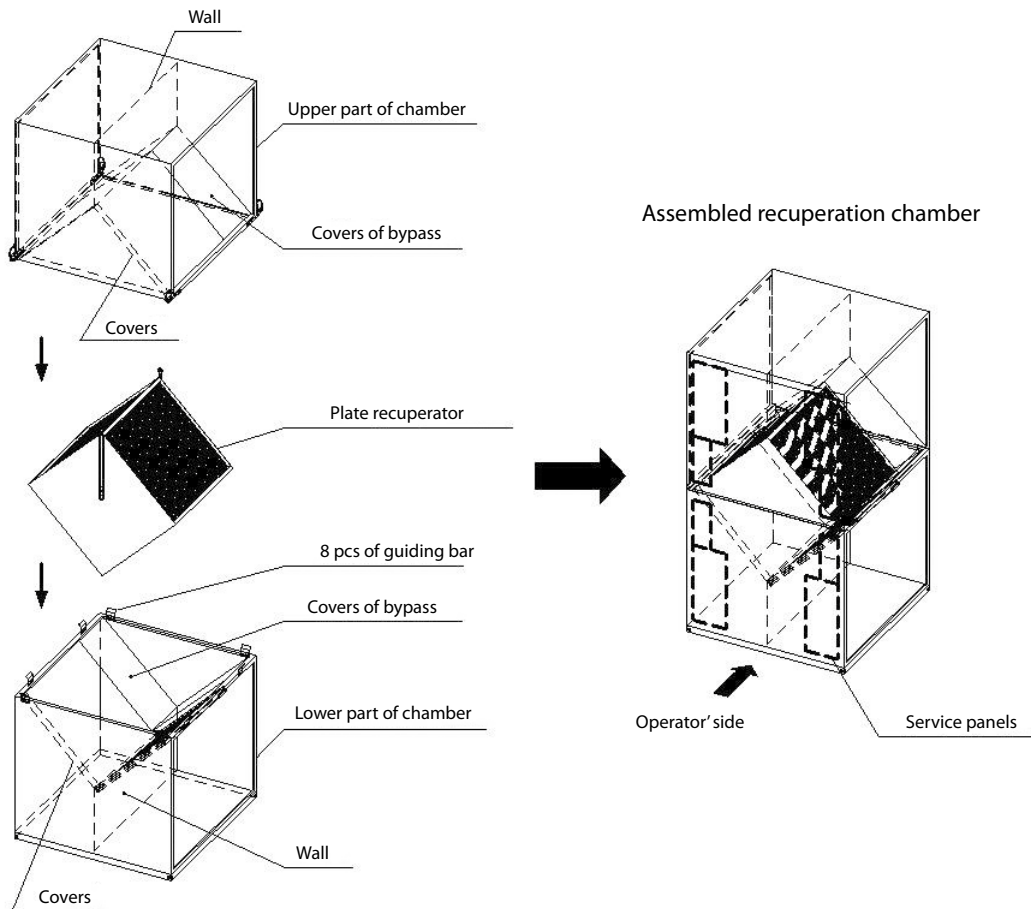


Figure 1 – Assembly diagram of split chamber

B.1 HANDLING

The following items are supplied

- Lower part of the recuperation chamber
- Upper part of the recuperation chamber
- Plate recuperator
- All loads are fitted with handling points, see Figure 2
- The lower and upper parts of the chamber are fully fitted with dampers, eliminators, holders, etc.

The following items are not supplied

- Crane with appropriate weight rating
- Crane and binding equipment such as eyes, hooks, chains, fabric slings

Recommended design of the handling horizontal bar

- Length of the horizontal bar = minimum length of the chamber

- Joints, fasteners
- Standard accessories needed to assemble the recuperation chamber (described in the document Air-handling Units MANDÍK Installation, Commissioning and Maintenance)

- Assembly tools
- Handling horizontal bar with attachment points, see Figure 3

The bearing capacity of the horizontal bar corresponding with the weight of the heaviest load

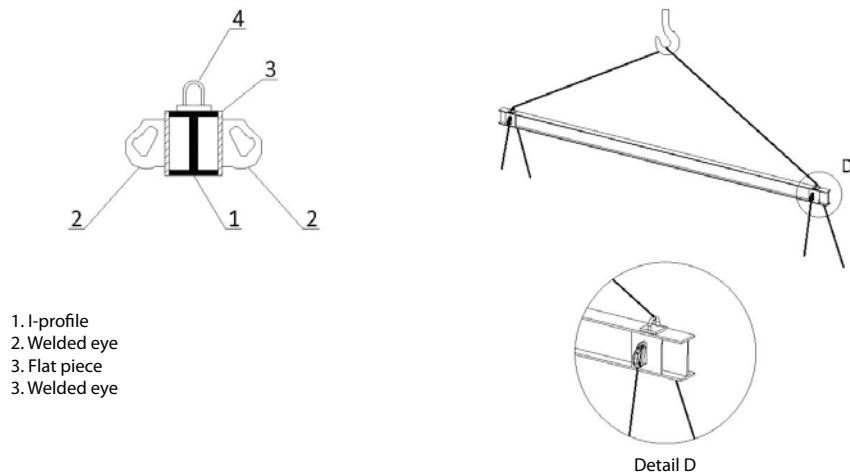


Figure 3 – Recommended design of handling horizontal bar

B.2 SEATING OF CHAMBER LOWER PART TO ITS PLACE

- Use the openings in the base frame to fasten the slings, as shown in Figure 2, Detail C
- Fasten the binding equipment to the handling bar, see Figure 3
- Fasten the crane hook to the handling bar, see Figure 3
- Move the chamber lower part to the prepared surface (described in the document Air-Conditioning Units MANDÍK Installation, Commissioning and Maintenance, Section 5.6 General Assembly of the Unit)
- Length of the horizontal bar = min. length of the chamber



Do not stay under the load during lifting – fatal injuries may be caused by falling loads!

Do not lead a fabric sling through openings in the base frame – there is a risk of shearing off the fabric and subsequent fall of the load!

An example of recommended fastening of the lower part of the chamber to the openings in the base frame using a handling horizontal bar:

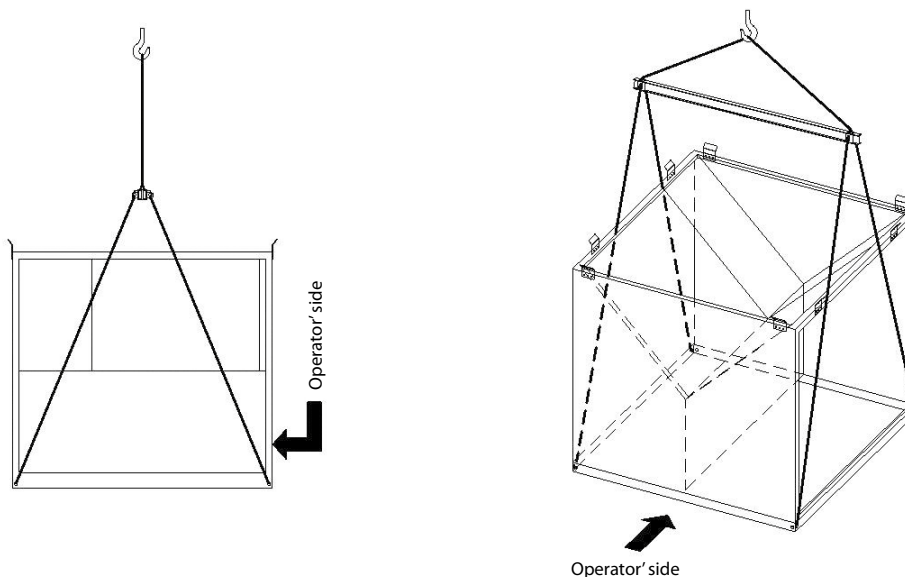


Figure 4 – Example of handling with lower part of chamber

B.3 FASTENING OF THE PLATE RECUPERATOR

■ Use the handling points to fasten the plate recuperator, as shown in Figure 2, Detail A

■ For recommended methods of fastening the plate recuperator see Figure 5



Do not lead a fabric sling through the handling points – there is a risk of shearing off the fabric!

