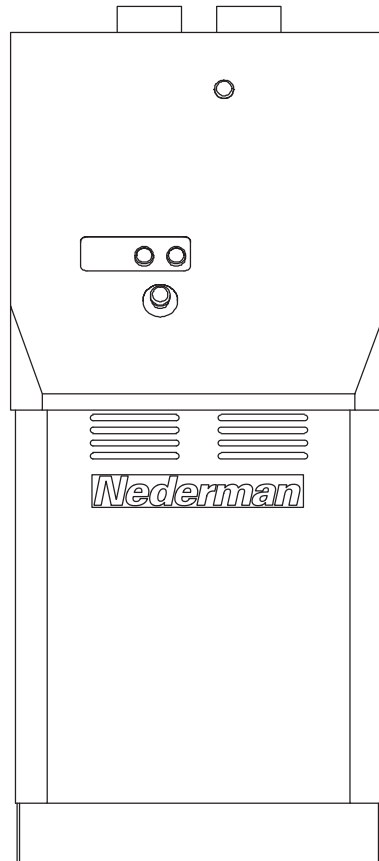


Vacuum and Control unit

PAK-M



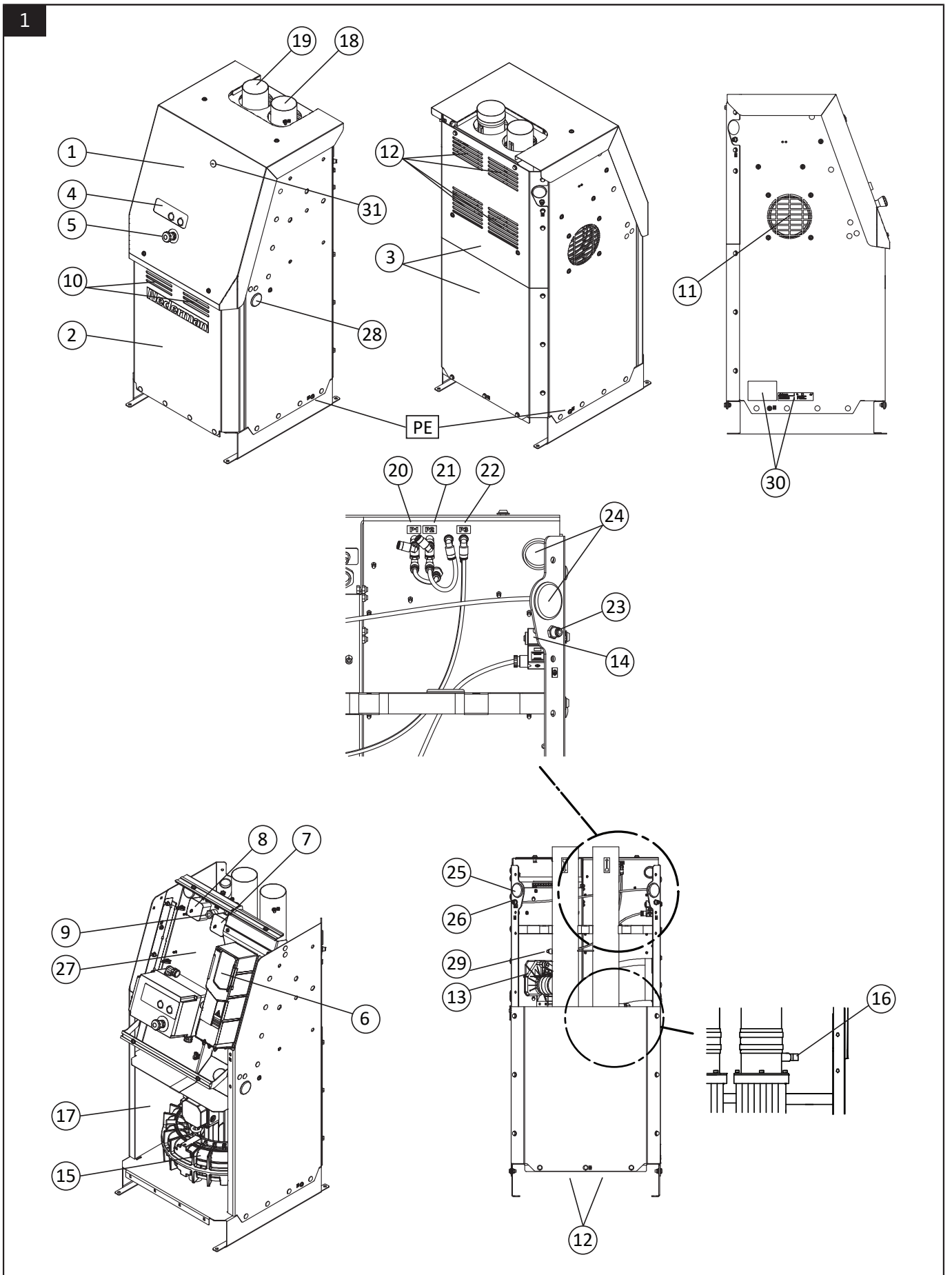
Original installation and service manual

EN INSTALLATION AND SERVICE MANUAL

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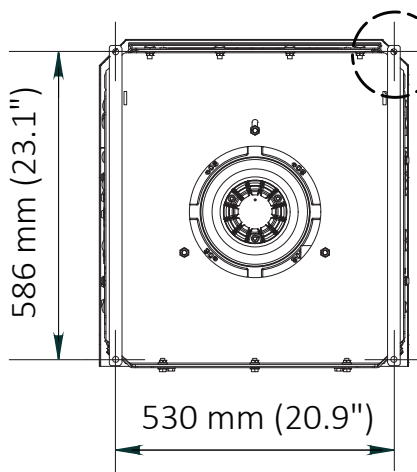
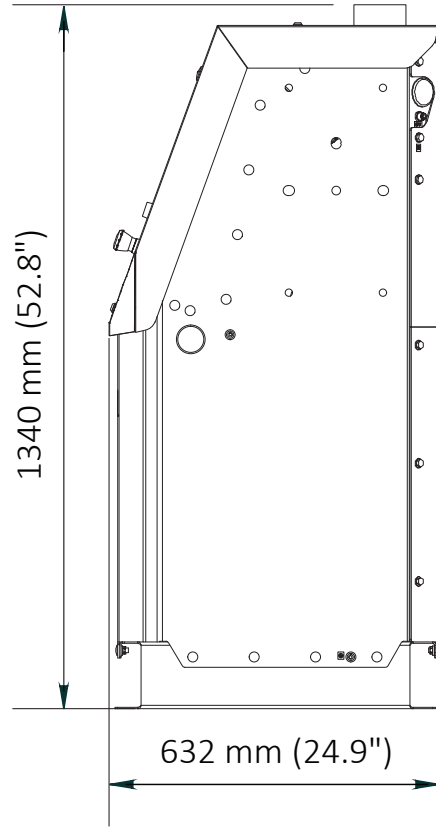
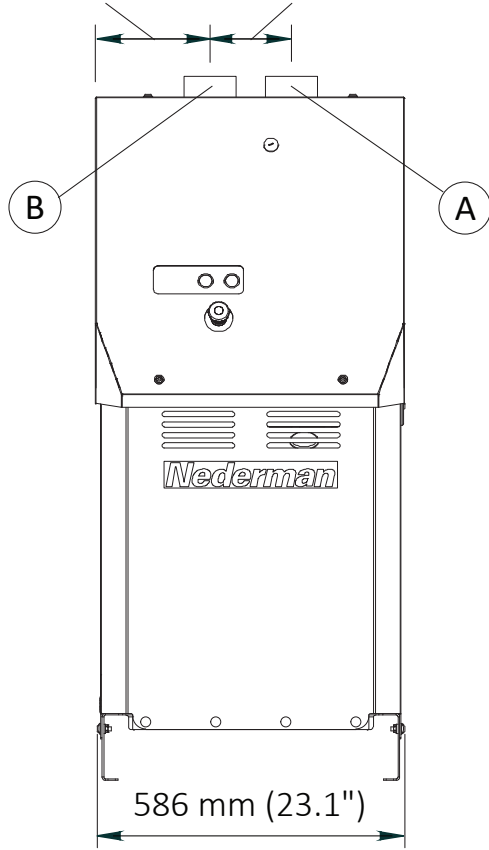
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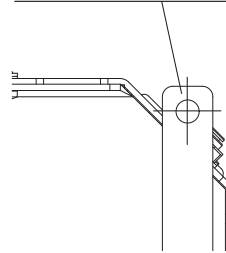


