

# PLANNING AND OPERATING INSTRUCTIONS

Pressurized steam humidifier  
Condair **Esco**

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# 1 Introduction

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## 1.1 First things first!

Thank you for choosing the Condair Esco pressurized steam humidifier (abbreviated to Condair Esco).

The Condair Esco has been built using state-of-the-art technology and in accordance with the latest safety regulations. However, improper use of the Condair Esco may put users and/or third parties at risk and/or may also cause damage to material assets.

Please observe and comply with all information and safety instructions in this documentation and in the instructions to the components built into the humidifier system to ensure safe, proper and cost-efficient operation of the Condair Esco.

Should you have any questions after reading these instructions, please contact your local Condair representative. We will be happy to assist.

## 1.2 Information about the planning and operating instructions

### Delimitations

**These planning and operating instructions are about the Condair Esco in the various versions.** Options and accessories have only been described insofar as this is necessary for correct operation. Please see the relevant instructions for additional information on the options and accessories.

The information in this manual is limited to the planning and operation of a Condair Esco pressurized steam humidifier and is aimed at correspondingly trained and adequately qualified groups of persons.

These planning and operating instructions are accompanied by various separate documents which are included with delivery. Where necessary, these instructions may refer to these publications.

## Symbols used in this manual



### CAUTION!

The signal word "CAUTION" together with the general hazard symbol indicates information provided in this documentation which, if ignored, could lead to **damage and/or the failure of the device or other equipment**.



### WARNING!

The signal word "WARNING", together with the general hazard symbol, indicates safety and hazard information given in this documentation which, if ignored, **could lead to injury to people**.



### DANGER!

The signal word "DANGER", together with the general hazard symbol, indicates safety and hazard information given in this documentation which, if ignored, could lead to **serious injury or even death to people**.

## Storage

Keep this documentation in a safe place for further use. If these instructions are lost or if you are unsure whether this documentation is still up to date, please contact your Condair representative.

## Language versions

This documentation is available in various languages. For more information, please contact your Condair representative.

## 2 For your safety

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### General information

Any persons tasked with working on the Condair Esco pressurized steam humidifier must have read and understood the planning and operating instructions prior to starting work.

An understanding of the content of these planning and operating instructions is a basic prerequisite for protecting personnel from danger and operating the device safely and properly.

All pictograms, signs and labels applied to the Condair Esco pressurized steam humidifier must be observed and kept in a clearly legible condition.

### Personnel qualifications

The Condair Esco pressurized steam humidifier must only be installed, operated or serviced by persons familiar with the Condair Esco and who are adequately qualified for this work. It is the responsibility of the customer to ensure that the planning and operating instructions is supplemented by in-house instructions regarding supervision and reporting requirements, work organisation, personnel qualification, etc.

The operator of the Condair Esco pressurized steam humidifier must ensure that no unauthorised persons operate the humidifier.

Any work described in sections entitled "Operation", "Maintenance" and "Troubleshooting" must exclusively be carried out by **trained and adequately qualified specialist personnel that has been authorised by the operator**.

Furthermore, for safety and warranty reasons, interventions may only be undertaken by specialist personnel authorised by Condair.

It is assumed that all persons entrusted to work on the Condair Esco are familiar with and abide by the regulations on occupational health and safety and accident prevention.

### Intended use

The Condair Esco has been designed for connecting to an existing pressurized steam system and it is intended exclusively for duct air humidification within the specified operating conditions. Any other use without the written permission of Condair is deemed to be improper use and can render the Condair Esco hazardous.

Proper use also demands that **all information in this documentation and the installation instructions about the Condair Esco (in particular, all safety and hazard information) is duly observed**.

### **Hazards that may arise from the Condair Esco:**

The Condair Esco operates with hot, pressurized steam. Leaking steam can cause severe scalding and touching the system components during operation can cause burns. Observe and follow the following instructions:

- Do not touch any pipes and components of the Condair Esco pressurized steam humidifier during operation.
- Work must not be carried out on the Condair Esco and its components during operation and steam and condensate lines connected to the Condair Esco must not be disconnected.
- Before starting work on the Condair Esco, the system must be shut down, depressurized and secured against unintentional recommissioning (secure shut-off valves in the closed position and mark as intentionally closed, disconnect the power supply or pneumatic supply to the actuator, etc.).
- Allow sufficient time for the system to cool down after decommissioning to prevent burns.
- Condair Esco steam connection units must not be tampered with by the customer.

### **Unauthorised modifications to the device**

Do not make additions or modifications to the Condair Esco **without the written permission of** Condair.

When replacing any faulty components on the unit, use **only genuine accessories and spare parts** provided by your Condair representative.

## 3 Product overview

### 3.1 General notes on the Condair Esco

Condair Esco pressurized steam humidifiers are ideal for use wherever existing steam from an on-site compressed steam network is available for humidification. The Condair Esco pressurized humidifier takes the steam from an existing steam network and releases it evenly into the air stream without spraying condensate. Condair Esco pressurized steam humidifiers – models DR73 and DL40 – are compact, easy to install, safe to operate and enable an optimised humidification section thanks to their PC design. The tightly closing rotary valve with linear valve characteristic prevents steam from entering the air stream when closed. The steam capacity is regulated extremely accurately via an electric or pneumatic actuator on the valve unit.

#### Safe operation

A steam trap connected directly to the valve unit ensures a clean, condensate-free steam supply to the steam pipes. The nozzles of the steam pipes, which only take the steam from the core flow, make jacket heating unnecessary. The actuators of the valve unit are closed in de-energised state so that in the event of an interruption in the supply voltage, the control valve closes automatically and the steam supply to the steam pipes is interrupted.

#### Flexible use

The Condair Esco pressurized steam humidifier is available with two different steam distributor models. A total of 4 different valve units are available in ductile cast iron and two in stainless steel.

#### Compact

Strainer, secondary steam separator, steam trap, rotary vane control valve and actuator form a compact unit that takes up little space.

#### Easy to install

Combining all vital parts in the compact valve unit eliminates costly additional installations and avoids sealing problems during assembly.

#### Simple system design

Special design enables a Condair Esco pressurized steam humidifier to be designed quickly and easily based on system input and output parameters.

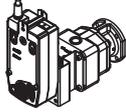
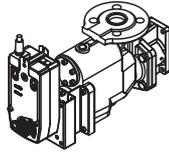
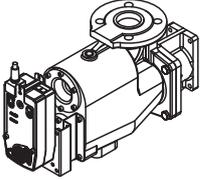
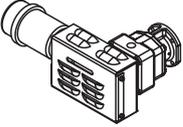
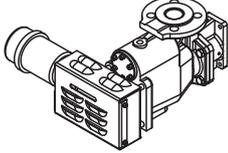
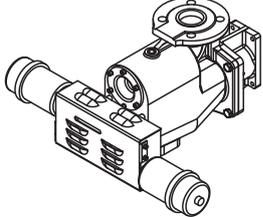
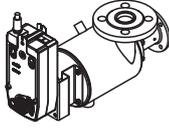
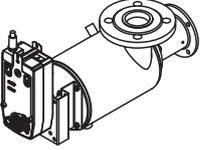
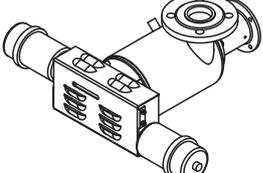
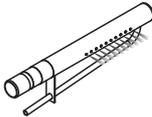
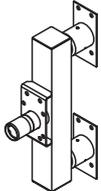
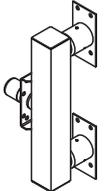
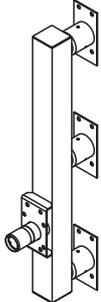
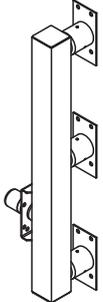
**Important:** Please read these instructions carefully. It contains important information that can help you design a Condair Esco pressurized steam humidifier with the design software.

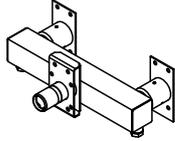
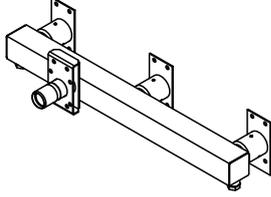
## 3.2 System description

Each Condair Esco pressurized steam humidifier consists of the following individual components:

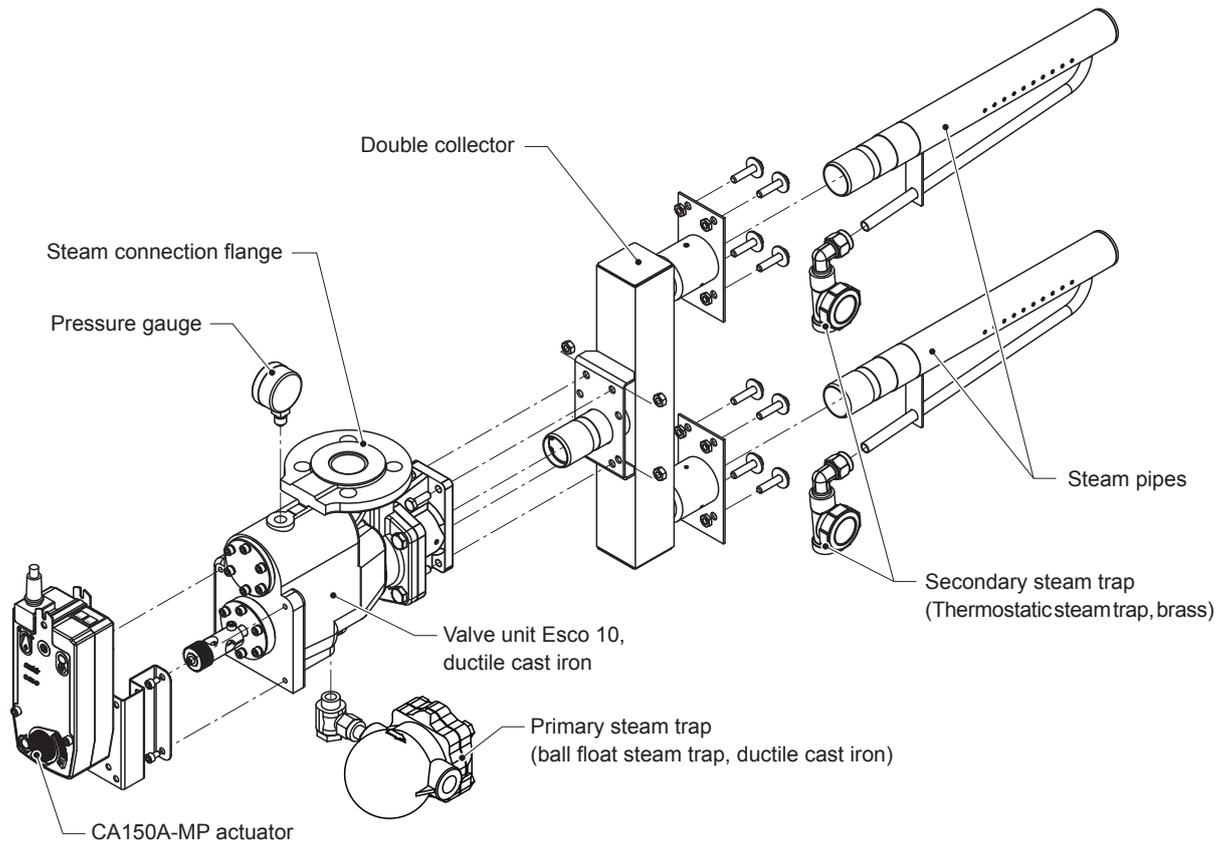
- **Valve unit** (made of ductile cast iron or stainless steel)
- **Actuator** (CA150A-MP electric actuator or pneumatic actuator)
- **Primary steam trap** with a screw connection (cast iron or stainless steel) is connected directly to the valve unit.
- **Steam distributor** (DL40 or DR73)
- **Secondary steam trap** with a screw connection (brass or stainless steel) is connected to the condensate pipe of the steam distributor.
- Options

### 3.2.1 Condair Esco DL40 overview

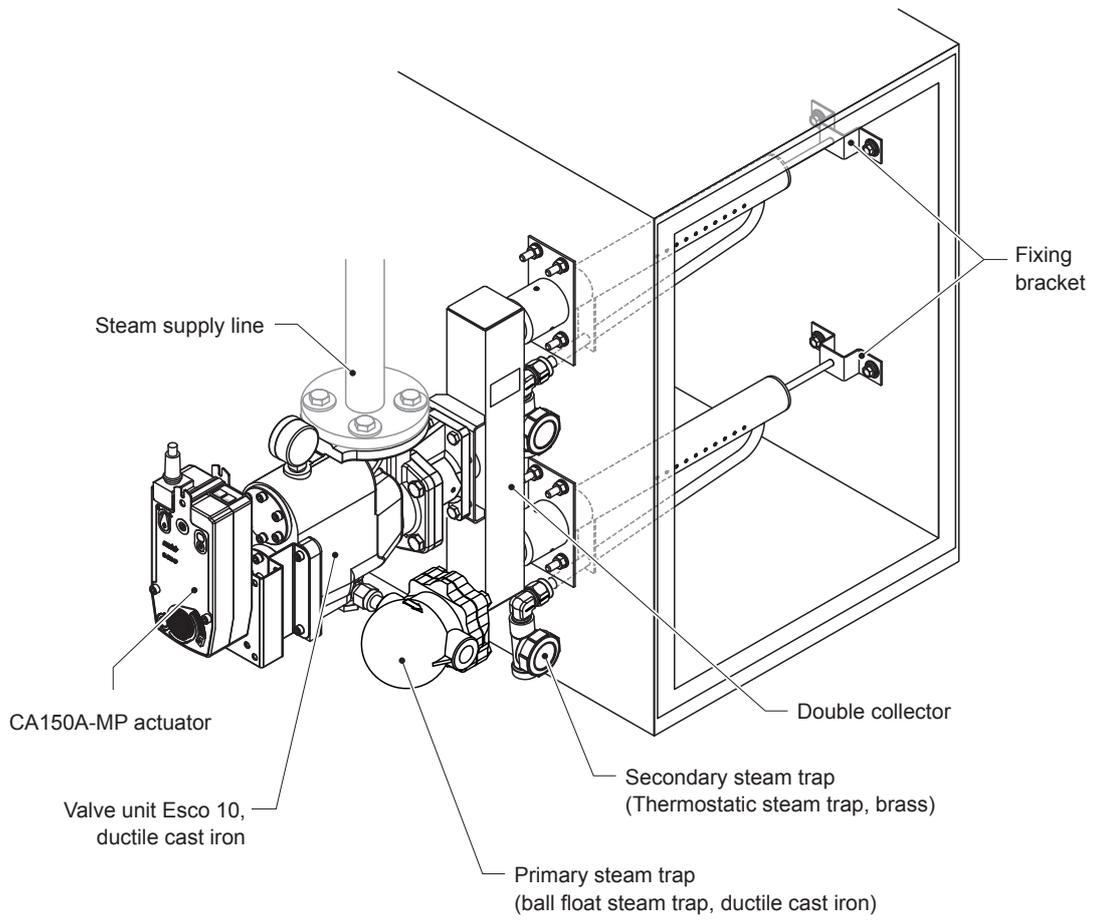
	Esco 5	Esco 10	Esco 20	
Valve units, ductile cast iron with electric actuator CA150A-MP				
Valve units, ductile cast iron with pneumatic actuator				
Valve units, stainless steel with CA150A-MP electric actuator				
Valve units, stainless steel with pneumatic actuator				
DL40 steam pipe (Nozzles arranged on the right or left)		 		
Collector for two DL40 steam pipes for horizontal air ducts/air handling units		Standard connection 	Connection right 	Connection left 
Collector for three DL40 steam pipes for horizontal air ducts/air handling units		Standard connection 	Connection right 	Connection left 

	Esco 5	Esco 10	Esco 20
Collector for two DL40 steam pipes for vertical air ducts/air handling units			
Collector for three DL40 steam pipes for vertical air ducts/air handling units			
Primary steam traps			
Thermostatic steam trap			
Ball float steam trap			
Inverted bucket steam trap			
Ball float steam trap, stainless steel			
Inverted bucket steam trap, stainless steel			
Secondary steam traps			
Thermostatic steam trap			
Thermostatic steam trap, stainless steel			
Pressure gauge			

**Example: System overview Condair Esco 10 ductile cast iron with DL40 double collector**

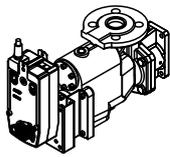
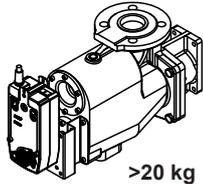
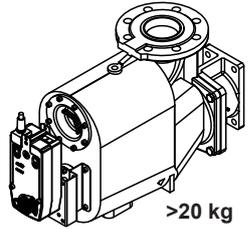
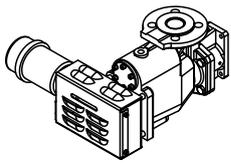
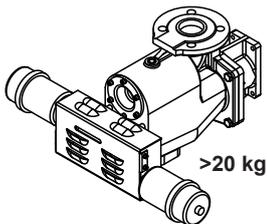
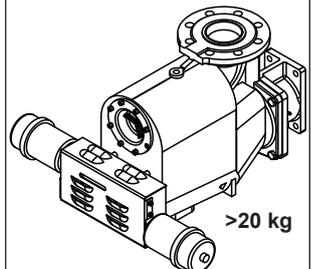
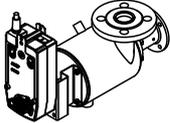
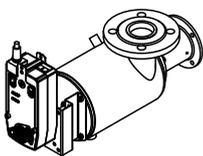
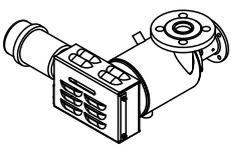
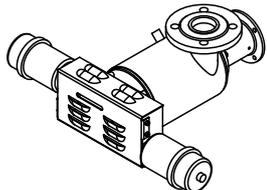


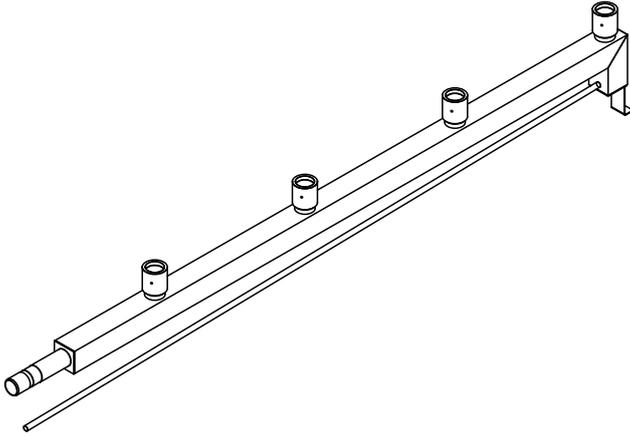
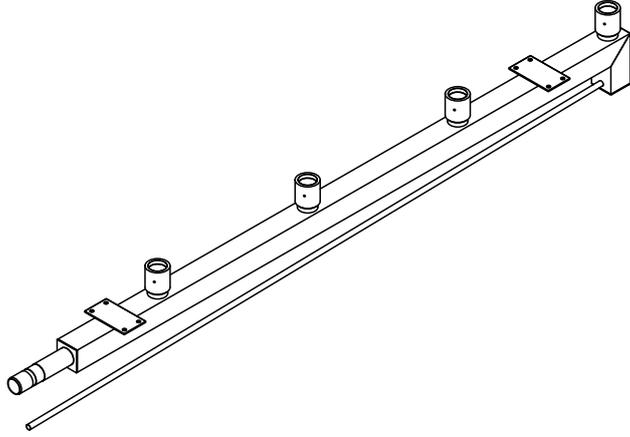
*Fig. 1: Overview components Condair Esco 10 ductile cast iron with DL40 double collector*



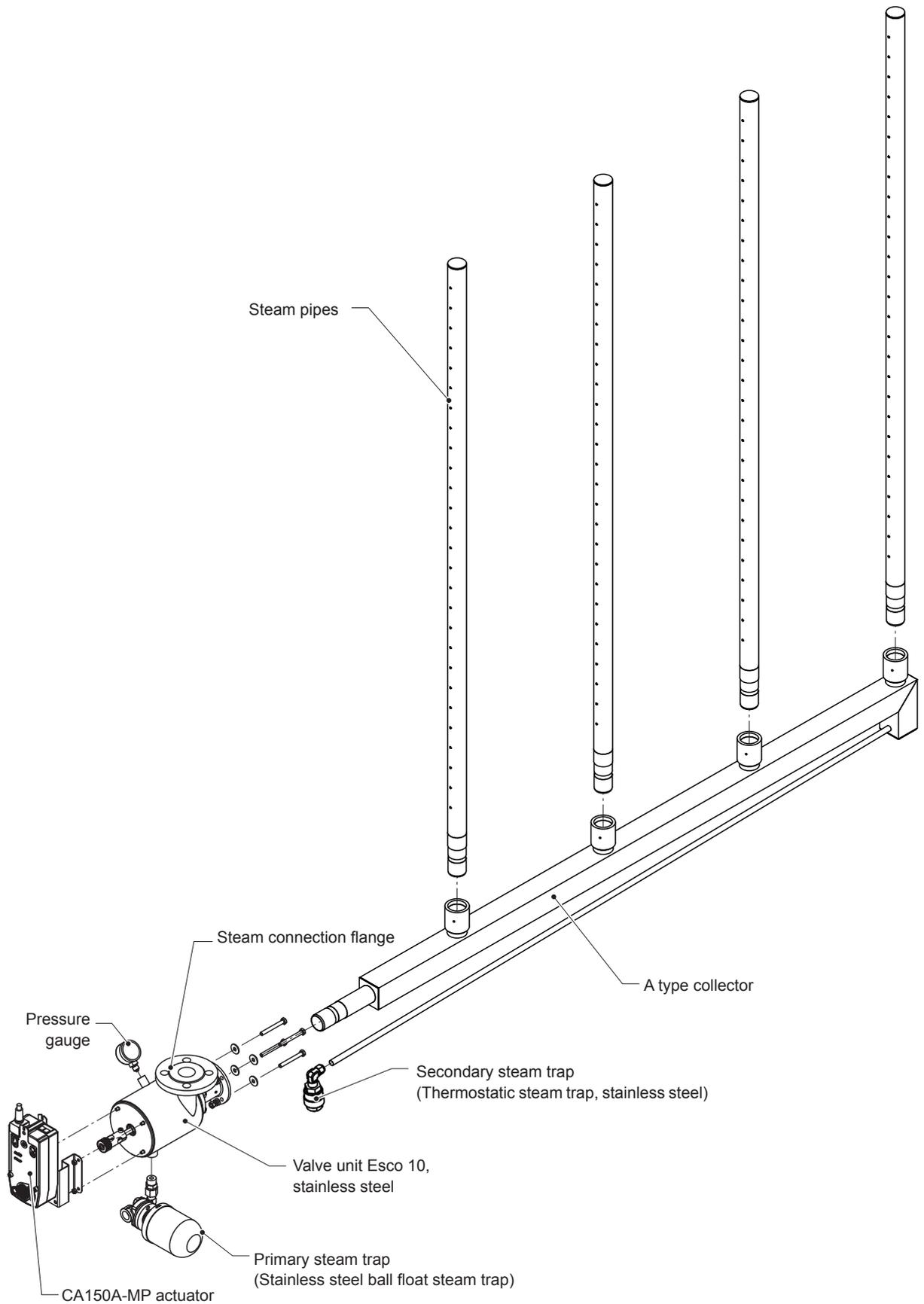
*Fig. 2: Installation overview Condair Esco 10 ductile cast iron with DL40 double collector*

### 3.3 Esco DR73 overview

	Esco 10	Esco 20	Esco 30
Valve units, ductile cast iron with electric actuator CA150A-MP		 >20 kg	 >20 kg
Valve units, ductile cast iron with pneumatic actuator		 >20 kg	 >20 kg
Valve units, stainless steel with electric actuator CA150A-MP			
Valve units, stainless steel with pneumatic actuator			
DR73 steam pipe			

	Esco 10	Esco 20	Esco 30
DR73 collector, A type			
DR73 collector, B type			
Primary steam traps			
Ball float steam trap			
Inverted bucket steam trap			
Ball float steam trap, stainless steel			
Inverted bucket steam trap, stainless steel			
Secondary steam traps			
Thermostatic steam trap			
Thermostatic steam trap, stainless steel			
Pressure gauge			

**Example: System overview Condair Esco 10 stainless steel with DR73 A type**



*Fig. 3: Overview components Condair Esco 10 stainless steel with DR73 A type*

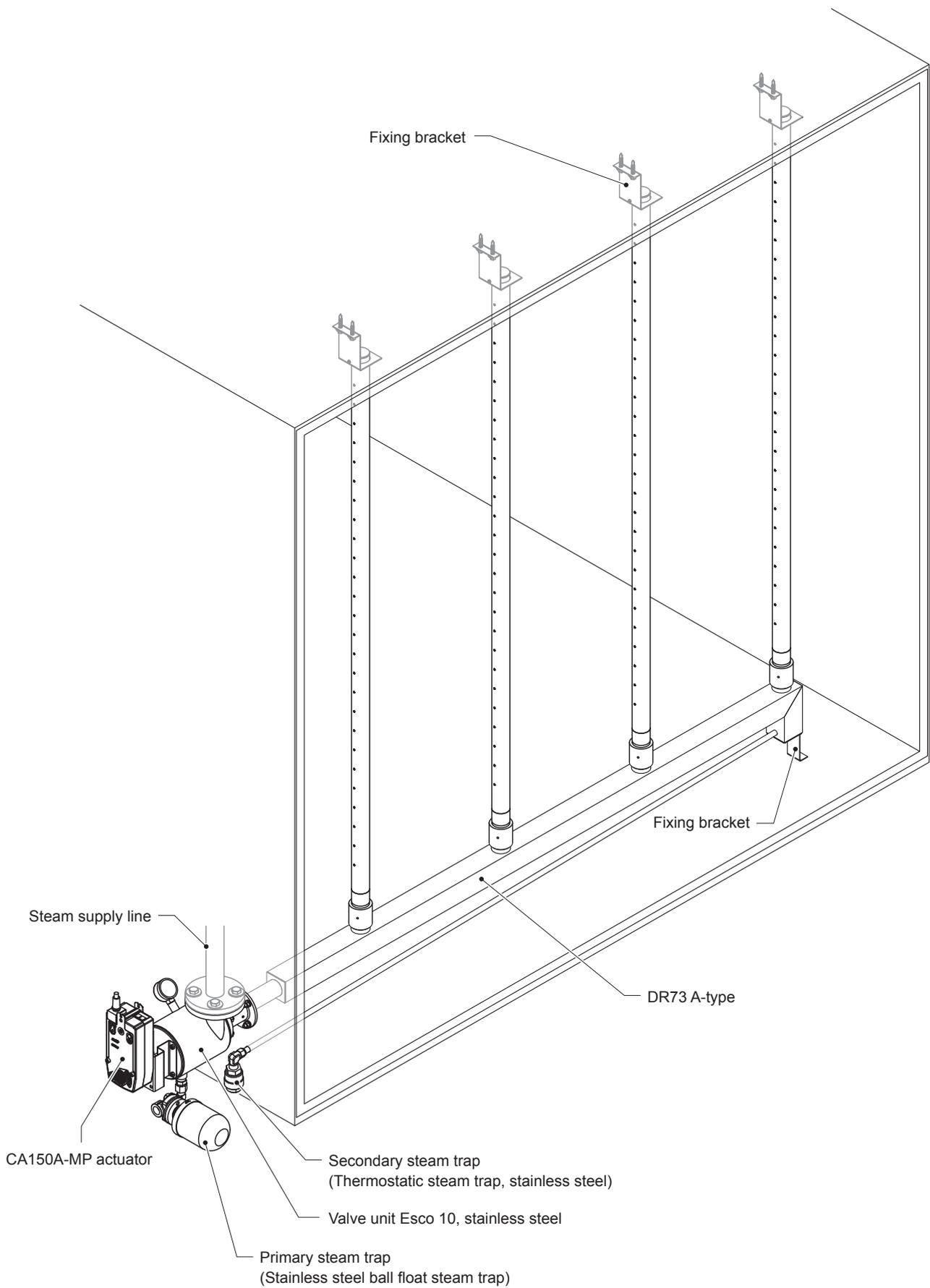
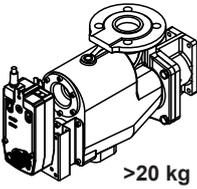
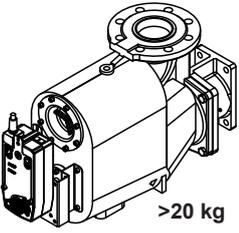
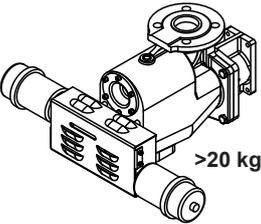
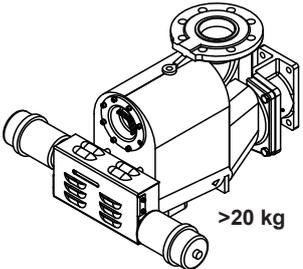
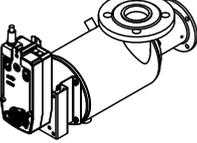
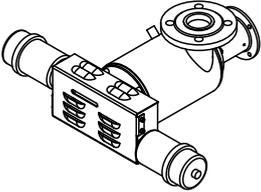
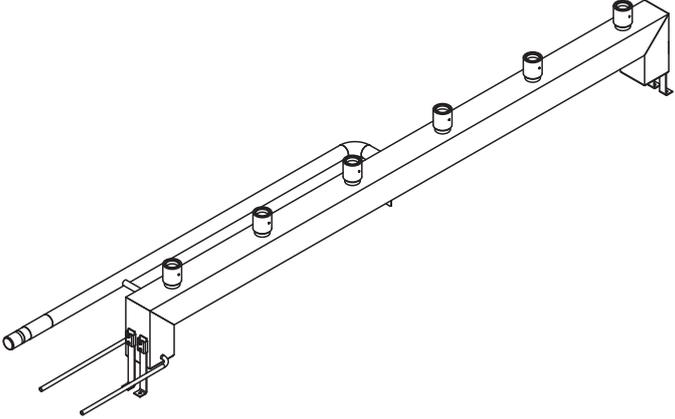
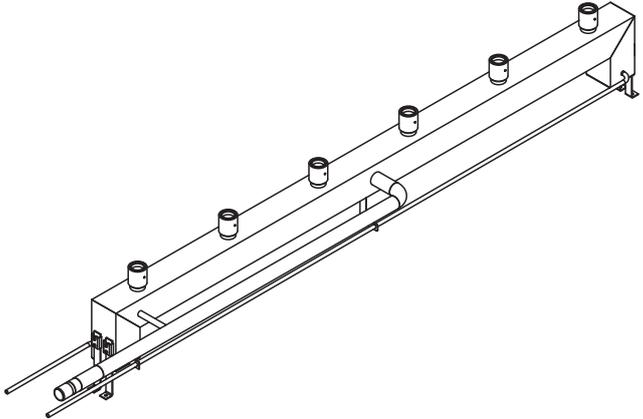
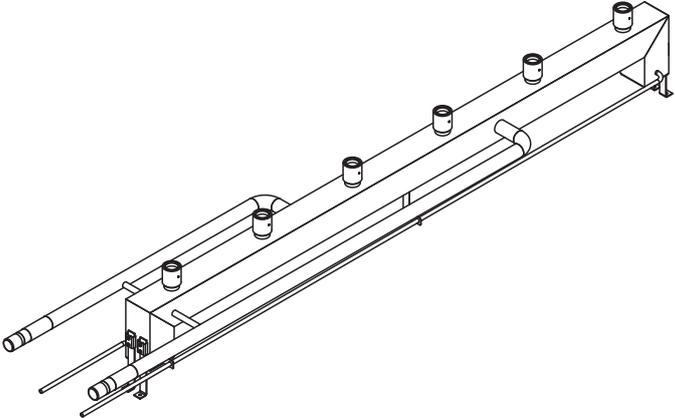
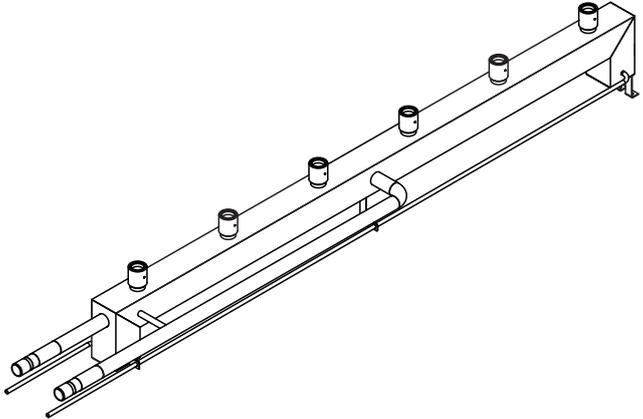
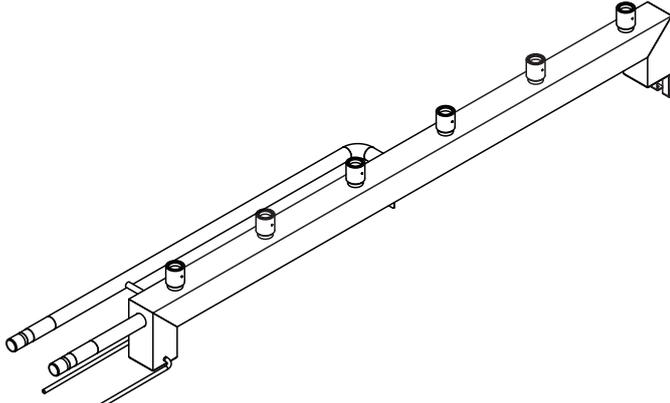


Fig. 4: Installation overview Condair Escos 10 stainless steel with DR73 A type

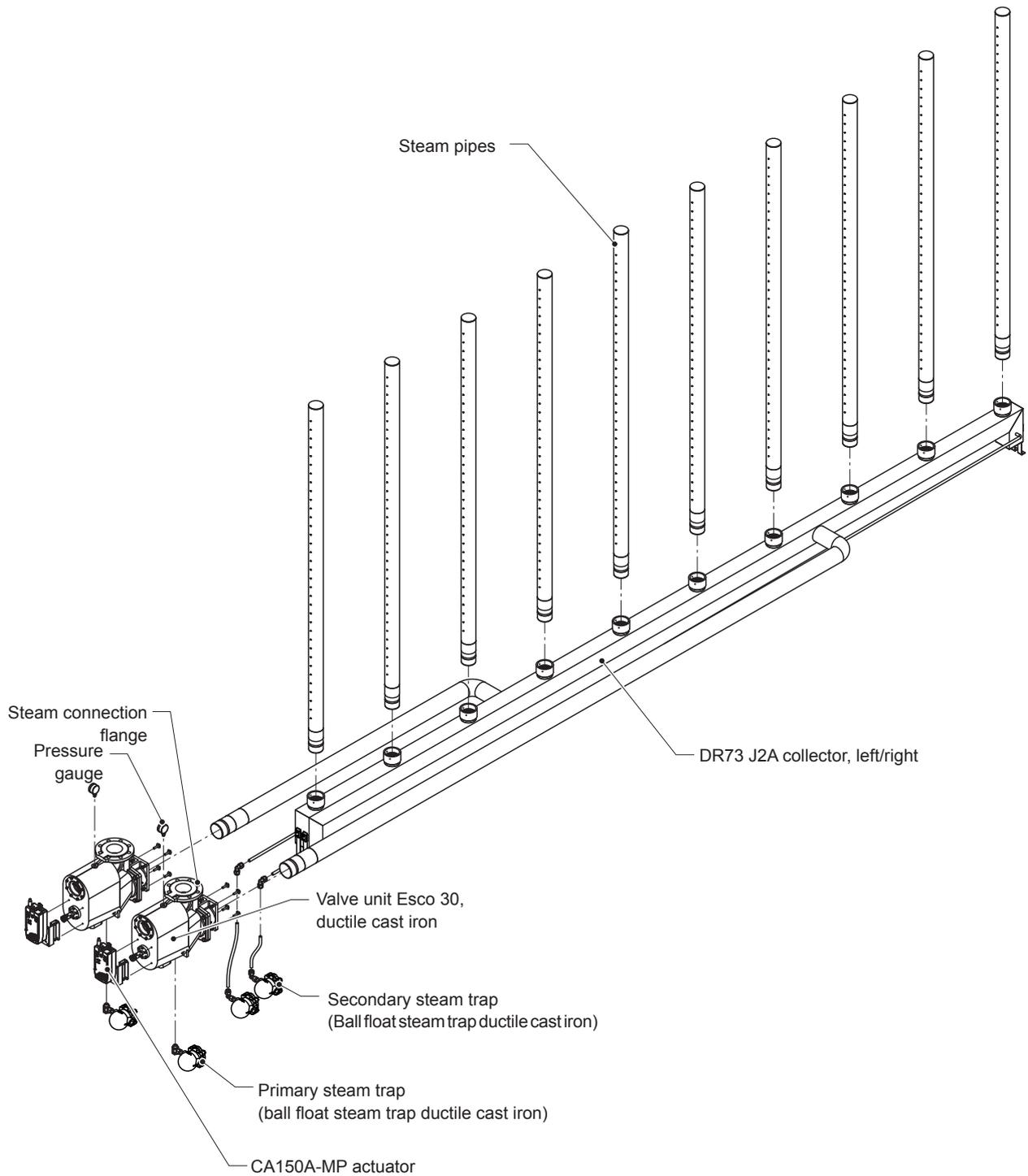
### 3.4 Esco DR73 J overview

	Esco 20	Esco 30
Valve units, ductile cast iron with electric actuator CA150A-MP	 <p>&gt;20 kg</p>	 <p>&gt;20 kg</p>
Valve units, ductile cast iron with pneumatic actuator	 <p>&gt;20 kg</p>	 <p>&gt;20 kg</p>
Valve unit, stainless steel with electric actuator CA150A-MP		
Valve unit, stainless steel with pneumatic actuator		
DR73 steam pipe		

Esco 20	Esco 30
DR73 JA collector, left	
DR73 JA collector, right	
DR73 J2A collector, left/right	
DR73 J2A collector, right/middle	

	Esco 20	Esco 30
DR73 J2A collector, left/ middle		
Primary steam traps		
Ball float steam trap		
Inverted bucket steam trap		
Ball float steam trap, stainless steel		
Inverted bucket steam trap, stainless steel		
Secondary steam traps		
Thermostatic steam trap		
Ball float steam trap		
Thermostatic steam trap, stainless steel		
Ball float steam trap, stainless steel		
Pressure gauge		

**Example: System overview Condair Esco 30 ductile cast iron with DR73 J2A left/right**



*Fig. 5: Overview components Condair Esco 30 ductile cast iron with DR73 J2A left/right*

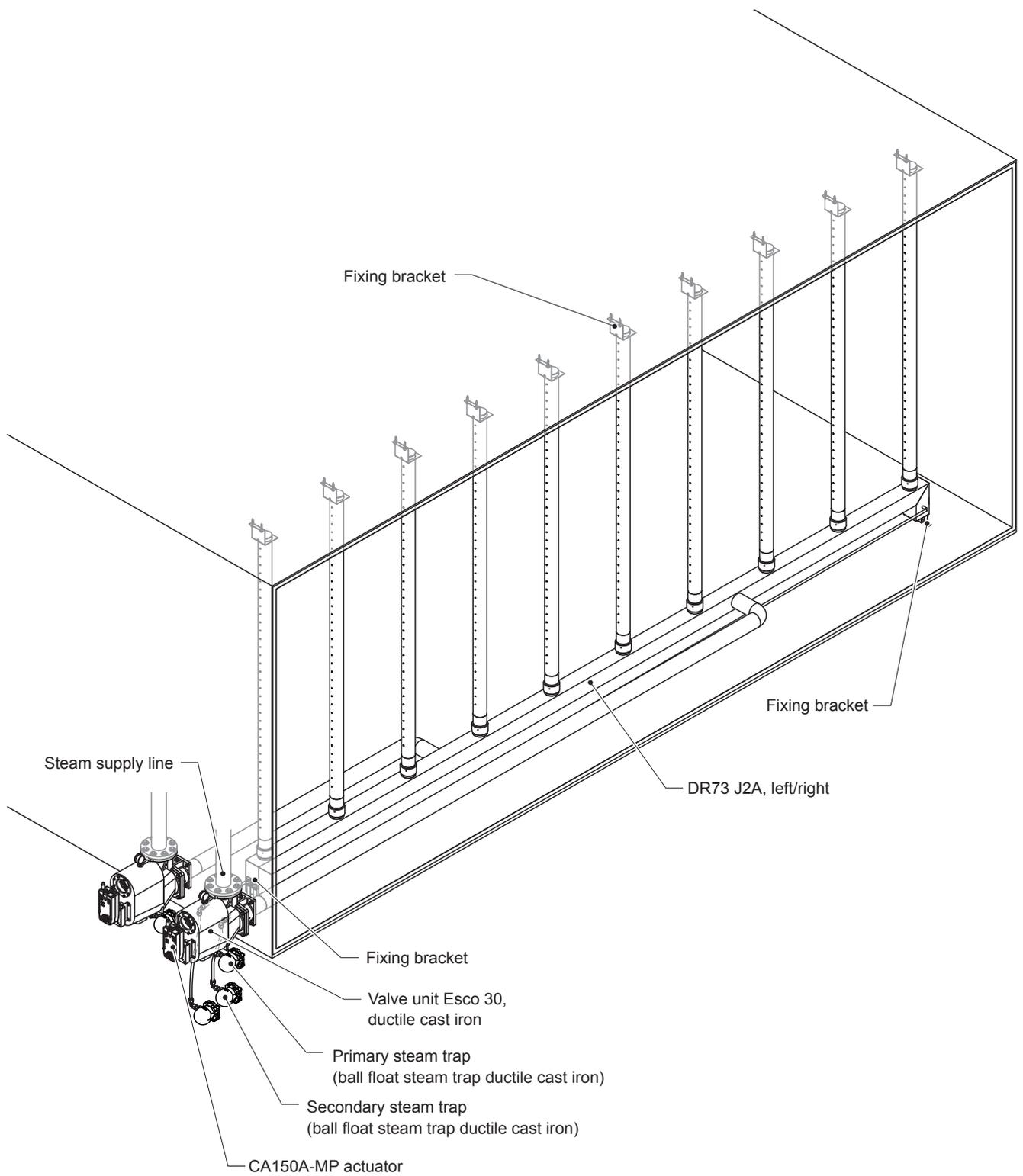


Fig. 6: Installation overview Condair Esco 30 ductile cast iron with DR73 J2A left/right

## 3.5 How it works

Condair Esco pressurized steam humidifiers (models DR73 and DL40) are connected to an on-site pressurized steam network.

The steam within the system when the ceramic rotary valve is closed is drained via the primary-side steam trap. This means that the Condair Esco is always ready for operation. However, the steam distributor remains cold and does not heat the air flow.

As soon as a humidity demand is present, the electric or pneumatic actuator opens the rotary valve in the valve unit and steam flows into the steam distributor. Before steam leaves the valve unit, condensate droplets are filtered out in the integrated steam separator so that only dry steam enters the steam distributors.