An example of correct fastening of the plate recuperator:

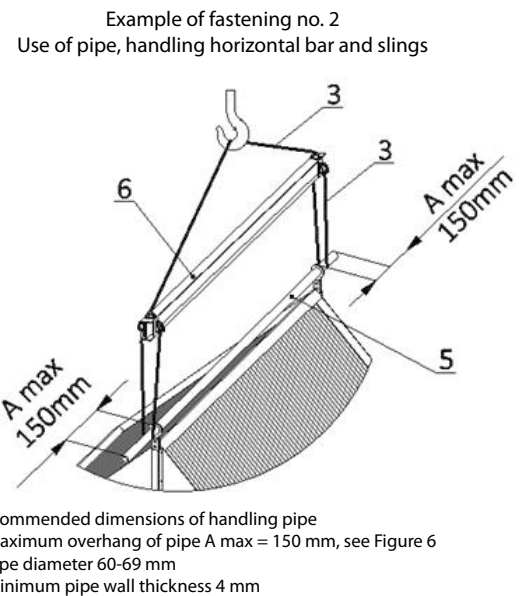
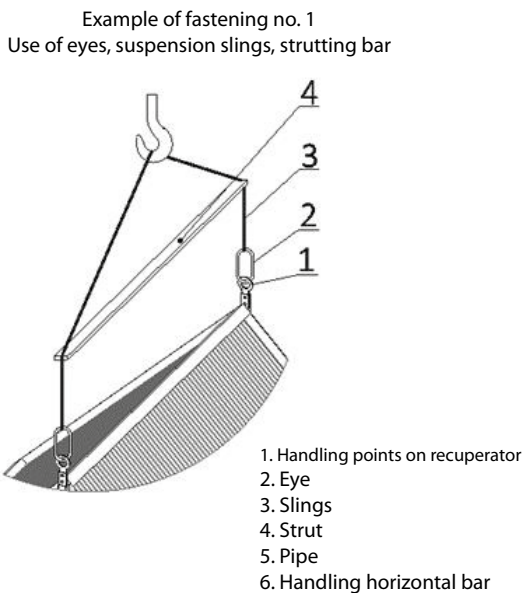


Figure 5 – Recommended methods of fastening plate recuperator

Suspension of plate recuperator – handling position:

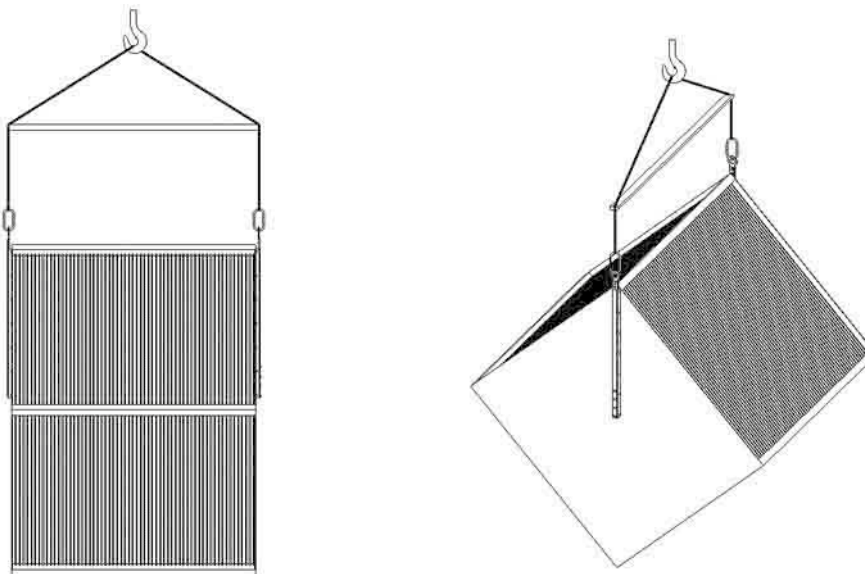


Figure 6 – Fastened plate recuperator

B.4 SEATING OF PLATE RECUPERATOR INTO CHAMBER LOWER PART

- The lower and upper parts of the chamber are fitted with a seal, see Figure 7
- Seat the recuperator on the prepared seal, see Figure 8
- The correct position of the recuperator – the maximum distance of the front surface of the recuperator suspension, see Figure 9, Detail E

When positioning the recuperator, always lift it enough so that the installed seal is not damaged.

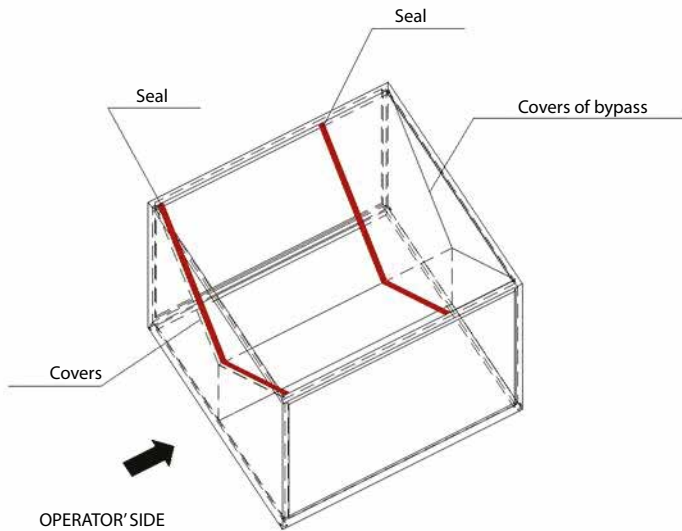
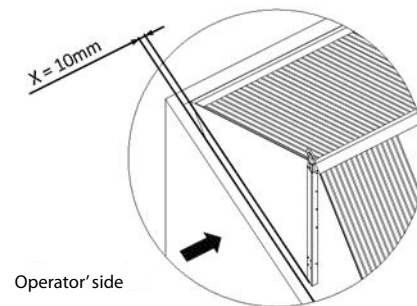


Figure 7 – Location of seal



Detail E – position of recuperator in relation to chamber

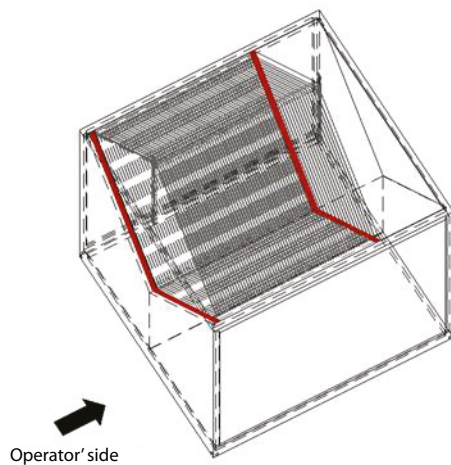


Figure 8 – Fixing of recuperator

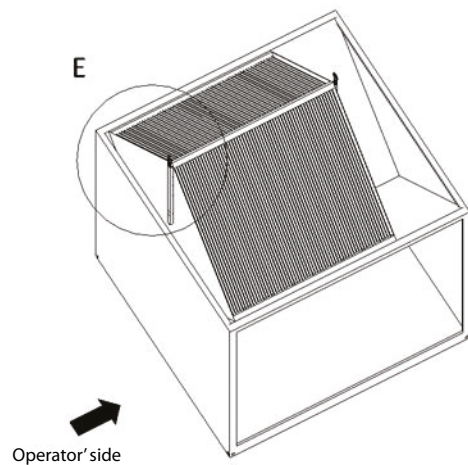


Figure 9 – Centring of recuperator

B.5 REMOVAL OF RODS WITH CRANE EYES – NOT DIVIDED EXCHANGER

After correct seating of the recuperator, remove eight M8 bolts on either side; see Figure 10, Details F and G.

