ESA PYRONICS INTERNATIONAL
SIAD Group

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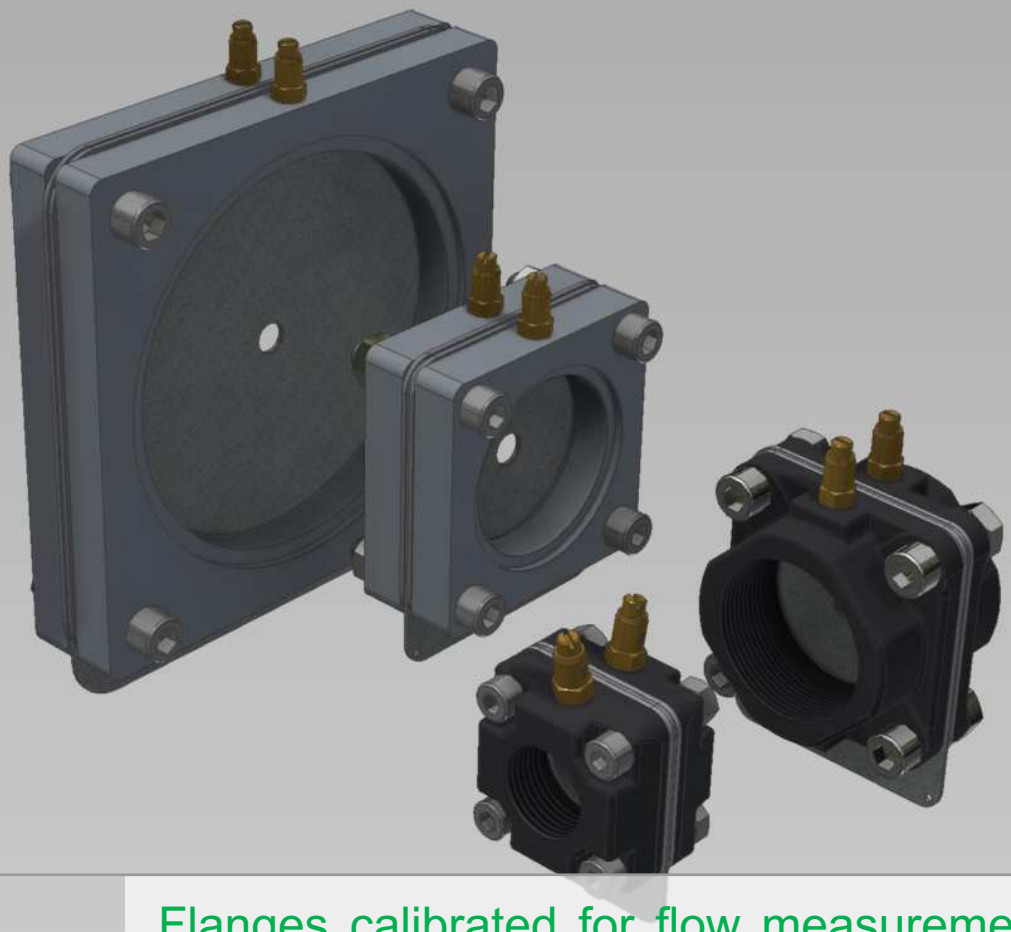


Flanges calibrated for flow measurements

POP-S

www.esapyronics.com

GENERAL WARNINGS

- Each manual, including this one, is an integral part of the ESA catalog.
- Each manual may contain errors or give rise to interpretative doubts. ESA invites you to report any interpretative errors or doubts but will not be able to consider such occurrences as the cause of any disputes.
- This manual and all its parts (logos, texts, photos, tables, graphics, etc ...) cannot be reproduced or modified in whole or in part without the written consent of ESA.
- The technical information relating to the design, installation, regulation and operation of the combustion plant intended to host ESA products must be previously shared with ESA. Failing this, ESA declines all responsibility in relation to damage to things and people deriving from improper use of the products.
- In general, a combustion plant is not designed for oven drying refractories. In case of this use, ESA declines any responsibility in this regard.
- The performance of the products indicated in each manual is the result of tests conducted using ESA equipment at our Research and Development Center, under certain operating conditions. These performances cannot be guaranteed using other equipment or outside the aforementioned conditions.
- The design, installation, adjustment and operation of a combustion plant require compliance with all applicable safety standards and regulations. ESA declines any responsibility in relation to its products, if used in plants or in circumstances in which the regulations in force in the place of use are not respected.
- All installation, maintenance, ignition and calibration operations must be carried out by qualified personnel in compliance with all the points indicated in this manual. The indications given in this document do not exempt the customer/user from observing the general and specific legal provisions.
- All personnel responsible for checking and operating the device must be informed of the contents of this manual and must strictly follow its instructions. The operator must wear suitable clothing and PPE according to the legal requirements, respecting the general safety and risk prevention rules. If clarifications, additional information or training are required, contact the ESA sales offices.
- ESA reserves the right to modify the technical characteristics of the products by updating the relative manual at any time and without notice. By consulting the website **www.esapyronics.com** it is possible to download the manuals updated to the latest revision in Italian and English.

LOGISTICS AND DISPOSAL

- **Transport:** protect the equipment from shocks, vibrations, atmospheric agents, etc... Upon receipt of the product, check the labeling in accordance with the order and promptly notify any discrepancies and/or transport damage.
- **Storage:** store the product in a suitable place, according to the product specifications.
- **Packaging:** the material used must be disposed of according to local regulations.
- **Disposal:** comply with local legislation on this matter.

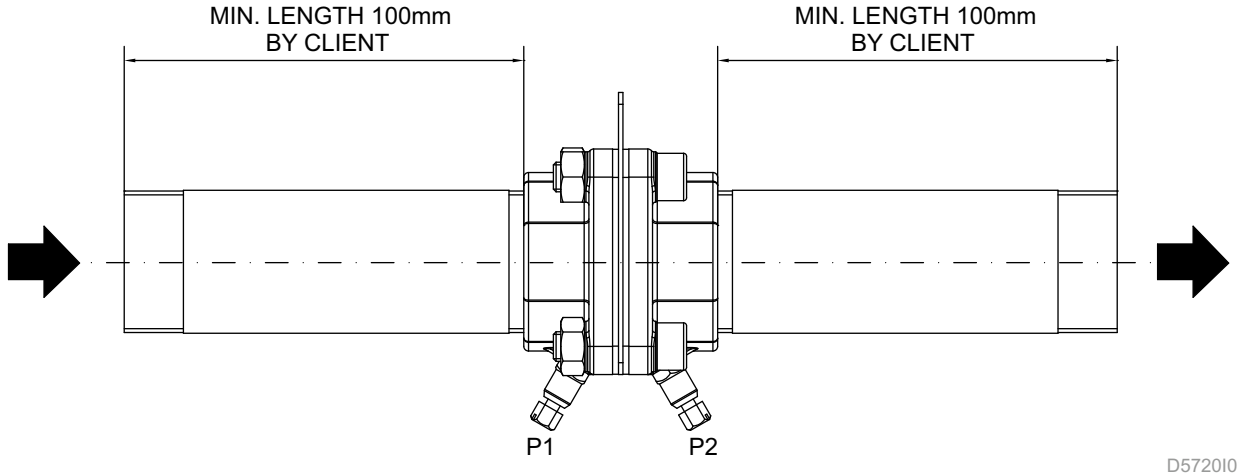
CERTIFICATIONS

EAC for the Eurasian market (Russia, Belarus and Kazakhstan).

- ESA adopts the Quality System certified by DNV GL in compliance with the **UNI EN ISO 9001** standard.
- ESA adopts the Code of Ethics and Behavior pursuant to Legislative Decree **231/01**.
- ESA products are designed, manufactured and controlled in compliance with the Directives/Regulations, in particular **UNI EN 746-2** "Industrial thermal process equipment - Part 2: Safety requirements for combustion and for the handling and treatment of fuels" harmonized with the Machinery Directive **2006/42/EC**.

