

**Differential Pressure
Detectors
(Meter Bodies)
For PREX3000 Series
and KF-B Series**

User's Manual

Azbil Corporation

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DESCRIPTION

1. GENERAL

The differential pressure detector (meter body) accepts a differential pressure through its high and low pressure connection ports, converts the differential pressure into a torque force by its center section to which the high and low pressures are applied through respective diaphragms, and feeds a torque via its torque tube to a pneumatic transmitter (Model KDP) or a pneumatic controller (Model KFDB).

Some models of detectors have a flange incorporated with diaphragm for connection of the high pressure line.

2. MODELS

Measured Pressures or Type of Instrument	Model Numbers of Instruments Used in Conjunction	Operator's Manual Used in Conjunction
Standard Type, High/Medium Differential Pressures	Models KDP11/22 Models KFDB11/22	OM2-5220-1101 (KDP) OM2-6220-0000 (KFDB)
Standard Type, Low Differential Pressures	Model KDP33 Model KFDB33	
Standard Type, Very Low Differential Pressures	Model KDP44 Model KFDB44	
Flange Type	Models KDP61/62 Models KFDB61/62	
Remote-sealed diaphragm Type	Models KDP71/72 Models KFDB71/72	
High Working Pressure Type	Models KDP81/82 Models KFDB81/82	

3. INSTRUCTIONS FOR INSTRUMENTS (TRANSMITTERS AND CONTROLLERS) USED IN CONJUNCTION

For the instructions for instruments used in conjunction, refer to respective Operator's Manuals which cover the operating principles, service and unit replacement procedures, and calibration and adjustment procedures of these instruments.

STRUCTURES OF METER BODIES

1. EXTERNAL VIEWS

Although external views of meter bodies differ by models as shown in Figure 1, the bracket mounting section and instrument connection section are identical for models 11/22, 71/72, and for models 33/44, 81/82.

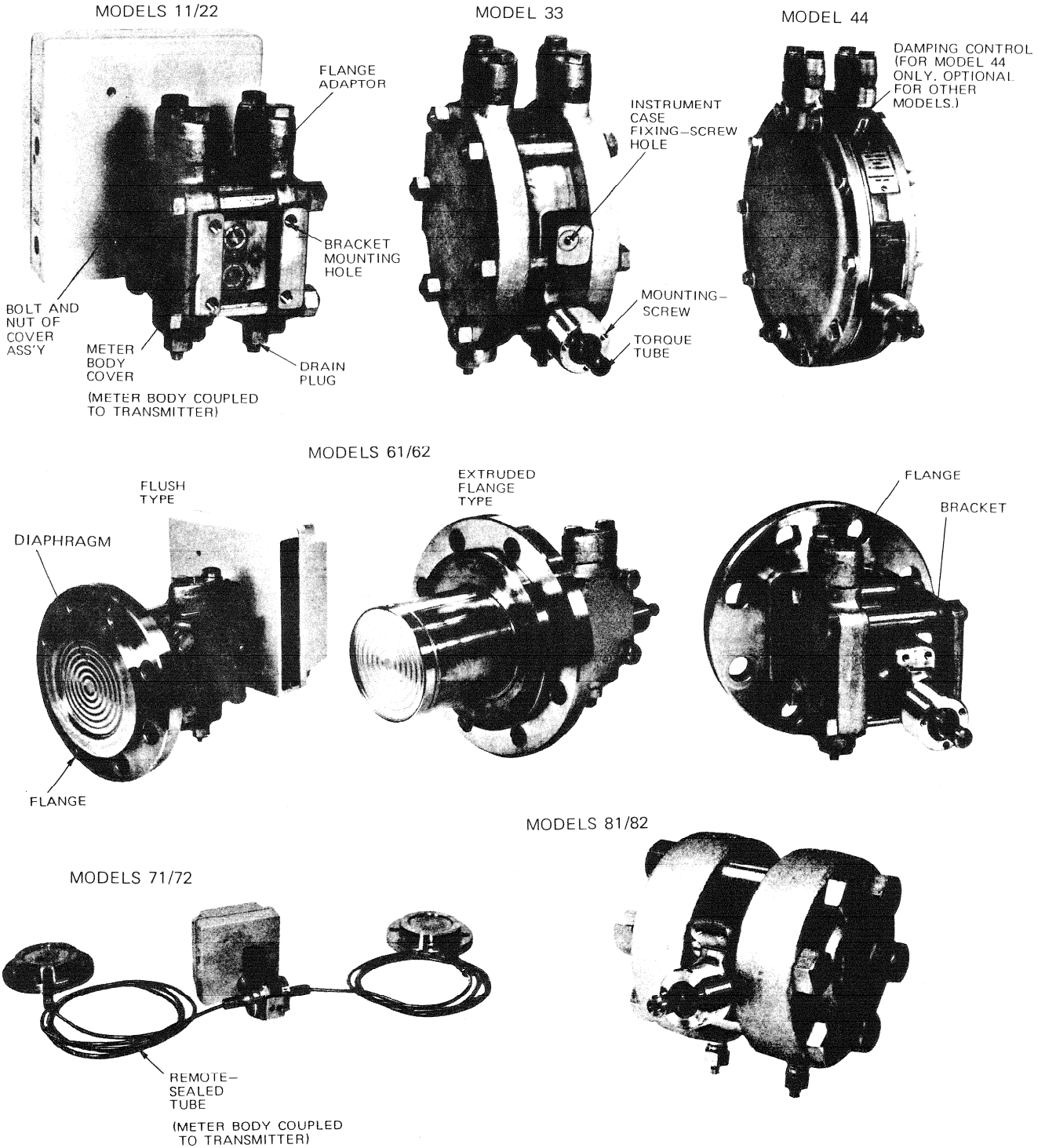


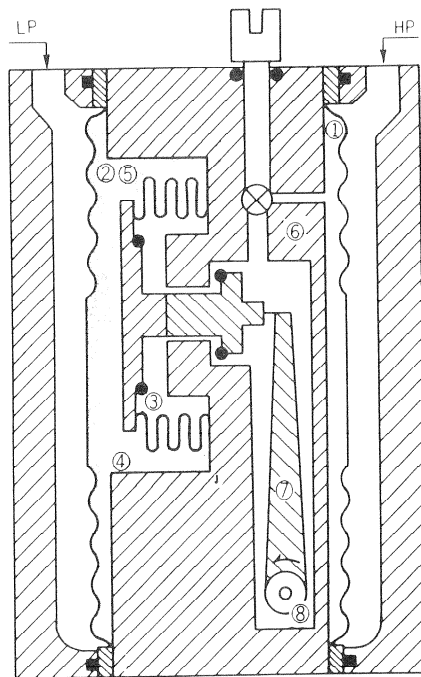
Figure 1. External Views of Meter Bodies

2. STRUCTURES AND OPERATING PRINCIPLES

The structures and operating principles of the meter bodies are covered in this section.

