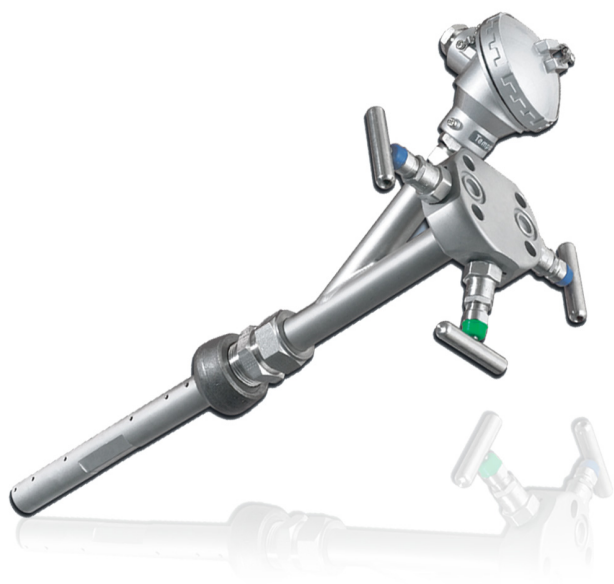


Operating instructions OI/FPD350-EN Rev. H

FPD350 Torbar Averaging pitot tubes



The Company

We are an established world force in the design and manufacture of measurement products for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

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1 General Information

Warning. The Pressure Equipment described in this manual is supplied, where appropriate, in accordance with the European Directive 97/23/EC and is designed to work in pressurized systems. Take care when installing all equipment and follow the instructions given. Failure to do this could result in damage to equipment and create possible hazards to operators and other equipment. Only use the equipment on the process for which it was originally designed. Install the equipment into a system that has been designed to allow for venting or draining of the process. For the necessary safety requirements refer to the appropriate instructions in this manual.

1.1 Description

Torbar is a multi-port, self-averaging primary flow element, based on the 'Pitot Tube' principle of fluid flow measurement. Torbar produces an averaged differential pressure (DP) signal proportional to the square of the flow rate. This DP output is normally connected via small-bore piping to a Differential Pressure Transmitter that produces an electrical signal in proportion to the flow rate.

There are 4 main versions:

1. For insertion through a threaded fitting with a compression coupling.
2. For insertion through a flange.
3. 'Hot-tap' versions, to enable insertion and withdrawal under pressure.
4. Small pipe size versions equipped with 15 to 50 mm (0.5 to 2 in) in-line fittings and butt-welded, screwed or flanged ends.

1.2 Health and Safety Information

Torbar is supplied specifically for the application detailed on the tag-plate attached by a ring to the head of the product. Before installing Torbar, ensure the tag-plate information is correct for that application and matches the required specification. **Do not** use Torbar for any other application without consulting ABB Limited or an accredited agent.

The instructions in this document detail the important basic information to ensure correct installation. However, it is the user's responsibility to ensure that suitably qualified personnel perform the installation to established and recognized engineering codes of practice.

Warnings in this document and warning labels on both the Torbar and its containers/packaging must be observed.

Warning.

- Before drilling into a process pipe, or before carrying out any maintenance activity or component replacement, reduce the pipe pressure to a safe level and remove all potentially injurious process material.

Note that this warning does not necessarily apply when installing 'Hot-Tap' versions of Torbar (except models FPD350.(L7/H7/H8).E2). However, ensure the process material does not exceed the pressure and temperature limits of the Torbar as specified.

- The part of the Torbar external to the process pipe may present a burn hazard, especially if the maximum temperature of the process material exceeds 100 °C (212 °F). Either lag or shield the exposed parts of the Torbar to protect personnel or display clear warning signs to alert personnel to the possible hazard. Refer to Standard EN563: 1904 'Safety of Machinery – Temperatures of Touchable Surfaces'.

It is the customer's responsibility to ensure the products detailed in this publication are not used for purposes other than those for which they are designed.

Any modification to or adaptation of Torbar may invalidate its certification.

It is the user's responsibility to ensure that adequate protection exists to prevent pressurization in excess of the maximum specified pressure for Torbar, even in the event of a fire.

If there are any queries regarding the instructions in this publication, contact either ABB Limited or their accredited agent before installing Torbar.

2 Initial Installation

2.1 General

The differential pressure generated by the Torbar exits at the high- and low-pressure connections on the head of the device. The connections are identified by the letters L (low pressure) and H (high pressure).

The direction of flow is indicated by the small indentations on the head – see Fig. 2.1. The indentations must be positioned on the downstream side of the flow and are clearly visible from various directions and distances. Exceptions to this are Models FPD350.T1.T1/W1/F1 and FPD350.T5, and Direct Mount Head options.

In addition, an arrow is stamped on the head of all Torbar models to indicate direction of flow.

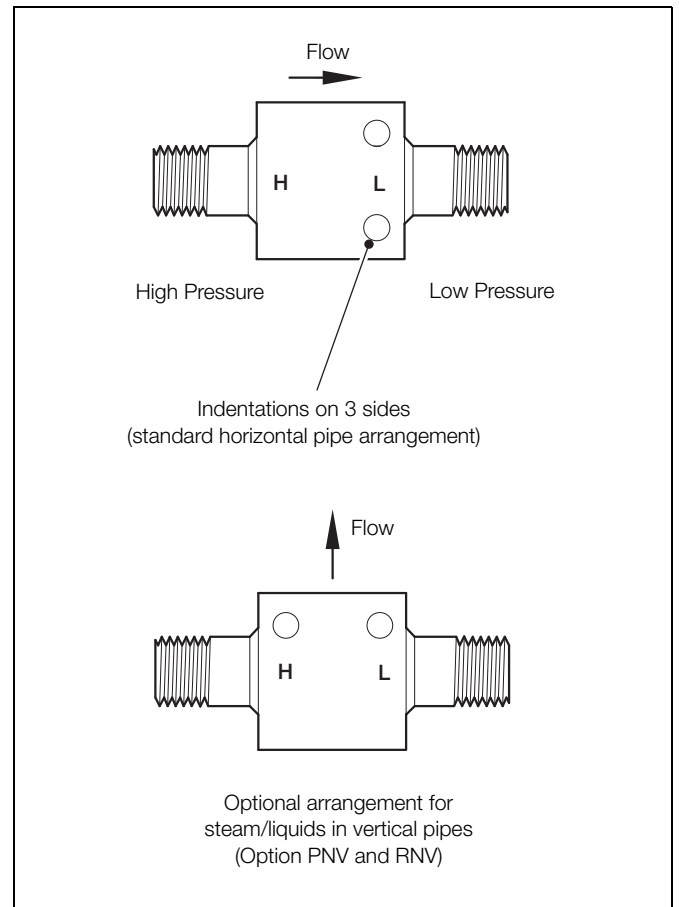


Fig. 2.1 Torbar Head Flow Alignment Marks

To prevent noisy signal outputs, do not install Torbar in a pulsating flow. Vibration also distorts the output signal and affects the structural limits of Torbar.

2.2 Mounting

2.2.1 General

Select a location with sufficient clearance to install and remove Torbar.

Referring to Fig. 2.1, install Torbar:

- at right angles to the pipe run
- across the pipe diameter
- aligned with the pipe axis