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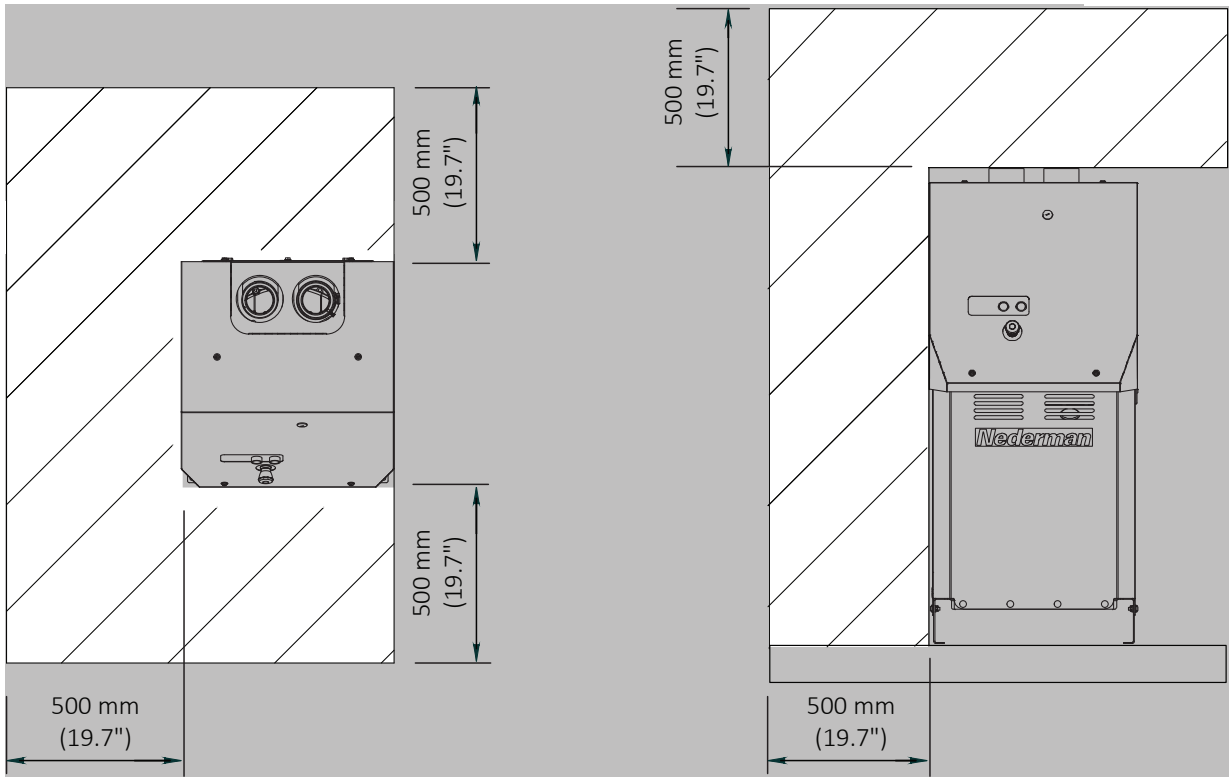
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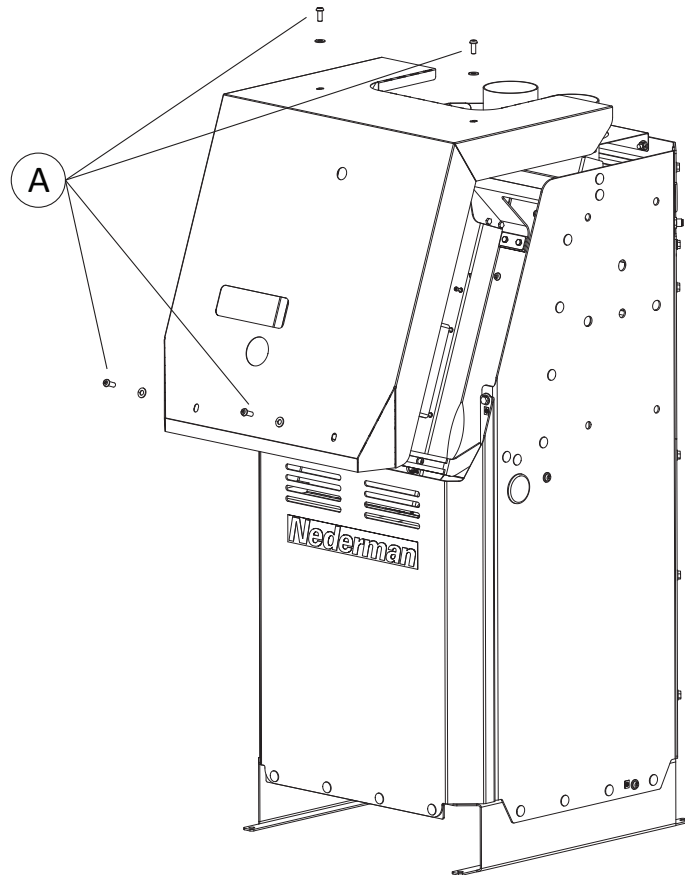
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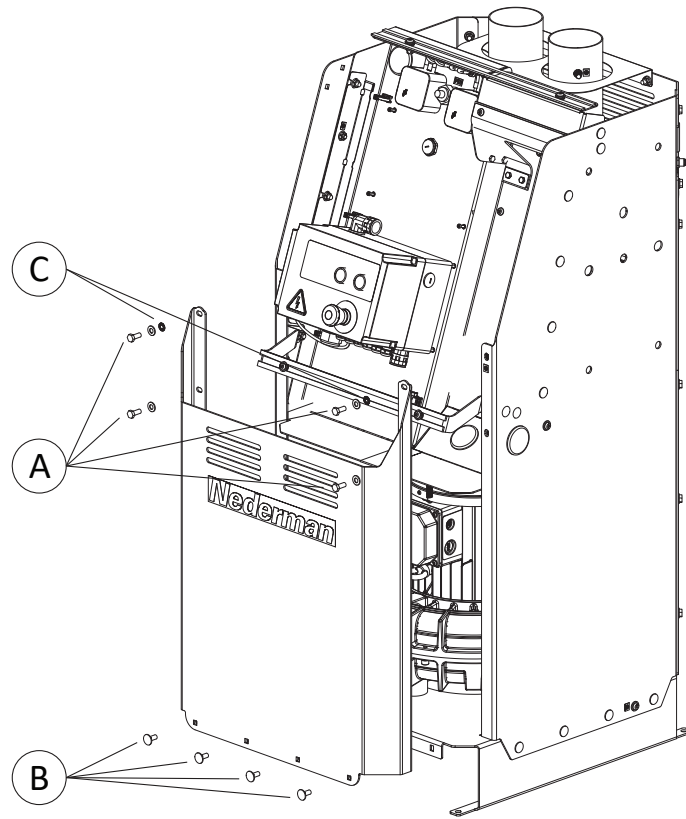
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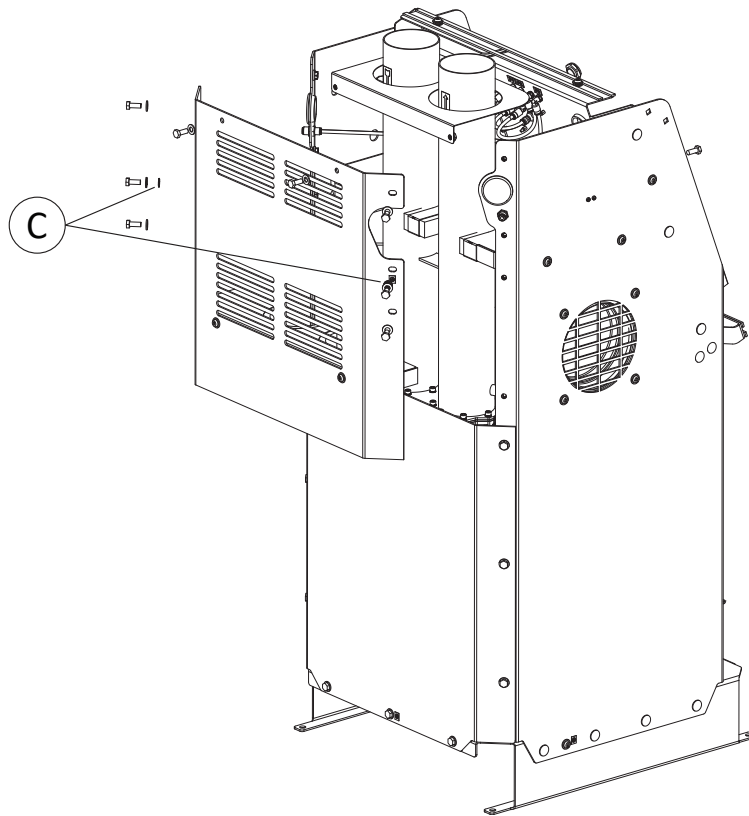
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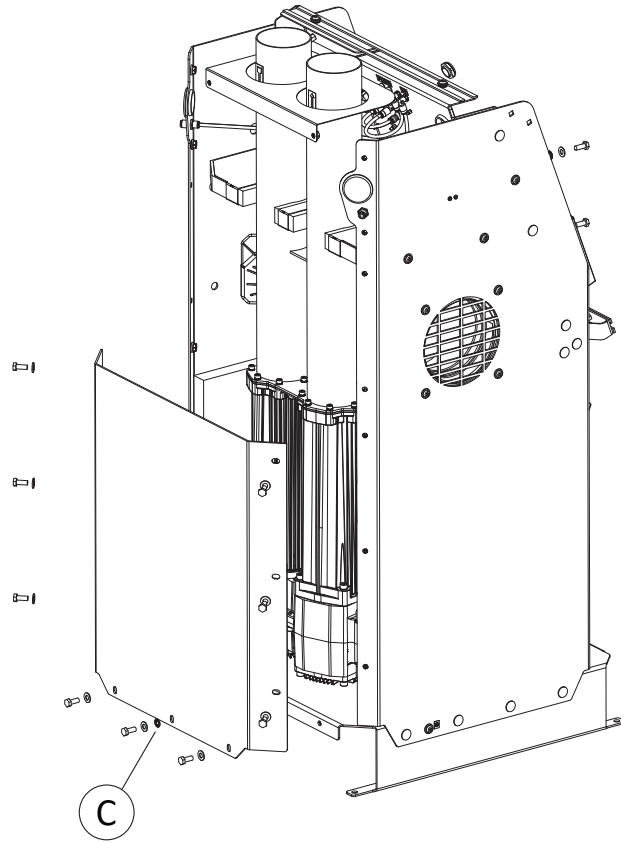
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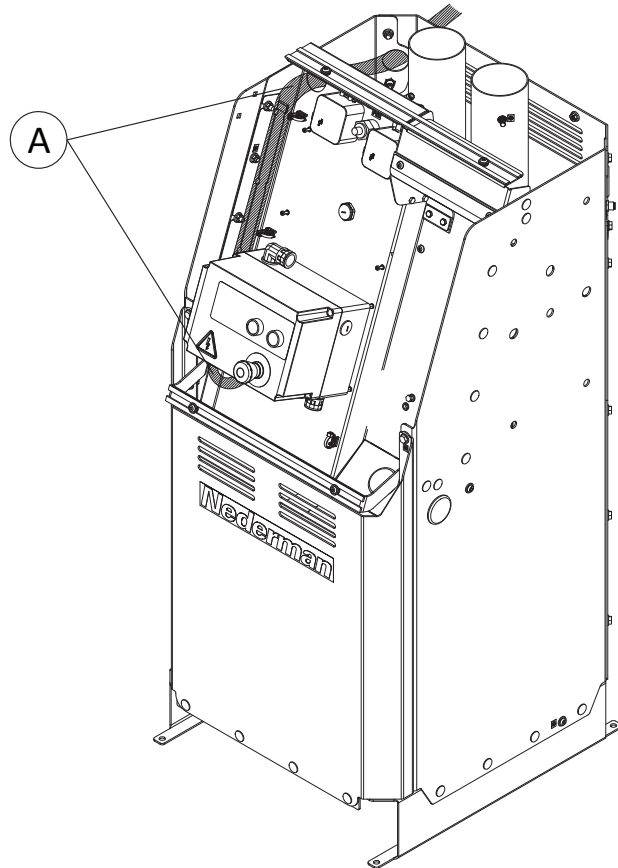