2.1 Models 11/12, 33, and 81/82

- (a) The high and low process pressures (HP and LP) are fed via diaphragms (1) and (2) to the center section (oil filled section) of the meter body. The HP acts on the differential pressure detecting bellows from the right hand side (3) and the LP from the left hand side (4). When in the equilibrium state (zero differential pressure state), identical forces are exercised on both sides of the differential pressure detecting bellows (5).
- (b) As the pressure of the HP side rises thereby increasing the differential pressure, the differential pressure detecting bellows moves leftward. The movement of the bellows is fed as a torque via the torque arm to the beam of the transmitter.

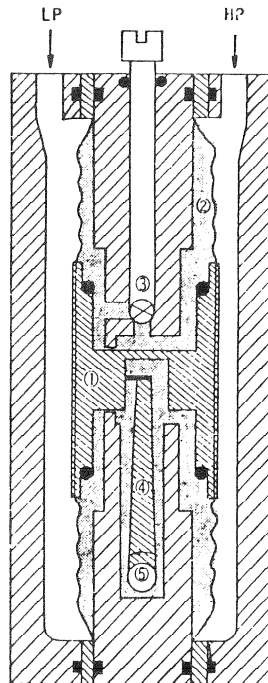


- 1 HP SEAL DIAPHRAGM
- 2 LP SEAL DIAPHRAGM
- 3 LIQUID FILL OF HP SIDE
- 4 LIQUID FILL OF LP SIDE
- 5 DIFFERENTIAL PRESSURE DETECTING BELLOWS
- 6 DAMPING CONTROL (OPTIONAL)
- 7 TORQUE ARM
- 8 TORQUE TUBE

Figure 2. Operating Principle of Meter Body

2.2 Model 44

- (a) The high and low process pressures (HP and LP) are fed via the diaphragms and supports (1) to the center section (silicone filled section) (2) of the meter body. The HP acts on the pressure detecting diaphragm from the right hand side and the LP from the left hand side. When in the equilibrium state (zero differential pressure state), identical forces are exercised on both sides of the differential pressure detecting diaphragm.
- (b) As the pressure of the HP side rises, the support moves leftward. The liquid fill flows through the damping control (3). The movement of the diaphragm is fed as a torque via the torque arm (4) to the beam of the transmitter (5).

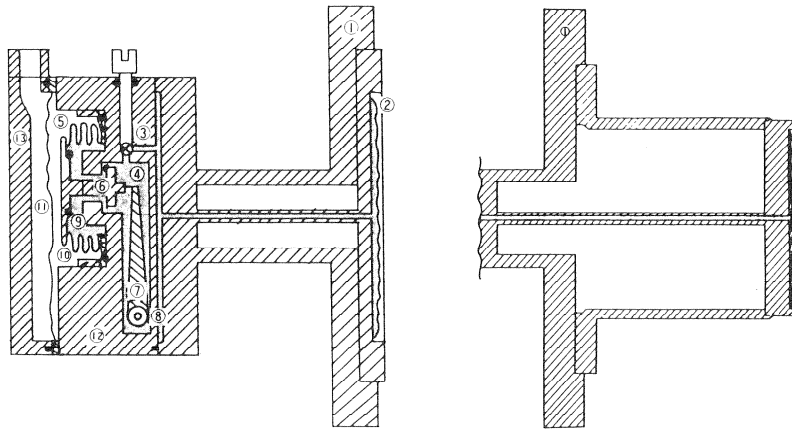


- 1 DIAPHRAGM AND SUPPORT
- 2 LIQUID FILL
- 3 DAMPING CONTROL
- 4 TORQUE ARM
- 5 TORQUE TUBE

Figure 3. Operating Principle of Meter Body

2.3 Models 61/62

- (a) The high and low process pressures (HP and LP) are fed via diaphragms (2) and (11) to the center section (silicone filled section) of the meter body. A pressure which is proportional to the liquid head in the process vessel is fed via the seal diaphragm (2) and liquid fill to the bellows (5) at the center section of the meter body.
- (b) The bellows (5) moves in proportion to the liquid head pressure. The movement of the bellows is fed as a torque via the plunger (6) and torque arm (7) to the beam of the transmitter.



Flush Diaphragm

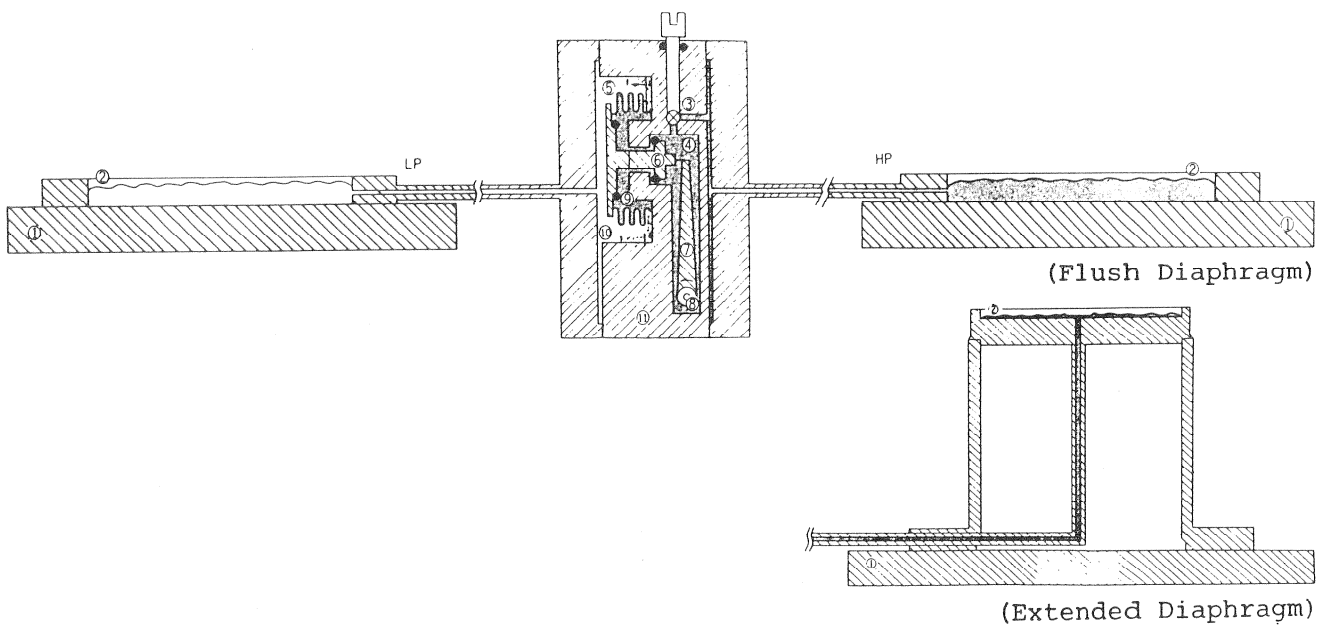
Extended Diaphragm

- | | | | |
|---|----------------------------|----|---------------------------|
| 1 | PROCESS CONNECTION FLANGE | 8 | TORQUE TUBE |
| 2 | SEAL DIAPHRAGM | 9 | OVERLOAD SEAL |
| 3 | DAMPING CONTROL (OPTIONAL) | 10 | LP LIQUID FILL (SILICONE) |
| 4 | HP LIQUID FILL (SILICONE) | 11 | SEAL DIAPHRAGM |
| 5 | BELLOWS | 12 | CENTER BODY |
| 6 | PLUNGER | 13 | LP COVER |
| 7 | TORQUE ARM | | |

