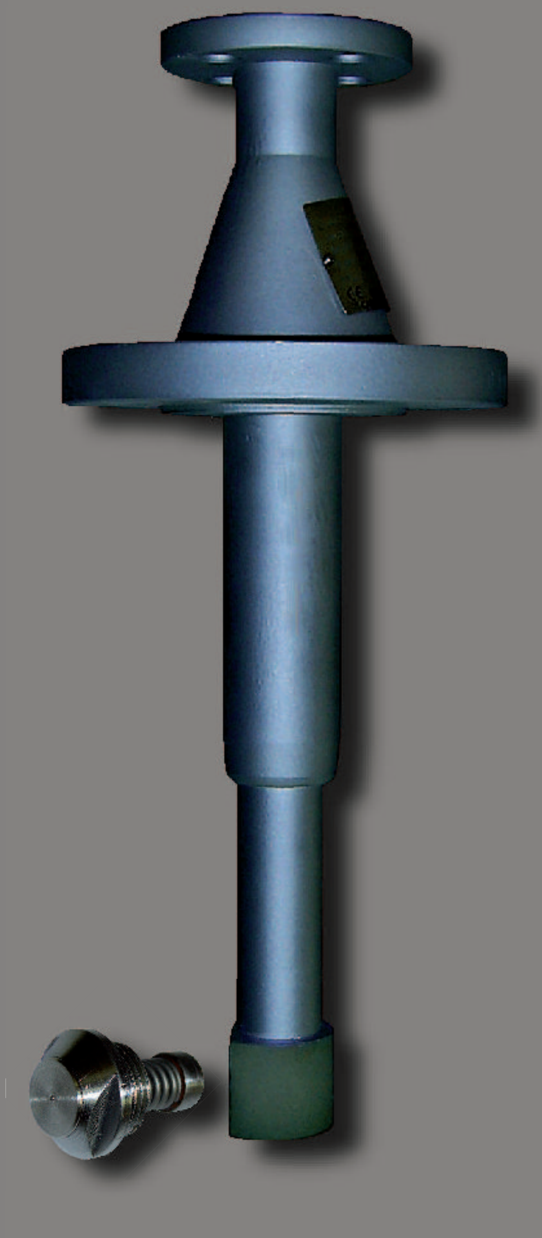
DM VARI*spring*

Variable area spring assisted desuperheater



DF VARI*fix*

Fixed area desuperheater

Suitable for:

- Steam
- Process gas

Markets:

- Oil & gas
- Power
- General industry

CC0039E - Rev.5 **|** 26/03/2014

DM VARI*spring*

Introduction

Variable area Varispring DM nozzles minimize the limitation of fixed area types deriving from the fluid velocity reduction when flowrate decreases (see insert for other information).
This is obtained by automatically reducing the passage area when flowrate decreases so to maintain a fluid velocity consistent with the need of a good atomization.

With reference to Figure 1 here below the description of this nozzle :
The spring (4) is loaded by the nut (3) and keeps the plug (2) in the closed position. Nut is locked by the pin (5) to avoid any loosening.

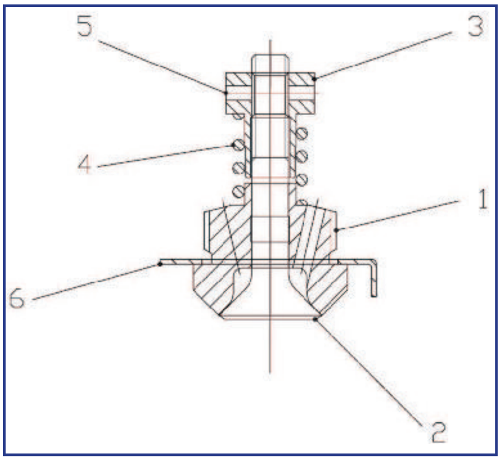


Fig. 1 - DM Nozzle

When water pressure inside the nozzle tends to rise, the Δp between steam and water increases till the water action on the plug exceeds the spring load and the plug starts to open.
The water starts to blow out from the nozzle flowing through the special drilling of the nozzle body (1) which whirls the flow before it gets in contact with the plug conical surface.
The plug atomizes the water through a 90 degrees about-shaped conical pattern.
Spring load can be set to obtain the desired start opening pressure.