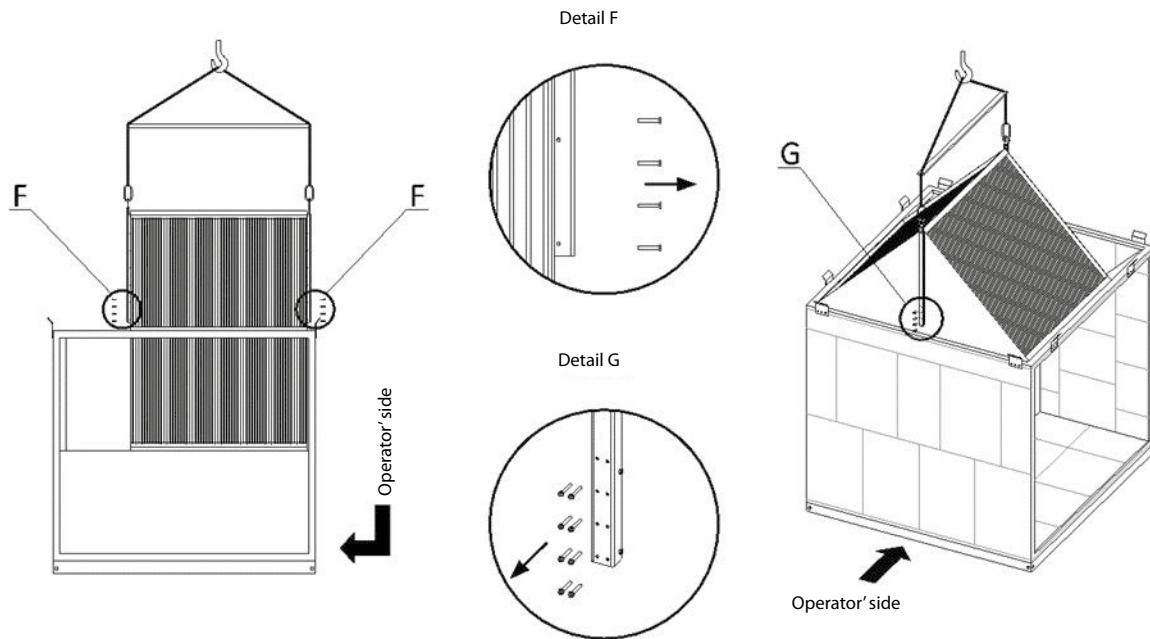


Figure 10 – Preparation for removing recuperator rods – removal of bolts

After removing the bolts, lift the rods from recuperator cases, see Fig. 11:

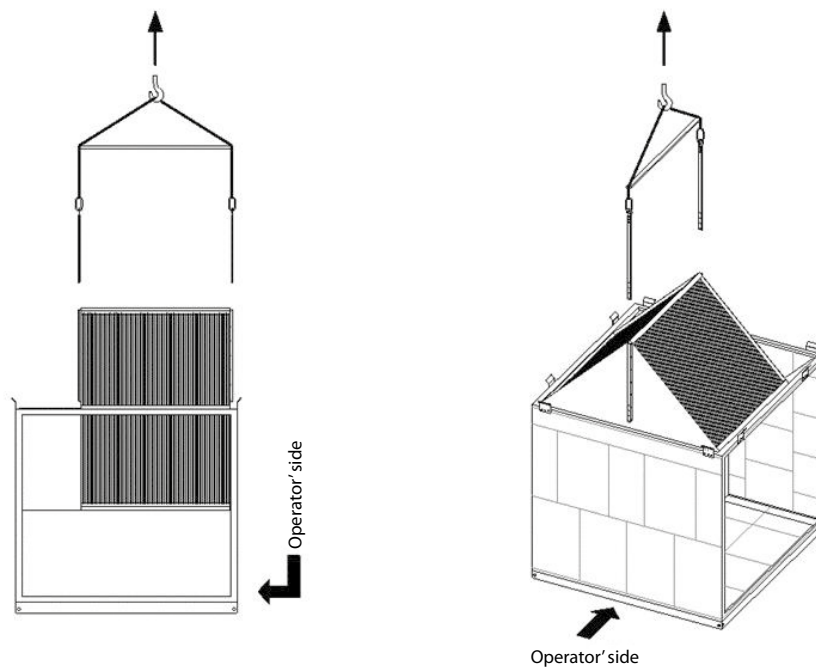


Figure 11 – Lifting of recuperator rods

B.6 FITTING THE SPLIT PLATE RECUPERATOR IN THE LOWER PART

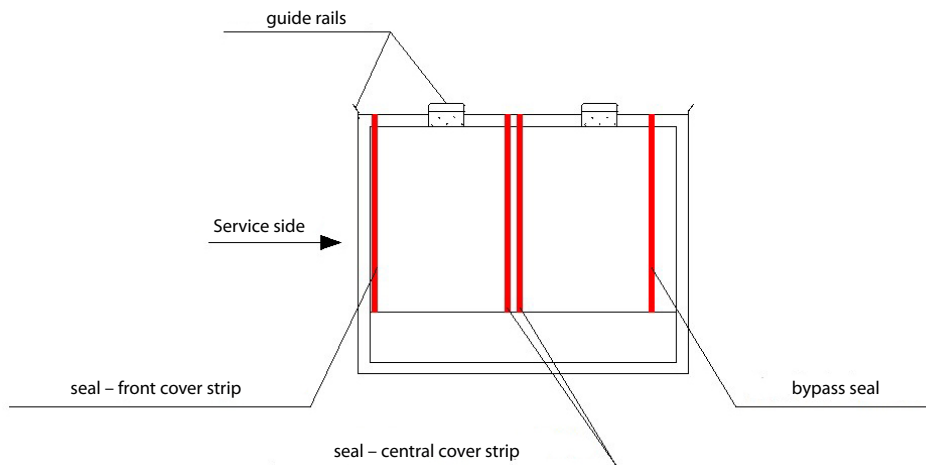


Figure Description of the chamber – sealing strips, guide plates

The sealing strips are mounted in the lower and upper part of the chamber, the guide plates located on the lower chamber serve for precise and unambiguous seating of the upper part of the chamber. After the upper part has been placed on the lower part and their eccentric is subsequently connected, the guide plates are dismantled - see further in the assembly procedure.

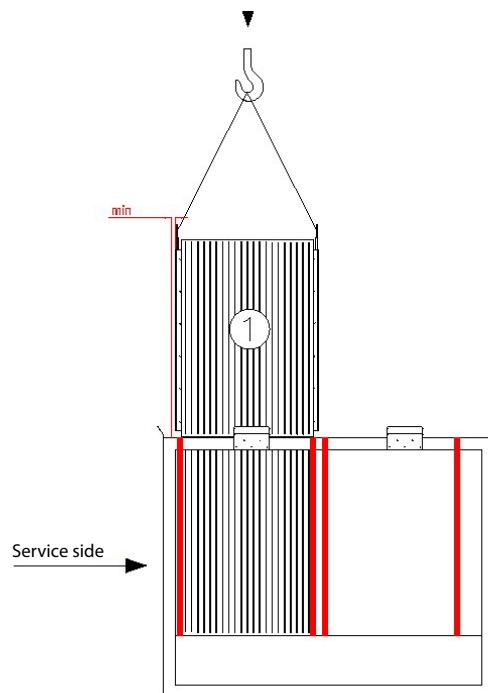
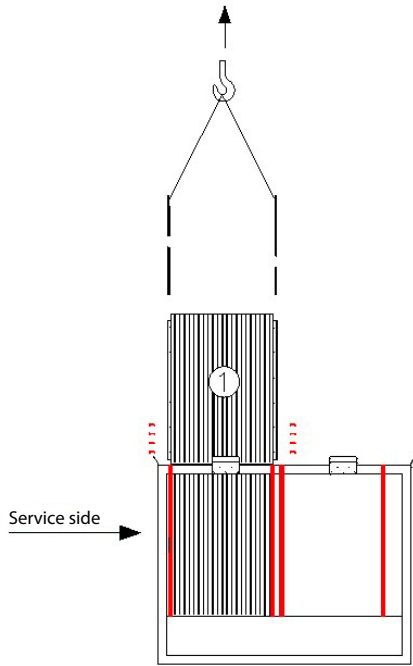


