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1 Introduction

1.1 To the very beginning

We thank you for having purchased the **steam humidifier Defensor Mk5**.

The steam humidifier Defensor Mk5 incorporates the latest technical advances and meets all recognized safety standards. Nevertheless, improper use may result in danger to the user or third parties and/or impairment of material assets.

To ensure a safe, proper, and economical operation of the steam humidifier Defensor Mk5, please observe and comply with all information and safety instructions contained in the present technical documentation.

If you have questions, which are not or insufficiently answered in this documentation, please contact your Defensor supplier. They will be glad to assist you.

1.2 Notes on the technical documentation

Limitation

The subject of this technical documentation is the steam humidifier **Defensor Mk5** in the versions: “**Visual**” and “**Process**”. The various accessories (humidistats, water filter, etc.) are only described insofar as this is necessary for proper operation of the equipment. Further information on accessories can be obtained in the respective instructions.

This technical documentation is restricted to:

- the **planning** of a humidifying system that is to be equipped with a steam humidifier Defensor Mk5
- the **installation, commissioning, operation** and **servicing** of the steam humidifier Defensor Mk5

The technical documentation is supplemented by various separate items of documentation (spare parts list, installation instructions for electrical installation, etc.). Where necessary, appropriate cross-references are made to these publications in the technical documentation.

Conventions



This symbol draws attention to **safety instructions and warnings** of potential danger which, if unheeded, could result in injury to persons and/or damage to property.

Safekeeping

Please safeguard this technical documentation in a safe place, where it can be immediately accessed. If the equipment changes hands, the documentation should be passed on to the new operator. If the documentation gets mislaid, please contact your Defensor supplier.

Language versions

This technical documentation is available in various languages. Please contact your Defensor supplier for information.

2 For your safety

Intended use



Steam humidifiers Defensor Mk5 are intended exclusively for **direct or indirect room humidification or for humidification in laboratory and process applications** within the specified operating conditions. Any other type of application, without the written consent of your Defensor supplier, is considered as not conforming with the intended purpose. The manufacturer/supplier cannot be made liable for any damages resulting from improper use. The user bears full responsibility.

Operation of the equipment in the intended manner requires **that all the information in these instructions is observed (in particular the safety instructions)**.

General safety instructions

- The steam humidifier Defensor Mk5 must only be installed, operated serviced and in all cases repaired **only by persons who are adequately qualified** to undertake such work and are well acquainted with the product. Ascertaining the qualifications is the customer's responsibility.
- **Caution, danger of electric shock! The Defensor Mk5 is operated with mains voltage. Before commencing work** on the Defensor Mk5, the unit is to be **rendered inoperative** in accordance with section 6.3 and prevented from further inadvertent operation (isolate unit from the electrical power supply, isolate water supply).
- Observe all **local safety regulations**.
 - relating to the operation of mains-operated **electrical and electronic equipment**
 - and the **provision of water, steam and electrical installations**
- Poorly maintained humidification systems can endanger health. **The servicing intervals should therefore be adhered to without reservation and the servicing work carried out correctly.**
- If it is suspected that **safe operation is no longer possible**, then the Defensor Mk5 should immediately **be shut down and secured against accidental power-up**. This can be the case under the following circumstances:
 - if the Defensor Mk5 is damaged
 - if the Defensor Mk5 is no longer operating correctly
 - if connections and/or piping are not sealed or cables are loose
- The Defensor Mk5 must **only be operated under the specified operating conditions** (see section 7).
- The Defensor Mk5 is protected according to IP21. Make sure the units are installed in a drip-proof location
- **Caution!** If the Defensor Mk5 is installed in an area without a water drain, water sensors must be fitted in the area, such that in the event of leakage in the water system, the water feed is safely shut off.
- **Caution, danger of corrosion!** In order to avoid damage, **no corrosion-sensitive components** should be located in the area of the aerosol streams.
- No work/repair should be carried out on the Defensor Mk5 other than that described in these instructions.
- Use exclusively **original accessories and spare parts** available from your Defensor supplier.
- **No modifications must be undertaken** on the Defensor Mk5 without the express written consent of Axair Ltd.



3 Product overview

3.1 Unit types

The steam humidifiers **Defensor Mk5** are available in **2 different type series**:

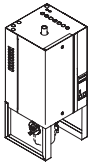
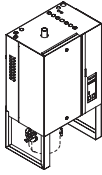
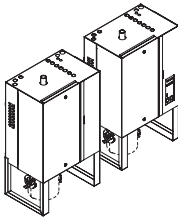
- **Visual**
For direct or indirect room air humidification with **standard requirements for control precision**.
- **Process**
For direct or indirect room air humidification in **laboratory and process applications** where there are **increased requirements for control precision**.

Basically, the devices of both type series are of the same construction except for the level control and electronics. The Visual units >10 kg/h are equipped with a combined contactor/electronic control and a level unit with a single float. To achieve a higher level of accuracy the Process units include a dedicated electronic control with special control software and are equipped with a level unit comprising two floats.

They are available in versions suitable for operation with **untreated water (with lime collector tank)** or with **fully demineralized water (without lime collector tank)**. All versions are equipped, as standard, with an **operating and display unit**, by means of which the current operating parameters can be read and the equipment configured for operation, and an **integrated PI controller**. The equipment can be supplied with various other options.

Type overview and type designation

The units of both type series are available in various versions with **different steam capacities** and **layout of the power section** (heating voltage). The following table provides an overview of the various models and their capacity ranges.

Defensor Mk5 Visual.../Process...											Heating voltage
 small				 large				 Double unit large			
5	8	10	16	20	24	30	40	50	60	80	
max. steam capacity in kg/h											
5.0	8.0	10.0	16.0	20.0	24.0	30.0	40.0	50.0	60.0	80.0	400V/3~/50...60Hz
4.6	7.3	9.0	14.6	18.0	21.9	27.0	36.2	45.0	54.0	72.4	220V/3~/50...60Hz
5.1	8.4	10.3	16.7	20.6	25.1	30.6	41.5	51.4	61.7	83.1	415V/3~/50...60Hz
5.1	8.7	10.3	---	---	---	---	---	---	---	---	240V/1N~/50...60Hz
5.1	8.0	10.0	---	---	---	---	---	---	---	---	230V/1N~/50...60Hz
3.9	5.8	7.1	11.6	14.3	17.4	21.5	28.8	35.7	43.0	57.7	200V/3~/50...60Hz

The type designation is structured as follows:

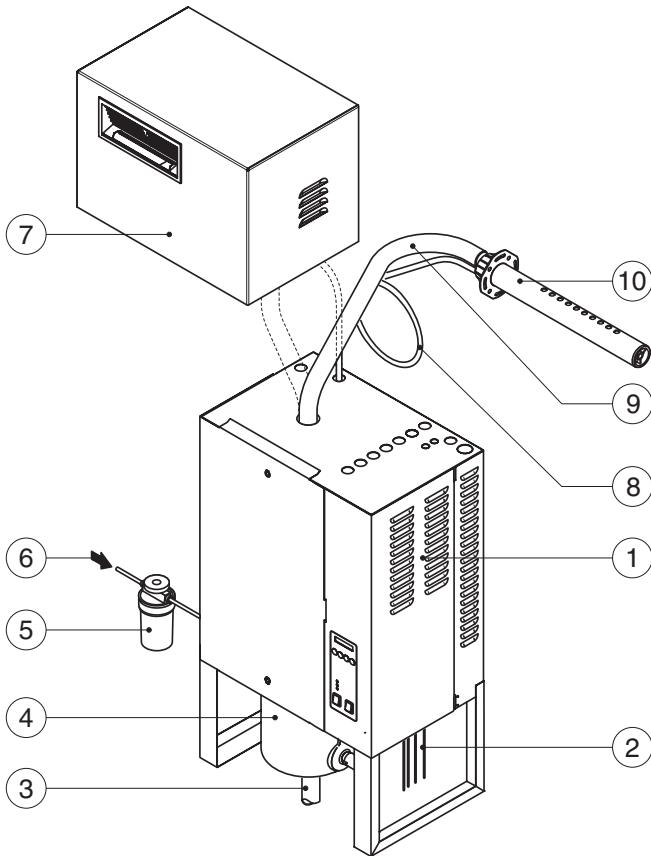
Designation		Code
Brand name		Defensor
Product line		Mk5
Type series	<ul style="list-style-type: none"> – Direct or indirect room humidification – Humidification for laboratory and process applications 	Visual Process
Operating mode	<ul style="list-style-type: none"> – Operation with untreated water (with lime collector tank) – Operation with fully demineralized water (without lime collector tank) 	<ul style="list-style-type: none"> – VE
Steam capacity in kg/h	– 5, 8, 10, 16, 20, 24, 30, 40, 50, 60 or 80	..
Heating voltage	<ul style="list-style-type: none"> – 400V/3~/50...60Hz – 220V/3~/50...60Hz – 415V/3~/50...60Hz – 240V/1N~/50...60Hz – 230V/1N~/50...60Hz – 200V/3~/50...60Hz 	<ul style="list-style-type: none"> 400V/3~ 220V/3~ 415V/3~ 240V/1N~ 230V/1N~ 200V/3~

3.2 Standard delivery

The standard delivery includes:

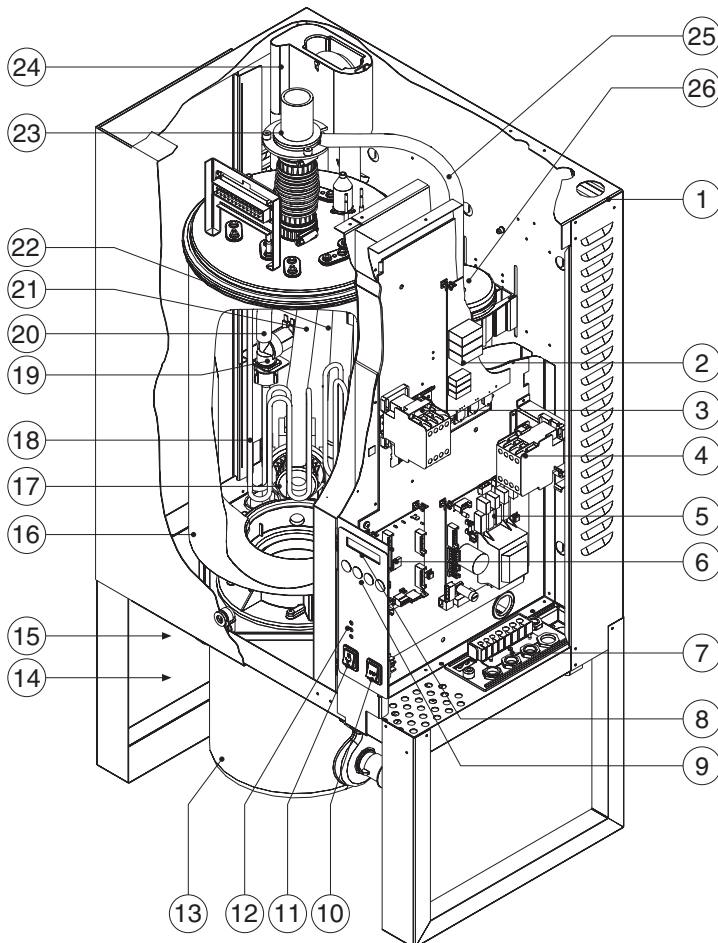
- Steam humidifier Defensor Mk5 compl. (according to type designation) equipped with the desired options (remote operating and fault indication, pressure compensation kit, etc.) according to chapter 4.3
- Fixing set including dowels and fixing screws (for single units up to 40 kg/h), mounting profile with dowels and fixing screws (for double units 50...80 kg/h)
- Technical documentation
- Installation instructions
 - yellow: Electrical installation
 - blue: Unit fitting/steam and water installation
- Spare parts list (red)
- Ordered accessories (steam distribution pipe, steam hose, etc.) according to chapter 4.4

3.3 Humidification system overview



- 1 Steam humidifier
- 2 Electrical connections
- 3 Water drainage
- 4 Lime collector tank (only on units for operation with untreated water)
- 5 Filter valve (accessory "Z261")
- 6 Water supply (building side)
- 7 Fan unit (accessory "FAN..")
- 8 Condensate hose (accessory "KS10")
- 9 Steam hose (accessory "Z10")
- 10 Steam distribution pipe (accessory "81-...")

3.4 Steam humidifier construction



- 1 Housing (500 or 600)
- 2 Power board
- 3 Heating contactor (Visual >10 kg/h only)
- 4 Mains contactor
- 5 Supply module
- 6 Control board
- 7 Cable openings
- 8 LC-Display
- 9 Control keys
- 10 Unit switch
- 11 Drain switch
- 12 Status indicator (LED)
- 13 Lime collector tank (only on units for operation with untreated water)
- 14 Drain
- 15 Water connection
- 16 Steam cylinder
- 17 Drain pump
- 18 Resistance heating element
- 19 Inlet valve with filter
- 20 Water supply
- 21 Filling pipe
- 22 Overflow pipe
- 23 Steam outlet connector
- 24 Water cup
- 25 Pressure equalizing pipe
- 26 Level unit

3.5 Functional description

The Defensor Mk5 steam humidifier is an unpressurized steam generator for direct (with fan unit) and indirect (with steam distribution pipe) room air humidification in ventilating and air-conditioning systems. In conjunction with a steam distribution pipe "Process" the unit may be used for humidification in laboratory and process applications.

The Defensor Mk5 operates on the resistance heating principle and is therefore suitable for operation with raw water, fully demineralized water and partially softened water.

Water supply

The water is taken via a filter valve (accessory "Z261") to the steam humidifier. It reaches the steam cylinder via the inlet valve (level controlled) and the open water cup.

Level regulation

The water level in the steam cylinder is continuously monitored with the level unit. If the water level reaches a preset level (owing to the evaporation process) the level unit supplies a signal to the controller. This opens the inlet valve and the steam cylinder is filled up. When the preset operating level is reached, the level unit supplies another signal to the controller to close the inlet valve.

The pressure equalizing pipe between the steam connection and the level unit ensures that the water levels are the same in the steam cylinder and the level unit.

Steam generation regulation

The steam is produced in the steam cylinder by several resistance heating elements. An external or the internal regulator for connection as required control the steam production fully variably from 0 to 100 %.

Flushing

The evaporation process increases the concentration of minerals in the water of the steam cylinder. A suitable volume of water must be flushed through the steam cylinder from time to time and replaced by fresh water to ensure that this concentration does not exceed a specific value unsuitable for operation. The Mk5 steam humidifier performs an auto-adaptive flushing. This consists of the following two forms of flushing:

- **Automatic flushing** takes place as soon as the water in the steam cylinder exceeds the upper operating level (e.g. by foaming of the water).
- **Flushing dependent on time** performs the flushing process at preselected time intervals (see section 6.1 "Adjustments").

Automatic or time-dependent flushing takes place depending on the water quality and the operating data. If the lowest operating level is reached during the flushing process, the inlet valve remains open until the water level in the steam cylinder has reached the normal working level again. If the lowest operating level is not reached, the inlet valve is closed.

Lime collector tank

The minerals precipitated by the evaporation process accumulate at the bottom of the steam cylinder. Units designed for operation with untreated water are equipped with an additional lime collector tank located directly underneath the steam cylinder. This way the minerals do not accumulate in the steam cylinder but mainly in the collector tank thus extending the service intervals and reducing the maintenance costs.

Units designed for operation with fully demineralized water do not have a lime collector tank as fully demineralized water contains only small amounts of minerals.

4 Basic planning

All the data necessary for the selection and layout of a Defensor Mk5 humidifier system are provided in the following chapters. The following planning steps are required:

- Selecting the unit (see chapter 4.1)
- Selecting the control system (see chapter 4.2)
- Selecting options (see chapter 4.3)
- Selecting accessories (see chapter 4.4)

4.1 Selecting the unit

The selection of the unit is reflected in the type description:



1. Application

The type series can be selected on the basis of the following table:

Scope of use	Type series
For direct or indirect room air humidification with standard requirements for control precision.	Visual
For direct or indirect room air humidification in laboratory and process applications where there are increased requirements for control precision.	Process

Defensor Mk5 Visual VE 24-400V/3~

Achievable control precision

- Visual: $\pm 5\%rh$ (assuming optimum control distance, PI-control and use of untreated water)
 $\pm 2\%rh$ (assuming optimum control distance, PI-control and use of **fully demineralized water**)
- Process: $\pm 2\%rh$ (assuming optimum control distance, PI-control and use of untreated water)
 $\pm 1\%rh$ (assuming optimum control distance, PI-control and use of **fully demineralized water**)

2. Supply water quality

Description	Version
unit with a lime collector tank for operation with untreated water and partially softened water.	–
Unit without a lime collector tank for operation with fully demineralized water with a conductivity value $<15\ \mu S$. Caution! Unit without lime collector tanks should not be operated with untreated water or partially softened water.	VE

Defensor Mk5 Visual VE 24-400V/3~

3. Calculating the maximum required steam capacity

The maximum required steam capacity is calculated from the following formulas:

$$m_D = \frac{V \cdot \rho}{1000} \cdot (x_2 - x_1) \quad \text{or} \quad m_D = \frac{V}{1000 \cdot \varepsilon} \cdot (x_2 - x_1)$$

m_D : maximum steam demand in **kg/h**

V : volume of supply air portion per hour in **m³/h** (for indirect room humidification) or room volume to be humidified per hour in **m³/h** (for direct room humidification)

ρ : specific gravity of air in **kg/m³**

ε : specific volume of air in **m³/kg**

x_2 : desired absolute room air humidity in **g/kg**

x_1 : minimum absolute supply air humidity in **g/kg**

The values for ρ , ε , x_2 and x_1 can be gathered from the **h,x-diagram** or the **Carrier-Diagram** for moist air respectively.

For a rough estimate of the calculated steam capacity, the following table can be used. The values listed in the table are based on a desired room air temperature of 20°C and a desired relative room air humidity of 45 %rh.

Max. portion of supply air in m ³ /hr or room volume to be humidified per hour in m ³ /hr			max. steam capacity in kg/h
Temperature / rel. humidity of supply air			
-15 °C / 90 %rh	-5 °C / 80 %rh	5 °C / 60 %rh	
650	850	1000	5
1000	1350	1600	8
2000	2650	3200	16
2500	3300	4000	20
3000	4000	4800	24
3750	5000	6000	30
5000	6600	8000	40
6250	8250	10000	50
7500	9900	12000	60
10000	13200	16000	80

Defensor Mk5 Visual VE 24-400V/3~

Example:

Max. portion of supply air 3000 m³/h, temperature/rel. humidity of supply air -15°C/90%rh

Important notes:

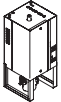

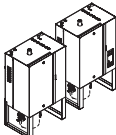
- The listed formulas and values from the tables do not consider absorption or release of humidity of materials located in the room being humidified.
- It is absolutely crucial to **carefully calculate** the maximum steam capacity. Over-dimensioned steam humidifiers interfere with the control stability.
- For systems where the max. required steam capacity varies extensively (e.g. for test facilities or for systems with variable air volume flow, etc.), please contact your Defensor supplier.

4. Heating voltage/control voltage

Heating voltage

The Defensor Mk5 steam humidifiers are available with various heating voltages. The maximum achievable steam capacity and the power consumption are directly dependent on the selected heating voltage (see table).