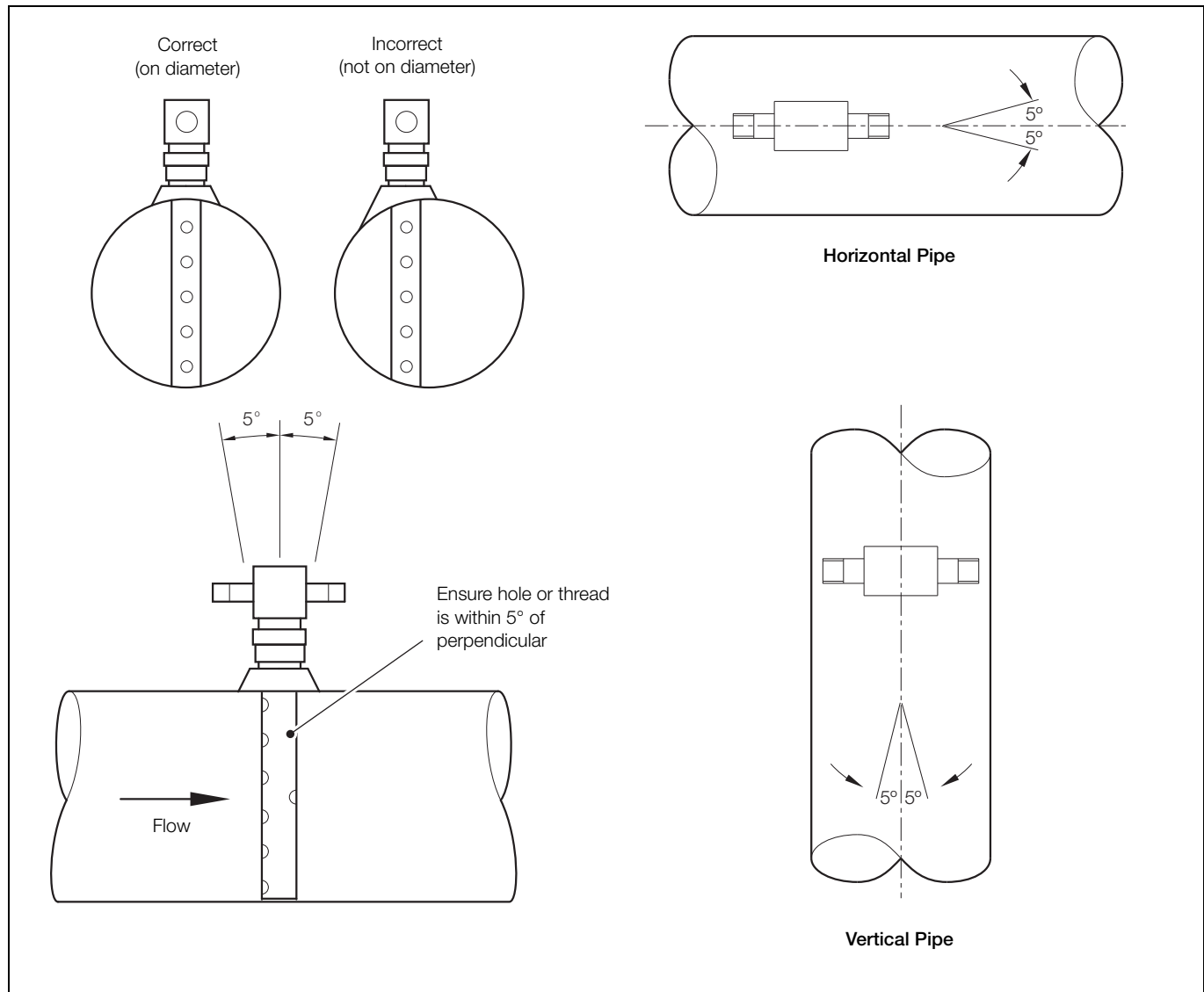


Fig. 2.2 Torbar Alignment

2.2.2 Horizontal Pipe Mounting – Gas

To ensure the instrument lines contain only gas, install Torbar with the instrument connections **above** the centre line of the pipe, at least 5 ° above the horizontal – see Fig. 2.3.

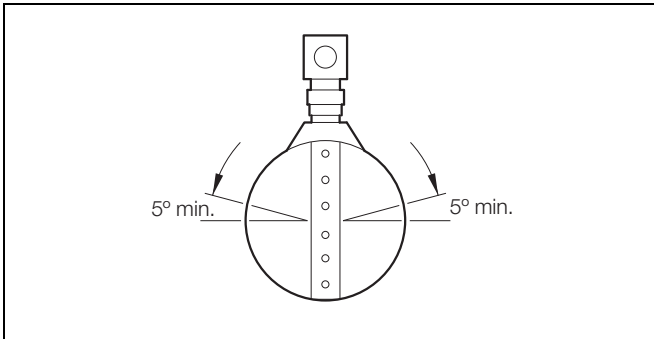


Fig. 2.3 Horizontal Pipe Mounting – Gas

2.2.3 Horizontal Pipe Mounting – Liquids

To ensure the instrument lines contain only the process liquid, install Torbar with the instrument connections **below** the centre line of the pipe, at least 5 ° below the horizontal – see Fig. 2.4.

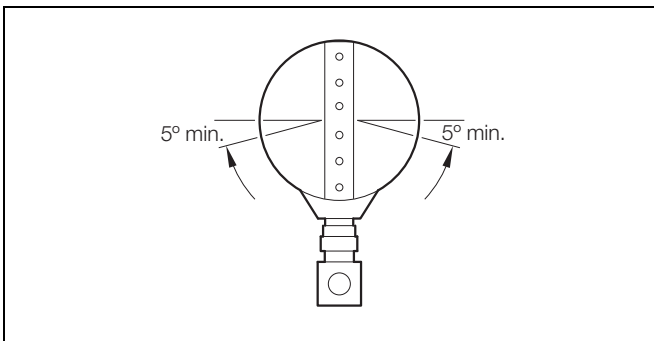


Fig. 2.4 Horizontal Pipe Mounting – Liquids

2.2.4 Horizontal Pipe Mounting – Steam

To ensure the instrument lines contain only steam, install Torbar with the instrument connections **at or below** the centre line of the pipe – see Fig. 2.5. Filling tees or condensate pots should be fitted as appropriate.

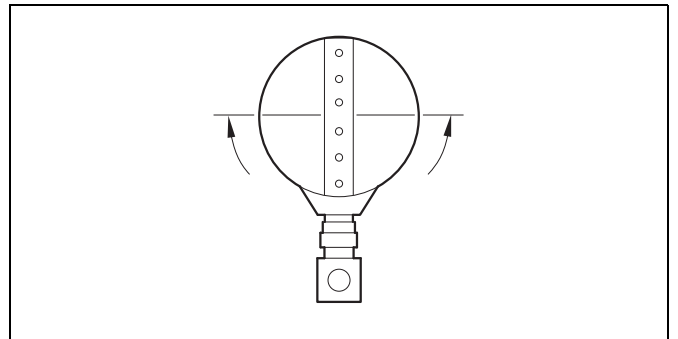


Fig. 2.5 Horizontal Pipe Mounting – Steam

2.2.5 Vertical Pipe Mounting – All Applications

Install only Torbar options PNV and RNV in vertical pipelines.

To ensure an equal head of gas, liquid or steam in both instrument lines, Torbar options PNV and RNV are designed so that the instrument lines are in the horizontal plane when the Torbar is installed (see Fig. 2.1).

Any lateral-mounting angle is suitable – see Fig. 2.6.

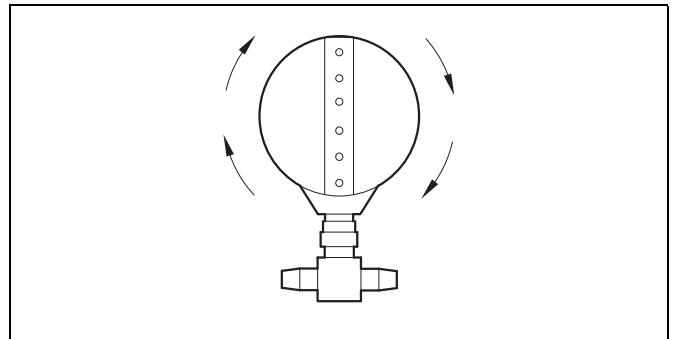


Fig. 2.6 Vertical Pipe Mounting – All Applications

2.2.6 Straight Pipe Requirements

To meet specified accuracy figures, install Torbar at distances of **no less** than those shown in Fig. 2.7 from flow disturbances in the pipe. If Torbar is installed within distances less than those shown, absolute accuracy will decrease BUT repeatability of measurement will continue to be excellent due to the inherent averaging characteristics. If it is not possible to comply with this instruction and maximum accuracy is required, or for other piping configurations, consult ABB.

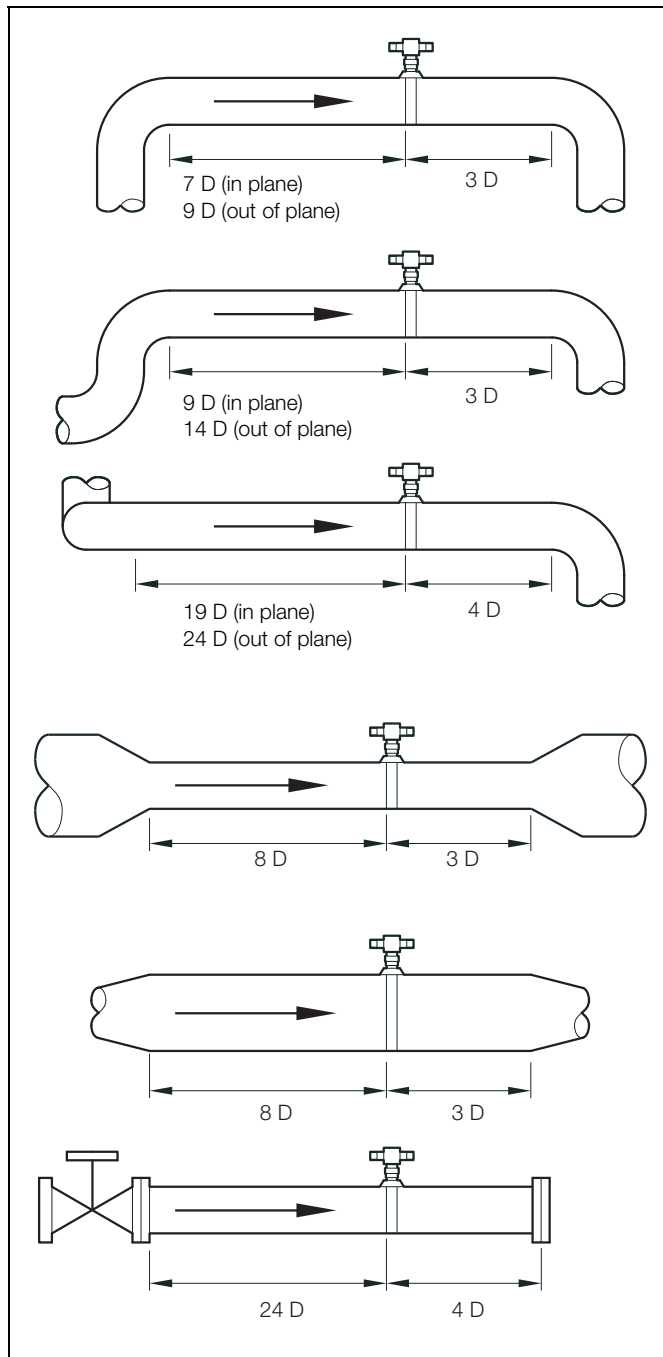


Fig. 2.7 Straight Pipe Requirements

2.2.7 Lagging (steam applications only)

The following instructions apply to both horizontal and vertical pipe installations:

1. Lag the entire Torbar head and fitting assembly extending to the process pipe to prevent the formation of condensate. Excessive amounts of condensate forming in the head or fitting assembly has a detrimental effect on the correct functioning of Torbar. Extend the lagging to (but do not lag) the filling tees, condensate pots (if fitted) and isolation valve handles.
2. In retractable Torbar installations, ensure the lagging is easily removable.
3. Ensure the tag plate is positioned outside the lagging for ease of identification.

