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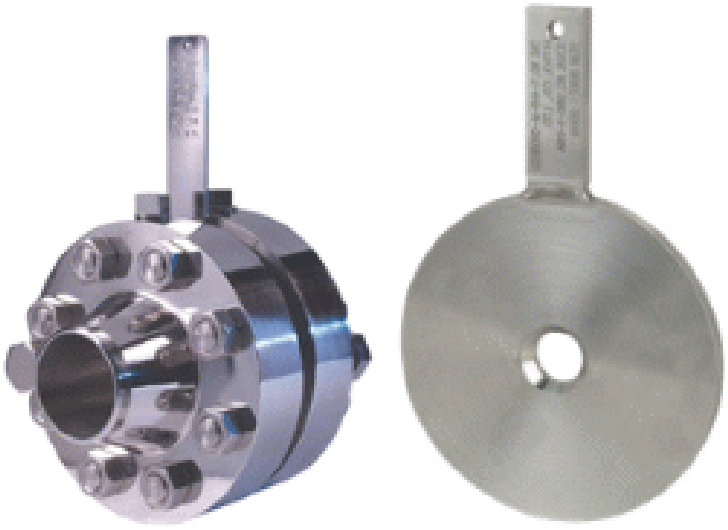
INSTRUCTION MANUAL

DIFFERENTIAL PRESSURE FLOW MEASURING ORIFICE

HOF / HOP Series



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You shall be well-informed of the contents where WARNING is marked before carrying out the work.

You shall be careful where CAUTION is marked to carry out the work.

You shall be aware of where NOTICE is marked to carry out the work.

Summary

This section briefly explains each chapter in this manual.
In *Installation* section, it explains the check points before installation and direction for installation, location selection, and installation method for Measuring Orifice of HOF/HOP Series.
In *Inspection & Maintenance* section, it explains the checkup of the connection parts after installation, and maintenance method of Measuring Orifice of HOF/HOP Series.

Installation

Below information is for the direction for installation, location selection, and installation method of measuring orifice (HOF/HOP Series).

1. Warning

Failure to install in accordance with the instructions in this manual may result in system accidents and serious injury. Therefore, skilled workers shall perform the installation after well informing of this manual.

2. Check Points before Installation

The following is a brief description to installation the HOP/HOF Series. If the flange union is already installed, check whether flange's size and pressure rating are the same as those listed in the orifice handle and start from the middle step of the installation.

- Decide where to install the HOP/HOF Series on the pipeline.
- Decide the direction of orifice installation subject to service condition
- Determine the proper straight length refer to [Table 1] of *Straight Length Requirements* section.
- Check the installation configuration of the orifice.
- Install the orifice plate and hardware in accordance with *Installation of Hardware* section.
- Check if there is any leakage of fluid.

3. Precautions for receiving inspection

The following points shall be surely checked after receiving of instrument.

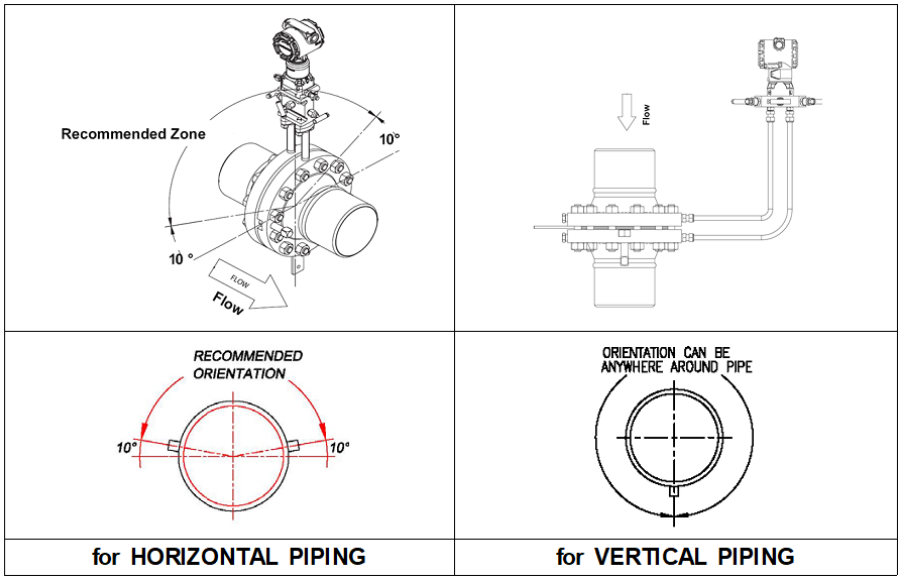
- Check the specification of received product as same as ordered specification.
- Make sure the inner diameter of the pipeline for installation shall be same as pipe I.D which described on the nameplate of orifice.
- Carefully check any damage on the orifice during the transportation.