DESCRIPTION

The POP-S series calibrated flanges for flow measurements are devices suitable for measuring air or gas flow rates. The principle of the measurement method is based on the installation of a calibrated orifice inside the pipeline. As the fluid flows, a static pressure difference is created between the upstream and downstream sections of the orifice, proportional to the flow rate of fluid that is passing. By measuring the pressure difference across the orifice (with a special differential pressure gauge or pressure transmitter) and using suitably calculated conversion tables, it is possible to take an instant flow reading. In combustion plants, calibrated flanges represent the ideal instrument for measuring and controlling air and gas flow rates; the regulation of the air / gas ratio in the burners is very simplified when the volumes of the combustion air and fuel gas flows are precisely known.
To make the conversion between pressure drop and flow rate possible, the composition and physical characteristics of the gas (pressure and temperature) must be known.
The drilling of the orifice is performed with accurate machining to obtain precision measurements. Each calibrated flange has the orifice diameter stamped on the insert to facilitate identification.



FEATURES

Technical features

Fluids:	Non aggressive gases according to EN437
Maximum operating pressure:	400 [mbar] @ 25 [°C] *161 ["WC] @ 77 [°F]*
Operating temperature:	-20 ÷ +400 [°C] *-4 ÷ +752 [°F]*
Storage temperature:	0 ÷ +40 [°C] *32 ÷ 104 [°F]*
Available sizes:	Threaded from DN10 to DN50 according to ISO 7/1, NPT thread on request. To weld from DN65 to DN150 according to ESA PF E5701 flange
Connection:	Flanged according to ESA PF & PFF flange
Measurement error:	±5%

Construction features

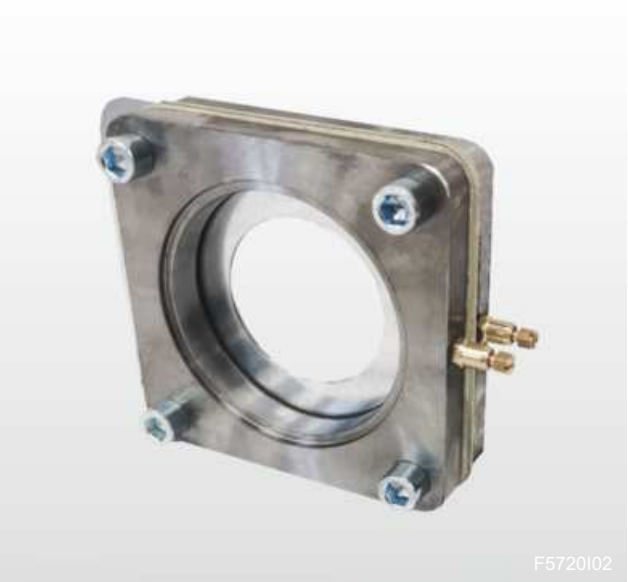
Threaded flanges:	G25 cast iron
Welding flanges:	Fe 360
Port disc:	Galvanized Fe 360 / AISI304 on request (high temperature)

Accessories

Pressure ports:	Pressure taps ESA E5712
Gaskets:	AFM-34 / X-plus on request
Fittings:	Materials: nickel-plated brass / AISI321 for Ø8mm tube

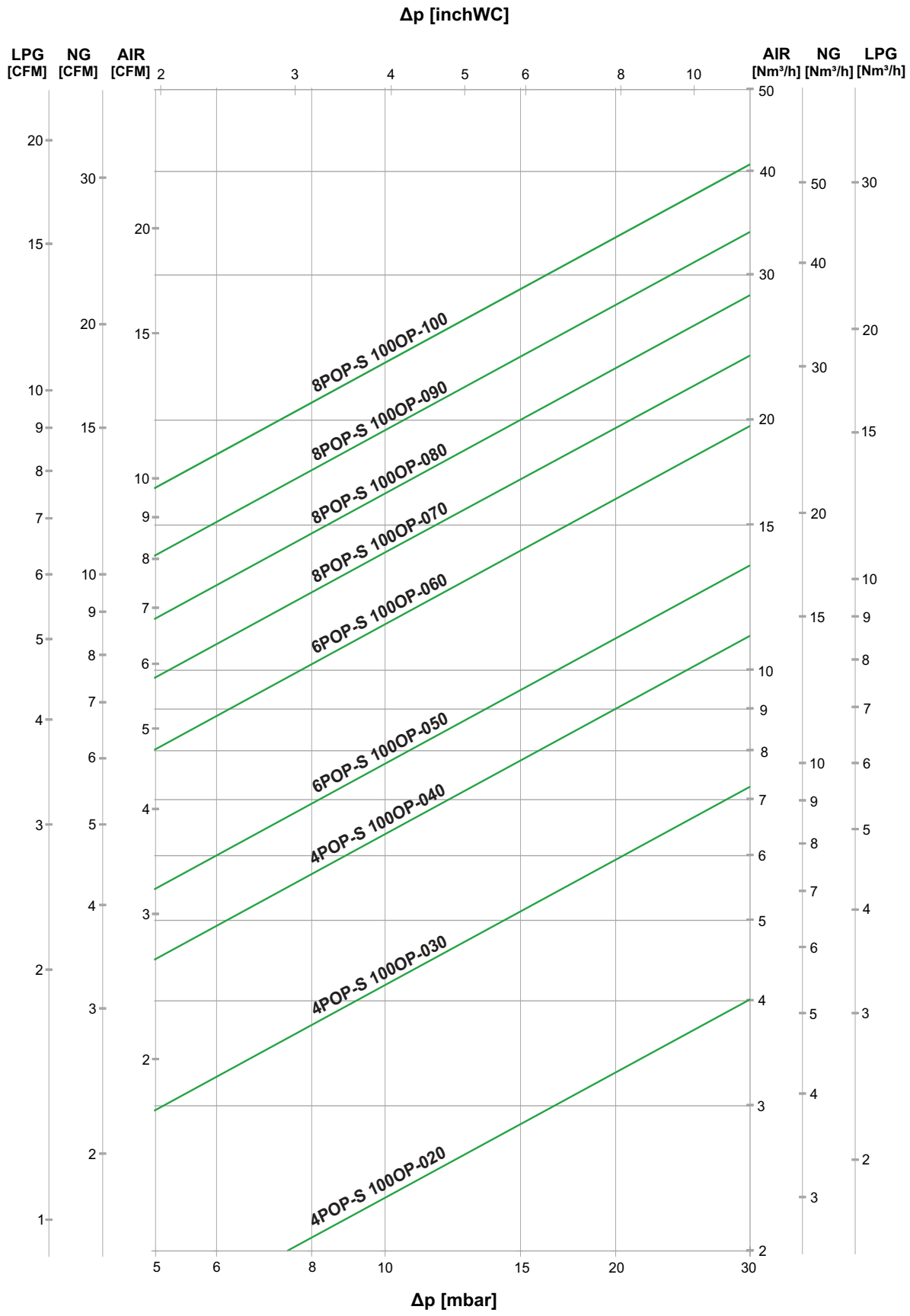
GALLERY

threaded POP-S



weld POP-S

100OP - FLOW CHART



T=0 [°C] e Ps=1013 [mbar]