Defensor Mk5 Visual VE 24-400V/3~

		400 V/3~			220 V/3~			415 V/3~			240 VAC/1N~			230 V/1N~			200 V/3~		
		50...60 Hz			50...60 Hz			50...60 Hz			50...60 Hz			50...60 Hz			50...60 Hz		
Defensor Mk5 Visual.../Process...		kg/h	kW	A	kg/h	kW	A	kg/h	kW	A	kg/h	kW	A	kg/h	kW	A	kg/h	kW	A
	... 5-..	5.0	3.8	5.5	4.6	3.4	9.0	5.1	4.0	6.0	5.1	4.0	17.0	5.1	4.0	16.5	3.9	3.0	8.2
	... 8-..	8.0	6.0	8.7	7.3	5.5	14.4	8.4	6.5	9.0	8.7	6.5	27.2	8.0	6.0	26.0	5.8	4.5	13.1
	... 10-..	10.0	7.5	11.0	9.0	6.7	17.7	10.3	8.0	11.5	10.3	8.0	33.0	10.0	7.4	32.0	7.1	5.5	16.1
	... 16-..	16.0	12.0	17.4	14.6	10.9	28.7	16.7	13.0	18.1	—	—	—	—	—	—	11.6	9.0	26.1
	... 20-..	20.0	14.9	21.5	18.0	13.5	35.4	20.6	16.0	22.3	—	—	—	—	—	—	14.3	11.1	32.2
	... 24-..	24.0	18.1	26.2	21.9	16.4	43.1	25.1	19.5	27.2	—	—	—	—	—	—	17.4	13.5	39.2
	... 30-..	30.0	22.3	32.3	27.0	20.2	53.1	30.6	24.0	33.5	—	—	—	—	—	—	21.5	16.7	48.3
	... 40-..	40.0	30.0	43.3	36.2	27.2	71.4	41.5	32.3	45.0	—	—	—	—	—	—	28.8	22.4	64.9
	... 50-..	50.0	14.9 + 22.3	21.5 + 32.3	45.0	13.5 + 20.2	35.4 + 53.1	51.4	16.0 + 24.0	22.3 + 33.5	—	—	—	—	—	—	35.7	11.1 + 16.7	32.2 + 48.3
	... 60-..	60.0	22.3 + 22.3	32.3 + 32.3	54.0	20.2 + 20.2	53.1 + 53.1	61.7	24.0 + 24.0	33.5 + 33.5	—	—	—	—	—	—	43.0	16.7 + 16.7	48.3 + 48.3
	... 80-..	80.0	30.0 + 30.0	43.3 + 43.3	72.4	27.2 + 27.2	71.4 + 71.4	83.1	32.3 + 32.3	45.0 + 45.0	—	—	—	—	—	—	57.7	22.4 + 22.4	64.9 + 64.9

Should you require a unit with a different heating voltage, please contact your Defensor supplier.

Control voltage

Defensor Mk5 steam humidifiers are designed for a standard control voltage of **220...240V/50...60Hz**.

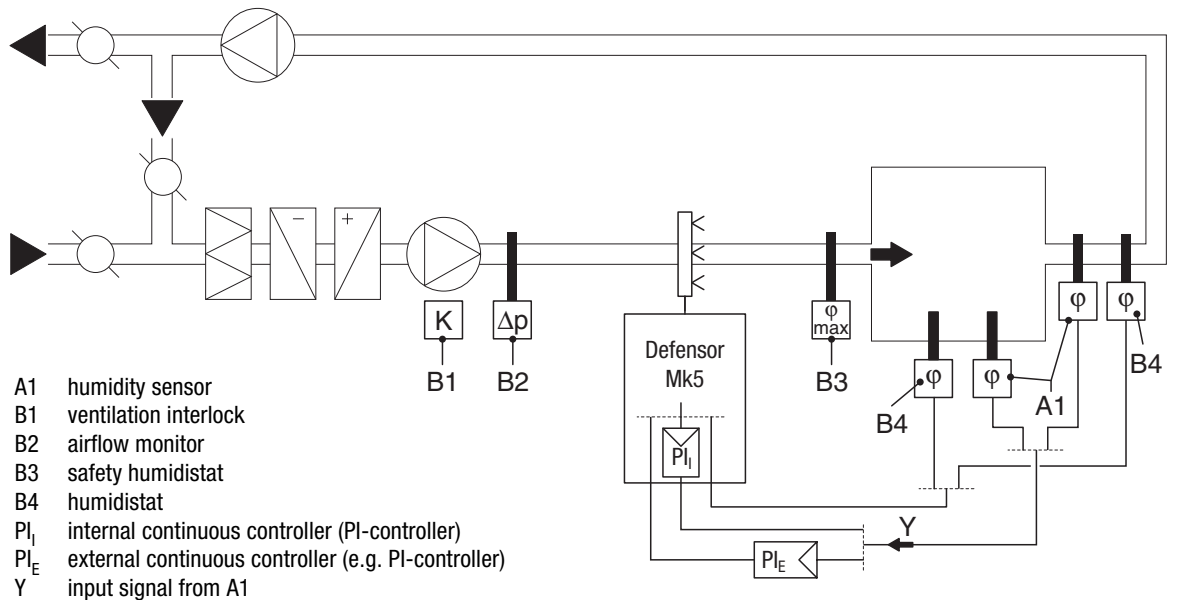
If used in systems without separate control voltage supply, the Defensor Mk5 may be equipped with an optional transformer 450-500 V/230 V (see chapter 4.4).

4.2 Selecting the control system

The various control systems

– System 1: Room humidity control

System 1 is suited for **direct room humidification** and **air conditioning systems with mainly recirculated air**. The humidity sensor or humidistat respectively is preferably located in the room itself or in the exhaust air duct.

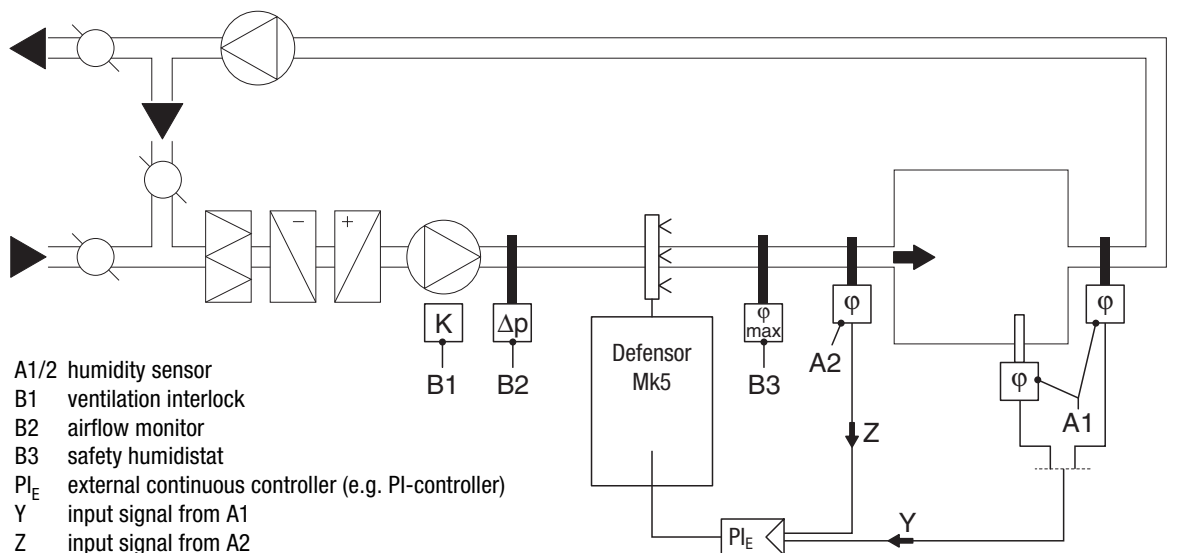


– System 2: Room humidity control with continuous limitation of the supply air humidity

System 2 is suited for air conditioning systems with a **large portion of supply air, low supply air temperature, post-humidification, or variable airflow volume**. If the supply air humidity exceeds the preset value, the continuous limitation is effected prior to the room humidity control.

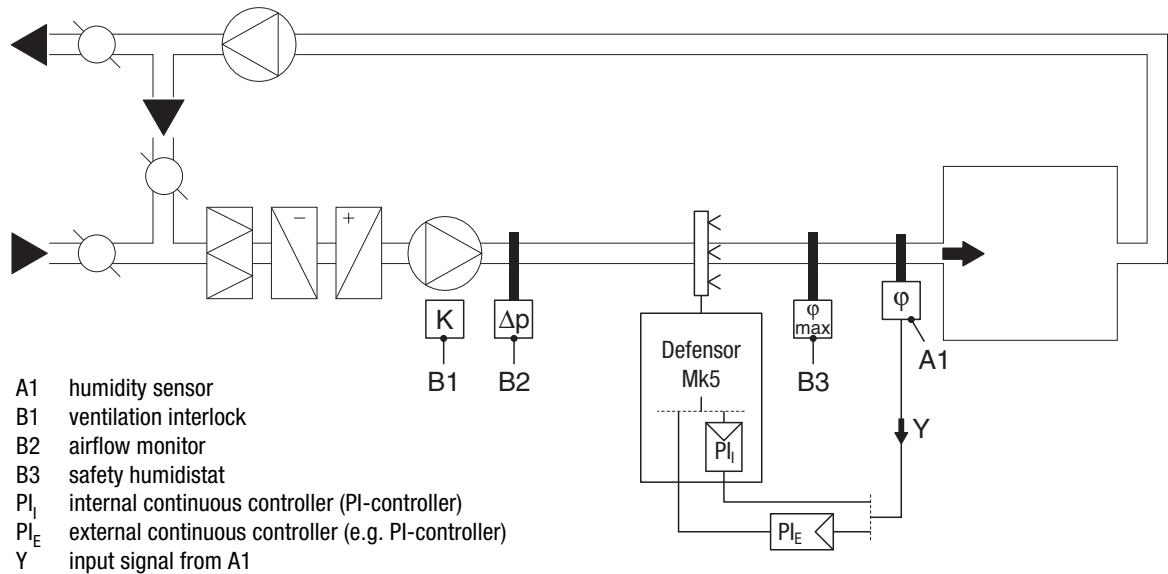
The humidity sensor (A1) is preferably located in the exhaust air duct or in the room itself. The humidity sensor (A2) for the limitation of the supply air humidity is located in the supply air duct after the steam distribution pipe. This control system requires a **external continuous controller** with the option to connect a second humidity sensor.

Attention! The continuous limitation of the supply air humidity is no substitute for the safety humidistat.



– **System 3: Supply air humidity control**

Supply air humidity control (humidity sensor installed in supply air duct) should be used only where room humidity control is impracticable for technical reasons. Such systems always require a PI-controller. The humidity sensor (A1) is located in the supply air duct after the steam distribution pipe.



Which humidity control system for which application?

Application	Location of the humidity sensor	
	Room or exhaust air duct	supply air duct
Air conditioning systems with: supply air portion up to 33%	System 1	System 1
supply air portion up to 66%	System 1 or 2	System 2 or 3
supply air portion up to 100%	System 2	System 3
Supply air humidity control	—	System 3
Direct room humidification	System 1	—

Please contact your Defensor supplier, if your application meets the following conditions:

- Humidification of small rooms up to 200 m³
- Air conditioning systems with a high number of air exchanges
- Systems with variable air volume flow
- Test facilities with extreme control accuracy requirements
- Rooms with a high variation in max. steam capacity
- Systems with temperature fluctuations
- Cold rooms and systems with dehumidification

4.3 Options

The following table presents an overview of all options which are available for the steam humidifier Defensor Mk5.

Defensor Mk5 Steam capacity in kg/h	Visual			Process		
	5...16	20...40	50...80	5...16	20...40	50...80
Interface RS232/RS485 (Interface PCB RS232/RS485 for data exchange with a building control system)	—			RS		
number	-	-	-	1	1	1
Remote operating and fault indication (PCB with relay contacts for the connection of remote displays for "Operation", "Steam", "Fault" and "Service")	RFS					
number	1	1	1	1	1	1
Pressure compensation kit up to 10'000 Pa (Assembly kit for the installation of the filling bowl on the equipment cover, for the operation of the steam humidifier in installations with duct air pressures up to 10'000 Pa)	OVP					
number	1	1	2	1	1	2
Transformer 450-500V/230V (Transformer for systems without a separate control voltage supply)	TRAF ¹⁾					
number	1	1	1	1	1	1
Connection terminal 400-415 V/3~ (Separate terminals for systems where direct connection of heating voltage to main contactor (standard version) is not permitted by local regulations)	KLK	KLG		KLK	KLG	
number	1	1	2	1	1	2
Unit housing stainless steel	S-Inox	L-Inox		S-Inox	L-Inox	
number	1	1	2	1	1	2

¹⁾ When ordering indicate the type of unit

4.4 Accessories

4.4.1 Accessories overview

The following table presents an overview of all accessories which are available for the steam humidifier Defensor Mk5.

Defensor Mk5 Steam capacity in kg/h	Visual			Process		
	5...16	20...40	50...80	5...16	20...40	50...80
Steam distribution pipe (see accessory details in chapter 4.4.2)	81-...					
number	1	2		1	2	
Steam distribution pipe Process (see accessory details in chapter 4.4.2)	Z..					
number	1	2		1	2	
OptiSorp steam distribution system (see accessory details in chapter 4.4.2)	System 1	System 2		System 1	System 2	
number	1	1		1	1	
Fan unit (see accessory details in chapter 4.4.2)	FAN16	FAN40		FAN16	FAN40	
number	1	1	2	1	1	2
Steam hose / meter	Z10 (Ø54/42.4)					
number	1	2		1	2	
Steam hose 1 1/4" reinforced / meter	Z250					
number	1	2		1	2	
Condensate hose / meter	KS10					
number	1	2		1	2	
Filter valve	Z261					
number	1 (per system)					
Mounting profile	BS4	BS5	BS6 ¹⁾	BS4	BS5	BS6 ¹⁾
number	1	1	1	1	1	1
Humidity control potentiometer, room	HRP1000					
number	1 (per system)					
Humidity control potentiometer, duct	HPH1000					
number	1 (per system)					

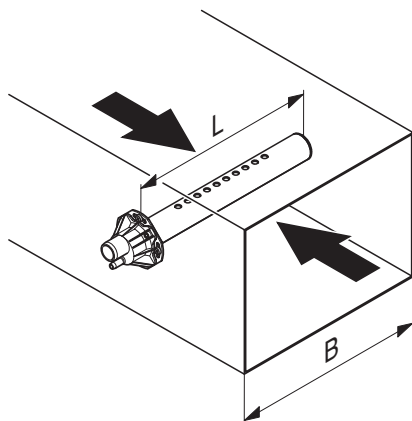
¹⁾ For double units the mounting profiles BS6 are included in the standard delivery

4.4.2 Accessory details

Steam distribution pipes 81-... for indirect room humidification

The steam distribution pipes are selected on the basis of the **duct width** (for horizontal installation) or the **duct height** (for vertical installation) and the capacity of the steam humidifier.

Important! Always select the longest possible steam distribution pipe (optimum humidification distance).



Steam distribution pipes 81-... for Defensor Mk5 (CrNi steel)		Duct width (B)	Steam output
Type	Length in mm (L) ³⁾	in mm	max. in kg/h
81-200 ¹⁾	200	210...400	10
81-350 ²⁾	350	400...600	30
81-500 ²⁾	500	600...750	30
81-650	650	750...900	50
81-800	800	900...1100	50
81-1000	1000	1100...1300	50
81-1200	1200	1300...1600	50
81-1500	1500	1600...2000	50
81-1800	1800	2000...2400	50
81-2000	2000	2200...2600	50
81-2300	2300	2500...2900	50
81-2500	2500	2700...3100	50

¹⁾ Only for units with a max. steam capacity of 10 kg/h

²⁾ Only for units with a max. steam capacity of 30 kg/h

³⁾ Special length available on request

Note: If the humidification distance (see chapter 5.3.1) has to be reduced for technical reasons, the amount of steam per basic unit must be divided between two steam distribution pipes or the **OptiSorp steam distribution system** must be used. If this is the case, contact your Defensor supplier.

Steam distribution pipe “Process” (accessory “Z...”)

The steam distribution pipe “Process” is used for **direct humidification of material** in manufacturing processes (process humidification), or in ventilation ducts with a **critical saturation distance** (the steam distribution pipe “Process” reduces the saturation distance by approximately 30%). The desired length must be specified when ordering.

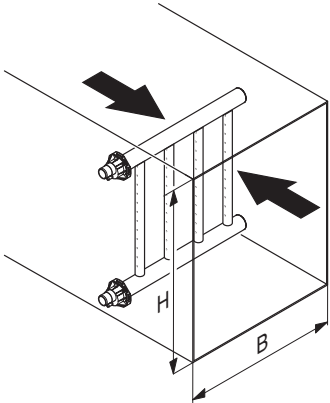
Please contact your Defensor distributor, they will assist you in customizing the steam distribution head “Process”. Please have the following information readily available:

- steam quantity in kg/h
- dimensions of ventilation duct (width x height)

Important! The table for the determination of the humidification distance provided in chapter 5.3.1 does not apply to the Process steam distribution pipe.

OptiSorp steam distribution system

The OptiSorp steam distribution system is used in ventilation ducts where only a short humidification distance is available (see chapter 5.3.1 for calculation of humidification distance). Duct dimensions should be given when ordering. Please note the following data for this:



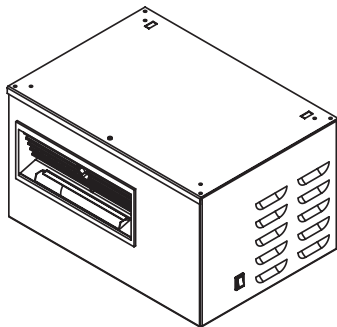
OptiSorp	Number of steam connections	max. steam capacity in kg/h ¹⁾	Duct dimension	
			Width in mm	Height in mm
System 1	1	45 (30)	450...2700	450...1650
System 2	2	90 (60)	450...2700	450...2200

¹⁾ For duct width <600 mm the values in parenthesis are valid

Note: Further information on the OptiSorp steam distribution system can be found in the separate Technical Documentation supplied with the product.

Fan unit

The fan units – in combination with the steam humidifiers Defensor Mk5 Visual – are used for the direct room humidification. They can be mounted **separately above the unit** to the wall.



The type of fan unit (FAN16 or FAN40) and the amount required is dependent on the steam capacity of the basic unit(s) and can be gathered from the table in chapter 4.4.1.

Note: Further information on the fan unit can be found in the separate Technical Documentation supplied with the product.

The fan units are delivered with:

- Installation accessories including steam hose
- Technical Documentation Fan unit

4.5 Additional planning instructions

In addition to the selection of the steam humidifier, the accessories and the options, other points should be considered during planning. Please note the information in the following chapters:

- Unit fitting (see chapter 5.2)
- Steam installation (see chapter 5.3)
- Water installation (see chapter 5.4)
- Electric installation (see chapter 5.5)

If you have other questions relating to planning that are not adequately covered by technical documentation, please contact your Defensor representative. He will be happy to provide further assistance.

5 Mounting and installation works

5.1 Safety instructions for mounting and installation works



- All mounting and installation work must be performed **only by adequately qualified personnel**. Ascertaining the qualifications is the customer's responsibility.
- All local regulations relating to the execution of the respective installation work (Water, steam and electrical installation) must be noted and complied with.
- All the information contained in this technical documentation relating to equipment assembly and to water, steam and electrical installation must be unconditionally observed and complied with.
- **Caution - Danger from electric shock! The connection of the steam humidifier to the mains electrical supply must not be made until all installation work has been completed.**
- Electronic components are very sensitive to electrostatic discharges. In order to protect these components, during all installation work with the equipment opened, precautions must be taken against damage due to electrical discharge (ESD protection).