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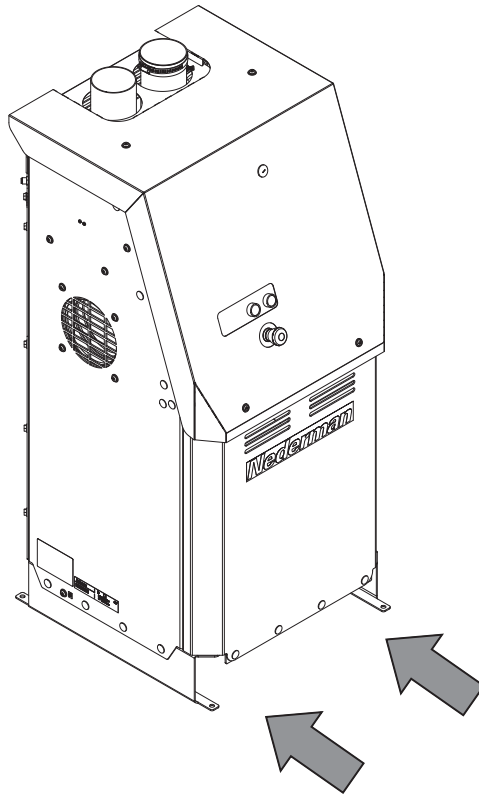
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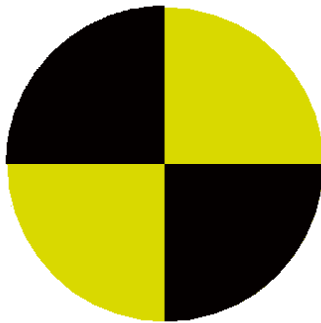
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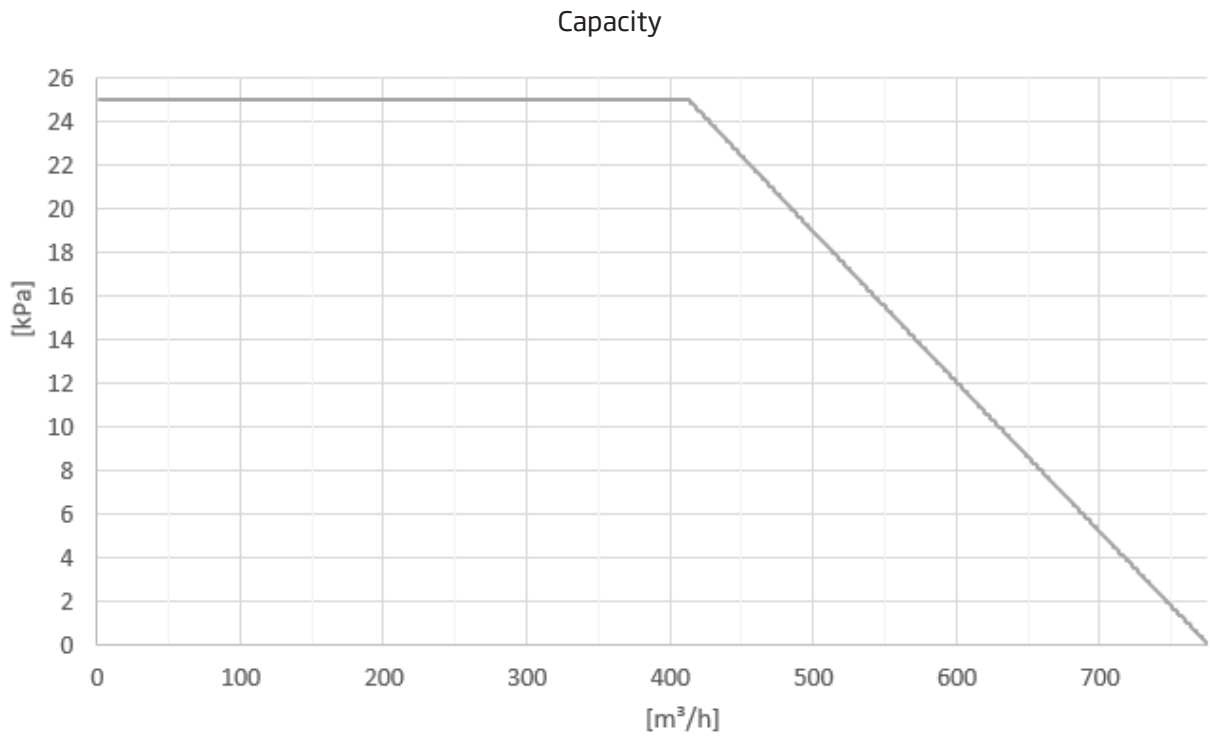
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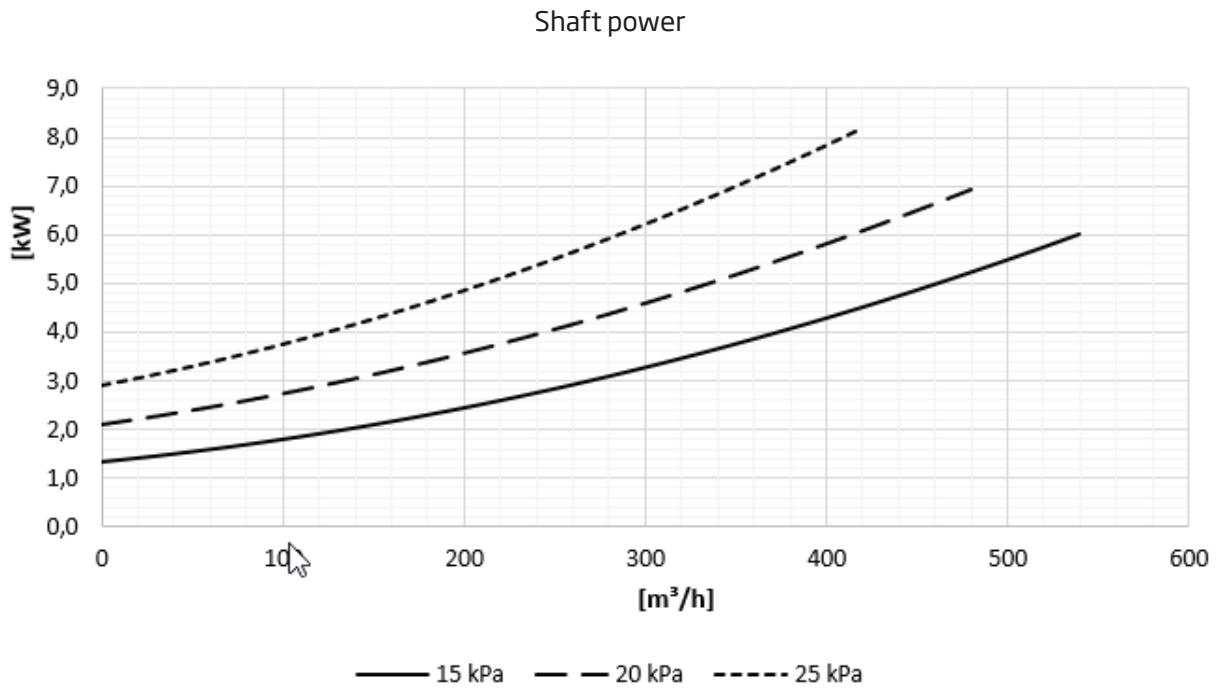
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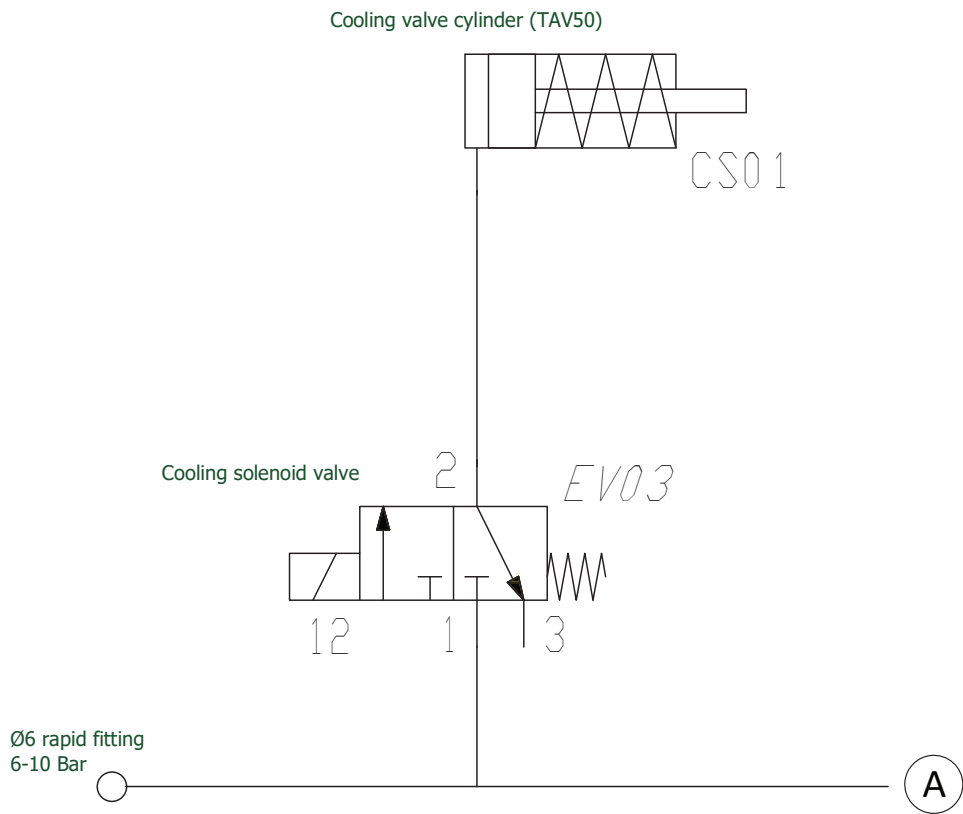
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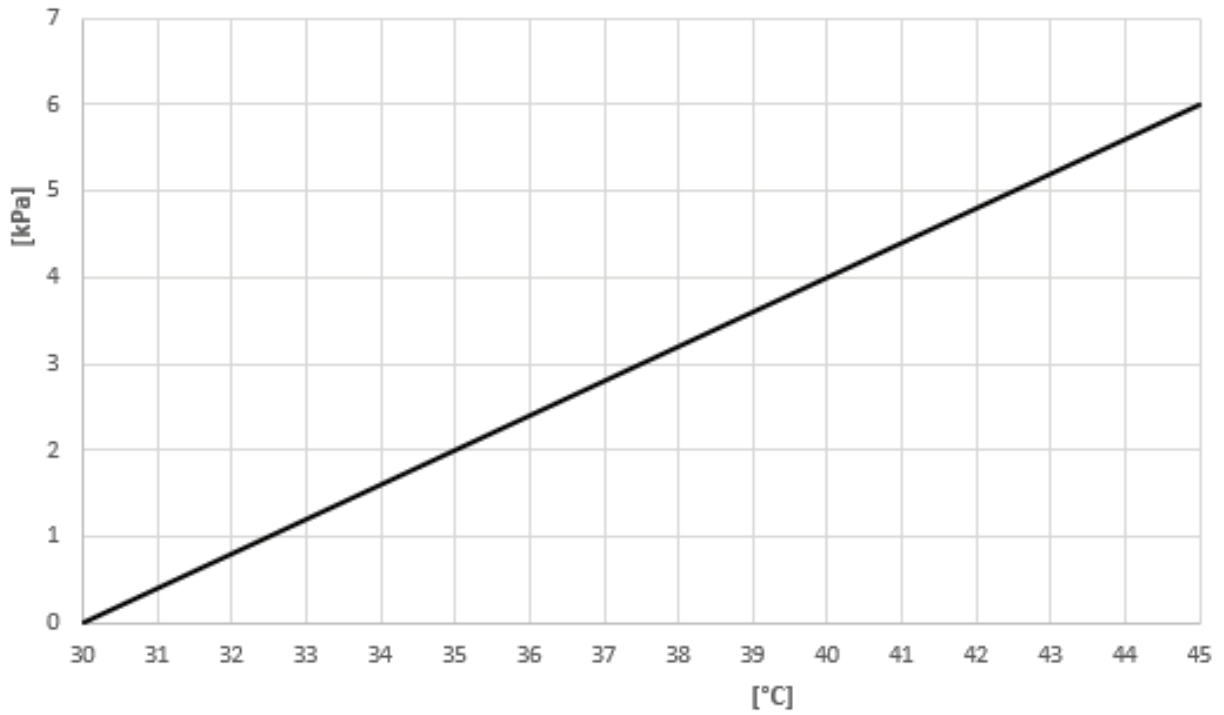