**DL40 model:** In the DL40 model, steam enters the steam pipe(s) directly from the valve unit or via the double/triple collector installed on the outside of the air duct/air handling unit. The steam inside the steam pipe(s) is taken from the core flow and blown out with slight pressure via the special nozzles in or in contrary to the direction of the air flow. Condensate collecting on the inner wall of the pipe is discharged via the condensate pipe and the thermostatic secondary steam trap.

**Model DR73:** In the DR73 model, steam flows from the valve unit via the collector to the vertically arranged steam pipes where it is taken from the core flow and blown out through special nozzles with light pressure on both sides across the air flow. Condensate collected in the steam pipe slides down the pipe wall into the horizontally mounted collector and is discharged there using condensate pipe(s) and the thermostatic secondary steam trap(s).

Since the steam in both series is only taken from the core flow of the steam pipes, it is free of condensate. For this reason, there is no need for jacket heating, which pre-heats the steam pipe in order to avoid condensation. As a result, there are no warm-up phases in which energy is required for jacket heating, nor delays when humidification is required. In addition, there is less installation work required, as there is no need for connecting piping for a jacket heater.

There is no condensate backup in both series, even when depressurized, as the steam pipe drains via the condensate pipe installed at a natural gradient.

### 3.6 Identification (rating plate)

The rating plate is located on the right or left side of the heat deflector plate of the actuator adapter.

The designation of the valve unit has also been labelled:

- For ductile cast iron valves on the rear of the steam connection flange
- On stainless steel valves on the rear of the valve housing
- Stamped on a metal badge. This is on the valve body/flange screw (valve disk only).

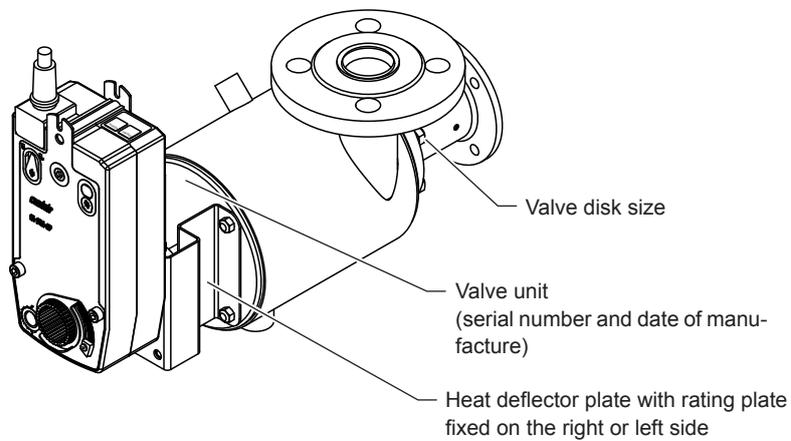
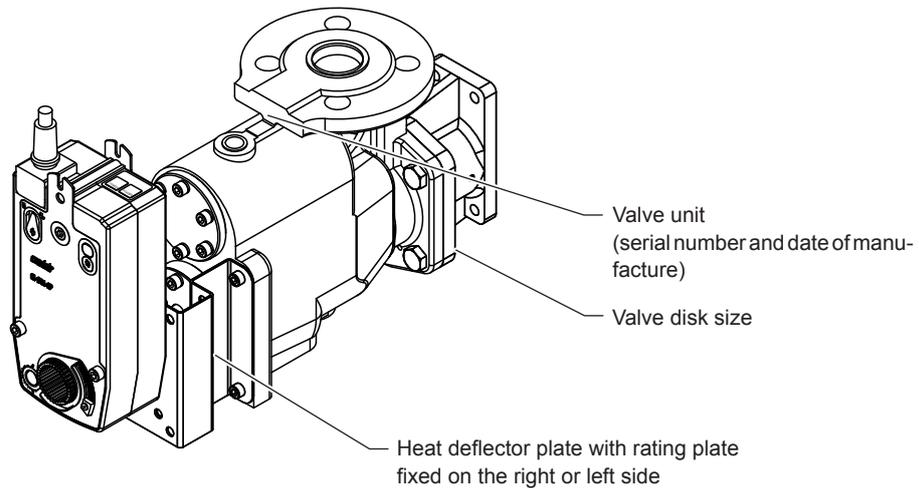


Fig. 7: Positioning of the rating plate

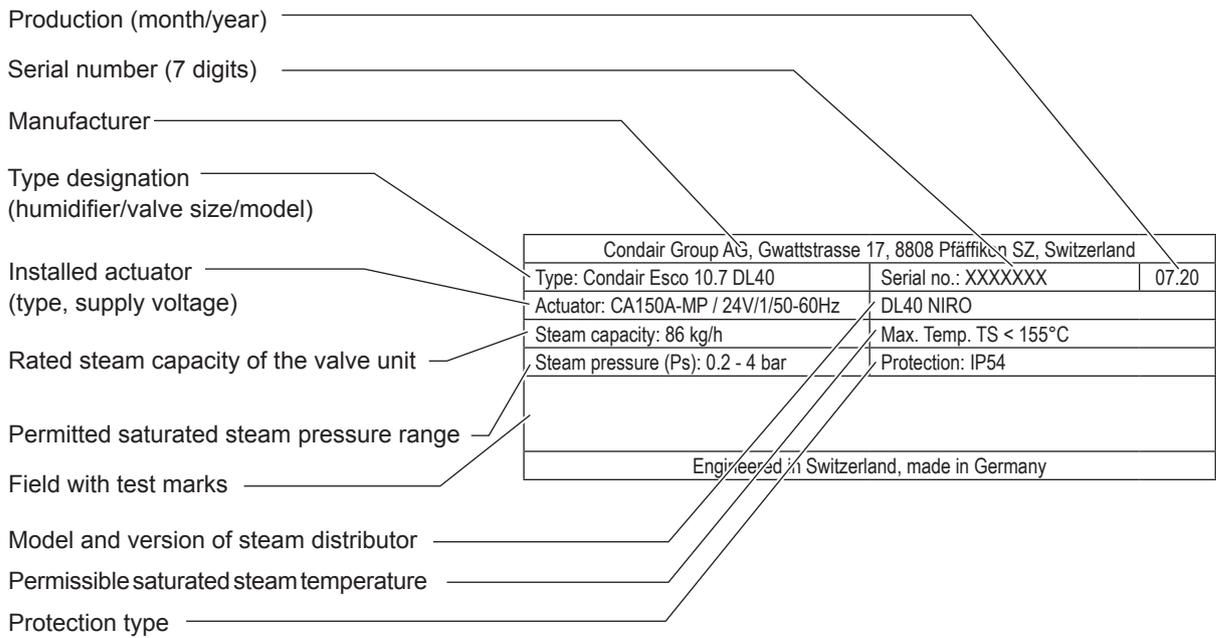


Fig. 8: Example: rating plate of a Condair Esco with CA150A-MP electric actuator

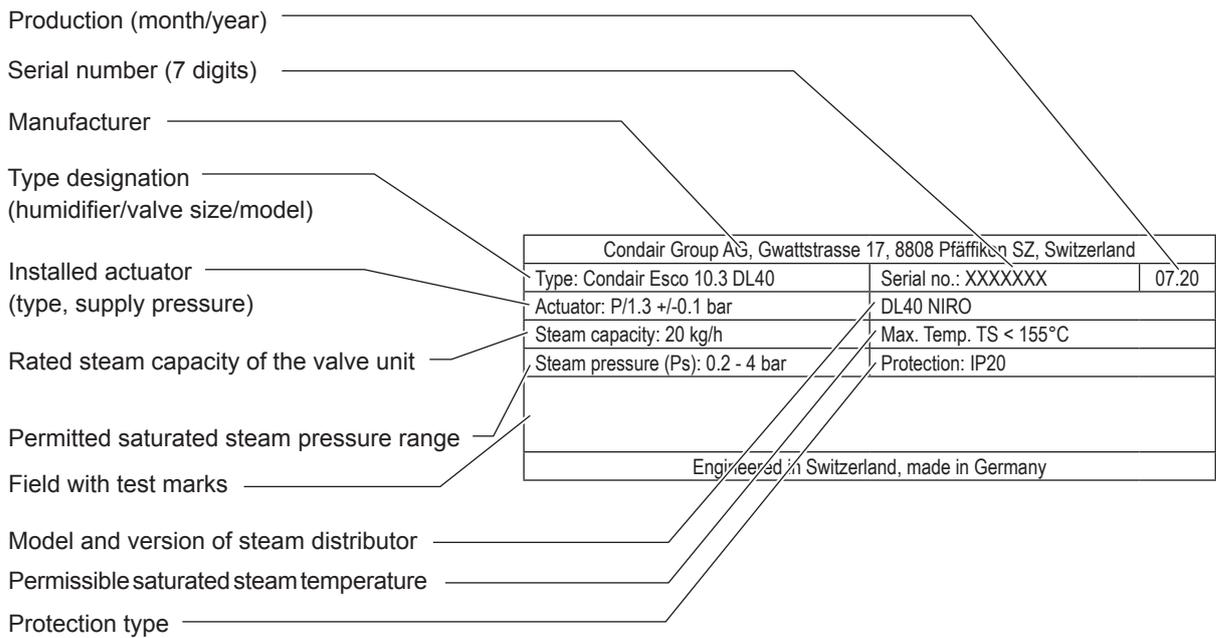


Fig. 9: Example: rating plate of a Condair Esco with pneumatic actuator

## 3.7 Scope of delivery

The Condair Esco pressurized steam humidifier is supplied as a complete system. No additional pipe sections, connectors, screws, etc. within the system must be procured by the installer!

Standard scope of delivery:

- Valve unit with installed electric or pneumatic actuator
- Flange gasket for steam supply line
- Steam trap with screw connection
- Self-adhesive drilling templates
- Operating and installation instructions, spare parts list (hard copy)

With DL40 steam distributor:

- Steam pipe(s) with secondary steam trap and screw connection
- If necessary, double or triple collector

With DR73 steam distributor:

- Steam distribution system with secondary steam trap
- Fixing bracket for the steam pipes incl. self-drilling screws for fastening

Not included in the scope of delivery:

- Sealing paste or sealing tape (heat-resistant up to 200 °C)
- Screws for the flange of the steam supply line
- Pneumatic hose when using the pneumatic actuator
- Extension pipe sections for secondary steam traps for DR73 JA and J2A types

## 3.8 Storage and transport

### Storage

Condair Esco components must be stored in their original packaging in a protected location under the following conditions:

- Room temperature: 5 to 40°C
- Room humidity: 10 to 75 %rH

### Transport

Where possible, always transport Condair Esco components in the original packaging and use a suitable means of transport or suitable lifting device.



### WARNING!

The customer is responsible for ensuring that staff are trained on handling heavy goods and are aware of and adhere to the relevant provisions on occupational safety and accident prevention.

### Packaging

If the packaging should be disposed of, follow local environmental protection guidelines. Recycle the packaging material wherever possible.

## 3.9 Components

### 3.9.1 Valve unit (or also steam connection unit)

#### Steam connection

The valve unit is connected to the steam supply line from above using a DIN standard flange or a 1/2" threaded connection on the Esco-5.

#### Strainer (for ductile cast iron valve units only)

The strainer is located inside the valve units and it is positioned at a 90 degree angle to the steam supply line. Thanks to the special design of the strainer, steam flows evenly through the entire strainer surface into the steam separator at a significantly reduced velocity. If necessary, the screw connection allows easy cleaning of the strainer. The strainer is made of stainless steel 1.4301. It must not be confused with a steam filter, which has a significantly smaller mesh size.

Information:

- Stainless steel valves do not feature a strainer. The Esco stainless steel valve unit is based on the use of pure steam, making the strainer superfluous. In any case, there must not be any dirt particles in the pure steam.
- Esco-5 ductile cast iron valve units do not feature an integrated strainer. However, this can optionally be mounted externally (in-line strainer).

#### Secondary steam separator (not for Esco 5)

In the secondary steam separator, condensate droplets are once again removed from incoming steam. In the case of ductile cast iron valve units, this is done by steam deflection with baffles. In stainless steel valve units this is done using a forced spiral movement. With both principles, the enclosed condensate droplets in the steam are forced to the inner surfaces of the valve unit by inertia, from where they flow downwards into the primary steam trap from where they are discharged.

**WARNING: The secondary steam separator does not replace the steam separator in the steam network**, but merely serves to remove any re-occurring condensate droplets from the steam prior to steam distribution resulting from heat loss.

#### Control valve

The humidifier control valve within the valve unit consists of two ceramic discs (silicon carbide) pressed together, one of which is fixed, while the other, known as the valve disk, rotates.

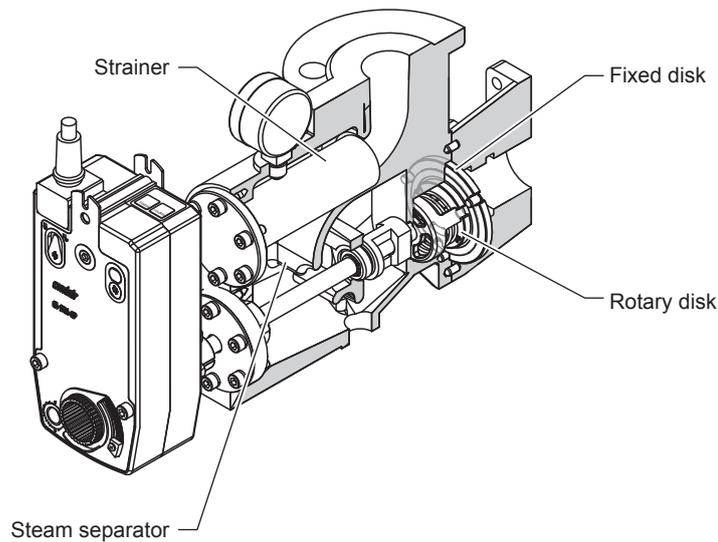


Fig. 10: Ductile cast iron control valve (Fig. shows Esco 10 ductile cast iron)

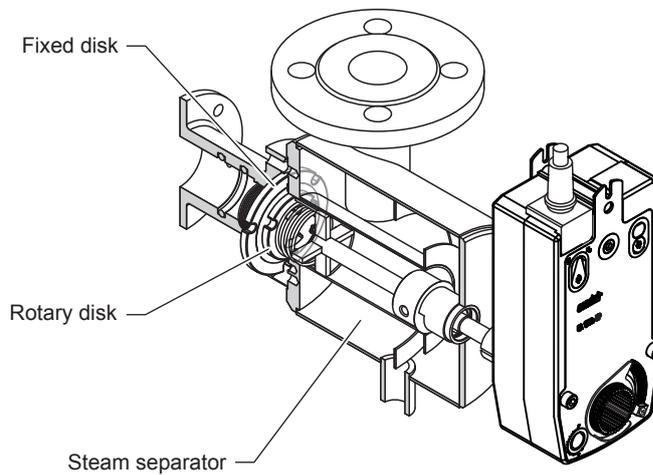


Fig. 11: Stainless steel control valve (fig. shows Esco 10 stainless steel)

The control valve characteristic is linear from the opening point of the valve over the entire control range, which simplifies the regulation of the steam capacity compared to equal percentage or proportional characteristic curves.

For the different valve units (Esco-5, Esco-10, Esco-20 and Esco-30), valve disks with different sized orifices are available. The valve disk thus determines the KVs value or the possible steam output of the valve unit. The valve units can be used for DL40 and DR73 steam distributors. Esco-5 and Esco-30 valve units are the exception.

## Valve unit technical data

	Valve unit					
	Esco-5	Esco-10		Esco-20		Esco-30
	Ductile cast iron	Ductile cast iron	Stainless steel	Ductile cast iron	Stainless steel	Ductile cast iron
Max. steam capacity <sup>1)</sup>	125 kg/h	250 kg/h		500 kg/h		1000 kg/h
Matches steam distributor	DL40	DL40 and DR73		DL40 and DR73		DR73
Number of valve disks	7 (5-1 to 5-7)	10 (10-1 to 10-10)		4 (20-1 to 20-4)		4 (30-1 to 30-4)
KVs values [m <sup>3</sup> /h]	0.16, 0.25, 0.4, 0.63, 1.0, 1.6, 2.5, 4.0, 6.3, 8.0			6.3, 10, 16, 21		16, 25, 33, 43
Steam connection	G 1/2" internal thread	DN32 PN16 flange		DN50 PN16 flange		DN80 PN16 flange
Integrated steam separator	No	Yes	Yes	Yes	Yes	Yes
Integrated strainer	No	Yes	No	Yes	No	Yes
Valve body and flange material	Ductile cast iron	Ductile cast iron	Stainless steel 1.4301 (AISI 304)	Ductile cast iron	Stainless steel 1.4301 (AISI 304)	Ductile cast iron
Shaft material	1.4305 (AISI 303)					
Drive material	Brass	Brass	Stainless steel	Brass	Stainless steel	Brass
Compression spring material	1.4401 (AISI 316)					
Stuffing box material	Aluminiumbronze	Aluminiumbronze	Plastic	Aluminiumbronze	Plastic	Aluminiumbronze
Seal material	PTFE					
O-ring material	EPDM/silicone with PTFE coating or FKM					
Permissible ambient temperature	5 to 50 °C					
Permissible steam pressure	0.2 to 4.0 barg					
Max. permissible steam temperature	Saturated steam temperature, max. 155°C at 4.0 bar					
Weight (valve unit only)	5.0 kg	14.2 kg	8.0 kg	27.5 kg	14.0 kg	52.2 kg
Steam trap on valve unit (primary steam trap)	Thermostatic capsule steam trap	Ball float or inverted bucket steam trap				
Actuator	Electric (Conair CA150A-MP) or pneumatic (Sauter AK41)					
Direction of rotation	Valve opens clockwise					
Pressure gauge option	No	Yes	Yes	Yes	Yes	Yes
Mounting set option	Yes	Yes	Yes	Yes	Yes	Yes
Flange plate option	Yes	Yes	Yes	Yes	Yes	Yes
Strainer option	Yes	--	--	--	--	--
Position controller option (pneumatic actuator only)	Yes	Yes	Yes	Yes	Yes	Yes

<sup>1)</sup> Refer to the following diagrams for the steam pressure required for maximum steam capacity.

The correct valve unit and the valve disk size are determined using the following diagrams. For this purpose, you need the required humidification capacity and the steam overpressure.

Note: The following diagrams also apply to the corresponding stainless steel valve units.

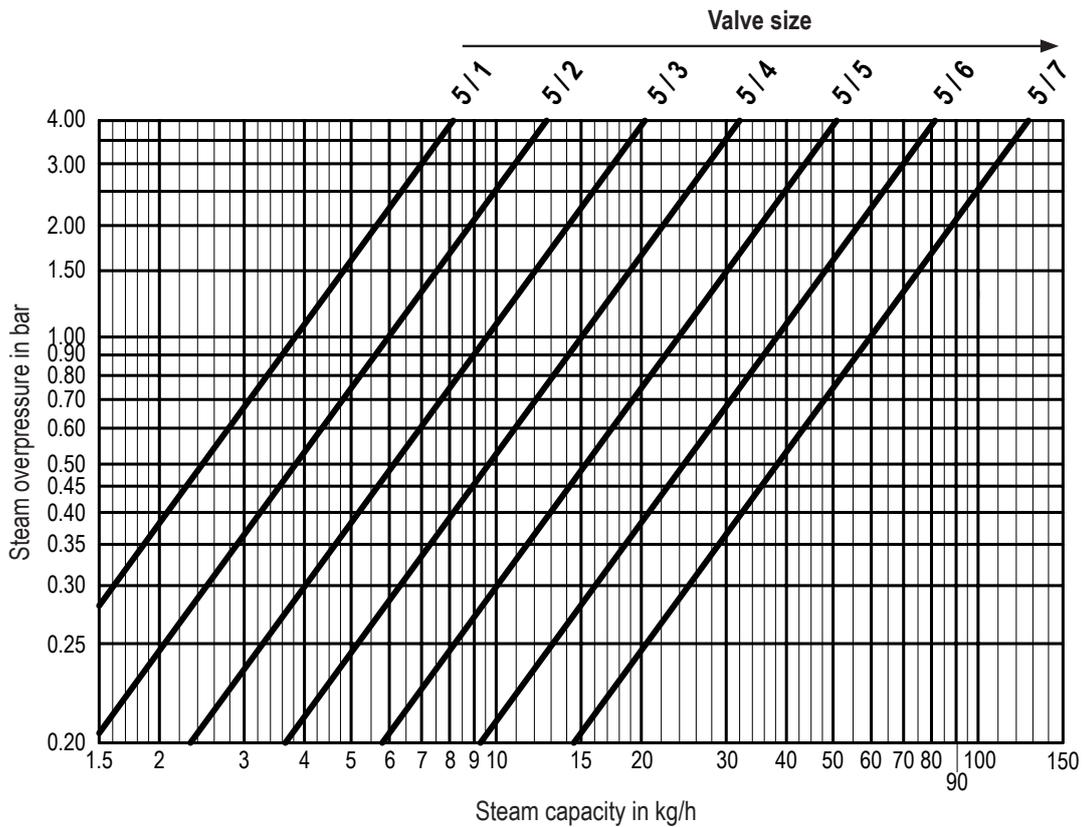


Fig. 12: Esco 5 valve unit selection chart

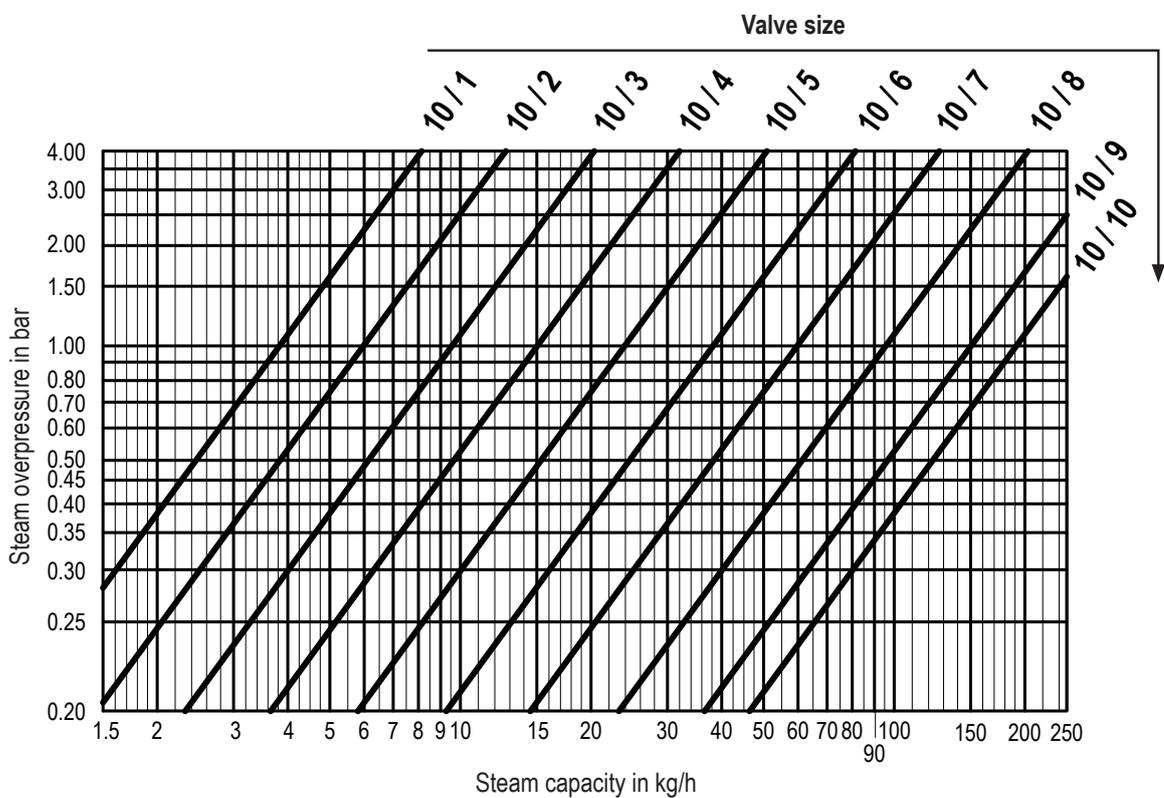


Fig. 13: Esco 10 valve unit selection chart

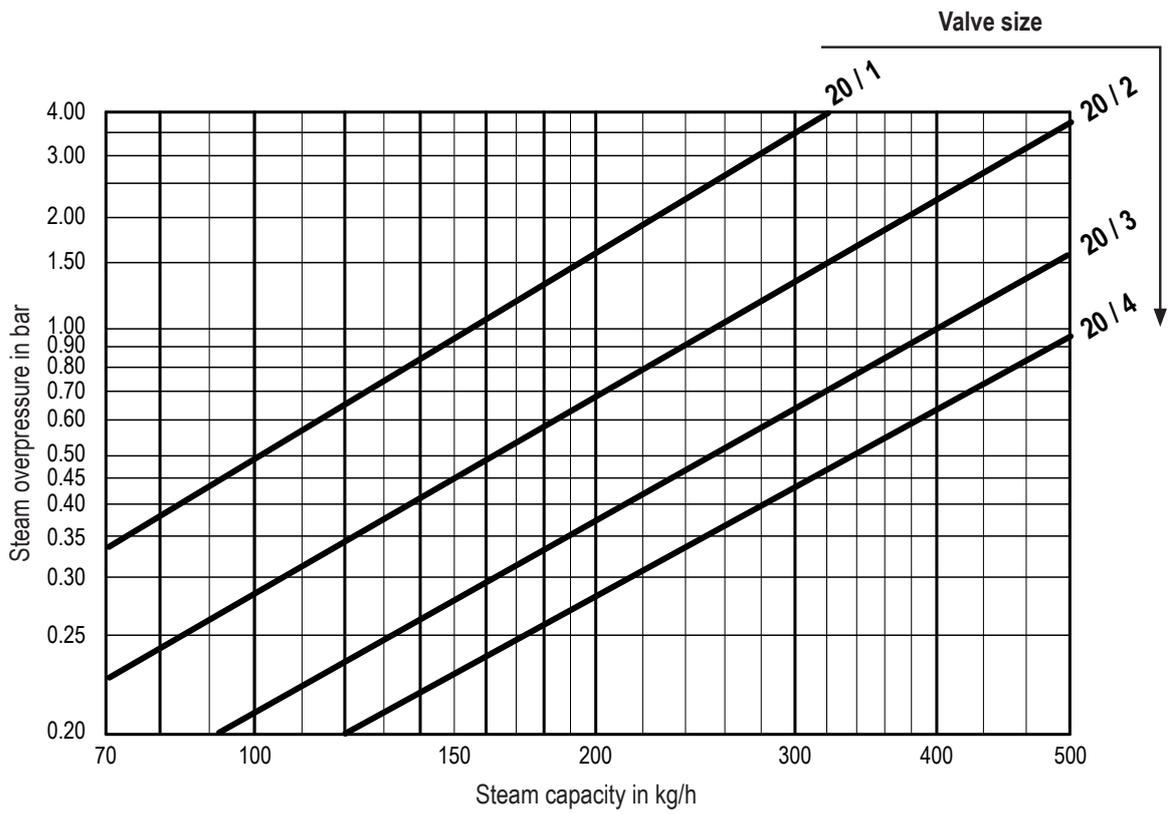


Fig. 14: Esco 20 valve unit selection chart

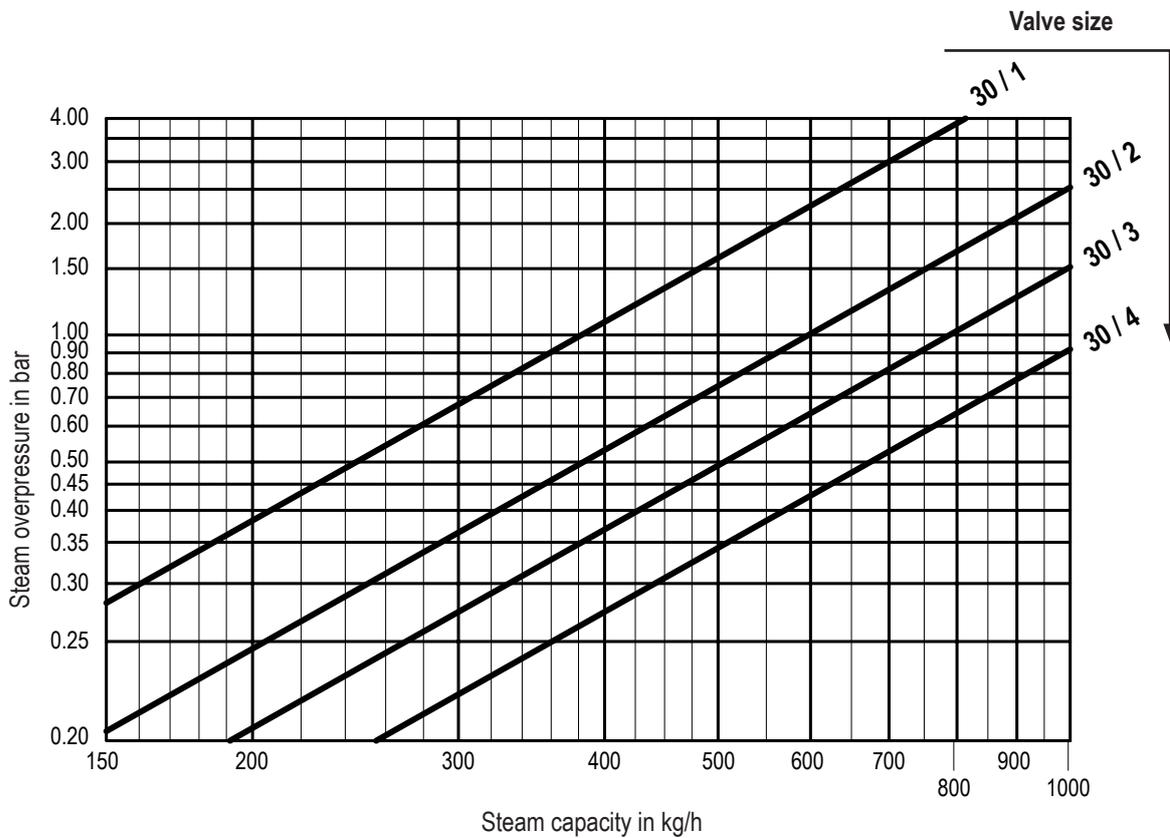


Fig. 15: Esco 30 valve unit selection chart

### 3.9.2 Actuators

The Condair Esco pressurized steam humidifier is equipped with an electric Condair rotary actuator. If required, a pneumatic actuator is also available ex works.

Adapters for the assembly of third-party actuators are available. When using third-party actuators the responsibility for the correct functionality of the actuator/valve unit combination lies with the customer.

Actuators, installed ex works:

- CA150A-MP
- Sauter AK41 pneumatic actuator

Adapter for installing a third-party actuator:

- Sauter ASF SF 122
- Siemens GCA 161.1E
- Joventa DM 1.1 F-R

Adapter for attaching an electropneumatic positioner to the pneumatic actuator:

- Samson 3730-2

#### 3.9.2.1 CA150A-MP electric actuator

The actuator housing consists of a metal base and cover plate with a welded plastic housing. A spring return ensures the emergency function. The factory default working range of the CA150A-MP starts from a demand signal of 2 VDC. However, as a result of the valve disc overlap in closed state (to ensure absolute tightness), the valve only opens at a signal value of 3 VDC.

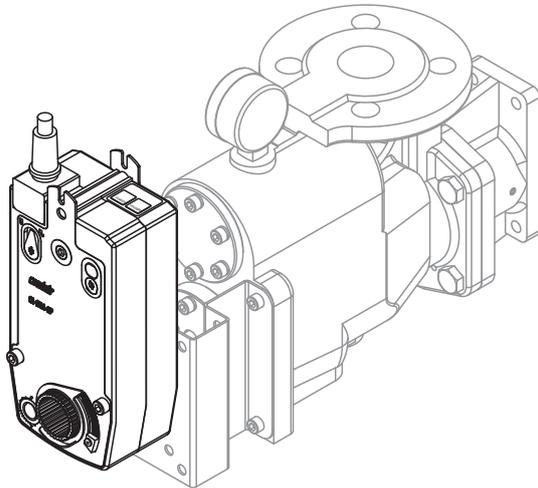
The actuator can also be configured and has an internal memory for error messages, active and operating time.

#### CA150A-MP electric actuator technical data

Power supply	24 VDC or 24 VAC 50 to 60 Hz (connection only via safety isolating transformer)
Dimensioning for cables	11 VA
Cable length, connection cable	1 m (4 x 0.75)
Rated power	In operation: 8.5 W, in standby: 3.5 W
Demand signal	2 to 10 VDC (adjustable: 0.5 to 10 VDC) Optionally also 4 to 20 mA using a 500 Ω resistor
Input resistance	100 kΩ (0.1mA)
Feedback	2 to 10 VDC (adjustable: 0.5 to 10 VDC)
Direction of rotation	Opens clockwise
Runtime for 0 to 100 %	150 s (adjustable: 70 to 220 s)
Spring return runtime	20 s
Torque	20 Nm (motor and spring return)
Max. rotation angle	90°
Response sensitivity	80 mV (at 2 to 10 VDC)
Reversal hysteresis	200 mV (at 2 to 10 VDC)
Resolution	1 %
Rotation angle limitation	37° to 90° in 3° increments with mechanically adjustable end stop and electronic angle adjustment (adaptation)
Protection rating	III (safety extra-low voltage)
Degree of protection	IP54, drip-proof
UL	cULus according to UL 60730-1A, UL 60730-2-14 and CAN/CSA E60730-1:02
Direct bus connection	MP bus

Parameter adjustment	Using parameter tool (external display with access to actuator parameters)
Permissible ambient temperature	5 to 50 °C
Permissible maximum ambient humidity	80%, non-condensing
Weight	2 kg

Condair Esco 10 ductile cast iron with CA150A-MP electric actuator



Condair Esco 10 stainless steel with CA150A-MP electric actuator

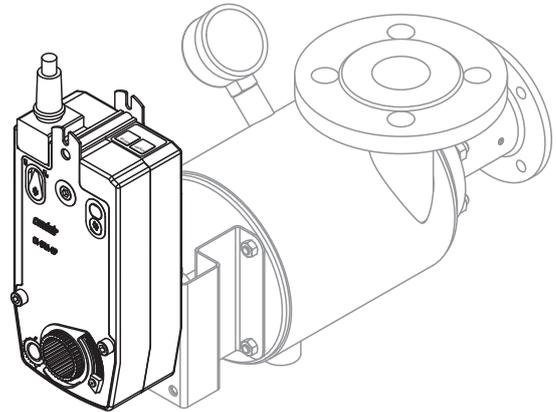


Fig. 16: CA150A-MP actuator

**Valve characteristic, Esco valves with CA150A-MP actuator**

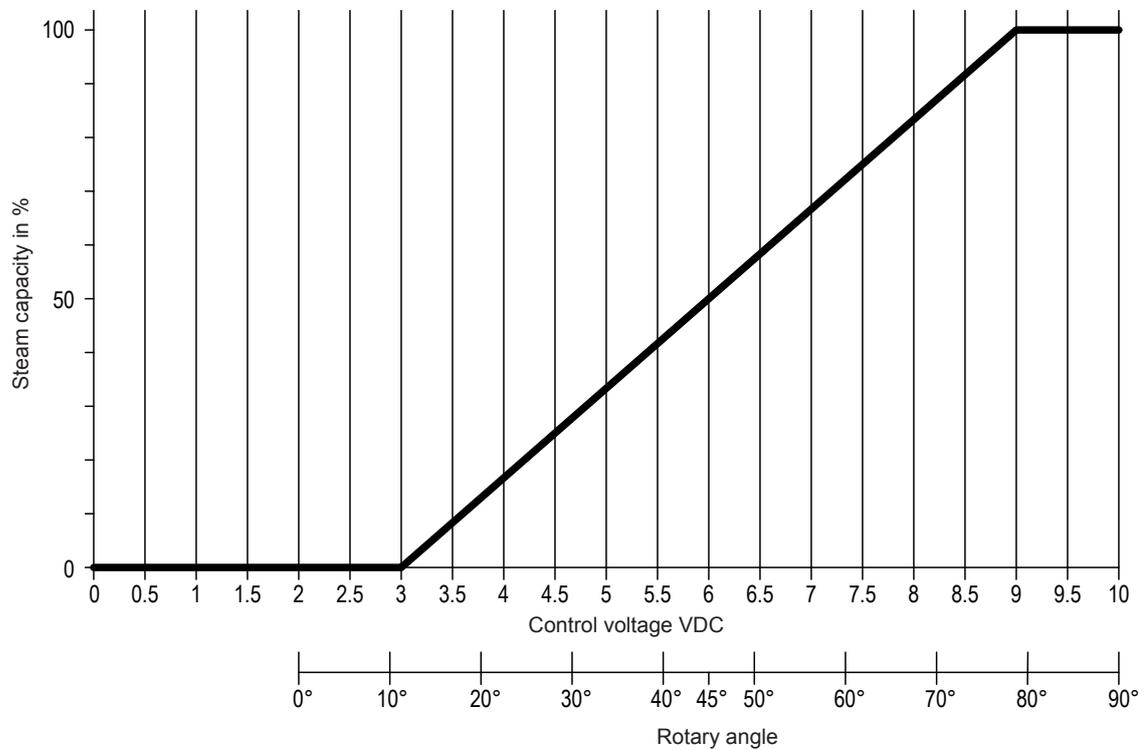


Fig. 17: Valve characteristic, Esco valves with CA150A-MP actuator

### 3.9.2.2 Pneumatic actuator

The actuators are fitted with an adapter and delivered complete with the respective valve unit ready for connection. The lifting movement of the pneumatic cylinder is changed to a rotating movement on the shaft using a 40 mm lever.

Optionally, the pneumatic actuator can be equipped with a mechanical positioner. A positioner has the following objectives:

- Increasing positioning accuracy thanks to mechanical feedback (via tension spring) of the current actuator position towards the positioner. As a result, the positioner "forces" the actuator into the correct position.
- Working range and zero point adjustment

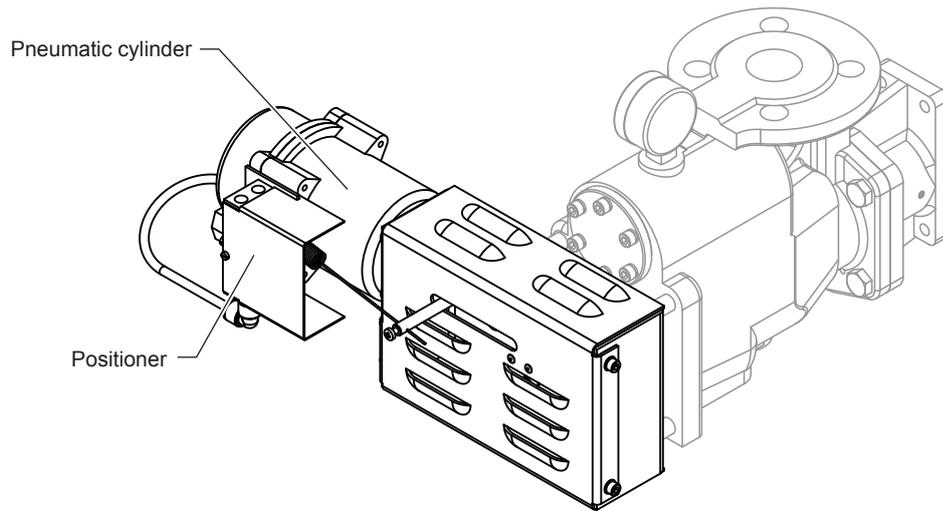
If the positioner for the valve unit with pneumatic actuator is also included in the order, it is mounted on the actuator and pre-set ex works.

#### Technical data – Sauter AK41/XSP31 pneumatic actuator

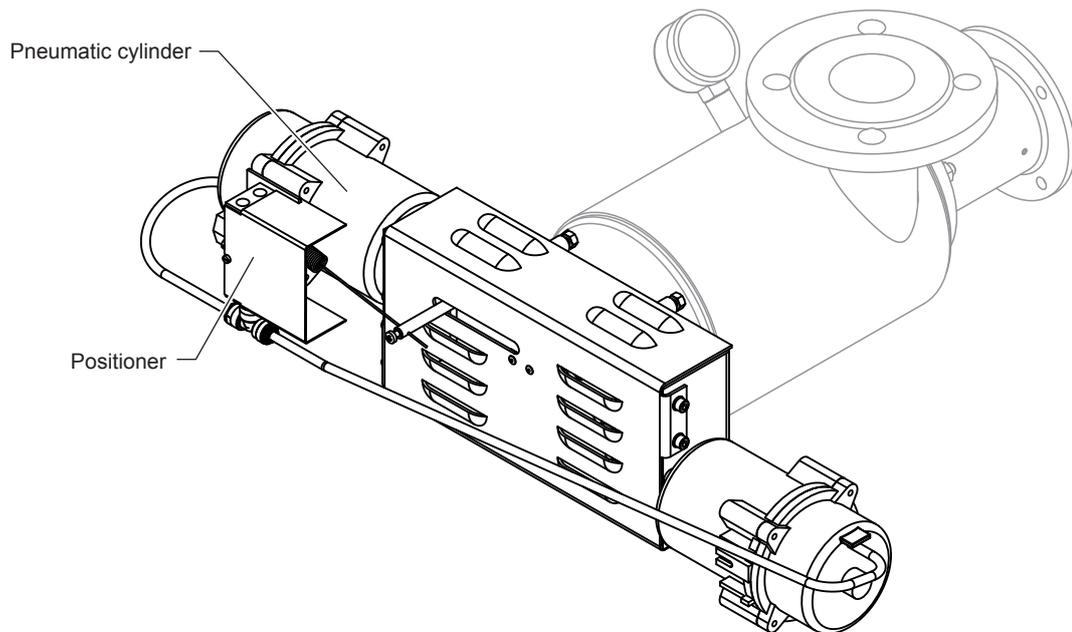
Sauter AK41 pneumatic actuator	
Supply pressure	Max. 1.5 bar
Demand signal	0 to 1.2 bar
Working range	0.3 to 0.9 bar
Spindle adjustment force	100 N
Stroke	63 mm
Air consumption for 100% stroke	0.5 l/n
Direction of rotation	Spindle extends = actuator opens
Runtime for 0 to 100 %	7 s
Spring return runtime	approx. 1 s, depending on air resistance
Degree of protection	IP20
Permissible ambient temperature	5 to 50 °C
Number of cylinders	Esco 5 and 10: 1 cylinder Esco 20 and 30: 2 cylinders
Cylinder installation position	Horizontal Note: With one cylinder, the installation position can also be rotated by 90° clockwise (cylinder upwards).
Housing material	Glass fibre reinforced plastic
Spindle material	Stainless steel

Sauter XSP31 positioner	
Supply pressure	1.3 ± 0.1 bar
Max. pilot pressure	1.4 bar
Working range	0.2 to 1.0 bar
Permissible ambient temperature	5 to 50 °C
Compressed air connections	Rp 1/8"
Housing material	Light metal

Condair Esco 10, ductile cast iron with Sauter AK41 pneumatic actuator and Sauter XSP31 positioner



Condair Esco 20, stainless steel with Sauter AK41 pneumatic actuator and Sauter XSP31 positioner



*Fig. 18: Sauter AK41 pneumatic actuator and Sauter XSP31 positioner*

Please refer to the additional installation instructions for the pneumatic actuator.

