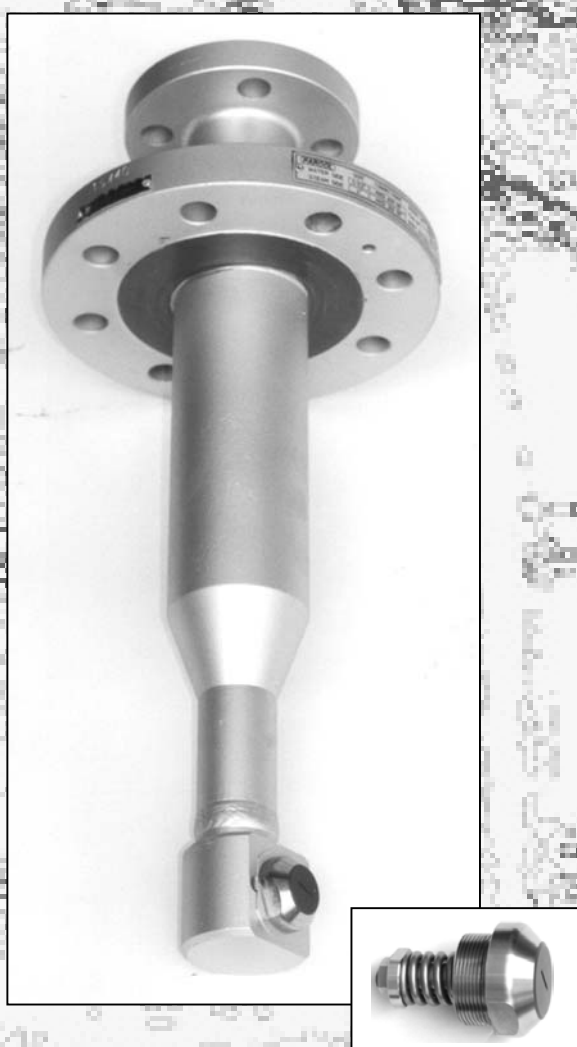




3-4000 SERIES DESUPERHEATERS



3-4000 SERIES DESUPERHEATERS

PARCOL 3-4000 series desuperheaters are used to reduce the steam temperature by directly water injection inside the superheated steam flow.

The above series includes 3-4100 variable area and 3-4500 fixed area models.

LV variable area series, including LVP and LVM models, allows solving the most common desuperheating problems without practical limitations in flow rate and operating conditions.

Fixed area LF nozzles, on the contrary, are designed for limited power processes with limited load changes.

3-4100 VARIABLE AREA MODELS

Classification

3	-	4	1	X	X
			1	Without injection chamber	
			2	With injection chamber	
			1	Probe type, single nozzle (LVP)	
			2	External mounted, multiple nozzles (LVM)	
			4	Probe type, multi-nozzle (LVP)	
			1	Spring assisted variable area nozzle LV type	

All the models are provided with the basic variable area spring-loaded LV nozzle.

LV - VARIABLE AREA NOZZLE

Description and operation

The LV nozzle is the basic component of all 3-4100 desuperheaters; it is threaded and locked by a special tab washer (5).

Main components of the nozzle are (see fig. 1):

- plug (1)
- nozzle body (2)
- spring (3)

The spring, compressed by the ring nut (4), keeps the plug pressed against the nozzle seat until the Δp between water and steam exceeds its preload. When the plug opens the water circulates through nozzle openings, which, due to their multi-helical design, make the flow to whirl before it gets in contact with the inside plug cone.

Due to such a special path, the water coming out of the 85° conical blade shaped nozzle is perfectly atomized.

While in a traditional type fixed area nozzle, decreasing the water flow rate the sprinkling velocity also decreases being the outlet section constant, with a LV nozzle type the plug (1) sets automatically reducing the meatus with the nozzle body (2), reducing the differential pressure up to balancing the spring load (3). Thanks to spring preload, water velocity in the meatus is kept satisfactorily high also for low water flow rates.

Therefore, Parcol variable area spring-loaded LV nozzles executions guarantee steady sprinkling efficiency independently of water flow rate.