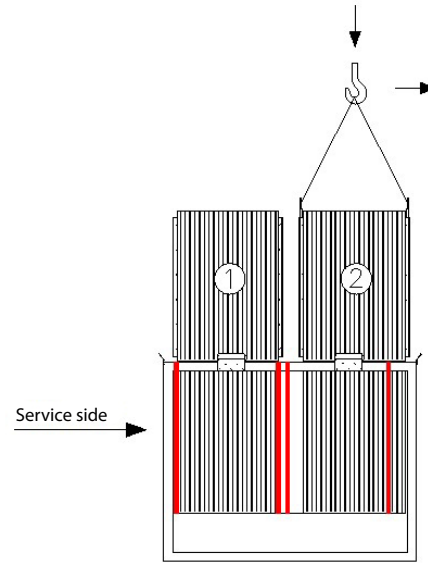
Figure Handling the plate heat exchanger 1

Place the recuperator 1 as close as possible to the front wall (operator side). The recuperator must rest on the prepared seal located on the cover strips. The tightness between the recuperators and the cover strips of the upper and lower part of the chamber will be ensured in the last step of the assembly of the chamber by means of self-tapping screws - also further in the procedure.



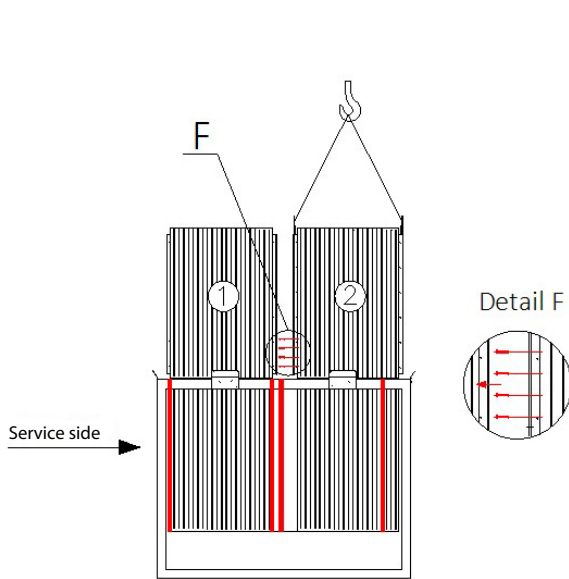
After mounting the recuperator, unscrew the screws of both hinges and slide the hinges out of the housings

Figure Unlocking the recuperator hinges 1



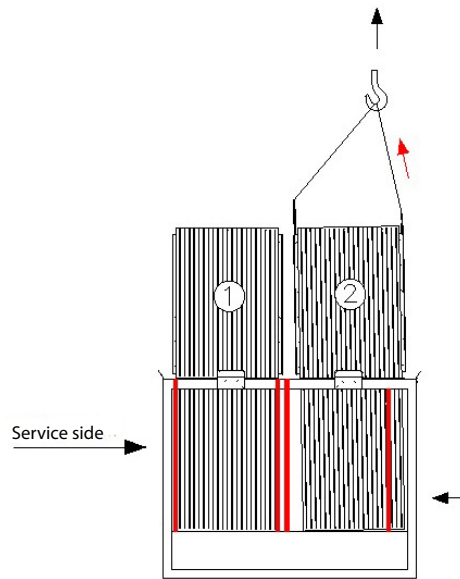
Place the recuperator 2 as close as possible to the rear wall of the chamber, leaving as much mounting space as possible between the two recuperators

Figure Handling the plate heat exchanger 2



Remove the recuperator 2 inner hinge bolts 2 see detail F

Figure Removing the inner hinge bolts



The inner hinge is already unlocked, it only occupies the outer hinge of the recuperator 2. Raise the recuperator 2 approx. 1 cm and reach it manually to the front recuperator 1

Figure Handling the recuperator 2

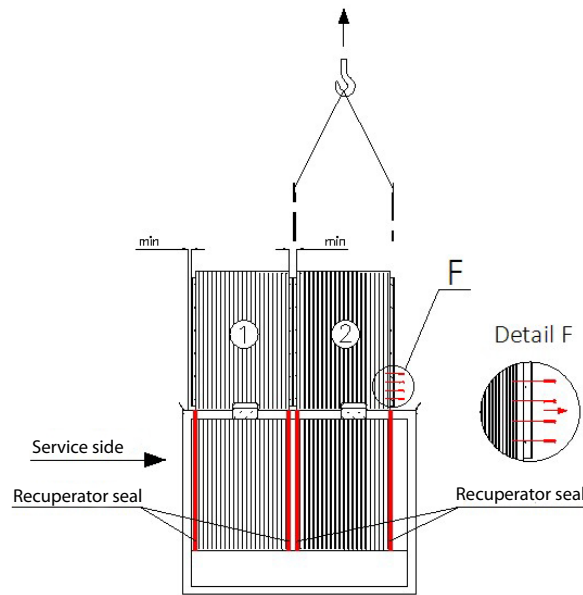


Figure Unlocking the external hinge of the recuperator 2

The final position of both parts of the recuperator in the chamber is determined by the seal on the cover strips. The fronts of both parts of the recuperator must always rest on the prepared EPDM seal on the cover strips. After the final installation of the recuperator, remove the screws of the external hinge of the recuperator 2, see detail F.

For further procedure, see the section Fitting the upper part of the recuperator of the recuperation chamber

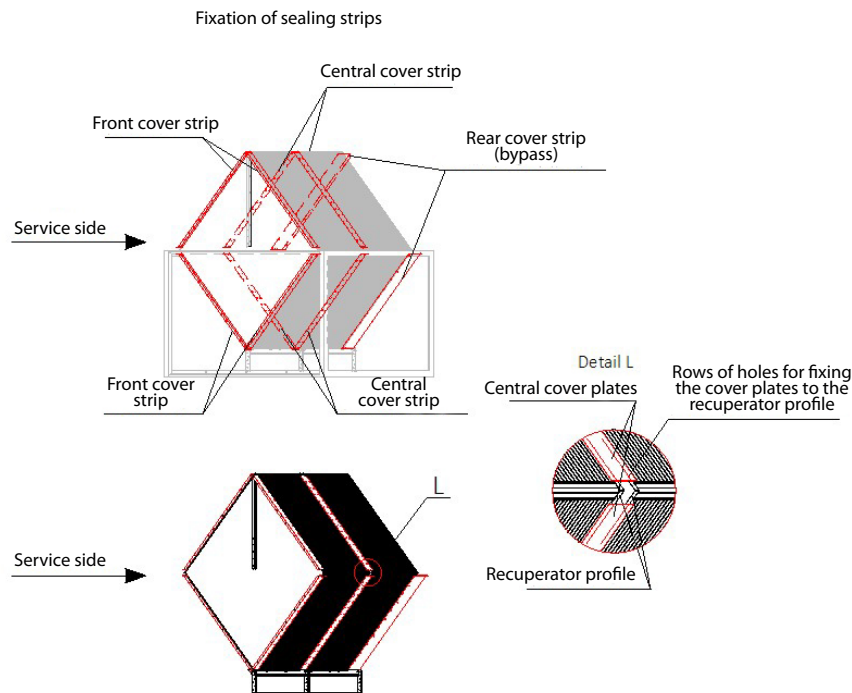


Figure Fixing the rails to the heat exchanger profiles

Fix the cover strips (front, center, rear) to the recuperator profiles using the enclosed self-tapping screws. For fixing and sealing, use the prepared holes in the cover strips, if necessary, fix to the recuperator at any point in the leak. In places where closed damper leaves prevent access to the sealing strips, the damper must be opened. The damper is opened manually.