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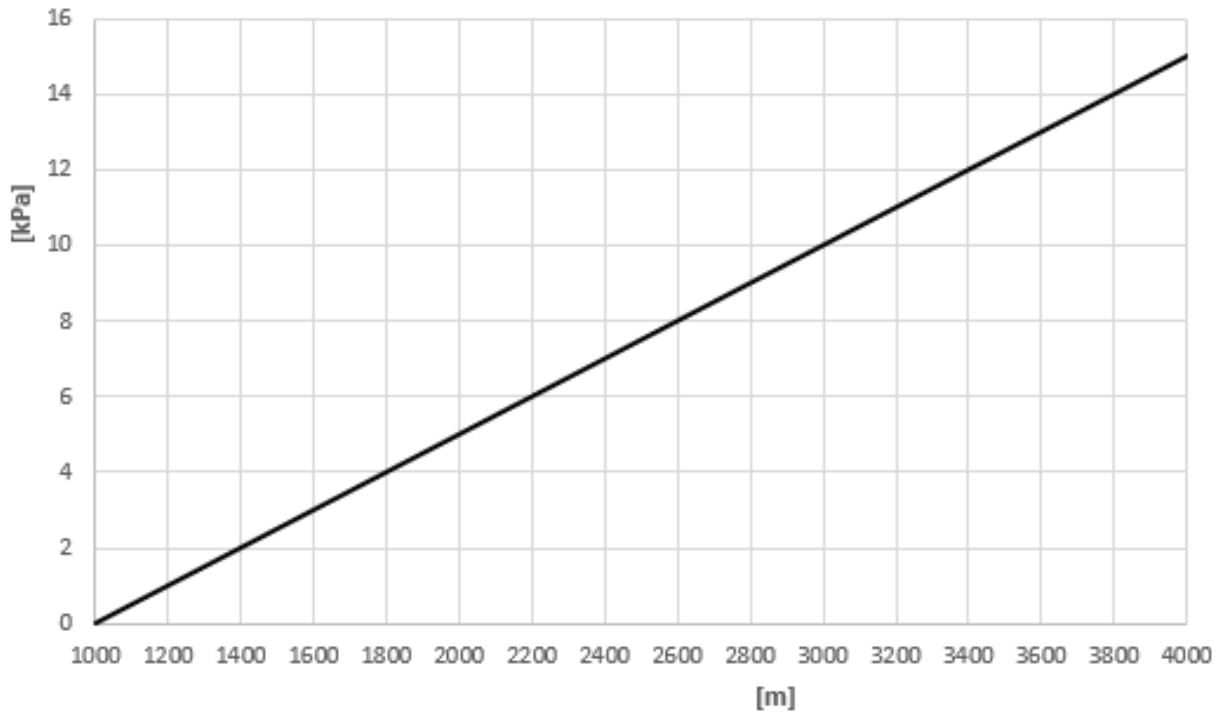
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Ambient temperature derating