### 3.9.3 Steam traps

#### 3.9.3.1 Primary steam trap

Each Esco valve unit must be equipped with a primary steam trap that is connected to the corresponding connection at the bottom of the valve unit. The main objectives of the primary steam trap are:

- Draining condensate from the Esco valve unit
- Discharging air and non-condensable gases from the Esco valve unit
- Preventing steam from entering the condensate line

In addition to the valve unit, the primary steam trap also drains some of the steam supply line. Suitable screw connections are supplied for connecting the steam traps below the valve unit.

#### Overview of primary steam trap

	Ball float steam trap	Ball float steam trap, stainless steel	Inverted bucket steam trap	Thermostatic capsule steam trap
				
	With thermal bleed element and integrated strainer	With thermal bleed element	With vent bore (for differential pressure <1.5 and 1.5 to 4.0 bar)	With strainer and thermal bleed element
Suitable for the following valve unit	Esco-10, ductile cast iron Esco-20, ductile cast iron Esco-30, ductile cast iron	Esco-10, stainless steel Esco-20, stainless steel	For all valve units except Esco-5	Esco-5
Housing material	Ductile cast iron	Stainless steel 1.4308	Stainless steel 1.4301	Stainless steel 1.4305
Material, inside	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Bleed element	Thermal	Thermal	Bore	Thermal
Strainer	Yes	No	No	Yes
Connections	Rp 1/2"	Rp 1/2"	Rp 1/2"	Rp 1/2"
Max. Differential pressure	4.5 bar	4.5 bar	4.0 bar or 1.5 bar	--
Weight	3.4 kg	2.7 kg	1.9 kg	0.5 kg
Manufacturer	Spirax Sarco			

#### Information:

- All types used, including screw connections, are supplied in stainless steel if the Esco valve unit is also ordered in stainless steel.
- The standard steam trap is the "ball float" model because it has proven to work best in practice. Exception: The Condair Esco-5 uses the thermostatic capsule steam trap as standard.

Please follow the following instructions when handling the steam traps:

- None of the steam traps used operate below freezing point. They must therefore be protected against frost so that cooled condensate does not freeze.
- Inverted bucket steam traps must not be used in systems with superheated steam, since superheated steam removes the condensate reservoir and the inverted bucket can thus blow through (continuous steam discharge at the steam trap). In general, it is strongly recommended to only use saturated steam. Since it is often not apparent in advance whether superheated steam is used for the Esco (overheated steam can occur after a pressure reduction, for example), we recommend the use of a ball float steam trap.
- When selecting the inverted bucket steam trap the differential pressure between inverted bucket steam trap in/out must be known. This differential pressure must not be higher than permitted for the selected inverted bucket steam trap, as this will otherwise remain in the closed position.

The following two types can be ordered ex works:

- Inverted bucket steam trap for differential pressure less than 1.5 bar
- Inverted bucket steam trap for differential pressure 1.5 – 4.0 bar

It is often difficult to determine the differential pressure because the backpressure downstream of the inverted bucket steam trap is unknown. The ball float steam trap used in the Esco can help, which has a max. permissible differential pressure of 4.5 bar, thus covering the entire Esco pressure range.



**WARNING!**

**Risk of water and steam hammers**

If an inverted bucket steam trap is operated above the permissible differential pressure, it closes and can no longer open! The risk of water and steam hammers increases.

- Thermostatic capsule steam traps and the upstream condensate pipe must not be insulated under any circumstances, since their function is based on the cooling of the condensate.
- Ensure that the steam traps are installed in the correct position. For this purpose, follow the instructions in the Esco installation instructions. Incorrectly installed steam traps can cause malfunctions or steam hammers.

## How the ball float steam trap works

The ball float steam trap is a mechanical trap that works with the buoyancy force of the condensate.

If there is air in the steam, the saturated steam temperature is not reached at the corresponding pressure and the thermal bleed element (1) opens (see [Fig. 19. left](#)). As soon as the air has escaped from the ball float steam trap, the saturated steam temperature rises and the thermal bleed element closes (see [Fig. 19. centre](#)).

The condensate from the valve unit collects in the float housing. If there is no or only a small amount of condensate in the float housing, the outlet valve (2) is closed, which is connected to the ball float via a lever (see [Fig. 19. centre](#)). If the condensate level rises, the ball float is raised, the lever opens the outlet valve and the condensate drains (see [Fig. 19 right](#)).

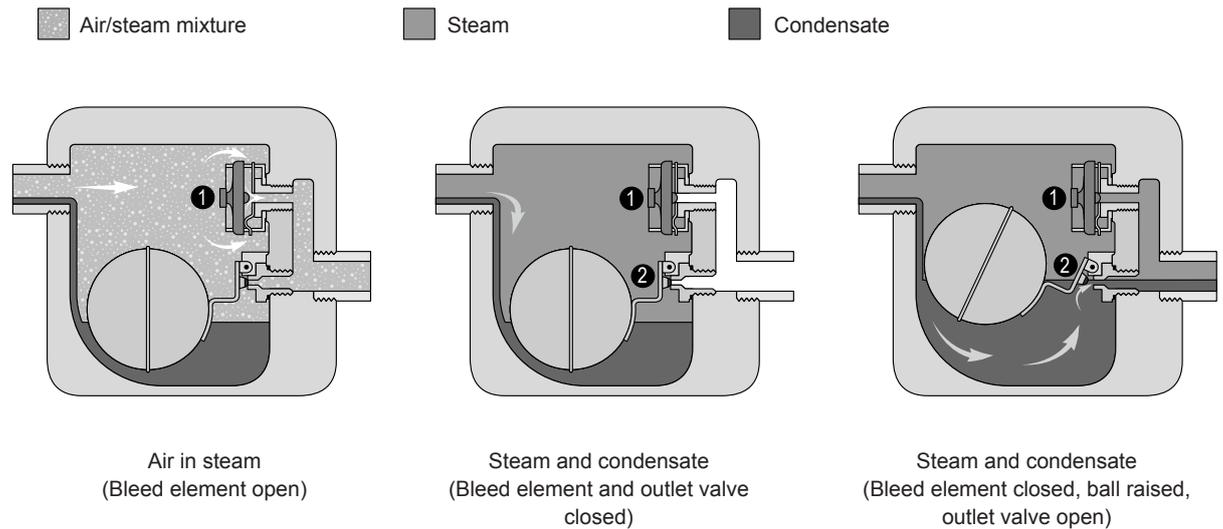


Fig. 19: How the ball float steam trap works

## How the inverted bucket steam trap works

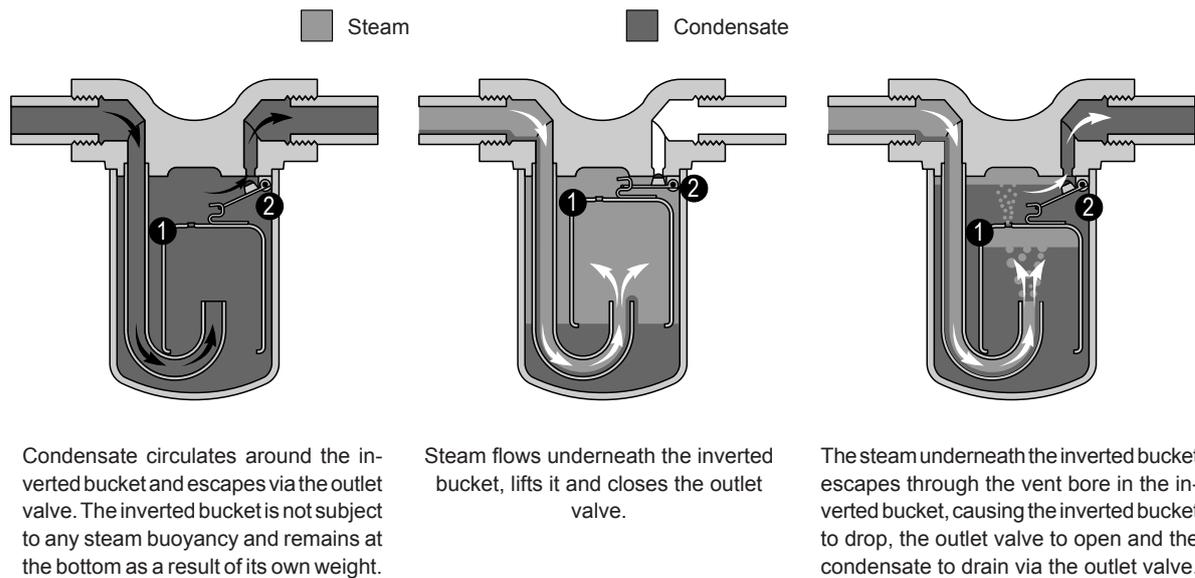
The inverted bucket steam trap is a mechanical trap without thermal bleed element. It works on the basis of the buoyancy force of the steam.

In the case of very large amounts of condensate, the inverted bucket is completely surrounded by condensate. This escapes through the outlet valve (2) (see [Fig. 20. left](#)).

The incoming steam lifts the inverted bucket (1) as a result of the buoyancy force and the outlet valve (2) is closed via a lever (see [Fig. 20. centre](#)).

Even if no fresh condensate flows into the drain, the steam under the inverted bucket slowly condenses or escapes through the bleed bore, causing the inverted bucket to sink. The outlet valve (2) opens and the condensate escapes (see [Fig. 20. right](#)).

Bleeding takes place slowly through a small bore in the top of the inverted bucket. Inverted bucket steam trap therefore always suffer from minor steam loss and are not efficient breathers (see [Fig. 20. right](#)).



*Fig. 20: How the inverted bucket steam trap works*

## How the thermostatic capsule steam trap works

This type of steam trap takes advantage of the temperature difference between saturated steam and condensate or a mixture of saturated steam and air.

If only saturated steam is present in the steam trap, it remains closed. The steam trap cools down as a result of the accumulation of condensate or air, as cooled condensate or air has a lower temperature than saturated steam.

The thermal element opens at a temperature below that of the saturated steam. In order for the condensate to cool down, a backup section is required upstream of the trap. As a result of the thermal operating principle, a thermostatic capsule steam trap always works with a delay. The faster the condensate cools down, the shorter the delay. The thermostatic capsule steam trap is open at temperatures below the saturated steam temperature and therefore also at ambient temperature.

Thermostatic capsule steam traps used in Condair Esco open when the condensate cools down (relative to the saturated steam temperature):

- Brass type: 13°C (13 Kelvin)
- Stainless steel type: 4 °C (4 Kelvin)

## 3.9.4 Steam distributor

### 3.9.4.1 Esco DL40 steam distributor

#### General information

- **Main applications:**
  - Smaller air ducts/air handling units
  - Vertical air ducts/air handling units
- **Concept:**  
Combination of standard parts (steam pipe(s) and collectors)
- **Steam flow:**
  - Via the valve unit into the steam pipe with one steam pipe
  - Via the valve unit into the collector and from there into the 2 or 3 steam pipes
- **Steam extraction:**
  - Via stainless steel nozzles from the steam core flow of the steam pipes
- **Steam output direction:**
  - With or in contrary to the air flow
- **Condensate:**
  - The condensate runs past the nozzles along the inside wall of the pipe and is transported to the end of the pipe by the steam flow.
- **Condensate discharge:**
  - The condensate is collected upstream of the thermostatic capsule steam trap in the condensate pipe and cools down. As soon as it has cooled down, the steam trap opens and only closes again once hot steam flows into it.

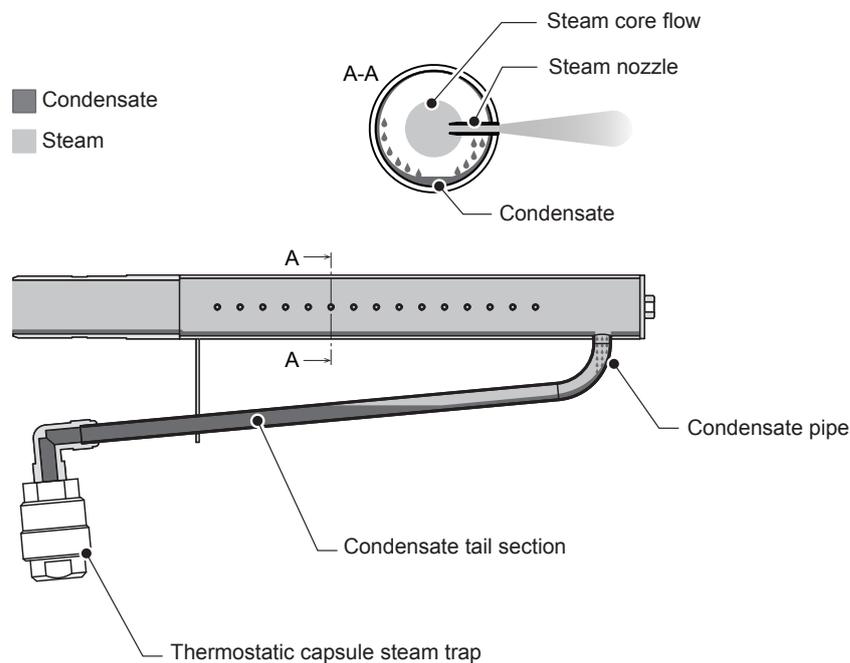


Fig. 21: DL40 steam pipe

## DL40 steam distributor overview

	Valve unit suitable for Esco DL40				
	Esco-5 ductile cast iron	Esco-10 ductile cast iron	Esco-10 stainless steel	Esco-20 ductile cast iron	Esco-20 stainless steel
Number of steam pipes	1	1 to 3		1 to 3	
Secondary steam trap for steam pipes	Thermostatic capsule steam trap				
Secondary steam trap connections	Rp 1/2" internal thread				
Number of different steam pipe lengths	9	16		12	
Air duct/air handling unit width	275 to 2124 mm	250 to 4299 mm		600 to 4299 mm	
Air duct/air handling unit height	200 to 3500 mm				
Steam connection, outer diameter	ø41 mm	Ø41 mm		Ø59.5 mm	
Steam pipe material	Stainless steel 1.4301/07 (AISI 304 / 304L)				
Double or triple collector material					
Secondary steam trap material	Brass	Brass	Stainless steel	Brass	Stainless steel
Steam trap screw-in elbow connector material	Brass	Brass	Stainless steel	Brass	Stainless steel
Fixing bracket for steam pipe	Option				

### Steam pipes for Esco DL40

- The number of steam pipes is determined based on the air duct/air handling unit height.

Number of steam pipes	Air duct/air handling unit height
1	200 to <700 mm
2	700 to <1000 mm (for air duct/air handling unit heights from 600 to 700 mm on request)
3	1000 to 3500 mm

- The steam pipe length is selected based on the air duct/air handling unit width. Various steam pipe lengths are available to optimise the air duct/air handling unit width.

#### Steam pipe code

- The first digit (5, 10 or 20) shows the connection diameter of the steam pipe.
- The digits after the "/" show the steam pipe length "xxx" in cm, from the valve or collector connection flange.

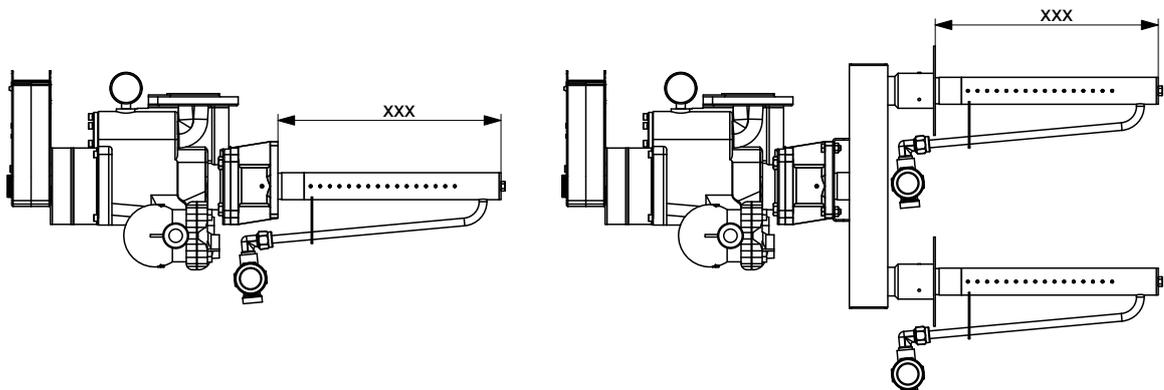


Fig. 22: DL40 steam pipe length

Example 1: Steam pipe 10/178

- **10:** Connection diameter for Esco-10 valve unit = 41.0 mm
- **178:** 178 cm long from valve or collector flange (see dimension "xxx" in [Fig. 22](#))

Note: For Esco-5 steam pipes, add 2 cm to the specified length, i.e. a steam pipe 5/178 has a length "xxx" of 180 cm.

**Available steam pipes**

Steam connection diameter	Steam pipe code	Air duct/air handling unit width [mm]	Max. permissible steam capacity [kg/h]
ø41 mm for connection to: Esco 5 ductile cast iron	5/023	275-424	16
	5/038	425-524	27
	5/048	525-624	32
	5/058	625-724	41
	5/068	725-924	50
	5/088	925-1224	62
	5/118	1225-1524	94
	5/148	1525-1824	118
ø 41 mm for connection to: Esco 10 ductile cast iron Esco 10 stainless steel DL40 double and triple collector	5/178	1825-2124	127
	10/023 <sup>1)</sup>	250-399	16
	10/038 <sup>1)</sup>	400-499	27
	10/048 <sup>1)</sup>	500-599	32
	10/058 <sup>1)</sup>	600-699	41
	10/068 <sup>1)</sup>	700-899	50
	10/088 <sup>1)</sup>	900-1199	62
	10/118 <sup>1)</sup>	1200-1499	94
	10/148 <sup>1)</sup>	1500-1799	118
	10/178 <sup>1)</sup>	1800-2099	142
	10/208 <sup>1)</sup>	2100-2399	187
	10/238 <sup>1)</sup>	2400-2699	214
	10/268 <sup>1)</sup>	2700-2999	241
	10/298 <sup>1)</sup>	3000-3299	250
	10/328 <sup>1)</sup>	3300-3599	250
10/358 <sup>1)</sup>	3600-3899	250	
10/388 <sup>1)</sup>	3900-4299	250	
ø 59.5 mm for connection to: Esco 20 ductile cast iron Esco 20 stainless steel	20/058 <sup>2)</sup>	600-899	41
	20/088 <sup>2)</sup>	900-1199	62
	20/118 <sup>2)</sup>	1200-1499	94
	20/148 <sup>2)</sup>	1500-1799	118
	20/178 <sup>2)</sup>	1800-2099	142
	20/208 <sup>2)</sup>	2100-2399	187
	20/238 <sup>2)</sup>	2400-2699	214
	20/268 <sup>2)</sup>	2700-2999	241
	20/298 <sup>2)</sup>	3000-3299	268
	20/328 <sup>2)</sup>	3300-3599	295
	20/358 <sup>2)</sup>	3600-3899	322
	20/388 <sup>2)</sup>	3900-4299	349

<sup>1)</sup> When using double or triple collectors, 10/xxx steam pipes are always used regardless of which valve unit is used.

<sup>2)</sup> 20/xxx steam pipes are only required for single piping in connection with the Esco-20 valve unit.

### Single piping

With single piping, the steam pipe is pushed directly from the inside of the air duct/air handling unit through the air duct/air handling unit wall into the flange of the valve unit. Installation takes place in the centre of the air duct/air handling unit height.

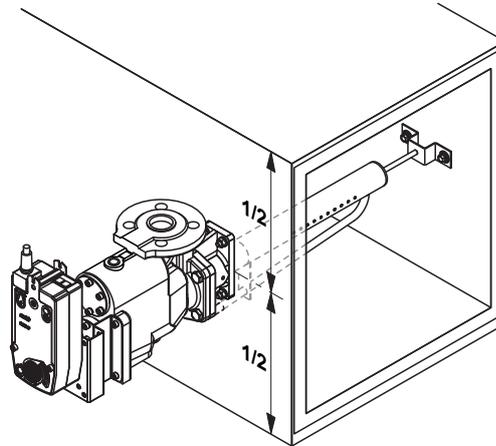


Fig. 23: Single piping

### Multiple piping

With multiple piping, the steam pipes are pushed from the inside of the air duct/air handling unit through the air duct/air handling unit wall into the sockets of the double and triple collector, which is installed on the outside of the air duct/air handling unit. The collectors are installed centrally at the height of the air duct/air handling unit (horizontal air ducts) or air duct/air handling unit width (vertical air ducts). A minimum distance of 200 mm (dimension "A") or more must be observed otherwise condensation may collect.

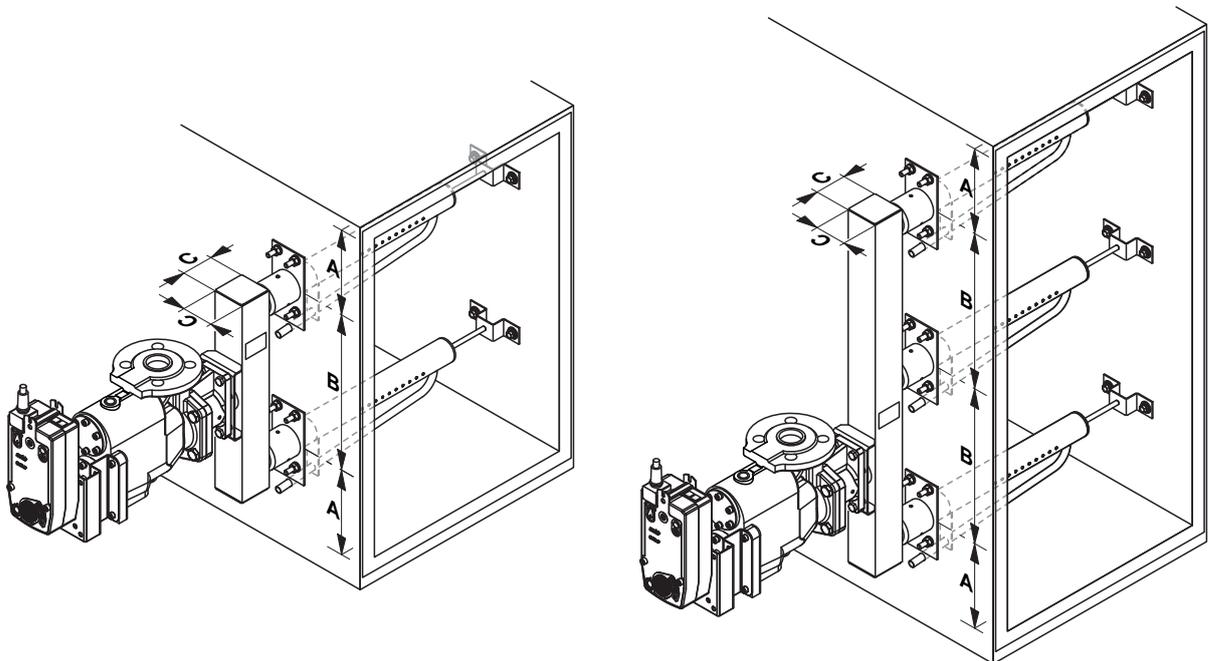
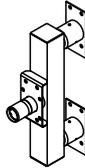
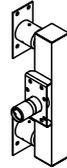
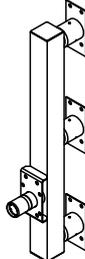
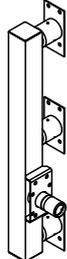
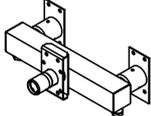
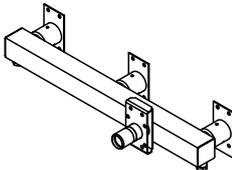
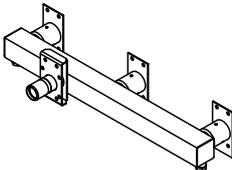


Fig. 24: Multiple piping with double or triple collector

## Overview of collectors for DL40

Steam pipe distance (see dimension "B" in <a href="#">Fig. 24</a> )	200, 250, 300, 600, 900		
Square tube cross-section (see dimension "C" in <a href="#">Fig. 24</a> )	Square 60 x 60 mm max. 116 kg/h Square 80 x 80 mm max. 211 kg/h Square 100 x 100 mm max. 335 kg/h Square 120 x 120 mm max. 488 kg/h		
Material	Stainless steel 1.4301/07 (AISI 304 / 304L)		
Silencer	Optional, available for all collectors		
Installation	In horizontal air ducts/air handling units Special collectors for vertical air ducts/air handling units are available		
Variants of the collectors for horizontal air ducts/air handling units	Double collectors		
	Connection valve unit on the front (standard) 	Connection valve unit on the right side <sup>1)</sup> 	Connection valve unit on the left side <sup>1)</sup> 
	Triple collectors		
	Connection valve unit on the front (standard) 	Connection valve unit on the right side <sup>1)</sup> 	Connection valve unit on the left side <sup>1)</sup> 
Vertical air duct/air handling unit collector variants <sup>2)</sup>	Double collector 		
	Connection valve unit right 	Connection valve unit left 	

<sup>1)</sup> The versions "Connection valve unit on the right side" and "Connection valve unit on the left side" are used where the valve unit must not protrude far from the air duct/air handling unit due to lack of space.

<sup>2)</sup> In vertical air ducts/air handling units, the two outer pipes must blow out the steam opposite to the centre of the air duct. For more details about installation, see the "Esco DL40 Vertical Duct Installation Guide".

Since a lot of condensate can accumulate in the collector pipes for vertical air ducts/air handling units throughout the entire collector width, the collectors are equipped with two threaded sleeves. One or two thermostatic capsule steam traps can optionally be attached to these sleeves to drain the condensate (at least one is recommended).

### 3.9.5 Esco steam distributor DR73

#### General information

- **Main application:**
  - Larger horizontal air ducts/air handling units (>1.5 m<sup>2</sup>)
- **Concept:**
  - Custom-manufactured steam distribution system determined on the basis of the available space, the air volume flow rate, the steam output, the air velocity and the air temperature.
- **Steam flow:**
  - Via the valve unit into the horizontal collector. From there, into the vertically arranged steam pipes.
- **Steam extraction:**
  - Via stainless steel nozzles from the steam core flow of the steam pipes
- **Steam exit direction:**
  - Across the air flow on both sides
- **Condensate:**
  - The condensate runs along the inside walls of the pipes past the nozzles and collects in the collector where it is transported into the end piece by the steam flow.
- **Condensate discharge:**
  - The condensate is collected upstream of the thermostatic capsule steam trap in the condensate pipe and cools down. As soon as it has cooled down, the steam trap opens and only closes again once hot steam flows into it.

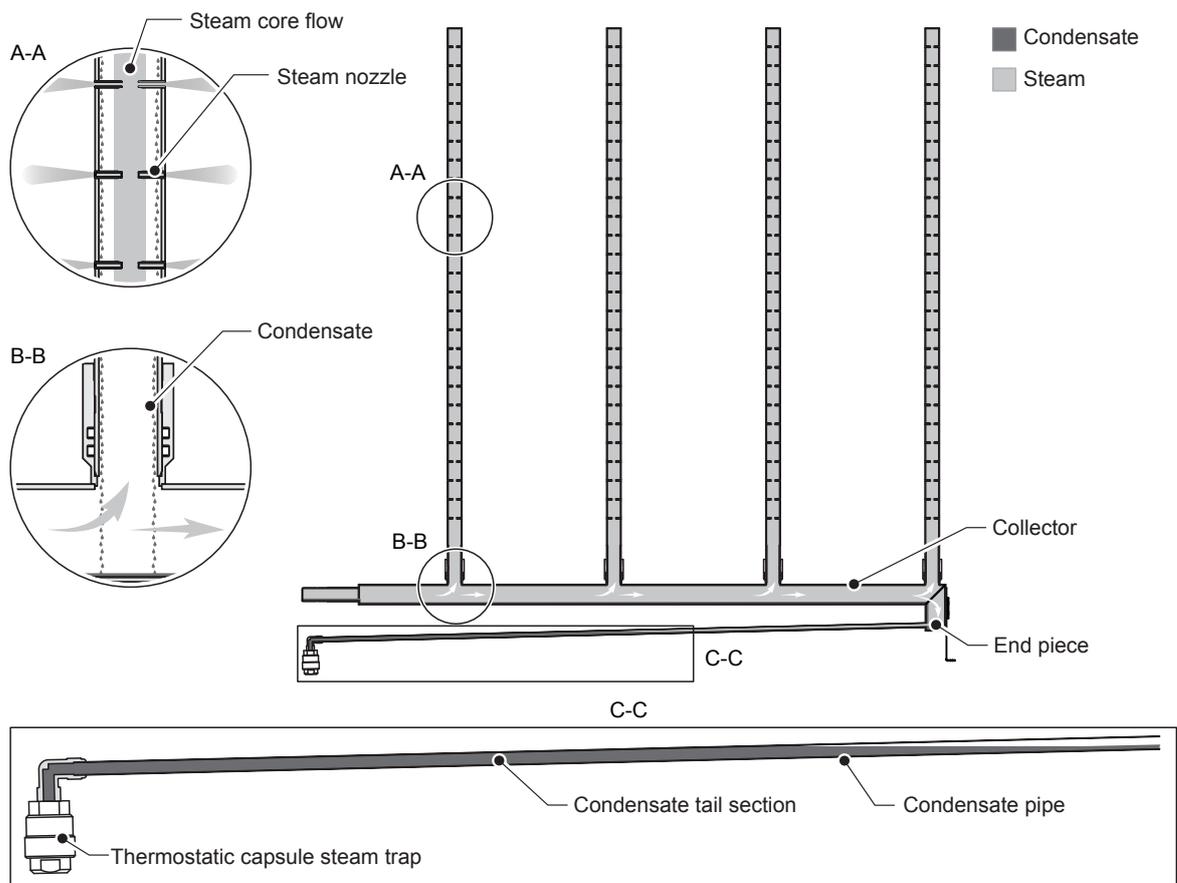


Fig. 25: DR73 steam distributor

## Collector supports

As standard, the collector is delivered with one or two fixing bracket(s) to attach it to the air duct/air handling unit floor. There is also the option of telescoping supports towards the side wall.

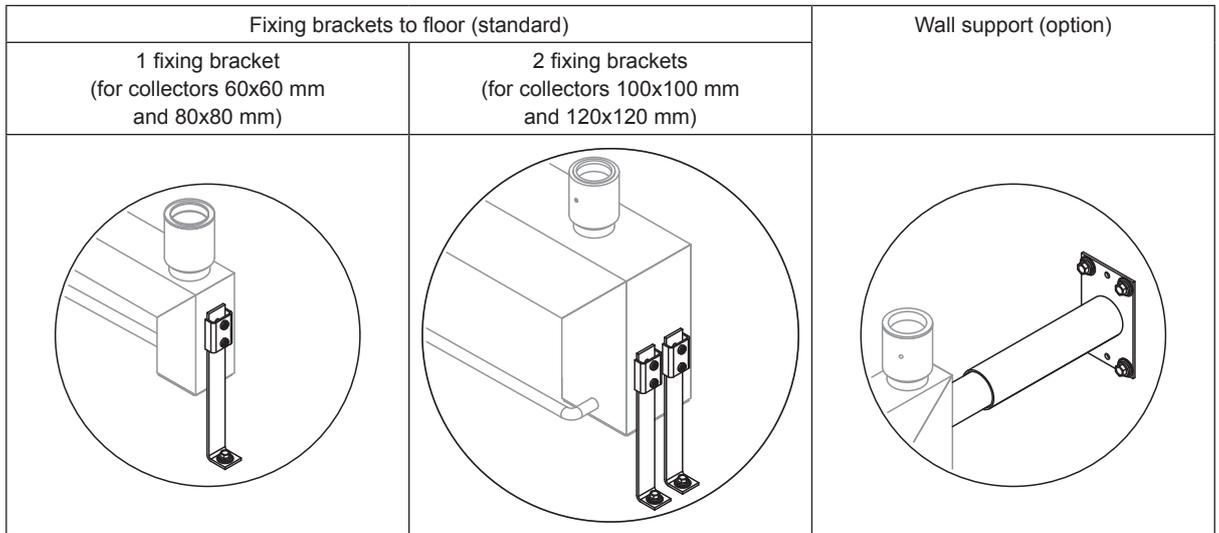
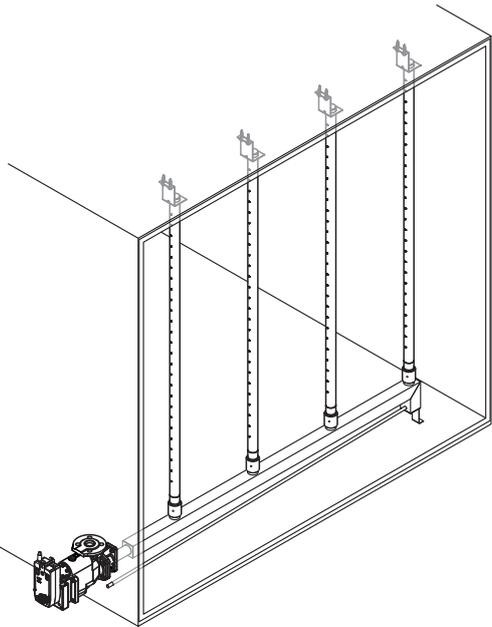
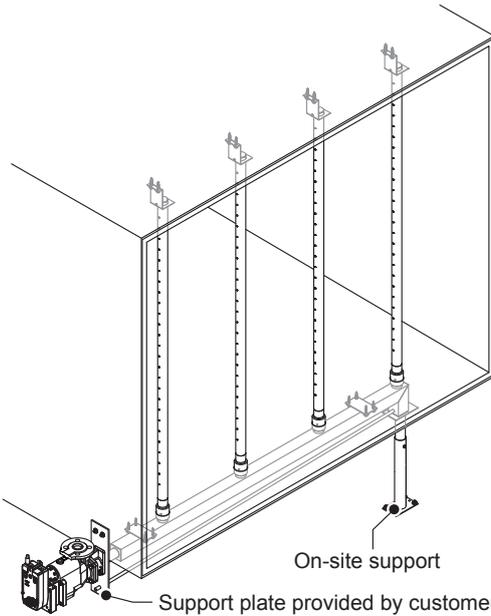


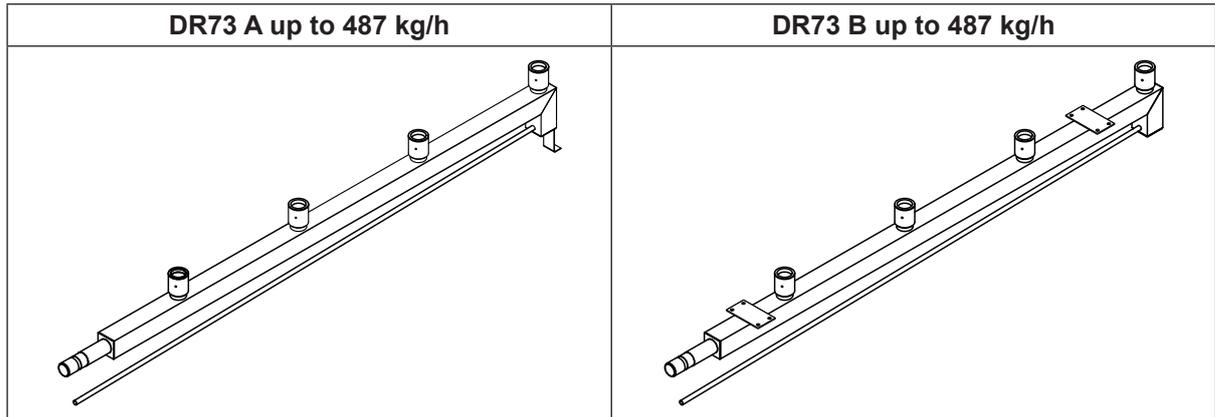
Fig. 26: Collector supports

The Condair Esco DR73 system is compatible with various installation types, which have been described in more detail below.

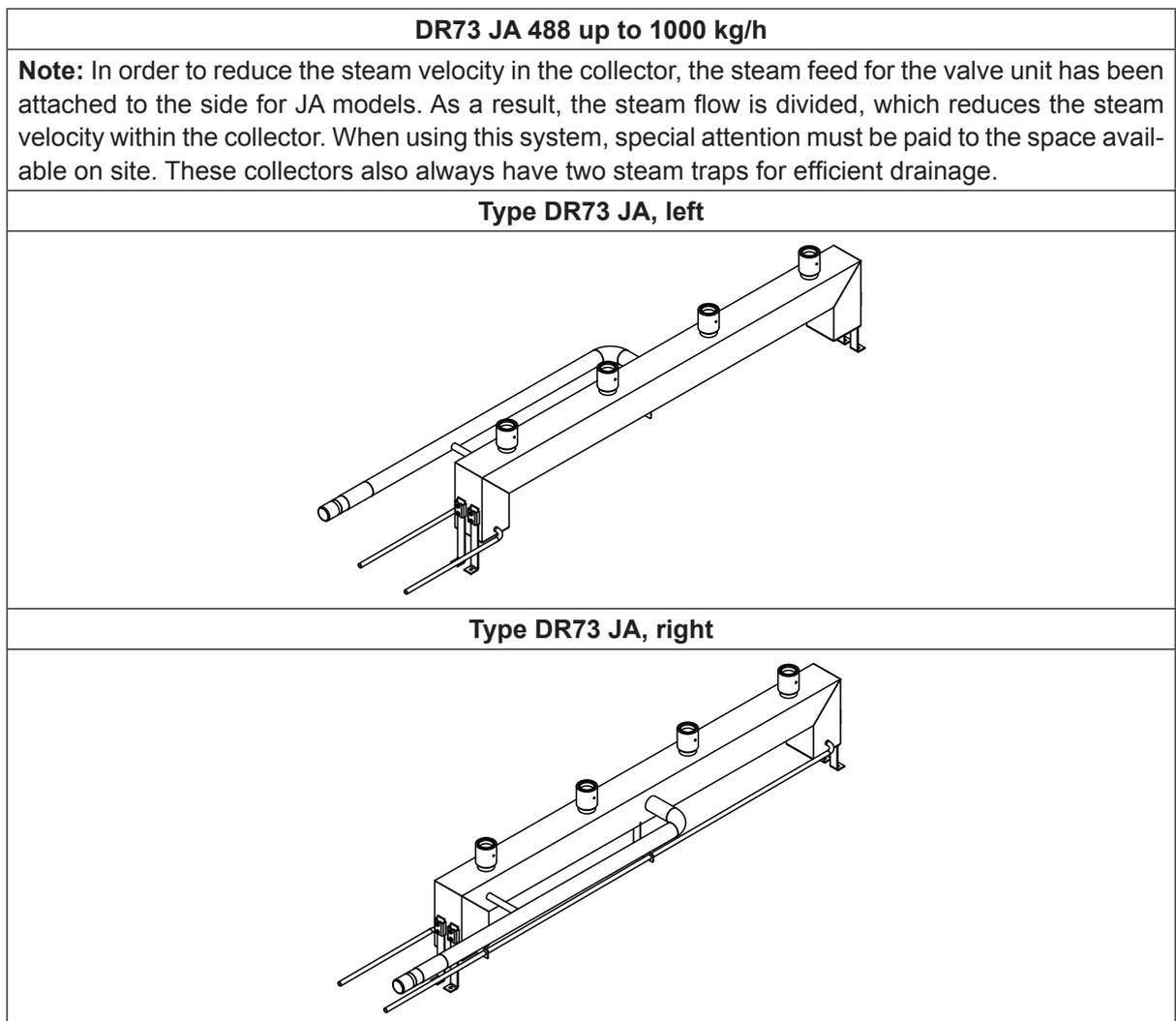
## Installation type/versions

Type A/type JA	Type B
The collector is mounted inside the air duct/air handling unit. This type is the standard version.	For installation in air ducts/air handling units with ground clearance. The collector is mounted below the air duct/air handling unit. This type is rarely used as the installation cost is higher.
	

## Overview of DR73 collectors



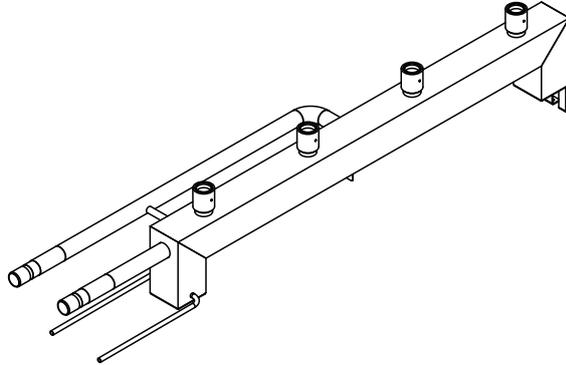
## Overview of DR73 J collectors



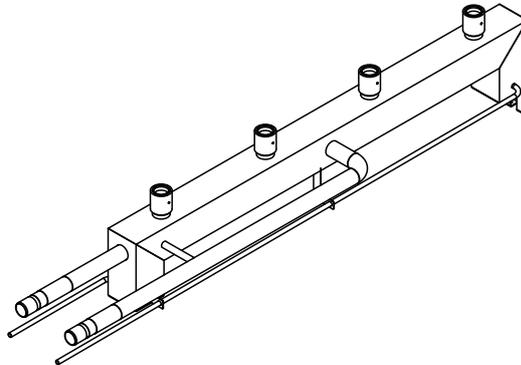
### DR73 J2A from 1000 to 2000 kg/h

In order to reduce the steam velocity in the collector, at least one steam feed is attached to the side of the J2A models. As a result, the steam flow is divided, which reduces the steam velocity. The following feed variants are possible. When using this system, special attention must be paid to the space available on site. These collectors also always have two steam traps for efficient drainage.

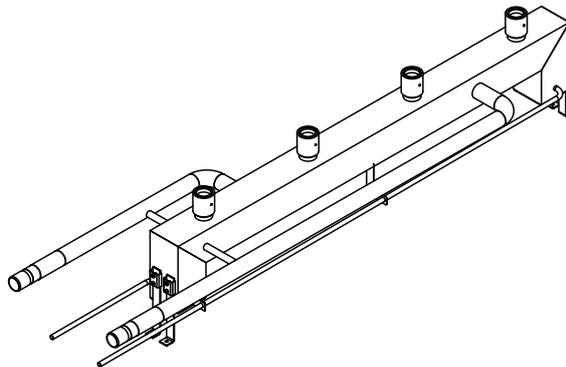
#### DR73 J2A, left middle



#### DR73 J2A, right middle

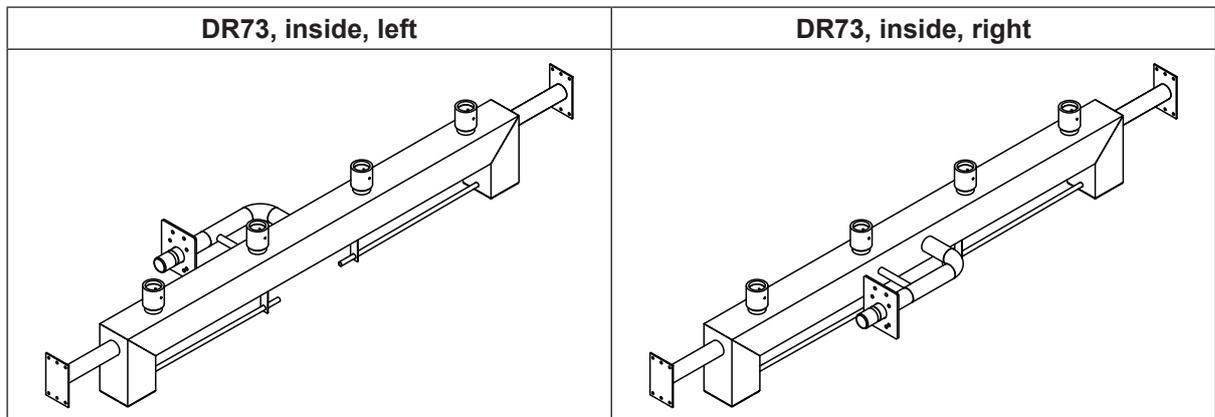


#### Type DR73 J2A, left right



### DR73 valve unit mounted on the inside

For special cases where the valve unit must be located inside the air duct/ air handling unit, e.g. outdoor systems, there is the option for collectors that have the valve connection on the side of the collector. These versions are only possible if there is sufficient space. For more information, contact your Condair partner.