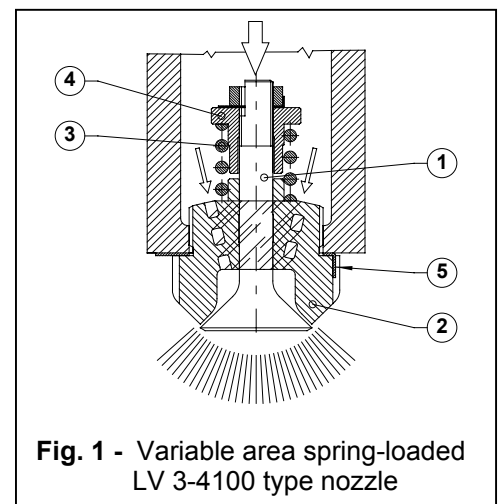


Fig. 1 - Variable area spring-loaded LV 3-4100 type nozzle

Such a capability is correctly called *sprayability* (instead of the more known *rangeability*) to better identify the intrinsic atomization capability versus flow rate change taking into account also water Δp changes across the nozzle.

Characteristic data

size : LV1, LV3, LV5, LV7 and LV8

flow rates : see data of desuperheaters provided with LV nozzles.

characteristic curve : C_v /travel and travel/ Δp characteristic curves are summarized in the diagram of Fig. 2, which plots C_v as a function of Δp , for various values of set pressure.

settings : standard setting = 3 bar

Different settings (from 1 to 5 bar) may be used for special requirements.

The 3 bar value is a compromise between the necessity to keep a certain back pressure on the control valve and a minimum seating force on the plug and also to increase the control range of the desuperheater.

sprayability : $C_{v_{max}} / C_{v_{min}} \cdot \sqrt{\Delta p_{max} / \Delta p_{min}}$ where Δp_{min} is approximately 3 bar.

The ratio $C_{v_{max}}/C_{v_{min}}$ can be determined accordingly to the minimum acceptable spray quality at minimum steam flow taking into account of nozzle size and superheated steam process conditions.

$C_{v_{min}}$ and Δp_{min} values can be drawn out by the Fig. 2 as a function of setting pressure p_t .

Ex: nozzle LV1, $p_t = 3$ bar, $\Delta p_{max} = 30$ bar, $\Delta p_{min} = 3.5$ bar, $C_{v_{max}}/C_{v_{min}} = 11.4$ (from figure 2).

$$Sy = 11.4 \cdot \sqrt{30/3.5} = 33.4$$

materials :

plug	: 17-4-PH
nozzle body	: 1-4913
spring	: Inconel X-750
tab washer	: AISI 304

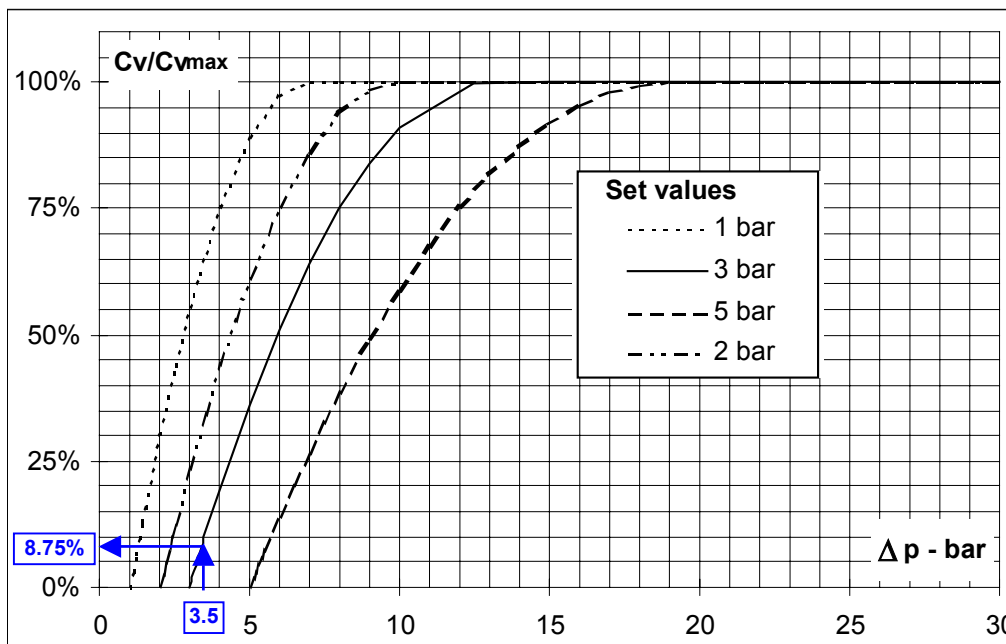


Fig.2

C_v versus Δp .

The maximum plug travel occurs with different Δp values depending on the value of nozzle set pressure.