5.2 Unit fitting

5.2.1 Humidifier location

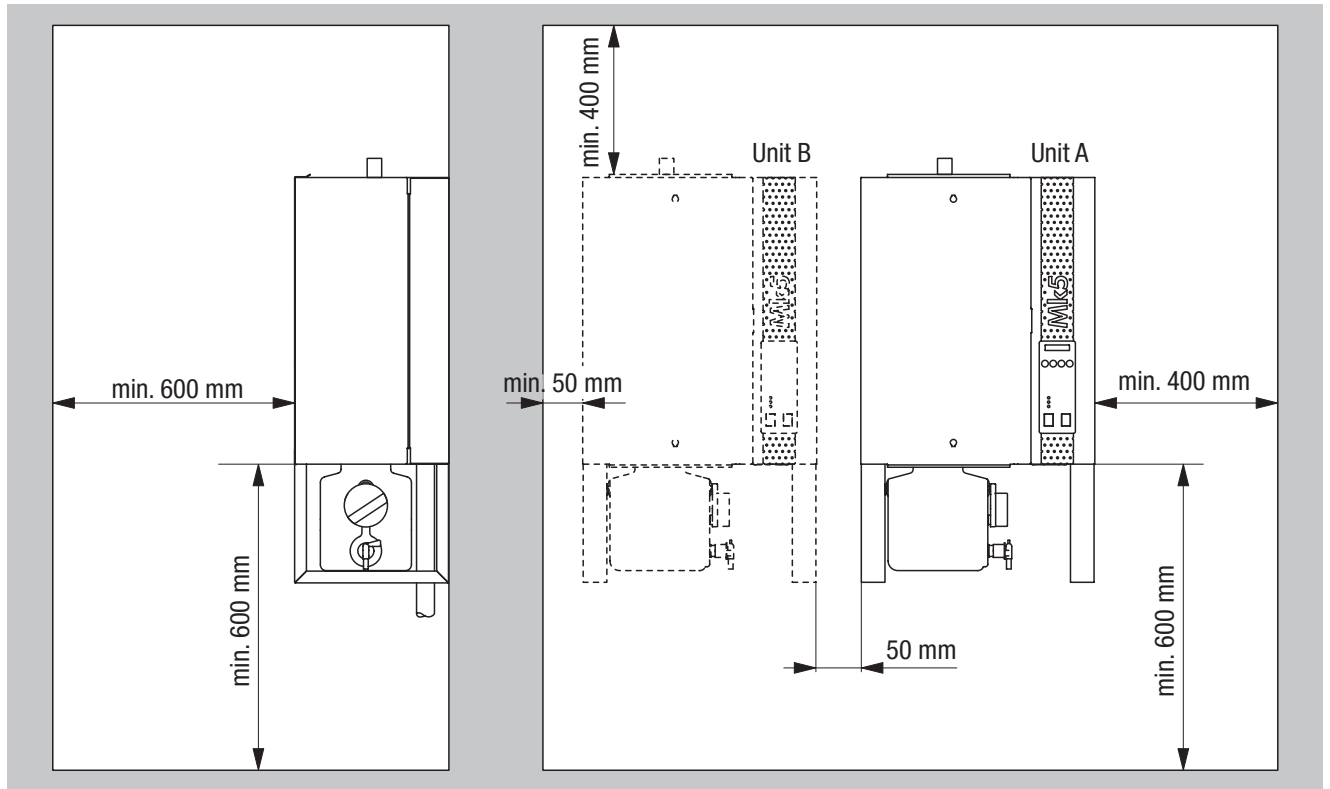
The installation site of the steam humidifier depends largely on the location of the steam distribution pipe or fan unit (see chapter 5.3.1 and 5.3.2), respectively. To ensure proper functioning of the steam humidifier and to obtain an optimal efficiency, the following points must be considered and observed when choosing the location for the steam humidifier:

- Install the steam humidifier so that the **length of the steam hose is kept as short as possible (max. 4 m)** and that the **minimum bend radius (R= 300 mm)** and **up-slope (20 %)** or **down-slope (5 %)** of the steam hose is observed (see chapter 5.3.3).
- The steam humidifiers Defensor Mk5 are designed for wall-mounting. Make sure that the construction (wall, pillar, floor-mounted console, etc.) to which the humidifiers are to be mounted, offers a sufficiently high load-bearing capacity (take notice of the weight information found in this chapter), and is suitable for the installation.

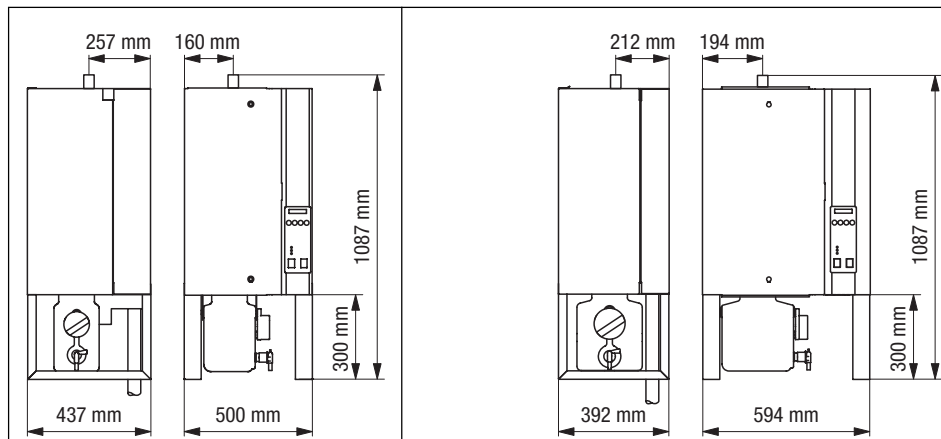


- Warning!** Do not mount the steam humidifier directly to the ventilation duct (insufficient stability).
- The back panel of the Defensor Mk5 is retaining heat during operation (max. surface temperature of the metal housing approx. 60 - 70 °C). Make sure, therefore, that the construction (wall, pillar, etc.) to which the units are to be mounted, does not consist of heat-sensitive material.
 - For operation involving a fan unit, the steam humidifier must always be installed lower than the fan unit.
 - Install the steam humidifier in such a manner that it is freely accessible with sufficient space available for maintenance purposes (refer to the following illustration for minimum distances).

Minimum distances to observe



Dimensions and Weights



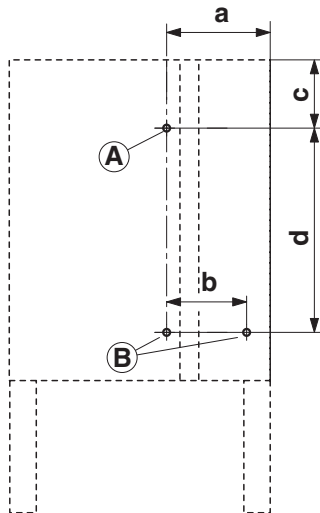
Housing size	small				large				Double unit large		
	5	8	10	16	20	24	30	40	50	60	80
Steam capacity in kg/h	5	8	10	16	20	24	30	40	50	60	80
Netweight in kg	36	36	37	38	41	43	43	44	1x41 1x43	2x43	2x44
Grossweight in kg	51	51	52	53	71	73	73	74	1x71 1x73	2x73	2x74

5.2.2 Mounting the humidifier



Caution! When fixing the Defensor Mk5, use **only the fixing materials supplied with the unit**. If fixing with the materials supplied is not possible in your particular case, select a method of fixing that is of similar stability. In case of doubt, please contact your Defensor supplier.

Note: The following explains how to fix the unit without optional mounting profiles. To install the unit with mounting profiles, please note the special instructions printed on the packaging.



Measure	Housing	
	small	large
a	232.0 mm	237.0 mm
b	175.0 mm	181.0 mm
c	166.5 mm	166.5 mm
d	460.0 mm	460.0 mm

- Use the drilling template (printed on the packing) to mark attachment point “A” on the wall.
Important! Observe location notes.
- Drill hole $\varnothing 10$ mm, insert the supplied plastic plug, and tighten the screw until the distance between the wall and the screw head is 5 mm.
- Unlock left front panel and remove both front panels. Hang up the unit on the screw, and use the spirit level to adjust it horizontally and vertically.
- Mark attachment points “B”. When finished, remove the unit again.
- Drill holes $\varnothing 10$ mm and insert the supplied plastic plugs.
- Hang the unit up on the screw again before attaching it with the remaining two screws. Before tightening the screws, readjust the unit with the spirit level.
- Reattach the front panels and lock them.

5.2.3 Inspecting the installed unit

Use the following check list to ascertain that the installation was performed correctly:

- Is/are the unit(s) in the correct place?
(see chapter 5.2.1)
- Is/are the unit(s) correctly aligned vertically and horizontally?
- Is steam humidifier properly secured?
(stability of the carrying structure)

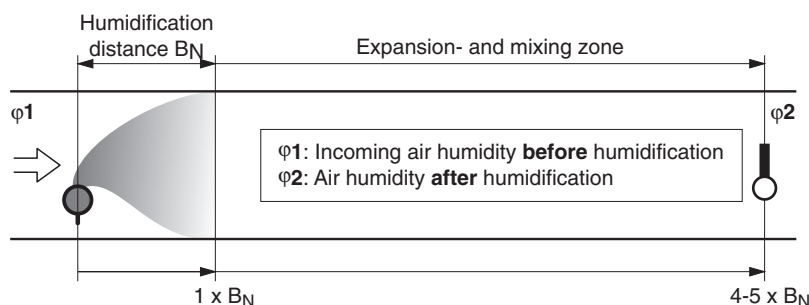
5.3 Steam installation

5.3.1 Positioning and mounting of the steam distribution pipes

The location for the steam distribution pipes should be determined at the time of dimensioning the air conditioning system. Please note the following instructions to ensure proper humidification of the duct air.

Calculating the humidification distance

The water vapour, emitting from the steam distribution pipes, requires a certain distance to be absorbed by the ambient air so that it is no longer visible as steam. This distance is referred to as **humidification distance “ B_N ”** and serves as a basis for the determination of the minimum distances from the upstream components in the system.



The calculation of the humidification distance “ B_N ” is dependent on several factors. For a rough estimation of the humidification distance “ B_N ”, the following table is useful. Recommended standard values listed in this table are based on a supply-air temperature range of 15°C to 30°C. The values given in bold type **only apply to steam distribution pipes 81-...**, the values in brackets apply to the **OptiSorp steam distribution system**.

Humidity at inlet ϕ_1 in %rh	Humidification distance B_N in m					
	Humidity at outlet ϕ_2 in %rh					
	40	50	60	70	80	90
5	0.9 (0.22)	1.1 (0.28)	1.4 (0.36)	1.8 (0.48)	2.3 (0.66)	3.5 (1.08)
10	0.8 (0.20)	1.0 (0.26)	1.3 (0.34)	1.7 (0.45)	2.2 (0.64)	3.4 (1.04)
20	0.7 (0.16)	0.9 (0.22)	1.2 (0.30)	1.5 (0.41)	2.1 (0.58)	3.2 (0.96)
30	0.5 (0.10)	0.8 (0.17)	1.0 (0.25)	1.4 (0.36)	1.9 (0.52)	2.9 (0.88)
40	–	0.5 (0.11)	0.8 (0.20)	1.2 (0.30)	1.7 (0.45)	2.7 (0.79)
50	–	–	0.5 (0.13)	1.0 (0.24)	1.5 (0.38)	2.4 (0.69)
60	–	–	–	0.7 (0.16)	1.2 (0.30)	2.1 (0.58)
70	–	–	–	–	0.8 (0.20)	1.7 (0.45)

For duct widths <600 mm the humidification distance for the OptiSorp system increases by approx. 50%

ϕ_1 in %rh: Relative supply air humidity prior to humidification at the lowest supply air temperature
 ϕ_2 in %rh: Relative supply air humidity after the steam distribution pipe at maximum capacity

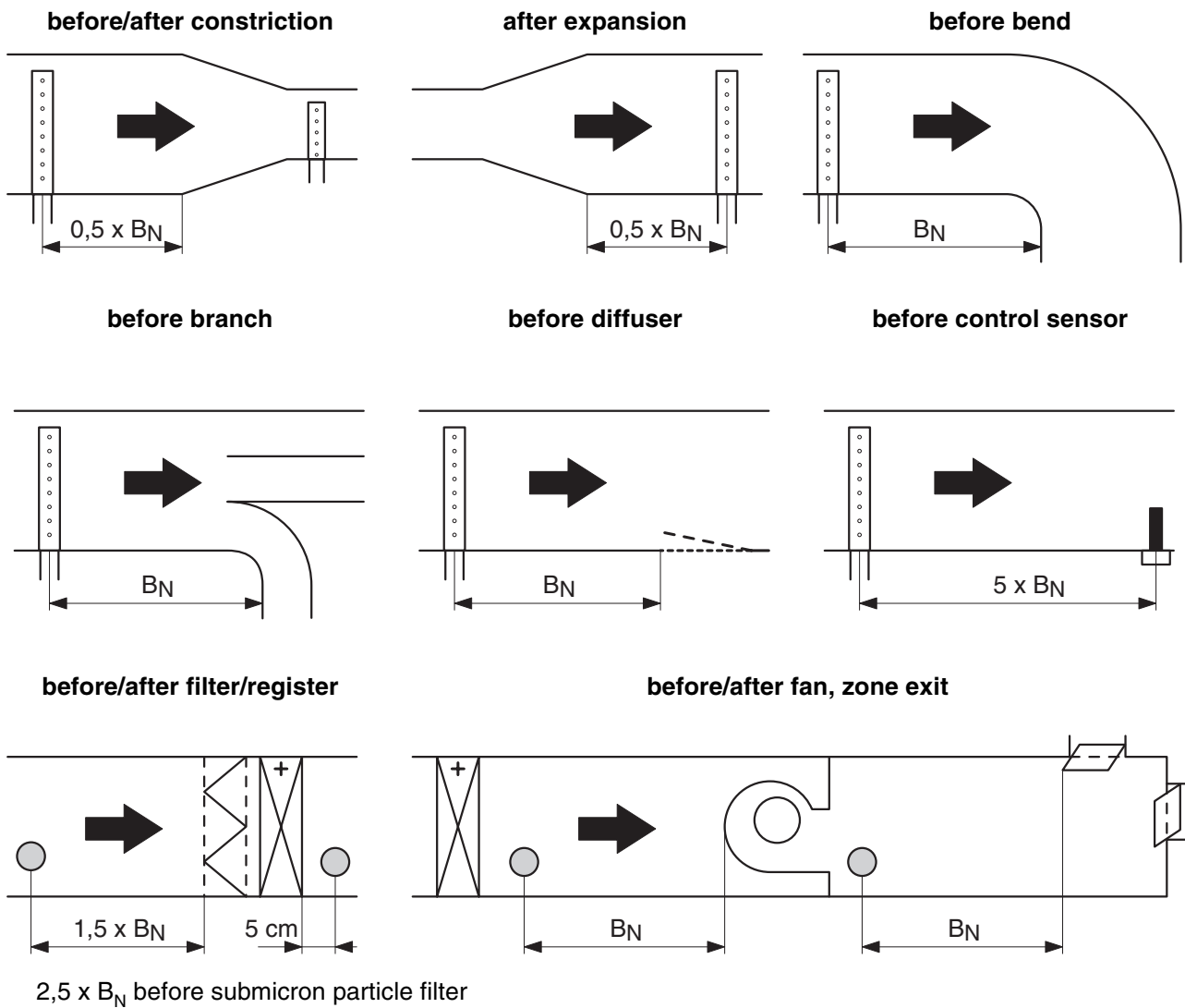
Example

given: $\phi_1 = 30$ %rh, $\phi_2 = 70$ %rh
 humidification distance B_N : **1,4 m** (0.36 m for OptiSorp steam distribution system)

Note: If the humidification distance has to be reduced for technical reasons, the amount of steam per basic unit must be divided between two steam distribution pipes or the **OptiSorp steam distribution system** must be used. If this is the case, contact your Defensor supplier.

Minimum distances to be observed

To prevent the water vapour, that is emitting from the steam distribution pipe, from condensing on downstream system components, a minimum distance to the steam distribution pipe must be observed (depends on the humidification distance " B_N ").



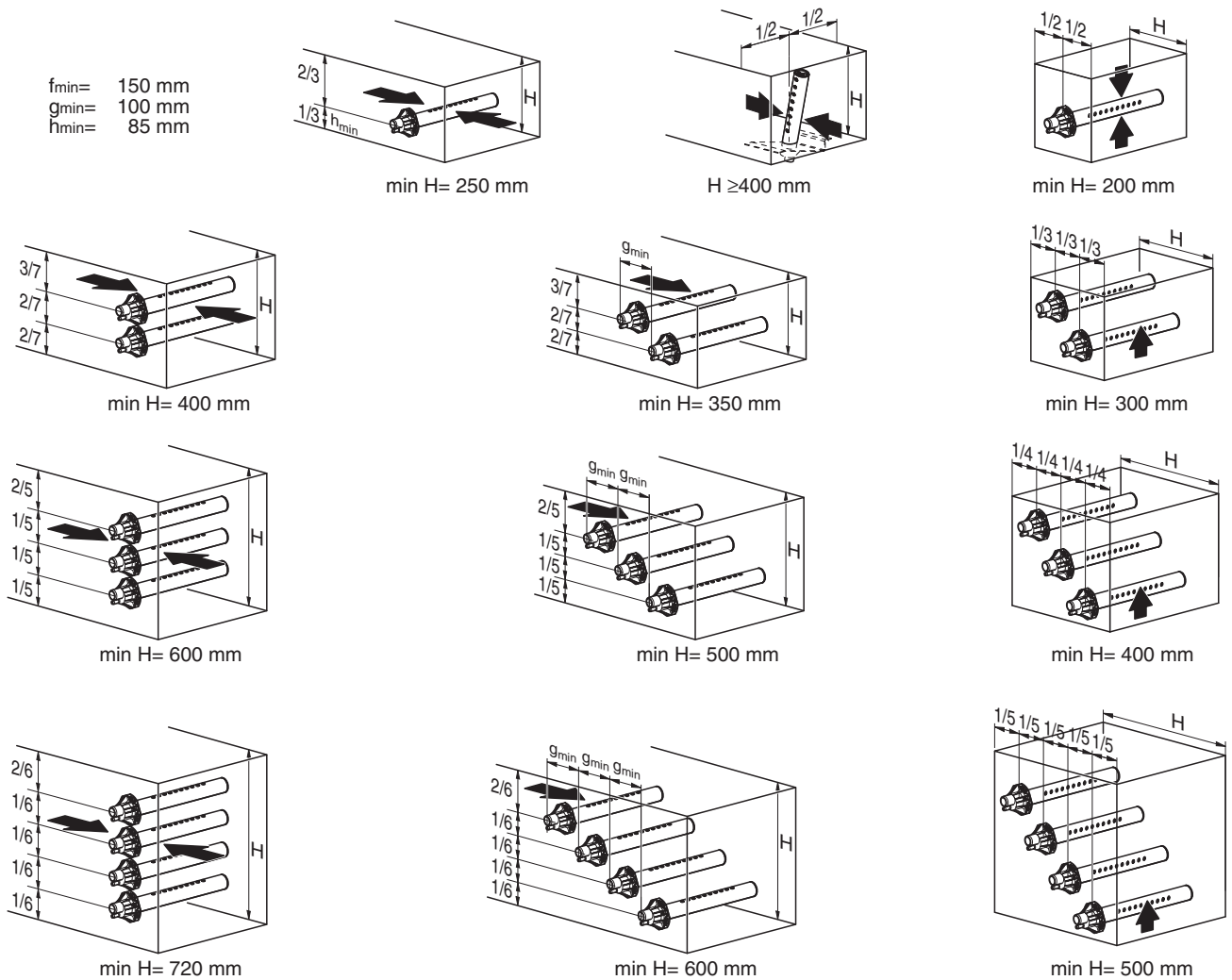
Installation notes and dimensions

The steam distribution pipes are designed for either **horizontal** installation (on the duct wall) or, with accessories, for **vertical** installation (in the duct floor). The **outlet orifices should always point upwards and at right angles to the airflow**.

If possible, the steam distribution pipes should be installed on the **pressure side** of the duct (**max. duct pressure 1500 Pa**). If the steam distribution pipes are installed on the suction side of the duct, the **maximum vacuum must not exceed 1000 Pa**.

Select a location for the installation, tailored to suit your duct (see the following illustrations) and position the steam distribution pipes in the duct so that a uniform distribution of steam is achieved.