Figure 4. Operating Principle of Meter Body

2.4 Models 71/72

- (a) The high and low process pressures (HP and LP) are fed via diaphragms (2) to the center section (silicone filled section) (11) of the meter body. The HP is fed via the seal diaphragm (2) and liquid fill (4) to the bellows (5) at the center section of the meter body. The LP is fed via the seal diaphragm (2) and liquid fill (10) to the bellows (5).
- (b) The bellows (5) moves in proportion to the differential pressure between HP and LP. The movement of the bellows is fed as a torque via the torque rod (8) to the beam of the transmitter.



- | | | | |
|---|---------------------------|----|---------------------------|
| 1 | PROCESS CONNECTION FLANGE | 7 | TORQUE ARM |
| 2 | SEAL DIAPHRAGM | 8 | TORQUE ROD |
| 3 | DAMPING CONTROL | 9 | OVERLOAD SEAL |
| 4 | HP LIQUID FILL (SILICONE) | 10 | LP LIQUID FILL (SILICONE) |
| 5 | BELLOWS | 11 | CENTER BODY |
| 6 | PLUNGER | | |

Figure 5. Operating Principle of Meter Body

INSTALLATION

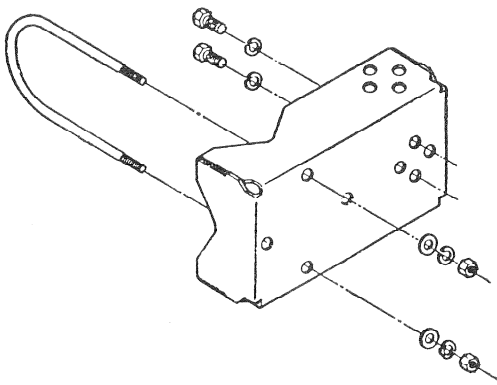
1. GENERAL

The meter body (detector), together with the instrument (transmitter) coupled to it, can be installed on a 50-mm pipe stanchion by using the accessory bracket and U-shape bolt.

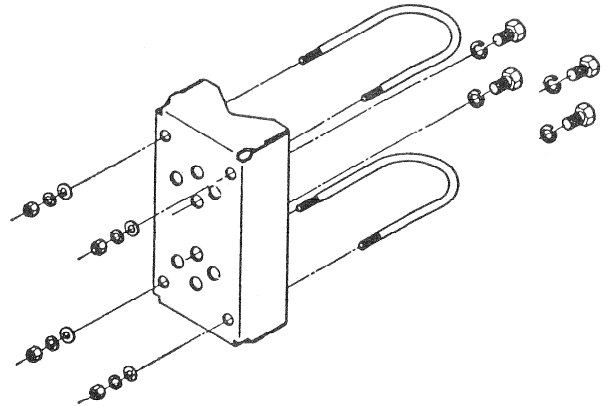
Model 61/62 meter body can be installed simply by fixing its flange to the process.

2. BRACKET AND BOLTS

There are two types of mounting brackets. The bracket and bolts for installation are supplied accompanying each meter body.



For 11/22 and 71/72 Models



For 33, 44 and 81/82 Models

Figure 6. Mounting Brackets

3. PLACE OF INSTALLATION

When selecting a place of installation for the instrument, take into consideration the matters related to instrument inspection, maintenance, longevity, and operation safety as follows:

- (1) Select a place where temperature change is small (within the limits of -30°C to $+80^{\circ}\text{C}$). Avoid a place where the instrument is exposed to high temperature by radiation from a source of heat.

When water is measured, pay attention to freezing which may cause damage to the meter body. Provide appropriate means to guard against freezing.

- (2) Select a place where is reasonably free from humidity and vibration.
- (3) Be sure to provide spaces for inserting a screwdriver for adjustment and span change.

4. INSTALLATION METHOD

Install the meter body in such attitude that its diaphragm or bellows planes are made vertical.

4.1 Installation of Regular-type Meter Body

The meter body, together with the transmitter coupled to it, can be installed in either one of the following methods:

- o Pipe stanchion mount
- o process pipe mount

In either case, fix the meter body to a 50 mm vertical or horizontal pipe using the mounting bracket and U-shape bolt. Fix the pipe securely to a foundation so that the pipe does not sway. (See Figure 8)

To install the meter body on a process pipe line, prepare brackets for mounting the 50-mm pipe to the process pipe. (See Figure 7)

When installing a remote-sealed type of meter body, exercise care not to sharply bend or twist the capillary tube and not to damage the diaphragm.

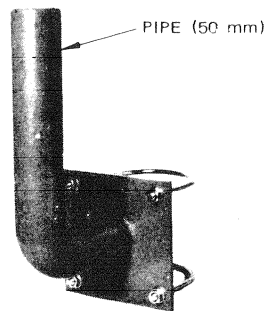


Figure 7. Example of Line Mount Bracket

Note: When installing the transmitter (meter body) on a 50-mm pipe, note that the order of mountings (transmitter, bracket, and 50 mm pipe) differs depending on the mounting direction.

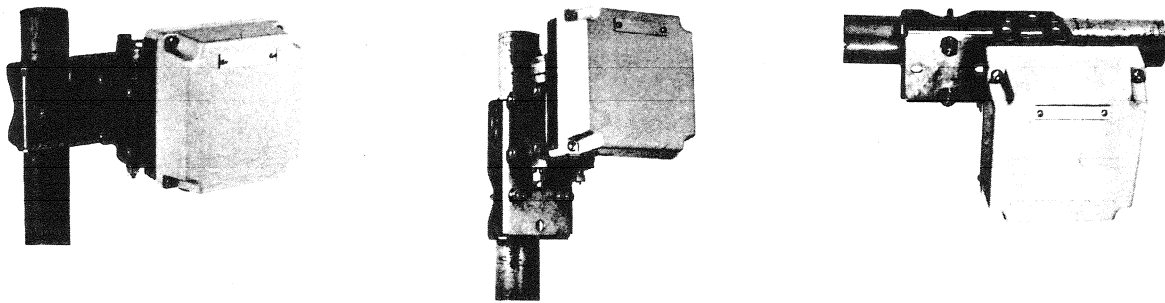


Figure 8. Installation Examples

4.2 Installation of Model 61/62/71/72

Connect the detector flange to a process flange*. Tighten the bolts uniformly. The center of the flange represents the zero point of the liquid level. (See Figure 10.) If the zero point is raised, the head increases by a corresponding amount.