1. Access the actuator with the service panel
2. Unlock the actuator and then turn the driven blade to a position that allows the cover strips to be attached
3. Fix the cover strips to the recuperator profiles via the open damper

B.7 SEATING OF UPPER PART OF RECUPERATION CHAMBER

- USE THE CRANE EYES ON THE UPPER PART FOR FIXING THE INCLUDED BINDING EQUIPMENT, SEE FIGURE 2, B DETAIL
- DO NOT LEAD A FABRIC SLING THROUGH THE CRANE EYES – THERE IS A RISK OF SHEARING OFF THE FABRIC
- ATTACH THE BINDING EQUIPMENT TO THE HANDLING BAR, SEE FIGURE 3
- SEAT THE UPPER PART OF THE CHAMBER ON THE LOWER PART; THE ACCURATE POSITION WILL BE ENSURED BY GUIDING BARS, SEE FIG. 1 1
- ATTACH THE CRANE HOOK TO THE HANDLING BAR, SEE FIG. 3
- CAUTION! LENGTH OF THE HORIZONTAL BAR = MIN. LENGTH OF THE CHAMBER



Do not stay under the load during lifting – fatal injuries may be caused by falling loads!

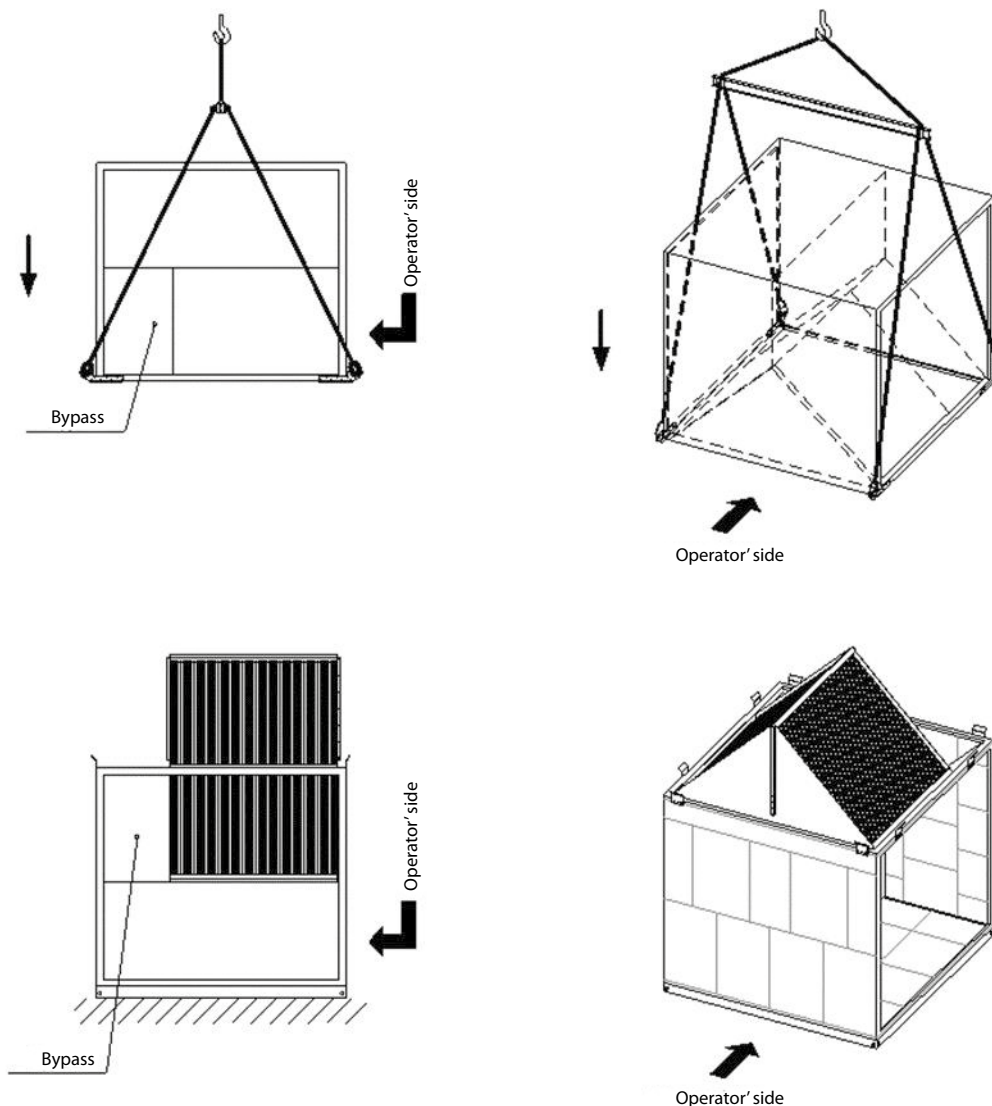


Figure 12 – Fixing of upper part of chamber

B.8 REMOVAL OF CRANE EYES, CONNECTION OF CHAMBERS

- Loosen 9 pieces of M8 bolts on each hinge, see Figure 13, Detail H
- Remove the crane eyes, see Figure 13

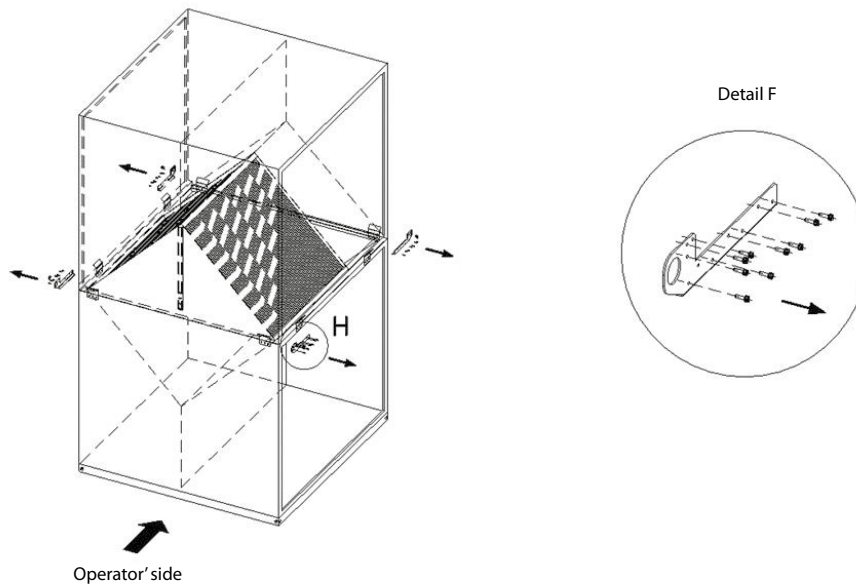


Figure 13 – Removal of suspension eyes from upper part of chamber

B.9 REMOVAL OF GUIDING BARS, CONNECTION OF CHAMBERS

- Remove 3 pieces of M8 bolts, see Figure 14, Detail J

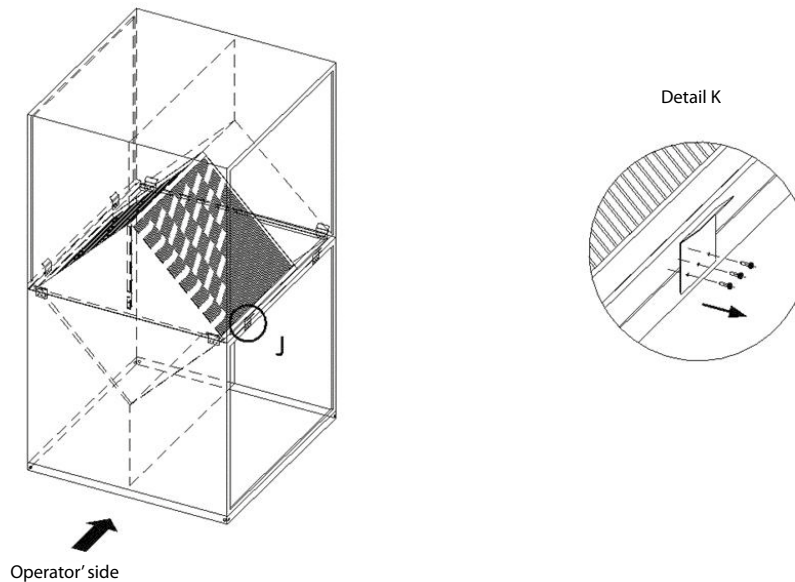


Figure 14 – Removal of guiding bars

- Connect the upper and lower parts of the chamber from the operators' side and from the rear side, see Figure 15
- Use the joints, which are included, to connect the parts
- Make the connection using 6 pieces of M8 bolts, see Detail K