4. Installation Configuration

The orifice shall be installed by selecting proper direction according to counter pipe and measured fluid.

■ Gas Applications

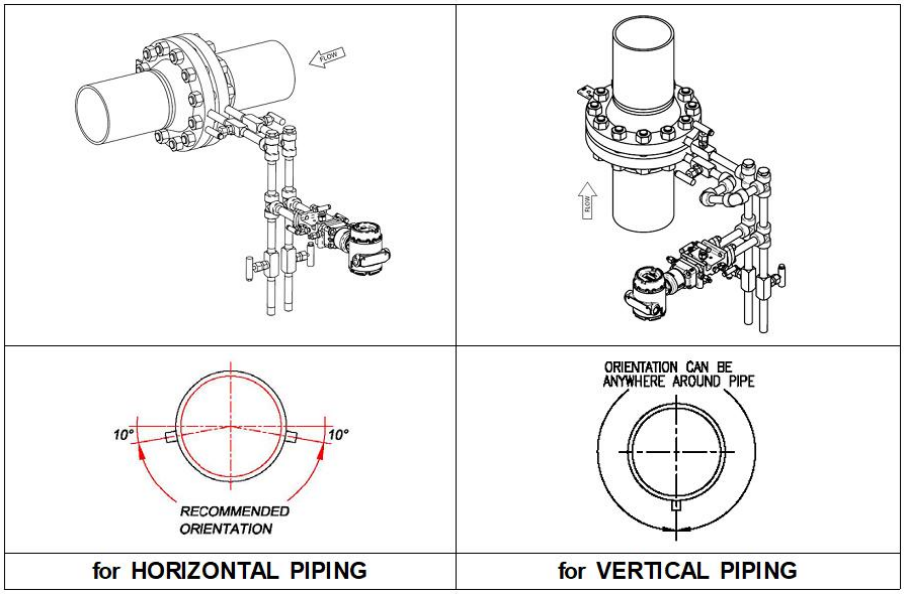
Please adjust the direction of pressure taps to the recommend direction of below <Figure 1>, and install the differential pressure transmitter above orifice element. Also, the drain hole of the orifice plate shall be located at the bottom of pipe in order to drain the condensate water.



<Figure 1>

■ Liquid Applications

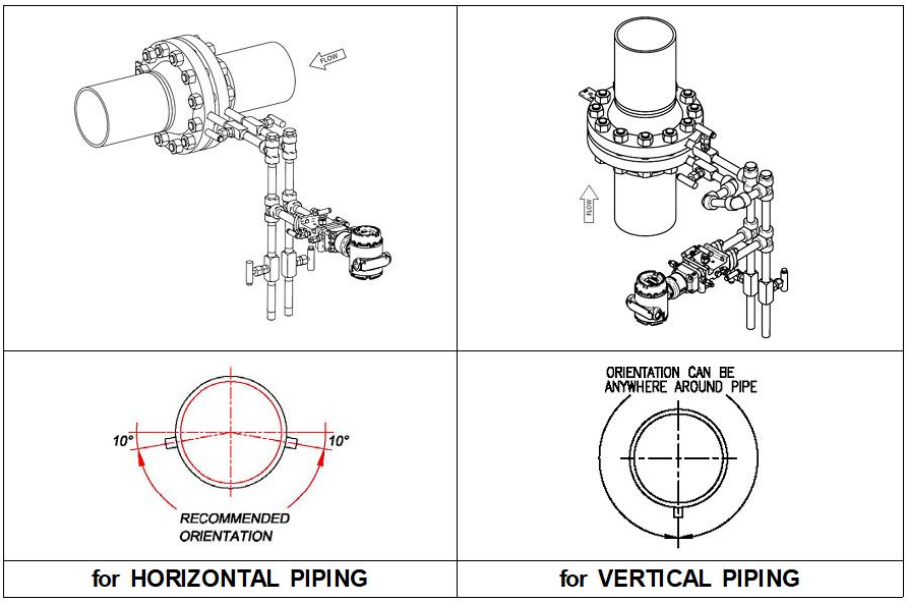
Please adjust the direction of pressure taps to the recommend direction of below <Figure 2>, and install the differential pressure transmitter below orifice element. Also, the drain hole of the orifice plate shall be located at the top of pipe in order to drain the bubble.