* Flange gaskets are to be prepared by customer. When using a semi metallic gasket or a rubber gasket, select an one whose shape is such that it will not be brought into contact with the detector diaphragm (95 mm dia.).

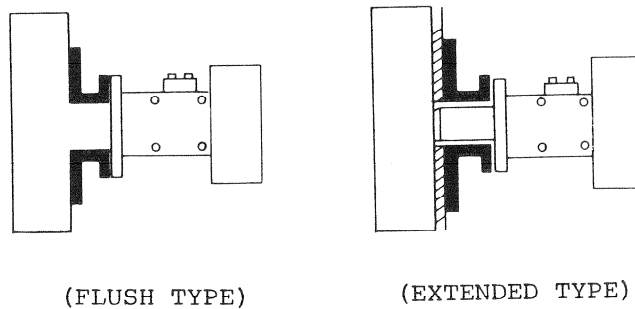


Figure 9. Connection to Process Vessel

4.3 Mounting Attitude

When the meter body is incorporated with a vent provision, install it in such attitude that vent can be fully done. Entrapped drain and other foreign matter remaining in the meter body will adversely affect measurement.

It is ideal to install the meter body so that its diaphragm or bellows planes are made vertical.

After installation is over, perform ZERO adjustment*.

* Refer to the section for calibration.

When a diaphragm pressure receiver type of meter body (Models 61/62, 71/72) is used for liquid level measurement, the zero point will be as shown in Figure 10. Calculate the output referring to the dimensions and calibrate the instrument accordingly.

Note: For the portion from the minimum liquid level (0% level) to a height of 25 mm, the output is not linearly proportional to the liquid level.

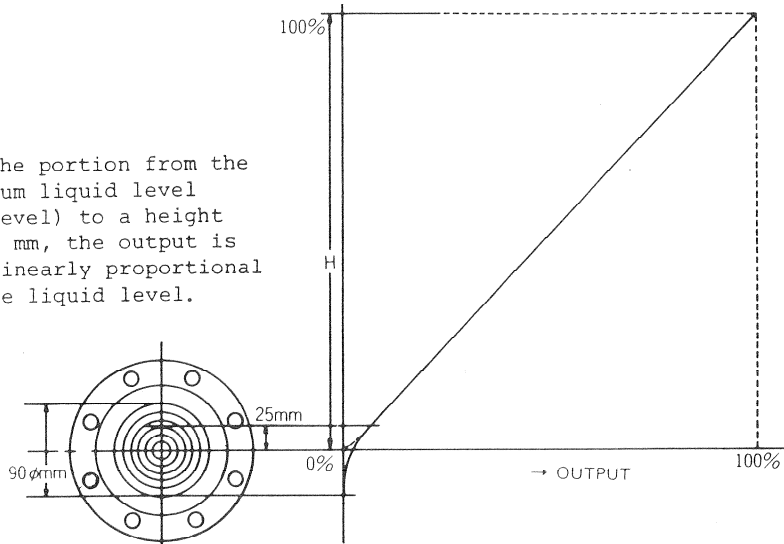


Figure 10. Zero Point of Diaphragm

Note: For the portion from the minimum liquid level (0% level) to a height of 25 mm, the output is not linearly proportional to the liquid level.

5. PRESSURE PIPING

5.1 Models 11/22/33/44/81/82

- (1) Piping method (tapping pressure connection method) may differ depending on the installation position of the instrument and the conditions of the process pipe line. In general, a manifold piping method or a manifold valve method is used. (The manifold valve is available as an option.)

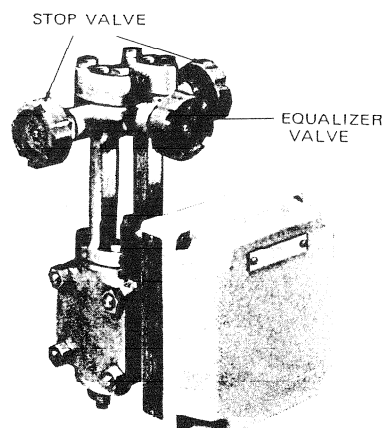


Figure 11. Manifold Valve

- (2) When in flow measurement and the meter body is installed lower than the pipe line, it is recommended to provide blow pipes.

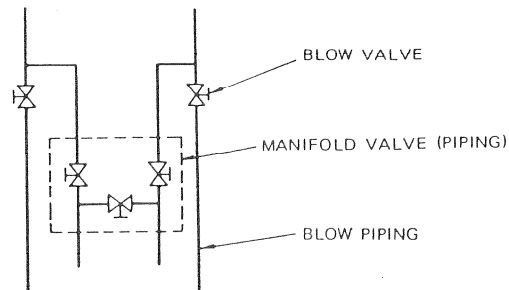


Figure 12. Blow Piping

- (3) For the pressure connection piping from the pressure tap position to the transmitter, provide a gradient so that drain is returned through the tapping position to the process line.
- (4) Regarding the process pressure connection ports of the meter body, the high pressure side (HP) is located to the right and the low pressure side (LP) to the left as viewed from the front of the meter body (transmitter).

If the high pressure side and low pressure side are required to be used in the reverse from the viewpoint of piping, use a Reverse Unit*.

* The Reverser Unit is available as an option. This unit cannot be used for Model 81/82.

- (5) For the pipes for pressure tapping from the process pipe, use pressure pipes of appropriate schedule number and nominal thickness. A typical example is 1/2-inch Schedule 80 steel pipe. For measurement of water or steam, copper pipes are used in general.

Examples of pressure piping are shown in Figure 13.