2.3 Models FPD350.T1.T1/W1/F1

Models FPD350.T1.T1/W1/F1 are supplied with the Torbar element installed in a pipe section. Table 2.1 details the type of fitting supplied with each model. The pipe length and relevant thread or flange sizes are shown on the drawing supplied with the Torbar.

Model	Fitting
FPD350.T1.W1	Butt weld
FPD350.T1.T1	Threaded
FPD350.T1.F1	Flanged

Table 2.1 Models FPD350.T1.T1/W1/F1

2.4 Threaded Models FPD350.T3 and FPD350.T4.E1

Note. For models with a Duct-Mounting Plate, refer to Section 2.6, page 8.

Install the Torbar as follows:

1. Select the required insertion position and mark the pipe.
2. Drill a 6 mm (0.24 in) pilot hole at the marked position, then drill to the appropriate size – see Table 2.2.

Note. If a full penetration weld is required, measure the inside diameter of the fittings supplied with the Torbar.

Threaded Torbar Model	FPD350.T3.E1	FPD350.T4.E1
Hole size in mm (in)	16 (0.63)	28 (1.1)

Table 2.2 Hole Size

3. Align the threaded fitting concentrically over the hole and tack-weld in place.
4. Using a suitably sized and threaded length of pipe, check the threaded fitting is concentric and aligned correctly – see Fig. 2.2, page 4.
5. Weld the threaded fitting to the pipe.
6. Slide the compression-fitting assembly onto the Torbar.
7. Insert the Torbar through the threaded fitting into the pipe until it touches the opposite internal wall.
8. Apply appropriate sealant to the threads of the compression fitting.
9. Screw the compression fitting into the threaded fitting until hand-tight.
10. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
11. Holding the head of the Torbar with a wrench to maintain correct orientation, use a long wrench to tighten the compression fitting until approximately one thread is left exposed under the nut, ensuring the Torbar does not turn.
12. Check the Torbar is installed correctly and aligned.

2.5 Threaded Models FPD350.T4.E2

Note. For models with a Duct-Mounting Plate, refer to Section 2.7, page 9.

Install the Torbar as follow:

1. Select the required insertion position and mark the pipe.
2. Drill a 6 mm (0.24 in) pilot hole at the marked position, then drill to 28 mm (1.1 in).

Note. If a full penetration weld is required, measure the inside diameter of the fittings supplied with the Torbar.

3. Align the threaded fitting concentrically over the hole and tack-weld in place.
4. Using a suitably sized and threaded length of pipe, check the threaded fitting is concentric and aligned correctly – see Fig. 2.2, page 4.
5. Weld the threaded fitting to the pipe.
6. Measure exactly 180° around the pipe circumference and mark the pipe.
7. Repeat steps 2 to 5.
8. Slide the compression-fitting assembly onto the Torbar.
9. Insert the Torbar through the threaded fitting into the pipe until it enters the opposite fitting.
10. Apply appropriate sealant to the threads of the support plug.

Continued...

11. Referring to Fig. 2.8, screw support plug (A) into threaded fitting (B) and tighten, ensuring that:
 - a. support plug (A) contacts the Torbar (C)
 - b. the distance between the head of support plug (A) and the pipe wall does not exceed 60 mm (2.4 in).

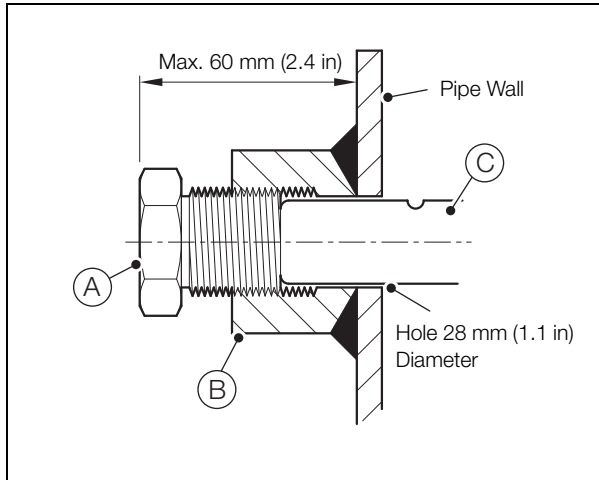


Fig. 2.8 Threaded Model FPD350.T4.E1 Support Plug

12. Apply appropriate sealant to the threads of the compression fitting.
13. Screw the compression fitting into the threaded fitting until hand-tight.
14. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
15. Holding the head of the Torbar with a wrench to maintain correct orientation, use a long wrench to tighten the compression fitting until approximately one thread is left exposed under the nut, ensuring the Torbar does not turn.
16. Check the Torbar is installed correctly and aligned.

2.6 Threaded Models FPD350.T3.E1 and FPD350.T4.E1 with Thin Wall Duct Mounting Plates (Option DF1)

Install the Torbar as follows:

1. Select the required insertion position and mark the pipe.
2. Drill a 6 mm (0.24 in) pilot hole at the marked position, then drill to the appropriate size – see Table 2.3.

Threaded Torbar Model	FPD350.T3.E1	FPD350.T4.E1
Hole size in mm (in)	16 (0.63)	28 (1.1)

Table 2.3 Hole Size

3. Align the thin wall duct mounting plate and gasket concentrically with the hole, ensuring the Torbar can pass cleanly through the plate's threaded fitting and into the pipe.
4. Drill through the thin wall duct mounting plate fixing holes and gasket into the pipe. **Do not** separate the gasket from the mounting plate.
5. Secure the thin wall duct mounting plate and gasket to the pipe with rivets.
6. Slide the compression-fitting assembly onto the Torbar.
7. Insert the Torbar through the threaded fitting into the pipe until it touches the opposite internal wall.
8. Apply appropriate sealant to the threads of the compression fitting.
9. Screw the compression fitting into the threaded fitting until hand-tight.
10. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
11. Holding the head of the Torbar with a wrench to maintain correct orientation, use a long wrench to tighten the compression fitting until approximately one thread is left exposed under the nut, ensuring the Torbar does not turn.
12. Check that the Torbar is installed correctly and aligned.

2.7 Threaded Model FPD350.T4.E2 with Thin Wall Duct Mounting Plates (Option DF1)

Install the Torbar as follows:

1. Select the required insertion position and mark the pipe.
2. Drill a 6 mm (0.24 in) pilot hole at the marked position, then drill to 28 mm (1.1 in).
3. Align the thin wall duct mounting plate and gasket concentrically with the hole, ensuring the Torbar can pass cleanly through the plate's threaded fitting and into the pipe.
4. Drill through the thin wall duct mounting plate fixing holes and gasket into the pipe. **Do not** separate the gasket from the mounting plate.
5. Secure the thin wall duct mounting plate and gasket to the pipe with rivets.
6. Measure exactly 180° around the pipe circumference and mark the pipe.
7. Repeat steps 2 to 5.
8. Slide the compression-fitting assembly onto the Torbar.
9. Insert the Torbar through the threaded fitting into the pipe until it enters the opposite fitting.
10. Apply appropriate sealant to the threads of the support plug.

11. Referring to Fig. 2.9, screw support plug (A) into threaded fitting (B) and tighten, ensuring that:

- a. support plug (A) contacts the Torbar (C)
- b. the distance between the head of support plug (A) and the pipe wall does not exceed 60 mm (2.4 in).