<Figure 2>

■ Steam Applications

Please adjust the direction of pressure taps to the recommend direction of below <Figure 3>, and install the differential pressure transmitter below orifice element. Also, the drain hole of the orifice plate shall be located at the bottom of pipe in order to drain the condensate water.



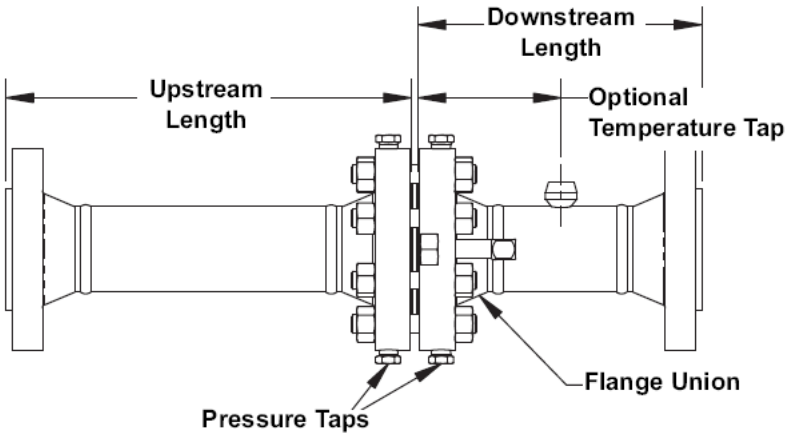
<Figure 3>

■ Others

- The flow conditioners or straighteners shall be installed at upstream of orifice.
- It shall be installed that inlet of orifice handle shall be directed and forwarded to the upstream.

5. Straight Length Requirements

In order to accurately measure the flow rate using an orifice, the minimum straight length as shown in below <Figure 4> is required under the condition that the medium is full and flows in the pipeline. Refer to below <Table 1> and <Table 2> to determine the straight length to be secured, and if the ratio of upstream and downstream is shorter, it shall be contacted us to determine a better accurate installation point.



<Figure 4>

■ In case already installed the flow conditioners or straighteners at upstream (ISO-5167-2:2003)

Table 4 — Permitted range of straight lengths between an orifice plate and a 19-tube bundle flow straightener (1998) downstream of fittings located at a distance, L_f, from the orifice plate

Values expressed as multiples of internal diameter, D

Diameter ratio β	Single 90° bend [b]				Two 90° bends [b] in perpendicular planes ($2D \geqslant S$) [a]				Single 90° tee				Any fitting			
	$30 > L_f \geqslant 18$		$L_f \geqslant 30$		$30 > L_f \geqslant 18$		$L_f \geqslant 30$		$30 > L_f \geqslant 18$		$L_f \geqslant 30$		$30 > L_f \geqslant 18$		$L_f \geqslant 30$	
1	2		3		4		5		6		7		8		9	
—	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]	A [c]	B [d]
$\leqslant 0,2$	5 to 14,5	1 to n [e]	5 to 25	1 to n [e]	5 to 14,5	1 to n [e]	5 to 25	1 to n [e]	5 to 14,5	1 to n [e]	1 to 25	1 to n [e]	5 to 11	1 to n [e]	5 to 13	1 to n [e]
0,4	5 to 14,5	1 to n [e]	5 to 25	1 to n [e]	5 to 14,5	1 to n [e]	5 to 25	1 to n [e]	5 to 14,5	1 to n [e]	1 to 25	1 to n [e]	5 to 11	1 to n [e]	5 to 13	1 to n [e]
0,5	11,5 to 14,5	3 to n [e]	11,5 to 25	3 to n [e]	9,5 to 14,5	1 to n [e]	9 to 25	1 to n [e]	11 to 13	1 to n [e]	9 to 23	1 to n [e]	f g	3 to n [e]	11,5 to 14,5	3 to n [e]
0,6	12 to 13	5 to n [e]	12 to 25	5 to n [e]	13,5 to 14,5	6 to n [e]	9 to 25	1 to n [e]	f h	7 to n [e]	11 to 16	1 to n [e]	f	7 to n [e]	12 to 16	6 to n [e]
0,67	13	7 to n [e]	13 to 16,5	7 to n [e]	13 to 14,5	7 to n [e]	10 to 16	5 to n [e]	f	8 to n [e]	11 to 13	6 to n [e]	f	8 to 10	13	7 to n-1,5 [e]
0,75	14	8 to n [e]	14 to 16,5	8 to n [e]	f	9,5 to n [e]	12 to 12,5	8 to n [e]	f	9 to n [e]	12 to 14	7 to n [e]	f	9,5	f	8 to 22
Recommended	13 for $\beta \leqslant 0,67$	13 for $\beta \leqslant 0,75$	14 to 16,5 for $\beta \leqslant 0,75$	14 to 16,5 for $\beta \leqslant 0,75$	13,5 to 14,5 for $\beta \leqslant 0,67$	13,5 to 14,5 for $\beta \leqslant 0,75$	12 to 12,5 for $\beta \leqslant 0,75$	12 to 12,5 for $\beta \leqslant 0,75$	13 for $\beta \leqslant 0,54$	13 for $\beta \leqslant 0,75$	12 to 13 for $\beta \leqslant 0,75$	12 to 13 for $\beta \leqslant 0,75$	9,5 for $\beta \leqslant 0,46$	9,5 for $\beta \leqslant 0,75$	13 for $\beta \leqslant 0,67$	13 for $\beta \leqslant 0,75$