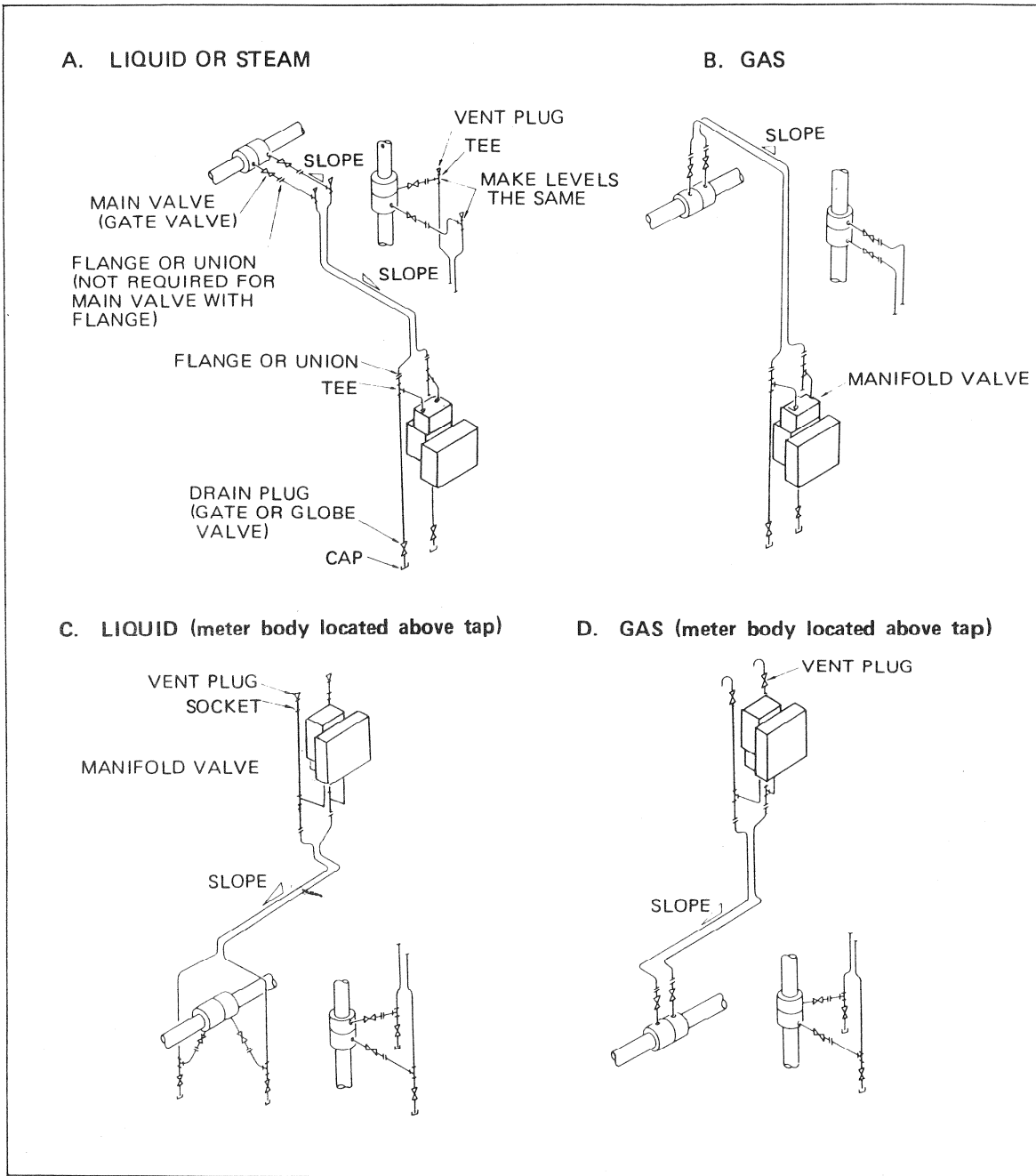


Figure 13. Pressure Piping for Flow Measurement

(6) To change connections to process:

If it is required to change process connections (vent and drain) between upper and lower positions, remove the two flanges of the connection ports and also the plugs of vent and drain, and change the positions between upper and lower. (Refer to the overall dimension drawings.)

(7) Pressure tapping methods:

For tapping methods of process pressures, refer to the illustrations given in this section. The "H" is the high pressure side of the meter body and the "L" is the low pressure side. They are marked on the meter body.

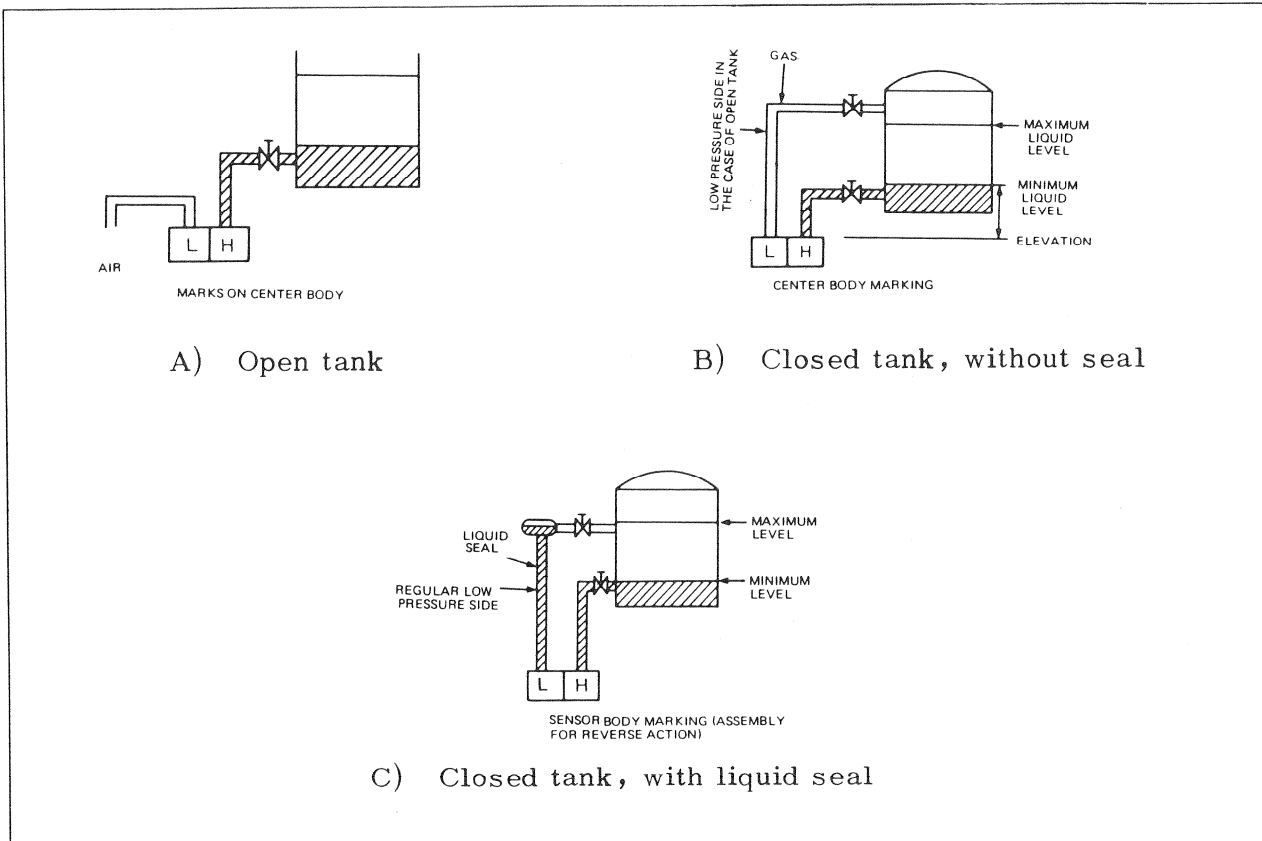


Figure 14. Connections of Pressure Pipes for Liquid Level Measurement

The liquid level corresponding to the difference between the 0% level and the center of the meter body is given from the beginning. In the case of A or B shown in Figure 14, make compensation (provide an elevation) for the corresponding amount and set the output at 0.2 to 1.0 kgf/cm² for liquid level 0 to 100%. In the case of C, a pressure corresponding to the head of the seal liquid is applied to the low pressure side to the state of A or B and consequently the high/low relationship between the H side and L side of the meter body is in the reverse. Therefore, compensation (suppression) should be made for the seal liquid head for the difference between 100% level position and 0% level position.