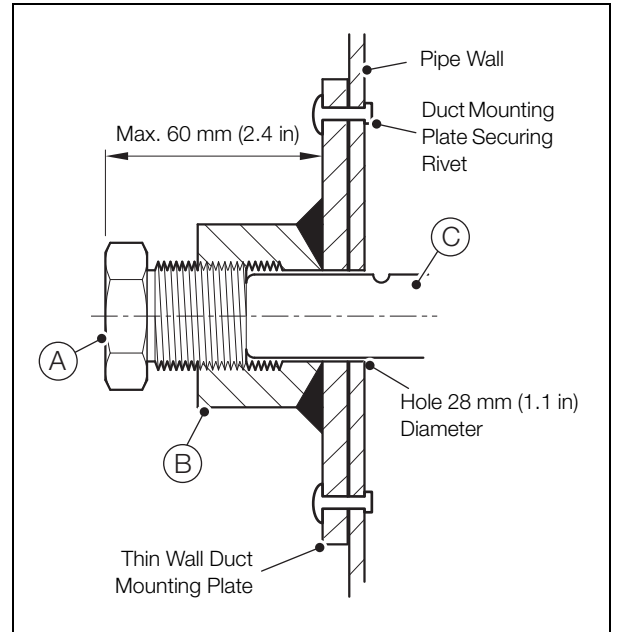


Fig. 2.9 Threaded Model FPD350.T4.E2 Thin Wall Duct Mounting Plate Support Plug

12. Apply appropriate sealant to the threads of the compression fitting.
13. Screw the compression fitting into the threaded fitting until hand-tight.
14. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
15. Holding the head of the Torbar with a wrench to maintain correct orientation, use a long wrench to tighten the compression fitting until approximately one thread is left exposed under the nut, ensuring the Torbar does not turn.
16. Check that the Torbar is installed correctly and aligned.

2.8 Flanged Models FPD350.(T3/T4/T5).E1

Install the Torbar as follows:

1. Install the flanged pipe fitting (stand-off) – see Section 2.18, page 24.
2. Position the gasket onto the Torbar flange and carefully insert the Torbar through the flanged pipe fitting (stand-off) until the two flanges mate squarely.
3. Turn the upper flange until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
4. Fit the flange securing bolts and tighten equally and evenly, observing correct procedures appropriate to the flange.
5. Check the Torbar is installed correctly and aligned.

2.9 Flanged Models FPD350.(T4/T5).E2

Note. For models with a flanged end-support fitting (mounting types F3 and F4), refer to Section 2.10, page 11.

Install the Torbar as follows:

1. Install the flanged pipe fitting (stand-off) – see Section 2.18, page 24.
2. Measure exactly 180° around the pipe circumference and mark the pipe.
3. Drill a 6 mm (0.24 in) pilot hole at the marked position, then drill to the appropriate size – see Table 2.4.

Flanged Torbar Model	FPD350.T4.E2	FPD350.T5.E2
Hole size in mm (in)	33 (1.3)	70 (2.75)

Table 2.4 Hole Size

4. Insert the Torbar through the flanged pipe fitting (stand-off) into the pipe and check that the tip protrudes through the hole in the opposite pipe wall when the two flanges mate squarely.
5. Position the end-support cup over the tip of the Torbar, ensuring the tip is concentric with the hole, and tack-weld the end-support cup in place.
6. Remove the Torbar and complete the support cup full-penetration weld.
7. Position the gasket on the Torbar flange and carefully insert the Torbar through the flanged pipe fitting (stand-off) until the two flanges mate squarely, ensuring the tip of the Torbar enters the end-support cup.
8. Turn the upper flange until the arrow on the top face of the Torbar flange is aligned with the direction of flow.
9. Fit the flange securing bolts and tighten equally and evenly, observing correct procedures appropriate to the flange.
10. Check the Torbar is installed correctly and aligned.

2.10 Flanged Models FPD350.(T4/T5).E2 with Flanged End-Support Fitting (mounting types F3 and F4)

Install the Torbar as follows:

1. Install the flanged pipe fitting (stand-off) – see Section 2.18, page 24.
2. Measure exactly 180° around the pipe circumference and mark the pipe.
3. Drill a 6 mm (0.24 in) pilot hole at the marked position, then drill to the appropriate size – see Table 2.4.

Flanged Torbar Model	FPD350.T4.E2	FPD350.T5.E2
Hole size in mm (in)	33 (1.3)	70 (2.75)

Table 2.5 Hole Size

4. Insert the Torbar through the flanged pipe fitting (stand-off) into the pipe and check that the tip protrudes through the hole in the opposite pipe wall when the two flanges mate squarely.
5. Position the flanged pipe fitting (stand-off) over the tip of the Torbar, ensuring the tip enters, and is concentric with, the end support stub.
6. Refer to Section 2.18, Steps 3b and 3c on page 24 and tack-weld the flanged pipe fitting (stand-off) in place.
7. Remove the Torbar.
8. Refer to Section 2.18, Steps 3d to 3g on page 24 and complete the installation of the flanged pipe fitting (stand-off).
9. Position the gasket on the Torbar flange and carefully insert the Torbar through the flanged pipe fitting (stand-off) until the two flanges mate squarely, ensuring the tip of the Torbar enters the opposite flanged pipe fitting (stand-off).
10. Turn the Torbar flange until the arrow on the top face of the Torbar flange is aligned with the direction of flow.
11. Fit the flange securing bolts and tighten equally and evenly, observing correct procedures appropriate to the flange.
12. Check the Torbar is installed correctly and aligned.
13. Position a gasket on the flanged end support flitting, ensuring the integral support cup faces the tip of the Torbar.
14. Fit the flanged end support flitting to the flanged pipe fitting (stand-off), ensuring the tip of the Torbar enters the integral support cup.
15. Fit the flange securing bolts and tighten equally and evenly, observing correct procedures appropriate to the flange.

2.11 Models FPD350.(L6/L7).E1

Warning. Models FPD350.(L6/L7).E1 are designed for 'Hot-Tap' installation. Observe all relevant safety precautions for drilling into pressurized pipelines and ensure the process material does not exceed the Torbar's specified pressure and temperature limits.

Install the Torbar as follows:

1. Select the required insertion position and mark the pipe.
2. Align the threaded fitting over the mark and tack-weld in place.
3. Using a suitably sized and threaded length of pipe, check the threaded fitting is aligned correctly – see Fig. 2.2, page 4.
4. Weld the threaded fitting to the pipe.
5. Referring to Fig. 2.10:
 - a. Apply suitable sealant to the close nipple (A) and isolation valve (B) and fit them to the threaded fitting (C). Tighten securely.
 - b. Attach hot-tap drilling equipment to isolation valve (B) in accordance with the manufacturer's instructions.
 - c. Drill a 6 mm (0.24 in) pilot hole in the process pipe at the marked position, then drill to the appropriate size – see Table 2.6.

Threaded Torbar Model	FPD350.L6.E1	FPD350.L7.E1
Hole size in mm (in)	16 (0.63)	28 (1.1)

Table 2.6 Hole Size

- d. Withdraw the drill, close isolation valve (B) fully and remove the hot-tap drilling equipment.
- e. Ensure packing material is in place in packing gland (D).
- f. Fit pressure chamber (E), complete with packing gland (D), to isolation valve (B), using appropriate sealants where necessary.
- g. Insert the Torbar into packing gland (D) and tighten the packing gland until it is fully sealed, ensuring the Torbar is able to slide through it.
- h. Ensure safety chain (F) is securely attached to pressure chamber (E).
- i. Attach chain link (G) to safety chain (F), ensuring the safety chain is tight.
- j. Carefully open isolation valve (B) and check for leaks around packing gland (D).

Continued...

- k. Insert the Torbar through isolation valve (B) until it touches the opposite internal wall of the process pipe.

Warning. During step l, maintain continuous pressure on the Torbar to ensure that it remains in contact with the opposite internal wall of the process pipe.

- l. Reposition chain link (G) to tighten safety chain (F).
 - m. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
 - n. Fully tighten packing gland (D), ensuring the Torbar does not turn. Check for leaks.
 - o. Ensure that safety chain (F) is fully tightened and secure.
6. Check the Torbar is installed correctly and aligned.

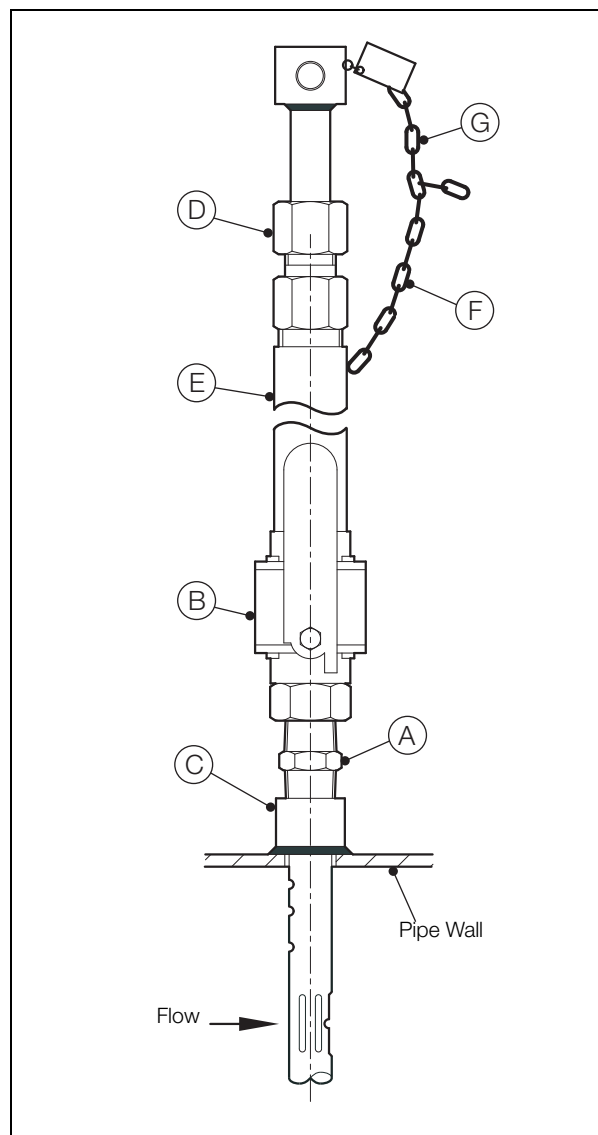


Fig. 2.10 Installation of Threaded Models FPD350.L6.E1 and FPD350.L7.E1

2.12 Threaded Model FPD350.L7.E2

Warning. Threaded model FPD350.L7.E2 is supported in the process pipe at the Torbar tip as well as at the entry point into the pipe, therefore it cannot be 'Hot-Tap' installed. Before drilling into the pipe, reduce the pipe pressure to a safe level and remove all hazardous material. Before inserting the probe, you must also stop the flow completely, to ensure that the probe can correctly engage with the end support.