LVP - PROBE TYPE DESUPERHEATER

It consists of a tubular flanged element where one or more downstream oriented LV nozzles are mounted.

The desuperheater is fastened on a pipe nosepiece, the length of which is adjusted, according to the pipe diameter, to keep the center of the spraying area close to the pipe axis.

Two versions are available: injection chamber to be welded to the pipe (3-4112 series), or flanged (3-4111 series) for connection through a pipe nosepiece having the dimension listed apart.

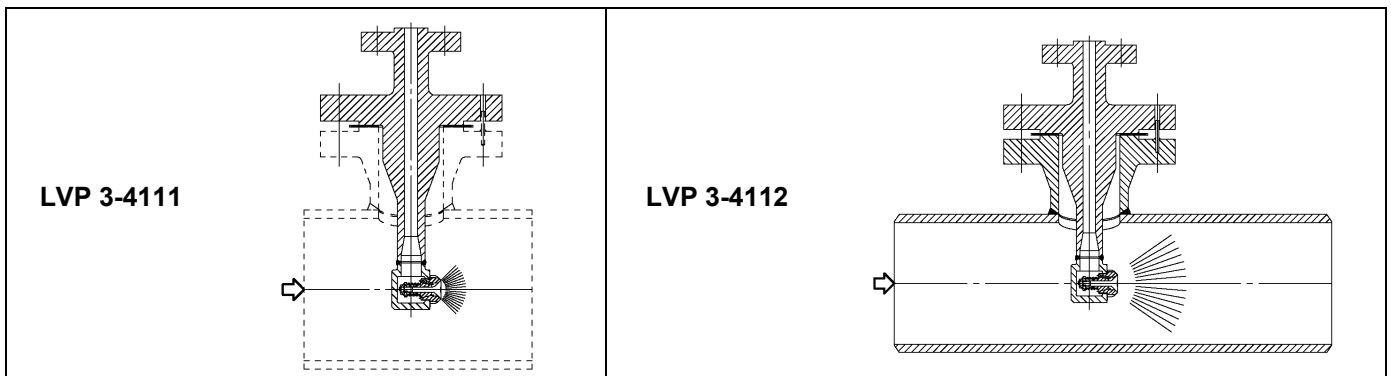
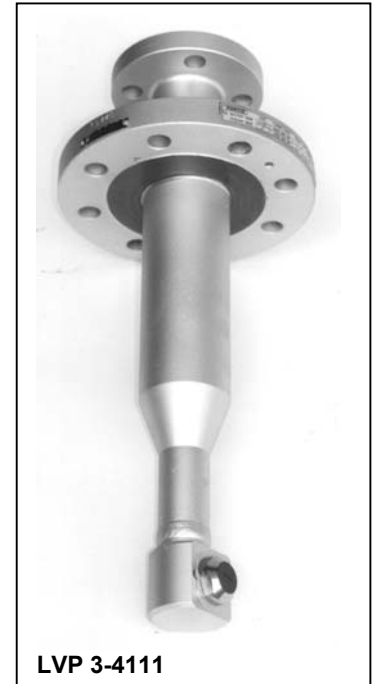
The injection chamber of 3-4112 model may be provided with inside protection liner, should it be required by the operating temperature.

One LV nozzle only is provided for in the standard design, two nozzles can be mounted on the same probe for special applications.

The nozzle orientation, with regard to flow direction, is granted by a gauge pin, whose seat must be drilled on site on the nosepiece flange, should the desuperheater be supplied disassembled (3-4111 series).

Characteristic data

size	: water side: from ½" to 2" steam side: from 2" to 6"
connections	: 3-4111 model – ANSI, UNI, DIN flanges – BW connection on request 3-4112 model – BW connection according to pipe size
ratings	: water side: ANSI 150 ÷ 1500 (PN 16÷250) steam side: ANSI 150 ÷ 1500 (PN16÷ 250) higher ratings on request
flow rates	: may be calculated by common equations (see 1-I bulletin) using the Cv's listed in the table. The water mass flow rate can not exceed in any case 25%÷26% of the steam one
sprayability	: for single nozzle desuperheaters see LV nozzle basic values. for multiple nozzles having different sizes and/or settings general turndown improvements are possible.
design	: for water inlet perpendicular to the pipe (standard) : integral forged, supplied with welded nosepiece for water inlet parallel to the pipe (on request) : forged or laminated parts welded together
materials	: body : Carbon or Cr-Mo steels according to operating temperatures injection chamber : same material as the pipe



Flow coefficients LVP models

maximum obtainable Cv ⁽¹⁾				Δp min bar	Δp max bar
nozzle number	1	2 ⁽⁴⁾	3		
Nozzle type	LV-1	0.8	1.5	2.2	(2) 30
	LV-3	1.6	3	4.4	
	LV-5	3.15	6	9	
	LV-7	6.3	12	18	
	LV-8	9	17	25	
Max injectable water % ⁽³⁾		22%	24%	26%	

(1) - Maximum reachable Cv values at maximum plug opening.