ITEM	NAME	MATERIAL
1	Nozzle body	AISI 422
2	Plug	17-4 PH H1100
3	Nut	AISI 316
4	Spring	INCONEL X750
5	Pin	AISI 304/316
6	Locking washer	AISI 316L

Why is this device called variable area nozzle?
Should the outlet section remain constant the spray velocity would decrease at low flow, in spring-assisted DM nozzles, the spring load being almost constant, the flow section is reduced and the Δp tends to be constant.

In other words, being
F_{spring} = thrust area · Δp ≈ constant and flowrate ÷ Cv · $\Delta p^{0,5}$

The static balance of the plug is maintained only if Cv is reduced when flowrate decreases. Therefore the plug automatically closes, the Δp doesn't fall down and the water velocity tends to be the same.
Unfortunately the real thrust area of the plug is not constant through its travel and the relationship between Fspring and Δp is not just linear.
The thrust area is greater near the closed position and Δp tends to decrease with a less efficient atomization at low flowrates. Therefore to find the relationship Cv vs Δp tests are necessary.

In Fig.2 the test results of Carraro DM nozzles

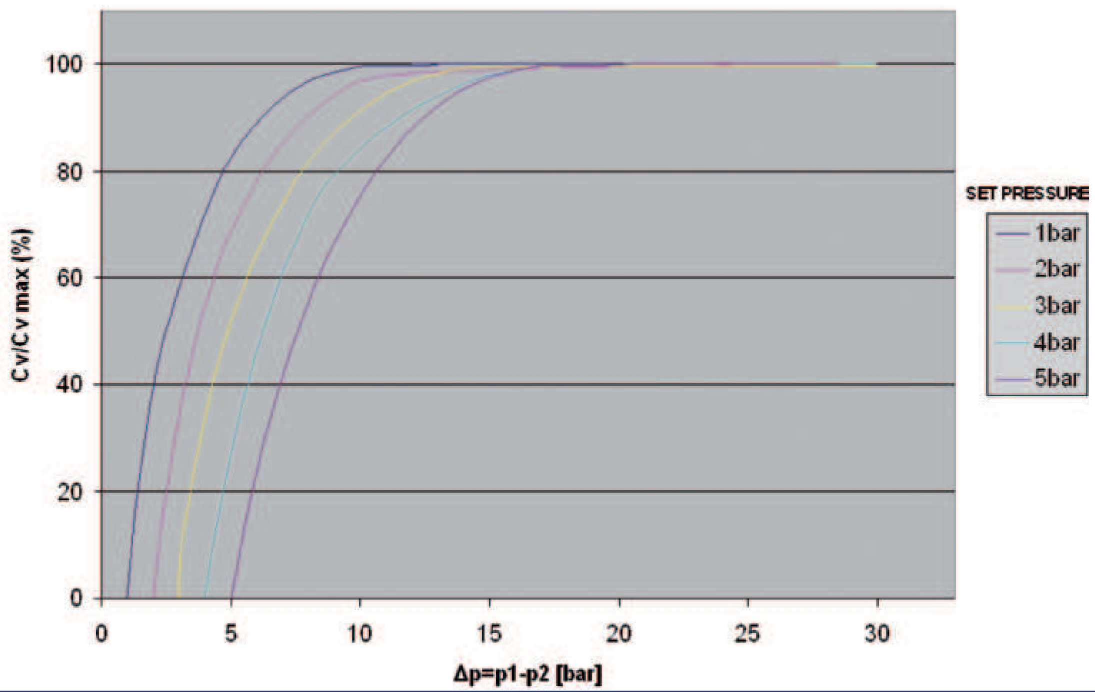


Fig. 2 - Cv of DM nozzles vs the Δp for every set pressure

VARIABLE AREA vs FIXED AREA NOZZLES

To approach variable area equipments a comparison with the fixed area devices is necessary with particular regards to the rangeability characteristic.