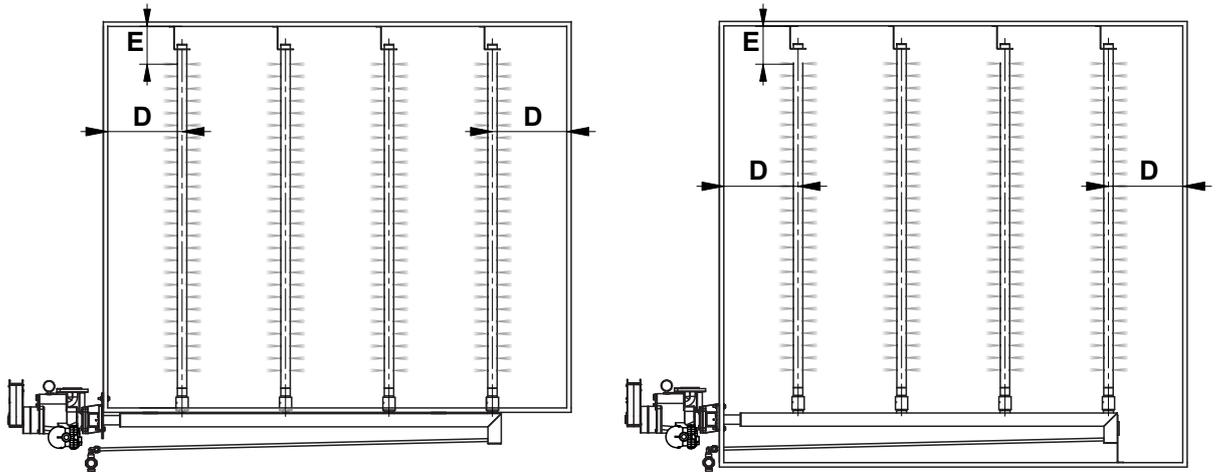


### Overview of the DR73 steam distributor

	Valve unit suitable for Esco DR73				
	Esco-10 ductile cast iron	Esco-10 stainless steel	Esco-20 ductile cast iron	Esco-20 stainless steel	Esco-30 ductile cast iron
Quantity of steam pipes	2 to 20, depending on air duct/air handling unit width and steam capacity				
Secondary steam trap	Thermostatic capsule steam trap or ball float steam trap from 488 kg/h steam capacity				
Steam trap connections	Rp 1/2" internal thread				
Installation position	Only in horizontal air ducts/air handling units, steam pipes positioned vertically				
Air duct/air handling unit width [mm]	800 to 6000				1000 to 6000
Height of air duct/air handling unit [mm]	600 to 5000, type A 400 to 5000, type B				1000 to 5000
Outer diameter of steam connection [mm]	Ø 41		Ø 59.5		Ø 88.0
Steam pipe material	Stainless steel 1.4301 (AISI 304)				
Collector material					
Secondary steam trap material	Brass Ductile cast iron	Stainless steel Stainless steel	Brass Ductile cast iron	Stainless steel Stainless steel	Brass Ductile cast iron
Thermostatic capsule steam trap					
Ball float steam trap					
Fixing bracket for steam pipes	Standard				
Collector wall support	Option				

## Dimensioning of the DR73 steam distributor

In addition to the required steam output, the air velocity in the air duct/air handling unit is an important parameter for dimensioning the DR73 steam distributors. The air velocity determines the wall distance from the outermost steam pipes and the permissible steam capacity per metre of steam pipe.



W [m/s]	D mm	E mm	Max. steam capacity per linear metre of steam pipe kg/h
1	400	160 to 170	30
2	350	160 to 170	35
3	300	160 to 170	40
4	270	160 to 170	45
5	200	160 to 170	50

- W = Air velocity  
 E = Top nozzle ceiling clearance  
 D = Distance from wall to outermost steam pipes  
 Max. steam capacity = Max. steam capacity in kg/h per linear metre of steam pipe

## 3.10 Options

### Pressure gauge



Use: For all valve units except Esco-5

Pressure gauge for installation on the valve unit in two versions:

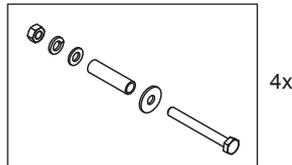
- Pressure gauge 0 to 2.5 bar for steam overpressure up to 1.5 bar
- Pressure gauge 0 to 6.0 bar for steam overpressure up to 4.0 bar

Accuracy class: 1.6

Material housing: Sheet steel or stainless steel

Connection: G 1/4"

### Mounting set for insulated air ducts/air handling units

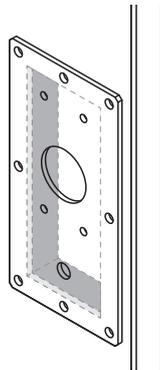


Use: For all valve units and DL40 collectors

This option consists of spacer sleeves and threaded connections. The spacer sleeve serves to not compress the air duct/air handling unit insulation when the screw connection is tightened.

The spacer sleeve is available in two lengths, 45 mm and 75 mm, and must be shortened to the insulation thickness.

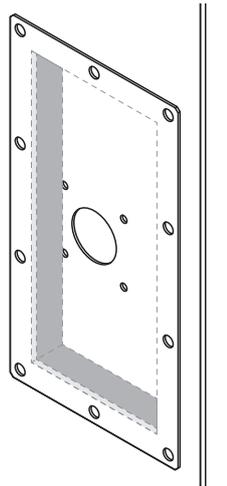
### DL40 flange plate



Use: For DL40 steam distributor

The flange plate serves as an installation aid for air ducts/air handling units where a square piece is cut out of the air duct/air handling unit wall instead of the passages. The flange plate closes the recess and has the hole pattern of the valve unit.

### Flange plate DR73



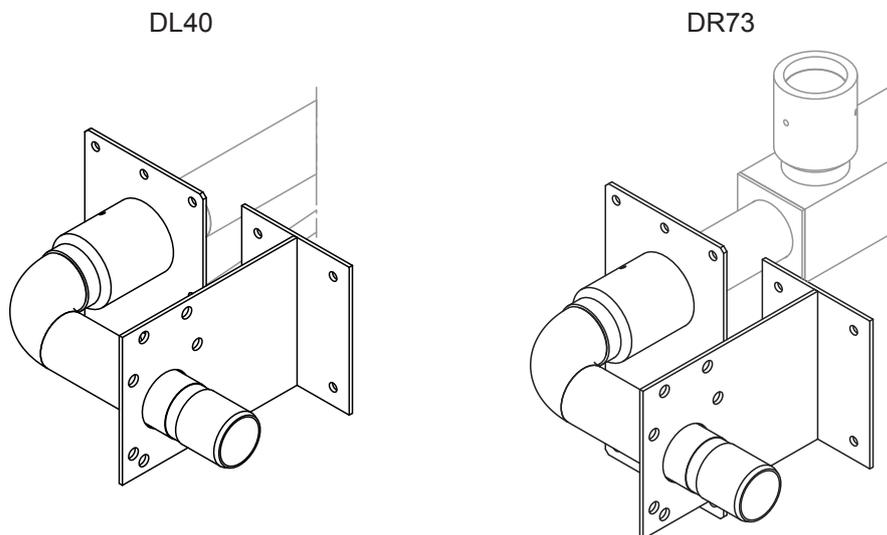
Use: For type A DR73 steam distributor type  
The flange plate serves as an installation aid for air ducts/air handling units where a square piece is cut out of the air duct/air handling unit wall instead of the passages. The flange plate closes the recess and has the hole pattern of the valve unit.

### Strainer G 1/2" - G 1/2"



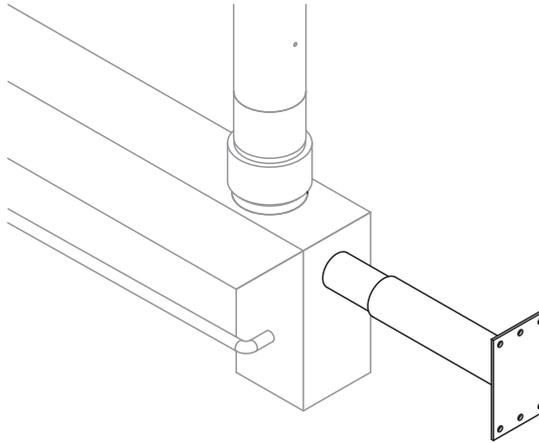
Use: For installation in the steam supply line of Esco 5 ductile cast iron.

### Option: 90° adapter valve unit



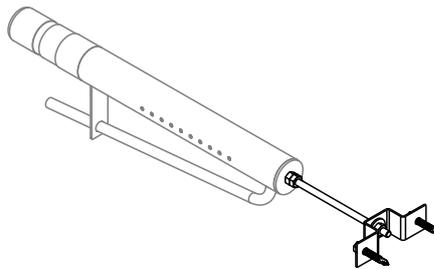
Use: For DR73 or DL40 single piping.  
Enables space-saving mounting of the valve unit rotated by 90°.  
The elbow swivels on both sides and is sealed with O-rings in the socket.

### Collector spud (DR73 wall support)



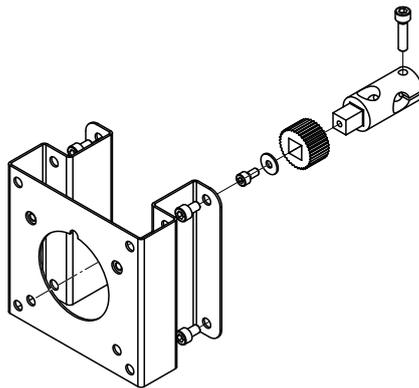
**Use:** For DR73 steam distribution system (except B, JB and J2B type)  
This telescopic support to the air duct/air handling unit inner wall is used to support a DR73 steam distribution system without the need to drill holes or screw into the drain pan.

### DL40 steam pipe fixing bracket



**Use:** For all DL40 steam pipes  
With this option, the DL40 steam pipes can be supported by a 250 mm or 500 mm threaded rod on the air duct/air handling unit inner wall. The threaded rod must be shortened on site to the length that is actually required.  
**Note:** The fixing brackets can only be used if the air duct/air handling unit has a wall thickness of at least 30 mm.

#### Adapter for CA150A-MP



Use: For all valve units  
If an Esco valve unit without mounted CA150A-MP actuator is required, the adapter must be ordered as an option in order to be able to attach the CA150A-MP actuator to the valve unit.

#### Adapter for Siemens GCA 161.1 or Sauter ASF123

Use: For all valve units  
This adapter can be used to attach a Siemens GCA161.1 or Sauter ASF123 actuator to the Esco valve unit. The customer is responsible for its procurement and correct function when using an external actuator.

#### 4 – 20 mA control signal

Use: For all electric actuators with 2-10 VDC demand signal  
This option consists of a junction box with an integrated 500 ohm resistor and can be used to convert a 4-20 mA demand signal to a 2-10VDC signal.  
**Note:** The actuator feedback signal remains 2-10 VDC even when using this option.

# 4 Planning

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## 4.1 Requirements for steam boiler

The removal of steam from an existing steam network for humidification often creates different operating conditions for the steam network, which must be taken into account accordingly.

### **Feed water treatment**

The capacity of the feed water treatment must be adapted to the future steam extraction quantity. In addition, correct operation is required through regular maintenance.

Feed water additives must not exceed the values for a permissible concentration in the ambient air: please observe the local regulations in this regard! Consideration must also be given to the possible development of odours from additives in the feed water or from contamination of the steam.

### **Feed water pump**

The pump output must be adapted to the additional steam extraction.

### **Steam boiler**

All steam boilers that enable flawless steam extraction from a sufficiently large steam space are suitable. The additional steam extraction for humidification with the Condair Esco must be taken into account. If the steam boiler is too small, water may be carried along with the steam extraction for humidification.

**Important:** Continuous flow heaters and rapid steam generators are not suitable for humidification with the Condair Esco.

### **Boiler blowdown**

Continuous removal of steam for humidification increases the concentration of residue. Regular, sufficient blowdown of the steam boiler is mandatory.

## 4.2 Steam types and requirements

### Wet steam

Wet steam still contains a high proportion of unevaporated or re-condensate (proportion >2 %) and this is not suitable for humidification or generally for transport in steam lines. Fine water droplets act like abrasive grains and can cause considerable damage to the steam network or to the ceramic discs in the Esco valve unit. This process is also known as erosion. Abrasion marks on the ceramic disc openings usually indicate steam that is too wet.

### Saturated steam

Saturated steam has a non-evaporated water content of <2 % and is suitable for use with the Condair Esco.

### Superheated steam

If heat is added to the saturated steam, superheated steam is produced. Superheated steam is not visible, as it does not carry any unevaporated water droplets. It is used, for example, for the operation of steam turbines.



**DANGER!**

Superheated steam is not visible to the naked eye. There is therefore a risk of burns if steam escapes.

**Superheated steam is not suitable for humidification with the Condair Esco system, as this can lead to problems with the steam traps.**

Important note: Superheated steam can also be generated after a pressure reduction. A pressure reduction station must therefore only be so far away from the Condair Esco valve unit that the saturated steam temperature can be set upstream of the valve unit.

The following table shows the maximum saturated steam temperature in relation to the steam overpressure. If the steam temperature exceeds the corresponding saturated steam temperature at a certain steam overpressure, this is superheated steam.

Steam overpressure (barg)	Saturated steam temperature [°C]
0.2	107
0.4	111
0.6	115
0.8	118
1.0	121
1.5	128
2.0	134
2.5	139
3.0	144
3.5	148
4.0	153

## 4.3 Steam quality

There are basically 3 different steam qualities:

– **Plant steam**

This steam is not suitable for humidification. There is also high wear on the Condair Esco system due to particles or additives in the steam. The steam lines are usually made of carbon steel or grey cast iron pipes.

– **Filtered steam**

As the name suggests, this steam is filtered before use to ensure it is free of particles.

– **Pure and ultrapure steam**

The feed water has been treated in a water treatment plant (reverse osmosis). Steam distribution uses only stainless steel steam lines and components to prevent recontamination.

### Which steam quality?

The steam quality used must be determined by customers themselves and they are responsible for ensuring the steam quality is adequate. Do not use plant steam for air humidification if possible.

	<b>Plant steam</b>	<b>Filtered steam</b>	<b>Pure Steam</b>	<b>Ultrapure steam</b>
Feed water quality	Soft water (contains foreign substances from the boiler)	Soft water (may contain some harmless additives)	RO water or distilled water	Reverse osmosis water with further treatment
Area of application	General heating processes, unsuitable for humidification	Humidification	Humidification, cleanroom humidification and process humidification	
Components for steam generation and distribution	Mainly made of galvanised steel and grey cast iron or ductile cast iron		Stainless steel only	
Methods to ensure steam quality	Not required, steam may pass through a steam separator before use	Steam passes in addition to the steam separator through a fine steam filter immediately before use	High-quality feed water, stainless steel components for steam generation and distribution. Filtration is not mandatory as the high steam quality is maintained in all cases. Steam separator is required.	

Depending on the steam quality used, we recommend the following valve unit materials:

	<b>Valve unit material</b>
Plant steam <sup>1)</sup>	Ductile cast iron
Filtered steam	Stainless steel or ductile cast iron
Pure steam	Stainless steel (in rare cases ductile cast iron)
Ultrapure steam	Stainless steel mandatory

<sup>1)</sup> Only suitable for humidification to a limited extent, as high wear on the components

Of course, a stainless steel valve unit may also be used for plant steam, but this has hardly any effect on steam quality, as the steam penetrating in the valve unit is already contaminated. In contrast, when using ultrapure steam, a stainless steel valve unit must always be used, unless the customer expressly does not want this. Other types of steam often have other criteria, such as the process that must be humidified. A generally valid statement cannot be made. Clarify this with the responsible planners.

## 4.4 Air duct / air handling unit requirements

### Air duct/air handling unit design

In principle, the Condair Esco pressurized steam humidifier releases the steam into the duct air without dripping. However, overfeeding the steam generator, a blocked secondary steam trap or the defect of a regulator or control valve is sufficient to supply water or a condensate/steam mixture to the steam distributor.

Air duct or air handling unit requirements:

- Leak-tight humidifier vacant unit including drain pan with slope made of corrosion-resistant material with inspection door, inspection cover or other service opening
- No obstacles around the humidification section
- Distance to upstream obstacles for DL40 at least dimension "X" (see [Fig. 27](#)).
- Distance to upstream obstacles for DR73 at least 300 mm (see [Fig. 28](#)).
- Distance to downstream obstacles at least the length of the humidification distance according to the design software.
- Uniform air flow with min. 1 m/s air velocity

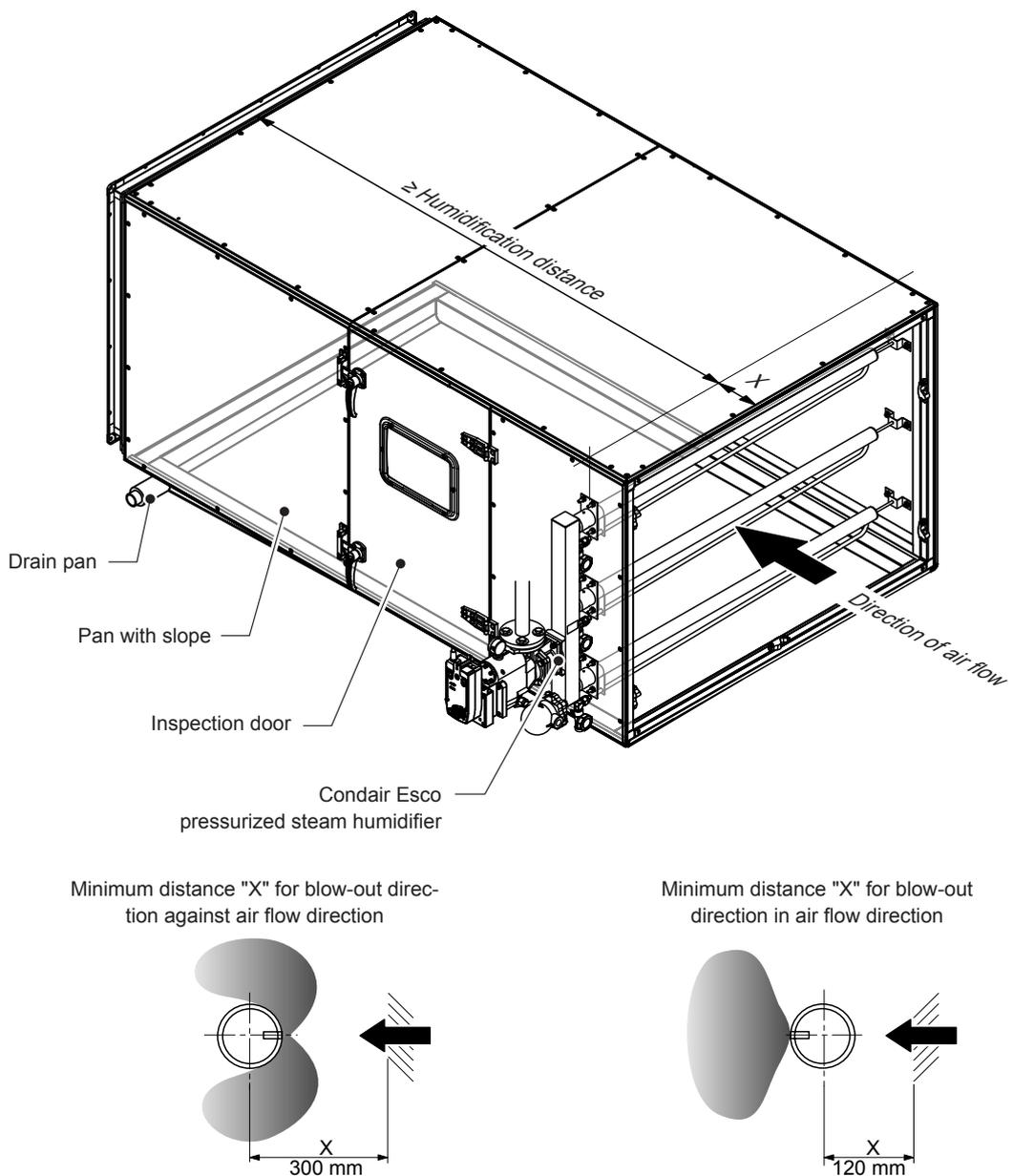


Fig. 27: Air duct/air handling unit with DL40: Distances to upstream and downstream obstacles

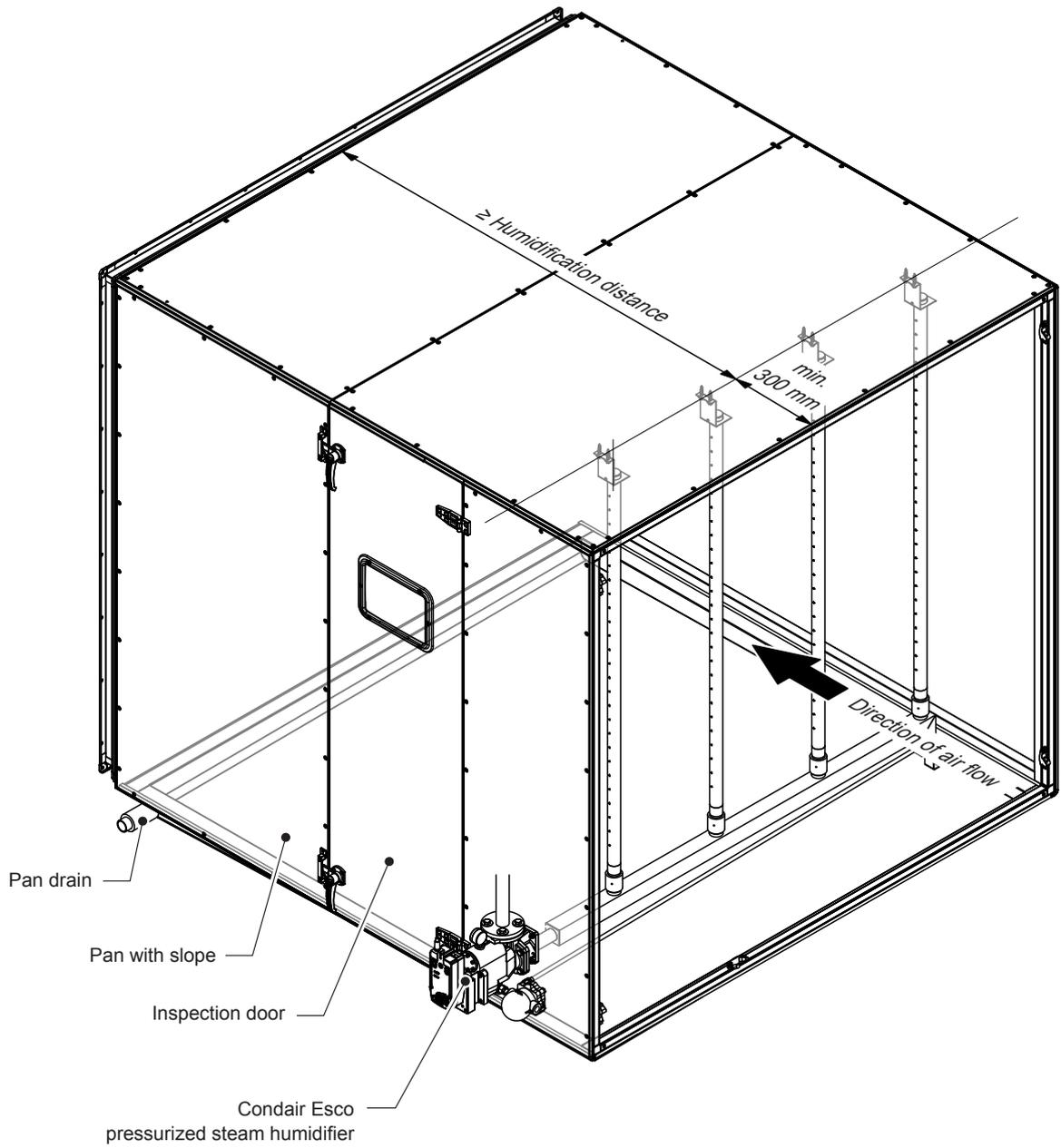


Fig. 28: Air duct/air handling unit with DR73: Distances to upstream and downstream obstacles

## Space requirements

The Condair Esco pressurized steam humidifier itself requires only approx. 300 mm in air flow direction of the air duct/Air handling unit. Exceptions are DR73 JA, JB or J2A, J2B devices that require between 500 mm and 700 mm.

However, each steam humidifier requires a humidification distance. The humidification distance (also known as the "fog zone" or "absorption distance") is the area downstream of the steam pipes in which incompletely evaporated water droplets would condense on obstacles. Your Condair partner will be happy to calculate the required humidification distance for you on request, taking into account obstacles such as filters or submicron filters.

The humidification distance depend on the air conditions and the downstream obstacles. For systems without downstream filters are generally between 0.5 to 2.0 m. However, humidification distances can also be significantly longer at low temperatures or high humidity requirements. Please note that an humidifier vacant unit that is too short can only be retrospectively corrected in rare cases. It is worthwhile planning the required humidifier distance carefully right from the start.

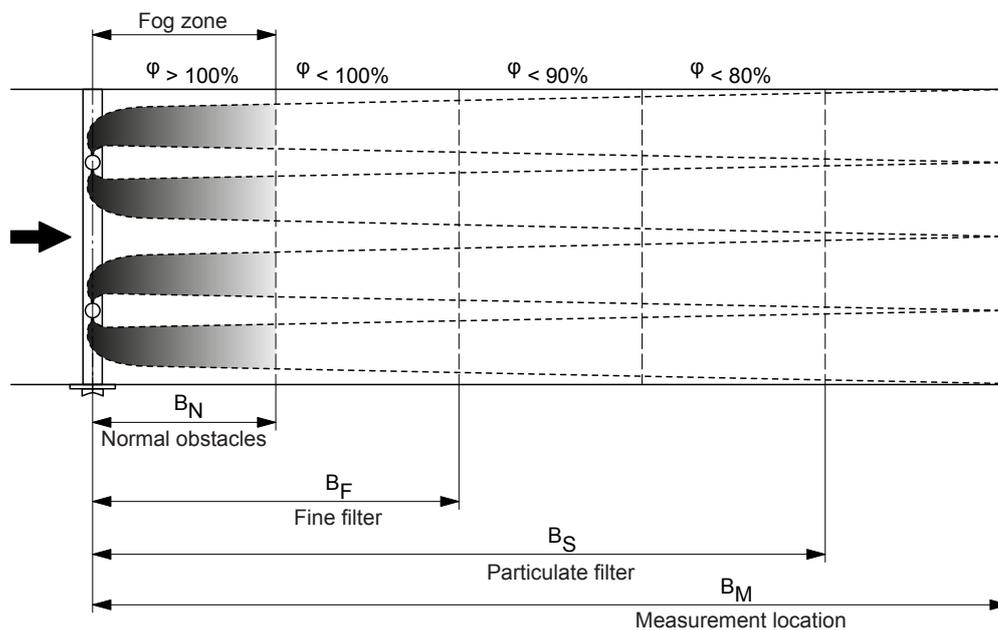


Fig. 29: Humidification plug terminology

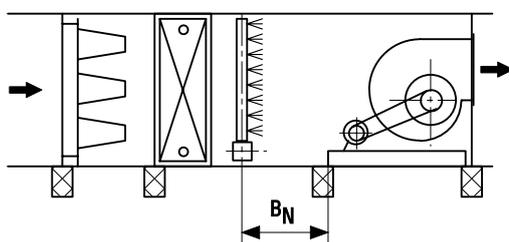


Fig. 30: Installation on the suction side of the fan.  
Downstream obstacle: fan

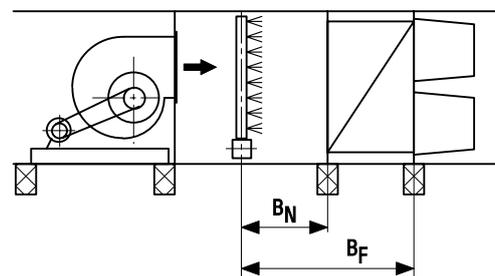


Fig. 31: Installation on the pressure side of the fan.  
Downstream obstacles: Silencer and fine filter

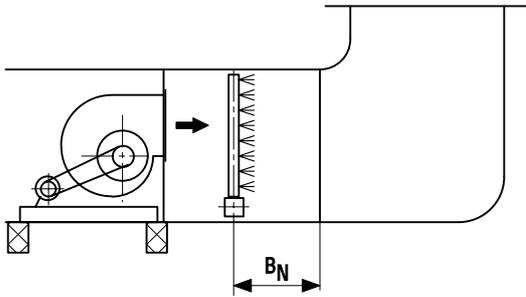


Fig. 32: Installation on the pressure side of the fan Downstream obstacle in the air duct: Elbow

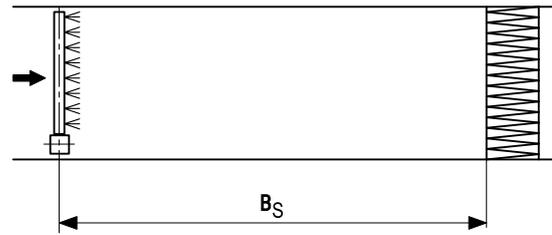


Fig. 33: Installation in air duct  
Downstream obstacle: Particulate filter

### Requirements for the installation site

The Condair Esco pressurized steam humidifier has been designed for installation in protected interior spaces, where it is protected from environmental influences.

If it is necessary to install the Condair Esco pressurized steam humidifier outdoors, the entire system must be accommodated in a protective housing (provided on site) that protects the system and the lines to the system against the following environmental influences:

- Rain
- Snow
- Frost
- Direct UV radiation

The actuator and the pressure gauge must not be covered with insulation material. Do not insulate thermostatic capsule steam traps.

#### CAUTION!

The functionality of the Condair Esco pressurized steam humidifier is not guaranteed if it is exposed to frost, rain, snow and direct UV radiation.

#### WARNING! Danger of steam hammers

All steam traps used do not work in frosty conditions (cold condensate can freeze). If steam traps are operated at temperatures below freezing point, there is a risk of steam hammers.

## 4.5 Requirement for the control of the actuators

The requirements listed below for the control of the actuators only serve as a basis. In any case, contact the relevant local regulatory specialists for detailed information.



### WARNING!

Even with external actuators, only use actuators with a return function (e.g. spring return) so that they close automatically when the high limit humidistat / air flow monitor is triggered.

**Note:** The Condair Esco pressurized steam humidifier requires a demand signal from an external controller (electrical controller or electro-pneumatic controller). Operation with a direct signal from a humidity sensor is not possible.

### 4.5.1 Request for control the CA150A-MP actuator

Main components:

- External humidity controller with setpoint setting and an output signal of 2 to 10 VDC
- High limit humidistat
- If necessary air flow monitor

The high limit humidistat and if applicable also a air flow monitor must also be connected directly to the power supply of the CA150A-MP. If the increase in humidity is too high, the power supply to the actuator is interrupted by the high limit humidistat or air flow monitor and the actuator is automatically shut off via the return spring.

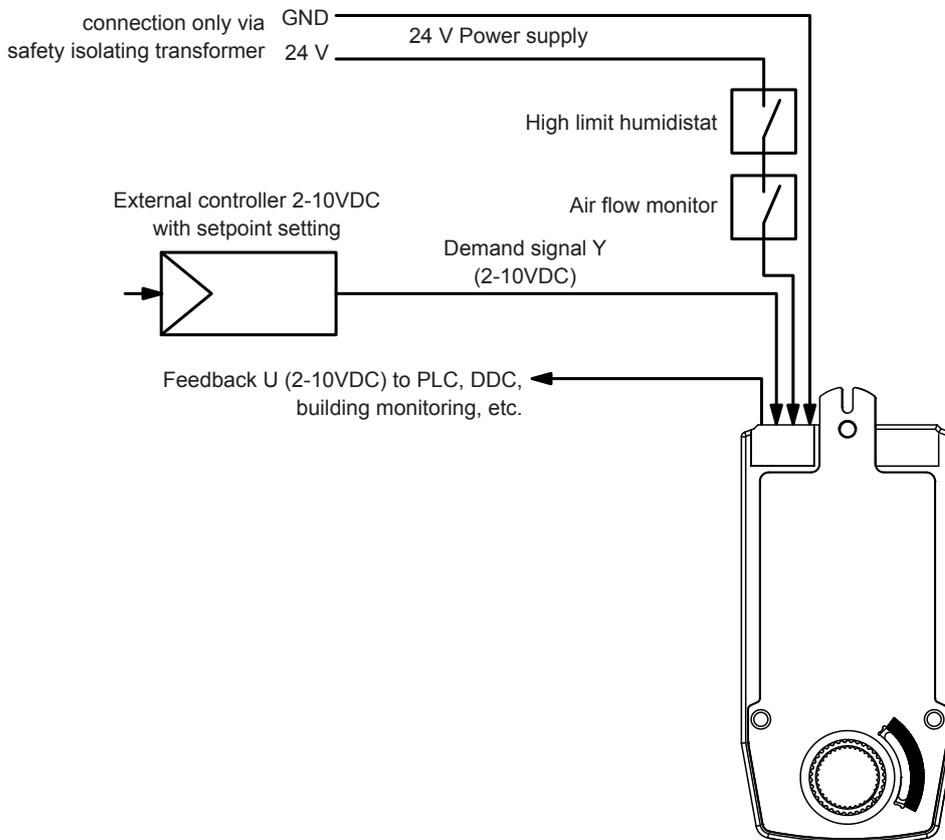


Fig. 34: Control diagram for the CA150A-MP actuator

## 4.6 Pressurized steam network

There are various requirements to the steam network to guarantee long and trouble-free operation of the Condair Esco pressurized steam humidifier or other steam components such as shut-off valves, strainers, pressure reductions, etc. These requirements must be followed for each steam network, whether an Condair Esco pressurized steam humidifier is used or not.

The responsibility for a correctly created and maintained steam network is the responsibility of the operator. Condair does not offer components for steam networks nor does it design steam networks. The design, construction and maintenance of steam networks must be carried out by a steam specialist.

However, Condair would like to draw attention to the most basic requirements, as these strongly influence the operation of the Condair Esco pressurized steam humidifier.

**⚠ DANGER!**  
**Equipment and personal injury due to water and/or steam hammer**

A water hammer occurs when condensate in steam pipes is pulled along by the steam flow. Water hammer must be prevented by means of pipe drainage, as it can cause serious damage to the system or endanger persons.

Steam hammer can occur when steam hits cooler condensate, cools down and condenses. Since the volume of condensate is smaller than that of steam, a free space is created. The resulting free space creates a vacuum that abruptly draws in condensate, which can lead to significant system damage or endanger persons.

### Simplified principle diagram of a steam network

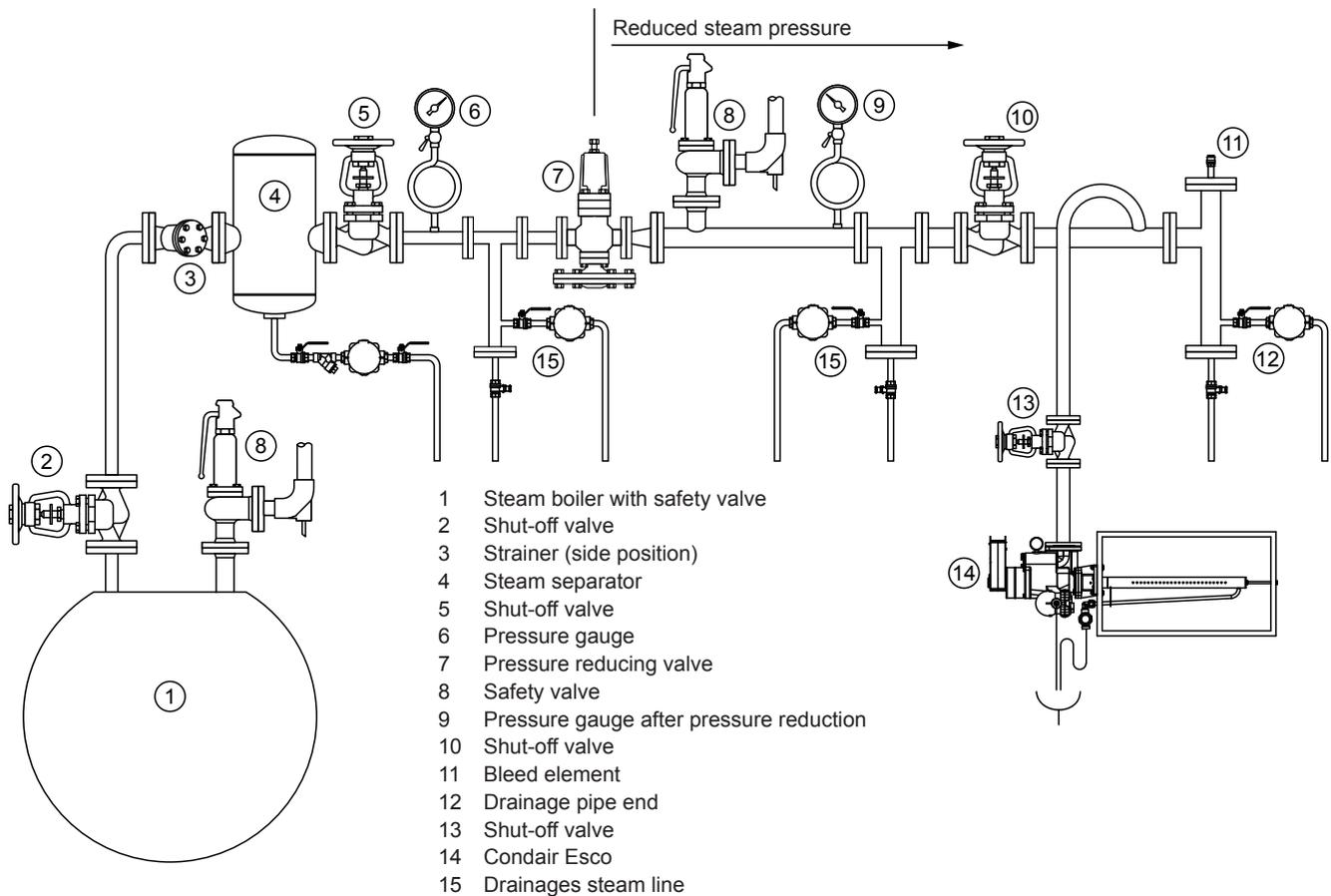


Fig. 35: Schematic diagram of steam network

## Steam supply line dimension

The steam supply line connected to the Esco valve unit must be dimensioned so that the steam velocity does not exceed 25 m/s.



**DANGER!**

**System damage and personal injury due to water hammer**

**Excessive steam velocity increases the risk of water hammer. This can cause serious damage to the system or endanger persons. In addition, the noise level and the wear on lines due to erosion increase.**

**Important:** The steam velocity decreases at the same steam capacity but higher pressure, as the specific steam volume decreases. Accordingly, a pressure reduction with a constant steam capacity results in an increase in the steam velocity.

The nominal diameter of the steam supply line has been listed in the table below:

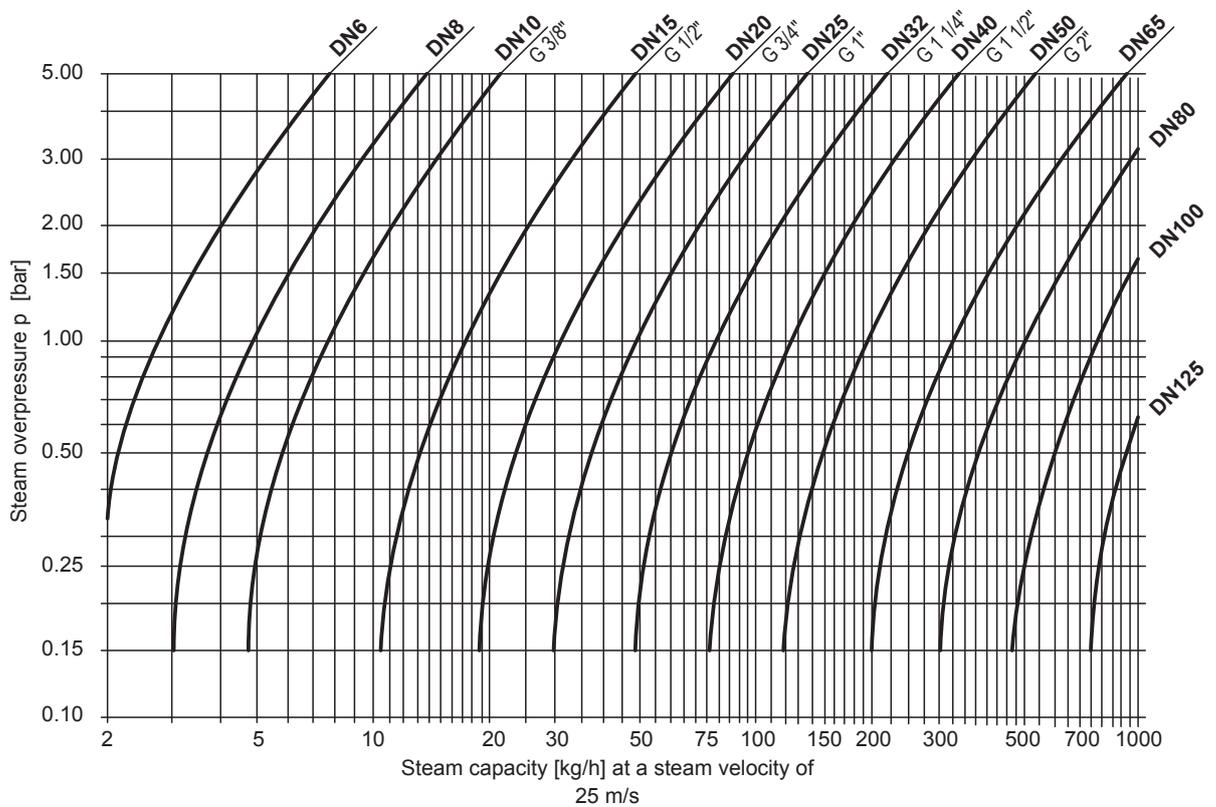


Fig. 36: Dimensioning diagram of steam supply lines

Note: If, due to the permissible steam velocity, a larger nominal diameter than the diameter on the flange of the valve unit must be used, the steam supply line must be extended immediately after the flange.