In positioning the steam distribution pipes, the following dimensions should be observed.



Note: Please note the instructions in the separate documentation for this product when locating the OptiSorp steam distribution system.

Guidelines for dimensioning the ventilation ducts

- To facilitate the installation of the steam distribution pipes and for control purposes, a sufficiently sized control opening should be planned.
- Within the range of the humidification distance, the ventilation duct should be water-proofed.
- Air ducts passing through cold rooms should be insulated to prevent the humidified air from condensing along the duct wall.
- Poor airflow conditions within the air duct (e.g. caused by obstacles, tight bends, etc.) can lead to condensation of the humidified air.
- Steam distribution pipes must not be mounted to round ducts.

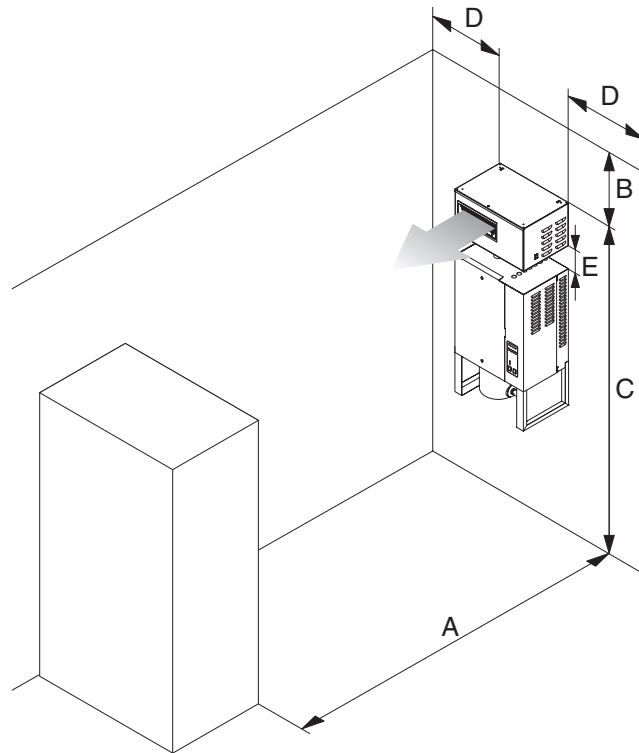
If you have questions relating to the dimensioning of ventilation ducts in combination with steam humidifiers, contact your Defensor supplier.

Installing the steam pipes/the OptiSorp steam distribution system

Detailed information on the installation of steam distribution pipes/OptiSorp steam distribution system can be found in the separate “Mounting Instructions” for this products.

5.3.2 Positioning and mounting of the fan unit

The fan unit is mounted **on the wall separately above the unit**. To allow the steam coming from the fan unit to spread out evenly, without condensing on obstacles (ceilings, joists, pillars, etc.), the following minimum dimensions must be observed when selecting the location for the fan unit.



	FAN16		FAN40	
m_D max.	8 kg/h	16 kg/h	30 kg/h	40 kg/h
A min.	3.0 m	6.0 m	8.0 m	10.0 m
B min.	0.5 m	0.7 m	1.0 m	1.5 m
C ca.	2.2 m	2.2 m	2.2 m	2.2 m
D ca.	0.5 m	0.7 m	1.0 m	1.5 m
E	0.15 ... 2.0 m	0.2 ... 2.0 m	0.3 ... 2.0 m	0.5 ... 2.0 m

Note: The minimum spaces in the table apply for a room atmosphere of 15 °C and max. 60 %rh. For lower temperatures and/or higher humidity the values must be increased accordingly

Note: In order to achieve a uniform distribution of the humidity within the room, additional factors such as the room size, the room height, etc., must be taken into consideration besides observing the minimum distances. If you have questions concerning the direct room humidification, please contact your Defensor supplier.

Further information is provided in the separate "Technical documentation for the fan unit".

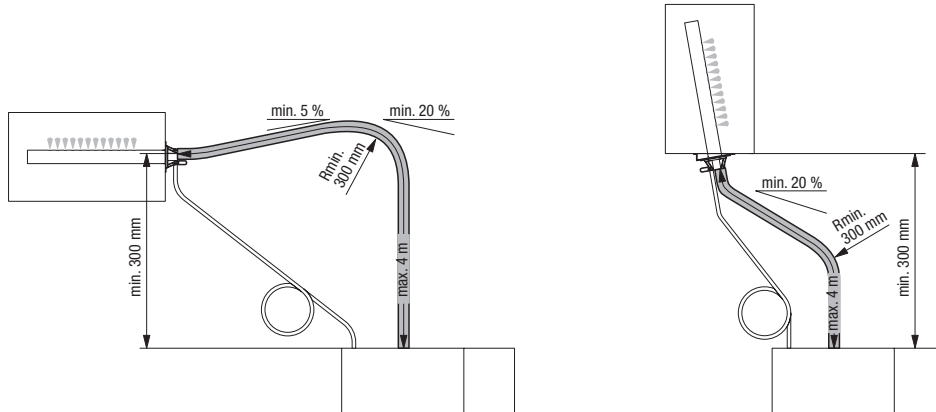
5.3.3 Installing the steam hose

Important! Use original Defensor steam hose exclusively. Other types of steam hoses can cause undesired operational malfunctions.

Instructions for the hose layout

The hose layout depends on the position of the steam distribution pipe:

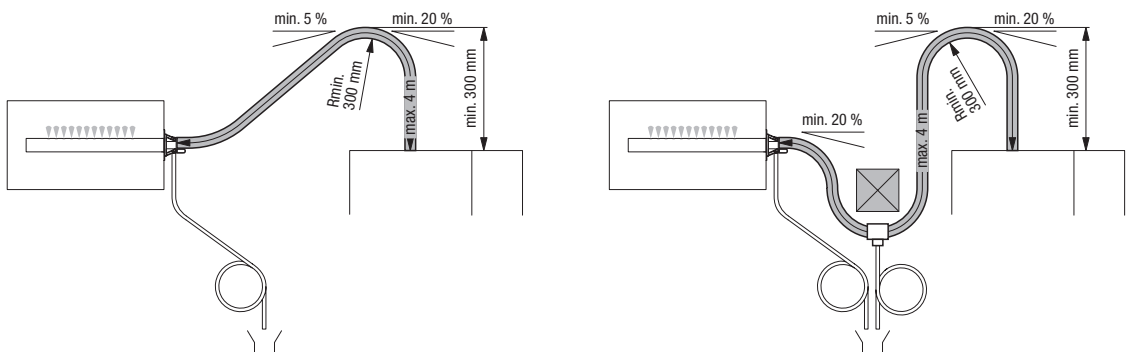
- Steam distribution pipe is mounted **more than 300 mm above the top edge of the humidifier:**



Initially, lead the steam hose with an **upslope of at least 20% over a minimum height of 300 mm**, then lead the hose with a **minimum upslope of 20%** and/or a **minimum downslope of 5%** to the steam distribution pipe.

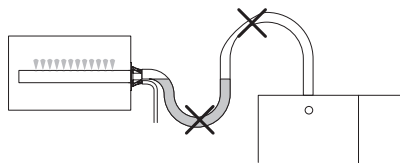
Note: For steam capacities ≤ 20 kg/h the separate return of the condensate via the condensation hose can be dispensed with. The special instructions for hose positioning in the “Steam distribution pipe installation instructions 81-...” should be noted.

- Steam distribution pipe is mounted **less than 300 mm above the top edge of the humidifier:**



Initially, the steam hose is led with an **upslope of at least 20% over a minimum height of 300 mm** above the top edge of the humidifier and then down to the steam distribution pipe with a **minimum slope of 5%**.

- The steam hose should be kept as short as possible (**max. 4 m**) while observing the **minimum bend radius of 300 mm**. **Important!** Allowance must be made for a **pressure loss of 10 mm water column (approx. 100 Pa)** per meter steam hose.
- Reductions in the cross section such as kinks should be avoided throughout the entire length of the hose. The installation of a stop cock in the steam hose is not permissible.



- Steam hoses must be prevented from sagging (condensate pockets); if necessary, support with pipe clamps, trough, or wall brackets, or install a condensate drain in the steam hose.
- **Important!** When deciding on the length and layout of the hose, it should be noted that the steam hose may become somewhat shorter with progressive ageing.

Securing the hose

The steam hose must be secured to the steam distribution pipe and humidifier steam outlet by means of **hose clamps**.

Steam line with fixed piping

For steam lines with fixed piping, the same instructions apply to the laying of the piping as already described. The following additional notes should be observed:

- The **minimum internal diameter of 45 mm** should be applied over the whole length of the piping.
- Use exclusively Cu pipe (operation with untreated water) or stainless steel (min. DIN 1.4301, operation with fully demineralized water).
- To minimize the condensate formation (=loss), the steam pipes must be insulated.
- The **minimum bend radius** for rigid piping is **100 mm**.
- Connection of the steam pipes to the steam distribution pipe and steam humidifier is effected by means of short lengths of steam hose secured with hose clamps. Connection to the steam humidifier is secured via a G 1 1/4" coupling.
- **Important!** Allowance must be made for a **pressure loss of 10 mm water column (approx. 100 Pa)** per meter line length or per 90° angle.

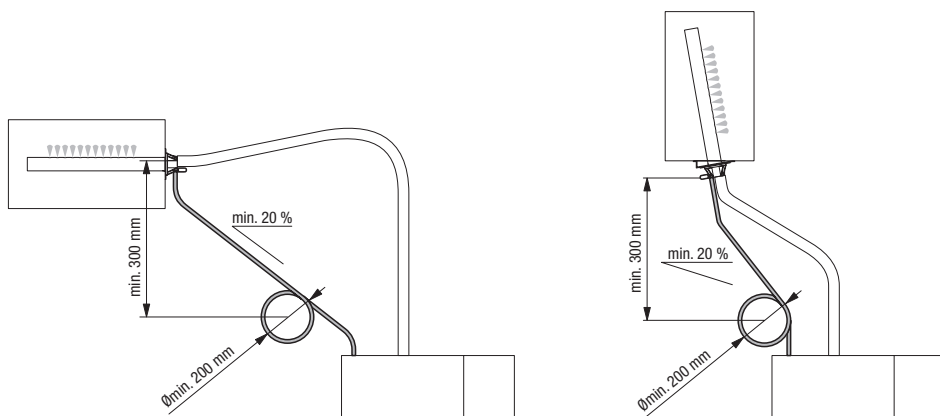
5.3.4 Installing the condensate hose

Important! Use original Defensor condensate hose exclusively. Other types of hoses can cause operational malfunctions.

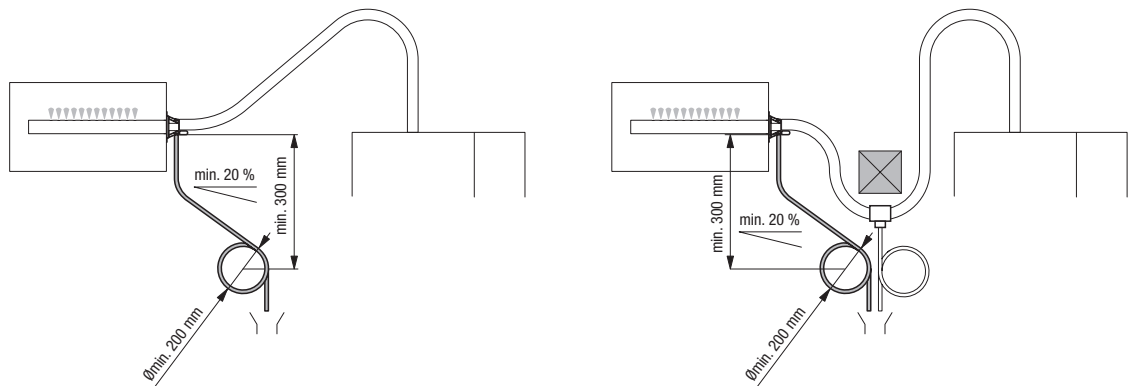
The hose layout depends on the position of the steam distribution pipe:

- Steam distribution pipe is mounted **more than 300 mm above the top edge of the humidifier**:

Condensate hose is led down to the humidifier with a **minimum slope of 20 %**, in the form of a **siphon (min. hose bend radius Ø200 mm)**, and inserted about 2 cm into the specified opening.



- Steam distribution pipe is mounted **less than 300 mm above the top edge of the humidifier**:
Condensate hose is led down with a **minimum slope of 20 %**, in the form of a **siphon (min. hose bend radius Ø200 mm)**, directly into a discharge funnel.



Note: If your unit feeds a number of steam distribution pipes, the individual condensate hoses are to be led into the discharge funnel.

Important! Before putting the unit into operation, the siphon of the condensate hose must be filled with water.

5.3.5 Inspecting the steam installation

Use the following check list to ascertain that the steam installation was performed correctly:

- Steam distribution pipe
 - Steam distribution pipe correctly positioned and secured (screws tightened)?
 - Are the outlet orifices at right angles to the air flow direction?
- Steam hose
 - Maximum length of 4 m?
 - Minimum bend radius of 300 mm (100 mm with fixed piping)?
 - Have the instructions for hose positioning been followed?
 - Steam hose: no sagging (condensate pocket)?
 - Rigid steam lines: properly insulated? Correct installation material used? Minimal internal diameter maintained?
 - Steam hose securely attached with clamps?
 - Heat expansion during operation and shortening of the hose with ageing taken into consideration?
- Condensate hose
 - Downslope of at least 20 %?
 - Siphon existing and filled with water?
 - Condensate hose correctly fixed?

5.4 Water installation



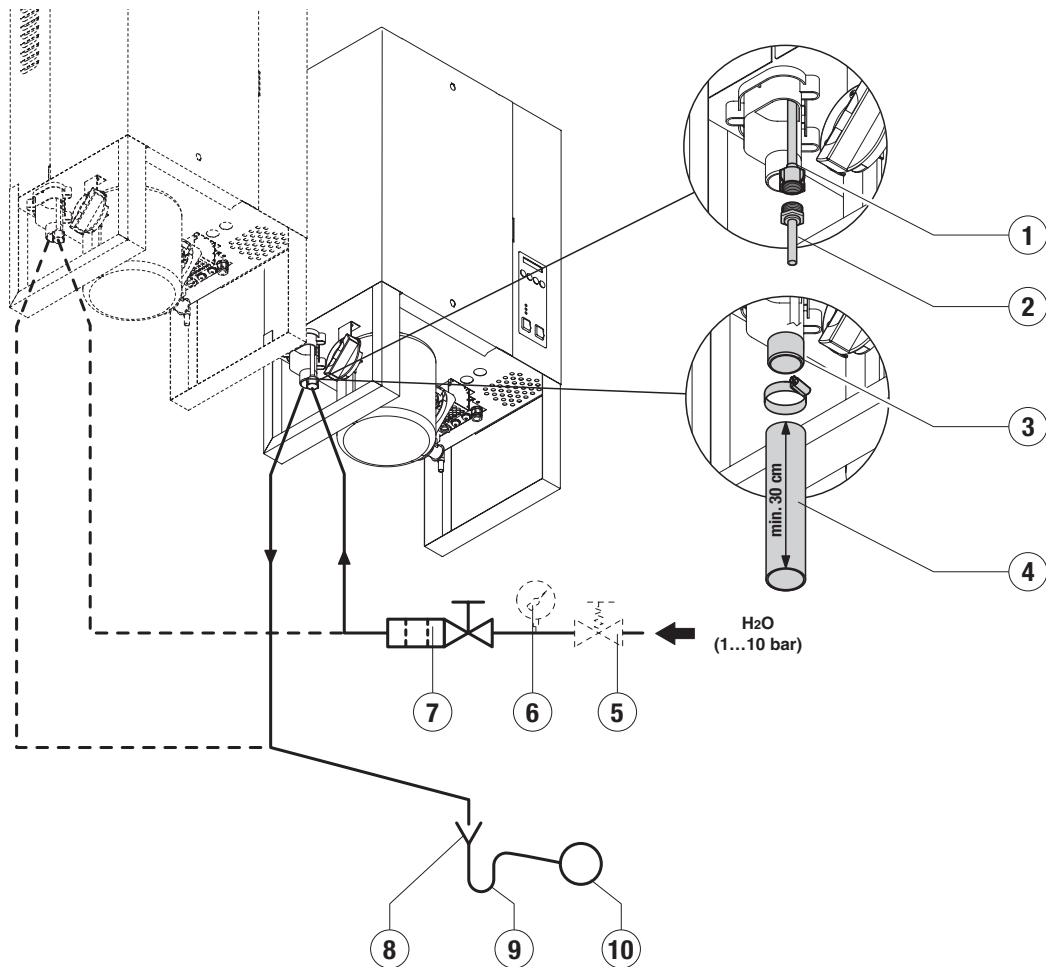
All work concerning the water installation must be performed **only by adequately qualified personnel** (e.g. plumbers). Ascertaining the qualifications is the customer's responsibility.

Please observe **all local regulations** concerning the installation of appliances to the mains and waste water systems.

Warning - danger of electric shock! For all installation work, the steam humidifier **must be disconnected from the mains supply and secured against unintentional re-connection.**

5.4.1 Performing the water installation

Overview water installation



- 1 Water connection, union nut G 1/2"
- 2 Water supply pipe (min. inner Ø: 8 mm)
- 3 Water drain Ø40 mm
- 4 Drain pipe (min. inner Ø: 40 mm, min. 30 cm directed vertically downwards)
- 5 Pressure reducing valve (compulsory for water pressures >10 bar, building side)
- 6 Manometer (installation recommended, building side)
- 7 Filter valve (accessory "Z261")
- 8 Funnel (building side)
- 9 Siphon (min. inner Ø: 40 mm, building side)
- 10 Drain line, building side (min. inner Ø: 40 mm)

Water supply

The water feed pipe (min. internal Ø: 8 mm) is to be connected via the **filter valve** that is available as an accessory, to the connection on the unit (see detailed illustration). Alternatively, a **shut-off valve** and a **water filter** may be installed. The installation of the filter valve should be made as close as possible to the steam humidifier.



Warning - danger of damage! Union nut at the humidifier connection must be **hand-tightened only**.

The following connection specifications must be observed:

- Connection on unit: **G 1/2" (Union nut)**
- Min. inner Ø of supply line: **8 mm**
- Admissible mains pressure **1.0 to 10.0 bar** (hammer-free system)
For mains pressures >10 bar, connection must be made via pressure reducing valve (adjusted to 2.0 bar). For mains pressures <1.0 bar please contact your Defensor supplier.
- Admissible supply temperature: **1...40 °C**
- The connection material must be **pressure-proof** and **certified for use in the drinking water supply**.



Warning! Fully demineralized water is aggressive. The connections for a demineralized water system should be made exclusively from **stainless steel (min. DIN 1.4301) or chemically resistant plastics (e.g. polypropylene)**.

- **Important!** Before connecting the water line, **the line should be well flushed out**.
- **Water quality:** For the water supply, use exclusively **fresh tap water** (raw water), **partially softened water** or **fully demineralized water (conductivity <15 µS) without additives** (e.g. Chlorine, disinfectant agents, ozone, etc.), **with a max. 1000 germs/ml**.
- **Note:** Softened water can lead to operating failures, since it has a tendency to foam during operation.

For more ample information on water quality please contact your Defensor supplier.

Water drain

The water drainage is effected without pressure. Thus, in order to avoid any damming of the water, the drain pipe must be led **straight down into a drainage funnel, through a piece of hose with a min. length of 30 cm**. Subsequently, the drain pipe is connected via **siphon** to the waste water system of the building. The minimum inside diameter of 40 mm must be observed over the whole length of the drain pipe. Make certain that the drain pipe is correctly fixed and easily accessible for inspections and cleaning purposes.

The following connection specifications must be observed:

- Drainage capacity: **approx. 2,5l/min per 15 kg/h steam capacity**
- Drainage temperature: **60...100 °C**



Warning! Use only **temperature-resistant** installation materials!