Fixed area plain nozzles have a constant flow rate changes. The ratio Cvmax/Cvmin is = 1 and consequently their rangeability is:

$$Ry = 1.\sqrt{\frac{\Delta p_{max}}{\Delta p_{min}}}$$

If the minimum fluid velocity through a fixed area nozzle to produce satisfactory water atomization is 35 m/s (4 ÷ 7 m/s upstream and 40 m/s in vena contracta) the corresponding Δp is 6 bar and the rangeability is therefore:

$$\sqrt{\Delta p_{max} / 6}$$

Assuming these nozzles can operate under a Δp_{max} = 25 ÷ 40 bar depending on water temperature the corresponding max value of Ry will be within:

$$Ry = \sqrt{25 \div 40 / 6} = 2 \div 2{,}5$$

To improve the performance of fixed area nozzles the **vortex type** is available. Such design increases the atomization degree of water with the same mean velocity and Δp. So the min Δp is dramatically reduced to about 1 bar and the corresponding Ry, even though Cvmax/Cvmin is = 1 again , is increased to:

$$Ry = \sqrt{25 \div 40 / 1} = 5 \div 6$$

Main characteristics

Sizes: DM4, DM8, DM12, DM25, DM40, DM 65

Flow capacity: see Cv table

Flow characteristic: Cv/Δp characteristic curves are plotted in the diagram of Fig. 2 for various values of set pressure.

Settings:standard setting = 3 bar

Other settings (from 1 to 5 bar) may be used for special applications.

The set pressure must be selected to take into account :

- the need of a back pressure on the control valve to limit cavitation
- a minimum seat load to limit leakage in closed position
- the control range of desuperheater

The std set pressure of 3 bar is a compromise through various needs.

Max Δp: 25 bar
Rangeability: from 15 to 30 depending on nozzle size and its set pressure

$$Ry = \frac{Cv_{max}}{Cv_{min}} \cdot \sqrt{\frac{\Delta p_{max}}{\Delta p_{min}}}$$

The ratio Cvmax/Cvmin varies from 8 for sizes DM4 and DM8 to 9 ÷ 10 for greater sizes.
The min Δp corresponding to min Cv can be drawn out by the Fig.2 on the curve of selected set pressure.

Example:
nozzle DM8, set pressure 3bar, at Cv_{max}/Cv_{min}= 12,5%, Δp_{min}= 4 bar if Δp_{max}= 25 the max Ry of DM8 is :

$$Ry = 8 \cdot \sqrt{\frac{25}{4}} = 20$$

With a set pressure 1 bar the corresponding value of Ry is about 30

Mounting: DM nozzles are used in two different constructions:
- probe type, flanged construction with optional injection chamber
- wall-welded-in, single or multiple construction with an injection chamber

Cv and flow capability of DM nozzles

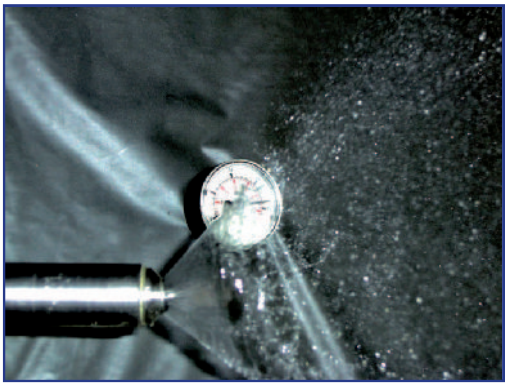
Nozzle	Seat diameter	Cv max	Travel	Max flowrate m3/h (1)
DM4	14 mm	1	0,7	4,3
DM8	21 mm	2	1	8,6
DM12	28 mm	3	1,2	12,9
DM25	39 mm	6	1,5	25,9
DM40	48 mm	10	2	43
DM65	55 mm	15	2,5	64,5

Note(1) - Δp = 25 bar – density 1000 kg/m3

The below table summarizes the rangeability and other characteristics of DM variable area nozzles compared with those of fixed area devices.

Fixed vs variable area nozzles characteristics:

Type of nozzle	Δp max	Δp min	Cvmax | Cvmin	Ry
Fixed area plain hole	30 bar	6 bar	1	2,2
Fixed area vortex type	30 bar	1,5 bar	1	4,5
Variable area DM type (set pressure 3 bar)	25 bar	3 ÷ 4 bar	8 ÷ 10	15 ÷ 30