15

Altitude derating



16



1 Preface and safety

Read all product documentation and the product identification plate carefully before installation, use, and service of this product. Replace documentation immediately if lost. Nederman reserves the right, without previous notice, to modify and improve its products including documentation.

This product is designed to meet the requirements of relevant EC directives. To maintain this status, all installation, maintenance, and repair is to be done by qualified personnel using only Nederman original spare parts and accessories. Contact the nearest authorized distributor or Nederman for advice on technical service and obtaining spare parts. If there are any damaged or missing parts when the product is delivered, notify the carrier and the local Nederman representative immediately.

1.1 PAK-M specifics

The Vacuum and Control unit can be used as a standalone vacuum source or be part of a complete PAK-M fitted with different dust separators, filters and accessories.

PAK-M comes in three main configurations:

- 1 A stand alone Vacuum and Control unit.
- 2 A Vacuum and Control unit with a Standard Dust Separator.
- 3 A Vacuum and Control unit with a Dust Separator in a DX/EX configuration.

The main manual is the User Manual for the stand alone Vacuum and Control unit. Other manuals are extensions of this manual. Please consider these notes:



NOTE!

- For each variant of PAK-M: Manuals are separated into User Manuals, Installation and Service Manuals, a Program Manual and accessory manuals.
- Refer to the correct manual in case of missing information. A manual generally describe the specific configuration; Dust Separator, ATEX, accessory, and so on.
- All manuals must be kept with care and made available to all persons involved in operating the equipment.
- Images in this Installation and Service Manual may differ slightly from your model.

1.2 Overall PAK-M safety

- PAK-M, including its configurations must be installed, used and maintained according to all related manuals in such a way that safety not will be neglected.
- All related manuals must be easily available, otherwise, the product will lack one of its fundamental safety requisites.



WARNING! Risk of personal injury

- Any functional disorders, especially those affecting the safety of the machine, must be rectified immediately. If improperly used, poorly connected, or altered, no matter how minor, the safety and reliability could be jeopardized.
- Grinding, welding or other hot works on PAK-M or the duct system should not be done without first stopping and cleaning the system.
- Do not collect items that may cause ignition or blocking. It is strictly prohibited to collect material that can undergo dangerous chemical or thermal reactions and/or self-ignite.
- Each PAK-M system must be dimensioned individually. To ensure that your system will be safe, a risk analysis must be performed for each installation and intended use.
- Do not make any changes to this product without consulting Nederman.
- Place fire alarms and an appropriate extinguishing system in all locations where collected dust is stored.



NOTE!

Some materials may undergo chemical reactions in combination with humidity/water. Such humidity may, for example, form if the humidity in the extracted air is condensed in the filters.

2 Installation

NOTE!

- Copy the installation protocol (appendix A), during installation, fill it in and save it as a service record. See [Chapter 7 Appendix A: Installation protocol](#).
- A value outside the limit or an incorrect/missing result is to be rectified before initial start-up and operation.

2.1 Transport and delivery check

It is recommended to transport the Vacuum and Control unit to the installation site while still in the factory packing. For lifting points, see [Figure 9](#).



WARNING! Risk of personal injury

To avoid a crushing risk. Be careful not to let the Vacuum and Control unit tip over. See the centre of gravity markings shown in [Figure 10](#).



NOTE!

Ensure that the forks stick out at the back, so it is a level lift.

The Vacuum and Control unit should be checked for any damage that may have occurred during transport. If there is damage or parts missing, the carrier and your local Nederman representative should be notified immediately.

- Protect the inlet and outlet. No dust, objects or debris are allowed to fall down into them when they are uncovered.
- For long transports fix the Vacuum and Control unit on a pallet or other structure. Existing lifting points are just for the final move/lift when fixing it in place for installation.
- Use proper lifting and protective gear.

2.2 Pre-installation

All installation is to be done by qualified personnel using only Nederman original parts and accessories.

The location where PAK-M is to be placed must be prepared before the installation.

- Consider the space required for use, service and maintenance. Ensure that handling is convenient.
- Leave free space to the front, back, left and above. See [Figure 3](#).



WARNING! Risk of personal injury

- Read and follow all the applicable installation requirements during installation.
- Use proper lifting equipment and protective gear.
- Adequate protective measures need to be installed if the Vacuum and Control unit is placed in an elevated position. Consider its total weight.
- Place PAK-M in a sufficiently ventilated room.
- Do not install the Vacuum and Control unit close to heat sources or hot surfaces.
- Beware of hot air from the outlet.



CAUTION! Risk of equipment damage

- Do not use the Vacuum and Control unit as a vacuum source without a filter if there is risk of material being sucked into the fan.
- Do not place the Vacuum and Control unit more than five meters from the filter/Dust Separator. If a longer distance is required, move the DPS switches closer to the filter to keep the measuring tubes short. The same goes for the connection to the pressure sensor which is recommended to be changed from measuring P1 to measuring P3B. Long measuring tubes can create incorrect readings and there is a risk that the changes of vacuum cause a pumping effect sucking dust into the tubes. Material needed for these changes is not included.

PAK-M shall be anchored to a hard, level and firm foundation. A general example would be a reinforced concrete foundation at least 190 mm (7,5 in) thick. When calculating for foundation or supporting structure the following factors should be considered:

- Total weight of the Vacuum and Control unit and the Dust Separator with accessories. See [Section 2.12 Technical data](#).
- Environmental and ambient conditions. See [Section 2.12 Technical data](#).
- Possible wind load.
- Recommended bolts for concrete are Hilti HDA-P/PF M10x50 or HSC-A/HSC-AR M8x50 or equivalent. If expansion bolts are to be used, the concrete foundation must be prepared according to bolt recommendations.

NOTE!

- Read all required product manuals before the assembly of PAK-M and pay close attention to the recommendations. Refer to the correct manual in case of missing information.
- If the Vacuum and Control unit is used as a part of a PAK-M installation with a Nederman Dust Separator, the separator information can be found in the Dust Separator manual.
- The designer of the system as a whole has to guarantee the correct function of all interacting products or components and ensure that the complete system meets all necessary safety requirements.
- It is recommended that a layout is made for the entire system before installation.
- Consider the traction force requirements when used with a PAK-M PAK-M DX.
- In case of high relative humidity, do not expose the Vacuum and Control unit to freezing temperatures.
- Do not place the Vacuum and Control unit in direct sunlight.
- Ensure that reverse airflow into the outlet is prevented.
- If the exhaust air duct is blocked, the Vacuum and Control unit may create an overpressure damaging equipment or the duct itself.
- If the Vacuum and Control unit is configured with a week timer and/or a pilot signal, a sign indicating that the machine is under automatic/remote control must be placed clearly visible on the machine. See [Figure 16](#) for an example.

2.2.1 Indoor installation requirements



WARNING! Risk of personal injury

- Never completely seal a small room where the Vacuum and Control unit is installed. Ensure it is installed in a well-ventilated room.
- Under some conditions, the Vacuum and Control unit may draw air directly into the high-pressure fan. This may cause dangerous under pressure in the room if air cannot enter freely. There are to be two openings for ventilation, at least 250×250 mm (10"×10") in size. One is to be placed up high and the other one down low.
- The warm exhaust air is to be directed from the Vacuum and Control unit and out of the premises. Connect a duct that directs the exhaust air outdoors. The air can be directed to a heat exchanger, but there are not to be any dampers that may obstruct the airflow.

2.2.2 Outdoor installation requirements

- The installation area needs to be protected from the weather. Cover the top of the Vacuum and Control unit to protect it from snow, rain or falling debris.

2.3 Main installation



WARNING! Risk of explosion

Do not open electrical connections when explosive atmosphere or dust is present.



NOTE!

Fill in the installation protocol during the installation.

- 1 Position the Vacuum and Control unit in the installation location without removing the factory packaging.
- 2 Remove the factory packaging.
- 3 Anchor the Vacuum and Control unit firmly to a hard, level and firm foundation. There are four holes in the bottom frame to be used to anchor the unit. See [Figure 2](#).
- 4 Remove the top cover, see [Section 3.9 Internal parts](#).
- 5 Route and connect mains power, see [Section 3.9 Internal parts](#) and electrical diagrams.
- 6 Check the earth connection from the factory ground to the chassis.

- 7 Connect compressed air, see the User Manual.
- 8 Connect pilot cable (optional).
- 9 Test start the Vacuum and Control unit.
- 10 Connect inlet and outlet ducting.
- 11 Adjust capacity and alarm switches if required. See [Chapter 4 Capacity adjustments](#).
- 12 If the flow is too high at the extraction points, reduce the vacuum level. This will save energy.
- 13 Refit the top cover
- 14 Follow the steps in related installation sections; duct, electrical and so on.