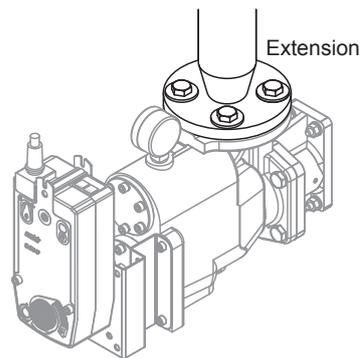


Fig. 37: Expansion of the steam supply line

### Insulation of steam lines

To avoid condensation of the steam on the pipe wall, all steam lines within the steam system must be insulated in accordance with the applicable regulations.

### Draining the steam lines



**DANGER!**

**Plant and personal injury due to water hammer and steam hammer**

**Incorrectly drained steam lines can lead to water and steam hammer during operation. This can cause serious damage to the system or endanger persons.**

**For this reason:** To avoid water hammer and steam hammer during operation, all steam lines must be properly drained so that no condensate water can accumulate anywhere in the steam line system. The correct drainage of the steam line system is the responsibility of the customer.

The main principles of steam line drainage have been listed below. These must be complied with:

- Drain the steam line every 20-40 m, regardless of how they run.

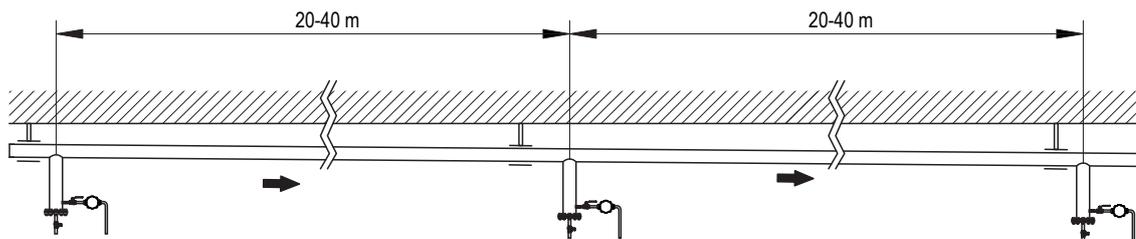


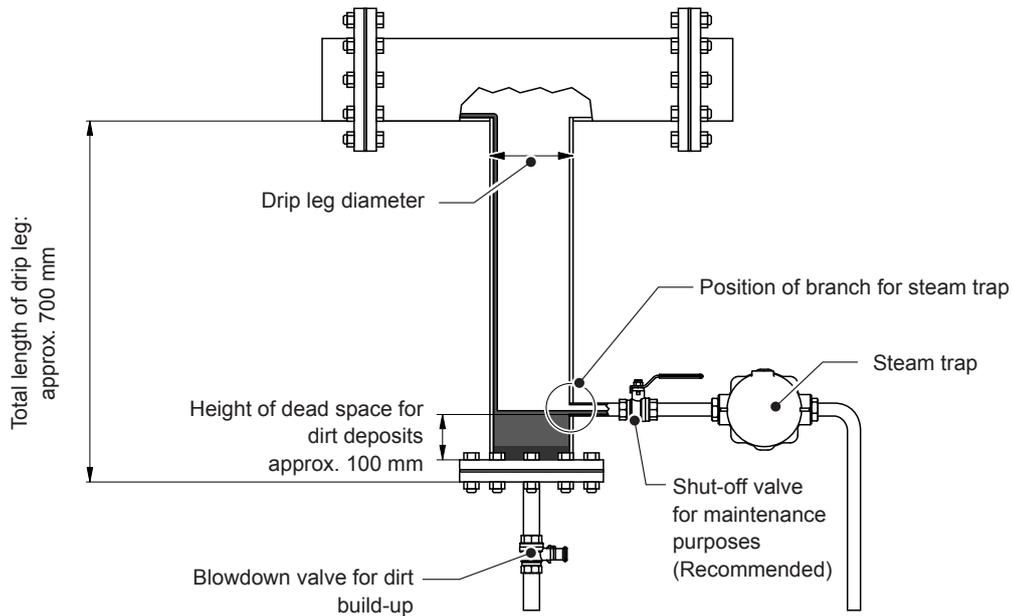
Fig. 38: Drainage

In addition, drainage must be provided wherever condensate can collect, such as:

- Upstream of the pressure reducer
- Upstream of the control valves
- Upstream of shut-off valves, if they can remain closed for a longer period of time
- Upstream and downstream of pipe jumps
- Upstream of any other steam fittings that could trap condensation

Drainage must be implemented using a drip leg. This must not be too narrow. The drip leg must also have the same nominal diameter up to and including a DN100 steam line, be approx. 700 mm long and not protrude into the steam line.

[Fig. 39](#) shows the correct execution of a condensate drip leg:

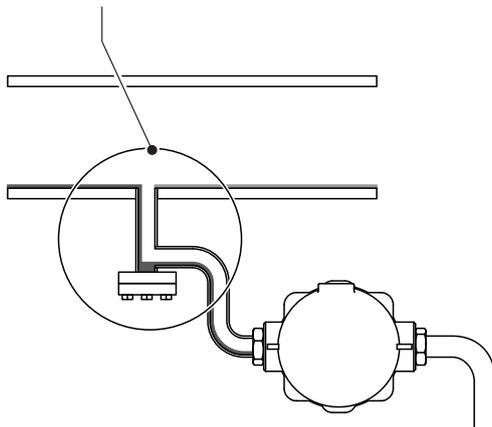


*Fig. 39: Example of a correctly designed drip leg*

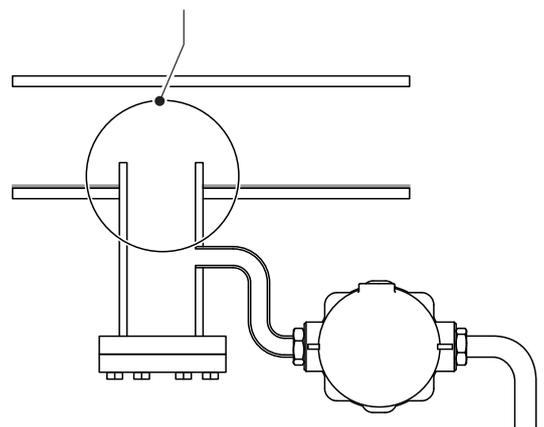
- If possible, a shut-off valve must be installed in the condensate drain pipe upstream of the steam trap for maintenance purposes.

[Fig. 40](#) shows two common errors:

**INCORRECT:** Drip leg too narrow with too little dead space



**INCORRECT:** Drip leg protrudes into steam line



*Fig. 40: Faulty drip legs*

## Air vent and drainage at the end of the steam line

The steam line must be drained at the end of the pipe and vented at the top!

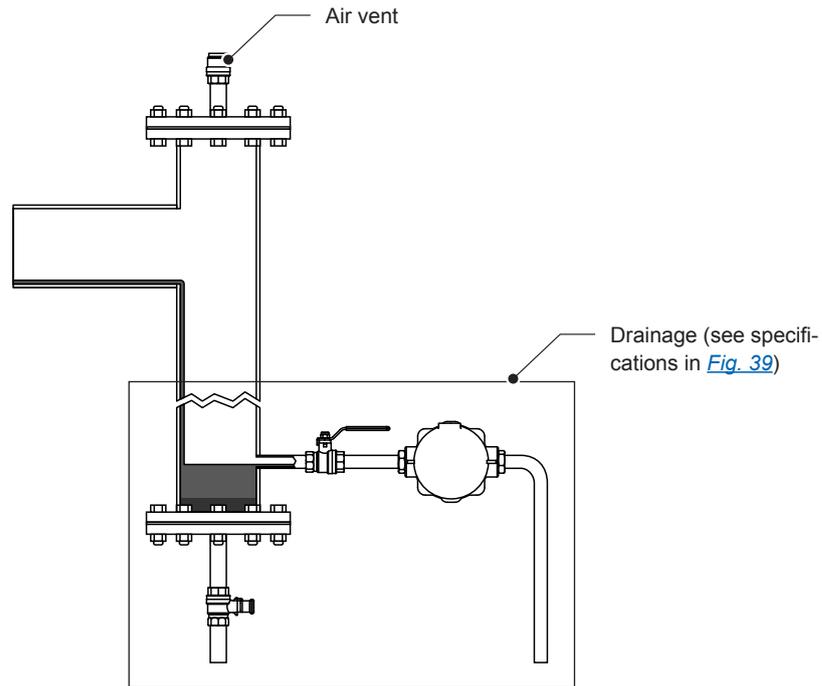


Fig. 41: Air vent and drainage at steam line end

## Routing the steam line

- The steam line must be supported with steam line brackets at regular intervals and must have a pipe gradient in the direction the steam moves greater than 1 to 2%. The steam line must be able to run freely in the brackets. The steam line must not sag under any circumstances, as this makes it difficult for the condensate to escape unhindered.

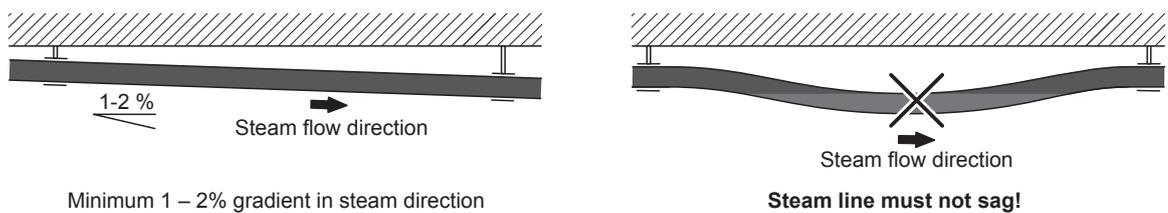


Fig. 42: Slope in steam direction/steam line must not sag

- Pipe expansion must be absorbed with expansion joints or loops.

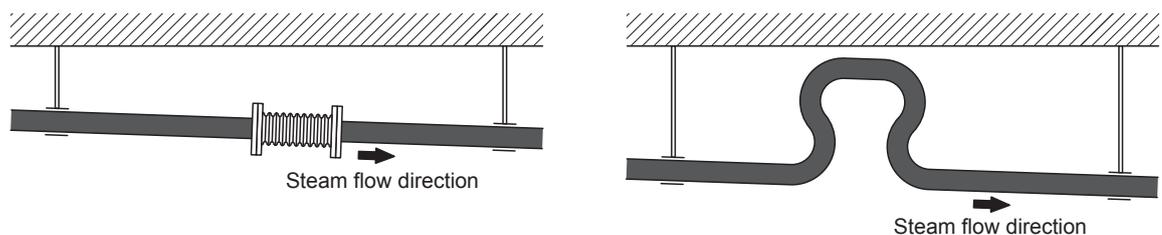


Fig. 43: Suspensions/expansion joints

- Ascending and descending steam lines must always be drained at the lowest point.

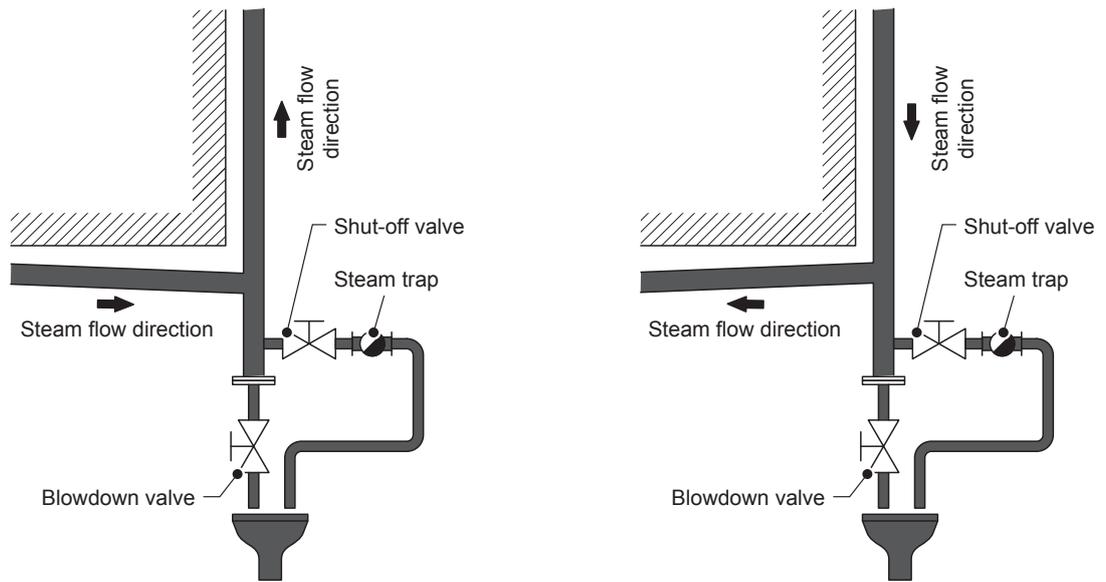


Fig. 44: Ascending and descending steam lines

- Steam lines for bypassing obstacles must always be drained at the lowest point.

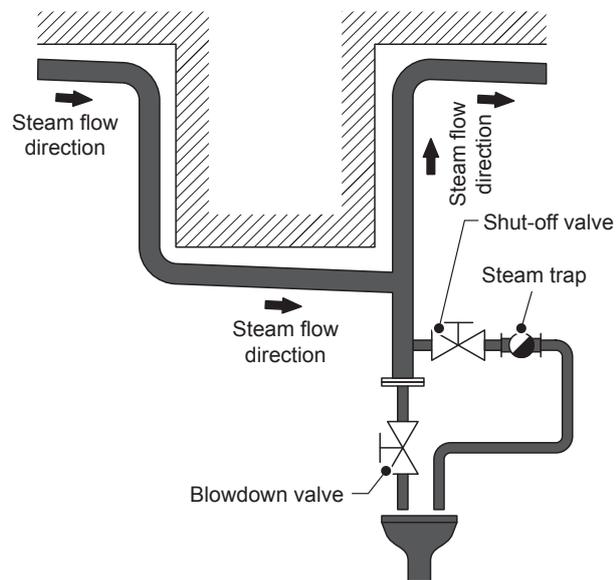


Fig. 45: Steam lines for bypassing obstacles

### Extraction of steam for Condair Esco pressurized steam humidifiers

Steam extraction for the Condair Esco pressurized steam humidifier must be carried out on the top of a properly drained main steam line in order to avoid unnecessary condensate being fed to the Condair Esco valve unit. A shut-off valve (provided on site) must be installed in the steam supply line upstream of the Condair Esco valve unit. The additional installation of a steam pressure gauge is recommended.

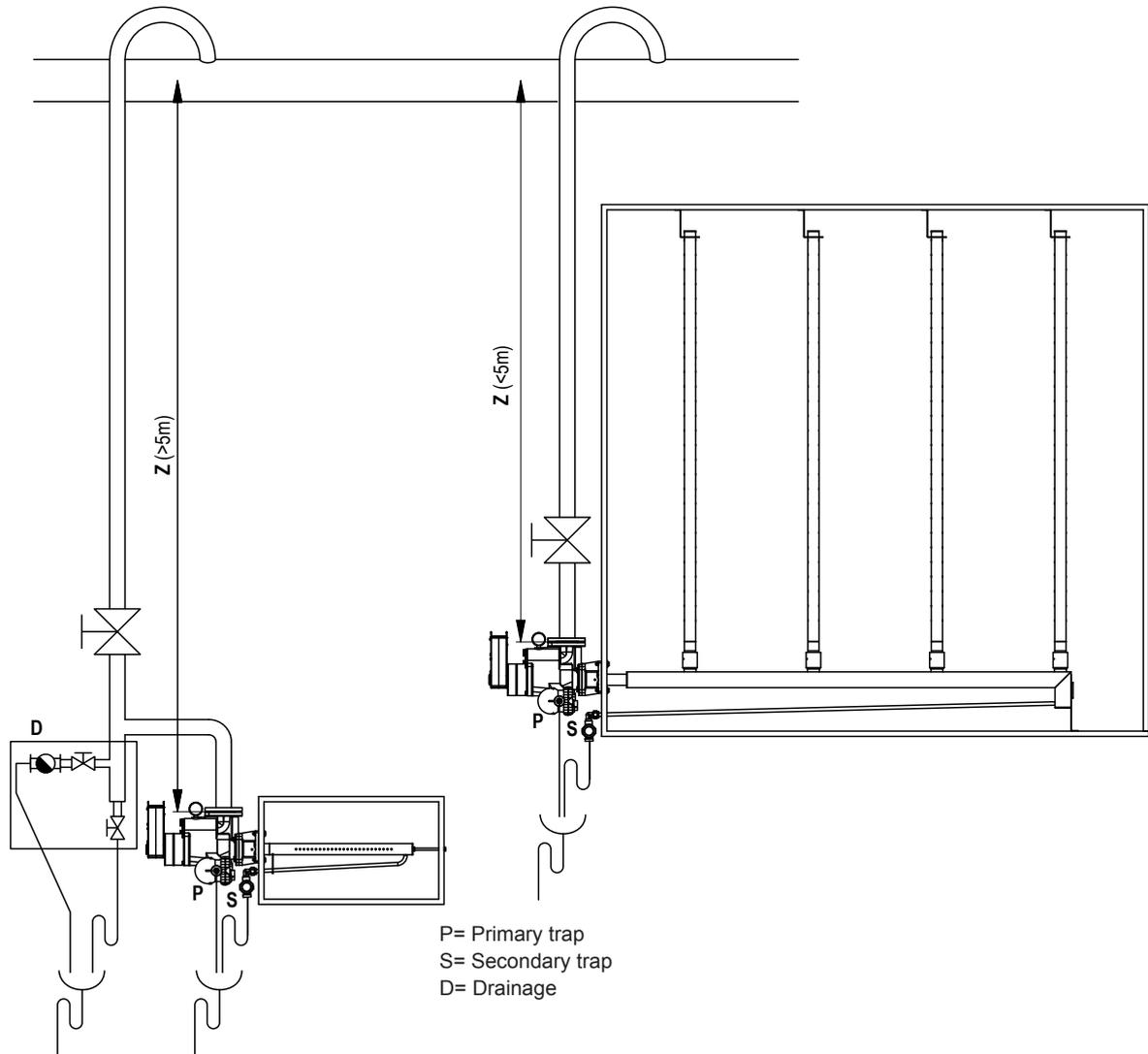


Fig. 46: Steam extraction

Note: If the length "Z" of the steam supply line is greater than 5 m, the end of the pipe must be drained with a drip leg and the branch for the valve unit must be on the side (see [Fig. 46, left](#)).

## 4.7 Condensate drain

### Condensate drain line requirements



#### **DANGER!**

**Equipment and personal injury due to water and steam hammer**

**Improperly implemented condensate drain lines can cause water and steam hammer during operation. This can lead to serious damage to the system or endanger persons.**

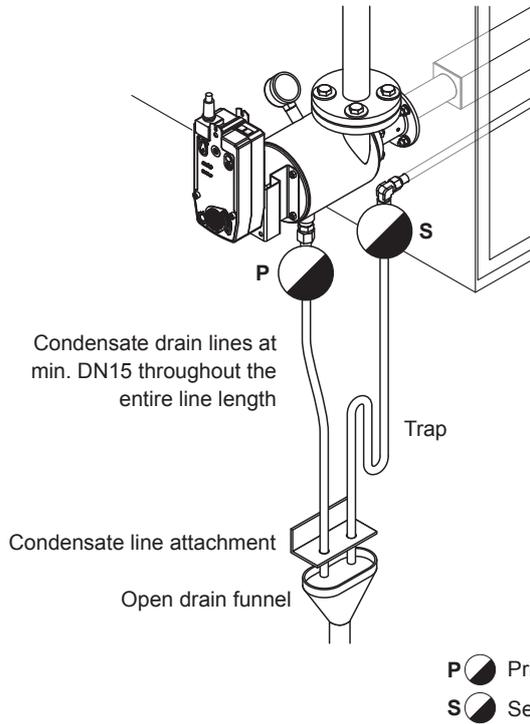
**For this reason: To avoid water and steam hammer during operation, all condensate drain lines must have been correctly installed in accordance with the following specifications.** The customer is responsible for correct installation of the condensate drain lines.

- The condensate lines to be provided by the customer are connected directly to the steam traps (primary and secondary steam traps) and connected with a slope of at least 1% into an open drain funnel or floor drain.
- Use rigid pipes for condensate lines only and no flexible hoses. All materials used for the condensate lines must have a minimum temperature resistance higher than that of the condensate.  
Note: Condensate has the same temperature as saturated steam before cooling.
  - Temperature range primary condensate: 110 to 155°C (depending on pressure)
  - Secondary condensate temperature: max. 120°CPlease observe the permissible temperatures of the building's waste water pipe and, if necessary, install condensate coolers in the condensate drain lines.
- The primary condensate (source valve unit) must be discharged separately from the secondary condensate (source steam distributor). This means that the two condensate drain lines must not be merged up to the open drain funnel/floor drain (see [Fig. 48](#)). Otherwise, it is possible that the primary condensate under higher pressure is forced into the steam distributor via the secondary condensate line and in the worst case floods it. The risk of steam hammers is also increased as the hotter primary condensate meets the secondary condensate.
- The drain line of the primary condensate can also be returned to the steam boiler with a maximum back pressure of 50% of the primary steam pressure. The discharge/return of the primary condensate is a matter for the client. The outlet line of the primary condensate must therefore always be discharged downwards. If installation conditions require the outlet line to discharge upwards, a non-return valve must be fitted in the outlet line.  
Note: 10 m height difference in the primary condensate line causes a theoretical back pressure of 1 bar (without bends or other obstacles in the condensate line).
- The drain line of the secondary condensate must be discharged downwards as this condensate is not under pressure.
- The diameter of the condensate line must not be reduced under any circumstances and must be designed with at least the same or larger diameter as the outlet on the steam trap (see [Fig. 47](#)). The reason for this is the flash steam that is generated when condensate is released at >100 °C to atmospheric pressure. The condensate can evaporate further as a result of the flash. This leads to an increase in volume, as a mixture of condensate (water) and post-evaporated steam is formed in the condensate line. The steam expands to approx. 1,600 times the volume, which increases the velocity in the condensate line considerably.
- The **condensate lines must be secured.**

## Examples of correctly installed condensate drain lines

### Type 1:

Primary and secondary condensate discharged into an open drain funnel



### Type 2:

Recirculation of primary condensate into the steam boiler, secondary condensate discharged into an open drain funnel

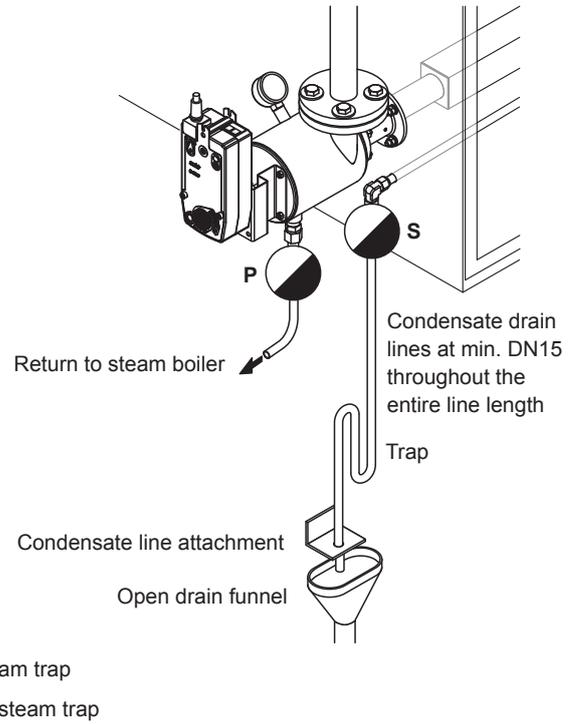
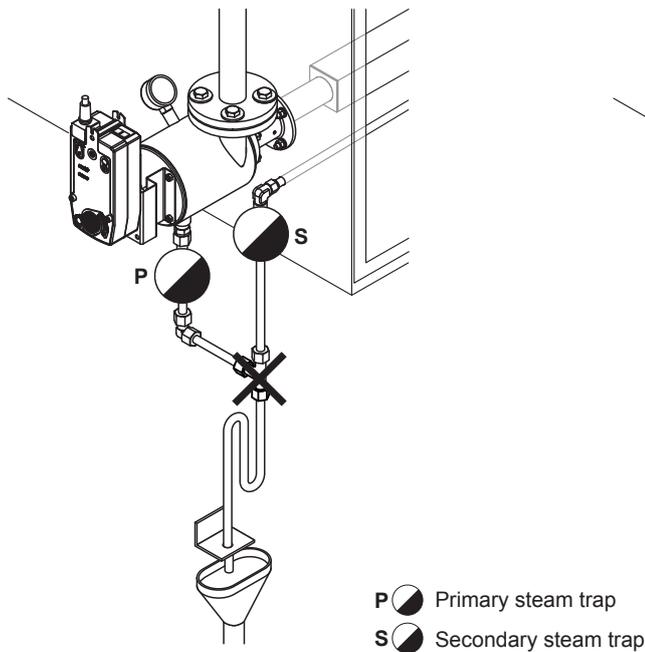


Fig. 47: Correctly installed condensate drainage

## Examples of incorrectly installed condensate drain lines

### Not permitted:

Merging the primary and secondary condensate drain lines



### Not permitted:

Reduction in diameter of primary and secondary condensate drain line

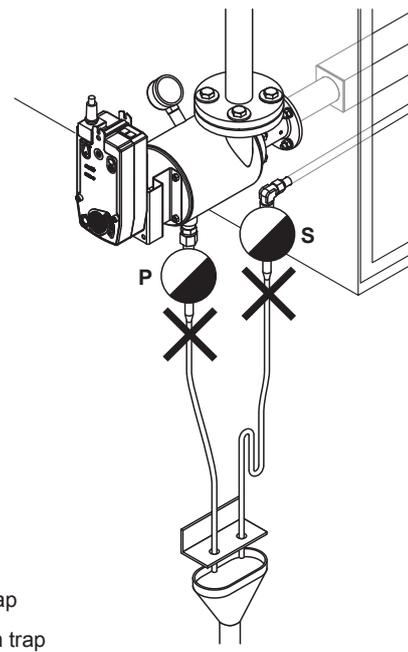
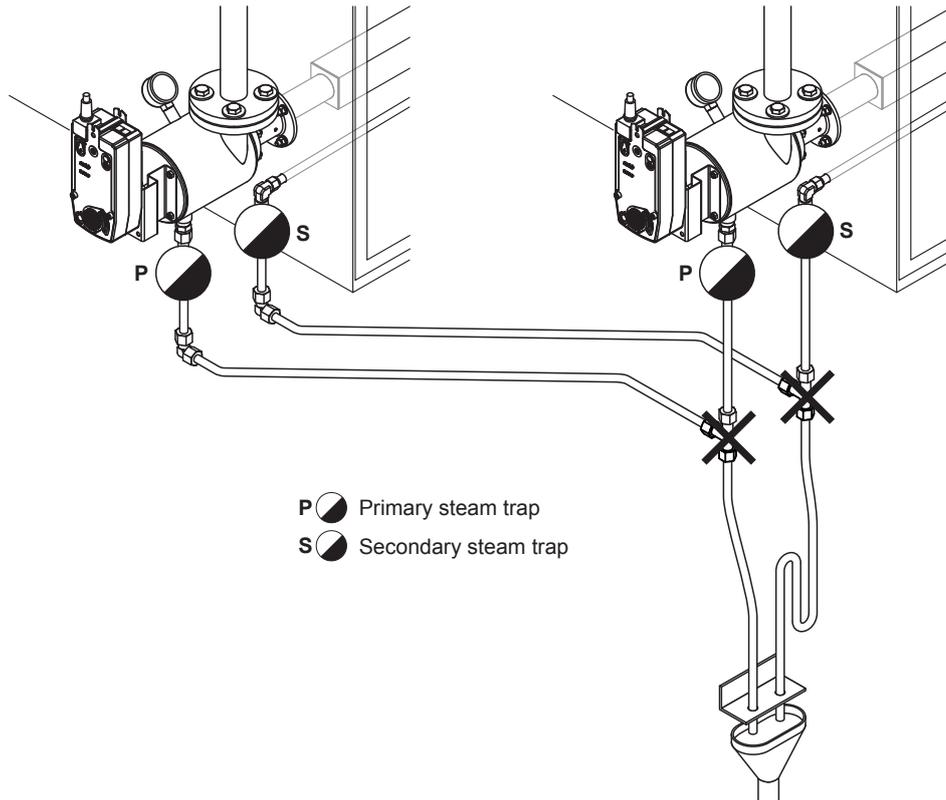


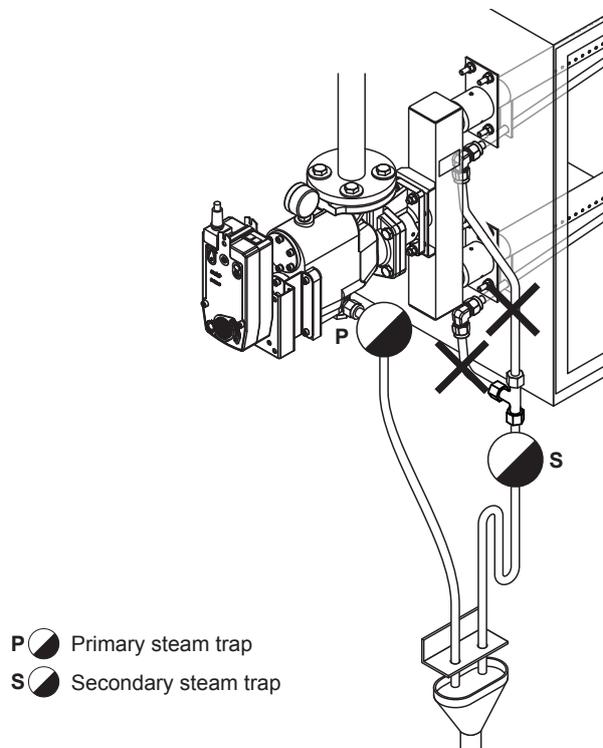
Fig. 48: Condensate drainage carried out incorrectly

**Not permitted:**  
Condensate discharged into a shared line not permitted.



*Fig. 49: Condensate drainage not carried out correctly*

**Not permitted:**  
Group drainage is not permitted. Each condensate line requires its own steam trap.



*Fig. 50: Condensate drainage not carried out correctly*

### **Flash steam (post-evaporation)**

When draining the pipe system with steam traps, flash steam (post-evaporation) can occur at the end of the condensate line, which is characterised by continuously escaping steam. The cause of this flash steam is the adaptation of the condensate to the external pressure and the large gradient between the condensate temperature and the room temperature.

Flash steam is normal and must not be confused with steam losses due to faults in the steam trap.



#### **CAUTION!**

Steam escaping from flash steam in enclosed spaces can lead to undesirable effects. In these cases, post-evaporation must be prevented by suitable measures (e.g. siphons, cooling section, etc.)

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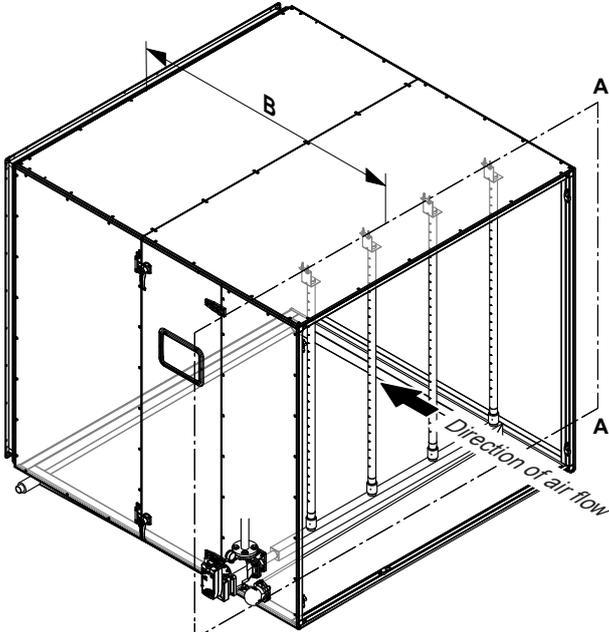
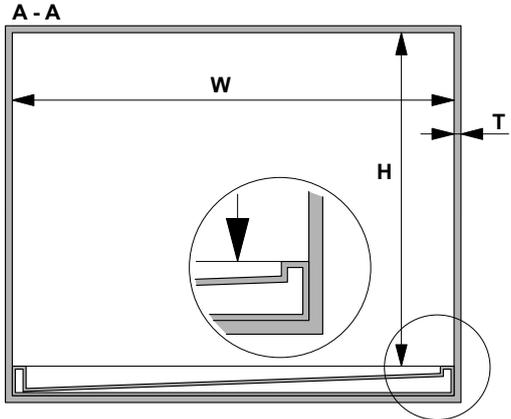
# 5 Selecting the Condair Esco system

## 5.1 Required system data

In order for your Condair partner to be able to determine the applicable Condair Esco system, the following information is required:

Air duct/air handling unit dimensions (see <a href="#">Fig. 51</a> )		
Width "W" (internal dimension)	mm	_____
Height "H" (internal dimension)	mm	_____
Wall thickness "T" of the air duct/air handling unit in installation area	mm	_____
Available humidification distance "B"	mm	_____
Air duct/air handling unit position: horizontal or vertical		_____

*Fig. 51: Air duct/air handling unit dimensions*

Air velocity in the air duct/air handling unit, or	m/s	_____
Air volume to be humidified per hour	m <sup>3</sup> /h	_____
Height above sea level of the system	m	_____
Supply air condition upstream of humidifier		
Temperature T1	°C	_____
Humidity x1	g/kg/%rH	_____

Desired air condition after humidification	
Temperature T2	°C _____
Humidity x2	g/kg/%rH _____
Steam Overpressure	barg _____
Obstacles downstream of humidifier	_____ _____ _____ _____
Variant (stainless steel or ductile cast iron)	_____
Preferred steam distributors (DL40 or DR73)	_____
Desired options	_____ _____ _____ _____

# 6 Commissioning and operation

## 6.1 Commissioning

Commissioning must always be carried out with the operator of the steam network or a steam network specialist!

Condair Group AG accepts no liability for damage caused by improper installation or inadequately maintained steam networks! We assume that all upstream components in the steam network comply with the requirements and local safety guidelines.

1. Assembly of the Condair Esco pressurized steam humidifier  
Check and ensure that the steam supply line and condensate lines are correctly connected and that the steam distributors and valve unit have been installed according to the installation manual.
2. Humidification section  
Check whether, as recommended, there is a condensate pan with drain around the steam humidifier.
3. Humidification distance  
Check and ensure that the humidification distance is complied with in accordance with the design. A longer humidification distance than calculated in the design is of course possible.
4. Steam supply line  
Check and ensure that the steam supply line is routed and drained according to the instructions in this manual.
5. Steam traps  
Check and ensure that the steam traps (primary and secondary steam traps) of the Condair Esco pressurized steam humidifier are installed in the correct position. Experience has shown that incorrect installation positions are the most frequent cause of errors.  
  
Check and ensure that the primary and secondary steam traps are discharged individually to the drain funnel.
6. Tightness  
**Slowly** open the shut-off valve in the steam supply line. Then check the steam pressure and the entire steam supply line up to the valve unit and the valve unit with the steam trap for leaks. If necessary, seal and re-tighten the screw connections.
7. Steam pressure at Esco valve unit  
Check and ensure that the permissible steam pressure at the Esco valve unit is between 0.2 and 4.0 bar. Pressure must correspond to the designed steam pressure.
8. Actuators  
Check and ensure that the actuators are connected in accordance with the instructions in the Condair Esco installation manual. If the actuator has been properly connected, trigger steam output at the steam distributors with a demand signal.
9. Steam distributor  
Check and ensure that the Esco steam distributor is tight and that a steady stream of steam is output from all nozzles, if necessary increase the request for this purpose.  
Note: Until the steam distributor is completely filled with steam, it is possible that steam is not output at all nozzles at the same time. This is normal.

10. Spring return at actuator  
Disconnect the supply voltage or the supply pressure from the actuator. The actuator must immediately mechanically close via the return spring.  
Note: If an external actuator without spring return is unexpectedly used, this reset must be ensured by additional components.
11. Emergency stop function on the actuator as a result of high limit humidistat and air flow monitor trigger.  
Trigger the emergency stop function via the high limit humidistat and the air flow monitor. The actuator must then also close via the return spring. The high limit humidistat and air flow monitor must interrupt the power supply to the actuator.
12. Steam traps  
Check whether condensate is drained periodically via the steam trap. Depending on the installation, this may not be visible as the condensate lines are not accessible up to the drain. In addition, check and ensure that the condensate lines are leak-tight and have been correctly installed.

## 6.2 Operation

### 6.2.1 Adjusting and comparing the angle of rotation of the CA150A-MP electric actuator

#### 6.2.1.1 Setting the angle of rotation

Using the adjustable mechanical stop on the actuator, the rotary angle can be reduced (e.g. for power limitation). From approx. 37° in 3° increments to 90°. For this purpose, proceed as follows:

1. Loosen the screw of the mechanical stop.
2. Move the stop to the desired position to reduce or increase the angle of rotation.
3. Retighten the screw of the stop.
4. Perform angle adjustment in accordance with [Section 6.2.1.2](#).

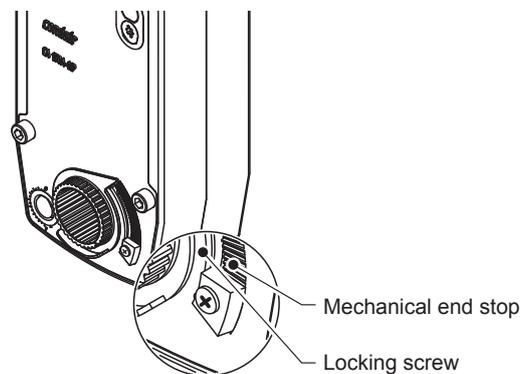


Fig. 52: Setting the angle of rotation

### 6.2.1.2 Adjusting the angle of rotation



#### WARNING!

During adjustment of the angle of rotation, the valve unit opens fully and, if steam pressure applies, humidification will start. If this is not desired, the steam supply to the valve unit must be shut off and depressurized.

If a new CA150A-MP actuator has been installed on the valve unit or the angle of rotation has been adjusted with the mechanical stop (e.g. for power limitation), the angle must be adjusted. With this function, electronic balancing takes place between the electronic control unit and the mechanical end stops. For this purpose, proceed as follows:

Press the <Adaptation> button on the top of the actuator for at min. 2 s. The actuator then moves automatically to the two end stops and saves the angle of rotation. The "Status" LED lights up during this time. The actuator then moves to the position given by the demand signal.

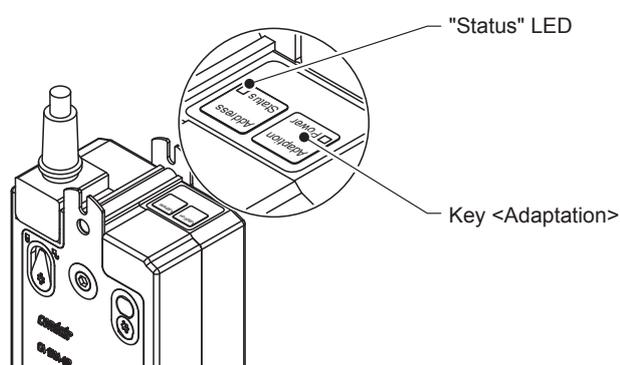


Fig. 53: Adjusting the angle of rotation

# 7 Maintenance

## 7.1 Regular maintenance

The Condair Esco pressurized steam humidifier does not feature parts that must be replaced regularly. It is therefore considered "maintenance-free". Nevertheless, it is advisable to carry out the following visual and functional checks regularly:

Component	When	
Check valve unit for leaks	Once a month	Check the following sealing points: <ul style="list-style-type: none"><li>– Shaft output</li><li>– Screw connection to steam trap</li><li>– Pressure gauge</li><li>– Flange connection</li></ul>
Check steam distributor for leaks	Once a month	Joints
Check steam overpressure	Once a month	Maximum permitted steam overpressure is 4.0 barg
Check pressure gauge	Once a year	Display accuracy and sight glass condition
Check steam trap function	Once a year	
Check actuator function	Once a year	Demand signal Feedback signal Wiring
Check actuator reset function using the spring	Once a year	In the event of a power failure or activation of the high limit humidistat, the actuator must close automatically via the return spring.
Clean or replace strainer	if required	In the event of extraordinary contamination in the steam supply line, the strainer must be replaced immediately.

### Cleaning

The steam distributor can be cleaned with the same cleaning agent as the humidifier vacant unit. It is important that all cleaning agents are rinsed off well. Often cleaning with a damp cloth is sufficient. Do not use any cleaning agents containing chlorine, as these can damage the stainless steel!

## 7.2 Check the strainer and replace it, if necessary (for ductile cast iron valve unit only)

Important: The strainer may only be removed by a Condair service technician.

1. Shut off the steam supply to the valve unit and secure it against unintentional opening.
2. Let the valve unit cool down.
3. Open the valve unit with a demand signal on the actuator so that the pressure in the valve unit can be completely reduced. Then remove the demand signal and allow the actuator to close completely.
4. Dismantling the actuator:
  - Electric actuator:
    - Loosen the 4 screws.
    - Pull off the actuator including heat shield from the actuator shaft.

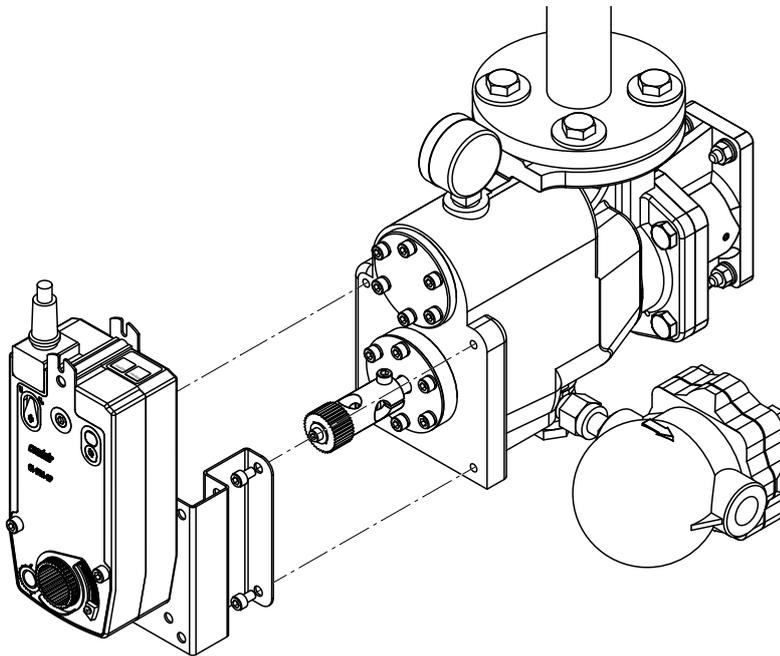


Fig. 54: Removing the electric actuator

- Pneumatic actuator:
  - Loosen the screw and remove cover plate "A".
  - Mark attachment point "C" and the protrusion of the spring strut "D" well using a pen. Remove screw "E" and remove spring "B".
  - Loosen 4 screws "F" and remove cover "G".
  - Loosen and remove screw "H".
  - Loosen the 4 screws "I" and remove the actuator from the actuator shaft.