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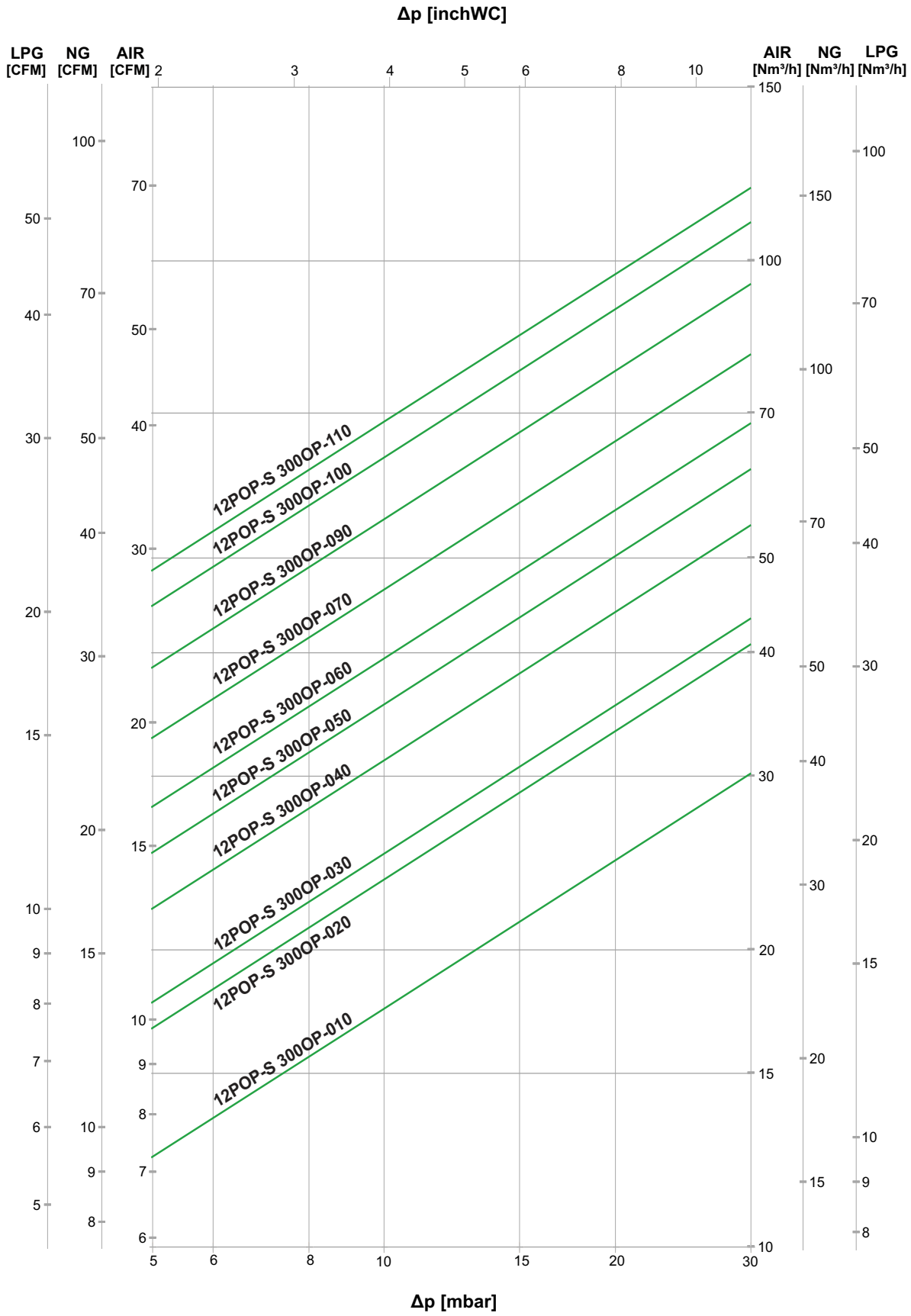
300OP - FLOW CHART



T=0 [°C] e Ps=1013 [mbar]

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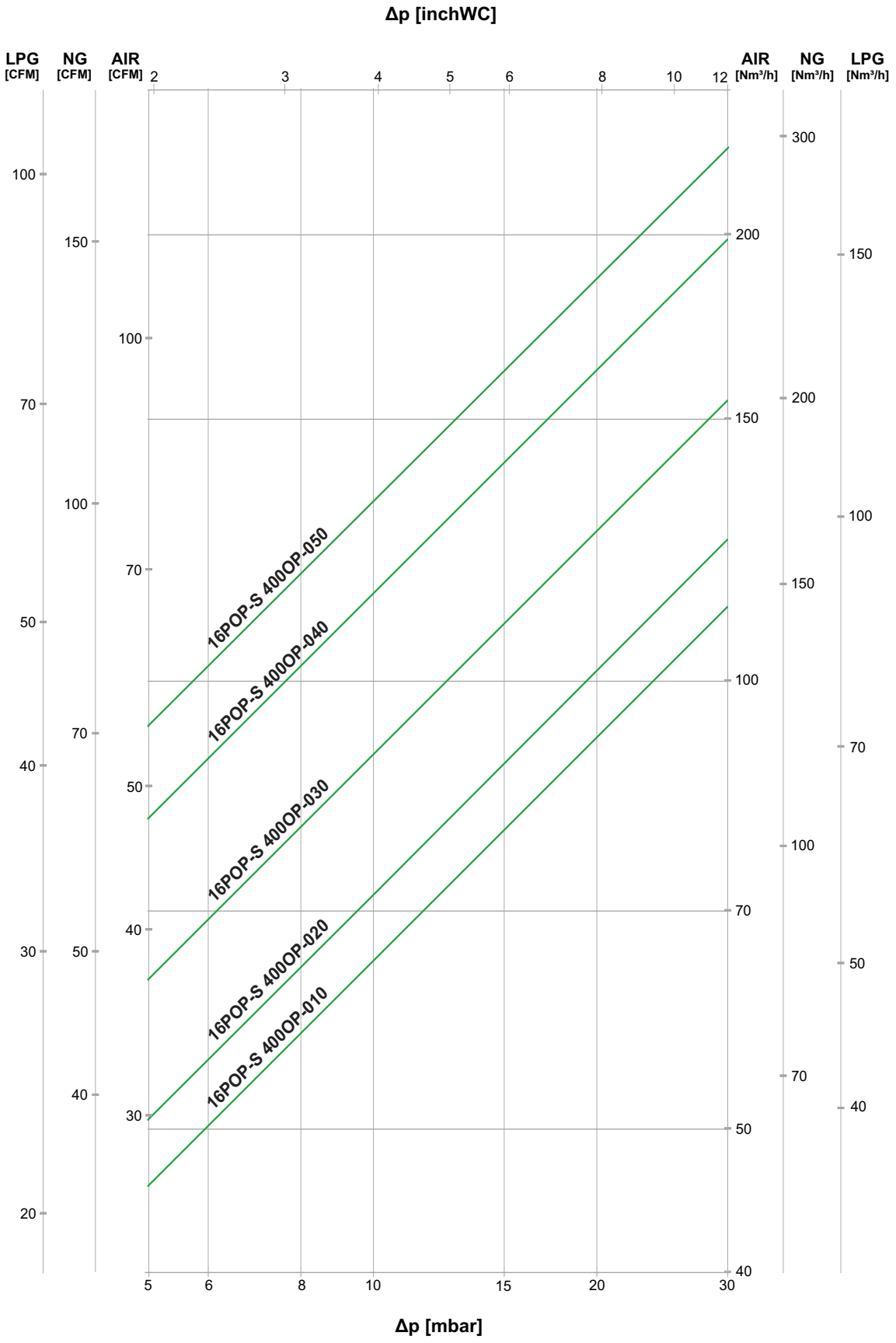
400OP - FLOW CHART