**NOTE!**

- The Vacuum and Control unit automatically adjusts for incoming mains voltage and frequency. For range see [Section 2.12 Technical data](#).
- After all installation and maintenance work: verify the earth connection.

2.4 Duct installation

- 1 Connect the duct to the inlet, see [Figure 2](#), item A.
- 2 Connect the pipe/hose (clean side) to the outlet, see [Figure 2](#), item B.

Consider the following when designing duct systems:

- It is important to use a correct duct diameter to avoid pressure losses and dust deposits in the system.
- Ensure that the correct transport velocity is achieved.
- Velocity may vary depending on how much of the vacuum system is used (infrequent use).
- Correct velocity depends on the properties of the transported material. Some composite applications can require velocities up to 25 m/s (82 ft/s).
- To keep the pipes clean a principle called “flushing” may be used. By fitting a valve at the end of the duct system each branch of the vacuum system can be flushed separately to reduce the risk of dust deposits. By not using the rest of the system, and opening the “flush valve”, a high amount of air will flush the system clean.
- Do not connect several PAK-M or other vacuum sources to the same duct system. This will cause errors in the vacuum regulation and undesired behaviour.
- If the dust is abrasive it may be necessary to use thick-walled (or rubber-coated) material in bends and other exposed areas.
- To avoid pressure losses, the duct system should be as short as possible and designed with two or more branches. Use larger diameters on the clean side to reduce pressure losses.
- Length to the suction source should be less than 25 meters.

**NOTE!**

This will affect capacity due to pressure drops, see [Figure 11](#) and [Figure 12](#).

2.5 Electrical installation

- Tighten cables including the ones already fitted that may have loosened during transport.
- Check the integrity of the control box, lid should be fitted correctly and no cable connections should be empty or missing.
- Correct voltage must be connected. Control signals must be fused, maximum 5A, to avoid heating of cables and equipment in case of damage, short circuit or malfunction.
- For the power circuit, control circuit and terminal connection diagrams, see the electrical diagrams that came with PAK-M.
- The connected wiring system is to be electrically connected to the Potential Equalizing System (PES) on the premises.
- Check that proper measures have been taken to avoid all types of electrical stray currents to and/or from the piping system and electrical wiring.
- The Vacuum and Control unit is not to be connected to the supply voltage via plug and socket but shall be permanently connected. Ensure that all electrical connections are secured properly.

- The electrical connection is NOT to be equipped with an earth leakage circuit breaker when the VFD is provided with an EMC filter. The EMC filter function will make the earth leakage circuit breaker shut off the power.



WARNING! Risk of personal injury

- Global as well as national and local electric regulations must be fulfilled.
- The electrical installation must be done by a certified electrician. Use electrical diagrams.
- A lightning conductor must be installed if PAK-M is installed outdoors.
- Check the continuity of the protective current circuit before the Vacuum and Control unit is used.
- Check that the supply voltage corresponds to the data on the machine plate of the Vacuum and Control unit, before connecting it to the mains supply.
- Following the European standard, the incoming 3-phase supply is to be fitted with a hand-operated disconnecting device that conforms to the demands of disconnectors. The disconnecting device is to be fitted within 2–3 m from the Vacuum and Control unit and be clearly visible. Refer to local and national standards when located outside of Europe.
- Operator controls shall be easily accessible. The need for additional emergency stop buttons and their placement shall be analysed according to EN ISO 13850.
- Always replace worn, faulty or defective electrical components with new original parts.

2.5.1 Secondary earthing, PE

Due to the safety requirements of the VFD there shall be a secondary protective earth conductor (PE), of the same cross-sectional area as the original protective earth conductor. It shall be connected to the chassis. See [Figure 1](#).

2.6 Compressed air installation

See [Figure 13](#) and [Section 2.12 Technical data](#). Item A is the exit for the compressed air. For example to a Dust Separator. See also item 26 in [Figure 1](#) and refer to the User Manual.



WARNING! Risk of personal injury

Use ear protection and safety goggles.

- Cleaning Valve (CV), Cleaning Cylinder (CC).
- For compressed air specifics, see [Section 2.12 Technical data](#).

Consider the following:

- As new ducts may contain dirt/particles/debris, the compressed air duct should be blown clean before connecting PAK-M.
- A compressed air filter must be installed to ensure safe operation of PAK-M. A main valve that bleeds the remaining pressure should be installed.
- It is recommended that a pressure switch, warning for insufficient pressure, is connected to the control system.
- The specified air consumption of PAK-M is limited to the short operation of the cleaning and cooling valve.
- Take necessary measures to avoid water/humidity in the compressed air when installed in cold environments.
- If anti-freeze additives are used, ensure continuous use. Once added, the removal of the anti-freeze additive can cause malfunction of the pneumatic components.
- To avoid personal injuries during maintenance, the main valve should be locked in a closed position.
- Use black tubing to differentiate compressed air from pressure measurements.

2.7 Setting VFD parameters

The VFD parameters are described in the Program Manual.



NOTE!

The vacuum level needs to be set correctly.

2.8 Connecting a Dust Separator

Remove the top cover and upper rear cover to access the bolts.

There are four M12 bolts holding them together and an M16 in the centre. The M16 is not tightened and is used as a pivot point for tilting. There is also a spring-loaded pin for holding the dust operator tilted at different angles. Only use one pin, and leave one leg without a pin.

2.9 Main parts

See User Manual and [Figure 1](#).

2.10 Accessories

Nederman is prepared for Nederman accessories and customer connections.

The installation of accessories, extra equipment, and functions are described in the manual for each product and according to the electrical diagrams that came with it. Consult your local Nederman representative for available accessories.

2.10.1 24V to external devices

The built-in 24V DC transformer can be used to power external devices like the Airflow Indicator 24V. But the connection must be fused with an appropriate sized fuse. Available power varies on model and accessory, but most have around 1A available. Check electrical diagrams for more information.

2.11 Pressure measuring points and connections

See the User Manual.

2.12 Technical data

Vacuum and Control unit	
Rated motor power	7,5 kW 50Hz / 9 kW 60 Hz
Power consumption	See the User Manual
Mains voltage/Frequency	380-480 V±10% / 50-60 Hz
Recommended input protection fuses	IEC fuse: 25A qG / UL fuse: 30A UL Class T
Protection class	IP54
Compressed air connection	Ø 6mm (0.24")
Compressed air quality	Clean dry, ISO 8573-1 class 5
Compressed air pressure	6 - 10 bar (87 - 145 PSI)
Capacity	See Figure 11 *
Maximum vacuum at fan	-27 kPa
Maximum frequency on VFD	72 Hz
Weight	183 kg (403 lb)
Dimensions:	See Figure 2
- Inlet, (A)	Ø 100 mm (3.94")
- Outlet, (B)	Ø 100 mm (3.94")
Sound level	<70 dB(A) according to ISO 11202:2010

Vacuum and Control unit	
Ambient temperature range (standard)	-15 - +30 °C (5 - 86 °F)
Max ambient temperature (derated)	+45 °C (113 °F)
Process air temperature	-15 - +60 °C (5 - 140 °F)
Max exhaust air temperature	120 °C (248 °F)
Relative humidity	Max. 90%
Maximum installation altitude	1000 m above sea level (4000 m with derating).
Corrosion class	C2 according to ISO 12944-2
Transformer voltage	24 VDC ±5%
Internal fuses	2 x 4A D=10x38mm CC Slow Blow
Vacuum level preset	15,0 kPa (2.2 PSI)
Main filter pressure switch, range	0,25 - 5,0 kPa (0.04 - 0.73 PSI)
Main filter pressure switch, preset	2,0 kPa (0.29 PSI)
Secondary filter pressure switch, range	0,25 - 5,0 kPa (0.04 - 0.73 PSI)
Secondary filter pressure switch, preset	4,0 kPa (0.58 PSI)
Material recycling, approx	98 weight-%
Main materials	Powder coated steel, cast aluminium, EEE components, rubber (EPDM)

* Clean filters, no derating of vacuum.

i NOTE!

- Some values depend on installation and application.
- For temperatures below zero: pneumatic components require dry air.
- Sound level is measured at front operator position with a distance of 1 m (39.4"), at height 1.6 m (63.0") running at 15 kPa.

3 Service and maintenance



WARNING! Risk of personal injury

- Only qualified service technicians - electrical, local regulations, product knowledge and so on - using the relevant PAK-M manuals, may perform service and maintenance on the Vacuum and Control unit. This includes disconnecting cables, hoses or other components and/or changing settings not specifically mentioned as allowed by user.
- Disconnect the supply voltage with the maintenance switch before any service, whether mechanical or electrical. Always lock the maintenance switch in the off position and, if possible, secure it with a padlock.
- Disconnect the compressed air supply before any service, whether mechanical or electrical.
- Always stop the Vacuum and Control unit before looking into the outlet. The fan rotates at high speed and debris and particles coming out of the outlet may cause eye injury.
- Maintenance work in elevated positions requires adequate safety measures.
- Use proper protective equipment where there is a risk of exposure to dust.
- Use proper lifting equipment and protective gear.
- The compressed air supply needs to be securely disconnected during maintenance.
- Avoid spilling materials.
- After all installation and maintenance work: test the earth connection, make sure that all hoses and connections are re-attached and verify that the Vacuum and Control unit is running normally without any warnings.