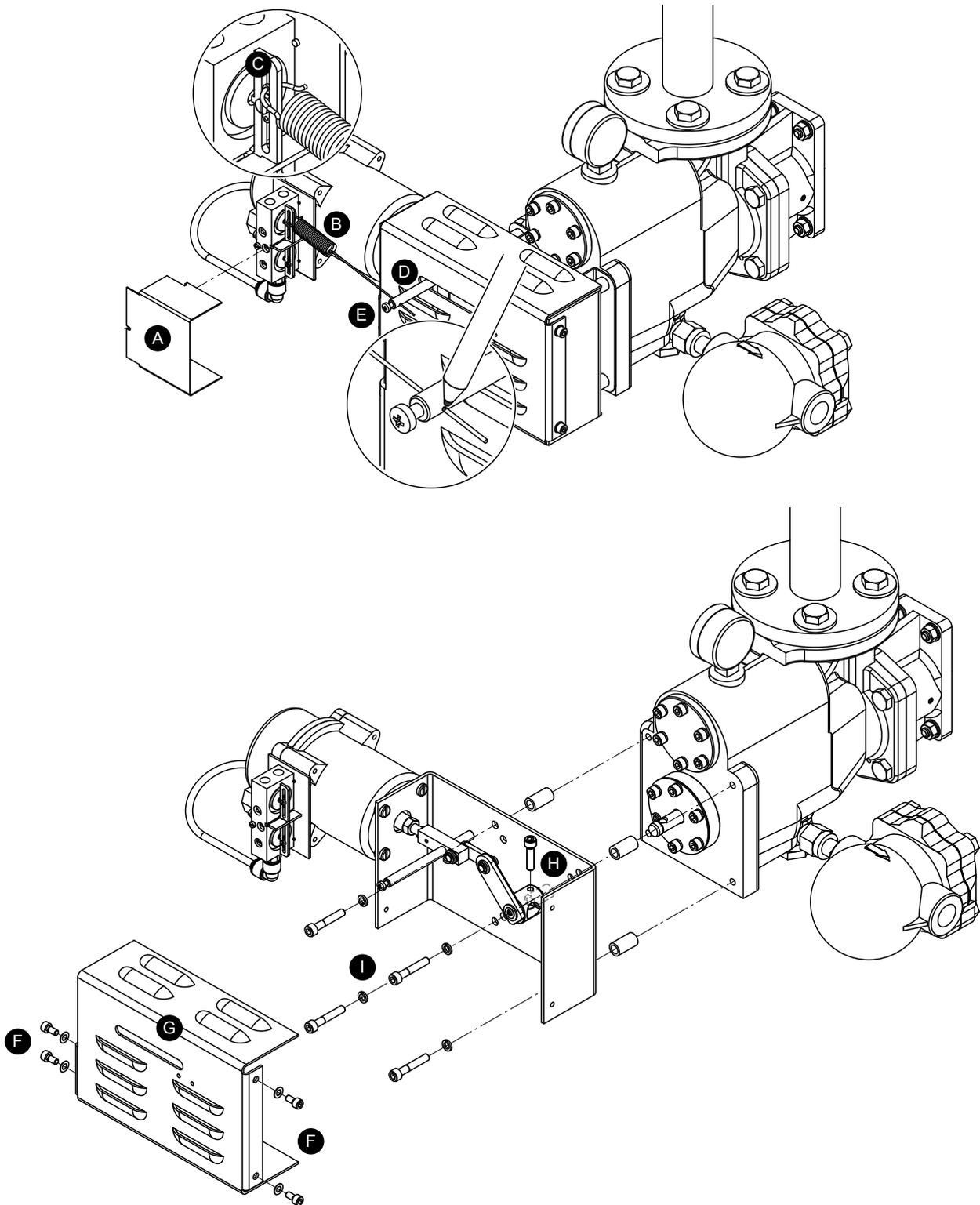


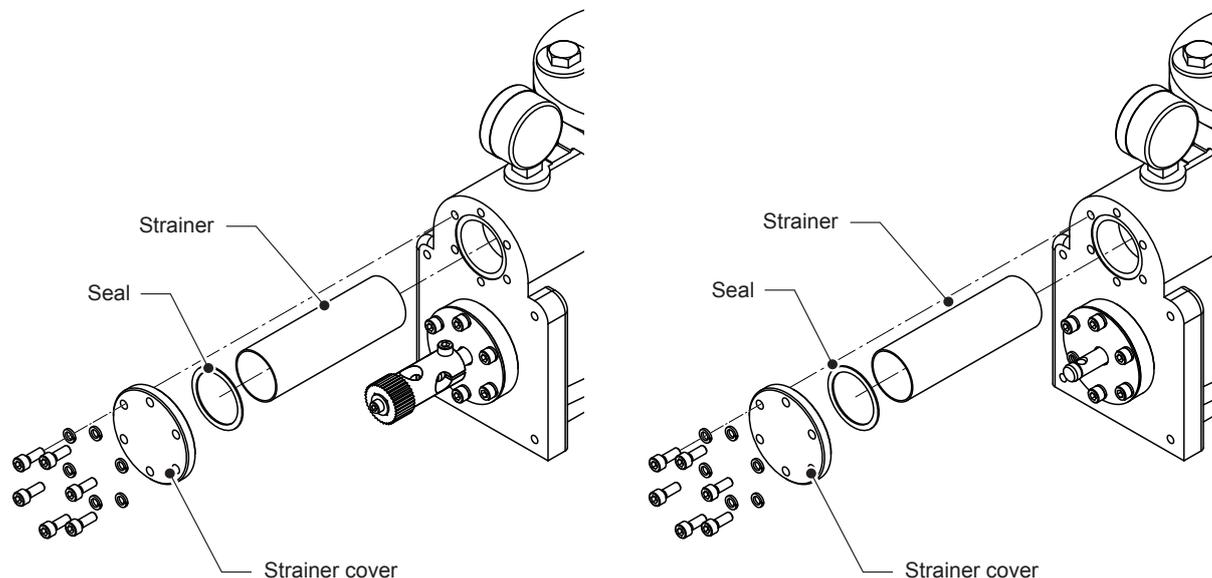
Fig. 55: Removing the pneumatic actuator

5. Remove the strainer cover and carefully pull out the strainer.



**CAUTION!**

Particles caught in the strainer must not fall into the valve unit!



*Fig. 56: Removing the strainer*

6. Clean and reinstall strainer. If necessary, install a new strainer.
7. Fit the strainer cover with a new seal.
8. Turn shaft counterclockwise up to the stop.  
Important: There is no stop on the Esco 5. In this case, the Allen screw on the coupling piece must be in a vertical position before the actuator is mounted.
9. Install the actuator: The actuators are installed in the reverse order of the work steps listed in item 4.  
Important: With the P-actuator, attach the spring to the correct attachment point and push the spring strut into the hole of the cylindrical pin up to the mark.
10. Trigger an adaptation for the electric actuator (see [Section 6.2.1](#)).
11. Open steam supply.
12. Check strainer cover for leaks.
13. Check the function of the actuator.

## 8 Troubleshooting



### WARNING!

The following inspection and corrective measures for troubleshooting may only be carried out by a Condair service technician or a service technician authorised by Condair.

Fault	Possible causes/errors	Test/remedy
No steam escaping from the steam nozzles	High limit humidistat permanently interrupts the supply voltage to the actuator	<ul style="list-style-type: none"> <li>• Reduce moisture on high limit humidistat</li> <li>• Air flow too low</li> <li>• Check high limit humidistat for correct wiring and if necessary correct it.</li> <li>• Check the high limit humidistat setting and, if necessary, set increase it.</li> <li>• Check valve size and if necessary correct it.</li> </ul>
	Incorrect or no demand signal on actuator	<ul style="list-style-type: none"> <li>• Correct demand signal.</li> <li>• Check wiring of strand 3 (Y) on the electrical actuator CA150A-MP and, if necessary, correct it.</li> <li>• For pneumatic actuator: Check the hoses to the actuator and, if necessary, correct it.</li> <li>• Check setting on the position controller and, if necessary, correct it (direction of action)</li> </ul>
	Ceramic discs jammed or faulty	<ul style="list-style-type: none"> <li>• Replace ceramic discs</li> </ul>
	Mechanical connection between actuator and valve shaft interrupted	<ul style="list-style-type: none"> <li>• Replace valve unit</li> </ul>
	Missing steam pressure at valve unit	<ul style="list-style-type: none"> <li>• Open shut-off valve in steam supply line</li> <li>• Check that there is no obstruction in the steam supply line that prevents the steam supply (e.g. packaging materials or protective plugs).</li> </ul>

<b>Fault</b>	<b>Possible causes/errors</b>	<b>Test/remedy</b>
Condensate sprays out of the steam nozzles	Steam boiler dimension too small (water is carried along).	<ul style="list-style-type: none"> <li>• Correct steam dimensioning.</li> </ul>
	Thermostatic secondary steam trap installed incorrectly (direction of flow).	<ul style="list-style-type: none"> <li>• Install the thermostatic secondary steam trap according to the installation instructions (observe flow direction).</li> </ul>
	Primary and secondary condensate lines have been merged.	<ul style="list-style-type: none"> <li>• Route the primary and secondary condensate lines separately.</li> </ul>
	Secondary condensate lines have not been routed with downward gradients.	<ul style="list-style-type: none"> <li>• Route secondary condensate lines with downward gradient.</li> </ul>
	Back pressure in condensate line too high (rising condensate line).	<ul style="list-style-type: none"> <li>• Reduce the height difference in the condensate line.</li> </ul>
	Steam supply line not drained according to specifications.	<ul style="list-style-type: none"> <li>• Check the steam trap installation position in the steam supply line and correct, if necessary</li> <li>• Increase the number of steam traps in the steam supply line</li> <li>• Check the function of the steam traps in the steam supply line and replace faulty steam traps.</li> </ul>
	Secondary steam trap faulty.	<ul style="list-style-type: none"> <li>• Replace secondary steam trap.</li> </ul>
	Thermostatic secondary steam trap insulated.	<ul style="list-style-type: none"> <li>• Remove the insulation on the steam trap.</li> </ul>
	Thermostatic secondary steam trap dirty.	<ul style="list-style-type: none"> <li>• Remove the steam trap and clean the strainer.</li> </ul>
	Too much condensate in the valve unit due to incorrect steam extraction from the steam supply line.	<ul style="list-style-type: none"> <li>• Check whether steam is being drawn from the top of the main steam line. If not correct it.</li> </ul>
Continuous steam output at steam trap outlet	Steam distributors are not mounted horizontally.	<ul style="list-style-type: none"> <li>• Align the steam distributor horizontally and re-attach it.</li> </ul>
	Steam trap jammed (ball float).	<ul style="list-style-type: none"> <li>• If the ball gets stuck repeatedly, the ball float steam trap must be replaced.</li> </ul>
	Steam trap faulty.	<ul style="list-style-type: none"> <li>• Replace steam trap.</li> </ul>
	Inverted bucket steam trap is operated with superheated steam.	<ul style="list-style-type: none"> <li>• Change steam trap type.</li> <li>• Use saturated steam.</li> </ul>
	Post-evaporation evident.	<ul style="list-style-type: none"> <li>• Install condensate cooling section so that the condensate no longer evaporates.</li> </ul>

<b>Fault</b>	<b>Possible causes/errors</b>	<b>Test/remedy</b>
No steam pressure at valve unit	On-site shut-off valve in the steam supply line closed	<ul style="list-style-type: none"> <li>• Open shut-off valve</li> <li>• Check actuation to shut-off valve and correct, if necessary.</li> </ul>
	Obstruction in the steam supply line (e.g. seal not removed from protective film)	<ul style="list-style-type: none"> <li>• Check that there is no obstruction in the steam supply line that prevents the steam supply (e.g. packaging materials or protective plugs).</li> </ul>
	Steam boiler out of operation	<ul style="list-style-type: none"> <li>• Start up the steam boiler if possible and permitted.</li> </ul>
	Pressure gauge faulty, pressure would normally apply.	<ul style="list-style-type: none"> <li>• Depressurise the valve unit and install a new pressure gauge.</li> </ul>
Ceramic discs worn or fractured	Use of steam that is too wet	<ul style="list-style-type: none"> <li>• Check the steam separator in the steam network and replace it. Improve the drainage of the steam supply line.</li> </ul>
	Dirt content in steam too high/poor steam quality	<ul style="list-style-type: none"> <li>• Check steam boiler water used and improve, if necessary.</li> <li>• Check steam lines for erosion.</li> <li>• Check the material of the steam lines and improve, if necessary.</li> </ul>
	Valve unit damaged by impact or other action	<ul style="list-style-type: none"> <li>• Check valve unit for external damage and replace it.</li> </ul>
Steam escapes at the steam nozzles when the valve unit is closed	Ceramic discs faulty or worn	<ul style="list-style-type: none"> <li>• Replace ceramic discs</li> </ul>
	Actuator not installed in home position	<ul style="list-style-type: none"> <li>• De-energise and disassemble the actuator, align the shaft in the home position and install the actuator.</li> </ul>
Valve unit leaking	Check that the primary steam trap has been correctly installed and is operating correctly.	<ul style="list-style-type: none"> <li>• Correct the installation position of the primary steam trap.</li> <li>• Replace the valve unit if the seal is faulty.</li> <li>• Check valve unit housing for cavities</li> </ul>

## 9 Technical data

Description		Unit	Esco DL40	Esco DL40 / DR73			Esco DR73		
			Esco 5 Ductile cast iron	Esco 10 Ductile cast iron	DL 10 stainless steel	Esco 20 Ductile cast iron	DL 20 stainless steel	Esco 30 Ductile cast iron	
Rated power	Maximum permissible steam capacity	kg/h	125	250	250	500	500	1000 or 2x1000	
Air duct/ air handling unit	Inside width <sup>1)</sup>	mm	DL40: 275 to 2124	DL40: 250 to 4299 / DR73: 800 to 6000 <sup>1)</sup>				DR73: 1000 to 6000 <sup>1)</sup>	
	Internal height <sup>1)</sup>	mm	DL40: 200 to 3500 / DR73: 600 to 5000 <sup>1)</sup>				DR73: 1000 to 5000 <sup>1)</sup>		
	Air velocity:	m/s	Min. 1 m/s						
Valve unit	Housing material		Ductile cast iron		Stainless steel 1.4301 / AISI 304	Ductile cast iron	Stainless steel 1.4301 / AISI 304	Ductile cast iron	
	KVs range	m <sup>3</sup> /h	0.16, 0.25, 0.4, 0.63, 1.0, 1.6, 2.5, 4.0, 6.3, 8.0			6.3, 10, 16, 21		16, 25, 33, 43	
	Strainer		Positioned externally	In valve body	—	In valve body	—	In valve body	
	Steam trap		Thermostatic steam trap	Ball float or inverted bucket steam trap	Ball float or inverted bucket steam trap, stain- less steel	Ball float or inverted bucket steam trap	Ball float or inverted bucket steam trap, stain- less steel	Ball float or inverted bucket steam trap	
	Permissible ambient tem- perature	°C	5 to 50 °C						
	Permissible ambient humidity	%rH	max. 80%, non-condensing						
Steam	Permissible steam pressure	barg	0.2 to 4.0						
	Steam quality		Saturated steam without any residue of chloride, sulphide, sulphate or ammonium compounds						
	Permissible saturated steam temperature	°C	max. 155°C at 4.0 barg						
Steam distribution	Steam pipe length	mm	DL40: 249 to 1799	DL40: 230 to 3880 / DR73: customer-specific				DR73: customer- specific	
	Material		Stainless steel 1.4301 / 07 (AISI 304 / 304L)						
	Steam trap		Thermostatic steam trap, brass		Thermostatic steam trap, stain- less steel	Thermostatic steam trap, brass or ball float steam trap <sup>2)</sup>	Stainless steel thermostatic steam trap or stainless steel ball float steam trap <sup>2)</sup>	Thermostatic steam trap, brass or ball float steam trap <sup>2)</sup>	
	Multiple piping	pcs.	No	DL40: 1 to 3 / DR73: 2 to 20				DR73: 2 to 20	
Connections	Steam supply		G1/2" internal thread	DN32 PN16 DIN flange		DN50 PN16 DIN flange		DN80 PN16 DIN flange	
	Primary steam trap		Rp 1/2"						
	Secondary steam trap								
	Pressure gauge		—	G 1/4" female thread on valve body					
	Steam outlet, valve unit	mm	ø 41.0			ø 59.5		ø 88.0	

Description		Unit	Esco DL40	Esco DL40 / DR73			Esco DR73
			Esco 5 Ductile cast iron	Esco 10 Ductile cast iron	DL 10 stainless steel	Esco 20 Ductile cast iron	DL 20 stainless steel
Actuator	Electrical type		CA150A-MP				
	Power supply	V	24 VAC 50 to 60 Hz / 24 VDC (connection only via safety isolating transformer)				
	Demand signal <sup>3)</sup>	VDC	0.5 to 10VDC, 2 to 10 VDC, optionally 4 to 20 mA				
	Feedback signal	VDC	0.5 to 10VDC, 2 to 10 VDC				
	Run time 0 - 100%	s	150 (adjustable 70 to 220)				
	Spring return		Yes				
	Protection		IP54				
	Power consumption	W / VA	Standby: 3.5 W, Operation: 8.5 W / 11 VA				
	Pneumatic type		Sauter AK41				
	Supply pressure	barg	1.3				
	Demand signal	barg	0.2 - 1.0				
	Run time 0 - 100%	s	7				
	Positioner		XSP31 (optional)				
	Protection		IP20				
	Spring return		Yes				
Network	Direct bus connection		MP bus (CA150A-MP only)				

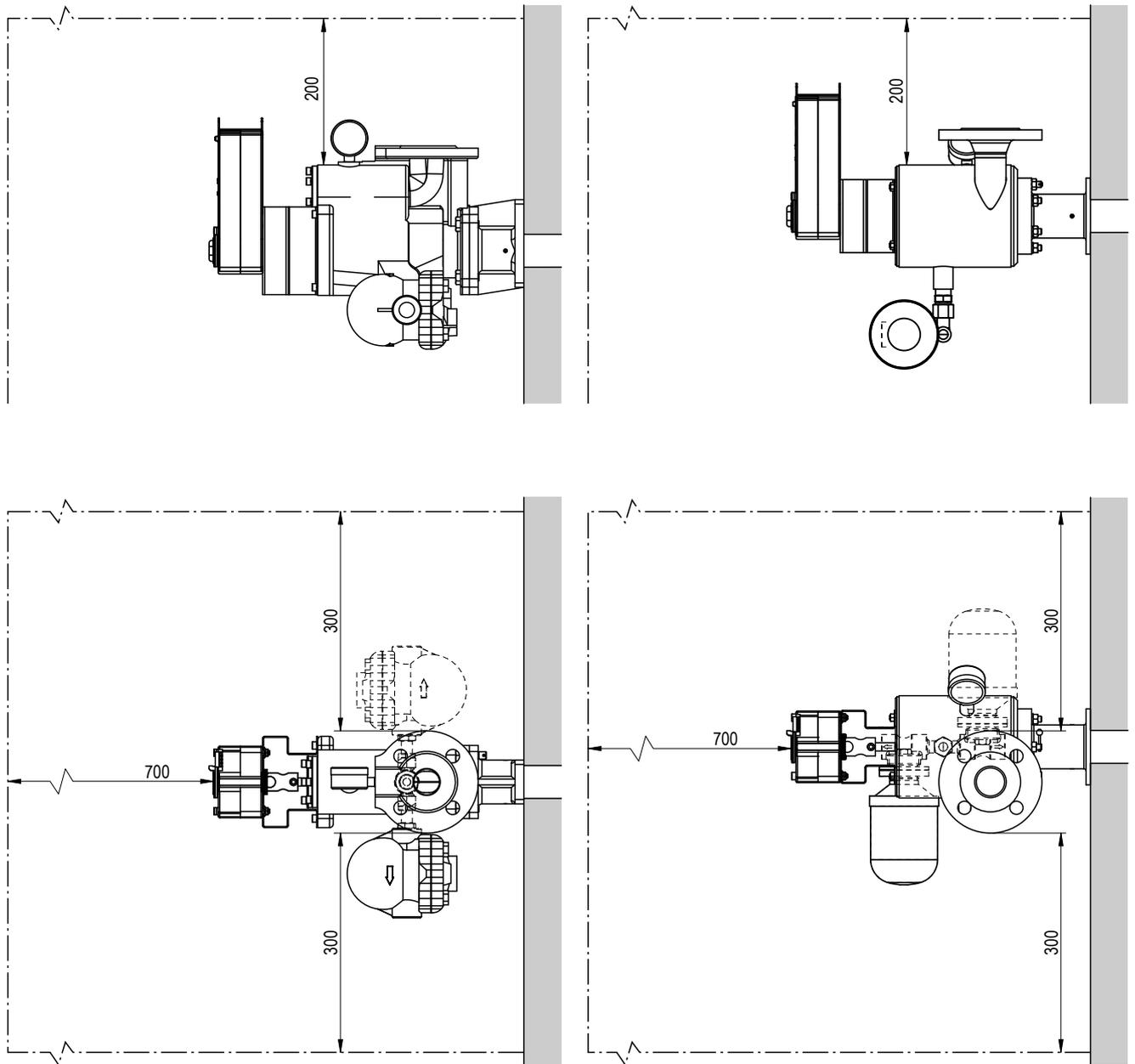
<sup>1)</sup> Depending on steam capacity, steam capacity per meter steam pipe and air velocity

<sup>2)</sup> Ball float steam traps are used for systems  $\geq 488$  kg/h

<sup>3)</sup> Adjustable with MP Parameter Tool

# 10 Appendix

## 10.1 Clearances to be maintained around the valve unit



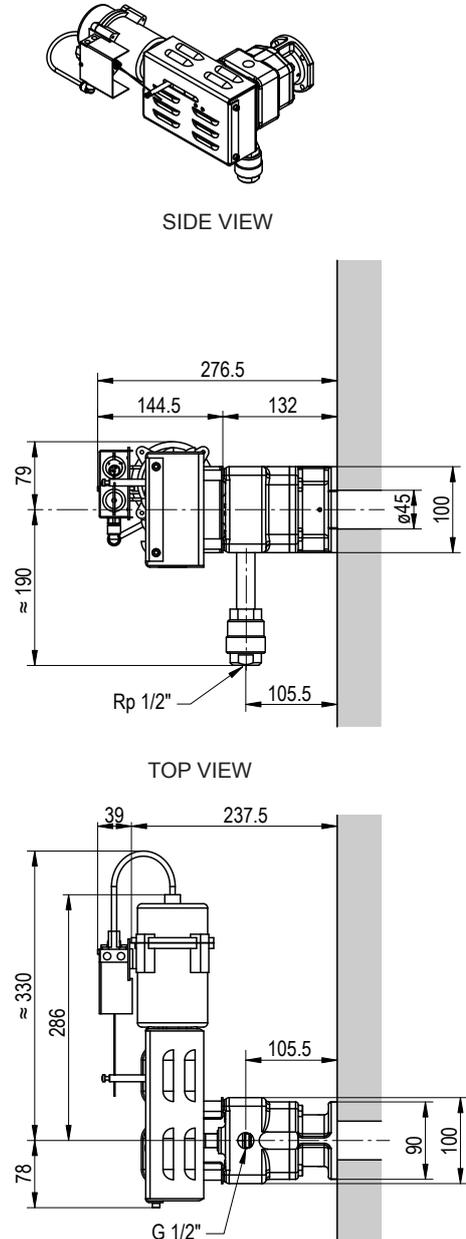
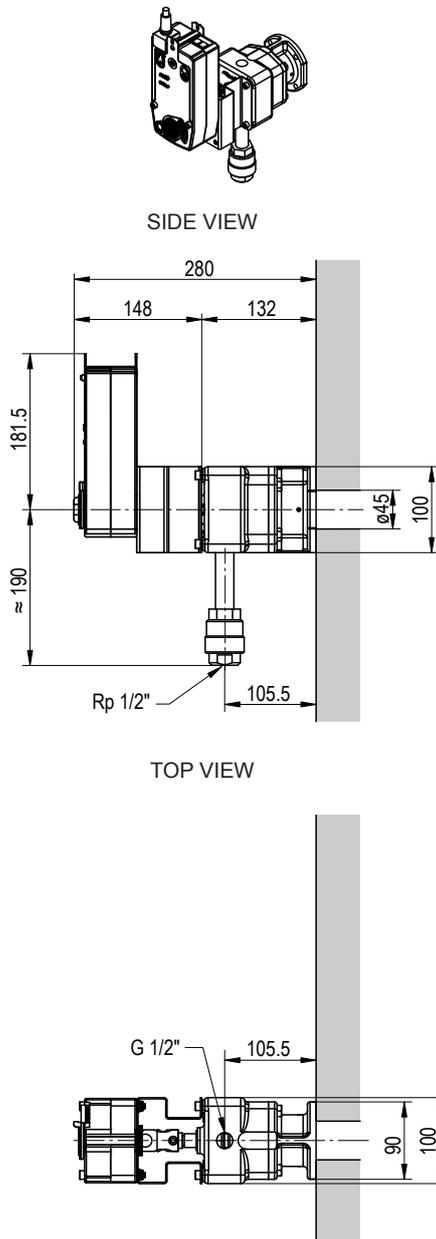
Dimensions in mm in mm

Fig. 57: Clearances to be maintained around the valve unit

## 10.2 Dimensional drawings

Note on dimensional drawings: In practice, all dimensions marked with "≈" may differ slightly due to conically threaded connections or deviating hose routing.

### 10.2.1 Dimensional drawings Condair Esco 5 ductile cast iron



Dimensions in mm

Fig. 58: Dimensional drawing, Esco 5 ductile cast iron with CA150A-MP electric actuator

Fig. 59: Dimensional drawing, Esco 5 ductile cast iron with Sauter AK41 pneumatic actuator

## 10.2.2 Dimensional drawings Condair Esco 10 ductile cast iron

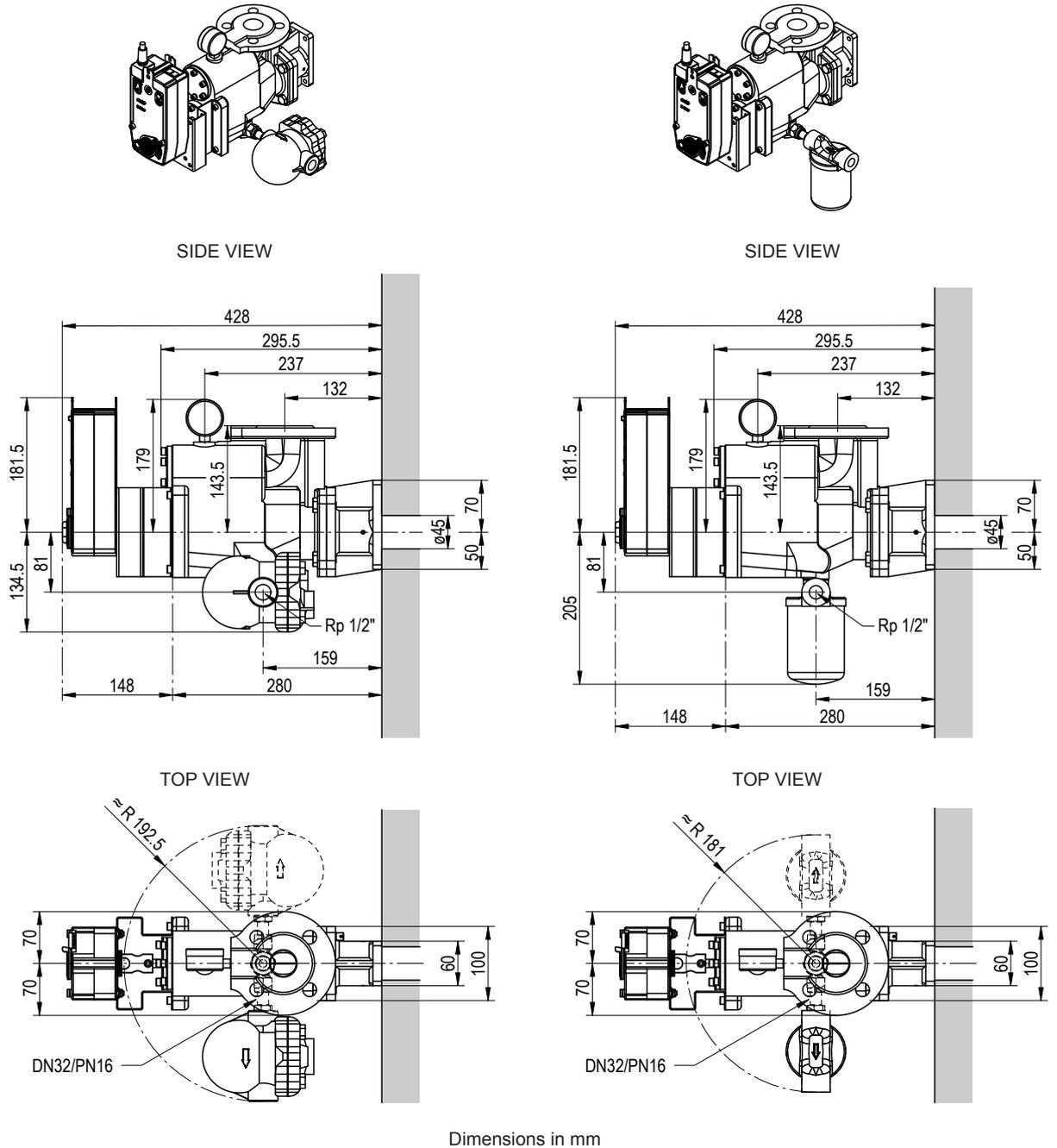


Fig. 60: Dimensional drawing, Esco 10 ductile cast iron with ball float steam trap with CA150A-MP electric actuator

Fig. 61: Dimensional drawing, Esco 10 ductile cast iron with inverted bucket steam trap with CA150A-MP electric actuator

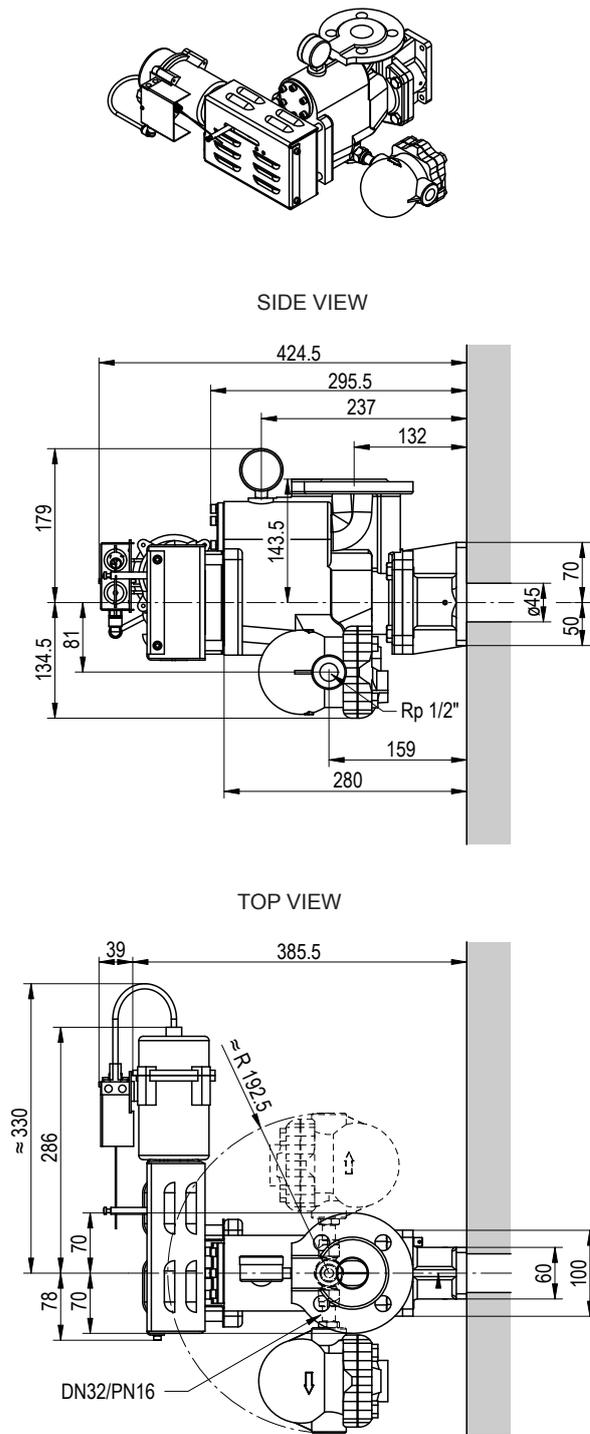


Fig. 62: Dimensional drawing, Esco 10 ductile cast iron with ball float steam trap with Sauter AK41 pneumatic actuator

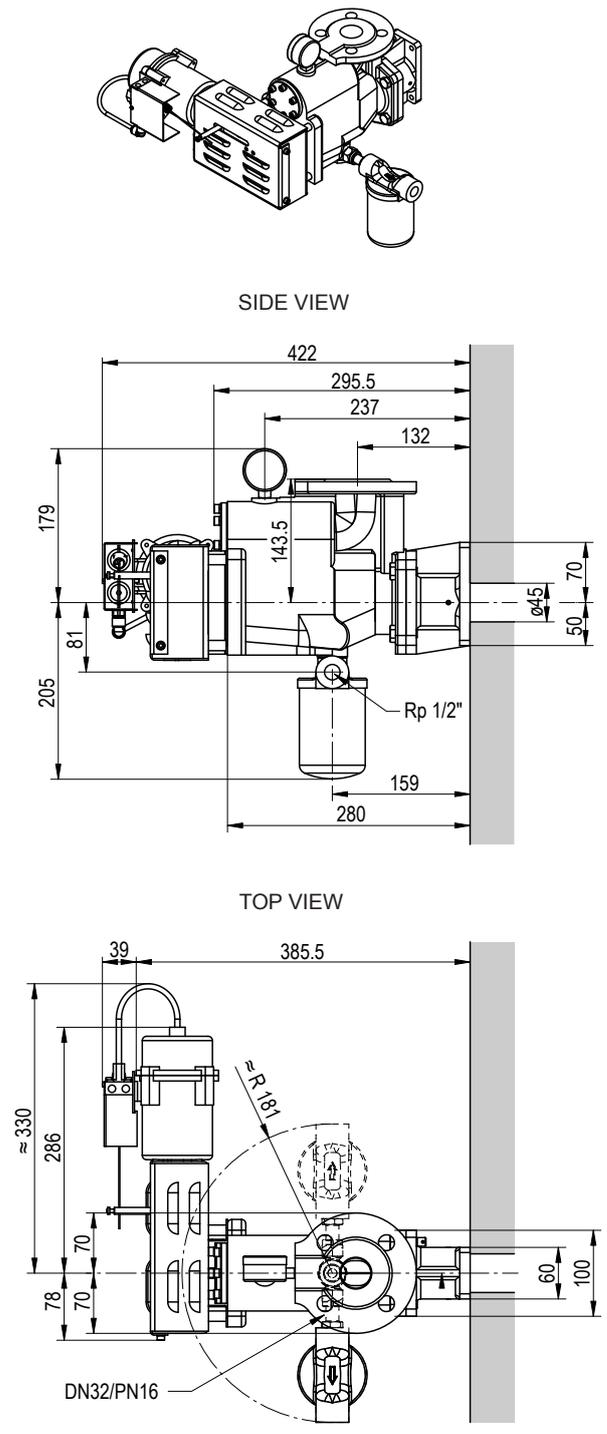
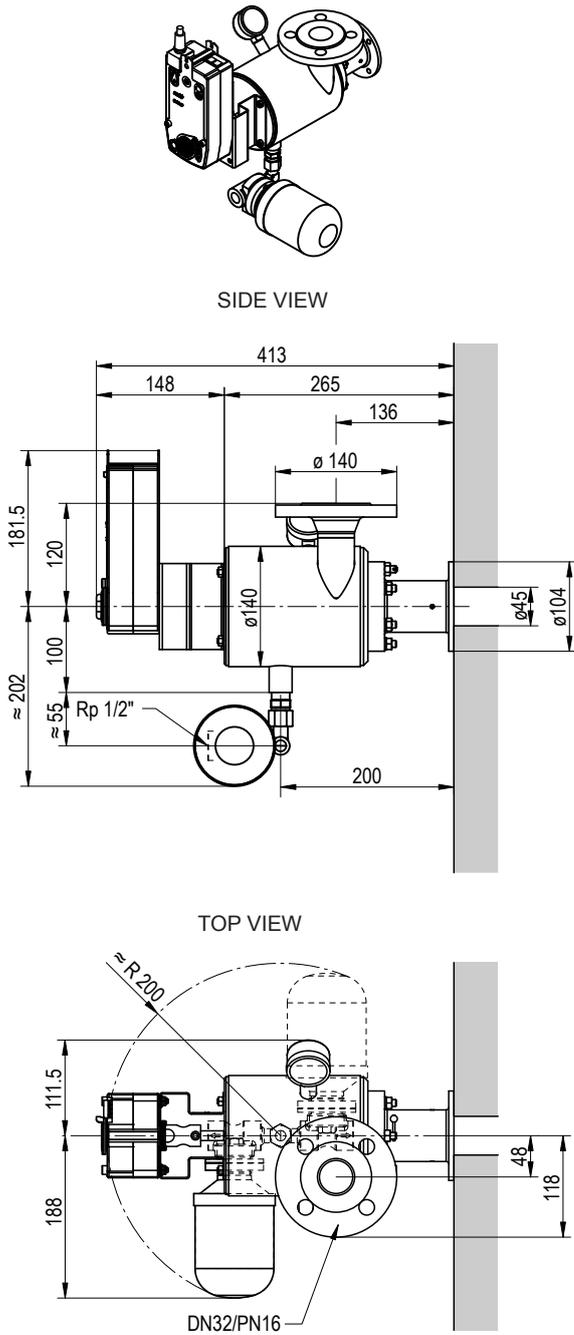


Fig. 63: Dimensional drawing, Esco 10 ductile cast iron with inverted bucket steam trap with Sauter AK41 pneumatic actuator

Dimensions in mm

### 10.2.3 Dimensional drawings Condair Esco 10 ductile stainless steel



Dimensions in mm

Fig. 64: Dimensional drawing, Esco 10 stainless steel with ball float steam trap with CA150A-MP electric actuator

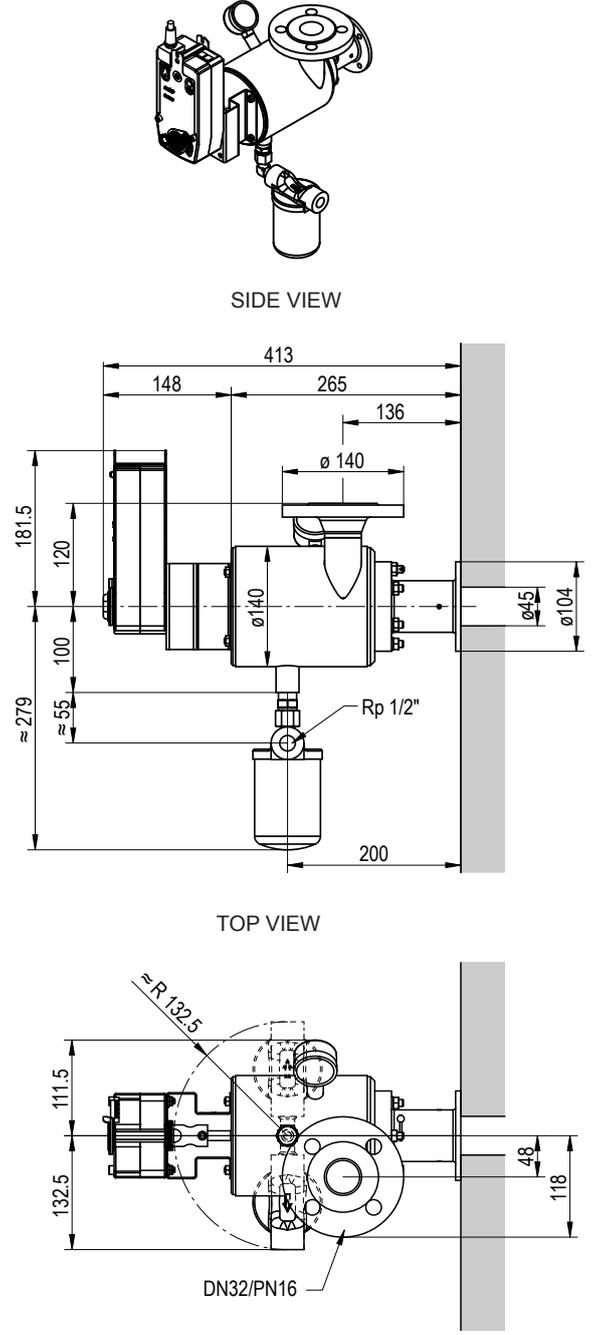
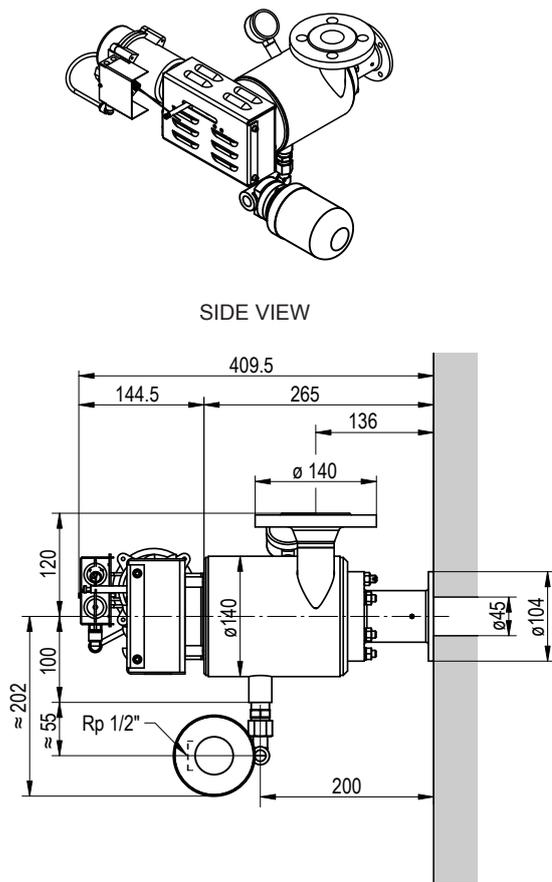
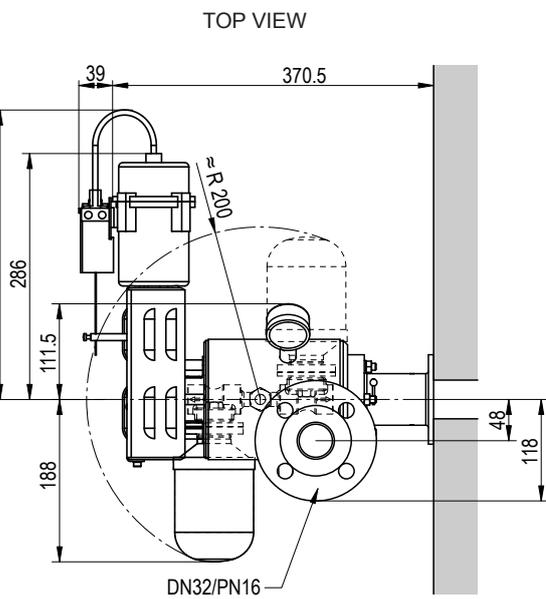


Fig. 65: Dimensional drawing, Esco 10 stainless steel with inverted bucket steam trap with CA150A-MP electric actuator