Install the Torbar as follows:

1. Select the required insertion position and mark the pipe.
2. Drill a 6 mm (0.24 in) pilot hole at the marked position, then drill to 28 mm (1.1 in).
3. Align the threaded fitting concentrically over the hole and tack-weld in place.
4. Using a suitably sized and threaded length of pipe, check the threaded fitting is concentric and aligned correctly – see Fig. 2.2, page 4.
5. Weld the threaded fitting to the pipe.
6. Measure exactly 180° around the pipe circumference and mark the pipe.
7. Repeat steps 2 to 5.
8. Referring to Fig. 2.11:
 - a. Apply suitable sealant to the close nipple (A) and isolation valve (B) and fit them to the threaded fitting (C). Tighten securely.
 - b. Ensure packing material is in place in packing gland (D).
 - c. Fit pressure chamber (E), complete with packing gland (D), to isolation valve (B), using appropriate sealants where necessary.
 - d. Fully open isolation valve (B) and insert the Torbar through the packing gland, isolation valve and process pipe until the tip exits at the opposite fitting.
 - e. Apply appropriate sealant to the threads of support plug (F).
 - f. Screw support plug (F) into threaded fitting (G) and tighten, ensuring that it contacts the Torbar.
 - g. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
 - h. Fully tighten packing gland (D), ensuring the Torbar does not turn.
 - i. Ensure safety chain (H) is securely attached to pressure chamber (E) and that chain link (J) is fitted.
 - j. Attach chain link (J) to safety chain (H) ensuring the safety chain is tight.

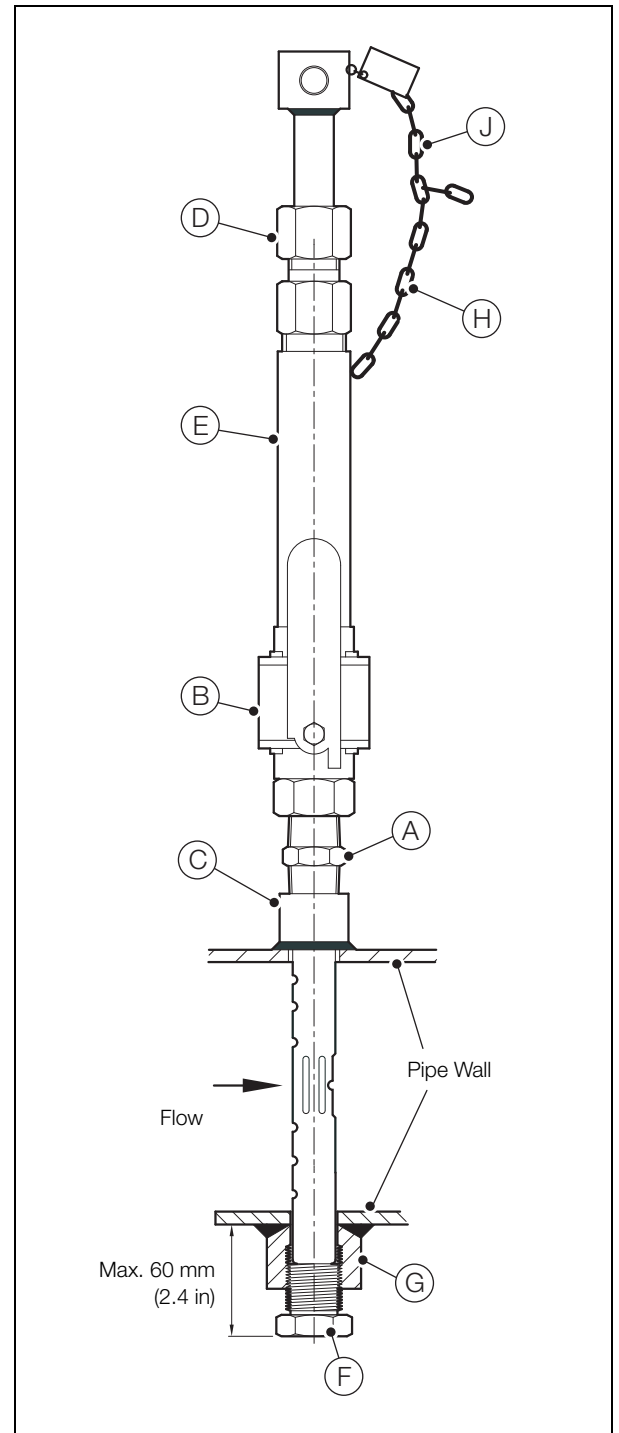


Fig. 2.11 Installation of Threaded Model FPD350.L7.E2

9. Check the Torbar is installed correctly and aligned.
10. Pressurize the process pipe and check for leaks.

2.13 Threaded Models FPD350.L6.E1 and FPD350.L7.E1

Warning. Threaded models FPD350.L6.E1 and FPD350.L7.E1 are designed for 'Hot-Tap' installation. Observe all relevant safety precautions for drilling into pressurized pipelines, and ensure the process material does not exceed the Torbar's specified pressure and temperature limits.

Install the Torbar as follows:

1. Select the required insertion position and mark the pipe.
2. Align the threaded fitting over the mark and tack-weld it in place.
3. Using a suitably sized and threaded length of pipe, check the threaded fitting is aligned correctly – see Fig. 2.2, page 4.
4. Weld the threaded fitting to the pipe.
5. Referring to Fig. 2.12:
 - a. Apply suitable sealant to the close nipple (A) and isolation valve (B) and fit them to the threaded fitting (C). Tighten securely.
 - b. Attach hot-tap drilling equipment to isolation valve (B) in accordance with the manufacturer's instructions.
 - c. Drill a 6 mm (0.24 in) pilot hole in the process pipe at the marked position, then drill to the appropriate size – see Table 2.7.

Torbar Model	H601	H701
Hole size in mm (in)	16 (0.63)	28 (1.1)

Table 2.7 Hole Size

- d. Withdraw the drill, close isolation valve (B) fully and remove the hot-tap drilling equipment.
- e. Ensure 6 packing rings are located correctly inside packing gland (D).

- f. Ensure the drawbolt (or optional geared) retraction assembly (E) is in the fully retracted position.
- g. Fit pressure chamber (F), complete with packing gland (D) and retraction assembly (E), to isolation valve (B), using appropriate sealants where necessary.
- h. Insert the Torbar into packing gland (D).
- i. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
- j. Tighten the packing gland bolts (G) equally and evenly until the packing gland is fully sealed, ensuring the Torbar is able to slide through it.
- k. Carefully open isolation valve (B) and check for leaks around packing gland (D).

Note. During step I, turn drive nuts (H) equally and evenly to prevent binding.

- l. **Drawbolt retraction assembly only** – turn each drive-nut (H) clockwise alternately until the Torbar passes through isolation valve (B) and contacts the opposite side of the process pipe. When the Torbar is inserted fully, ensure the drawbolts (J) and stop nuts (K) are in the positions shown.
- m. **Drawbolt retraction assembly only** – tighten lock nuts (L).

Note. The gear retraction handle is supplied loose and can be fitted to either side of the gears. However, ensure the handle is fitted so that the Torbar is inserted when the handle is turned clockwise.

- n. **Optional geared retraction assembly only** – turn the integral handle clockwise until the Torbar contacts the opposite side of the process pipe.
- o. Fully tighten packing gland bolts (G), ensuring the Torbar does not turn. Check for leaks.