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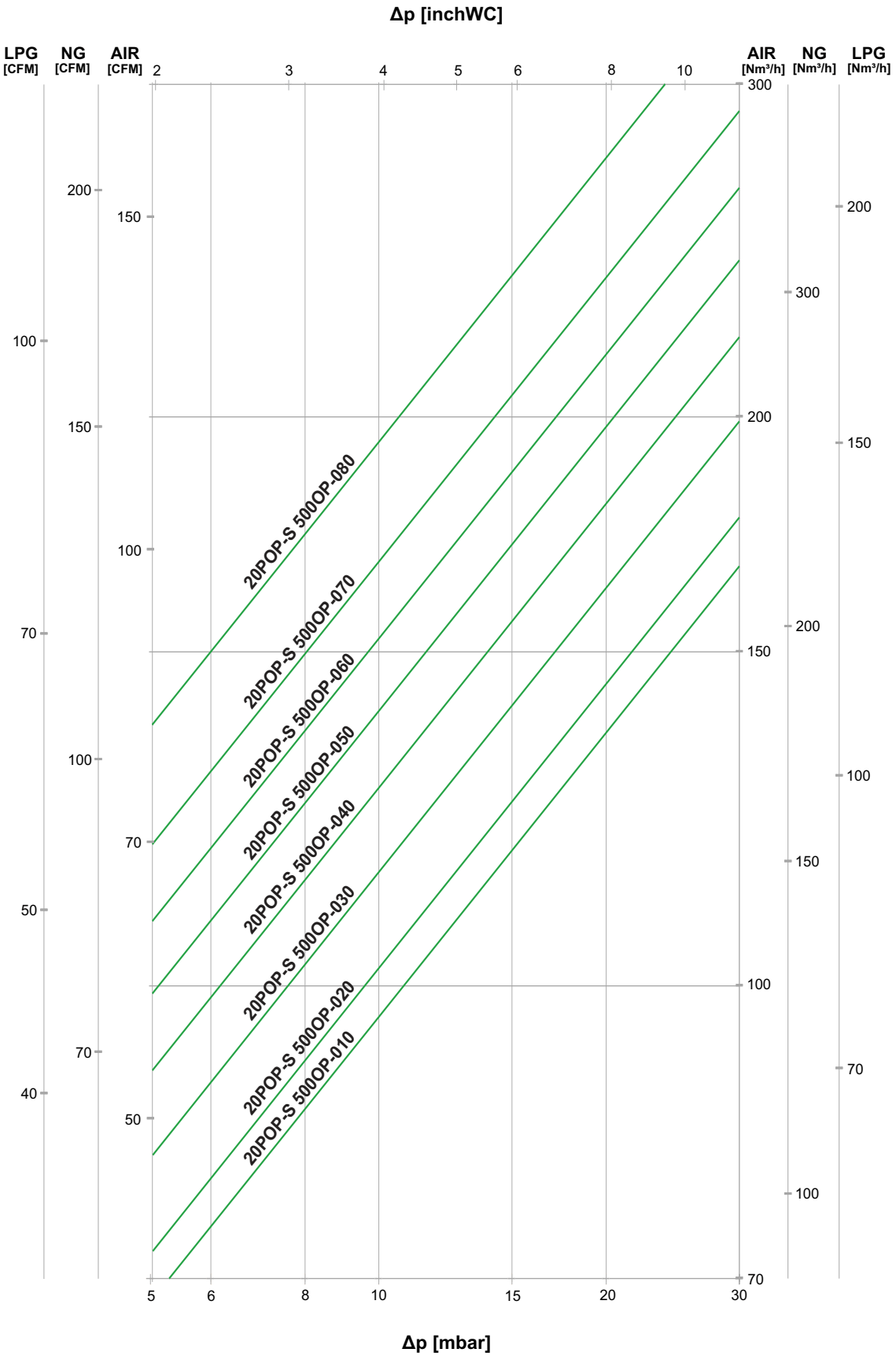
500OP - FLOW CHART



T=0 [°C] e Ps=1013 [mbar]

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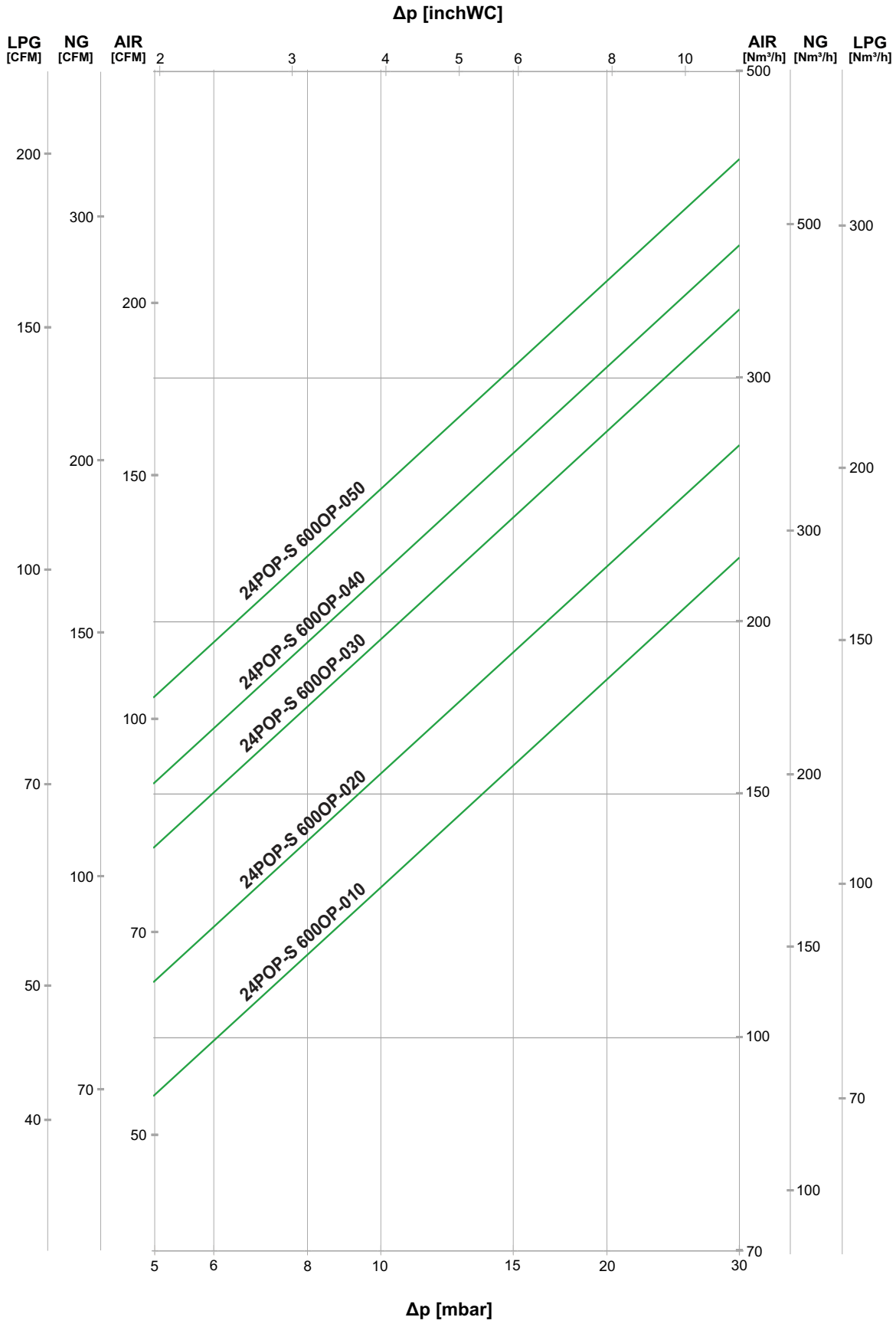
600OP - FLOW CHART



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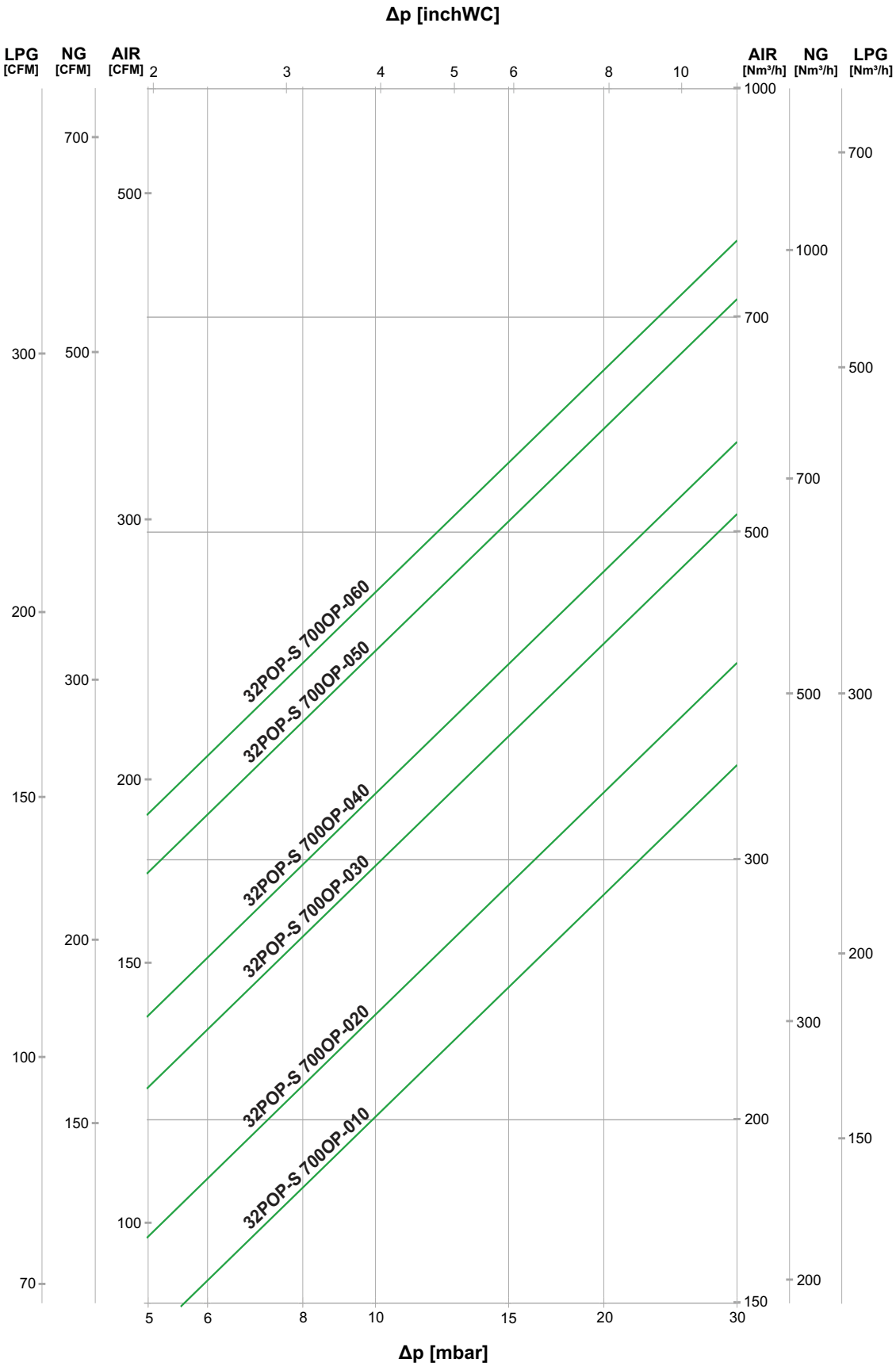
700OP - FLOW CHART