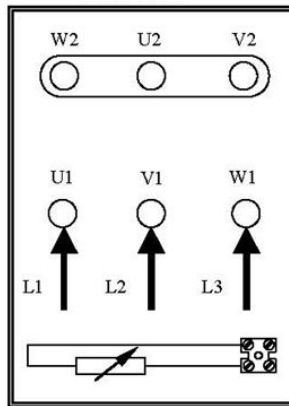
ANNEX C. WIRING OF ELECTRIC MOTORS

The nameplates of three-phase motors always show the nominal voltage and the required connection, e.g. Δ 230 V. This means that 230 V may be connected to each phase winding. If this motor is connected to a 400-volt network, it must be (its winding) star-connected (see the Table). When star-connected, phase voltage is on the winding, i.e. $400\text{ V} : \sqrt{3} = 230\text{ V}$.

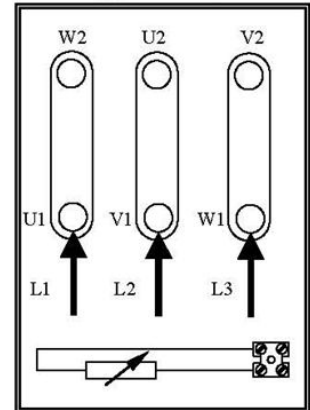
Mains voltage		690 V	400 V	230 V
Phase voltage	400 V	Y	Δ	
	230 V		Y	Δ



Motor plate



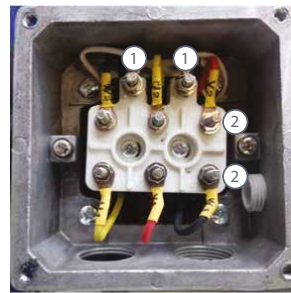
Star connection of motor with thermistor



Delta connection of motor with thermistor

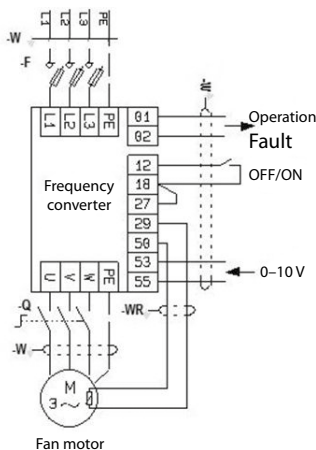


Terminal board lid with motor winding connection diagram

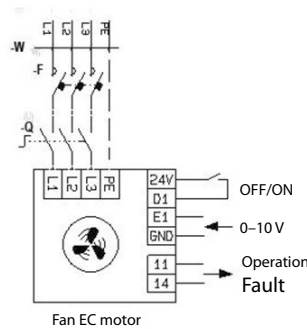


Terminal board of motor with thermistor

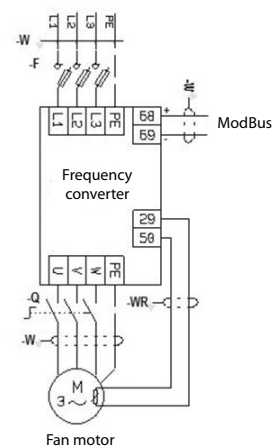
- ① Thermistor terminals
- ② Winding terminals



Typical wiring of fan motor with frequency converter Danfoss FC51 – controlled from terminal board



Typical wiring of fan EC motor Ziehl-Abegg



Typical wiring of fan motor with frequency converter Danfoss FC51 – ModBus control

ANNEX D. ELECTRICAL CONNECTIONS IN ACCORDANCE WITH DIRECTIVE 2004/108/EC – EMC

Recommendations for proper installation in terms of EMC

Frequency converters or switched power of electric heaters are the most common sources of interference. To eliminate interference, it is recommended to use sine filters that are connected to or before the switchboard of a measuring and control system to a power supply cable if frequency converters or an electric heater are powered from the switchboard of a measuring and control system. If frequency converters or an electric heater are not powered from the switchboard of a measuring and control system, it is necessary to install the sine filter directly to the frequency converters or to electric heating.

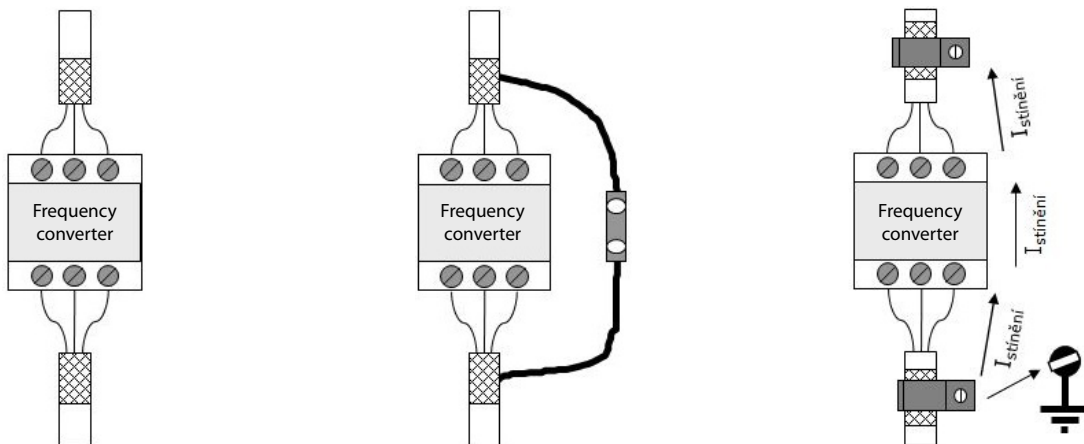
Motor cables

Cables to frequency converters must be led separately.

As the leakage current of the frequency converters exceeds 3.5 mA, reinforced protective earthing must be connected. According to the requirements of EN 50178, e.g. the minimum cross-section of grounding cable must be 10 mm² or 2 separate protective conductors must be used.

The sine filter must be connected as close to the frequency converter output as possible. Therefore, to connect the filter and the converters it is necessary to use shielded cables.

It is recommended to use metal bushings for shielded cables.



Very wrong way

Shielding interrupted without other measures

Wrong way

Shielding efficiency is limited

Good way!

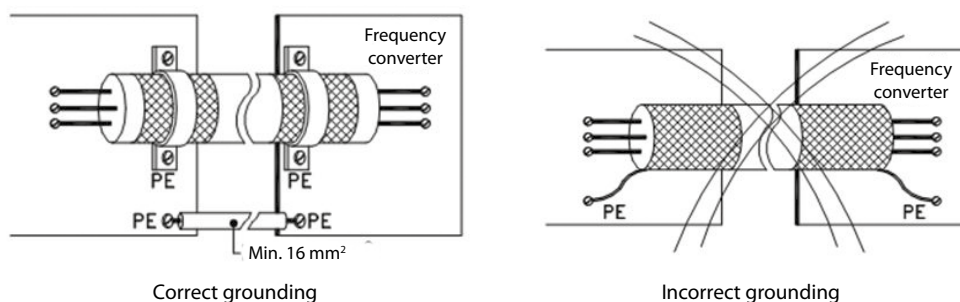
Shielding grounding via eyes

In case of poor grounding of the entire facility, equalization currents may flow through double-sided grounding shield. These equalizing currents may cause interference.