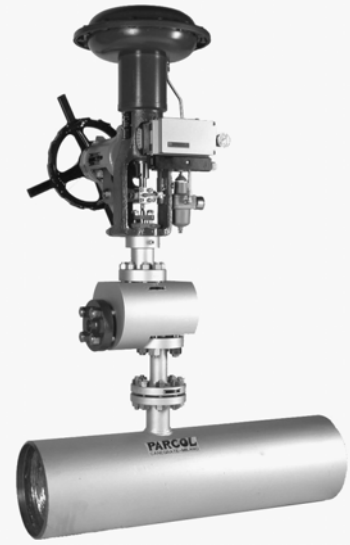
(2) - Value corresponding to spring setting (standard value is 3 bar).

(3) - % value referred to steam flow rate to be desuperheated.

(4) - LVM 3-4122 model to be preferred for equipment provided with two nozzle chamber

Nozzle size	LV-1	LV-3	LV-5	LV-7	LV-8
steam side connection	2"	3"	4"	4"	6"
minimum steam pipe DN (*)	4"	6"	8"	8"	12"
water connection DN	1/2"	1"	1.1/2"	2"	2"

(*) Model without pipe protecting liner



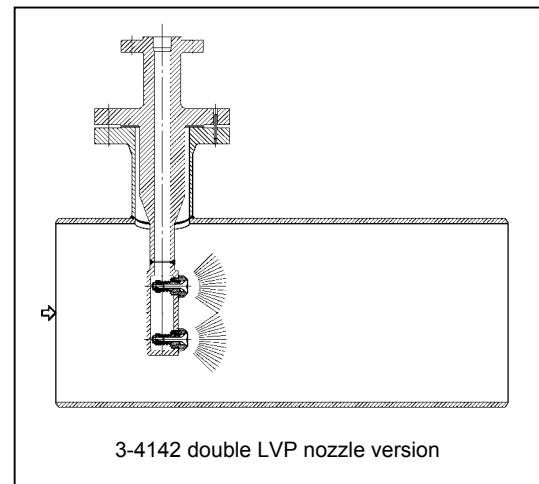
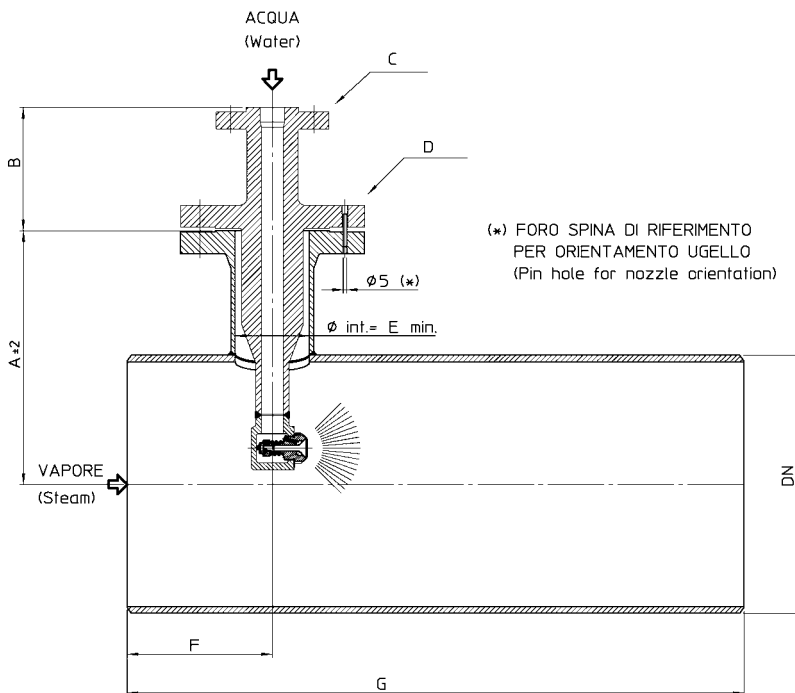
Limiphon 1-9711 + LVP 3-4111

Integrated design for desuperheating water reduction and control, suitable for high water-steam differential pressure.