T=0 [°C] e Ps=1013 [mbar]

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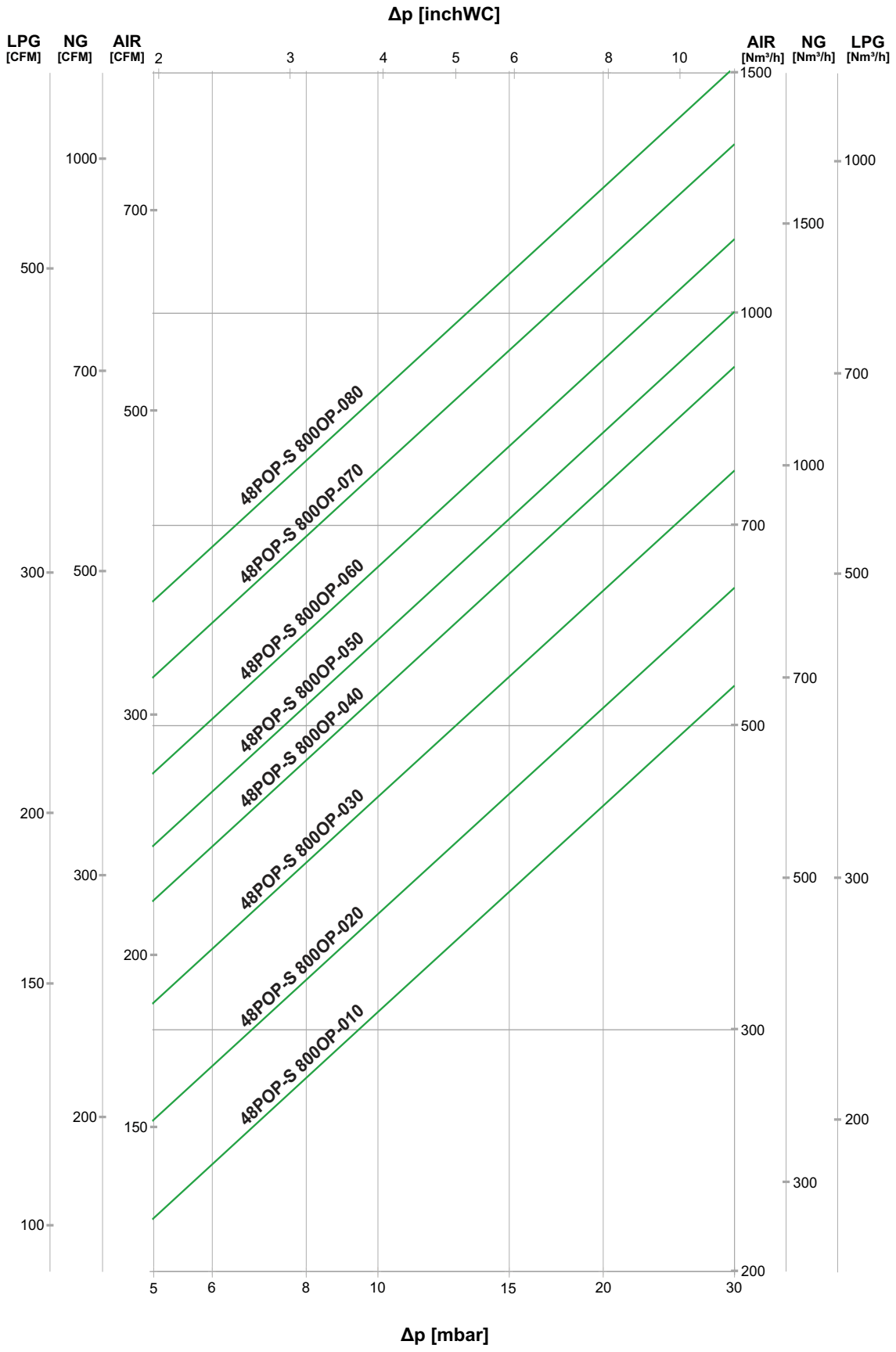
800OP - FLOW CHART

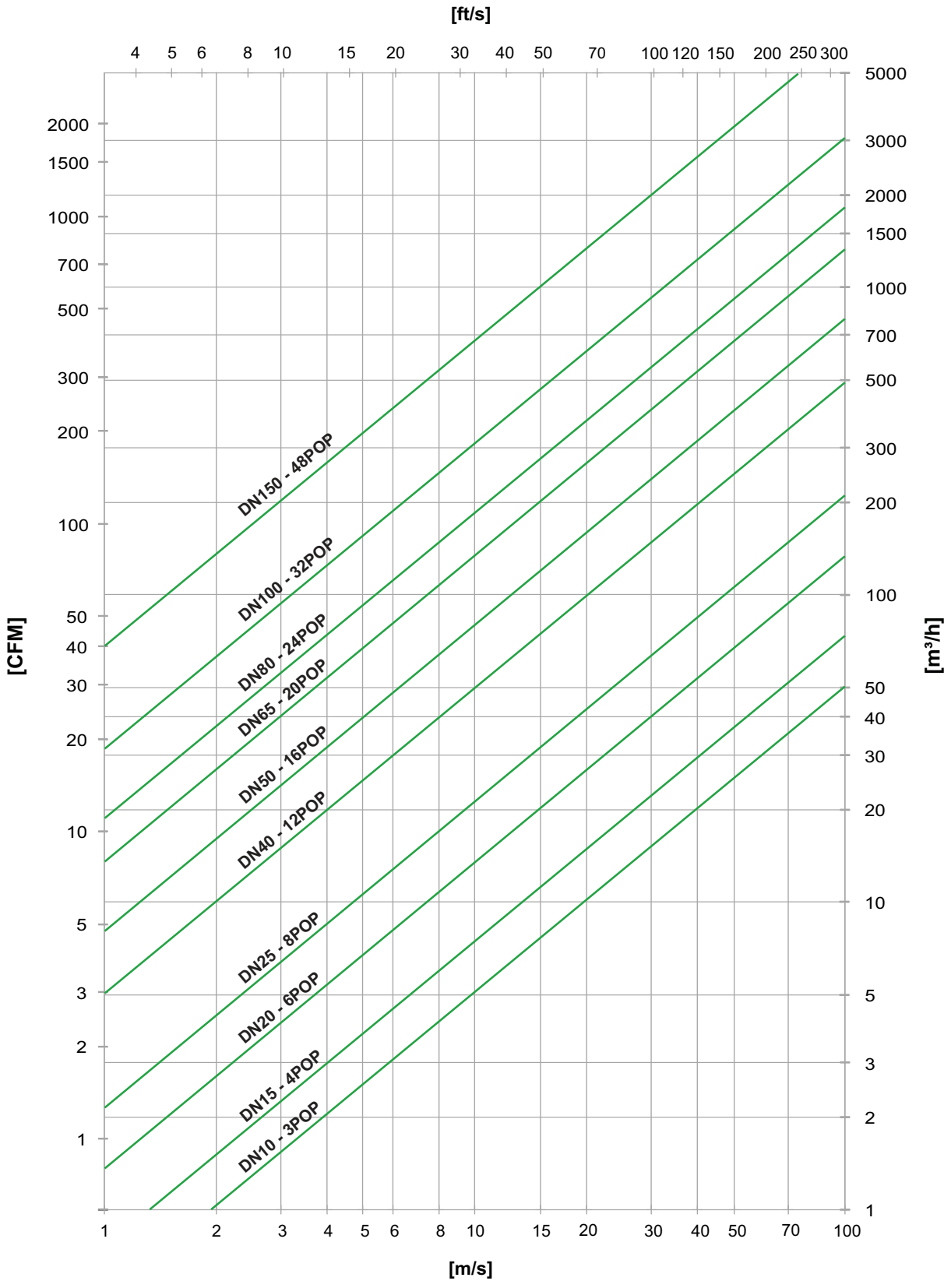


T=0 [°C] e Ps=1013 [mbar]