For "elevation" and "suppression", refer to Section 6.

5.2 Connection of Flange Type Meter Body to Process

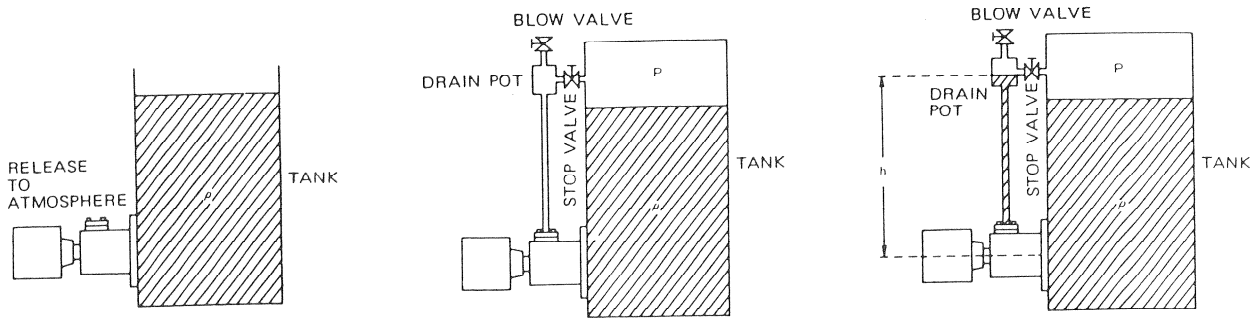


Figure 15. Process Connections of Model 61/62 for Liquid Level Measurement

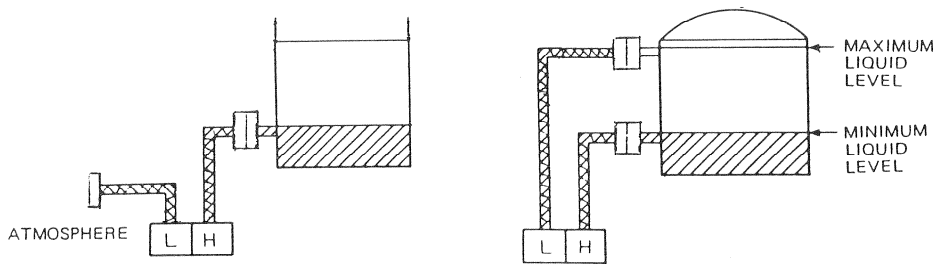
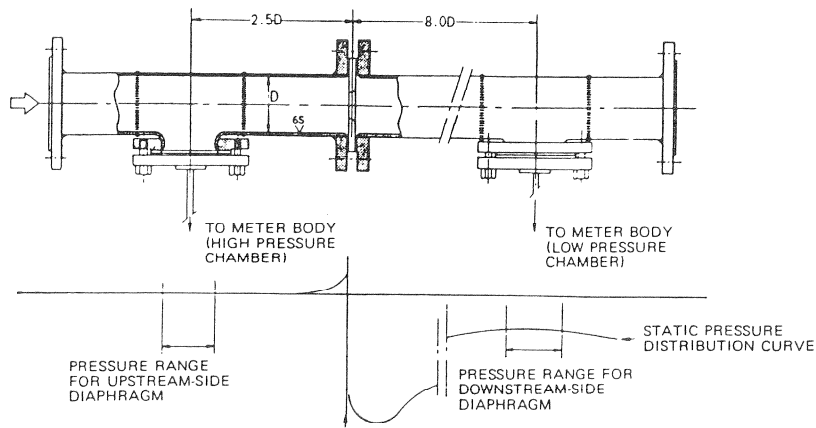
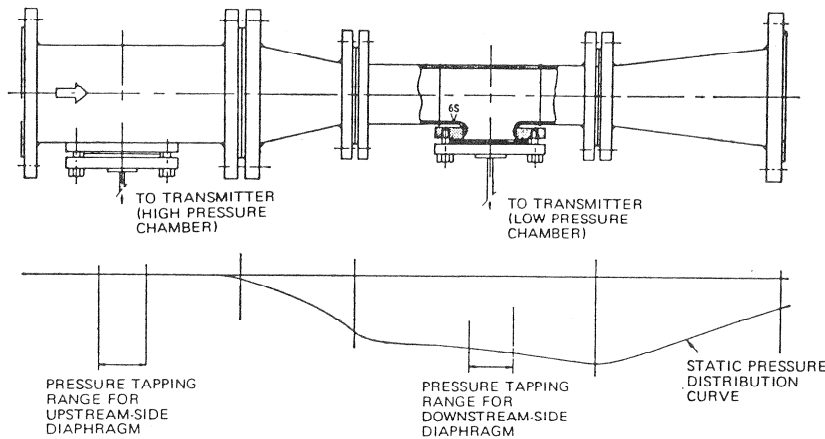


Figure 16. Process Connections of Model 71/72 for Liquid Level Measurement



**For flow measurement
with orifice plate**

Pipe diameter: 3 in. or over
Differential pressure: 1000 mmH₂O or over
Diameter ratio: 0.30 to 0.70



**For flow measurement
with Venturi tube**

Venturi tube throat diameter: 3 in. or over
Differential pressure: 1000 mm or over
Diameter ratio: 0.7

Figure 17. Pressure Tapping for Model 71/72
for Flow Measurement

- (1) Fix the flanges of the meter body to those of the process side by using gaskets and bolts. Be sure to uniformly and securely tighten the bolts in order to prevent leak.

Lay the capillary tubes in such manner that they are less subjected to large temperature change. Fix them so that they do not move.

- (2) Regarding the flange of the low pressure side when in level measurement of an open tank, fix it securely at a position where it will be less subjected to temperature change and mechanical vibration. Position the LP side flange at a height lower than that of the minimum liquid level.

Regarding the seal diaphragm, protect it so that it is not damaged and pay attention so that no drain is entrapped on it and no dust is collected on it.