Overall dimensions LVP models

TIPO UGELLO Nozzle type	B	C	D	E
LV-1	140	1/2"	2"	49
LV-3	180	1"	3"	73,5
LV-5	200	1.1/2"	4"	97
LV-7	200	2"	4"	102
LV-8	230	2"	6"	140

DN	A					F	G
	LV-1	LV-3	LV-5	LV-7	LV-8		
4"	250	300	350	350	450	150	550
6"						200	650
8"						200	700
10"						200	750
12"						200	800
14"	275	325	375	375	450	200	850
16"	300					200	900
18"	325					200	950
20"	350					250	1050
22"	375					250	1100
24"	400	425	450	450	475	250	1150
26"	425					250	1200
28"	450					250	1250



Above dimensions may change according to operating conditions and must be confirmed in the order

LVM – EXTERNAL MOUNTED, MULTIPLE NOZZLES DESUPERHEATER

The LVM 3-4122 model desuperheater is composed by more elements (or injectors) connected to one another and welded to an injection chamber that shall be installed on the piping by a BW welding.

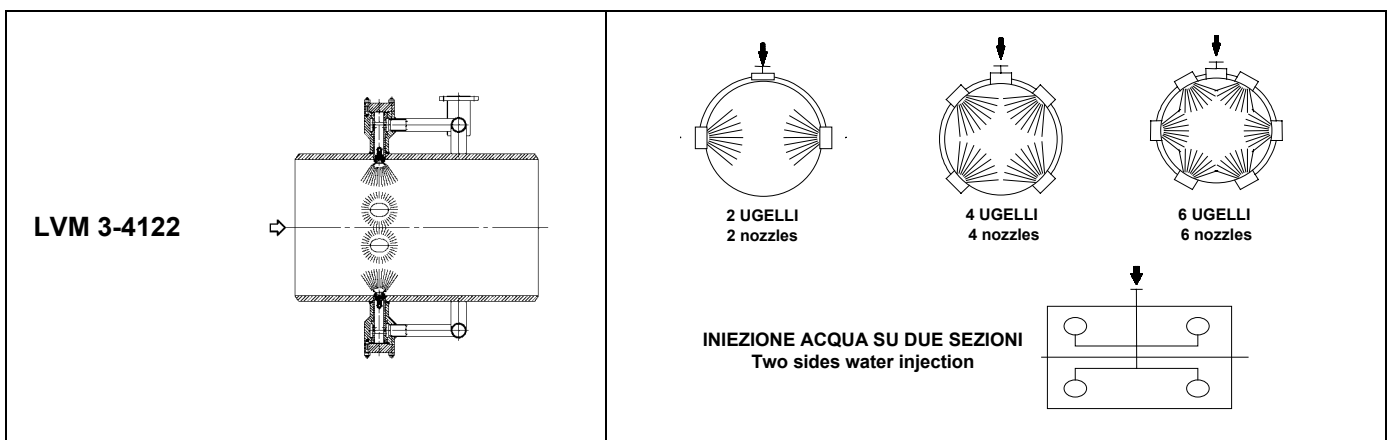
Each injector is composed by a LV nozzle threaded inside a drilled cage inserted in a stub pipe welded on the injection chamber and closed by a flanged bottom.

The injectors are uniformly distributed on chamber and are oriented perpendicularly to the pipe axis. A piping leading to a single inlet makes up the connection among the various injectors.

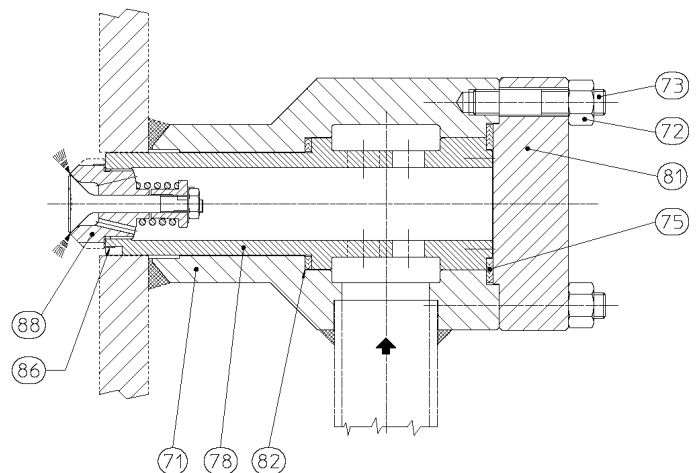
Water distribution piping system is purposely designed to avoid dangerous stresses generated by different water and steam temperatures.