G5720I07

VELOCITY CHARTS

To correctly size noise and pressure drops, the maximum recommended speed of the flow inside a pipe must be limited to 30 [m/s] or 5920 [ft/min] (ESA recommends <20 [m/s] or 3950 [ft/min]).
The velocities are calculated taking into account carbon steel pipes according to the standard EN 10255 Medium Series. Different pipe thickness will correspondingly result in different flow rates.



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PRESSURE CORRECTION COEFFICIENT TABLE

Pin [mbar]	20	50	70	100	150	200	250	300	350	400
K_P	1,024	1,008	1	0,987	0,965	0,943	0,924	0,906	0,889	0,873

TEMPERATURE CORRECTION COEFFICIENT TABLE

Tin [°C]	0	20	50	100	150	200	250	300	350	400
K_T	0,967	1	1,047	1,122	1,191	1,255	1,318	1,374	1,429	1,483

READING FLANGE DIMENSIONS

In order to correctly size the reading flange inside the POP-S series calibrated flanges, it is essential to have the following project data:

- Chemical composition of the fluid.
- Gas operating pressure and temperature.
- Nominal pipe diameter (or internal diameter if non-standard pipe).
- Nominal flow rate of fluid.
- Pressione differenziale desiderata sulla flangia calibrata.

Using the tools available in this technical bulletin, it is possible to carry out a rough sizing of the calibrated flange, provided that it is possible to operate with gaseous fluids under pressure up to 400mbarg and temperatures up to 400 °C (with the use of special correction coefficients), as shown below.
For a more accurate sizing it is necessary to contact ESA directly.

Method

First of all, it is necessary to determine the size of the pipe suitable for the application.
To do this, you can use the graph in the VELOCITY CHARTS paragraph, crossing on the vertical axis the volumetric flow rate of the application with the oblique line of the pipe, and considering that for a correct reading it is recommended to have a fluid speed that does not exceed 20 m/s.

Once the size of the pipe (and therefore of the POP-S flange) has been determined, move to the graph relating to the POP-S dimension chosen, and cross the normal flow rate on the vertical axis with the desired pressure drop across the calibrated flange, marking the meeting point between the two lines. At this point, select the orifice with the line that is closest to the meeting point.

NB1: The calibrated flange selection graphs show the most typical pressure drops for low pressure applications (Δp from 5 to 30mbar), but it is possible to have higher Δp.

NB2: The selected graphs of the calibrated flanges are obtained considering an inlet pressure of 70mbarg and a temperature of 20°C. In the case of different operating conditions, it is necessary to use the conversion coefficients to return to these design conditions, as shown in EXAMPLE 2.

NB3: The graphs for the selection of the calibrated flanges show the graduated flow rate scales relating to the three most used gaseous fluids: air, natural gas and LPG. In the case of other gases, it is necessary to convert the flow rate into an equivalent air flow rate, as shown in EXAMPLE 3.

EXAMPLE 1

Dimensioning of a flange calibrated for Natural Gas with the following project data:

Gas: Natural Gas
Temperature: 20°C
Normal flow rate: 50 Nm^3/h
Operating pressure: 70 mbarg
Δp desired on the flange: 10 mbar
Installed piping: DN40

In this case, the operating conditions correspond to those of the design with which the sizing curves were drawn, therefore it is not necessary to use any correction coefficient.
From the selection graph of the DN40 calibrated flanges (12POP-S), intersecting the flow rate of 50Nm^3/h on the vertical axis of the NG with the desired Δp of 10mbar, we see that the calibrated flange that is closest is the model 12POP-S 300OP-060.

READING FLANGE DIMENSIONS

EXAMPLE 2

Sizing of a calibrated hot air flange with the following design data:

Gas: Air
Temperature: 400°C
Normal flow rate: 200 Nm³/h
Operating pressure: 100 mbarg
Δp desired on the flange: 15 mbar

First of all, it is necessary to determine the size of the pipe that is most suitable for the application. For this it is necessary to calculate the density of the air at operating conditions, considering both the effects of temperature and pressure, with the following formula.

$$\rho_{air}\,(500°C;\,100\text{mbar g}) = \frac{P_{atm}\,[Pa] + P_{air}[Pa]}{\left(\frac{8314}{MM}\right) * T_{air}\,[K]} = \frac{101325 + 10000}{\left(\frac{8314}{28.96}\right) * (273.15 + 400)} = 0.576\left[\frac{kg}{m^3}\right]$$

Since the air density in Normal conditions (0°C, 101325 Pa), is known, it is possible to determine the volumetric flow rate:

$$\left[\frac{kg}{m^3}\right] = \frac{\rho_{air}\,(\text{Normal conditions})}{\rho_{air}\,(500\,°C;\,100\,\text{mbarg})} * Q\left[\frac{Nm^3}{m^3}\right] = \frac{1.293}{0.576} * 200 = 449\left[\frac{m^3}{h}\right]$$

At this point, use the VELOCITY CHARTS and choose a pipe that, with the volumetric flow rate just calculated, allows a fluid speed of less than 20 m/s. In this case you can opt for a DN100-32POP.

Once the piping has been determined, it is possible to proceed with the choice of the calibrated orifice. To do this, it is necessary to multiply the Normal flow rate by the temperature and pressure correction coefficients to return to the design conditions on which the selection curves have been drawn (Pin = 70 mbarg, Tin = 20°C).

$$Q_{N\_selezione} = \left[\frac{Nm^3}{h}\right] = Q_N\left[\frac{Nm^3}{h}\right] K_T\,(400\,°C) * K_P\,(100\text{mbarg}) = 200 * 1.483 * 0.987 = 292.7\left[\frac{Nm^3}{h}\right]$$

Using the selected graph of the calibrated flanges 32POP-S 700OP, intersecting the Normal selection flow rate just calculated on the vertical axis of the air with the desired Δp of 15 mbar, we see that the flange that comes closest is the 32POP-S model 700OP-020.

EXAMPLE 3

Sizing of a flange calibrated for CO2 gaseous with the following project data:

Gas: CO2
Temperature: 20°C
Normal flow rate: 100 Nm³/h
Operating pressure: 300 mbarg
Δp desired on the flange: 30 mbar
Installed piping: DN50

Since CO2 gas is not present among the gases on the graphs, it is necessary to convert the CO2 flow into an equivalent air flow. In this way, you can use the vertical axis relating to the air and proceed with the sizing. To do this, you can use the following formula, valid for converting the flow rates of all gases into equivalent air flows.

$$Q_{N\,air\,equiv} = \sqrt{\frac{\rho_{gas}}{\rho_{aria}}} * Q_{N\_gas} = \sqrt{\frac{1.976}{1,293}} * 100 = 123.6\left[\frac{Nm^3}{h}\right]$$

READING FLANGE DIMENSIONS

At this point it is necessary to use the correction coefficient for the pressure of 300mbarg:

$$Q_{N\_selezione} = \left[\frac{Nm^3}{h}\right] = Q_{N\ air\ equiv}\left[\frac{Nm^3}{h}\right] * K_P\,(300mbarg) = 123.6 * 0.906 = 112\left[\frac{Nm^3}{h}\right]$$

Using the selected graph of the calibrated flanges 16POP-S 400OP, intersecting the Normal selection flow rate just calculated with the desired Δp of 30 mbar, we see that the flange that comes closest is the model 16POP-S 400OP-010.