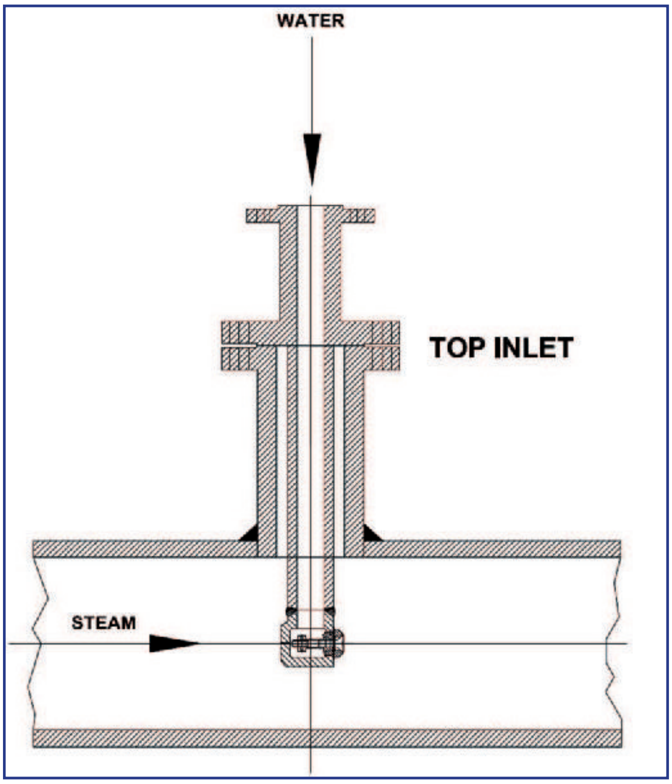


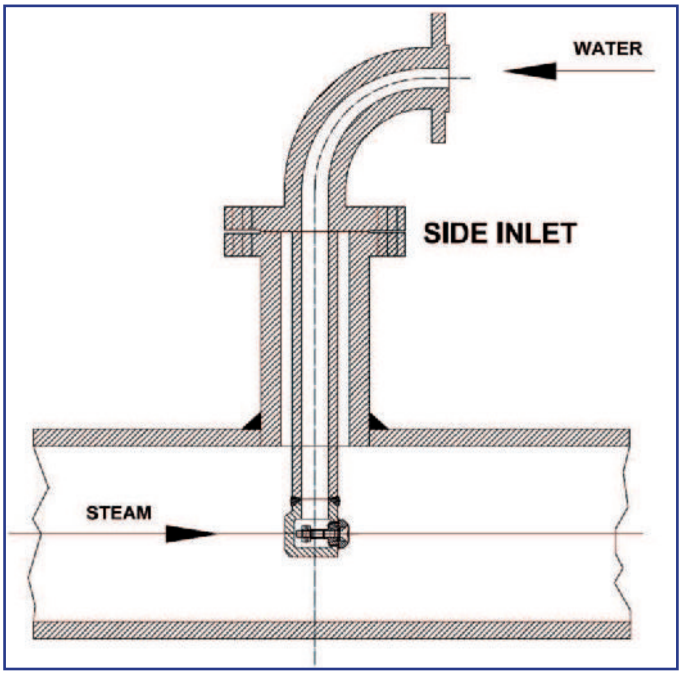
DM DESUPERHEATERS probe assembly

One or max two DM nozzles are fastened at the end on a tubular extension flanged to the pipe. Dimensions and ratings are listed in the next tables.
The injection is performed close to the pipe axis by adjusting the probe lenght. A reference pin located on the desuperheater flange ensures the correct orientation of the nozzle inside the piping. Probe assembly is normally performed with the same pipe material.
In the below table the standard combinations of water connections and pipe sizes are listed.

Nozzle type	DM4	DM8	DM12	DM25	DM40	DM65
water connection(1)	1"	1"	1"½	2"	2"½	3"
steam fitting connection(1)	2"	3"	4"	4"	6"	8"
minimum steam pipe size (C)	4"	6"	8"	8"	12"	14"