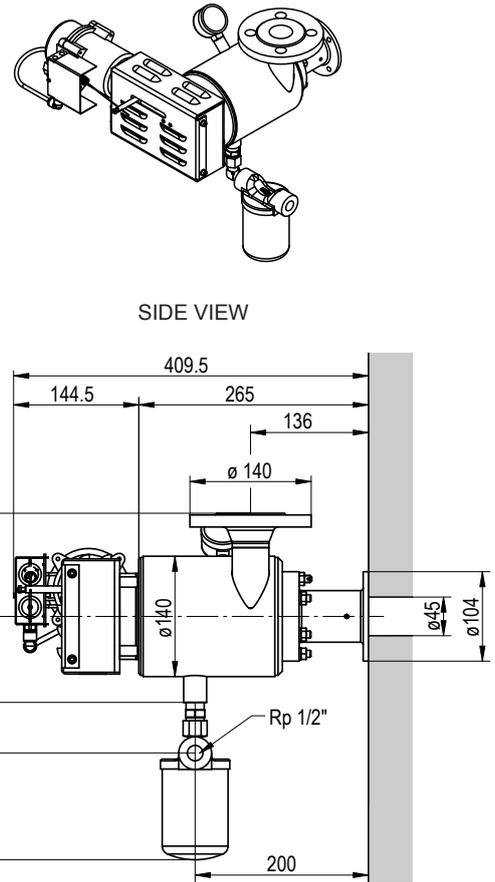
SIDE VIEW



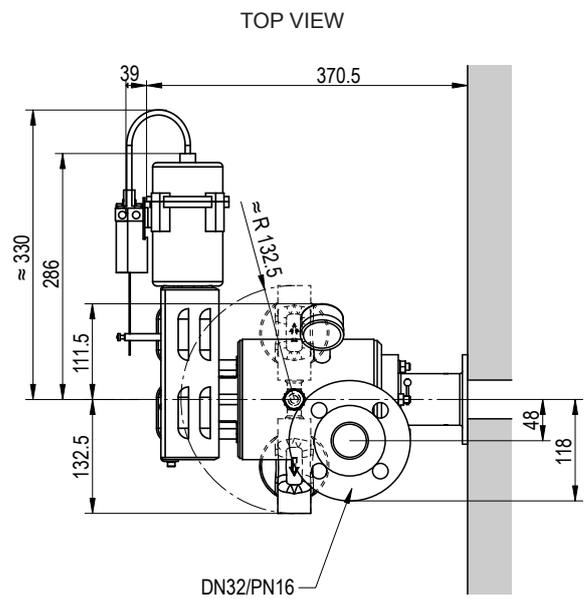
TOP VIEW

Dimensions in mm

Fig. 66: Dimensional drawing, Esco 10 stainless steel with ball float steam trap with Sauter AK41 pneumatic actuator



SIDE VIEW



TOP VIEW

Fig. 67: Dimensional drawing, Esco 10 stainless steel with inverted bucket steam trap with Sauter AK41 pneumatic actuator

### 10.2.4 Dimensional drawings Condair Esco 20 ductile cast iron

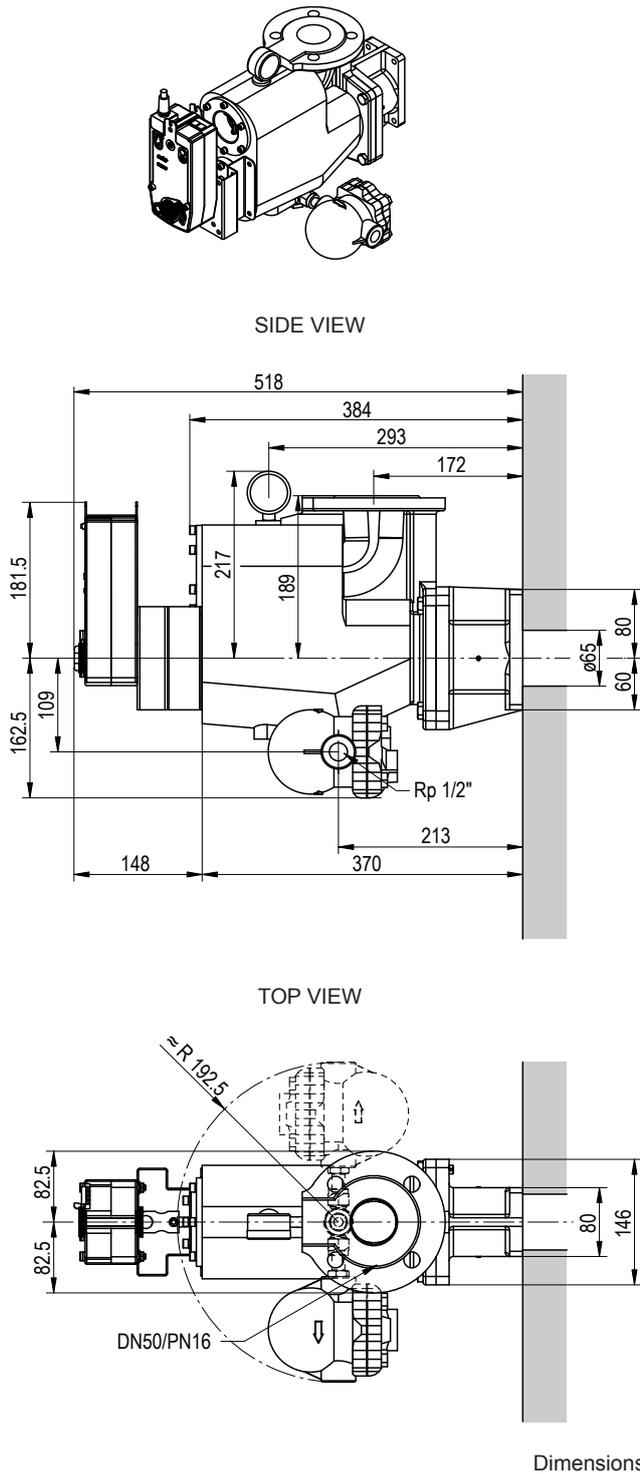


Fig. 68: Dimensional drawing Esco 20 ductile cast iron with ball float steam trap with electric actuator CA150A-MP

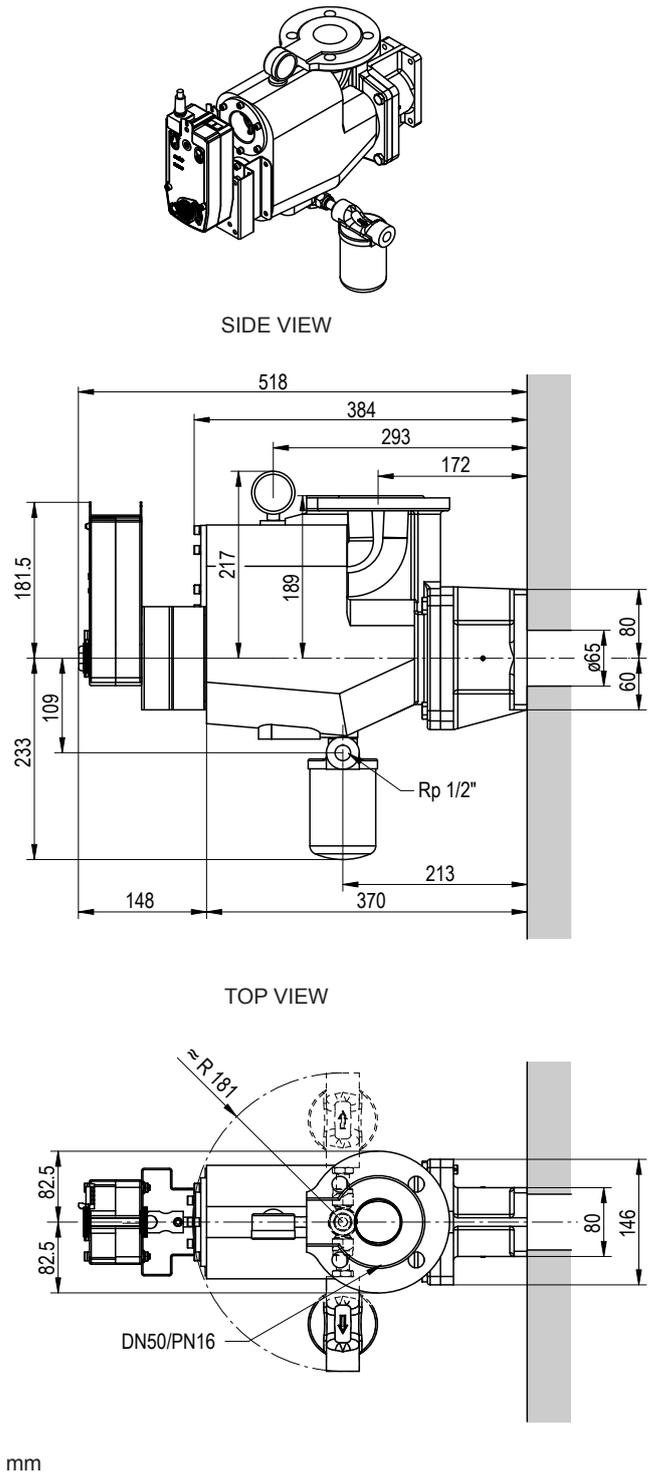
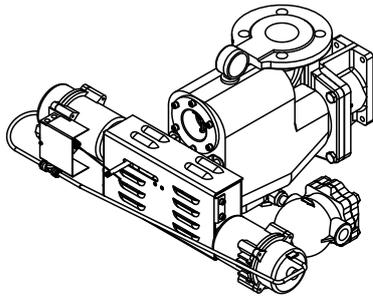
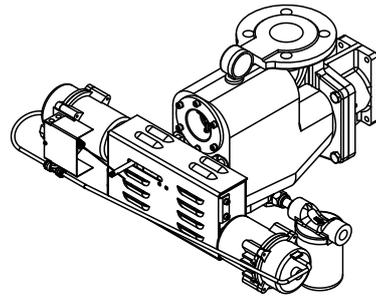
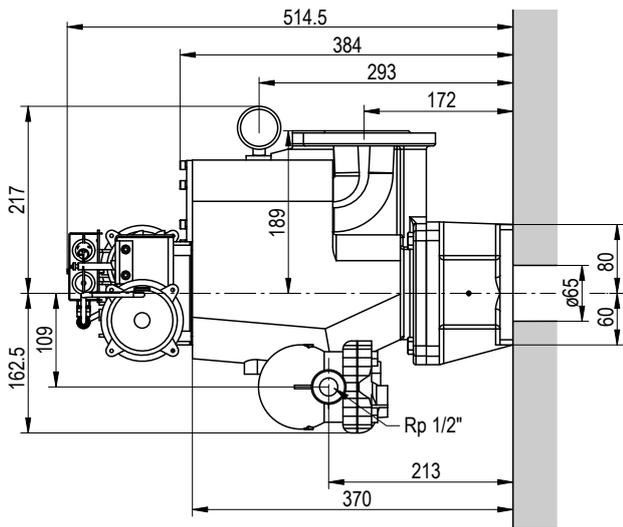


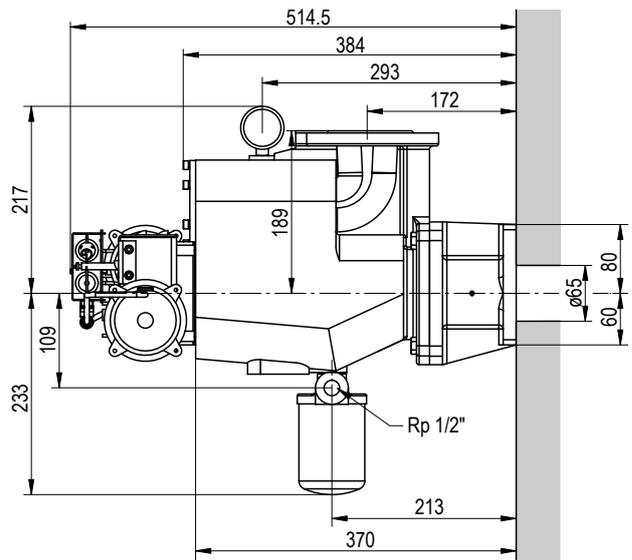
Fig. 69: Dimensional drawing Esco 20 ductile cast iron with inverted bucket steam trap with electric actuator CA150A-MP



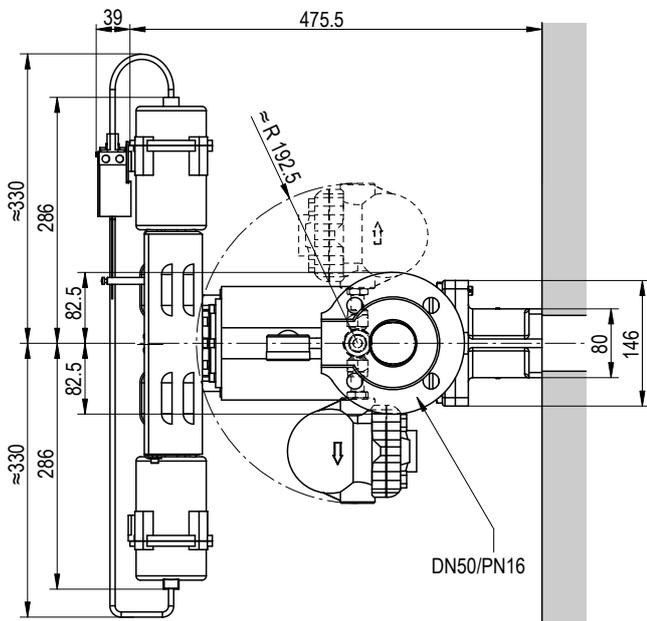
SIDE VIEW



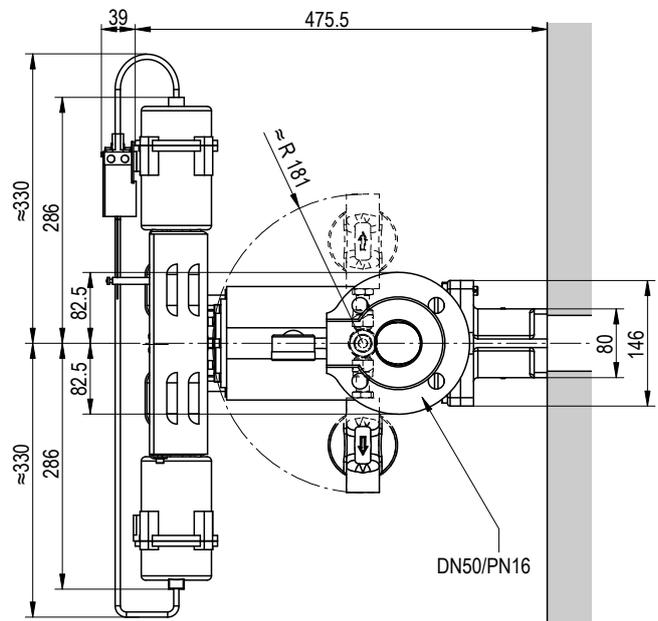
SIDE VIEW



TOP VIEW



TOP VIEW

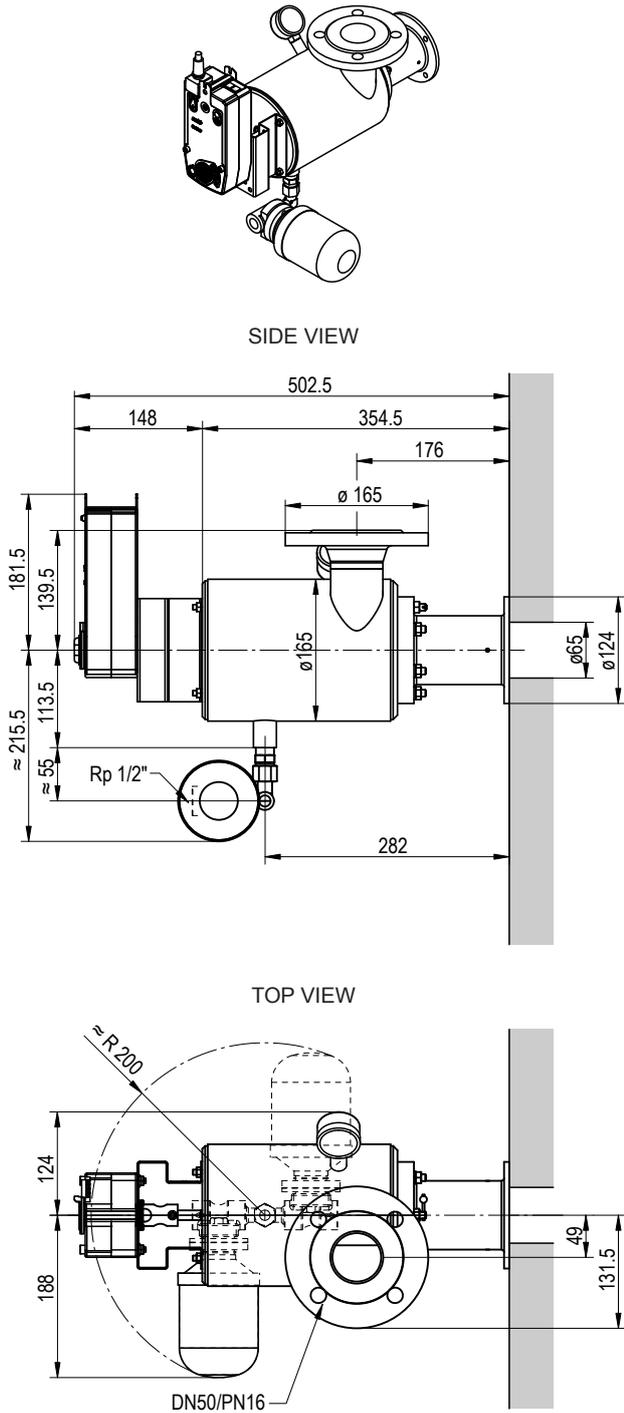


Dimensions in mm

Fig. 70: Dimensional drawing Esco 20 ductile cast iron with ball float steam trap with pneumatic actuator Sauter AK41

Fig. 71: Dimensional drawing Esco 20 ductile cast iron with inverted bucket steam trap with pneumatic actuator Sauter AK41

### 10.2.5 Dimensional drawings Condair Esco 20 stainless steel



Dimensions in mm

Fig. 72: Dimensional drawing Esco 20 stainless steel with ball float steam trap with electric actuator CA150A-MP

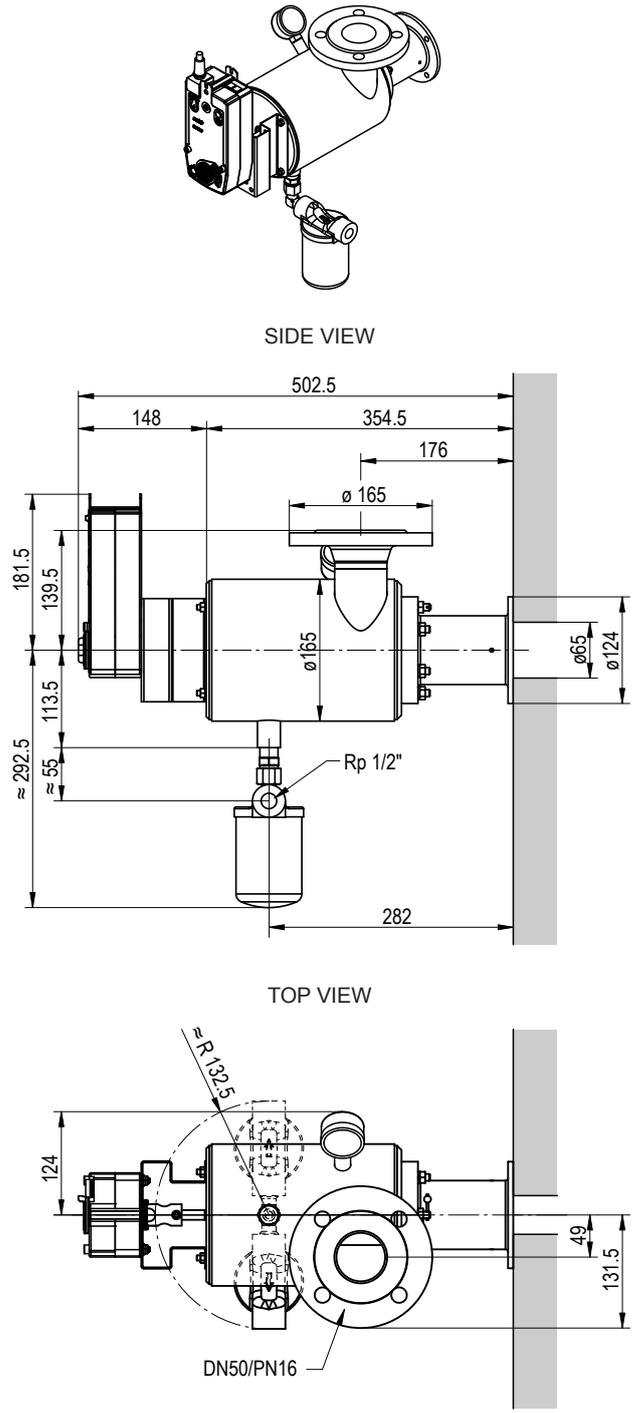
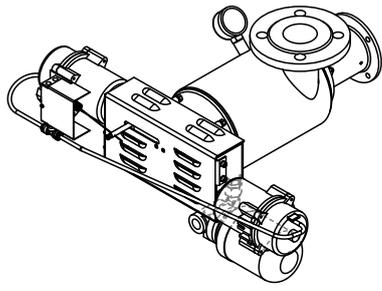
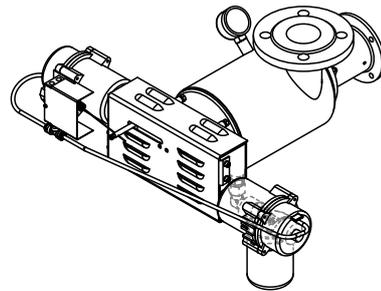
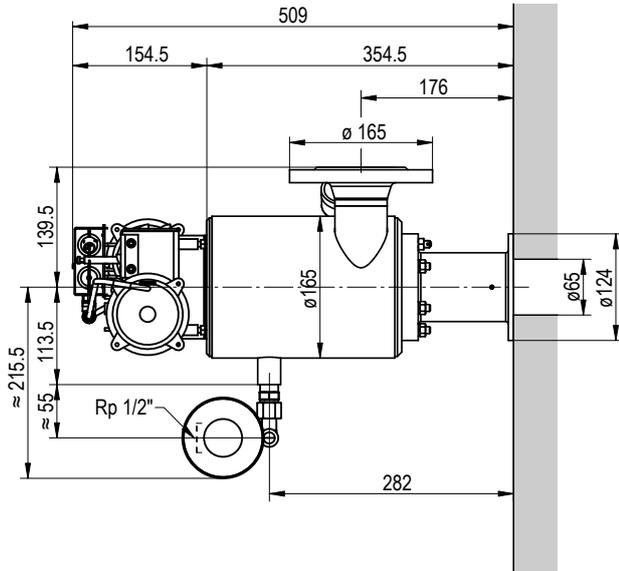


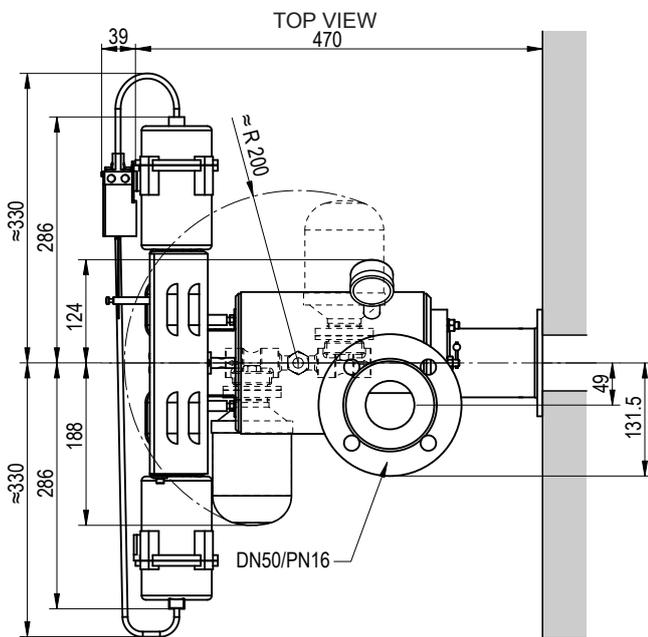
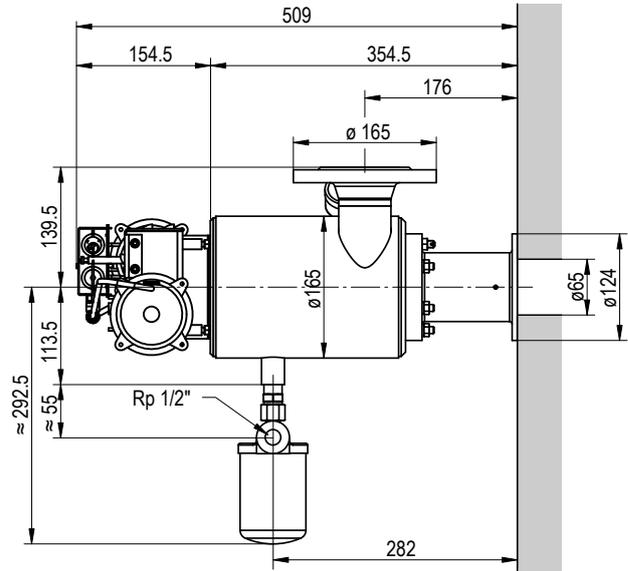
Fig. 73: Dimensional drawing Esco 20 stainless steel with inverted bucket steam trap with electric actuator CA150A-MP



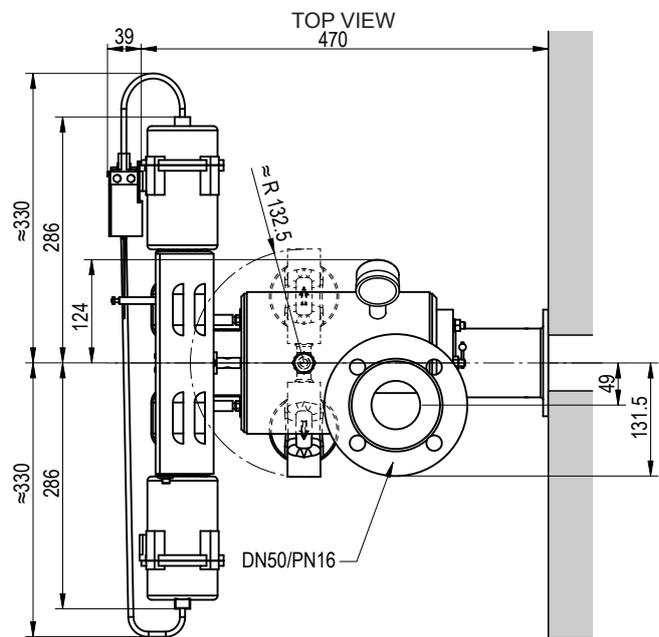
SIDE VIEW



SIDE VIEW



TOP VIEW



TOP VIEW

Dimensions in mm

Fig. 74: Dimensional drawing Esco 20 stainless steel with ball float steam trap with Sauter AK41 pneumatic actuator

Fig. 75: Dimensional drawing Esco 20 stainless steel with inverted bucket steam trap with pneumatic actuator Sauter AK41

### 10.2.6 Dimensional drawings Condair Esco 30 ductile cast iron

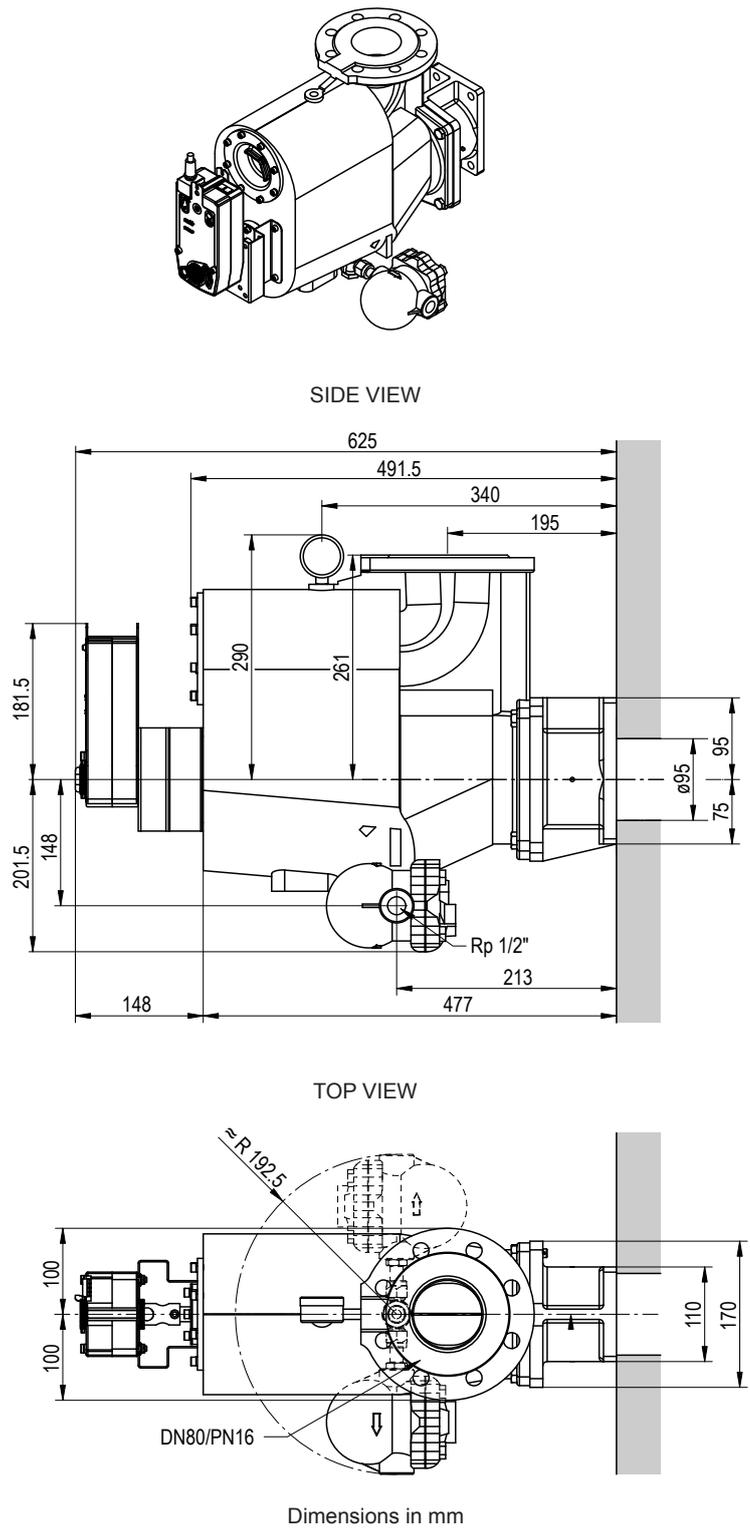


Fig. 76: Dimensional drawing Esco 30 ductile cast iron with ball float steam trap with electric actuator CA150A-MP



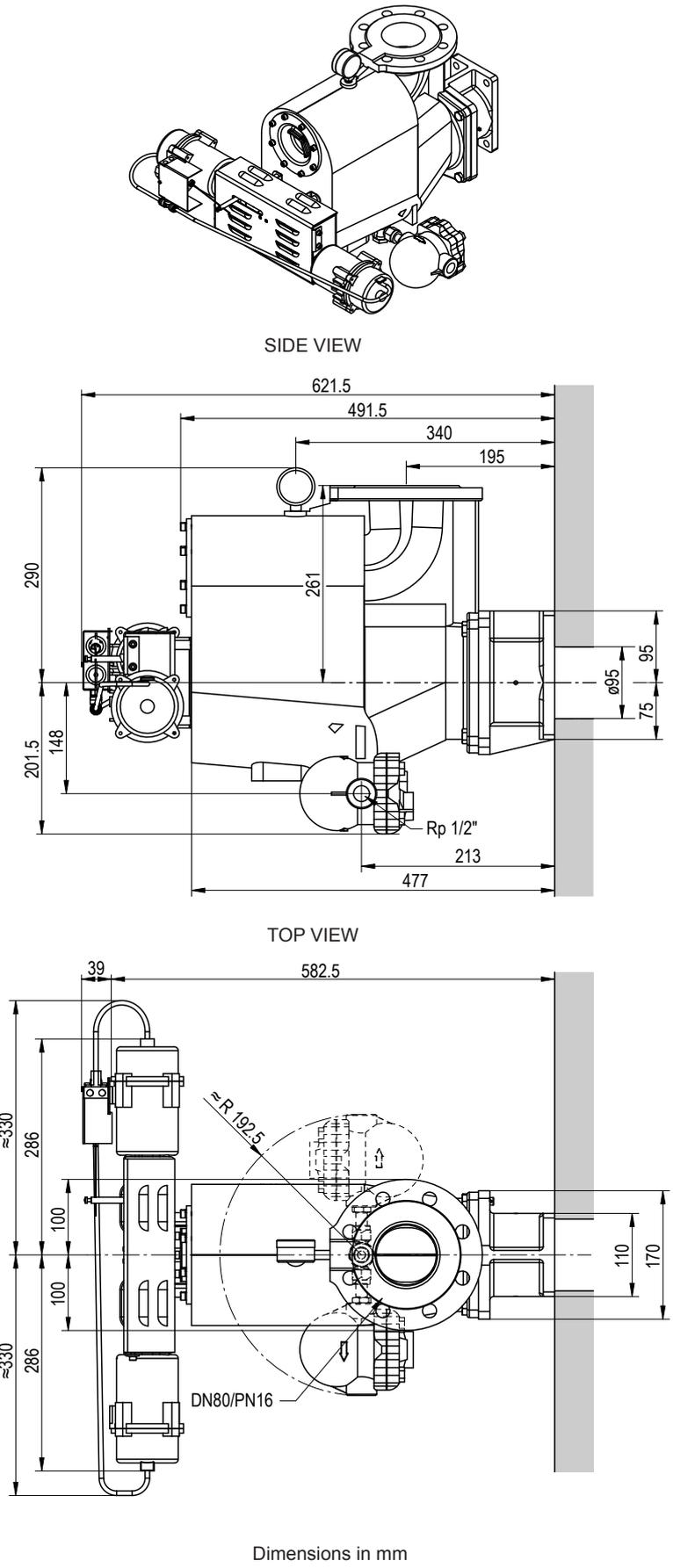
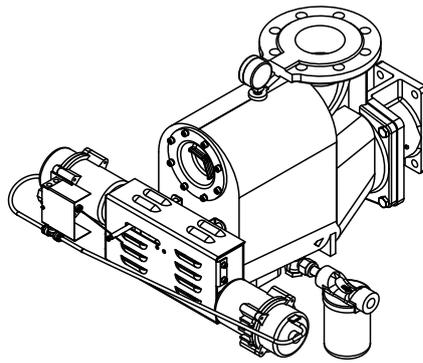
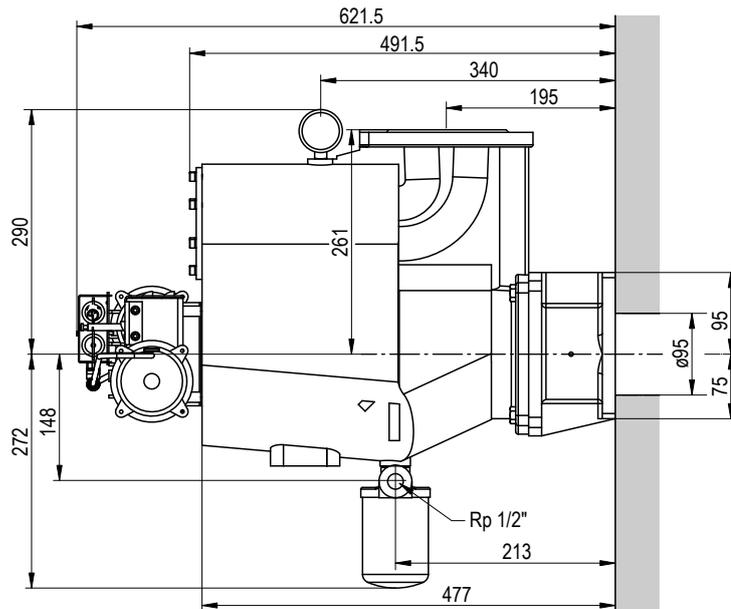


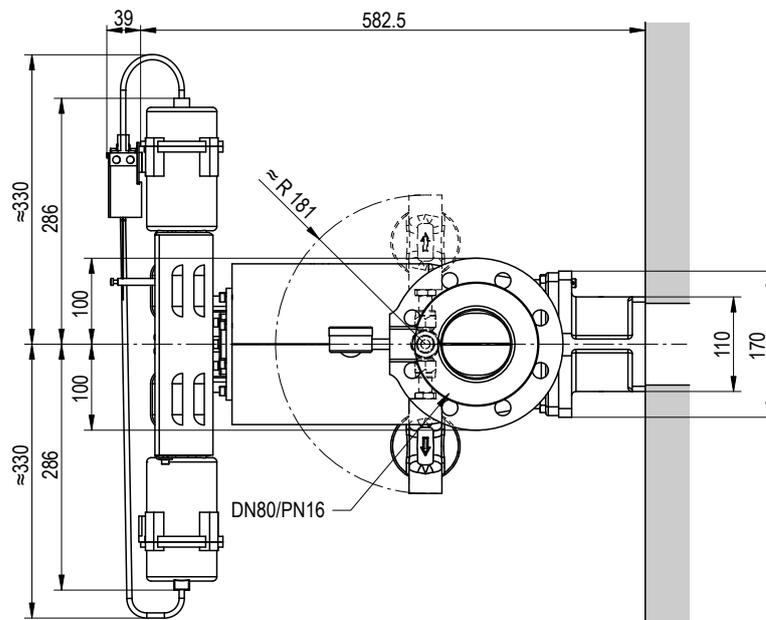
Fig. 78: Dimensional drawing Esco 30 ductile cast iron with ball float steam trap with pneumatic actuator Sauter AK41



SIDE VIEW



TOP VIEW

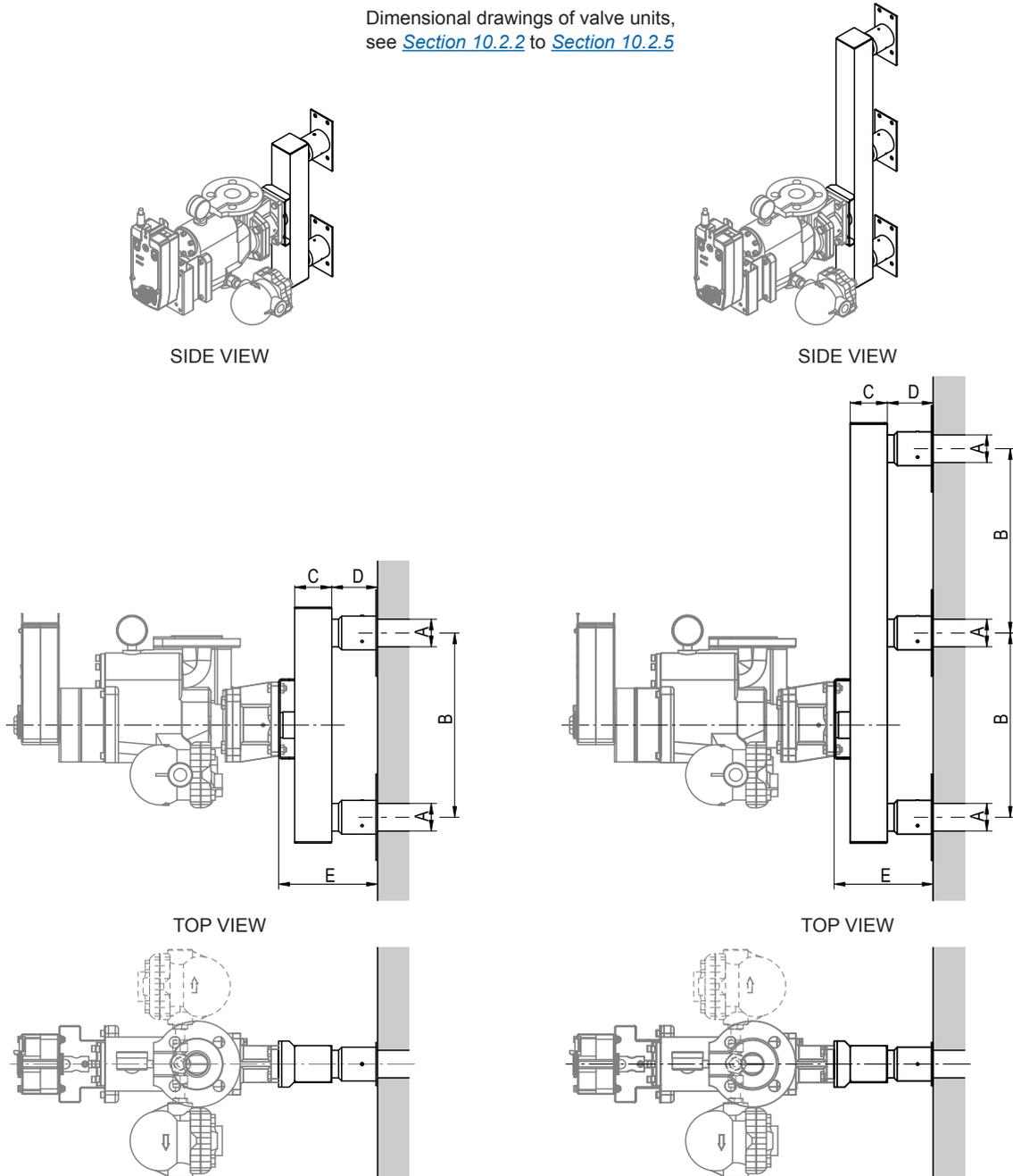


Dimensions in mm

Fig. 79: Dimensional drawing Esco 30 ductile cast iron with inverted bucket steam trap with pneumatic actuator Sauter AK41