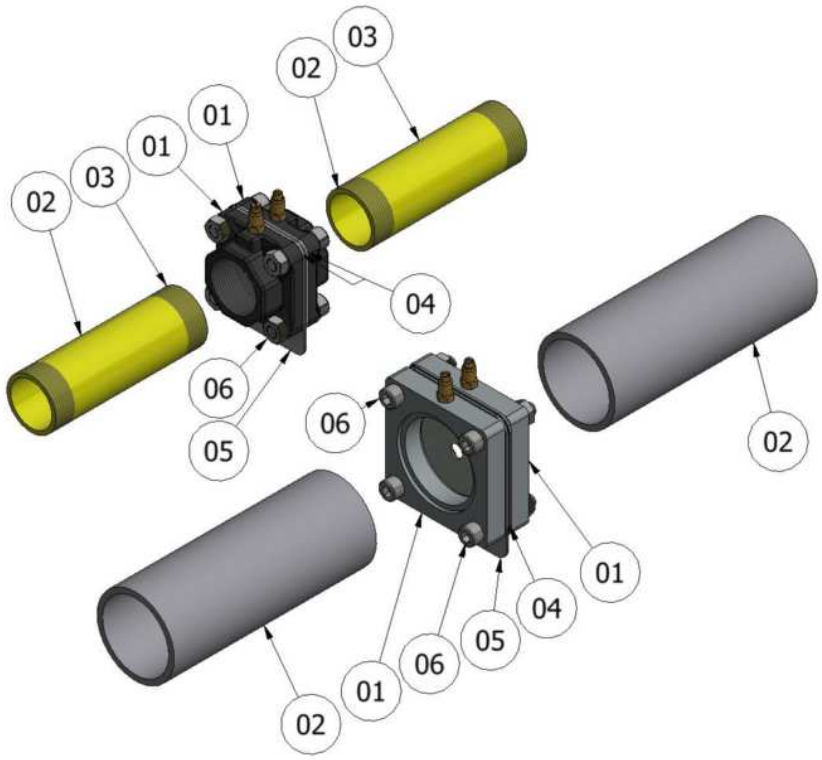
WARNINGS

POP-S flanges are suitable for approximate instant flow measurements; they are not recommended for precision measurements such as readings for electronic ratio adjustment or fuel consumption measurements. Any modification or repair performed by personnel not authorized by the manufacturer compromises the safety of the application and automatically invalidates the general warranty conditions. For correct use, observe the following warnings.

- Make sure that all system features are compatible with the specifications of the calibrated flange: hydraulic connections, type of fluid, operating pressure, flow rate, temperature range, etc...
- Make sure that the pipes are free from dirt or debris, which could obstruct the reading orifice hole.
- Before proceeding with any installation or service operation, close the upstream air/gas flow and disconnect the electrical supplies.
- It is good practice to install a filter upstream of the supply piping.
- Avoid water hammer. Do not damage the sealing surfaces of the flanges.
- Make sure that at the end of any intervention, the pressure points are properly screwed to prevent gas escaping.

- In insulated pipes, check that there is sufficient space for tightening the bolts.
- Check the thermal resistance of the gaskets.
- Pay attention to the exposed hot parts.

POP-S INSTALLATION



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The calibrated flanges of the POP-S series are supplied with gaskets.
The calibrated flange can be installed in a horizontal or vertical position, respecting a straight section of piping upstream and downstream of at least 100mm, taking care not to position the impulse taps on the lower part of the calibrated flange.
Maintenance and installation must be carried out by qualified personnel, in compliance with current regulations.

A Disassemble the flange, making sure to keep the gaskets and the calibrated orifice in place between the two flanges.

B Connect the pipes (**pos.02**) to the flanges (**pos.01**). Depending on the version, the connection can be welded or threaded:
- For threaded connections, use thread sealing paste between the piping and the flange, taking care not to block the sensing taps for pressure measurement.
- For welded connections, perform a tight weld and remove any residue.

C Make sure that no foreign body is present inside the flange (**pos.01**) or in the pipes (**pos.02**) before carrying out the assembly, if necessary remove the impurities.

D Check the correct alignment of the connection pipes (**pos. 02**) and check the correct distance between the pipes and the assembly (flanges **pos.01** / gaskets **pos.04** / orifice **pos.05**), in order to avoid exerting tension on the pipes when tightening the bolts.

E Make sure to install all the components between the two flanges, in order: flange (**pos.01**), gasket (**pos.04**), calibrated orifice (**pos.05**), gasket and flange. Position the calibrated orifice (**pos.05**), possibly keeping the printed words in a direction in which they are easily visible. Insert the bolts (**pos.06**).

F Using suitable tools, progressively screw the bolts (**pos.06**) crosswise, avoiding excessive tightening (refer to the paragraph "Screw tightening sequence on attachment flanges").

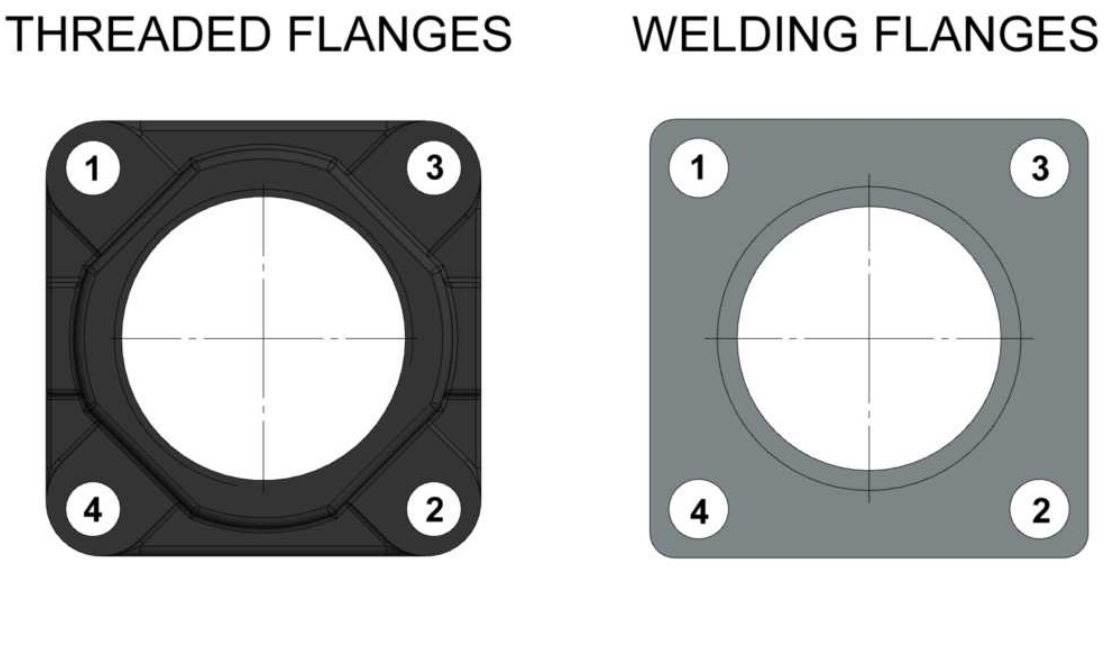
D Perform a leak test to verify the absence of gas leaks.

SEQUENCE OF SCREW TIGHTENING ON ATTACHMENT FLANGES

Tighten the bolts and nuts in a crisscross pattern, using a minimum of three tightening passes and maximum bolt stress as defined in the tables below.

STEP 1: Torque up to a maximum of 30% of the final torque value according to the torque sequence. Make sure the gasket is compressed evenly.
STEP 2: Torque up to a maximum of 60% of the final torque value.
STEP 3: Torque at final torque value (100%).

After completing the three basic torque steps, retighten the nuts at least once using the final torque crosswise until no further nut rotation is observed.