6. Check that the Torbar is installed correctly and aligned.

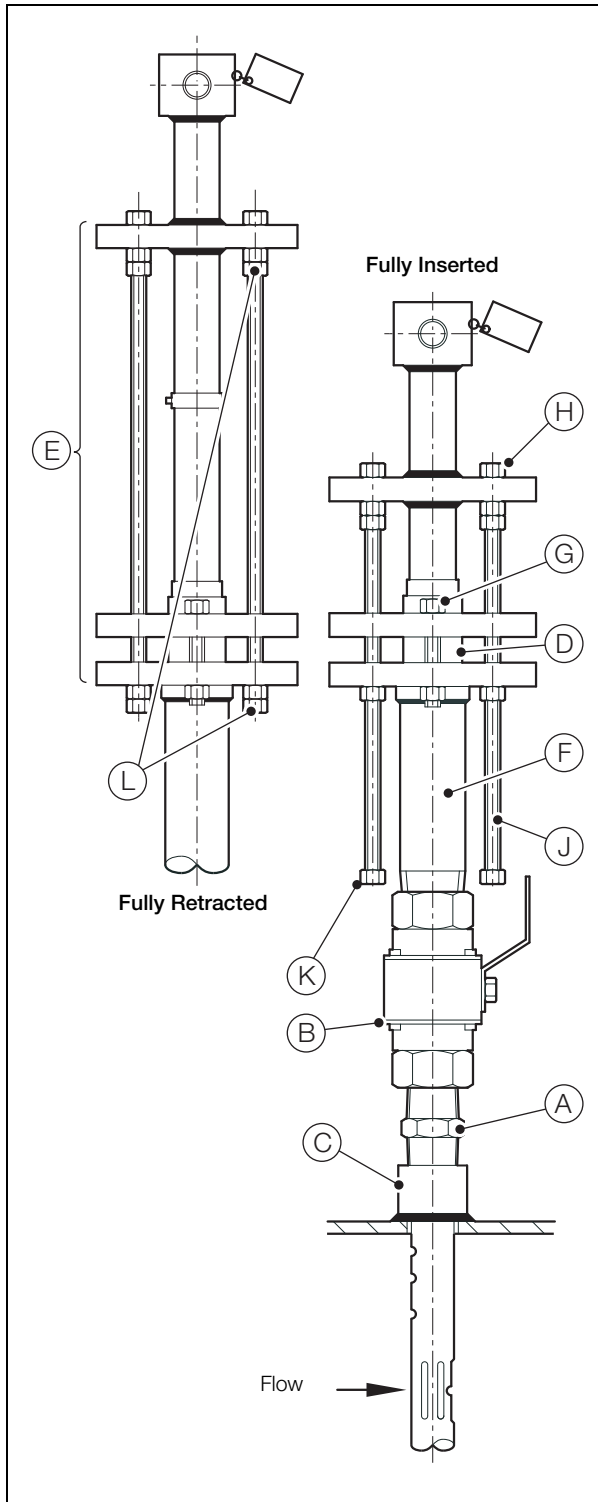


Fig. 2.12 Installation of Threaded Models FPD350.L6.E1 and FPD350.L7.E1

2.14 Threaded Model FPD350.H7.E2

Warning. Threaded model FPD350.H7.E2 is supported in the process pipe at the Torbar tip as well as at the entry point into the pipe, therefore it cannot be 'Hot-Tap' installed. Before drilling into the pipe, reduce the pipe pressure to a safe level and remove all hazardous material. Before inserting the probe, you must also stop the flow completely, to ensure that the probe can correctly engage with the end support.

Install the Torbar as follows:

1. Select the required insertion position and mark the pipe.
2. Drill a 6 mm (0.24 in) pilot hole at the marked position, then drill to 28 mm (1.1 in).
3. Align the threaded fitting concentrically over the hole and tack-weld in place.
4. Using a suitably sized and threaded length of pipe, check the threaded fitting is concentric and aligned correctly – see Fig. 2.2, page 4.
5. Weld the threaded fitting to the pipe.
6. Measure exactly 180° around the pipe circumference and mark the pipe.
7. Repeat steps 2 to 5.
8. Referring to Fig. 2.13:
 - a. Apply suitable sealant to the close nipple (A) and isolation valve (B) and fit them to the threaded fitting (C). Tighten securely.
 - b. Ensure 6 packing rings are located correctly inside packing gland (D).
 - c. Ensure the drawbolt (or optional geared) retraction assembly (E) is in the fully retracted position.
 - d. Fit pressure chamber (F), complete with packing gland (D) and retraction assembly (E), to isolation valve (B), using appropriate sealants where necessary.
 - e. Insert the Torbar into packing gland (D).
 - f. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.

- g. Tighten the packing gland bolts (G) equally and evenly until the packing gland is fully sealed, ensuring the Torbar is able to slide through it.
- h. Open isolation valve (B).

Note. During step I, turn drive nuts (H) equally and evenly to prevent binding.

- i. **Drawbolt retraction assembly only** – turn each drive-nut (H) clockwise alternately until the Torbar passes through isolation valve (B) and protrudes from the threaded fitting on the opposite side of the process pipe by 25 mm (1.0 in). When the Torbar is inserted fully, ensure the drawbolts (J) and stop nuts (K) are in the positions shown.
- j. **Drawbolt retraction assembly only** – tighten lock nuts (L).

Note. The gear retraction handle is supplied loose and can be fitted to either side of the gears. However, ensure the handle is fitted so that the Torbar is inserted when the handle is turned clockwise.

- k. **Optional geared retraction assembly only** – turn the integral handle clockwise until the Torbar protrudes from the threaded fitting on the opposite side of the process pipe by 25 mm (1.0 in).
 - l. Apply appropriate sealant to the threads of support plug (M).
 - m. Screw support plug (M) into threaded fitting (N) and tighten, ensuring that it contacts the Torbar.
 - n. Fully tighten packing gland bolts (G), ensuring the Torbar does not turn. Check for leaks.
9. Check the Torbar is installed correctly and aligned.
 10. Pressurize the process pipe and check for leaks.

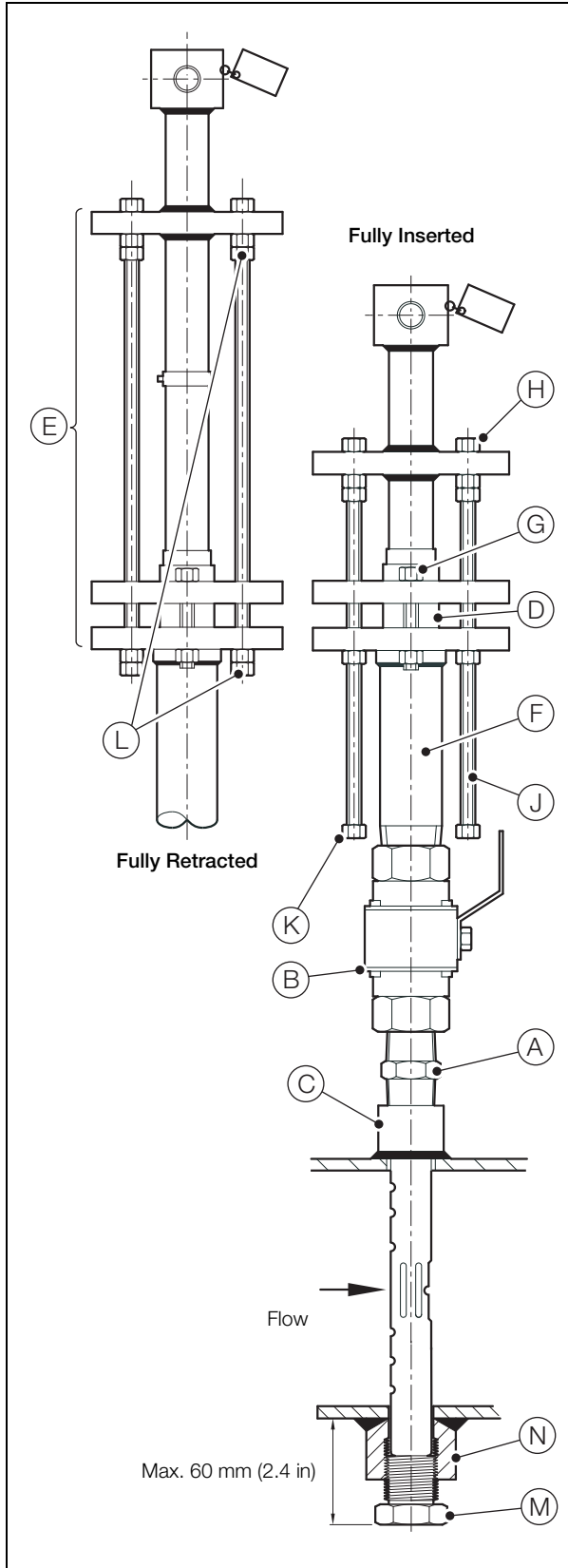


Fig. 2.13 Installation of Threaded Model FPD350.H7.E2

2.15 Flanged Models FPD350.(H6/H7/H8).E1

Warning. Flanged models FPD350.(H6/H7/H8).E1 are designed for 'Hot-Tap' installation. Observe all relevant safety precautions for drilling into pressurized pipelines, and ensure the process material does not exceed the Torbar's specified pressure and temperature limits.

Install the Torbar as follows:

1. Install the flanged pipe fitting (stand-off) – see Section 2.18, page 24.
2. Referring to Fig. 2.14:
 - a. Fit isolation valve (A) to flanged pipe fitting (stand-off) (B).
 - b. Attach hot-tap drilling equipment to isolation valve (A) in accordance with the manufacturer's instructions.
 - c. Drill a 6 mm (0.24 in) pilot hole in the process pipe at the marked position, then drill to the appropriate size – see Table 2.8.