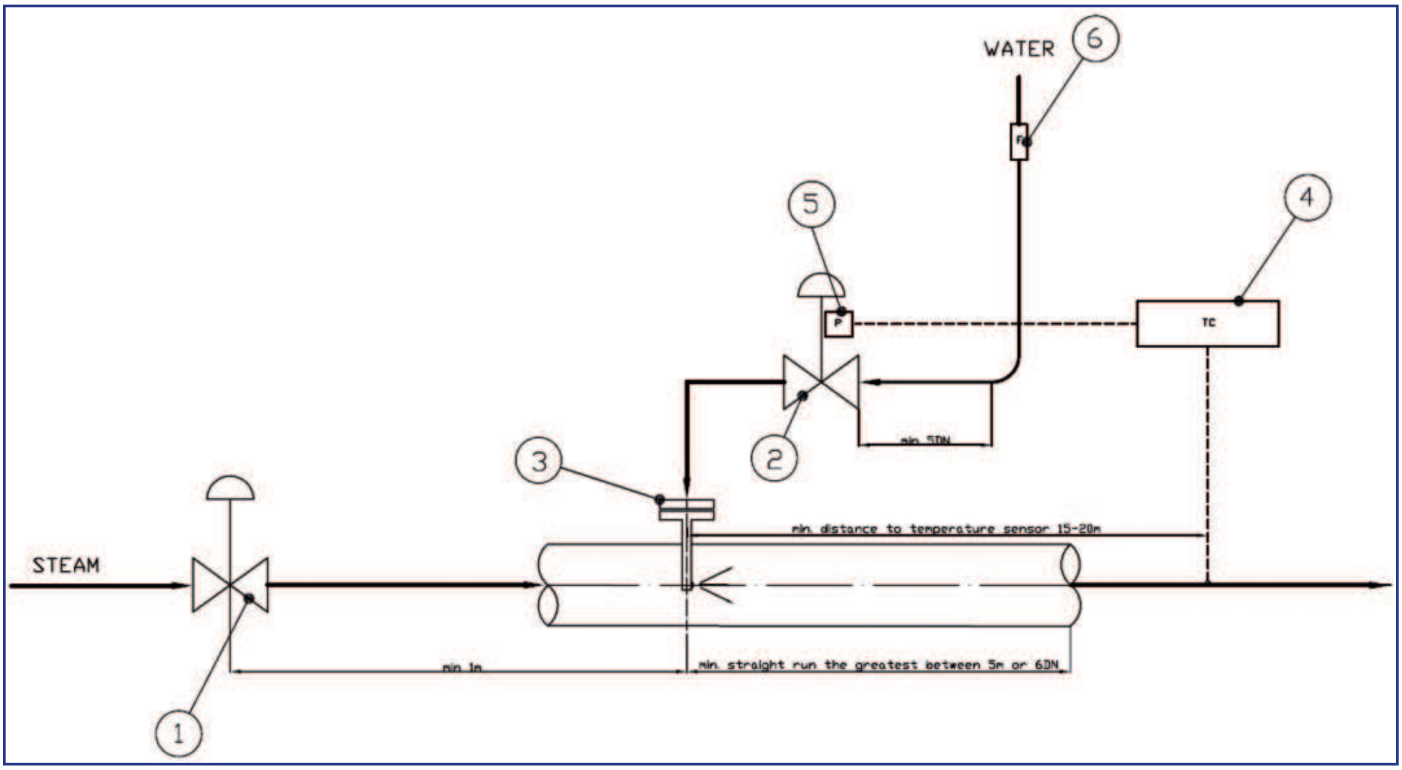
(1) Other size on request.





Engineering practice for efficient desuperheating

For efficient desuperheating the arrangement of installation are shown in figure.



LEGENDA

1) Pressure reducing valve
2) Water control valve
3) Carraro desuperheater
4) Temperature controller
5) Positioner
6) Filter (recommended)

VARI*spring* dimensions

NOZZLE	L		A	B	C min	G min[1]
	up to ANSI 900	ANSI 1500				
DM4	147	147	1”	2”	4”	49
DM8	186	186	1”	3”	6”	73,5
DM12	205	205	1-1/2”	4”	8”	97
DM25	205	205	2”	4”	8”	97
DM40	237	267	2-1/2”	6”	12”	146
DM65	250	300	3”	8”	14”	192

[1] The dimensions are consistent with sch.80 thicknesses. For different design (rating & dimensions) contact Carraro technical department.