D5720I03

4 bolt flange: 1,2,3,4

DN	PN 0.5	
[mm]	[Nm]	[Ft/lbs]
15/20/25	30	22
32/40/50	50	37
65/80/100	50	37
125/150	70	52

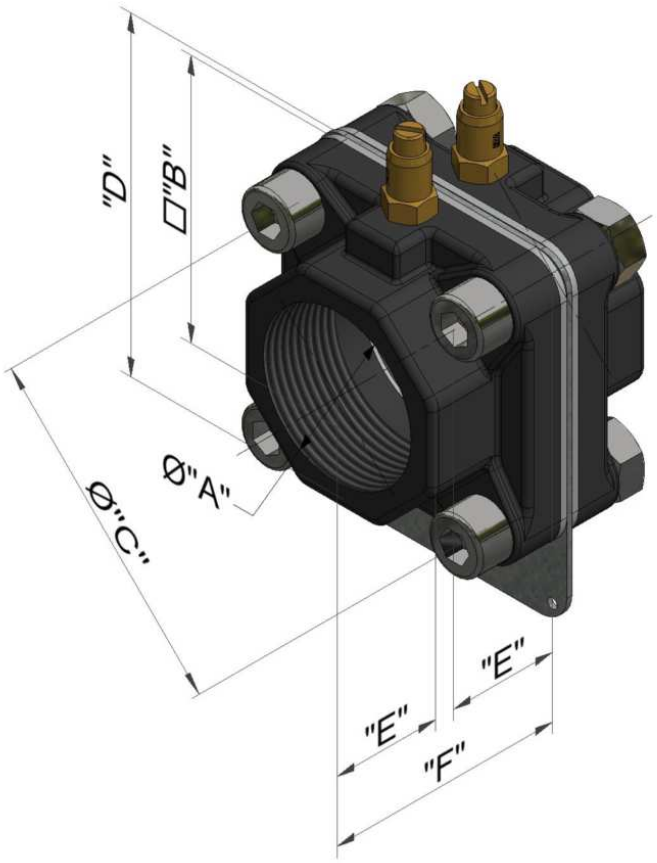
MAINTENANCE

All maintenance operations, due to the short time and working conditions in which they can be carried out, imply a greater risk of errors and accidents and must therefore be carried out after careful and in-depth analysis of the risks for the operators and for the process, making sure all necessary precautions are in place.

Operation	Frequency [months]	Note
Thigtness integrity	12	Check that there are no leaks to the outside with adequate leak detection liquids. In case of replacement, follow the instructions given in the INSTALLATION paragraph.
Bolt tightening	12	6 months in vibration applications.
Sealing of impulse sockets	6	Check the integrity and tightness of the sockets.

Component	Useful life [years]	Command cycles
Valve tightness control systems	10	250.000
Pressure switches	10	N/A
Burner control device	10	250.000
UV flame sensor / electrodes	10.000 operating hours	
Gas regulators	10	N/A
Solenoid valves	10	250.000
Relief valve	10	N/A
Regolation valve	10	N/A
Regulators	10	N/A
Servomotors	10	N/A

POP-S OVERALL DIMENSIONS - THREADED MODEL



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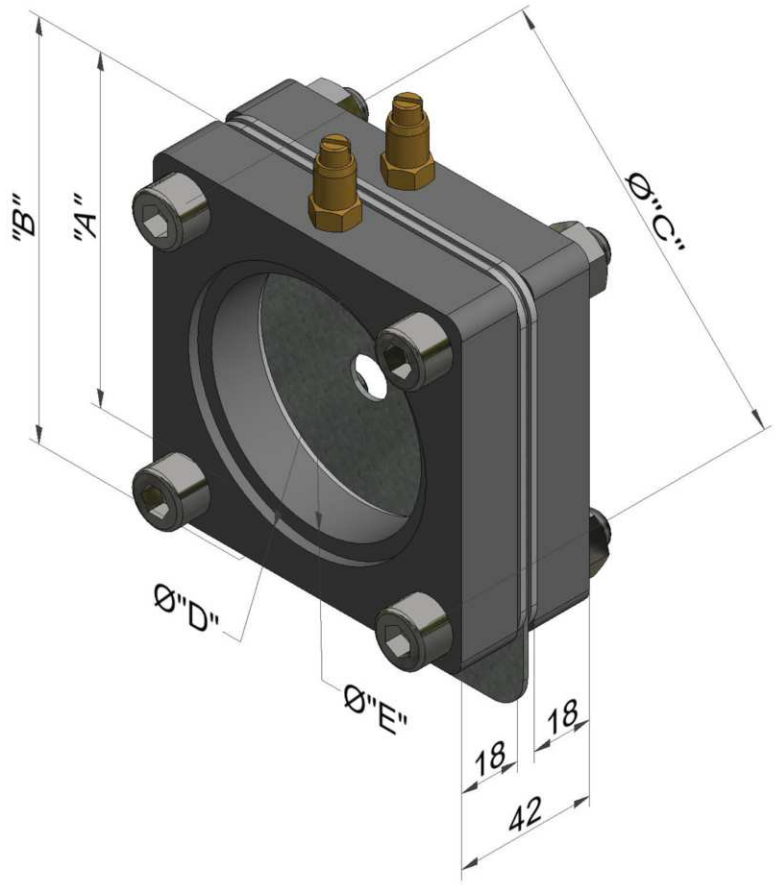
Model	Ø "A" (*)	□ "B"		Ø "C"		"D"		"E"		"F"		Mass	
		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[Kg]	[lbs]
3 POP-S	G 3/8"	60	*2.36*	60,3	*2.37*	79	*3.11*	21	*0.83*	48	*1.89*	1,0	*2.20*
4 POP-S	G 1/2"	60	*2.36*	60,3	*2.37*	79	*3.11*	21	*0.83*	48	*1.89*	0,9	*1.98*
6 POP-S	G 3/4"	60	*2.36*	60,3	*2.37*	79	*3.11*	21	*0.83*	48	*1.89*	0,8	*1.76*
8 POP-S	G 1"	60	*2.36*	60,3	*2.37*	79	*3.11*	21	*0.83*	48	*1.89*	0,8	*1.76*
10 POP-S	G 1.1/4"	76,2	*3.00*	81	*3.19*	95	*3.74*	30,5	*1.20*	67	*2.64*	1,3	*2.87*
12 POP-S	G 1.1/2"	76,2	*3.00*	81	*3.19*	95	*3.74*	30,5	*1.20*	67	*2.64*	1,1	*2.43*
16 POP-S	G 2"	87,3	*3.44*	96,8	*3.81*	107	*4.21*	30,5	*1.20*	67	*2.64*	1,5	*3.31*

(*) NPT thread on request

POP-S OVERALL DIMENSIONS - FLANGED MODEL



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Model	hose connections Ø	"A"		"B"		Ø"C"		Ø"D"		Ø "E"		Mass	
		[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[Kg]	[lbs]
20 POP-S	2.1/2	100	*3.94*	122	*4.80*	111,1	*4.37*	77	*3.03*	68	*2.68*	2,0	*4.41*
24 POP-S	3"	110	*4.33*	130	*5.12*	123,8	*4.87*	90	*3.54*	80	*3.15*	2,4	*5.29*
32 POP-S	4"	150	*5.91*	172	*6.77*	168,1	*6.62*	115	*4.53*	106	*4.17*	4,4	*9.70*
40 POP-S	5"	200	*7.87*	222	*8.74*	235	*9.25*	142	*5.59*	133	*5.24*	8,0	*17.64*
48 POP-S	6"	200	*7.87*	222	*8.74*	235	*9.25*	170	*6.69*	157	*6.18*	8,5	*18.74*

ORDERING CODE

	POP-S	-		-		-	
01			02		03		04

PIPE DIMENSIONS	cod. 01
3/8”	**3**
1/2”	**4**
3/4”	**6**
1”	**8**
1.1/4”	**10**
1.1/2”	**12**
2”	**16**
2.1/2”	**20**
3”	**24**
4”	**32**
5”	**40**
6”	**48**

02 MATERIAL	cod.
Standard	**//**
AISI304	**S4**
AISI316	**S6**

03 CONNECTION	cod.
BSP thread	**B**
NPT thread	**N**
To weld	**W**

04 CALIBRATED INSERT	cod.
	100OP-010
	100OP-020
	.....
	800OP-080

ESA contacts

The information contained herein is offered for use by technically qualified personnel at their discretion and risk without warranty of any kind.

We regularly update our data, for updated data please visit our web site www.esapyronics.com

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