According to the operating conditions specified apart, the injection chamber may be provided with an inside protection liner (see Parcol Bulletin 1-XI – Steam Conditioning Manual for further details).

The LVM design may be provided with nozzles having different size and settings, for good performance at various regimes, and mainly to improve sprayability.



ref.	Description	Material
72	NUT	ASTM 194-4
73	STUD	ASTM 193 B7
75	GASKET	AISI 321 + GRAPHITE
78	NOZZLE HOLDER	ASTM A 182 F6NM
81	COVER	ASTM A105
82	GASKET	AISI 321 + GRAPHITE
86	TAB WASHER	AISI 304
88	NOZZLE ASSEMBLY	VARIOUS



Characteristic data

size	: 1" to 4" for water connection; 4" to 40" for the injection chamber
connection	: ANSI, UNI, DIN flanges for water connection BW for the injection chamber according to pipe size
rating	: water side : ANSI 150÷1500 (PN16÷250) steam side : ANSI 150÷1500 (PN16÷250)
flow rate	: may be calculated by using the Cv listed apart as a function of nozzle number the max water versus steam flow rate can not exceed the value shown in Cv table
sprayability	: see values of basic LV nozzle. Turndown improvement is possible through a combination of different nozzle sizes and settings
design	: fabricated by welding together forged or laminated parts
material	: desuperheaters: Carbon or Cr-Mo steels according to operating temperature injection chamber: same material as the pipe internal liner: Cr-Mo steel



LVM 3-4122 desuperheater installed downstream a reducing valve

Flow coefficients LVM models

max obtainable Cv (1)						Δp min bar	Δp max bar
Number of nozzles	1	2	4	6	8		
Nozzle type	LV-1	0.8	1.5			(2)	30
	LV-3	1.6	3	6			
	LV-5	3.15	6	12	18		
	LV-7	6.3	12	24	36		
	LV-8	9	17	33	50		

Maximum injectable water quantity

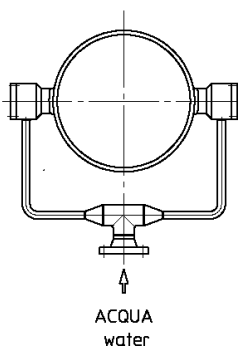
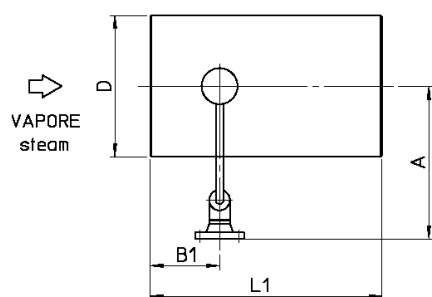
(% value referred to steam flow rate to be desuperheated)

Number of nozzles	1	2	4	6	8
one section	20%	22%	25%	28%	
two sections			30%		33%

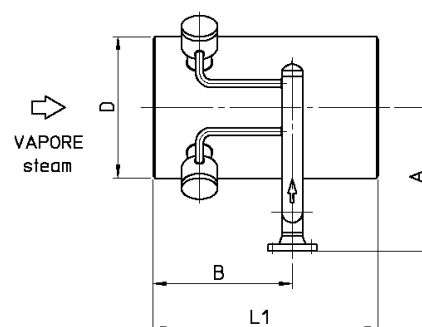
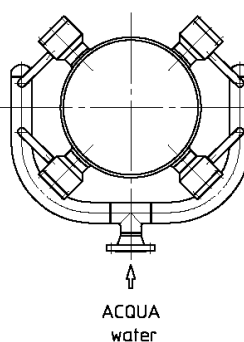
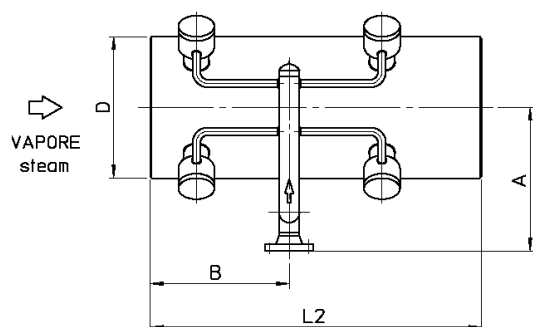
(1) - Maximum values reachable at maximum plug opening

(2) - Value corresponding to the spring setting (the standard value is 3 bar).