Warning! Fully demineralized water is aggressive. The connections for a demineralized water system should be made exclusively from **stainless steel (min. DIN 1.4301) or chemically resistant plastics (e.g. polypropylene)**.

- Connection on unit: **hose connection Ø40 mm**



Warning! Hose must be secured to the unit connection with a hose clamp.

- Min. inner Ø of drain line: **40 mm**
- Min. downslope after siphon: **10 %**

5.4.2 Inspecting the water installation

Use the following check list to ascertain that the installation has been performed correctly:

- Water supply
 - Has filter valve or shut-off valve and filter 5 μm respectively been installed in supply line?
 - Have admissible water pressure (1.0 – 10 bar) and temperature (1 – 40 °C) been observed?
 - Does supply capacity match the humidifier(s)?
 - Are all pipes properly secured (threaded connections tightened)?
 - Is the feed pipe properly sealed?
- Water drain
 - Has minimum inside diameter of drain pipes been maintained at least 40 mm throughout the entire length?
 - Has drain pipe been installed with a downslope of at least 10 %?
 - Has the heat resistance of the material used been verified to be at least 100°C?
 - Are hoses and lines properly secured (hose clamps and threaded connections tightened)?

5.5 Electric installation



– All work concerning the electric installation must be performed only by **adequately qualified personnel (electrician or workman with equivalent training)**. Ascertaining the qualifications is the customer's responsibility.



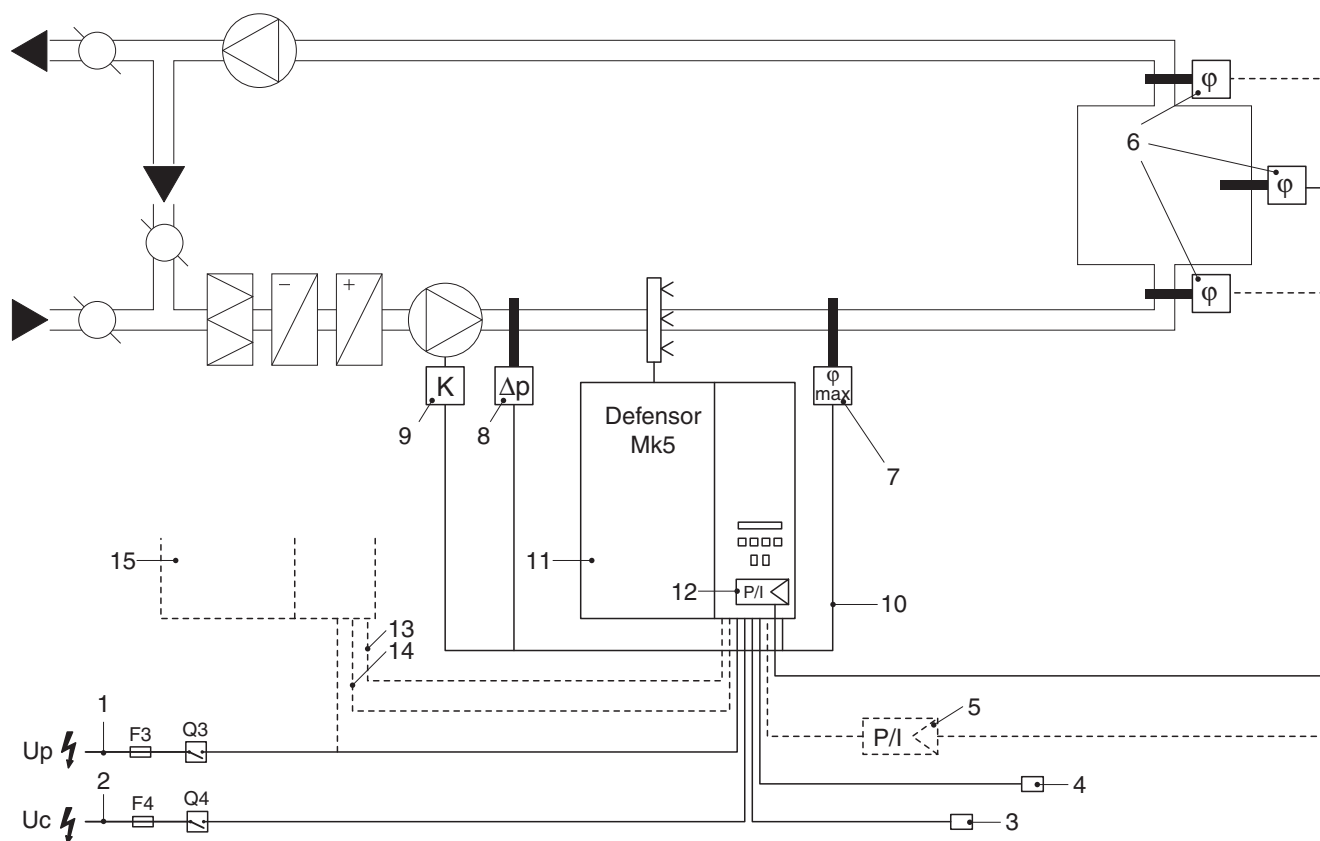
– **Warning - danger of electric shock!** The steam humidifier may be connected to electric mains only after all installation work has been completed.



– Please observe **all local regulations** concerning the electric installation.

– **Warning! Electronic** components inside the unit are very susceptible to electrostatic discharges. For the protection of these components, measures must be taken during all installation work to prevent damage caused by electrostatic discharge (ESD-protection)

5.5.1 Electric installation overview



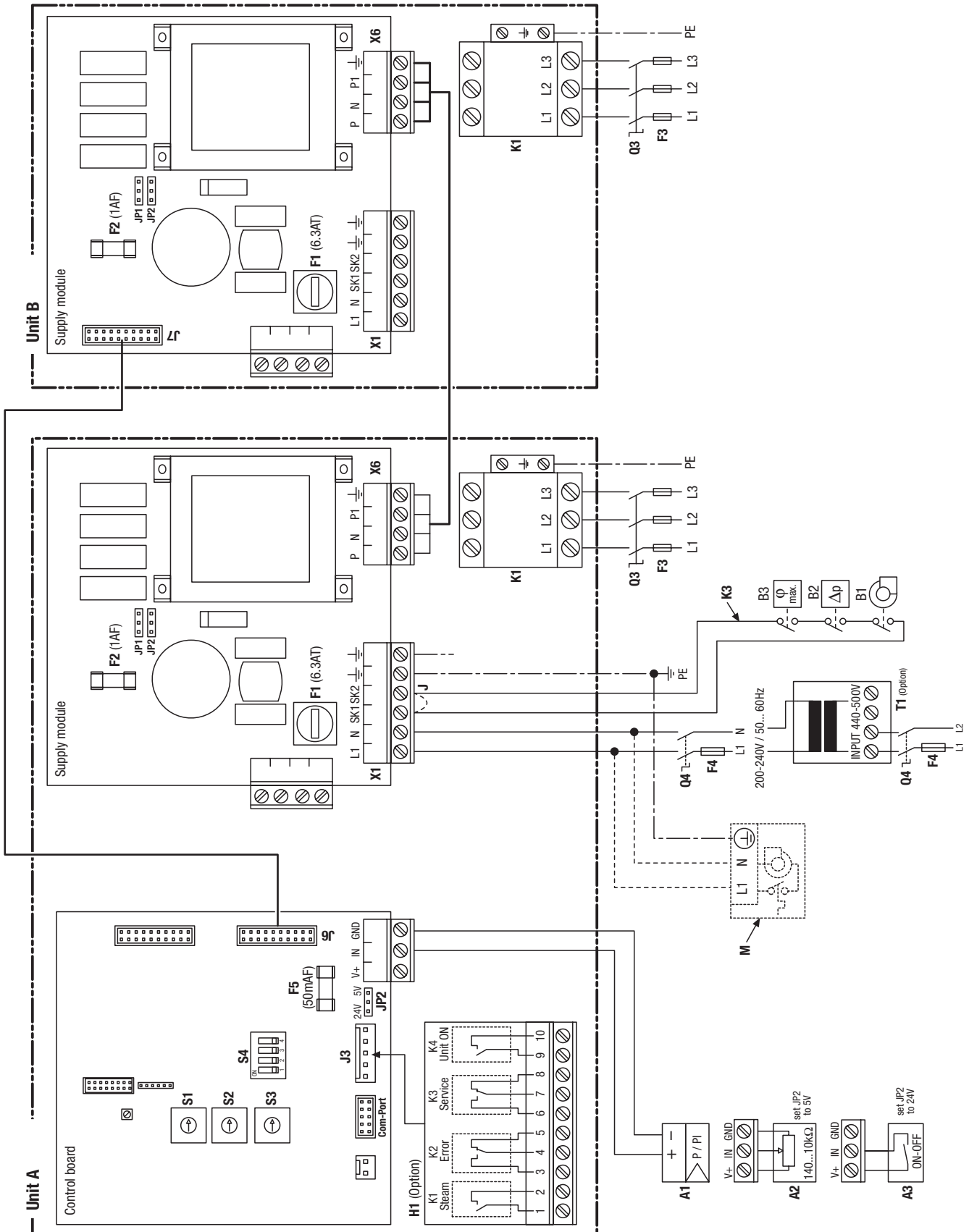
- | | | | |
|---|---|----|---------------------------------------|
| 1 | Supply heating voltage U_p | 8 | Airflow monitor |
| 2 | Supply control voltage U_c | 9 | Ventilation interlock |
| 3 | Interface RS232/RS485
(option "RS" for Mk5 Process only) | 10 | External safety circuit |
| 4 | Remote operating and fault indications (option "RFS") | 11 | Steam humidifier |
| 5 | External continuous controller | 12 | Internal continuous controller |
| 6 | Humidity sensor (supply air/room/exhaust) | 13 | Control voltage supply to second unit |
| 7 | Safety humidistat | 14 | Control line to second unit |
| | | 15 | Second unit (from 50 kg/h) |

5.5.2 Wiring diagram

The electrical installation is to be carried out in accordance with the following wiring diagram.



Caution! Observe the installation notes in the following section.



Legend to wiring diagram

A1	Controller (active) or humidity sensor
A2	Controller (passive), set jumper JP2 to 5V
A3	On/Off control, set jumper JP2 to 24V
B1	Ventilation interlock
B2	Airflow monitor
B3	Safety humidistat
F1	Internal fuse supply module (6.3 A, slow acting)
F2	Internal fuse supply module (1 A, quick acting)
F3	External fuse heating voltage supply (see table in the following chapter)
F4	External fuse control voltage (max. 10 A, slow acting)
F5	Internal fuse control module (50 mA, quick acting)
H1	Remote operating and fault indication (option "RFS")
J	Short circuited, if no external monitoring devices are connected
J3	Connection terminal for remote operating and fault indication
J6	Connection terminal for control line to unit B
J7	Connection terminal for control line from unit A
JP2	Jumper (control signal) on control board unit A
K1	Mains contactor (heating voltage) unit A/unit B
K3	External safety circuit (safety humidistat, airflow monitor, etc.)
M	Fan unit (accessory "FAN..")
Q3	External main switch heating voltage supply
Q4	External main switch control voltage supply
T1	Auto-transformer control voltage supply (option "TRAF")
S1	Rotary switch "drain interval"
S2	Rotary switch "maintenance interval"
S3	Rotary switch "control signal"
S4	DIP-switch "unit settings"
X1	Connection terminal for control voltage to supply module
X6	Connection terminal for voltage supply from unit A to unit B

5.5.3 Notes on component installation

Important note:

- All connecting cables in the electrical installation are to be fed in via the cable glands on the base of the unit (the exception to this is the heating voltage connection cable, for which the special clamp is provided).
- The details relating to individual components are to be noted and followed.

Heating voltage supply Up



Caution! Before connecting, ensure that the mains voltage corresponds with the **heating voltage for the unit (see mains code on the type label).**

The humidifier (in the case of twinned units, each separate unit) is to be connected to the mains supply in accordance with the connection schematic, via a **service switch “Q3”** (an all pole disconnecting device with a minimum contact opening of 3 mm is an essential requirement) and an **“F3” fuse group** (essential requirement: fuses are to be as detailed in the following table). The supply wiring is to be fed into the unit via the tension-relieving device (cable clamp) and connected to the terminals of the **“K1” mains contactor.**






Caution! On equipment versions combining two basic units, each unit has a type label.

	400 V/3~ 50...60 Hz				220 V/3~ 50...60 Hz				415 V/3P~ 50...60 Hz				240 V/1N~ 50...60 Hz				230 V/1N~ 50...60 Hz				200 V/3~ 50...60 Hz				
	P _N max. in kW	I _N max. in A	A _L min. in mm ²	F3 in A, quick acting	P _N max. in kW	I _N max. in A	A _L min. in mm ²	F3 in A, quick acting	P _N max. in kW	I _N max. in A	A _L min. in mm ²	F3 in A, quick acting	P _N max. in kW	I _N max. in A	A _L min. in mm ²	F3 in A, quick acting	P _N max. in kW	I _N max. in A	A _L min. in mm ²	F3 in A, quick acting	P _N max. in kW	I _N max. in A	A _L min. in mm ²	F3 in A, quick acting	
Mk5 Visual 5-.. Mk5 Process 5-..	3.8	5.5	1.5	10	3.4	9.0	2.5	16	4.0	6.0	1.5	10	4.0	17.0	2.5	20	4.0	16.5	4.0	20	3.0	8.2	1.5	10	
Mk5 Visual 8-.. Mk5 Process 8-..	6.0	8.7	1.5	10	5.5	14.4	2.5	16	6.5	9.0	1.5	10	6.5	27.2	6.0	32	6.0	26.0	6.0	32	4.5	13.1	1.5	16	
Mk5 Visual 10-.. Mk5 Process 10-..	7.5	11.0	1.5	16	6.7	17.7	2.5	20	8.0	11.5	1.5	16	8.0	33.0	10.0	40	7.4	32.0	10.0	40	5.5	16.1	2.5	20	
Mk5 Visual 16-.. Mk5 Process 16-..	12.0	17.4	2.5	20	10.9	28.7	6.0	32	13.0	18.1	2.5	20	—	—	—	—	—	—	—	—	9.0	26.1	6.0	32	
Mk5 Visual 20-.. Mk5 Process 20-..	14.9	21.5	6.0	25	13.5	35.4	10.0	40	16.0	22.3	4.0	25	—	—	—	—	—	—	—	—	11.1	32.2	10.0	40	
Mk5 Visual 24-.. Mk5 Process 24-..	18.1	26.2	6.0	32	16.4	43.1	16.0	63	19.5	27.2	6.0	32	—	—	—	—	—	—	—	—	13.5	39.2	16.0	63	
Mk5 Visual 30-.. Mk5 Process 30-..	22.3	32.3	10.0	40	20.2	53.1	16.0	63	24.0	33.5	10.0	40	—	—	—	—	—	—	—	—	16.7	48.3	16.0	63	
Mk5 Visual 40-.. Mk5 Process 40-..	30.0	43.3	16.0	63	27.2	71.4	25.0	80	32.3	45.0	16.0	63	—	—	—	—	—	—	—	—	22.4	64.9	25.0	80	
Mk5 Visual 50-.. Mk5 Process 50-..	14.9 + 22.3	21.5 + 32.3	6.0 + 10.0	25.0 + 40.0	13.5 + 20.2	35.4 + 53.1	10.0 + 16.0	40 + 63	16.0 + 24.0	22.3 + 33.5	4.0 + 10.0	25 + 40	—	—	—	—	—	—	—	—	—	—	—	—	—
Mk5 Visual 60-.. Mk5 Process 60-..	22.3 + 22.3	32.3 + 32.3	10.0 + 10.0	40.0 + 40.0	20.2 + 20.2	53.1 + 53.1	16.0 + 16.0	63 + 63	24.0 + 24.0	33.5 + 33.5	10.0 + 10.0	40 + 40	—	—	—	—	—	—	—	—	—	—	—	—	—
Mk5 Visual 80-.. Mk5 Process 80-..	30.0 + 30.0	43.3 + 43.3	16.0 + 16.0	63.0 + 63.0	27.2 + 27.2	71.4 + 71.4	25.0 + 25.0	80 + 80	32.3 + 32.3	45.0 + 45.0	16.0 + 16.0	63 + 63	—	—	—	—	—	—	—	—	—	—	—	—	—

Control signal / Humidity sensor signal

The connection of an external active controller “A1”, a passive controller “A2”, an On/Off Humidistat “A3” or a humidity sensor (for control via the internal controller), is accomplished on the appropriate contacts on the terminal strip in accordance with the connection schematic. Note the following connection information:

Connection	Controller			Humidity sensor																						
	active controller “A1”	extern passive controller “A2”	intern On/Off controller “A3”																							
Pos. Jumper JP2 – neutral  JP2 – 5V  JP2 – 24V  JP2	X	140 Ω...10 kΩ	X	X																						
Rotary switch S3 <table border="1"> <thead> <tr> <th>Pos.</th> <th>Signal</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>No signal selected</td> </tr> <tr> <td>1</td> <td>On/Off 24V</td> </tr> <tr> <td>2</td> <td>0...5 VDC (Potentiometer)</td> </tr> <tr> <td>3</td> <td>0...10 VDC</td> </tr> <tr> <td>4</td> <td>0...1 VDC</td> </tr> <tr> <td>5</td> <td>1...5 VDC</td> </tr> <tr> <td>6</td> <td>2...10 VDC</td> </tr> <tr> <td>7</td> <td>0...20 V Phase intersect</td> </tr> <tr> <td>8</td> <td>4...20 mA</td> </tr> <tr> <td>9</td> <td>0...20 mA</td> </tr> </tbody> </table>	Pos.	Signal	0	No signal selected	1	On/Off 24V	2	0...5 VDC (Potentiometer)	3	0...10 VDC	4	0...1 VDC	5	1...5 VDC	6	2...10 VDC	7	0...20 V Phase intersect	8	4...20 mA	9	0...20 mA	X	X	X	X
Pos.	Signal																									
0	No signal selected																									
1	On/Off 24V																									
2	0...5 VDC (Potentiometer)																									
3	0...10 VDC																									
4	0...1 VDC																									
5	1...5 VDC																									
6	2...10 VDC																									
7	0...20 V Phase intersect																									
8	4...20 mA																									
9	0...20 mA																									

Note: The controller humidity sensor is to be mounted at a suitable position in the duct after the steam distribution pipe, with a minimum separation of 5 times the humidification distance B_N (but not close to the heating or cooling units of the ventilation system).

Please refer to the separate installation instructions for the controller/sensor when positioning and connecting these components.

Control cable for versions with two units

The supplied control cable (flat ribbon cable) is connected to terminal “J6” on the control board of unit A and to terminal “J7” on the supply module of unit B.

Connecting the fan unit

See separate documentation “Fan unit”

RS232/RS485 connection

See separate documentation “Interface RS232/485”

5.5.4 Inspecting the electrical installation

Inspect for correct installation in accordance with the following checklist:

- Do the mains voltages applied correspond to the respective details stated on the rating plate/s for the power and control components?
- Are the voltage supplies (Power and control components) correctly fused?
- Is the service switch “Q” installed in the supply cable to the power and control components?
- Are all components correctly connected in accordance with the connection schematic?
- Are all connection cables fixed?
- Are the connecting cables free of tension (fitted through cable glands/secured with cable clamps?)
- Is the rotary switch “S3” set to correspond with the controller (active, passive, On/Off) or humidity sensor?
- Is jumper “JP2” on the control board correctly set for the controller used?

6 Operation

6.1 Unit configuration



Warning - danger of electric shock! Disconnect the steam humidifier from the mains supply (heating and control voltage) before opening the unit.

Warning! Electronic components inside the unit are very susceptible to electrostatic discharges. For the protection of these components, measures must be taken during all installation work to prevent damage caused by electrostatic discharge (ESD-protection).