Prerequisite for double-sided grounding shield is as follows: Sufficient potential equalization (min. 16 mm²).

Avoid braided grounding.

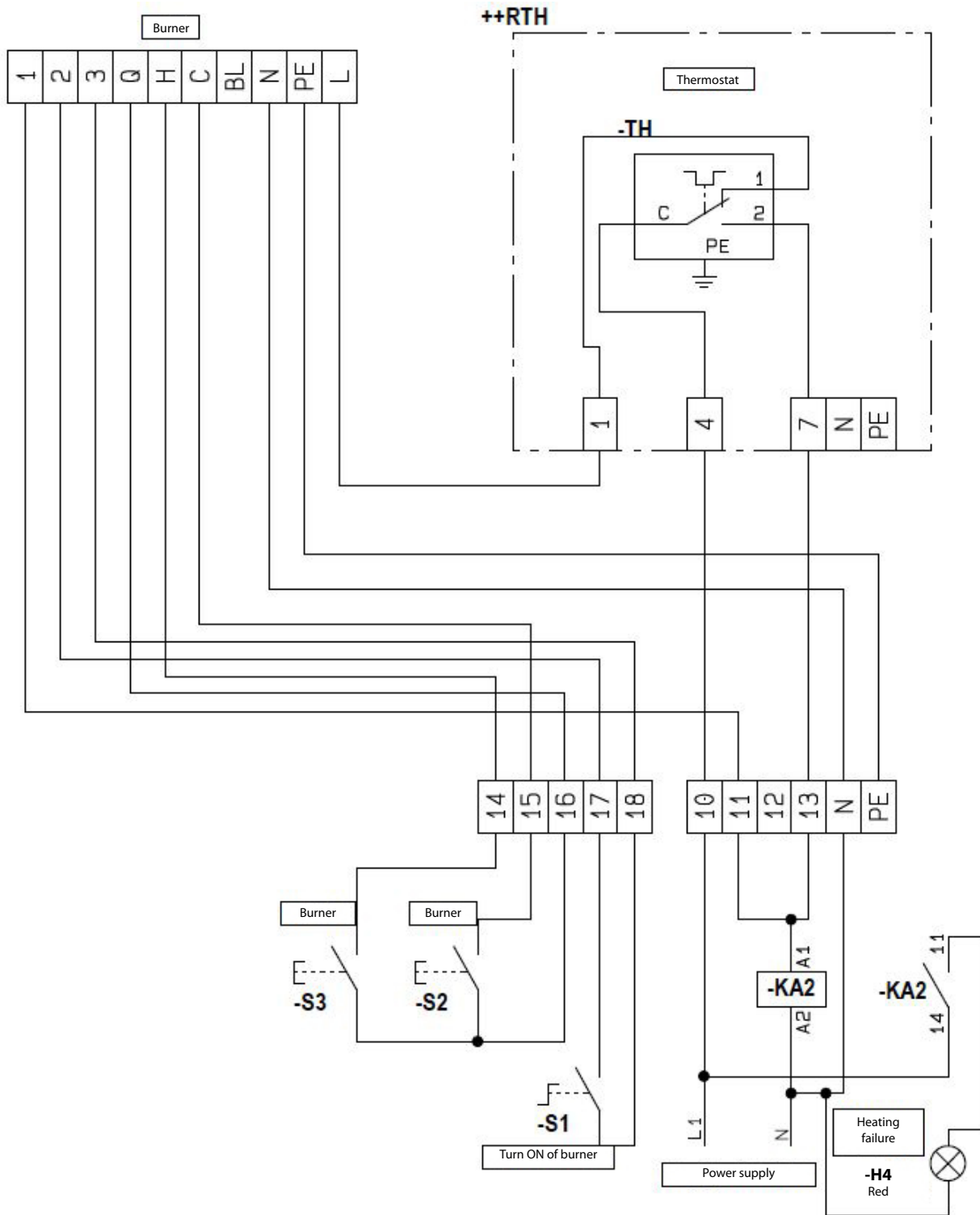
It is recommended to use a twisted-pair line for serial communication.