Flanged Torbar Model	FPD350.H6.E1	FPD350.H7.E1	FPD350.H8.E1
Hole size in mm (in)	16 (0.5)	28 (1.0)	65 (2.4)

Table 2.8 Hole Size

- d. Withdraw the drill, close isolation valve (A) fully and remove the hot-tap drilling equipment.
- e. Ensure 6 packing rings are located correctly inside packing gland (C).
- f. Ensure the drawbolt (or optional geared) retraction assembly (D) is in the fully retracted position.
- g. Fit flanged pressure chamber (E), complete with packing gland (C) and retraction assembly (D), to isolation valve (A).
- h. Insert the Torbar into packing gland (C).
- i. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
- j. Tighten the packing gland bolts (F) equally and evenly until the packing gland is fully sealed, ensuring the Torbar is able to slide through it.

- k. Carefully open isolation valve (A) and check for leaks around packing gland (C).

Note. During step l, turn drive nuts (G) equally and evenly to prevent binding.

- l. **Drawbolt retraction assembly only** – turn each drive-nut (G) clockwise alternately until the Torbar passes through isolation valve (A) and contacts the opposite side of the process pipe. When the Torbar is inserted fully, ensure the drawbolts (H) and stop nuts (J) are in the positions shown.
- m. **Drawbolt retraction assembly only** – tighten lock nuts (K).

Note. The gear retraction handle is supplied loose and can be fitted to either side of the gears. However, ensure the handle is fitted so that the Torbar is inserted when the handle is turned clockwise.

- n. **Optional geared retraction assembly only** – turn the integral handle clockwise until the Torbar contacts the opposite side of the process pipe.
- o. Fully tighten packing gland bolts (C), ensuring the Torbar does not turn. Check for leaks.

3. Check the Torbar is installed correctly and aligned.

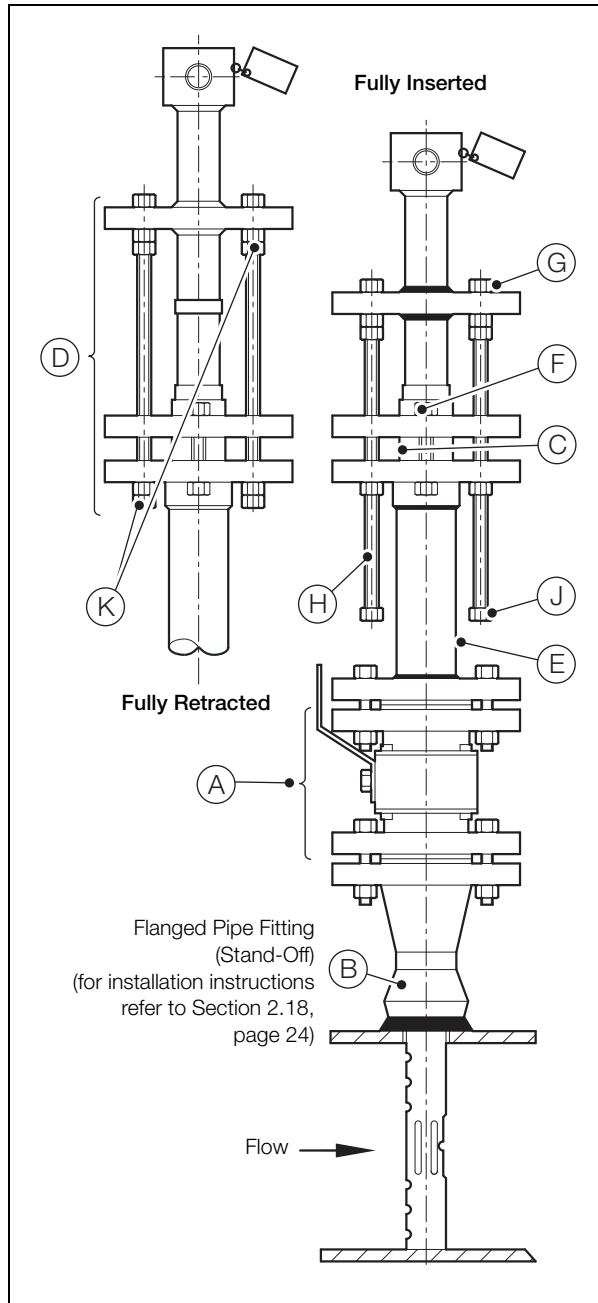


Fig. 2.14 Installation of Flanged Models
FPD350.(H6/H7/H8).E2

2.16 Flanged Models FPD350.(H7/H8).E2

Warning. Flanged models FPD350.(H7/H8).E2 are supported in the process pipe at the Torbar tip as well as at the entry point into the pipe, therefore they cannot be 'Hot-Tap' installed. Before drilling into the pipe, reduce the pipe pressure to a safe level and remove all hazardous material. Before inserting the probe, you must also stop the flow completely, to ensure that the probe can correctly engage with the end support.

Install the Torbar as follows:

Note. Step 1 is applicable only if the flanged pipe fitting (stand-off) is not installed.

1. Install the flanged pipe fitting (stand-off) – see Section 2.18, page 24.
2. Measure exactly 180° around the pipe circumference and mark the pipe.
3. Drill a 6 mm (0.24 in) pilot hole in the process pipe at the marked position, then drill to the appropriate size – see Table 2.9.

Flanged Torbar Model	FPD350.H7.E2	FPD350.H8.E2
Hole size in mm (in)	28 (1.1)	65 (2.56)

Table 2.9 Hole Size

4. Referring to Fig. 2.15:
 - a. Fit isolation valve (A) to flanged coupling (B).
 - b. Ensure 6 packing rings are located correctly inside packing gland (C).
 - c. Ensure the drawbolt (or optional geared) retraction assembly (D) is in the fully retracted position.
 - d. Fit flanged pressure chamber (E), complete with packing gland (C) and retraction assembly (D), to isolation valve (A).
 - e. Insert the Torbar into packing gland (C).
 - f. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
 - g. Tighten the packing gland bolts (F) equally and evenly until the packing gland is fully sealed, ensuring the Torbar is able to slide through it.
 - h. Open isolation valve (A).

Note. During step I, turn drive nuts (G) equally and evenly to prevent binding.

- i. **Drawbolt retraction assembly only** – turn each drive-nut (H) clockwise alternately until the Torbar passes through isolation valve (A) and protrudes from the hole on the opposite side of the process pipe by:

FPD350.H7.E2 – 40 mm (1.6 in)
FPD350.H8.E2 – 65 mm (2.6 in)

When the Torbar is inserted fully, ensure drawbolts (H) and stop nuts (J) are in the positions shown.

Note. The gear retraction handle is supplied loose and can be fitted to either side of the gears. However, ensure the handle is fitted so that the Torbar is inserted when the handle is turned clockwise.

- j. **Geared retraction assembly only** – turn the integral handle clockwise until the Torbar protrudes from the threaded fitting on the opposite side of the process pipe by:

FPD350.H7.E2 – 40 mm (1.6 in)
FPD350.H8.E2 – 65 mm (2.6 in)
 - k. Place end support cup (L) over the tip of the Torbar and tack-weld it to the process pipe.
 - l. Reverse step i (drawbolt retraction assembly) or step j (geared retraction assembly) and retract the Torbar by 100 mm (4.0 in).
 - m. Weld end support cup (L) to the pipe.
 - n. Repeat step i (drawbolt retraction assembly) or step j (geared retraction assembly) to re-insert the Torbar by 100 mm (4.0 in), ensuring it enters the support cup (L).
 - o. **Drawbolt retraction assembly only** – tighten lock nuts (K).
 - p. Fully tighten packing gland bolts (F), ensuring the Torbar does not turn. Check for leaks.
5. Check the Torbar is installed correctly and aligned.
 6. Pressurize the process pipe and check for leaks.