Overall dimensions LVM models



D		A	B	B1	L1	L2
inch	mm					
8"	200	350	350	150	550	800
10"	250	375	350	150	550	850
12"	300	450	400	150	600	900
14"	350	475	400	150	600	1000
16"	400	500	450	150	650	1100
18"	450	575	500	200	700	1200
20"	500	600	550	200	750	1300
22"	550	625	550	200	800	1400
24"	600	650	600	200	850	1500
26"	650	675	600	200	900	1600
28"	700	700	650	200	950	1700
32"	800	750	650	200	1000	1800
36"	900	850	700	200	1050	1900
40"	1000	900	700	200	1100	2000



Above dimension may change according to operation condition and must be confirmed in the order

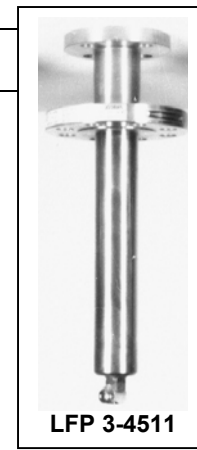
3-4500 FIXED AREA TYPES

LF type fixed atomizing nozzles are used in three models:

3-4511 - LFP probe type to be mounted on flanged nosepiece

3-4512 - LFC probe type provided with injection chamber

3-4531 - LFW wafer type



LF - FIXED AREA NOZZLES

LF nozzle is designed to perform a very fine atomization degree, similarly to that of injection engines (see fig. 3). The spraying area remains constant when the flow rate changes and consequently water velocity and jet turbulence are reduced. Nevertheless a whirl device (1) (called “turbulator”) mounted upstream the nozzle (2) can partially compensate for the above decrease of atomizing efficiency, thus keeping the turndown ratio acceptable for some applications.

The fixed area model, unlike variable area LV models, misses therefore the benefit of constant velocity; its rangeability and sprayability are the same and may be simply evaluated by the relationship:

$$R_y = S_y = \sqrt{\Delta p_{\max} / \Delta p_{\min}}$$

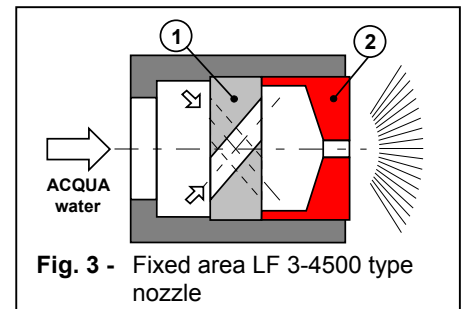
where Δp_{\min} is the minimum differential pressure generating a satisfactory atomizing degree.

This type of nozzles shows an average value of $\Delta p_{\min} \approx 1$ bar which corresponds to an apparent water velocity of 14 m/s (compared to ≈ 40 m/s of a plain not-assisted hole).

A max typical allowable $\Delta p_{\max} = 25$ bar leads to a value of **$R_y = 5:1$** . For different Δp_{\max} limits the R_y values have to be calculated accordingly.

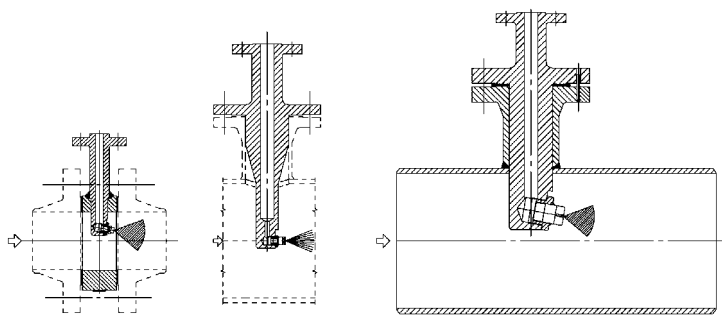
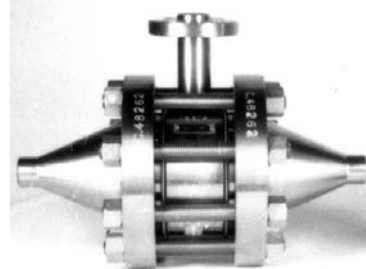
LF desuperheaters are normally used where required water flow rates are lower than the minimum ones adjustable by LV models (Cv lower than about 0.7).

Simple and inexpensive, LF nozzles may be adopted instead of LV nozzles of similar capacity, only if the magnitude of process load changes is compatible with the lower sprayability of these devices (about 5:1).