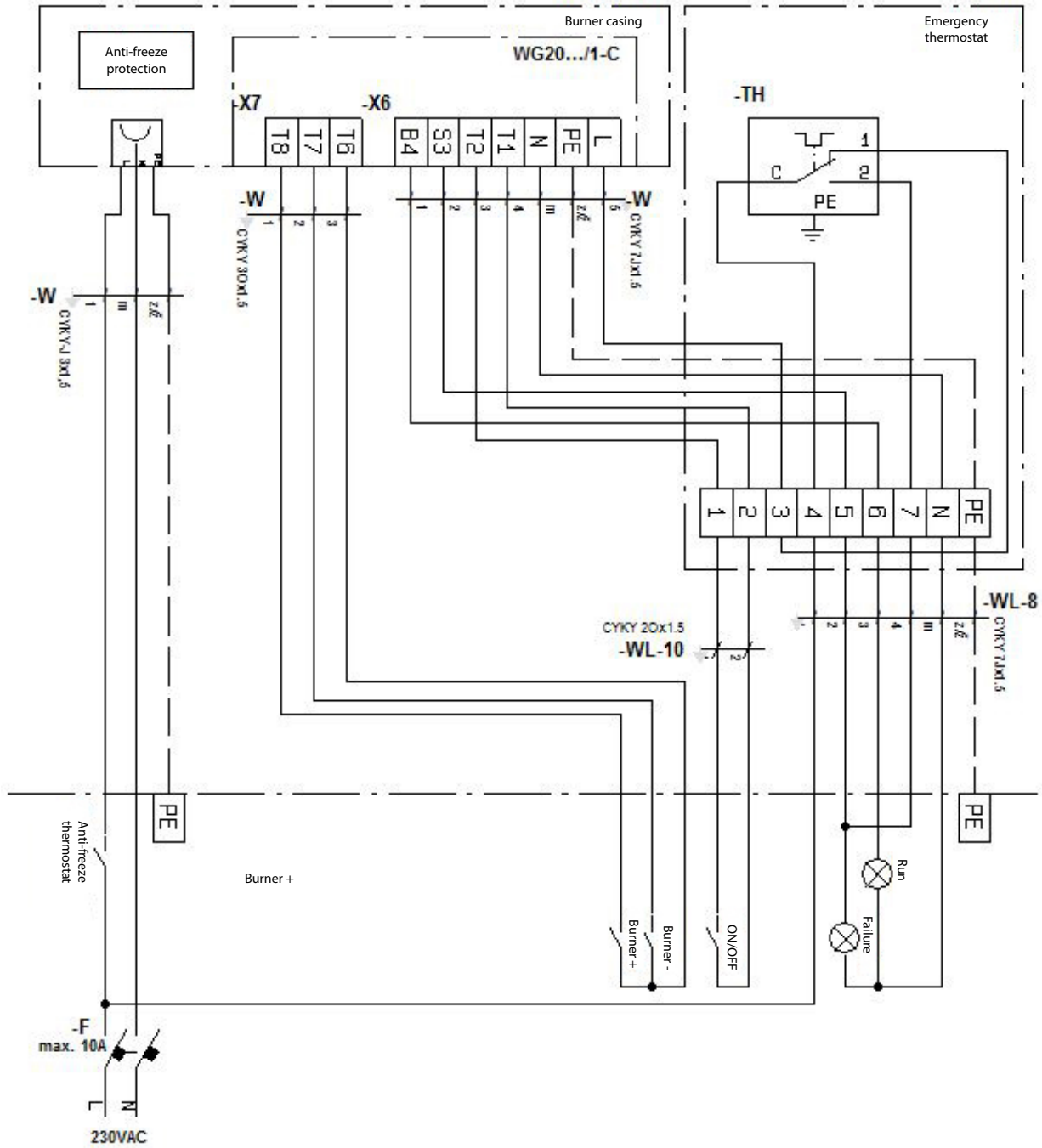
Correct grounding

Incorrect grounding

ANNEX E. ELECTRICAL CONNECTION OF GAS/OIL HEATER GHM

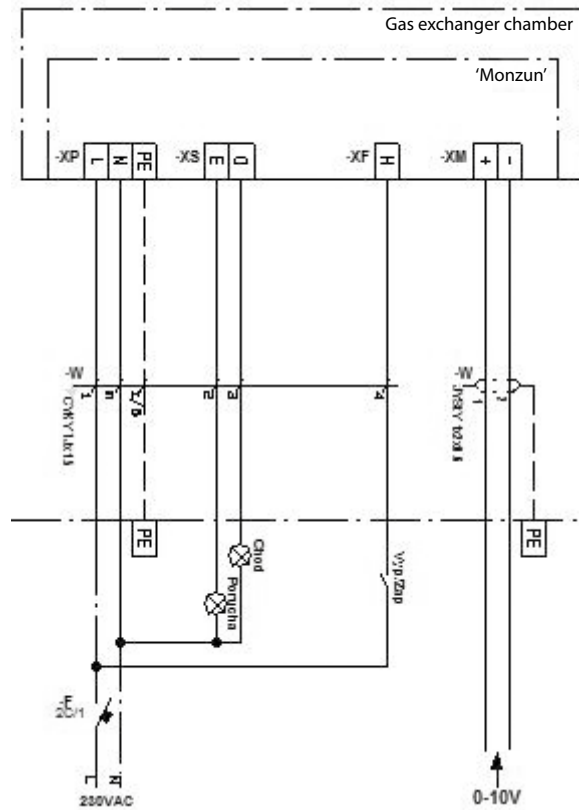


Typical connection of gas heater GHM with burner Riello BS3/M



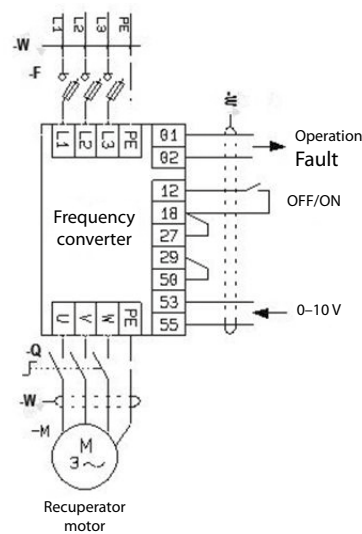
Typical connection of gas heater GHM with burner Weishaupt WG20.../1-C, ZM-LN

ANNEX F. ELECTRICAL WIRING OF 'MONZUN' GAS HEATER



Typical wiring of 'Monzun' gas heating

ANNEX G. ELECTRICAL WIRING OF ROTARY RECUPERATOR



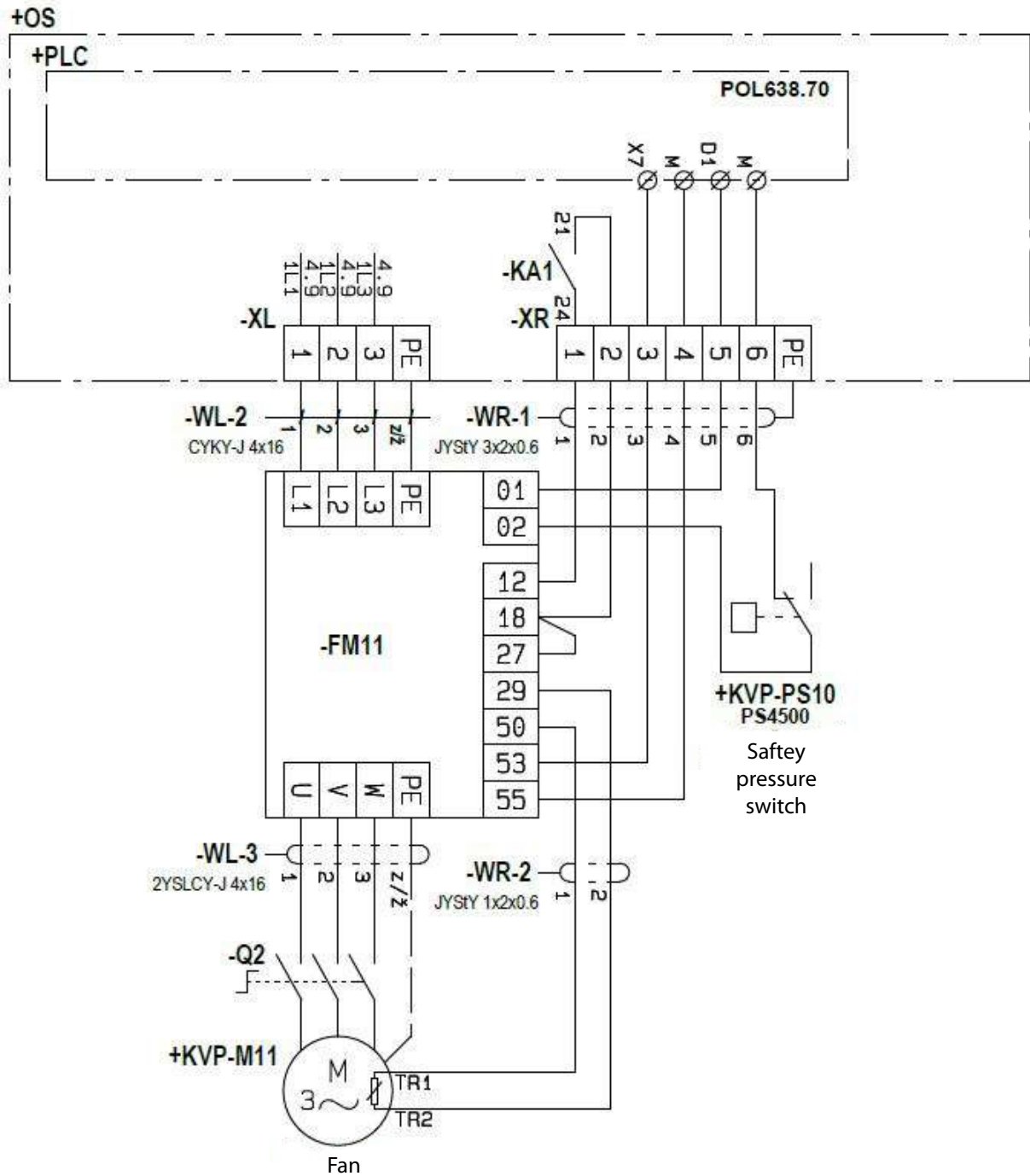
Typical wiring of fan motor of rotary recuperator with frequency converter Danfoss FC51 – controlled from terminal board

ANNEX H. RECOMMENDED END PRESSURE LOSSES OF FILTERS

The values listed below are based on the European standard EN 13 053.

Filtration class according to EN779			
	List of recommended end pressure losses according to EN 13 053	Unit	Value
1.	G3 grease trap	Pa	150
2.	G3 frame filter 48 mm	Pa	150
3.	G4 frame filter 48 mm	Pa	150
4.	G5 frame filter 48 mm	Pa	200
5.	G3 pocket filter 360 mm	Pa	150
6.	G4 pocket filter 360 mm	Pa	150
7.	M5 pocket filter 500 mm	Pa	200
8.	M5 pocket filter 630 mm	Pa	200
9.	M6 pocket filter 630 mm	Pa	200
10.	F7 pocket filter 630 mm	Pa	200
10.	F9 pocket filter 630 mm	Pa	300
11.	M5 pocket filter 500 mm ATEX	Pa	200
12.	F7 pocket filter 500 mm ATEX	Pa	200

ANNEX I. ELECTRICAL CONNECTION OF THE SAFETY DIFFERENTIAL FAN HIGH PRESSURE PRESSURE GAUGE



ANNEX J. ELECTRICAL CONNECTION OF THE SERVICE SWITCH / SERVICE SWITCH WITH FREQUENCY INVERTER