WARNING! Risk of explosion

Before performing any grinding, welding or other hot works on PAK-M, stop operation and clean all parts in contact with dust.



CAUTION! Risk of equipment damage

- During maintenance, it may be necessary to remove the acoustic enclosure over the motor while the motor is in operation. Take care to prevent objects from falling down into the motor cooling fan.



NOTE!

Fill out the service protocol for all maintenance performed on PAK-M. See [Chapter 8 Appendix B: Service protocol](#).

3.1 Checking pressure

- 1 Disconnect DPS1 and put your measuring instrument there instead.
- 2 Run the Vacuum and Control unit with the inlet closed.
- 3 If your measuring instrument shows more than 50 Pa, check hoses and connections for leaks and dirt.



NOTE!

Long hoses can cause deviations.

- 4 Repeat procedure for DPS2.

3.2 Checking duct pressure

- Connect a measuring point to the duct close to the inlet for measuring pressure.



NOTE!

- Alternatively you can use the plus point on DPS1. It is connected to the same measuring point as PID regulation and any leakage will cause the Vacuum and Control unit to run at higher speeds.
- Do not leave any points unconnected when the Vacuum and Control unit is running. They must be connected to an instrument or be plugged. If unconnected there will be a leakage and other sensors/switches measuring that pressure will not function.

3.3 Checking pressure at fan

The minus tube connected to DPS2 is directly connected to the fan inlet.

- When the Vacuum and Control unit is running at almost full speed (60-70 Hz), measure the pressure in this tube.

This gives the pressure at the fan.



NOTE!

- Don't forget to reconnect the tube to DPS2 after measuring.
- This tube is one of few tubes that are safe to disconnect during operation. It only effects the secondary filter monitoring.

3.4 Checking the cooling valve

The cooling valve opens both at high temperature and high pressure.

- 1 Open suction points in the duct system to create a large flow.
- 2 When the Vacuum and Control unit has reached high speed, then rapidly close these suction points.

This should make the duct pressure rise and temporarily trigger the cooling valve.

3.5 Maintenance schedule

Type of maintenance	Frequency
Regular inspection	Regularly and after changed operating conditions
Yearly inspection	One month after installation and every year

3.6 Regular inspection

- 1 Verify the functionality of controls and signals.
- 2 Inspect all parts of Vacuum and Control unit and pay special attention to the seals. Replace damaged parts.
- 3 Check all parts of all attachments. Tighten bolts if necessary.
- 4 Make sure the outside are free from dust layers.
- 5 Avoid dust build-ups around the Vacuum and Control unit and keep the specified areas around it clear for cleaning, service and maintenance. See [Figure 3](#).
- 6 Inspect and clean the motor compartment.
- 7 Check the pressure in hoses and connections. See [Section 3.1 Checking pressure](#).

3.7 Yearly inspection

- 1 Complete the steps in the regular inspection schedule.
- 2 Check all power, protective conductors and earth connections. Tighten, if required, to ensure good contact.
- 3 Ensure that the inside and the connection ducts are free from deposits. A build-up of deposits inside the duct system may cause a discharge of static electricity.
- 4 Check that all signs/markings regarding safe operation are in place and that the personnel know them.
- 5 Verify the function of all emergency stop buttons, alarms and signalling devices.

3.8 VFD

The VFD controls the motor so that it operates efficiently and maintains vacuum level to prevent dangerous negative pressure and the Vacuum and Control unit from overheating.



WARNING! Risk of electric shock

- Contact Nederman if the VFD needs service.
- Always use a VFD from Nederman with correct program and settings.
- VFD spare parts should be fitted by a competent person.
- The VFD is not to be opened until five minutes after the supply voltage has been disconnected. The capacitors inside hold a very dangerous voltage until they have discharged themselves.

**CAUTION! Risk of equipment damage**

Do not adjust any parameters in the VFD without written authorization from the person responsible for this product. See the Program Manual. Unauthorized adjustments may void the warranty and cause a severe risk.

**NOTE!**

- VFD settings are described in the Program Manual.
- The VFD manual is available from the manufacturer.
- The Parameter table is a separate document included with the PAK-M documentation.

3.9 Internal parts

Access the internal parts by removing the covers.

3.9.1 Top cover

See [Figure 4](#).

- Remove the four screws and washers, item A, and lift off the cover. Be careful of the emergency stop button.

You gain access to VFD, DPS, sensors, switches, terminal box and PLC (optional). From the back, you have some access to pressure connections and compressed air connections.

3.9.2 Front cover

See [Figure 5](#).

**NOTE!**

The top cover needs to be removed first.

The serrated washers, item C are used for earth connection on two of the screws, item A.

- Remove screws A and B. Tilt the front cover towards you to remove since there are hooks holding it to the bottom frame.

You gain access to the motor terminal box, motor label, and vibration sensor (optional).

3.9.3 Rear covers

See [Figure 6](#).

**NOTE!**

- The top cover needs to be removed first.
- The serrated washers, item C are used for earth connection.

- Remove the screws, washers and nuts.

Normally only removing the top part is required. You gain access to connection screws for a Dust Separator, the cooling valve, compressed air connections and pressure sensor connections.

See [Figure 7](#).

- Remove the screws, washers and nuts to remove the lower cover.

You gain access to the complete fan unit.

3.9.4 Motor and fan unit

The motor and the fan shares one shaft with one bearing in the motor and one in the fan. These bearings should be replaced according to the fan maintenance manual. Generally every 40,000 hours or every five years.

**NOTE!**

Time is reduced for higher temperatures. Both bearings must be replaced by a specialized operator and require special tools and new sealing.

- Contact Nederman or an authorized Nederman distributor when bearings need to be replaced.

3.10 Loading new software

Only Nederman qualified service technicians may make changes to, or install new software.

**CAUTION! Risk of equipment damage**

- Do not load new software from another source, even from the manufacturer of the inverter without Nederman approvals.

- Make notes of actual parameter settings. See separate manuals for loading software to VFD or PLC (optional).

4 Capacity adjustments

You can set the vacuum level the Vacuum and Control unit is keeping in the VFD. When determining the maximum vacuum set point you must consider the following factors:

- Measuring point placement
- Minimum flow
- Set point of pressure switch, DPS1 for the main filter. See item 7 in [Figure 1](#) and the Program Manual.
- Set point of pressure switch, DPS2 for the secondary filter. See item 8 in [Figure 1](#) and the Program Manual.
- Derating of temperature and altitude
- Length and size of exhaust ducting
- Other resistance

The Vacuum and Control unit has a maximum vacuum allowed at the inlet of the fan, see [Section 2.12 Technical data](#). This is reduced by each of the applicable factors.

**NOTE!**

- Too high vacuum set point triggers overheat protection. See [Chapter 6 Overheat protection](#).
- Higher vacuum creates higher energy consumption. See [Chapter 5 Power consumption](#).
- DPS2 may also be used if your PAK-M is split and there is ducting between the Dust Separator and the Vacuum and Control unit.
- Setting DPS1 to a low value may trigger constant cleaning. It is recommended to stay above 1 kPa, but it depends on the filter.
- If no secondary filter is used, set DPS2 to around 1 kPa. It should be low to detect changes but not so low that it triggers when there is full flow (filter cleaning).

4.1 Measuring point placement

The vacuum is normally measured in the point referred to as P1, connected on the dirty side upstream of the main filter. P1 delivers stable vacuum to the system regardless of the pressure drop in the filters. See the User Manual.

The vacuum at the fan depends on the pressure drop between the measuring point and the fan inlet. The main influences are:

- Pressure drop in ducting between the Vacuum and Control unit and the Dust Separator (if separated).
- Pressure drop over the main filter.

- Pressure drop over secondary filter (if applicable).

**NOTE!**

- If the measuring point is moved, the pressure drop may be different. For example, if the measuring point is changed to P3B, that is on the fan inlet, there will be no pressure drop to consider between the measuring point and the fan.
- An activated filter cleaning - filter dirty - may result in a higher pressure drop over the main filter. If this is an issue it is recommended to measure the vacuum directly at the fan (P3B). See item 29 in [Figure 1](#).

4.2 Minimum flow

Low flows increase the temperature. The cooling valve automatically corrects for this, but if you have issues with overheating at low flows, lowering the vacuum level reduces the temperature and the need for extra cooling. See [Chapter 6 Overheat protection](#).

**CAUTION! Risk of equipment damage**

- Avoid running against a closed inlet/zero flow for a long time. It shortens the lifetime of the Vacuum and Control unit.