- (3) For flow measurement, tapping for the differential pressure must be done in the "pipe tap" system. Therefore, locate the high-pressure-side tap at a location of 2.5D (D denotes the inside diameter of the process pipe) from the upstream side of the orifice and locate the low-pressure-side tap at a location of 8D from the downstream side of the orifice.

The tapping connection is of a 3-inch flange connection type. The flanges of the extension seal type of meter body can be directly used as the tapping flanges.

6. ELEVATION AND SUPPRESSION

6.1 Definitions of Elevation and Suppression

The terms "elevation" and "suppression" as used in this publication are defined as follows:

Elevation: Synonymous with "suppressed zero range"

An input range whose low end value is higher than zero. For example, a range of 20 to 100.

Suppression: Synonymous with "elevated zero range"

An input range whose low end value is lower than zero. For example, a range of -20 to 0.

6.2 Setting of Elevation/Suppression

For setting of elevation/suppression, refer to Section "CALIBRATION AND ADJUSTMENT" of Operator's Manual for Pneumatic Transmitter OM2-522-000.

Note: The specific-gravity of the liquid fill of Models 71/72 is 0.935 at 20°C. (For temperature compensation, use a factor of 0.001/°C)

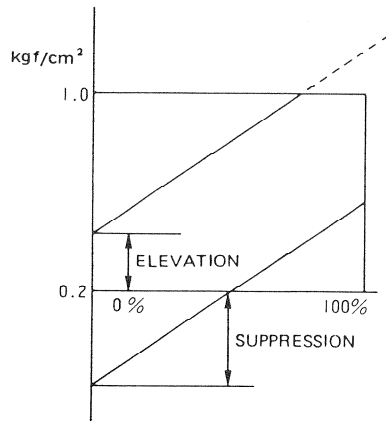


Figure 18. Elevation and Suppression

	Open Tank	Closed tank (without seal liquid)	Close tank (with seal liquid)
11, 22, 33, 44, 81, 82	Provide suppression corresponding to differential level between zero liquid level and center of pressure receiver multiplied by specific-gravity of liquid measured. Ⓐ		Provide suppression by amount corresponding to measuring liquid level multiplied by specific-gravity of measured liquid (seal liquid).
61, 62	No elevation/suppression is needed if the imaginary zero liquid level* conforms with center position of diaphragm of flange connection section. * Refer to Section 4.3 If the zero liquid level is higher than center position of diaphragm, provide elevation by an amount corresponding to the height multiplied specific-gravity of liquid measured. Ⓑ		Subtract from suppression the difference between zero liquid level and center position of diaphragm as elevation. Ⓒ
71, 72	Provide elevation by an amount corresponding to difference between center positions of HP and LP flange diaphragms multiplied by specific-gravity of seal liquid. When zero liquid level is higher than center position of HP flange diaphragm, add as elevation an amount corresponding to the height multiplied by specific-gravity of measured liquid. Ⓓ	Provide suppression by an amount corresponding to difference between center position of HP and LP flange diaphragms multiplied by specific-gravity of seal liquid. When zero liquid level is higher than center position of HP flange diaphragm, subtract from the above suppression an amount corresponding to the height multiplied by specific-gravity of measured liquid as elevation. Ⓔ	Not applicable

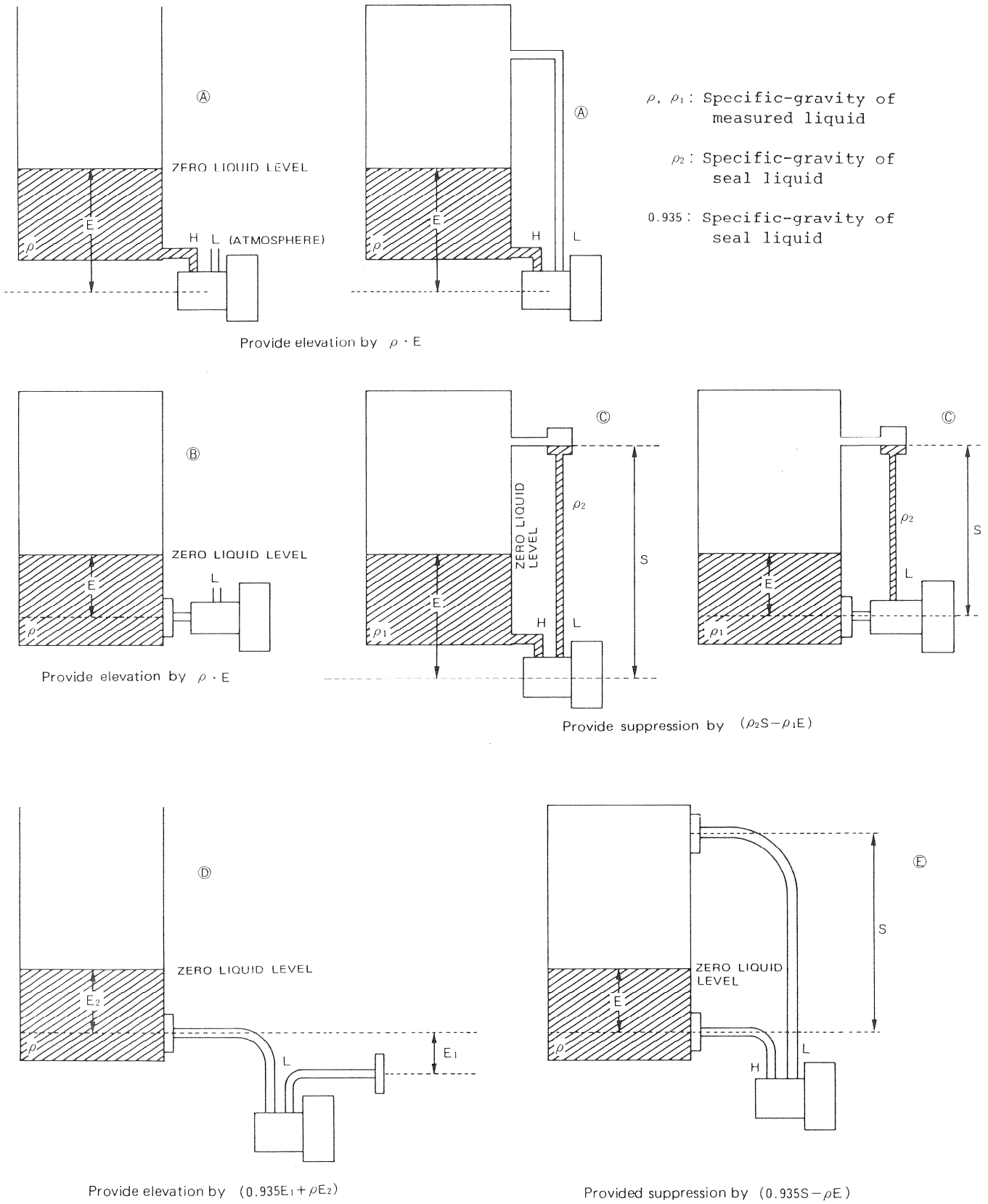


Figure 19. Calculation of Elevation/Suppression Values

OPERATION METHOD

The meter body, together with the transmitter coupled to it, starts operating as the air supply and process input are fed to it. (It is recommendable to check the operation of the transmitter before starting the running operation.)