All adjusting elements are situated on the control board:

- Rotary switch “S1”: drain interval
- Rotary switch “S2”: maintenance interval
- Rotary switch “S3”: control signal (see chapter 5.5.3)
- Rotary switch “S4”: unit settings

Setting the drain interval (“S1”)

The evaporation process increases the concentration of mineral salts in the steam cylinder. Periodic flushing followed by refilling of fresh water can keep the concentration of mineral salts at a low level.

The interval time to be selected depends on the quality of the water and the type of unit. It may have to be adapted to the actual circumstances during operation. The following maintenance intervals can be selected.

Position “S1”	drain interval at 100% steam capacity	Unit type Defensor Mk5 Visual/Process										
		5-..	8-..	10-..	16-..	20-..	24-..	30-..	40-..	50-..	60-..	80-..
0	∞											
1	720 min.	VE	VE	VE	VE	VE	VE	VE	VE	VE	VE	VE
2	360 min.											
3	180 min.											
4	120 min.	X										
5	60 min.		X	X								
6	30 min.				X							
7	20 min.					X	X					
8	10 min.							X	X	X	X	X
9	5 min.											

VE= Setting for fully demineralized water

X= Standard setting

Notes:

- The standard settings (see preceding table) refer to a water hardness of 210 ppm (12 °dH or 21 °fH, respectively). When using partially softened water the switch must be set to the next lower position (e.g. from position 5 to position 4).
- If the Defensor Mk5 is operated with fully demineralized water, the switch can be set to “1”.
- If no humidification takes place for more than 4 hours, the unit will proceed to a flushing cycle and a float test upon the next humidification request.

Setting the maintenance interval (“S2”)

The maintenance interval for the small and the extended maintenance is set with switch “S2”. When the set time has expired, a maintenance message indicates that the unit should be serviced.

The intervals to be selected depend on the quality of the water and the type of unit. It may have to be adapted to the actual circumstances during operation. The following maintenance intervals can be selected:

Position “S2”	Interval for		Unit type Defensor Mk5 Visual/Process											
	small maintenance	extended maintenance	5-..	8-..	10-..	16-..	20-..	24-..	30-..	40-..	50-..	60-..	80-..	
0	200 h	600 h												
1	300 h	600 h												
2	300 h	900 h												
3	450 h	900 h												
4	400 h	1200 h				X				X				
5	600 h	1200 h			X				X		X	X	X	
6	500 h	1500 h		X			X	X						
7	750 h	1500 h	X											
8	3000 h	3000 h												
9	6000 h	6000 h	VE	VE	VE	VE	VE	VE	VE	VE	VE	VE	VE	

VE= Setting for fully demineralized water

X= Standard setting for water with medium hardness (11°dH, 20°FH, 200 ppm)

Note: The maintenance interval times refer to a steam output of 100 %. If less output is required in operation, the maintenance intervals are correspondingly increased.

Setting the control signal (“S3”)

See informations in chapter 5.5.3

Unit settings (“S4”)

Various unit parameters can be set at the DIP switch “S4”. The unit parameters are preset at the factory and must only be changed by the customer in consultation with the Defensor representative.

Switch	Standard setting	Description
1	OFF	Automatic temperature stabilization ON/OFF When the automatic temperature stabilization is switched on, the water in the steam cylinder is maintained at a specific temperature when there is a break in steam production, so that steam can be immediately generated again on renewed demand.
2	OFF	Switch pause control ON/OFF In the “OFF” position the switching element’s pause (Triac and Contactors) is controlled normally (maintaining “Flicker”-regulations). In the “ON” position the pause is reduced to optimize the precision of control.
3	OFF	On/off switch delay heating contactor ON/OFF In the “OFF” position the on/off switch delay is set for optimal life of the contactors. In the “ON” position the on/off switch delay is reduced to optimize the precision of control (reduced life of heating contactors).
4	OFF	Spare

6.2 Putting into operation

The following procedure is carried out in order to operate the steam humidifier:

- **Examine the steam humidifier and installation for possible damage.**



Caution! Damaged units and units with damaged or defective installation features **must not be operated.**

- Open the **filter valve / shut-off valve** in the water feed line.
- Switch on the service switch for the mains supply (Heating and control voltage).
- Switch on the steam humidifier main switch.

test

The steam humidifier carries out a **system test**. The adjacent display appears and the three LEDs light for approx. 3 seconds.

If a fault is detected during the system test, a corresponding fault message is triggered (see chapter 6.7).

filling

If the system test is successful, the steam cylinder fills up and a float test is carried out (function check on the level unit). The adjacent display appears.

Note: If a fault is detected during the float test, an appropriate fault message is triggered (see chapter 6.7).

Mk5 Visual
ready

If the float test is successful, the Defensor Mk5 will be in **normal operating mode**. The adjacent display appears and the **green LED lights**.

- **The following procedure should be carried out only on the first occasion that the unit is operated:**

- Carry out the software-dependent equipment settings (Defensor service technician).

Note: Information on the settings that can be made by the customer is provided in chapter 6.5).

- Check for correct functioning of the monitoring equipment (external safety circuit).
- Check the function of the steam humidifier:
 - **Switch on the humidification** by raising the set humidity value on the humidity controller/humidistat.
 - **Switch off the humidification** by lowering the set humidity value on the humidity controller/humidistat.
- Set the desired humidity value on the humidity controller/humidistat.

The heating current switches on as soon as the humidity controller/humidistat **demands humidity**. The green LED lights and steam is produced after a short delay (approx. 5 minutes).

Operating status display on the unit

The operating status is displayed in the LED on the unit as follows:

- **Green LED lit:** Unit producing steam
- **Yellow LED flashing:** Major or minor servicing due. The relevant notice is shown in the display (see chapter 6.6).
- **Red LED flashing:** There is a problem. The unit is trying to solve the problem. The relevant **warning message** appears in the display (see chapter 6.7).
- **Red LED lit:** Insoluble problem. The relevant **error message** appears in the display (see chapter 6.7).

Remote operating and fault indication

If your steam humidifier is equipped with the optional remote operating and fault indication (option "RFS"), the operating status will be shown as follows:

Display on unit	Meaning	Activated remote display relay
Green LED lit	Steam production	K1 "Steam production"
Red LED lit	Insoluble problem	K2 "Error"
Red LED flashing	Fault elimination	No message
Yellow LED flashing	Steam cylinder service due	K3 "Maintenance"
Unit switched on	Unit ready for operation	K4 "Unit on"

6.3 Taking out of operation

The following procedure is followed when it is required to shut down the steam humidifier, e.g. for maintenance work:

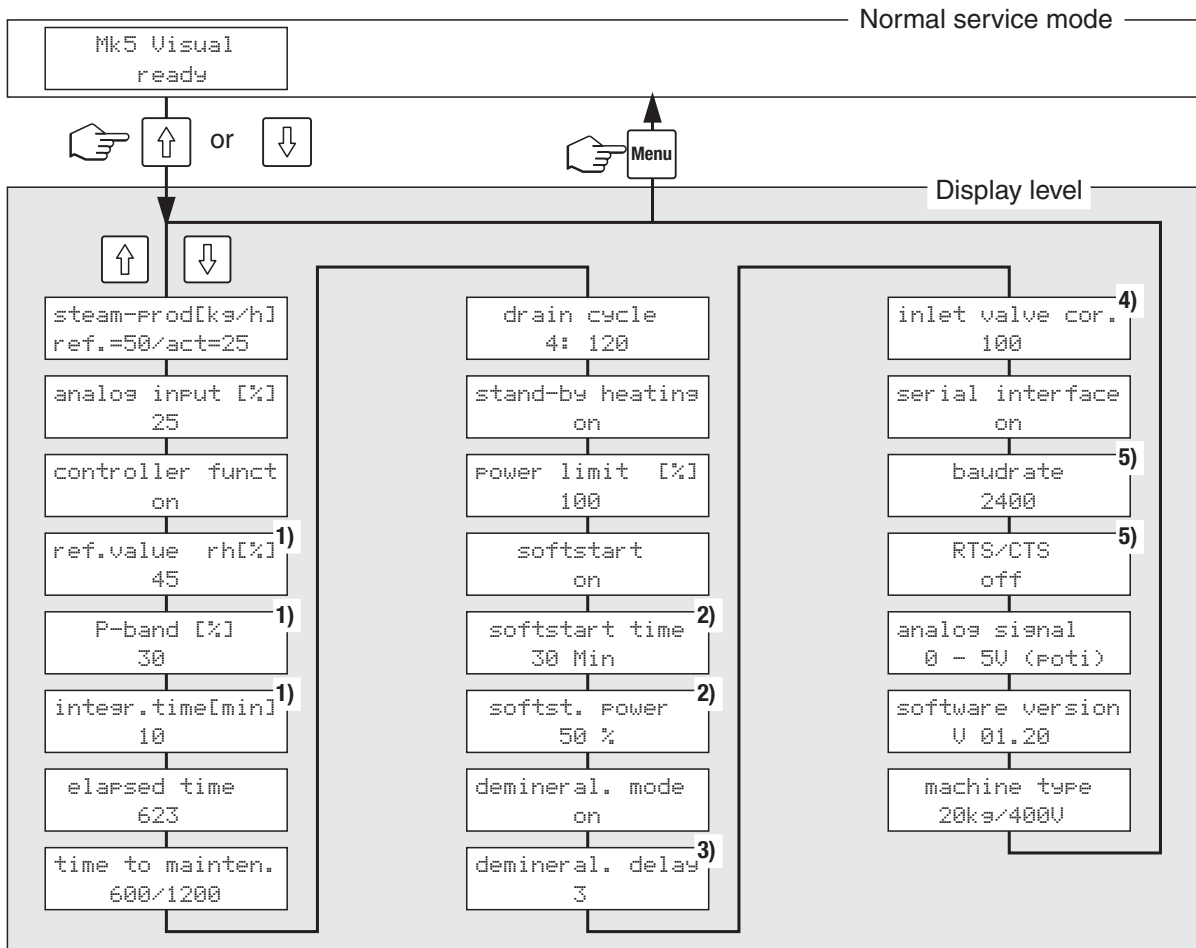
- Close the filter valve/shut-off valve in the water feed line.
- Briefly depress the drain switch for more than 7 seconds. The heating voltage is isolated and the steam cylinder empties. The yellow signal lamp lights.
- Wait until the steam cylinder is empty (approx. 5-10 minutes), then operate the off-switch on the steam humidifier.
- Isolate the steam humidifier from the mains supply: Switch off all service switches in the mains supply lines (heating and control voltage) and secure them in the off position.

6.4 Interrogation of the operating status

The Defensor Mk5 operating and display unit has a so-called 'display level' from which various operating parameters can be interrogated.

Note: It is not possible to change the values on the display level.

Overview of the display level and operation



Operation: Call up the display level with **<↓>** or **<↑>**

<↓> next operating parameter

<↑> previous operating parameter

Exit the display level with **<Menu>**

- Note:
- 1) appears only if "controller funct" is active ("on")
 - 2) appears only if "softstart" is active ("on")
 - 3) appears only if "demineral. mode" is active ("on")
 - 4) appears only on Mk5 Process units
 - 5) appears only if "serial interface" is active ("on")

Description of the operating parameters on the display level

The following describes the individual operating parameters that can be selected using the keys <↓> and <↑> , after the display level has been called-up.

```
steam-prod[kg/h]
ref.=50/act=25
```

– Steam production

Current actual and nominal value of steam production in kg/h.

- Nominal value: max. unit capacity x input signal value.
Note: if a capacity limitation is set the nominal value is given in brackets
- Actual value: max. unit capacity x input signal value x capacity limitation

Note: if the internal controller is activated only the actual value is shown.

Under the following conditions the actual value may differ from the nominal value: upon activation of the heating power, if capacity limitation is active, during the filling cycle of the steam cylinder.

```
analog input [%]
25
```

– Analog input (humidity demand)

Current value of the signal applied to the analog input in % of its max. value.

Note: If the internal controller is active the displayed value corresponds to the current air humidity (%rh).

```
controller funct
on
```

– Internal controller

Internal controller activated (“on”)/deactivated (“off”).

Note: The internal controller can be activated on the setting level (see chapter 6.5).

```
ref.value rh [%]
45
```

– Nominal value of relative humidity

Selected value of relative humidity in %rh.

Note: This option is available only if the internal controller is active.

```
P-band [%]
30
```

– Proportional range of the internal controller

Selected proportional range (P-Range) of the internal controller in %.

Note: This option is available only if the internal controller is active.

```
Integr.time[min]
10
```

– Integral time of the internal controller

Selected integral time of the internal controller in minutes.

Note: This option is available only if the internal controller is active.

```
elapsed time
623
```

– Working hours

Total of working hours elapsed since initial commissioning of the steam humidifier.

```
time to mainten.
600/1200
```

– Time remaining to small/extended maintenance

The time remaining (in hours) before the next small/extended maintenance.

Note: The stated times are based on 100 % steam capacity. If the operation is at a lesser capacity, the time should be extended accordingly. The maintenance intervals are set using the rotary switch “S2” on the control board. Please pay attention to the notes in chapter 6.1.

```
drain cycle
4: 120
```

– Flushing cycle

The following indications are provided for the set flushing interval:

Left: Switch setting on rotary switch “S1”

Right: Set flushing interval

Note: The flushing interval is set on switch “S1” on the control board. Please observe the notes in chapter 6.1.

```
stand-by heating
on
```

– Stand-by heating

Stand-by heating activated (“on”)/deactivated (“off”).

Note: If stand-by heating is active the water temperature in the steam cylinder is constantly kept at approx. 70 °C. Stand-by heating may be activated/deactivated with the DIP switch “S4-1” on the control board. Please observe the information given in chapter 6.1.

```
Power limit [%]
100
```

– Capacity limitation

The set capacity limitation as a percentage of the maximum capacity.

```
softstart
on
```

– Soft start

Soft start enabled (“on”)/disabled (“off”).

Note: After restart or after the unit has been idle for 4 hours (stand-by) the Soft start function reduces the humidification capacity to a preset value for a selectable period (value settings see parameters below).

```
softstart time
30 Min
```

– Time limit for Soft start

Selected time limit for Soft start function in minutes.

Note: This menu item is available only if the Soft start function is enabled.

```
softst. power
50 %
```

– Capacity limit for Soft start

Selected capacity limit for Soft start function in % of maximum capacity.

Note: This menu item is available only if the Soft start function is enabled.

```
demineral. mode
on
```

– Demineralization mode

Demineralization mode enabled (“on”)/disabled (“off”).

Note: The Demineralization mode flushes the steam cylinder within an hour after a preset number of scum detections has taken place (see Demineralization delay). This prevents the formation of scum.

```
demineral. delay
3
```

– Demineralization delay

Selected the delay for demineralization.

Note: This menu item is available only if the Demineralization mode is enabled.

Note: This value determines the number of scum detections allowed (maximum level in steam cylinder is reached) before the steam cylinder is flushed for a preset time.

```
inlet valve cor.  
100
```

– **Inlet valve correction**

Set inlet valve correction (cycle ratio) in % of standard setting value to balance out water pressure variations.

Note: This menu point is available only with Mk5 Process units.

```
serial interface  
on
```

– **Serial interface**

Serial interface (option) activated (“**on**”)/deactivated (“**off**”).

```
baudrate  
2400
```

– **Data transfer rate**

Selected data transfer rate (baud rate).

Note: This menu option is available only if the serial interface is active.

```
RTS/CTS  
off
```

– **Data flow control**

Transmission with (“on”) or without (“off”) RTS/CTS data flow control.

Note: This menu option is available only if the serial interface is active.

```
analog signal  
0 - 5V (Poti)
```

– **Analog signal**

Range of the active analog signal in V or mA, respectively.

Note: The range of the analog signal may be adjusted using the rotary switch “S3” on the control board. Please observe the information given in chapter 6.1.

```
software version  
V 1.00
```

– **Software version**

Current software version for the steam humidifier.

```
machine type  
20kg/400V
```

– **Unit type**

value left: Max. steam capacity in kg/h

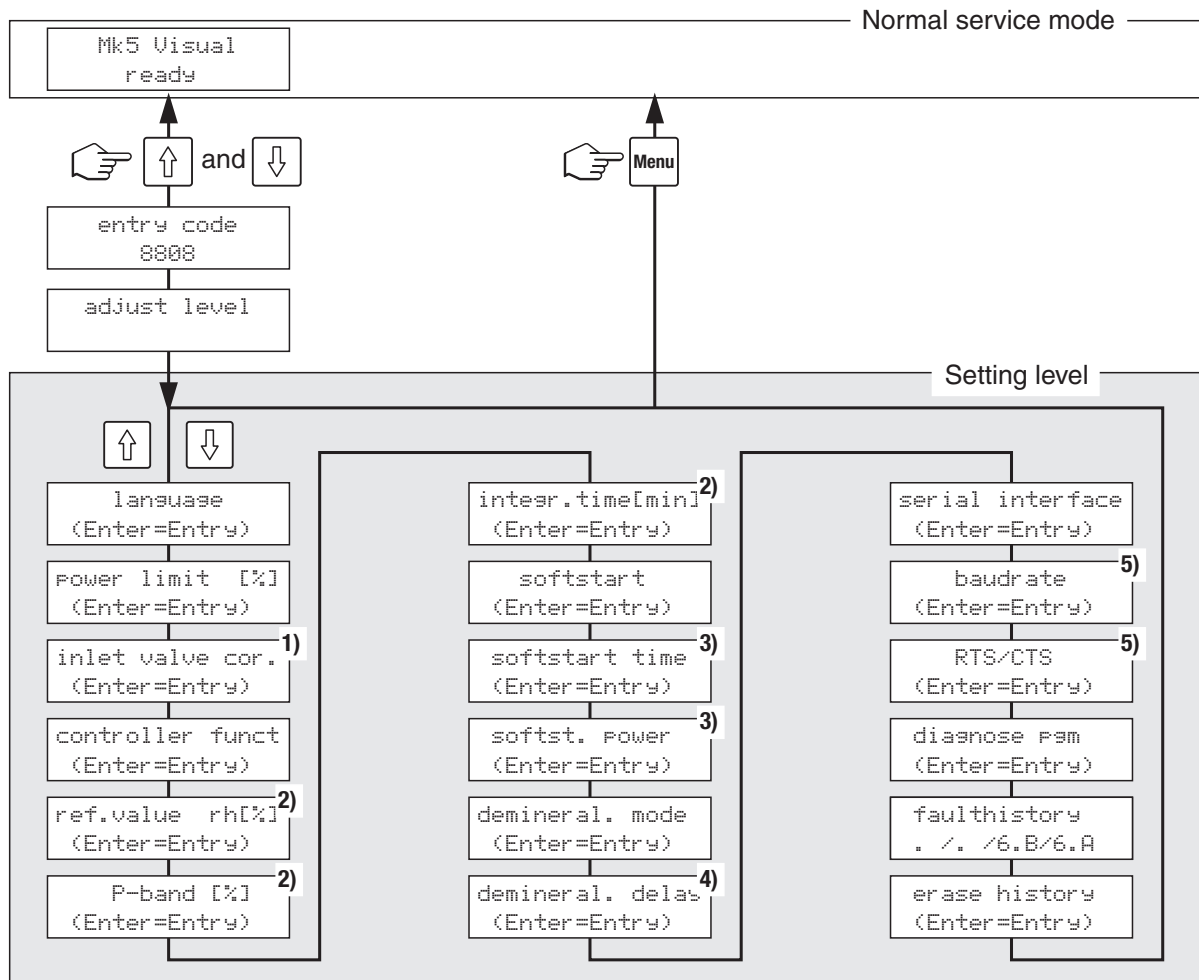
value right: Heating voltage in VAC

6.5 Setting the operating parameters

You can adapt various Defensor Mk5 steam-air humidifier operating parameters to the operating requirements on the setting level of the control and display unit. The setting level is protected by an access code to guard against unauthorized access.