4.3 Derating

4.3.1 Ambient temperature derating

Ambient temperatures above 30 °C require a derating of the vacuum level, both for the fan and the VFD. The reduction factor is 0,4 kPa for every 1 °C above 30 °C, up to 45 °C. See [Figure 14](#) where the vacuum derating is shown in kPa and ambient temperature in °C.

**NOTE!**

- This applies if the ambient temperature and process air temperature is the same. If they differ a derating of the process air temperature is required.
- The Vacuum and Control unit cannot be used in ambient temperatures above 45 °C.

4.3.2 Process air temperature derating

High process air temperatures may result in the Vacuum and Control unit using the cooling valve to cool down. This reduces the capacity. Suitable capacity adjustments depend on the PAK-M application conditions, but some general guidelines can be established:

- Colder process air only affects the fan, not the VFD.
- Warmer process air needs a reduced vacuum.

- Ambient temperature above 30 °C: The reduction factor is 0,3 kPa for every 1 °C the process air is above the ambient air temperature.
- Ambient temperature below 30 °C: The reduction factor is 0,3 kPa for every 1 °C the process air is above 30 °C. This total reduction value can then be reduced by 0,1 kPa for every degree the ambient temperature is below 30 °C. Example: Ambient 22 °C and process air 50 °C. Vacuum level reduction is $20 \times 0,3 - (8 \times 0,1) = 6 - 0,8 = 5,2$ kPa.

NOTE!

- This applies if the process air temperature and ambient temperature differ. If they are the same, a derating of the ambient temperature is required.
- High differences in ambient and process air should be avoided.
- The Vacuum and Control unit cannot be used for process air temperatures above 60 °C.

4.3.3 Altitude derating

The altitude derating reduction factor is 0,5 kPa for every 100 m above 1000 m. See [Figure 15](#) where the vacuum derating is shown in kPa and the height above sea level in m.

4.4 Exhaust ducting

All pressure drop after the exhaust will be a loss to the system. Keep the exhaust ducting short and large in diameter. For lengths < 12 m, Ø 100 mm ducting is adequate. For longer ducts increase the diameter or derate the max vacuum set point with the increased pressure drop in the exhaust ducting. See [Chapter 5 Power consumption](#).

NOTE!

- Beware of any resistance caused by other equipment.

4.5 Other resistance

Additional equipment that can cause pressure drops between measuring point and fan or on the exhaust ducting. This can be due to but not limited to: heat exchangers, silencers, jet caps, filters, fans, diverters, branches, nets, guards.



CAUTION! Risk of equipment damage

- Do not place any dampers between the measuring point and fan or on the exhaust ducting. A closed damper may cause the Vacuum and Control unit to overheat.

4.6 Calculating max vacuum set point

Many variables may affect the maximum pressure. Here's an example of how measuring point, P1 can be calculated:

- A Set point of DPS1 for the main filter: 2 kPa

- B Set point of DPS2 for the secondary filter: 4 kPa
 C Ambient temperature: 32 °C = 0,8 kPa
 D Process air temperature: 40 °C = 2,4 kPa
 E Altitude: 1400 = 2 kPa
 F Length and size of exhaust ducting: 7 m = 0 kPa
 G Other resistance: Nothing = 0 kPa

Total reduction of max vacuum: $2 + 4 + 0,8 + 2,4 + 2 = 11,2$ kPa

Max vacuum set point: $27 - 11,2 = 15,8$ kPa

NOTE!

In applications with rapid and large changes in usage, the vacuum level can fluctuate above set point. This can be because of duct volumes and other equipment. The cooling valve is used to mitigate the amplitude of the fluctuation. Rapid increases in usage can also cause vacuum levels below set point for a few seconds, before the Vacuum and Control unit has had time to increase speed.

5 Power consumption

Power consumption depends on the vacuum level, pressure drop over filters, placement of PID measuring point and the pressure drop over exhaust ducting. [Figure 12](#) shows how the shaft power, consumption, increases with flow at different vacuum set points for a complete PAK-M with clean filters and no exhaust ducting. P1 is used for PID regulation. Flow is shown in m³/h and shaft power in kW.

Here are some general rules regarding the power consumption:

- Increasing the vacuum set point will increase the flow in the system.
- Increasing the vacuum set point with 1 kPa increases the power consumption by 0,3-0,6 kW.
- Pressure drop from filters increase the power consumption by 0,20-0,4 kW/kPa.
- Pressure drop in the exhaust ducting increase the power consumption by 0,20-0,4 kW/kPa.
- Replacing filters with high pressure drop saves energy.

6 Overheat protection

The Vacuum and Control unit has four levels of overheat protection. All are monitoring the temperature of the exhaust air and triggers in order of rising temperature:

- 1 Cooling valve opens, this is considered normal operation.
- 2 Warning that the exhaust air is getting above normal temperature.
- 3 The cleaning is forced open. This normally result in a short pulse removing the vacuum for a few seconds and rapidly reducing the temperature. If

very hot the Vacuum and Control unit may repeat this pulse after about a minute.

- 4 The Vacuum and Control unit shuts down. VFD will show an error message and a reset is required.

Level 1 can happen during normal operation, but if you constantly get level 2 or 3 you need to investigate the cause and most likely reduce the vacuum level. If you get level 4 the cause must be investigated. Use the adjustments suggested in [Chapter 4 Capacity adjustments](#).



CAUTION! Risk of equipment damage

- Never run the Vacuum and Control unit without compressed air. The pressure will build up over main filter and the first two levels of cooling protection will be disabled.



NOTE!

- The cooling valve helps with cooling for low flows by adding a leakage flow of 120-180 m³/h. The Vacuum and Control unit runs like this until it manages to cool down. It should not be noticed unless a high flow is required before it has had time to cool down, which may take a few minutes. After this the Vacuum and Control unit can provide full flow again.
- The cooling valve may also open to help reduce spikes in vacuum level when the flow is decreased rapidly.
- When the cooling valve opens/closes there might be a small fluctuation in flow of around 5-15%.

7 Appendix A: Installation protocol

Type (PAK-M, PAK-M DX or PAK-M VAC):	Performed by:
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Date:	Art. No.:	Serial No.:
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Control item	Yes	No	Comment
Transport damages			
All components delivered			
Machine label matches the order			
Required User Manuals included			
Required Installation and Service Manuals included			
Factory test report included			
Radiation heat from surroundings is low			
Protection from wind, rain, snow, dust, etc. is good			
Foundation is according to specifications (can withstand total weight and strain on bolts)			
Ambient temperature is within range			
Access for service and maintenance			
Ventilation openings in the installation room are as specified			
Cooling intakes are free from blocking			
Process air temperature is within range			
Earth leakage circuit breaker works with VFD			
All power cables are adequately tightened			
Pilot signal is used			
Maintenance switch is used			
Compressed air tubes are cleaned and connected			
Compressed air is clean and dry			
A shut-off valve is installed for compressed air			
Inlet and outlet ducts are connected			
Accessories are installed			
Signs and warnings are appropriate			

Control item	Yes	No	Comment
Measuring tubes, P1, P2 and P3 are functioning			
Emergency stop works as expected			
Reset works as intended			
Vacuum reads expected value			
Filter cleaning works as intended			
Temperature reads expected value			
Date & time is set (if week timer is used)			

Electrical values

Mains voltage (V):	Mains fuse size (A):
Mains frequency (Hz):	Mains fuse type:

Vacuum levels

Ambient temp., derating value (kPa):	Main filter DPS1 set point (kPa):
Process air temp., derating value (kPa):	Secondary filter DPS2 set point, if used (kPa):
Altitude derating value (kPa):	Vacuum level (PID) setting (kPa):
Exhaust ducting length & size resistance (kPa):	Vacuum level at fan (kPa) * :
Other resistance in exhaust ducting (kPa):	

* Compare with max in technical data

8 Appendix B: Service protocol

Type (PAK-M, PAK-M DX or PAK-M VAC):		Performed by:	
Date:	Art. No.:	Serial No.:	
Control item	Yes	No	Comment
Radiation heat from surroundings is low			
Protection from wind, rain, snow, dust, etc. is good			
Foundation is according to specifications (can withstand total weight and strain on bolts)			
Ambient temperature is within range			
Access for service and maintenance			
Ventilation openings in the installation room are as specified			
Cooling intakes are free from blocking			
Dust deposits in work area			
Dust deposits inside			
Inlet and outlet ducts are connected			
Signs and warnings are appropriate			
VFD reads expected temperature value			
Compressed air shut-off valve is installed			
Compressed air pressure is correct			
Maintenance switch works as intended			
Mains fuse is correct type and size			
All power cables are adequately tightened			
Changes in duct system since installation (including exhaust)			
Changes in ambient conditions since installation			
Emergency stop works as expected			
Reset works as intended			
Cooling valve tested (optional)			
Filter cleaning works as intended			
Start and run is normal			

Vacuum levels

Main filter DPS1 set point (kPa):	Measured duct pressure (kPa):
Secondary filter DPS2 set point, if used (kPa):	Measured pressure (P3B/DPS2) at fan (kPa) *:
Vacuum level (PID) setting (kPa):	

* Compare with max in technical data and installation protocol

Additional notes

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