NOTE The straight lengths given in the table are the permitted lengths between the downstream end of a 19-tube bundle flow straightener (1998) (as described in 6.3.2.1) and the orifice plate given that a particular fitting is installed upstream of the 19-tube bundle flow straightener (1998) at a distance L_f from the orifice plate. The distance L_f from the orifice plate is measured to the downstream end of the curved portion of the nearest (or only) bend or of the tee or the downstream end of the curved or conical portion of the reducer or expander. The recommended values give tube bundle locations that are applicable over a specified range of β.

a S is the separation between the two bends measured from the downstream end of the curved portion of the upstream bend to the upstream end of the curved portion of the downstream bend.

b Bends should have a radius of curvature equal to $1,5D$.

c Column A for each fitting gives lengths corresponding to "zero additional uncertainty" values (see 6.3.2.3.2).

d Column B for each fitting gives lengths corresponding to "0,5 % additional uncertainty" values (see 6.3.2.3.3).

e n is the number of diameters such that the upstream end of the 19-tube bundle flow straightener (1998) is situated $1D$ from the downstream end of the curved or conical portion of the nearest fitting. It is desirable that the length between the upstream end of the 19-tube bundle flow straightener (1998) and the downstream end of the curved or conical portion of the nearest fitting should be at least $2,5D$, except where this would not give an acceptable value for the distance between the orifice plate and the downstream end of the 19-tube bundle flow straightener (1998).

f It is not possible to find an acceptable location for a 19-tube bundle flow straightener (1998) downstream of the particular fitting for all values of L_f to which the column applies.

g If $\beta = 0,46$ a value of 9,5 is possible.

h If $\beta = 0,54$ a value of 13 is possible.

<Table 1>

■ In case the flow conditioners or straighteners are not installed

Table 3 — Required straight lengths between orifice plates and fittings without flow conditioners

Values expressed as multiples of internal diameter, D

Diameter ratio β	Upstream (inlet) side of orifice plate																				Downstream (outlet) side of the orifice plate	
	Single 90° bend Two 90° bends in any plane ($S > 30D$) [a]		Two 90° bends in the same plane: S-configuration ($30D \geqslant S > 10D$) [a]		Two 90° bends in the same plane: S-configuration ($10D \geqslant S$) [a]		Two 90° bends in perpendicular planes ($30D \geqslant S \geqslant 5D$) [a]		Two 90° bends in perpendicular planes ($5D > S$) [a, b]		Single 90° tee with or without an extension Mitre 90° bend		Single 45° bend Two 45° bends in the same plane: S-configuration ($S \geqslant 2D$) [a]		Concentric reducer $2D$ to D over a length of $1,5D$ to $3D$		Concentric expander $0,5D$ to D over a length of D to $2D$		Full bore ball valve or gate valve fully open		Abrupt symmetrical reduction		Thermometer pocket or well [c] of diameter $\leqslant 0,03D$ [d]		Fittings (columns 2 to 11) and the densitometer pocket	
1	2		3		4		5		6		7		8		9		10		11		12		13		14	
—	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]	A [e]	B [f]
$\leqslant 0,20$	6	3	10	g	10	g	19	18	34	17	3	g	7	g	5	g	6	g	12	6	30	15	5	3	4	2
0,40	16	3	10	g	10	g	44	18	50	25	9	3	30	9	5	g	12	8	12	6	30	15	5	3	6	3
0,50	22	9	18	10	22	10	44	18	75	34	19	9	30	18	8	5	20	9	12	6	30	15	5	3	6	3
0,60	42	13	30	18	42	18	44	18	65 [h]	25	29	18	30	18	9	5	26	11	14	7	30	15	5	3	7	3,5
0,67	44	20	44	18	44	20	44	20	60	18	36	18	44	18	12	6	28	14	18	9	30	15	5	3	7	3,5
0,75	44	20	44	18	44	22	44	20	75	18	44	18	44	18	13	8	36	18	24	12	30	15	5	3	8	4

NOTE 1 The minimum straight lengths required are the lengths between various fittings located upstream or downstream of the orifice plate and the orifice plate itself. Straight lengths shall be measured from the downstream end of the curved portion of the nearest (or only) bend or of the tee or the downstream end of the curved or conical portion of the reducer or the expander.