Characteristic data

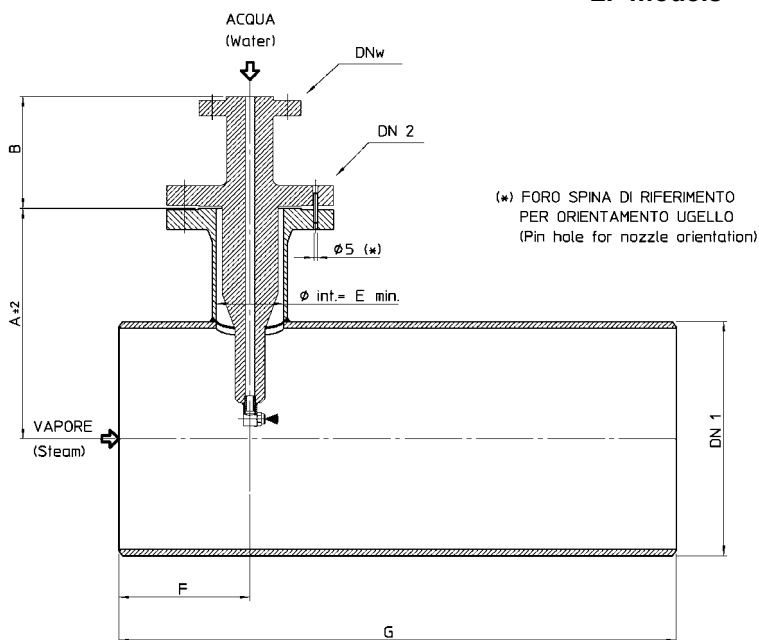
size	: LFP	- water side: ½" to 1"
		- steam side: 2" to 6"
	: LFW	- 1.1/2" to 4"
connections	: LFP and LFW: ANSI,UNI, DIN flanges (BW connection on request for LFP) 3-4512 type – BW connection according to pipe size.	
ratings	: water side : ANSI 150 ÷ 1500 (PN 16÷250)	
	steam side : ANSI 150 ÷ 1500 (PN16÷ 250) higher ratings on request.	
flow rates	: may be calculated by common equations (see bulletin1-I) using Cv listed in the table.	
	The maximum water mass flow rate can not in any case exceed 25% of the steam flow.	
design	: water inlet perpendicular to the pipe (standard): integral forged, supplied with threaded nozzle locked by tab washer.	
	water inlet parallel to the pipe (on request): welded construction between forged or laminated parts.	
materials	: body: Carbon steel or Cr-Mo steel according to operating temperature.	
	injection chamber: same material as the pipe.	


LFW 3-4531
LFP 3-4511
LFC 3-4512

LFW 3-4531

Flow coefficients LF models

DNw	1/2"								3/4"			1"				
Cv - gpm	0.03	0.04	0.06	0.085	0.11	0.14	0.18	0.3	0.36	0.43	0.6	0.7	0.83	1.1	1.4	2.7

Overall dimensions LF models

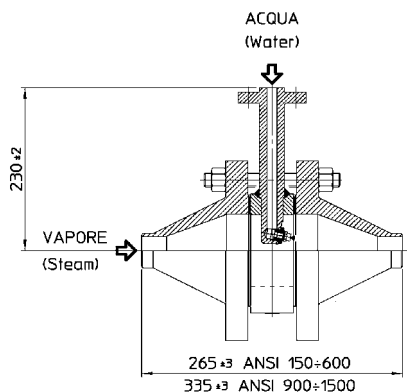


DN 1	A			F	G
	DNw 1/2"	DNw 3/4"	DNw 1"		
3"	250			150	500
4"				150	550
6"		300	300	200	650
8"				200	700
10"				200	750
12"				200	800
14"	275			200	850
16"	300			200	900
18"	325	325	325	200	950

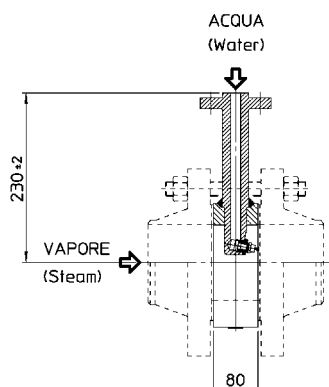
DNw	B	DN 2	E
1/2"	140	2"	49
3/4"	180	3"	73.5
1"	180	3"	73.5

LFW models

DN 1 1/2" - 2" - 2 1/2"



DN 3" - 4"



Above dimension may change according to operation condition and must be confirmed in the order