Caution! The settings on the setting level have a direct influence on the operating behavior of the steam-air humidifier. The settings must therefore only be made by personnel who are familiar with the techniques of humidification and climatic control and with the Defensor Mk5 system.

Overview of the setting level and operation



Operation:

- For call-up of the setting level see the following “Call-up of the setting level”
- **<↓>** Next menu item
- **<↑>** Previous menu item
- For change to set values see the section “Changing the set values”
- Exit the setting level with **<Menu>**

Note:

- 1) appears only on Mk5 Process units
- 2) appears only if “controller funct” is activate (“on”)
- 3) appears only if “softstart” is activate (“on”)
- 4) appears only if “demineral. mode” is activate (“on”)
- 5) appears only if “serial interface” is activate (“on”)

Call-up of the setting level

```
Mk5 Visual
ready
```

With the Defensor Mk5 in normal operation:

- Simultaneously depress the keys <↓> and <↑>.

```
entry code
9999
```

You are now prompted to enter the four digit access code “8808”. The digit on the far left flashes.

- Enter the access code “8808” as follows:

```
entry code
8999
```

Change the first digit with the keys <↓> and <↑>. Accept your input with the key <↵>. The next digit starts to flash.

Repeat this step for the remaining digits.

```
adjust level
```

After acceptance of the last digit, the adjacent message appears briefly on the display to confirm that you are on the setting level. The first menu item then appears on the display.

Note: If you have entered an incorrect code the message “**Incorrect Code**” appears briefly on the display. The unit then returns to the normal service mode.

To change the set values

The unit is on the setting level.

- Press the key <↵>, if you wish to change the current setting.

```
XXXXXXXXX
(Enter=Entry)
```

```
language
English
```

– Menu items with selected values

- Press the key <↓> or <↑>, in order to select the desired setting from the list.
- Accept your input with the <↵> key.

```
Sprache
Deutsch
```

– Menu item with numerical set value

The digit on the far left starts to flash.

```
ref.value rh [%]
045
```

- Press the key <↓>, in order to reduce the value of the selected digit or the key <↑>, in order to increase the value of the digit.

```
ref.value rh [%]
045
```

- Accept your entry with the <↵> key.

Note: If the value to be entered is a multi-digit value, the next digit starts to flash. You can change this digit as described above.

```
new data
entered
```

After confirming the last digit (numerical set value) and the selected set value, the adjacent message appears briefly on the display to confirm that you have entered a new value. Then the selected menu item appears again.

```
new data
not valid
```

Note: If an invalid value has been entered in a numerical input, the adjacent message appears.

```
unchanged
```

If you have exited the input field with the key <↵>, without having changed the set value, the adjacent message appears briefly on the display. Then the display for altering the set value appears again.

The process of changing the value can be interrupted at any point by pressing the <Menu> key. The last stored set value then remains unchanged.

Description of the menu items on the setting level

The following lists all the menu items that can be selected and changed after activation of the setting level.

```
language
English
```

– Language

Dialogue language of the display unit.

Factory setting: **depends on the country**

Options: **german, english, french**

Note: The display unit switches to the selected language immediately after the suitable language option has been confirmed.

```
Power limit [%]
100
```

– Capacity limitation

Limitation of the steam capacity (in %) in reference to the maximum steam capacity.

Factory setting: **100 %**

Setting range: **10...100 %**

Note: This parameter is used to limit the maximum performance in case the steam capacity exceeds the humidification required by your installation.

```
inlet valve cor.
100
```

– Inlet valve correction

Setting the cycle frequency of the inlet valve in % of the standard setting.

Note: This menu point is only given in Mk5 Process unit.

Factory setting: **100 %**

Setting range: **70-130 %**

Comment: The water feed quantity can be reduced (value <100) or increased (value >100) with this parameter in order to balance out variations in water pressure.

```
controller funct
off
```

– Controller setup

Activation (“on”)/Deactivation (“off”) of the internal PI controller.

Factory setting: **off**

Options: **on** (PI controller activated), **off** (PI controller deactivated)

Note: The internal controller must not be activated if an external controller is connected to the humidifier because the internal controller would interpret the analog signal of the external controller as the actual humidity value detected by a humidity sensor. This would cause the internal controller to switch the humidifier to 100% steam capacity if the input signal drops to 0% which, in turn, would lead to over-humidification.

```
ref.value rh [%]
045
```

– Nominal humidity value

Nominal humidity value in % rh.

Note: This menu option is available only if the internal PI controller is active.

Factory setting: **45 %rh**

Setting range: **10...100 %rh**

```
P-band [%]
030
```

– Proportional range (P-band) of the internal PI controller

Proportional range of the internal PI controller in %.

Note: This menu option is available only if the internal PI controller is active.

Factory setting: **30 %**

Setting range: **4...100 %**

Note: The P-Range is used to smooth the control characteristic. Increasing the P-Range boosts the smoothing applied to the control characteristic. However, this causes a permanent deviation, proportional to the bandwidth of the P-Range.

```
Intear.time[min]
010
```

– **Integral time** of the internal PI controller

Integral time of the internal PI controller in minutes.

Note: This menu option is available only if the internal PI controller is active.

Factory setting: **10 Minutes**

Options: **off** (000/integral time disabled), **2 - 100 Minutes**

Note: The integral time setting determines the period allowed to reach the nominal humidity. Setting the integral time to the optimal value prevents the control characteristic from overshooting and, at the same time, balances the permanent deviation caused by the P-Range value.

```
softstart
off
```

– **Soft start**

Enabling (on) or disabling (off) the Soft start function.

Factory setting: **off**

Available settings: **on** (Soft start enabled), **off** (Soft start disabled)

Note: After restart or after the unit has been idle for 4 hours (stand-by) the Soft start function reduces the humidification capacity to a preset value for a selectable period (value settings see parameters below).

```
softstart time
30 Min
```

– **Time limit for Soft start**

Select the time limit for the Soft start function in minutes.

Note: This menu item is available only if the Soft start function is enabled.

Factory setting: **30 minutes**

Setting range: **1...255 minutes**

```
softst. Power
50 %
```

– **Capacity limit for Soft start**

Set the capacity limit for the Soft start function in % of maximum humidification capacity.

Note: This menu item is available only if the Soft start function is enabled.

Factory setting: **50 %**

Setting range: **4...100 %**

```
demineral. mode
on
```

– **Demineralization mode**

Enabling (“on”) or disabling (“off”) the Demineralization mode.

Factory setting: **on**

Available settings: **on** (Demineralization mode enabled)

off (Demineralization mode disabled)

Note: The Demineralization mode flushes the steam cylinder within an hour after a preset number of scum detections has taken place (see next parameter “Demineralization delay”). This prevents the formation of scum.

```
demineral. delay
  3
```

– **Demineralization delay**

Set the demineralization delay after which a time-controlled flushing cycle will be initiated.

Note: This menu item is available only if the Demineralization mode is enabled.

Factory setting: **3**

Setting range: **1...9**

Note: The demineralization delay determines the number of times the maximum level (scum detection) may be reached before a time-controlled flushing cycle will take place.

```
serial interface
  off
```

– **Serial interface**

Activation (“on”)/deactivation (“off”) of the serial interface.

Factory setting: **“off”**

Options: **“off”** (interface deactivated), **“on”** (interface activated)

Note: Detailed instructions on the serial interface (installation, configuration, etc.) are given in the separate manual for the RS-232 and RS-485 interfaces.

```
baudrate
  2400
```

– **Data transfer rate (baud rate)**

Data transfer rate of the serial interface (in baud).

Note: This menu option is available only if the serial interface is active.

Factory setting: **2400**

Options: **300, 600, 1200, 2400, 4800, 9600**

Note: The selected value must match the data transfer rate used by the receiver (e.g. PC).

```
RTS/CTS
  off
```

– **Data flow control**

Transmission without (“off”) or with (“on”) RTS/CTS data flow control.

Note: This menu option is available only if the serial interface is active.

Factory setting: **“off”** (without RTS/CTS)

Options: **“on”** (with RTS/CTS), **“off”** (without RTS/CTS)

Note: RTS/CTS data flow control must only be enabled if the receiver uses RTS/CTS flow control as well.

```
Diagnose PAM
(ENTER=Entry)
```

– **Diagnostic program**

The diagnostic program simulates various operating conditions of the steam humidifier. However, the diagnostic program requires in-depth knowledge of particular internal functions of the unit. Therefore, the diagnostic program should be used by Defensor service technicians only.

```
faulthistory
././9.A/9.A
```

– **Error history**

Numerical codes of the last 4 errors encountered (oldest entry far left).

Note: For detailed information on the meaning of particular error numbers please refer to chapter 6.7.

```
erase history
(ENTER=Entry)
```

– **Delete fault history**

Fault history is deleted. An appropriate message appears following the deletion.

6.6 Maintenance



- **All maintenance work must be performed only by adequately qualified and trained personnel familiar with the dangers involved.** Ascertaining the qualifications is the customer's responsibility.
- Instructions and details concerning the maintenance work must be observed and adhered to without fail.
- Only the type of maintenance work outlined in this documentation must be carried out.
- Use original Defensor spare parts exclusively to replace defective parts.
- **Before maintenance is initiated, the steam humidifier must be taken out of operation in accordance with instructions in chapter 6.3 and protected against unintentional switching on.**

6.6.1 Notes on maintenance

To safeguard reliable operation, the maintenance of the Defensor Mk5 should be devised in three stages. A distinction is made here between periodic inspections, small maintenance and extended maintenance of the steam-air humidifier.

The intervals required between small maintenance and extended maintenance depend on the water quality and the quantity of steam generated and can be pre-selected on the rotary switch "S2" on the control board (see chapter 6.1). After expiry of the selected interval, the yellow LED flashes/lights and an appropriate message alternates with the normal operation indication.

The following is an overview of the work that should be undertaken for the three maintenance stages.

– Periodic inspections

When: **1 per week**

- Work:
- Inspect the water and steam installations for correct sealing and damage.
 - Inspect the drain line for soiling.
 - Inspect the electrical installation for loose cables and damaged components.
 - Inspect the steam-air humidifier for damage.

– Small maintenance

When: The **yellow LED flashes** and the message "sm. maintenance due" appears, alternating with the normal operation indication.

```
sm. maintenance
      due
```

- Work:
- Carry out the periodic inspection items
 - Empty the steam cylinder and clean the lime collector tank.

– Extended maintenance

When: The **yellow LED lights** and the message "lg. maintenance due" appears, alternating with the normal operation indication.

```
lg. maintenance
      due
```

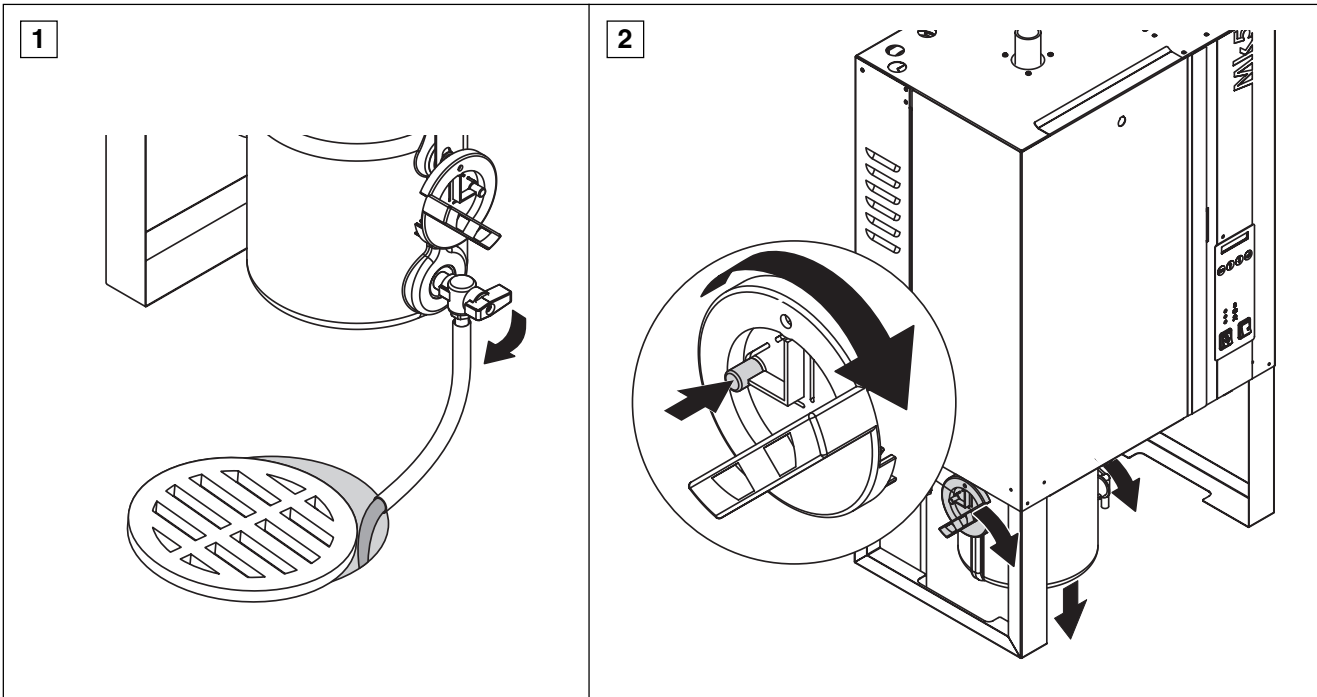
- Work:
- Carry out the periodic inspection items
 - Empty the steam cylinder and clean the lime collector tank.
 - Dismantle and clean the steam cylinder
 - Clean the unit inner chamber
 - Inspect the components inside the unit for damage

6.6.2 Dismantling and re-assembly work

Removal of the lime collector tank



Caution! Before commencing any dismantling work, the steam-air humidifier is to be **taken out of operation as described in chapter 6.3 and rendered safe from inadvertent operation.**



1. Empty the lime collector tank via the drain valve.



Caution: Danger of scalding! The water in the lime collector tank may be hot.

2. Press the securing knob on both rotation locks. Then rotate both rotation locks clockwise and remove the lime collector tank downwards, from the base of the unit.

Installation of the lime collector tank

Installation of the lime collector tank is carried out in the reverse sequence to that detailed above for removal.

Important! Before commencing the installation, check the O-rings for damage and replace them if necessary. The lime collector tank must be replaced every 5000 hours, or after 3 years at the latest.

Important! Turn the rotation locks anticlockwise up to the stop (both securing knobs must engage).

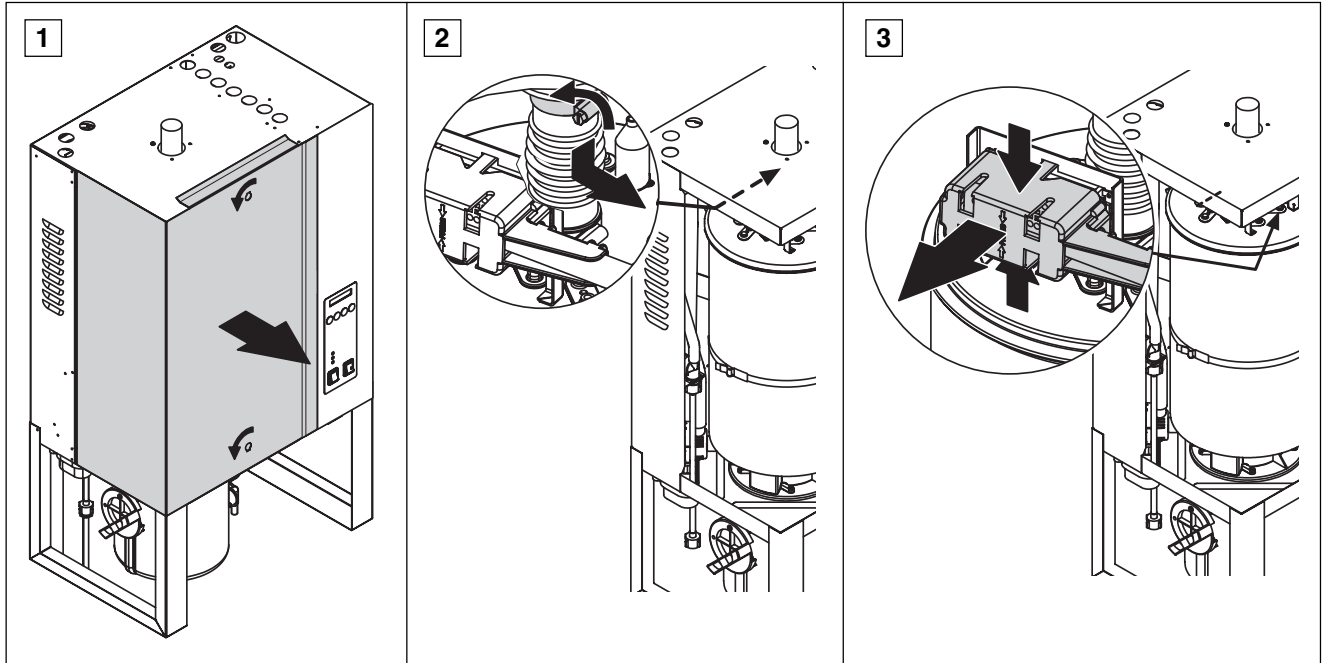
Important! Close drain valve on lime collector tank.