NOTE 2 Most of the bends on which the lengths in this table are based had a radius of curvature equal to $1,5D$.

a S is the separation between the two bends measured from the downstream end of the curved portion of the upstream bend to the upstream end of the curved portion of the downstream bend.

b This is not a good upstream installation; a flow conditioner should be used where possible.

c The installation of thermometer pockets or wells will not alter the required minimum upstream straight lengths for the other fittings.

d A thermometer pocket or well of diameter between $0,03D$ and $0,13D$ may be installed provided that the values in Columns A and B are increased to 20 and 10 respectively. Such an installation is not, however, recommended.

e Column A for each fitting gives lengths corresponding to "zero additional uncertainty" values (see 6.2.3).

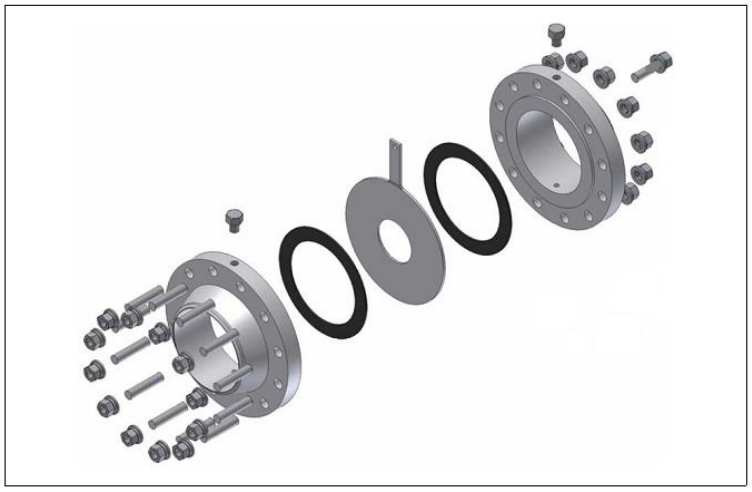
f Column B for each fitting gives lengths corresponding to "0,5 % additional uncertainty" values (see 6.2.4).

g The straight length in Column A gives zero additional uncertainty; data are not available for shorter straight lengths which could be used to give the required straight lengths for Column B.

h $95D$ is required for $Re_D > 2 \times 10^6$ if $S < 2D$.

<Table 2>

6. Installation of Hardware



<Figure 5>

- Install the orifice and flange in the order shown in <Figure 5>.
- In order to install the orifice, it shall be completely remove the pressure in the pipe and drain all.
- All assembly shall be performed after cleaning to prevent impurities from entering.
- After check the inlet mark of the orifice handle, it shall be matched with fluid flow in the pipeline.
- According to the *Installation Configuration* section, determined the direction of pressure tap, vent and/or drain hole, and install it in a position considering the minimum straight length require in the *Required Minimum Straight Pipe Length* section.

Inspection & Maintenance

1. Inspection of Connection Parts

- Check whether the installation is carried out against service condition according to the *Installation Configuration* section
- Check whether the straight length is sufficiently secured according to the *Required Minimum Straight Pipe Length* section.
- Check whether the connection parts such like flange, pressure pipe line, 3-way-valve, differential pressure transmitter, etc. are correctly connected.
- Check if there is a leakage after allowing of the fluid to flow in the pipeline.

2. Maintenance

- Regularly check if the pressure tap is clogged with foreign substances.
- Regularly check if the air bubbles or condensate water are discharged through vent or drain hole.
- Regularly check if the bore value of orifice is changed caused by erosion or abrasion.
- Regularly check if the foreign substances accumulated on the upstream of the orifice affect the pipe I.D (inside diameter).

Warranty & Contact

■ Warranty and Service

This product is subject to the warranty for 2 years of shipments and unpaid service will be provided for any damage found under normal operating conditions. If it is not about the failure of product, the service charge will be payable.
You can request A/S at our website or by contacting our headquarters.

■ Headquarters . Factory . Laboratory Contact Number

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