## 10.2.7 Dimensional drawings Condair DL40 double and triple collector

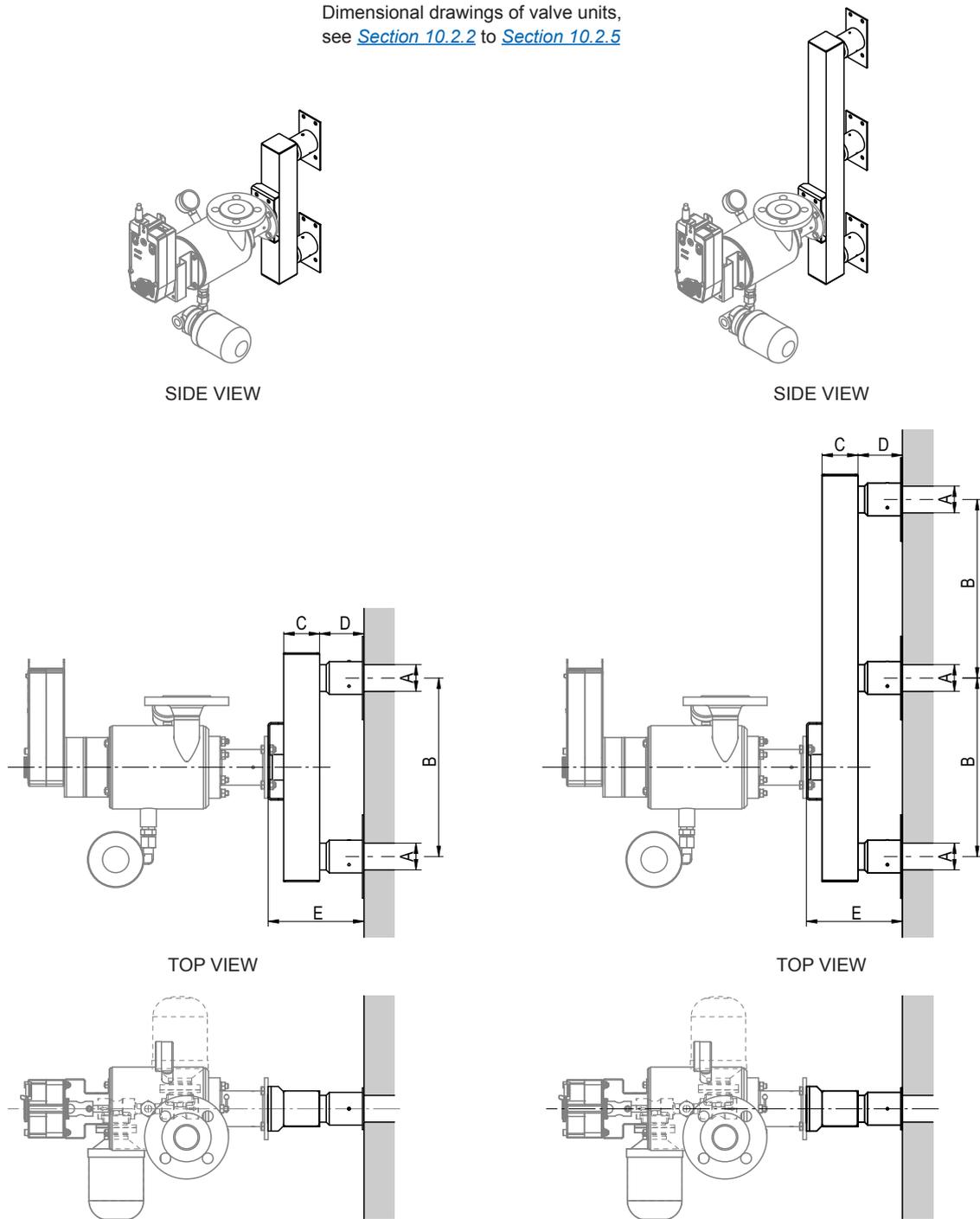
Dimensional drawings of valve units, see [Section 10.2.2](#) to [Section 10.2.5](#)



	Esco 10, ductile cast iron	Esco 20, ductile cast iron
Actuator	CA150A-MP electric actuator or Sauter AK41 pneumatic actuator	
A	ø45 mm	
B	200 mm / 250 mm / 300 mm / 600 mm / 900 mm	
C	60 mm / 80 mm / 100 mm	80 mm / 100 mm / 120 mm
D	75 mm	
E	161 mm / 181 mm / 201 mm	181 mm / 201 mm / 221 mm

Fig. 80: Dimensional drawing, DL40 double and triple collector, horizontal air duct, valve unit installed from the front

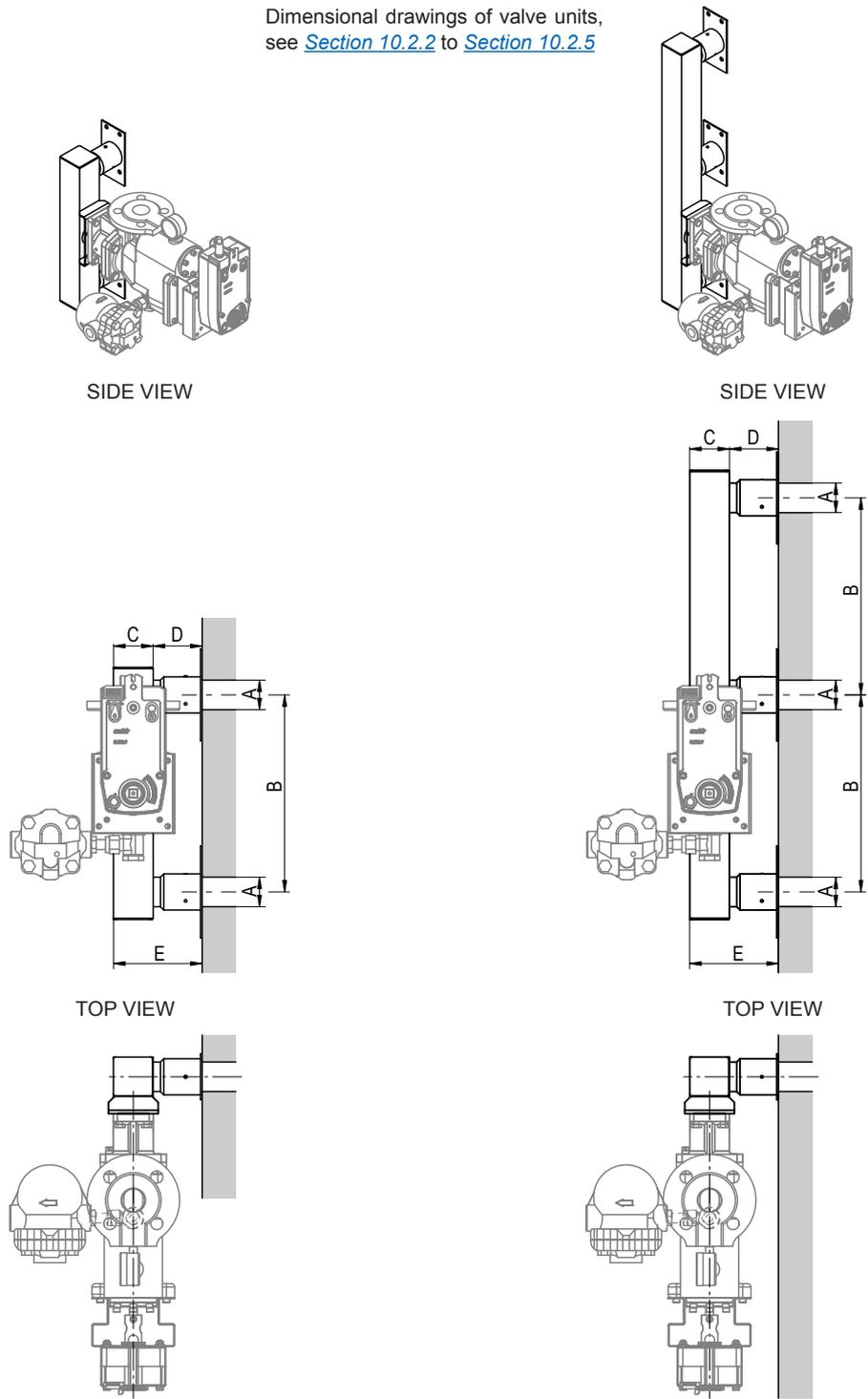
Dimensional drawings of valve units,  
see [Section 10.2.2](#) to [Section 10.2.5](#)



	Esco 10, stainless steel	Esco 20, stainless steel
Actuator	CA150A-MP electric actuator or Sauter AK41 pneumatic actuator	
A	ø45 mm	
B	200 mm / 250 mm / 300 mm / 600 mm / 900 mm	
C	60 mm / 80 mm / 100 mm	80 mm / 100 mm / 120 mm
D	75 mm	
E	161 mm / 181 mm / 201 mm	181 mm / 201 mm / 221 mm

Fig. 81: Dimensional drawing, DL40 double and triple collector, horizontal air duct, valve unit installed from the front

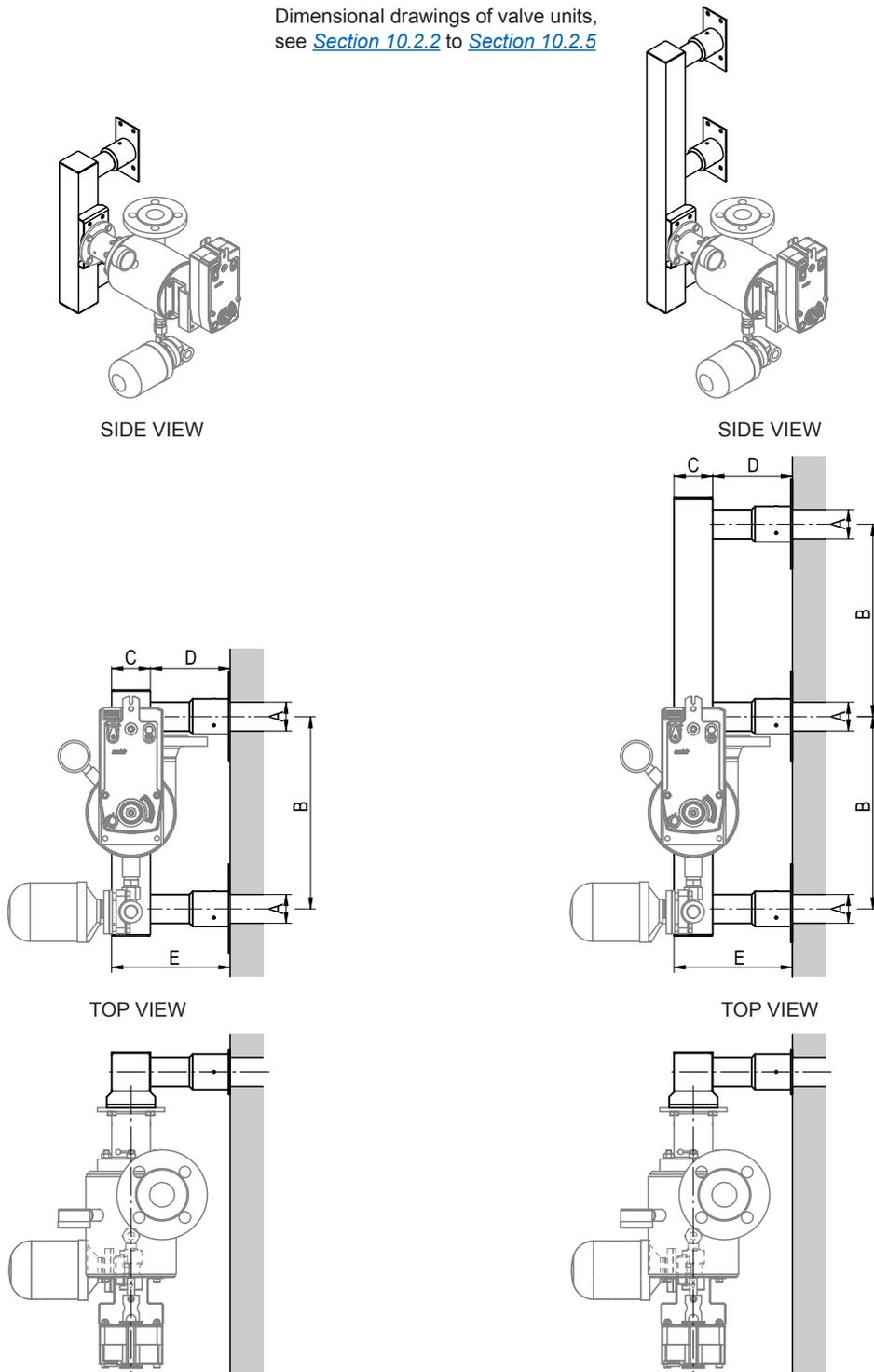
Dimensional drawings of valve units, see [Section 10.2.2](#) to [Section 10.2.5](#)



	<b>Esco 10, ductile cast iron</b>	<b>Esco 20, ductile cast iron</b>
Actuator	CA150A-MP electric actuator	CA150A-MP electric actuator
	Sauter AK41 pneumatic actuator	—
A	ø45 mm	
B	200 mm / 250 mm / 300 mm / 600 mm / 900 mm	
C	60 mm / 80 mm / 100 mm	80 mm / 100 mm / 120 mm
D	75 mm	
E	135 mm / 155 mm / 175 mm	155 mm / 175 mm / 195 mm

Fig. 82: Dimensional drawing, DL40 double and triple collector, horizontal air duct, valve unit installed on the right

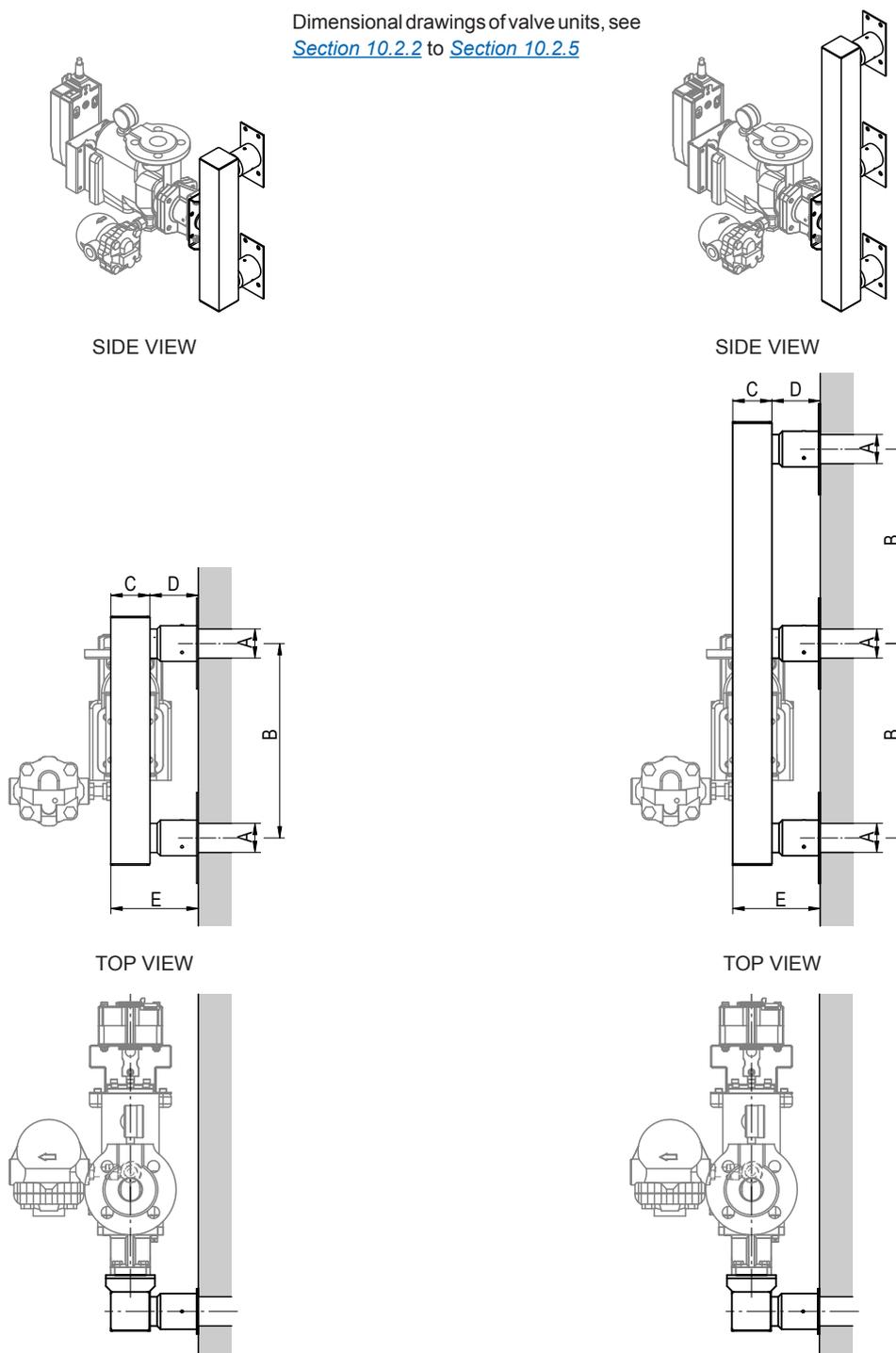
Dimensional drawings of valve units, see [Section 10.2.2](#) to [Section 10.2.5](#)



	<b>Esco 10, stainless steel</b>	<b>Esco 20, stainless steel</b>
Actuator	CA150A-MP electric actuator	CA150A-MP electric actuator
	Sauter AK41 pneumatic actuator	—
A	ø45 mm	
B	200 mm / 250 mm / 300 mm / 600 mm / 900 mm	
C	60 mm / 80 mm / 100 mm	80 mm / 100 mm / 120 mm
D	125 mm	
E	185 mm / 205 mm / 225 mm	205 mm / 225 mm / 245 mm

Fig. 83: Dimensional drawing, DL40 double and triple collector, horizontal air duct, valve unit installed on the right

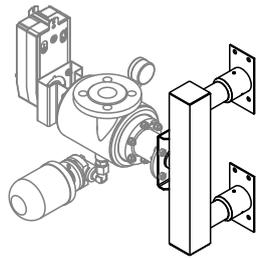
Dimensional drawings of valve units, see [Section 10.2.2](#) to [Section 10.2.5](#)



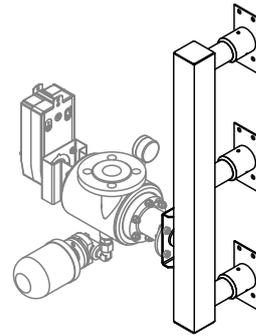
	Esco 10, ductile cast iron	Esco 20, ductile cast iron
Actuator	CA150A-MP electric actuator	
A	ø45 mm	
B	200 mm / 250 mm / 300 mm / 600 mm / 900 mm	
C	60 mm / 80 mm / 100 mm	80 mm / 100 mm / 120 mm
D	75 mm	
E	135 mm / 155 mm / 175 mm	155 mm / 175 mm / 195 mm

Fig. 84: Dimensional drawing, DL40 double and triple collector, horizontal air duct, valve unit installed on the left

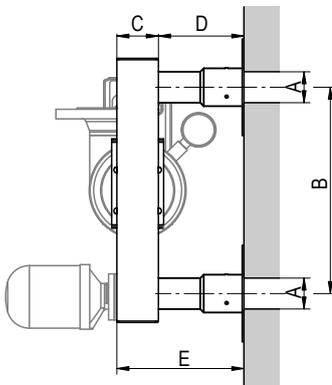
Dimensional drawings of valve units,  
see [Section 10.2.2](#) to [Section 10.2.5](#)



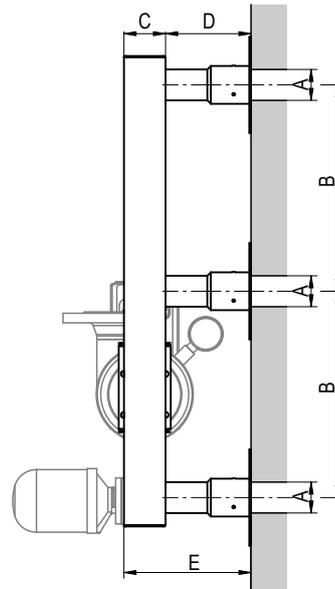
SIDE VIEW



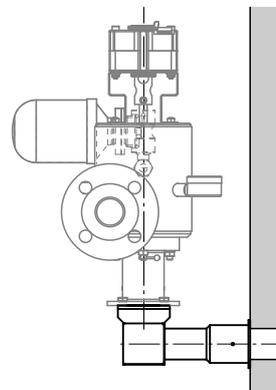
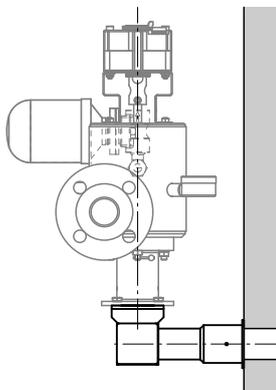
SIDE VIEW



TOP VIEW



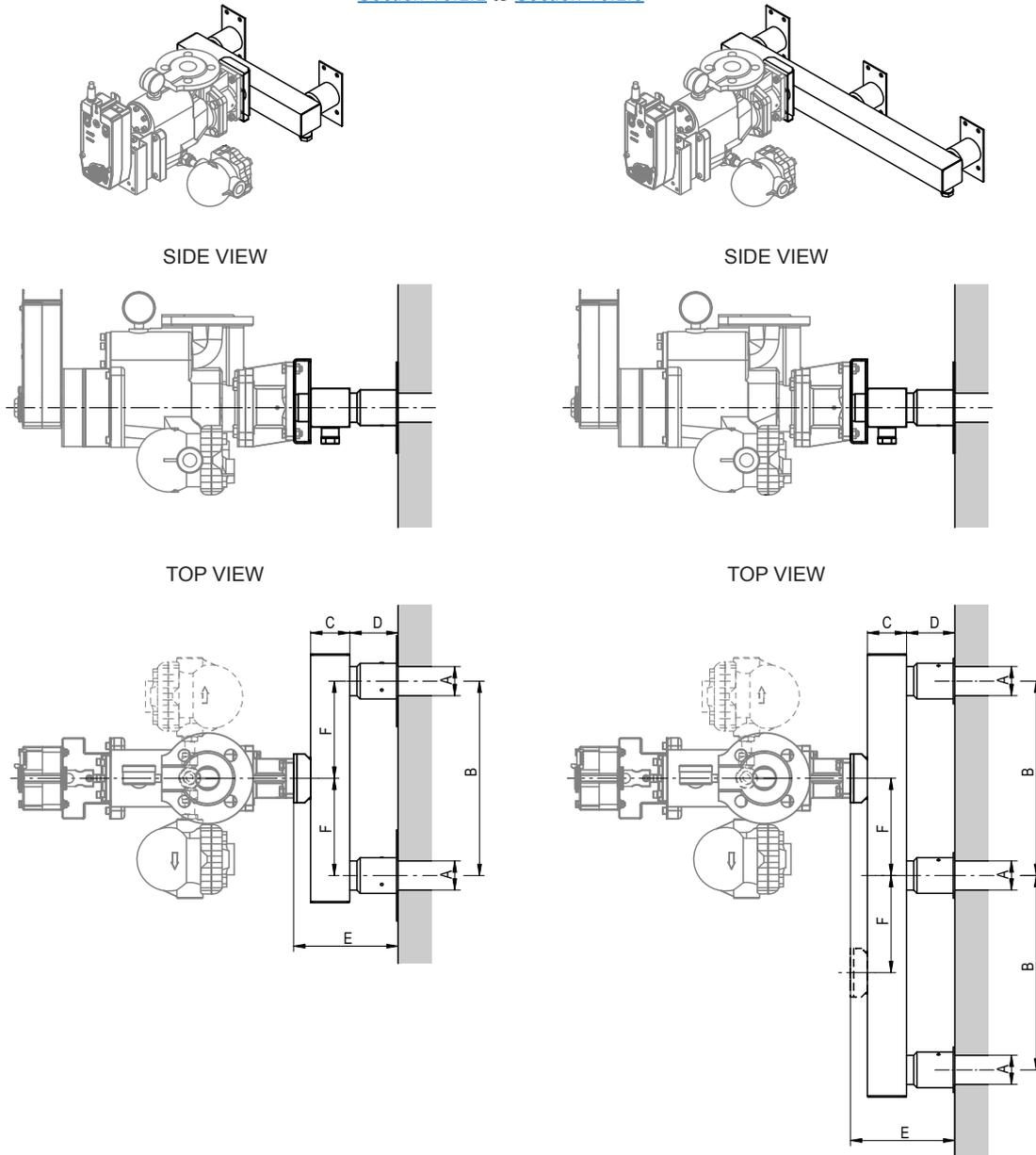
TOP VIEW



	Esco 10, stainless steel	Esco 20, stainless steel
Actuator	CA150A-MP electric actuator	
A	ø45 mm	
B	200 mm / 250 mm / 300 mm / 600 mm / 900 mm	
C	60 mm / 80 mm / 100 mm	80 mm / 100 mm / 120 mm
D	125 mm	
E	185 mm / 205 mm / 225 mm	205 mm / 225 mm / 245 mm

Fig. 85: Dimensional drawing, DL40 double and triple collector, horizontal air duct, valve unit installed on the left

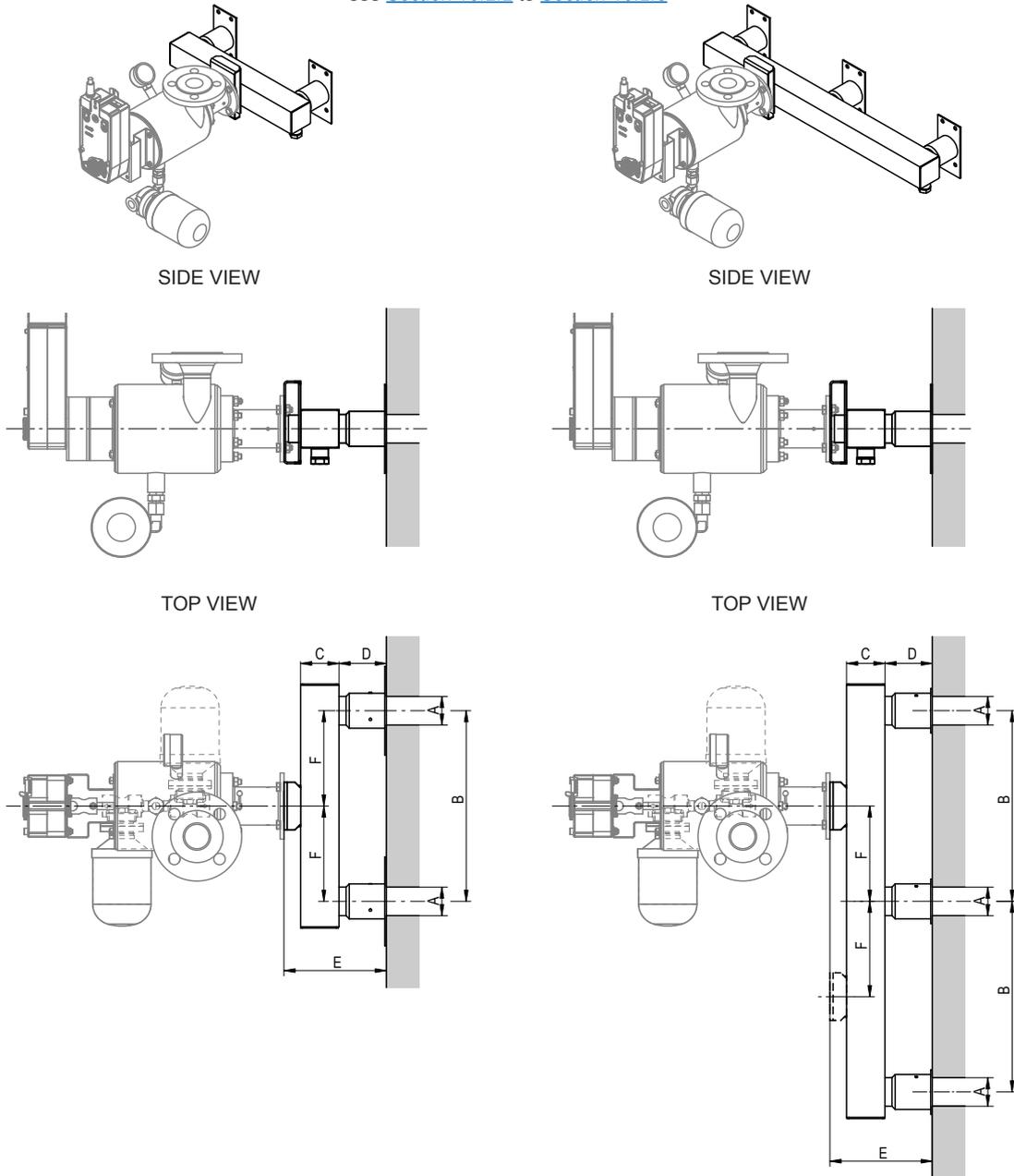
Dimensional drawings of valve units, see  
[Section 10.2.2](#) to [Section 10.2.5](#)



	Esco 10, ductile cast iron	Esco 20, ductile cast iron
Actuator	CA150A-MP electric actuator Sauter AK41 pneumatic actuator	
A	ø45 mm	
B	200 mm / 250 mm / 300 mm / 600 mm / 900 mm	
C	60 mm / 80 mm / 100 mm	80 mm / 100 mm / 120 mm
D	75 mm	
E	161 mm / 181 mm / 201 mm	181 mm / 201 mm / 221 mm
F	1/2 B	

Fig. 86: Dimensional drawing, DL40 double and triple collector, vertical air duct, valve unit installed from the front

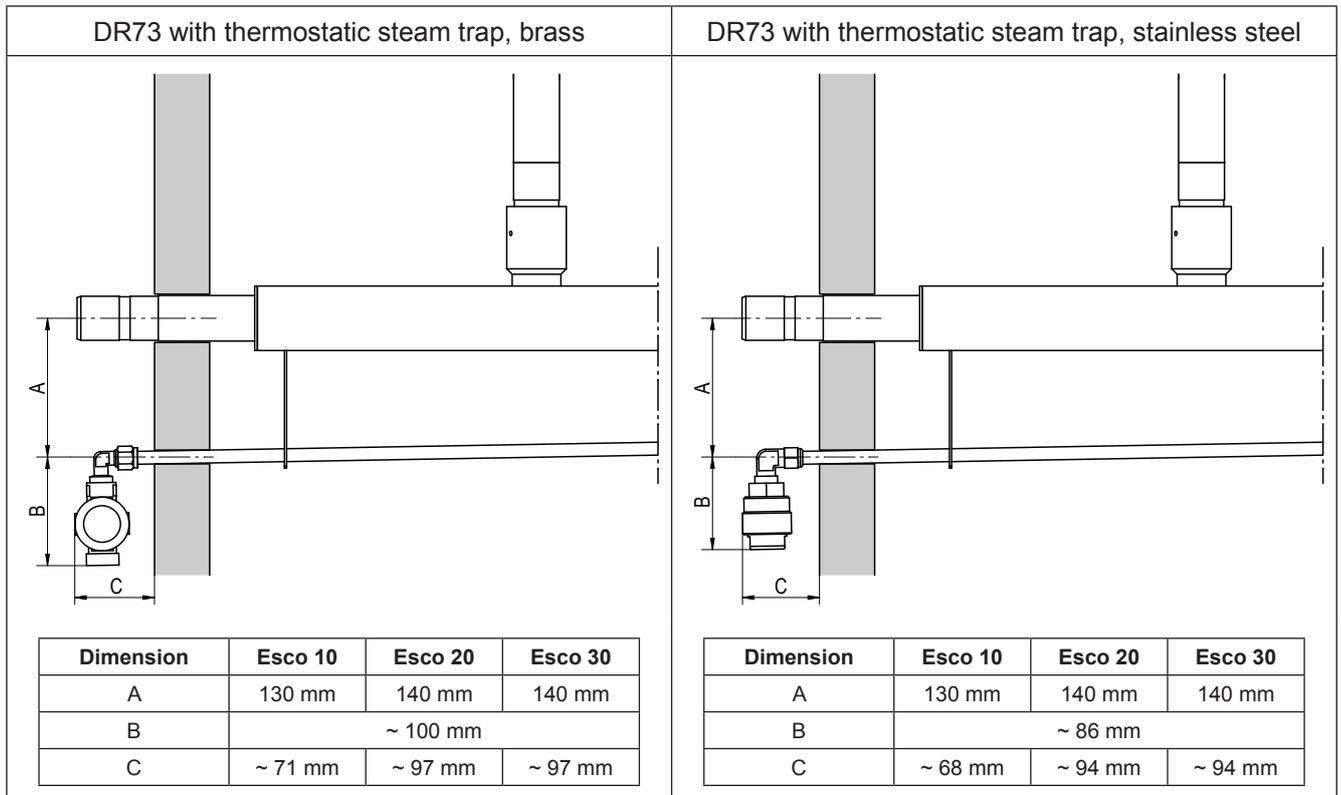
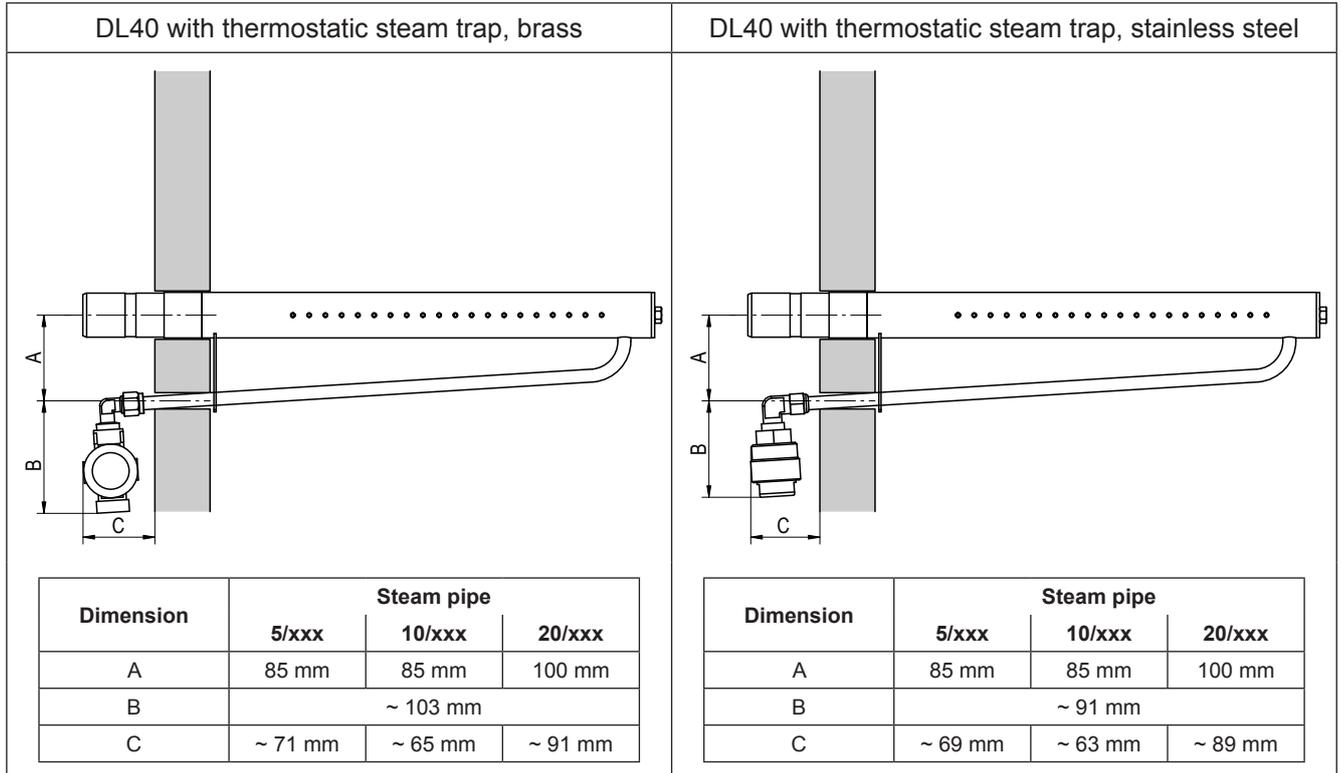
Dimensional drawings of valve units,  
see [Section 10.2.2](#) to [Section 10.2.5](#)



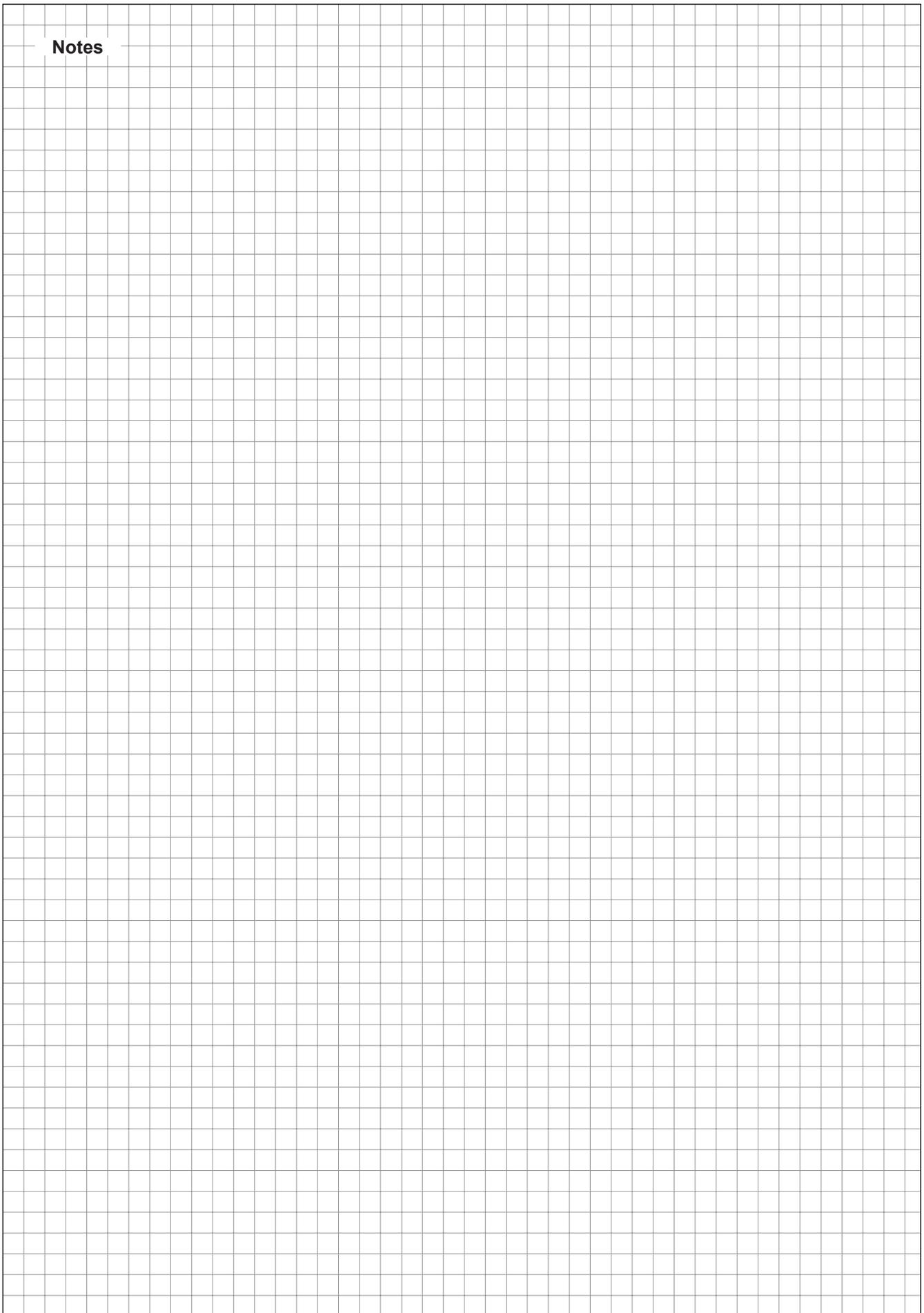
	Esco 10, stainless steel	Esco 20, stainless steel
Actuator	CA150A-MP electric actuator Sauter AK41 pneumatic actuator	
A	ø45 mm	
B	200 mm / 250 mm / 300 mm / 600 mm / 900 mm	
C	60 mm / 80 mm / 100 mm	80 mm / 100 mm / 120 mm
D	75 mm	
E	161 mm / 181 mm / 201 mm	181 mm / 201 mm / 221 mm
F	1/2 B	

Fig. 87: Dimensional drawing, DL40 double and triple collector, vertical air duct, valve unit installed from the front

## 10.2.8 Dimensional drawings secondary steam traps

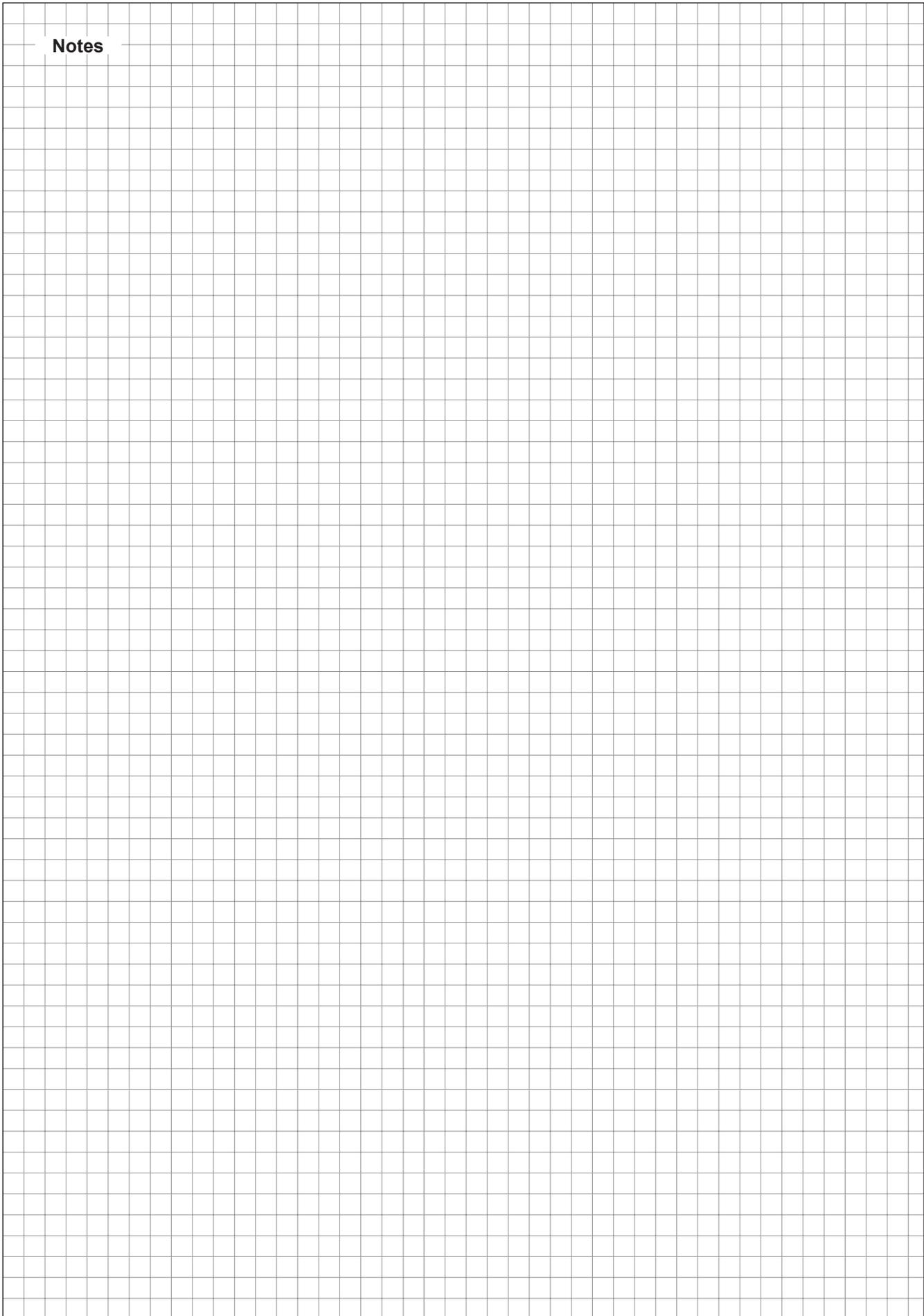


Notes



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