Removal and dismantling of the steam cylinder

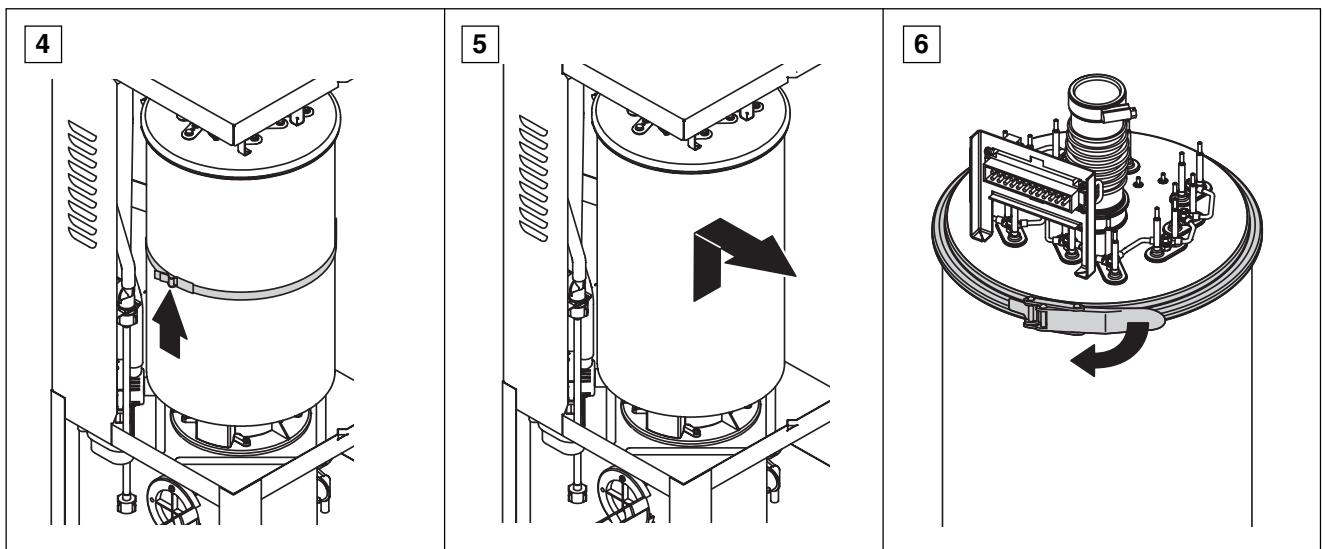
Caution! Before commencing any dismantling work, the steam-air humidifier is to be **taken out of operation as described in chapter 6.3 and rendered safe from inadvertent operation.**




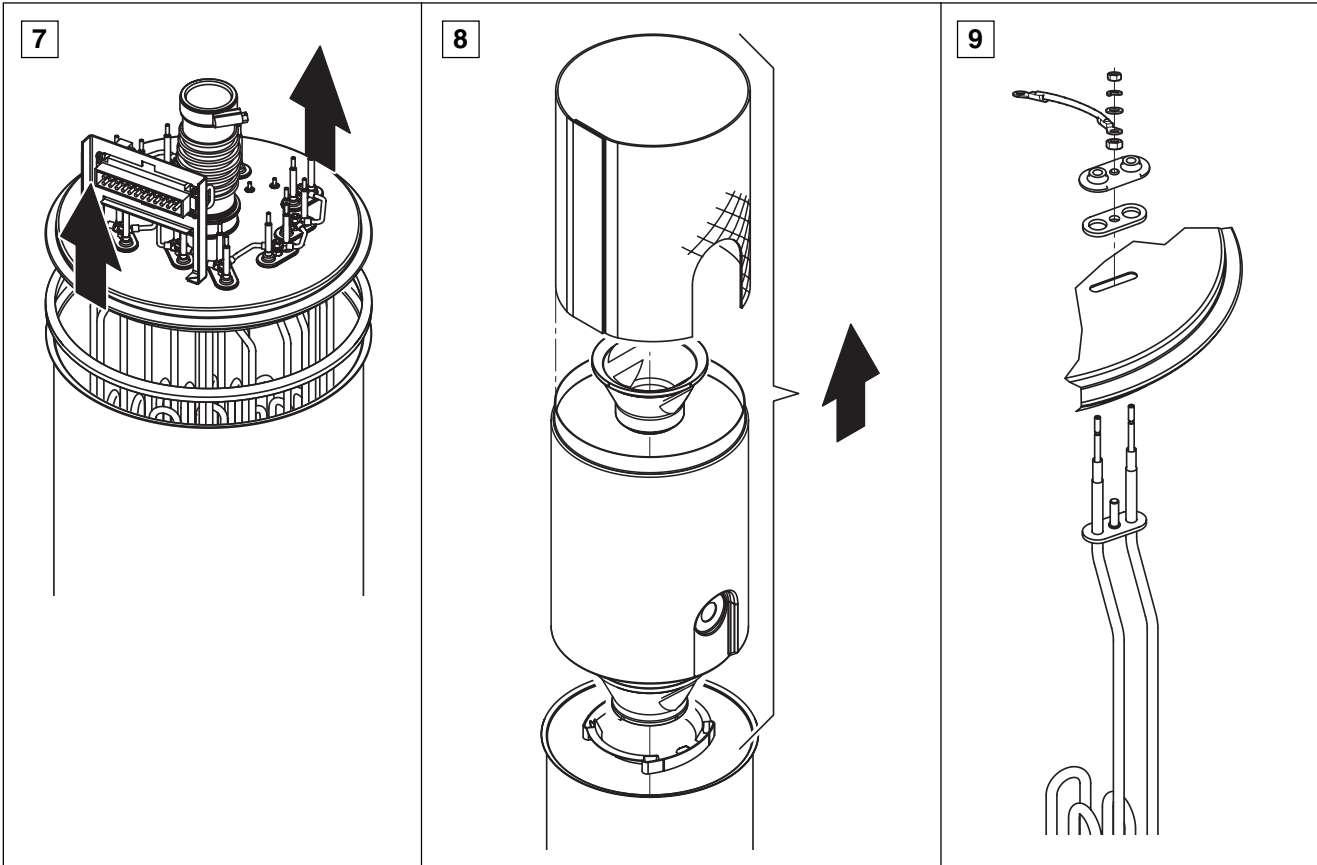
Caution! If steam has been produced shortly before discontinuing operation, **the steam cylinder will be hot.** Well-insulated gloves should therefore be worn when carrying out the removal operation.



1. Release the front door locking devices using a screwdriver (rotate 90° left) and remove the front doors.
2. Free the upper hose clamp of the steam hose using a screwdriver and pull the hose downward from the steam connection.
3. Press snap-fastenings together, then remove the heating cable loom plug connector from the connector socket.



4. Release the clamping ring (steam cylinder fixation).
5. Lift the steam cylinder carefully from the coupling bush and remove it towards the front of the unit.
 **Caution!** Set the steam cylinder down carefully.
6. Loosen the steam cylinder cover clamping ring.



7. Carefully lift off the cover with the heating rods.

Warning! Take care with the cover whilst it is removed, so as not to damage the heating rods.

Note: If the cover cannot be removed due to heavy calcification (maintenance period exceeded), place the steam cylinder in a basin of formic acid (8 %) until it can be removed (**Caution!** Observe instructions on the safe use of this cleaning agent).

8. If necessary, loosen the cylinder insert by lightly rotating it in either direction and lift it from the steam cylinder. Then remove the screen insert and the funnel insert.

9. If a heating element has to be replaced during servicing: first make a note of how the cables are connected and the position of the heating element. Then detach the cable, loosen the clamping nut and remove the heating element.

Assembly and installation of the steam cylinder

Assembly of the steam cylinder takes place in reverse sequence. Please note the following instructions:

- Installation of any heating elements which have been removed should follow figure 9. Please take care that the heating elements are correctly positioned and the cables are correctly connected (according to your notes).
- Before installation of the steam cylinder cover place the Duro sealant around the edge of the cover. The Duro sealant must be clean and undamaged (replace if necessary).
- Before installation of the steam cylinder in the unit check O-rings in the coupling box for damage and replace if necessary.
- Insert steam cylinder in the unit correctly and fasten with clamping ring.
- Fasten steam hose with hose clamps. A leaky steam hose can cause damp damage in the interior of the unit.
- The plug of the heating cable boom must connect in the connection box.

6.6.3 Notes on cleaning

Cleaning the steam cylinder, lime collector tank, steam cylinder insert

- Wherever possible, chip off the lime coating that has formed.
- Wash parts with lukewarm soap suds and then rinse off well.
Note: If the components are heavily scaled, place them in 8-percent formic acid until the scale has dissolved. Then treat components as previously described.

Cleaning the heating elements

- Immerse cover with heating elements fitted to 2 cm below the rim of the cover in a container with 8-percent formic acid. Allow the acid to take effect until the scale coating has dissolved.
Note: The heating elements do not have to be entirely free from scale.
- Then rinse heating elements thoroughly with fresh water.



Warning! Ensure that the electrical connections remain dry.

Warning! On no account remove scale coating on the heating elements with tools (screwdriver, scraper, etc.) or by striking. This could damage the heating elements.

Cleaning the interior of the unit

Wipe down components inside the unit with a damp cloth (clean water). Severely scaled components, e.g. the inlet funnel and the blow-off pump, should be cleaned using commercially available cleaning and descaling agents.

Warning! Ensure that the electrical connections and electronic components remain dry.

Notes on cleaning agents

Dilute formic acid is obtainable from any chemist's shop or drugstore.

Warning! Formic acid is indeed harmless to the skin, but it attacks the mucous membranes. Protect the eyes and respiratory tracts therefore from contact with the acid and its vapour (wear goggles and work in a well ventilated room or outside).

The use of disinfectants is only permitted if they leave no toxic residues. The components must be rinsed thoroughly with water after cleaning in all cases.



Caution! Do not use any solvents, aromatized or halogenized hydrocarbons, or other aggressive substances for cleaning purposes.

The information and instructions regarding cleaning agents are to be unconditionally observed and implemented. In particular: Information relating to the protection of personnel, environmental conservation and restrictions regarding usage.

In all cases, **local regulations relating to environmental protection** must be implemented.

6.6.4 To reset the maintenance indication

When maintenance work has been completed, the **maintenance display** can be reset as follows:

- **With the unit switched off**, depress and hold the drain switch.
- Switch on the steam-air humidifier with the unit switch.
- Continue to depress the blow-off pushbutton until the system test has finished (approx. 10 seconds).

6.7 Fault elimination

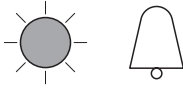
6.7.1 Fault indication

In case of malfunction during operation, the humidifier control checks whether there is a temporary problem (e.g. water supply interrupted for a short time) or whether it can resolve the problem by taking necessary measures. Such malfunctions set the unit into the “**Alarm**” status (fault elimination). The **red LED flashes** and an **alarm message** appears in the display alternating with the notice “**recovering - please wait**”.

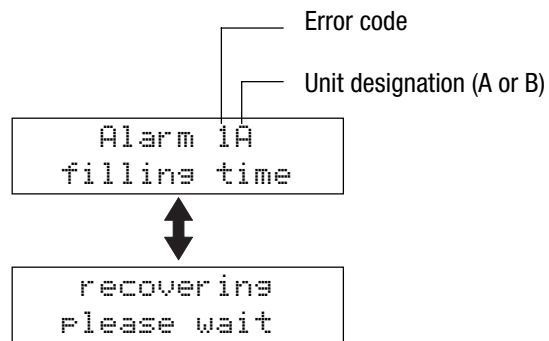
Note: If the cause of the malfunction disappears of its own accord or if the controls can repair the malfunction, the alarm message will automatically switch off.

Example of an “Alarm” indication

red LED flashes



Message in the display

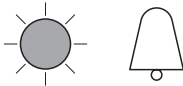


Note: If the unit is in display or setting level the alarm message in the display will be suppressed.

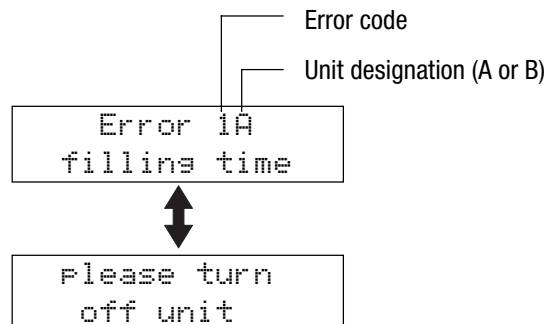
If the control, after several attempts, fails to solve the problem (number of attempts depends on the type of malfunction) or if the problem obstructs further operation, the heating voltage is interrupted via the main contactor. The **red LED stays lit** and an **error message** appears in the display alternating with the notice “**Please turn off unit**”.

Example of an “Error” indication

red LED stays lit



Message in the display



Note: If the unit is in the display or setting level the error message in the display will be suppressed.

6.7.2 What, if..?

Most operational malfunctions are not caused by faulty equipment but rather by improper installation or disregarding of planning guidelines. Therefore, a complete fault diagnosis always involves a thorough examination of the entire system. Often, the steam hose connection has not been properly executed, or the fault lies with the humidity control system.

The following table gives a list of possible malfunctions, the appropriate alarm or error message, details of their cause, and notes on how to deal with each problem.

Malfunction/Indication	Cause	Remedy
<p>Min. filling time not reached Error code: 1A/1B</p> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px; text-align: center;">Alarm 1A filling time</div> <div style="border: 1px solid black; padding: 2px; text-align: center;">Error 1A filling time</div>	<p>Water feed to steam cylinder heavily calcified. Level in steam cylinder and level unit do not match.</p>	<p>Carry out major servicing.</p>
<p>Internal safety chain interrupted Error code: 2A/2B</p> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px; text-align: center;">Alarm 2A safety chain int</div> <div style="border: 1px solid black; padding: 2px; text-align: center;">Error 2A safety chain int</div>	<p>Connection to over-temperature switch on steam cylinder broken or over-temperature switch faulty.</p> <p>Steam cylinder overheating, over-temperature switch has responded.</p> <p>Flat-band cable between control and power board interrupted or not connected.</p>	<p>Check connections or replace over-temperature switch.</p> <p>Inspect steam cylinder, clean if necessary. replace over-temperature switch.</p> <p>Inspect connections, connect or replace flat-band cable.</p>
<p>Max. filling time exceeded (alarm message only) Error code: 3A/3B</p> <div style="border: 1px solid black; padding: 2px; text-align: center;">Alarm 3A water supply</div>	<p>Water feed blocked (main water tap closed, filter valve closed or blocked).</p> <p>Water pressure too low.</p> <p>Inlet valve does not open, filter sieve in Inlet valve blocked or inlet valve faulty.</p> <p>Feed hoses into steam humidifier not connected or kinked.</p> <p>Level unit not connected</p> <p>Float in the level unit sticking or level unit faulty.</p>	<p>Check water feed (open main water tap, open or clean filter valve).</p> <p>Raise water pressure (range 1-10 bar).</p> <p>Inspect electrical connections and fuse F2 on supply module. Clean filter sieve or replace Inlet valve.</p> <p>Inspect hoses into Unit and connect if necessary. Replace Faulty Hoses.</p> <p>Connect level unit.</p> <p>Clean or replace level unit.</p>
<p>Max. vaporization time exceeded Error code: 4A/4B</p> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px; text-align: center;">Alarm 4A steam time</div> <div style="border: 1px solid black; padding: 2px; text-align: center;">Error 4A steam time</div>	<p>Individual heating elements faulty.</p> <p>Fuses on the power board faulty.</p> <p>Mains voltage too low or failure of a phase (L1, L2 or L3).</p> <p>Steam lead too long or not insulated.</p> <p>This error may also occur upon a cold start.</p>	<p>Replace faulty heating elements.</p> <p>Replace fuses on power board.</p> <p>Check mains voltage and connections.</p> <p>Maintain maximum lead lengths (max. 4m), Insulate steam lead.</p> <p>Enable Soft start (see chapter 6.5).</p>

Malfunction/Indication	Cause	Remedy
Max. flushing time exceeded Error code: 5A/5B <div style="border: 1px solid black; padding: 2px; width: fit-content; margin-bottom: 5px;">Alarm 5A drain</div> <div style="border: 1px solid black; padding: 2px; width: fit-content;">Error 5A drain</div>	Drain pump not connected or faulty. Outlet lead from unit kinked or blocked. Water outlet blocked (external outlet lead or siphon blocked). Hoses to level unit blocked.	Connect or replace drain pump. Inspect outlet lead from unit, replace if necessary. Clean water outlet lead and siphon. Clean or replace hoses.
Invalid level Error code: 6A/6B <div style="border: 1px solid black; padding: 2px; width: fit-content; margin-bottom: 5px;">Alarm 6A level indicat</div> <div style="border: 1px solid black; padding: 2px; width: fit-content;">Error 6A level indicat</div>	Level unit faulty. Magnetic field in vicinity of level unit.	Replace level unit. Eliminate magnetic field.
Steam pressure supervision (error only) Error code: 7A/7B <div style="border: 1px solid black; padding: 2px; width: fit-content;">Error 7A communication</div>	Steam hose blocked or restricted (water trap). Pressure balance adapter into steam connection fitting blocked. Duct pressure too high (>1500 Pa).	Inspect steam hose, clean if necessary and install correctly. Remove adapter and clean opening with a needle. Inspect ventilation settings.
External safety chain interrupted Error code: none <div style="border: 1px solid black; padding: 2px; width: fit-content; margin-bottom: 5px;">safety chain external A</div> <div style="border: 1px solid black; padding: 2px; width: fit-content;">mains failure B</div>	Ventilation interlock open. Automatic flow control has responded. Maximum humidistat has responded. No heating voltage available. Heating voltage dropped at Unit B.	Switch on ventilator/ventilation system. Inspect ventilator/filter of ventilation system. Servicing, inspect system if necessary. Check mains voltage.

Notes on fault elimination

Warning: Danger of death! In order to eliminate faults, the steam humidifier **must be switched off and secured against unintentional reconnection** as described in chapter 6.3. Take care that the electricity supply to the main contactor is disconnected (check with voltage tester).



Only allow trained and qualified personnel to repair faults. Faults relating to electrical installation (e.g. change of unit fuse) must only be carried out by authorized personnel or your Defensor representative's service technician.

Repair work and replacement of faulty components must only be carried out by your Defensor representative's service technician!

Exception: Replacing **faulty components during servicing** (see chapter 6.6) and **replacing faulty unit fuses** (see chapter 6.7.3).

6.7.3 Replacing unit fuses

Warning Danger of death! Before replacing the unit fuse the steam humidifier **must be switched off and secured against unintentional reconnection** as described in chapter 6.3. Take care that the electricity supply to the main contactor is disconnected (check with voltage tester).



Warning! Electronic components are very sensitive to electrostatic discharge. To protect these components, measures must be taken against damage from electrostatic discharge when replacing the unit fuse (ESD protection).

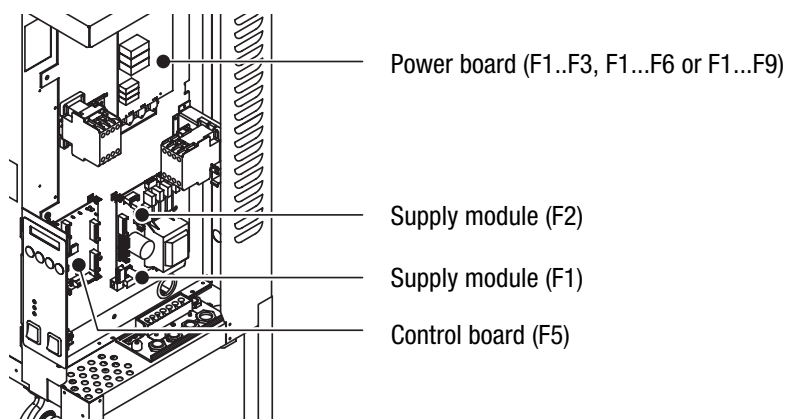
The unit fuses may only be replaced by trained and qualified personnel.

Important! If the unit fuse blows this is generally due to a faulty unit component. Therefore you should check these components before replacing the fuse (see table below).

Only use the correct type of fuse according to the following table.



Warning! It is not permitted to use repaired fuses.



Fuse	Specification	Before replacing, check
F1 on supply module	6.3 A, slow-acting	Drain pump (blocked or coil faulty)
F2 on supply module	1 A, quick-acting	Inlet valve (blocked or coil faulty)
F5 on control board	50mA, quick-acting	Control signal
F1...F3 on power board (Mk5 Visual/Process 5-.. and 8-..)	16 A, super quick-acting	Heating elements (on short-circuit)
F1...F9 on power board (all other models)	20 A, super quick-acting	Heating elements (on short-circuit)

6.7.4 Resetting fault indication “Error”

In order to return the steam humidifier to operation after fault elimination, the steam humidifier must be switched off for approx. 5 seconds and then switched on again.

7 Technical data

	Defensor Mk5 Visual/Process										
	5-..	8-..	10-..	16-..	20-..	24-..	30-..	40-..	50-..	60-..	80-..
Steam output	0 - 100 % infinitely variable										
Number of units	1	1	1	1	1	1	1	1	2	2	2
Steam connection	G 1 1/4"										
Resolution	1.0 %										
Control of steam output	0...20 V (Phase intersect), 0...10 VDC, 1...5 VDC, 0...5 VDC 0...4.25 VDC (Potentiometer), 0...1 VDC, 2...10 VDC 0...20 mADC, 4...20 mADC all potentiometric humidity sensors from 140 Ω...10 kΩ <2,5 VDC --> Off; ≥2,5 VDC...20 VDC --> On										
Duct air pressure	Overpressure max. 1500 Pa, Underpressure max. 1000 Pa (for duct pressures outside these values contact your Defensor supplier)										
Permissible ambient temperature	1...40 °C										
Permissible ambient humidity	1...75 %rh										
Water feed	– Connection G 1/2" – Permissible water pressure 1...10 bar – Feed temperature 1...40 °C – Water quality untreated water, fully demineralized water or partially softened water										
Water outlet	– Connection Internal-ø= 40 mm – Outlet temperature max. 90 °C										
Weight in kg	– Operation 51 51 52 53 71 73 73 74 1x71 2x73 2x74 1x73 – Net 36 36 37 38 41 43 43 44 1x41 2x43 2x44 1x43										
Dimensions in mm	– Height 1087 1087 – Width 500 594 – Depth 437 392										
Content of lime collector tank in l	5 10										
Test certificate	SEV, VDE										
Type of protection	IP21										



Reg.No. 40002-2

Consulting, Sales and Service:

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