<table>
<tr><th colspan="12">M</th></tr>
<tr><th rowspan="3">DN steam</th><th colspan="2">DM4</th><th colspan="2">DM8</th><th colspan="2">DM12</th><th colspan="2">DM25</th><th colspan="2">DM40</th><th>DM65</th></tr>
<tr><th colspan="11">nozzle number</th></tr>
<tr><th>1</th><th>2</th><th>1</th><th>2</th><th>1</th><th>2</th><th>1</th><th>2</th><th>1</th><th>2</th><th>1</th></tr>
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<tr><td>12”</td><td rowspan="7">458</td><td>-</td><td>-</td></tr>
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<tr><td>28” to 40”</td><td colspan="2">458</td><td colspan="2">454</td><td colspan="2">488</td><td colspan="2">488</td><td colspan="2">508</td><td>508</td></tr>
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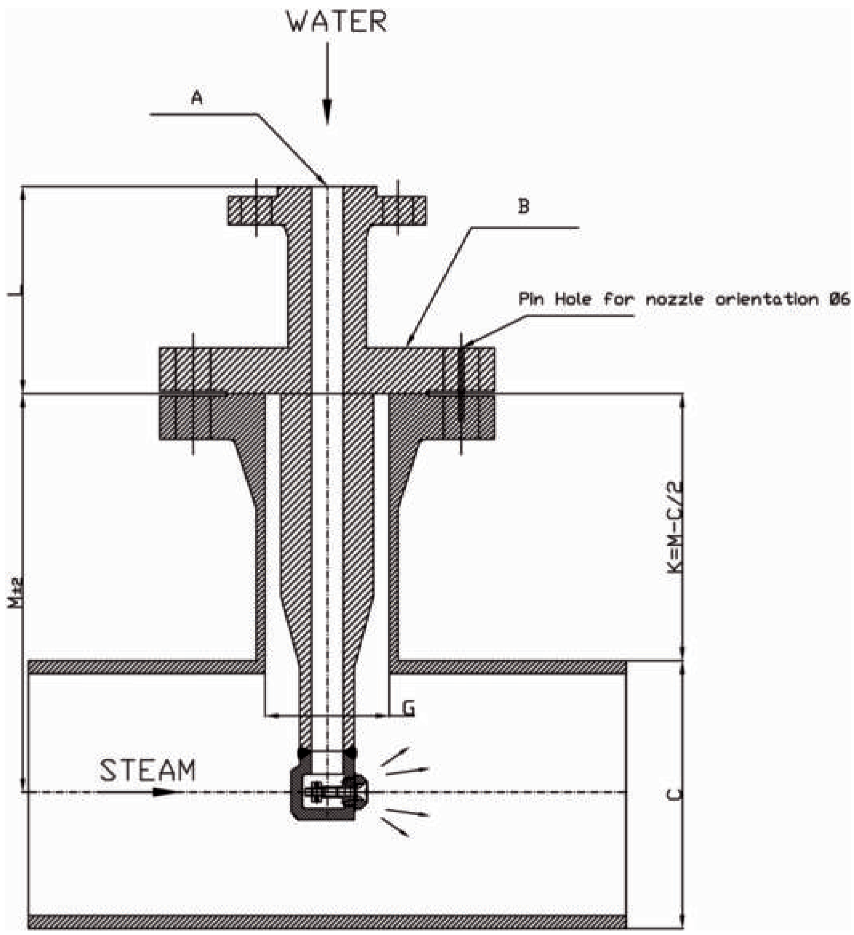

NOTE
K is the same for 28” to 40” pipe diameter.

About Carraro

Carraro Srl is a private independent company, operative since 1924 in the field of industrial valves. The firm produces and commercializes worldwide a broad range of industrial pressure regulators, desuperheaters and safety valves for fluids such as steam, process gases and liquids.
The flexible organization of Carraro allows a great customization of the products and the production of “taylor made” constructions. Most of the Carraro’s product range can be realized also in “exotic” materials such as e.g. duplex, superduplex, monel, hastelloy, aluminum bronze and others. Supported by a global network of sales offices, representatives and distributors, Carraro offers a wide range of solutions for the Oil&Gas, the Power industry and all other diversified industrial applications.

Carraro: product range

UB Regulators: direct-operated pressure regulators with compact design
Maxomatic Series: multifunction pilot-operated regulators for liquids
MM-BPM series: direct-operated, spring pressure regulators
AT series: direct-operated temperature regulators
M51 series: direct-operated, weight and lever pressure regulators
CS series: safety valves for vapours, gas, liquids
CSV series: safety valves for steam and gases
VRE series: electrically operated control valves
MCP - ACP series: pneumatically operated control valves
AIRMATIC series: electropneumatic safety valves
DSH series: desuperheaters

Approvals and certifications

UNI EN ISO 9001: 2008	✔
UNI EN ISO 14001: 2004	✔
97 / 23 / CE (PED)	✔
94 / 09 / CE (ATEX)	✔
RINA	✔
GOST R+RTN	✔
CRN Canada	✔

Cooperations with notified bodies

LLOYD’s REGISTER	✔
ABS	✔
BV	✔
DNV	✔

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