1. DIFFERENTIAL PRESSURE (FLOW) TRANSMISSION

The operation method (start up procedure) here is described assuming that manifold valves and blow piping are prepared as shown in Section 5.1 of Part "INSTALLATION." Of Model 71 or 72, operation is ready when its installation is over.

- (1) Check that piping is correctly done.
- (2) Unless self drain or self vent piping is done, liquid or gas will be entrapped in the measuring chambers and pressure connection pipes, thereby causing measurement errors. Be sure to drain out or vent out such liquid or gas. The same applies regardless of whether manifold valves are used or manifold piping is done. For the procedure, refer to Part "INSPECTION AND MAINTENANCE."
- (3) Zero point check:

When the instrument has become the measuring state, set a receiver instrument and check and adjust the zero point as follows: Of the manifold valves, close the stop valves of both high and low pressure sides and then open the equalizer valve. Next, open the stop valve of the high pressure side alone so that the process pressure of the high side alone is applied to both high and low pressure chambers of the meter body. Under this state, check the zero point. After the zero point check is complete, close the equalizer valve and then open the stop valve of the low pressure side.

- (4) Operating procedure:

To start operating the meter body from the state that all valves are closed, open or close them in the due order as noted in the following:

- (1) Open the equalizer valve.
- (2) Open the stop valve of low pressure side tapping-pipe and the stop valve of low pressure side of manifold.
- (3) Open the stop valve of high pressure side tapping-pipe and the stop valve of high pressure side of manifold.
- (4) Close the equalizer valve.

2. LIQUID LEVEL TRANSMISSION

The operation method (start up procedure) here is described assuming that the meter body is installed as shown in Sections 5.1 Figure 14 and 5.2 of Part "INSTALLATION". No operation procedure is needed for the process connections with flanges (diaphragms). Of Model 71 or 72, operation is ready when its installation is over.

- (1) Check that piping is correctly done.
- (2) Unless self drain or self vent piping is done, liquid or gas will be entrapped in the measuring chambers and pressure connection pipes, thereby causing measurement errors. Be sure to drain out or vent out such liquid or gas. For the procedure, refer to Part "INSPECTION AND MAINTENANCE."
- (3) Zero point check:

When the instrument has become the measuring state, set a receiver instrument and check and adjust the zero point.
- (4) Open the stop valves and start operating the instrument. When seal liquid is used, full the low pressure side tapping-pipe with seal liquid.

INSPECTION AND MAINTENANCE

For routine inspection and maintenance, pay attention to the following:

1. CHECK FOR LEAK FROM PIPING

Check that there is no leak in the piping from the pressure tap points to the meter body. If any loose connections are found, tighten them securely.

2. BLOW AND CLEANING OF METER BODY AND PIPING

To maintain constantly the instrument at its best performances meeting its specification accuracy, keep clean the meter body and its piping. If sediment or other foreign matters are entrapped in the pressure chambers of the meter body, measuring errors may be caused. To blow and clean the meter body and piping, proceed as mentioned in the following.

2.1 Blow Procedure

2.1.1 When No Blow Pipes are Provided

- (1) Close the stop valve of the high pressure side tapping pipe and that of the high pressure side of the manifold valve.
- (2) Check that the equalizer valve is closed.
- (3) Close the stop valve of the low pressure side tapping pipe and that of the low pressure side of the manifold valve.
- (4) Slowly open the both side vent plugs to release pressure. And shut them.
- (5) Open the stop valve of the high pressure side of the manifold valve and that of the high pressure side tapping pipe.
- (6) Open the equalizer and blow the piping via the high pressure side vent plug.
- (7) Close the equalizer valve, the stop valve of the high pressure side of the manifold valve, and that of the high pressure side tapping pipe.
- (8) Open the stop valve of the low pressure side of the manifold valve and that of the low pressure side tapping pipe.
- (9) Open the equalizer valve and blow the piping from the low pressure side vent hole.
- (10) Close all valve.
- (11) Start operating the instrument following the procedure explained in Part "OPERATION METHOD."

2.1.2 When Blow Pipes are Provided (See Figure 12 of Section 5, Part "INSTALLATION.")

- (1) Close the stop valve of the high pressure side of the manifold valve.
- (2) Close the stop valve of the low pressure side of the manifold valve.
- (3) Slowly open the blow valves of both high and low pressure sides to drain out sediment or other entrapped substance.
- (4) Close the blow valves of both high and low pressure sides.
- (5) Open the stop valve of the low pressure side of the manifold valve.
- (6) Open the stop valve of the high pressure side of the manifold valve.

2.1.3 Blow of Model 61/62 Liquid Level Meter

- (1) For an open tank liquid level meter, drain out liquid by loosening the drain plug at the bottom of the low pressure side cover at appropriate intervals.
- (2) For a closed tank liquid level meter of gas sealed type, at first close the stop valve of the low pressure side tapping-pipe and then open the blow valve to vent gas at appropriate intervals.
- (3) For a closed tank liquid level meter of liquid sealed type, check the seal liquid level and replace seal liquid at appropriate intervals.

To replace seal liquid, proceed as follows: Close the stop valve of the low pressure side tapping-pipe, open the blow valve, and loosen the drain plug to drain out seal liquid. Next, tighten the drain plug, feed seal liquid from the valve for blow until seal liquid overflows from the blow valve, close the blow valve, and then open the stop valve.

2.2 Cleaning of Meter Body

After the blowing of the piping as described in 2.1 is over, clean the meter body as described below. Of Models 71/72 and 61/62, clean only the diaphragms outsides of flanges.

- (1) Remove the covers of the meter body by removing their clamping-bolts.
- (2) Clean the diaphragm and the insides of the covers using soft brush and detergent. When doing this, be extremely careful not to defrom or damage the diaphragm.

- (3) When reassembling the covers, replace gaskets with new ones as required. (Refer to 4.2)
- (4) Fix the clamping-bolts of the covers with the specified tightening torques as shown in the following table.

Model	Tightening torque (kgf·cm)		Material of Clamping-bolts
	When new gasket is used	When gasket is re-used	
11/22, 61/62	450	300	Chrome molybdenum steel
33	450	300	Chrome molybdenum steel
44	200		Chrome molybdenum steel
81/82	1400		Chrome molybdenum steel

2.3 Notes for Use in Freezing Season

When the transmitter used for measurement of water or other freezable liquid is paused in a freezing season or area, loosen the drain plugs and drain out liquid from the pressure chambers to prevent freezing.

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