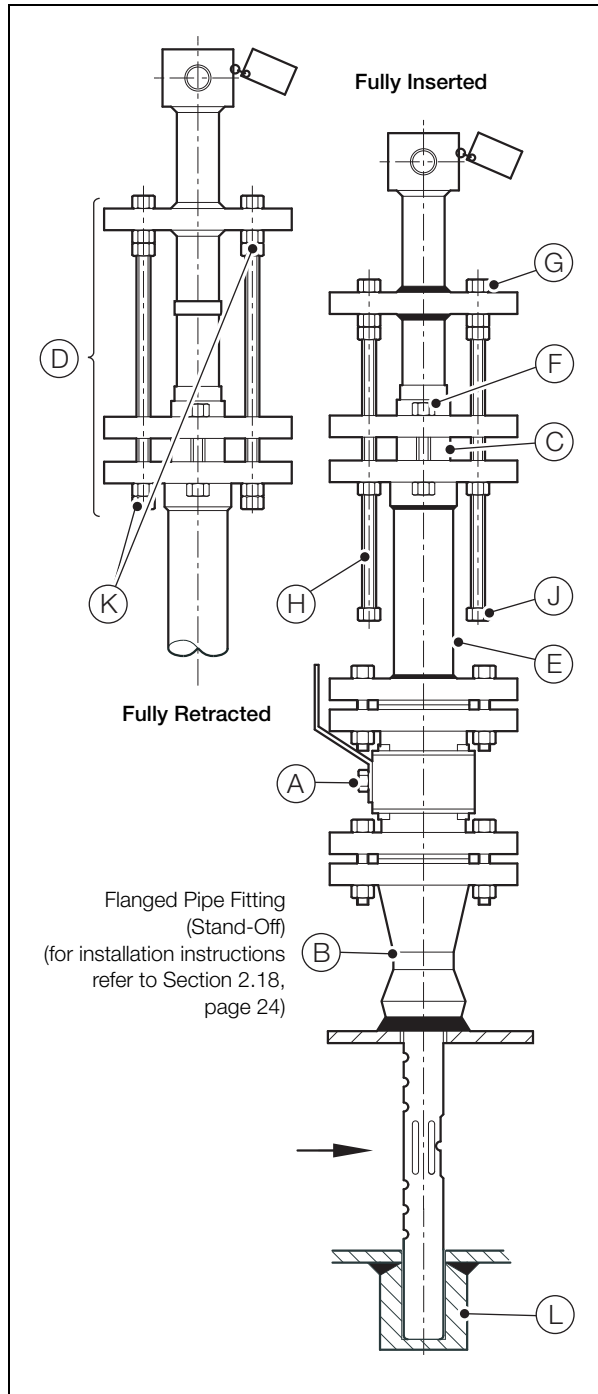


Fig. 2.15 Installation of Flanged Models
FPD350.(H7/H8).E2

2.17 Flanged Models FPD350.(H7/H8).E2 with Flanged End-Support Fitting (mounting types F3, F4)

Warning. Flanged models FPD350.(H7/H8).E2 are supported in the process pipe at the Torbar tip as well as at the entry point into the pipe, therefore they cannot be 'Hot-Tap' installed. Before drilling into the pipe, reduce the pipe pressure to a safe level and remove all hazardous material.

Note. The gear retraction handle is supplied loose and can be fitted to either side of the gears. However, ensure the handle is fitted so that the Torbar is inserted when the handle is turned clockwise.

Install the Torbar as follows:

1. Install the flanged pipe fitting (stand-off) – see Section 2.18, page 24.
2. Measure exactly 180° around the pipe circumference and mark the pipe.
3. Drill a 6 mm (0.24 in) pilot hole in the process pipe at the marked position, then drill to the appropriate size – see Table 2.10.

Flanged Torbar Model	FPD350.H7.E2	FPD350.H8.E2
Hole size in mm (in)	28 (1.1)	65 (2.56)

Table 2.10 Hole Size

4. Referring to Fig. 2.15:
 - a. Fit isolation valve (A) to flanged coupling (B).
 - b. Ensure 6 packing rings are located correctly inside packing gland (C).
 - c. Ensure the drawbolt (or optional geared) retraction assembly (D) is in the fully retracted position.
 - d. Fit flanged pressure chamber (E), complete with packing gland (C) and retraction assembly (D), to isolation valve (A).
 - e. Insert the Torbar into packing gland (C).
 - f. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
 - g. Tighten the packing gland bolts (F) equally and evenly until the packing gland is fully sealed, ensuring the Torbar is able to slide through it.
 - h. Open isolation valve (A).

Note. During step l, turn drive nuts (G) equally and evenly to prevent binding.

- i. **Drawbolt retraction assembly only** – turn each drive-nut (H) clockwise alternately until the Torbar passes through isolation valve (A) and protrudes from the hole on the opposite side of the process pipe by:

FPD350.H7.E2 – 40 mm (1.6 in)

FPD350.H8.E2 – 65 mm (2.6 in)

When the Torbar is inserted fully, ensure drawbolts (H) and stop nuts (J) are in the positions shown.

- j. **Geared retraction assembly only** – turn the integral handle clockwise until the Torbar protrudes from the threaded fitting on the opposite side of the process pipe by:

FPD350.H7.E2 – 40 mm (1.6 in)

FPD350.H8.E2 – 65 mm (2.6 in)

- k. Position the flanged pipe fitting (stand-off) (L) over the tip of the Torbar, ensuring the tip enters the end support stub.
- l. Refer to Section 2.18, Steps 3b and 3c on page 24 and tack-weld the flanged pipe fitting (stand-off) (L) in place.
- m. Reverse step i (drawbolt retraction assembly) or step j (geared retraction assembly) and retract the Torbar by 100 mm (4.0 in).
- n. Refer to Section 2.18, Steps 3d to 3g on page 24 and complete the installation of the flanged pipe fitting (stand-off) (L).
- o. Repeat step i (drawbolt retraction assembly) or step j (geared retraction assembly) to re-insert the Torbar until the tip is within:
 - FPD350.H7.E2 – 40 mm (1.6 in)
 - FPD350.H8.E2 – 65 mm (2.6 in)
 of the face of the flange on the flanged pipe fitting (stand-off) (L).
- p. Position a gasket on the flanged end support flitting (M), ensuring the integral support cup faces the tip of the Torbar.
- q. Fit the flanged end support flitting (M) to the flanged pipe fitting (stand-off) (L), ensuring the tip of the Torbar enters the support cup.
- r. **Drawbolt retraction assembly only** – tighten lock nuts (K).
- s. Fully tighten packing gland bolts (F), ensuring the Torbar does not turn. Check for leaks.

5. Check the Torbar is installed correctly and aligned.

6. Pressurize the process pipe and check for leaks.

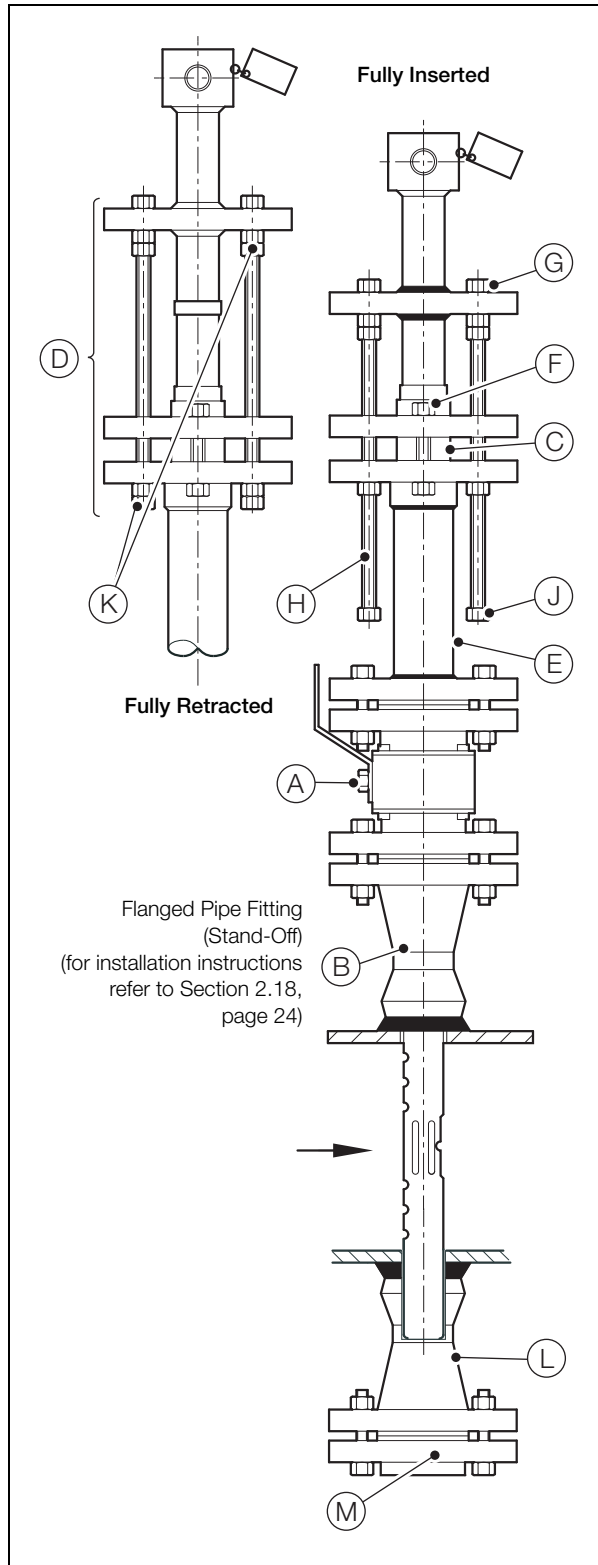


Fig. 2.16 Installation of Flanged Models
FPD350.(H7/H8).E2

2.18 Flanged Pipe Fitting (Stand-Off) Installation

Note. This Section is applicable only to flanged Torbar models.

Install the flanged pipe fitting (stand-off) as follows:

1. Select the required insertion position and mark the pipe.

Warning.

- Step 2 is applicable only to flanged Torbar models FPD350.(T3/T4/T5).(E1/E2) and FPD350.(H7/H8).E2 that cannot be hot-tap installed.
- Before drilling into the pipe, reduce the pipe pressure to a safe level and remove all hazardous material

2. Drill a 6 mm (0.24 in) pilot hole at the marked position, then drill to the appropriate size – see Table 2.11.

Flanged Torbar Model	FPD350.T3	FPD350.T4 FPD350.H7	FPD350.T5 FPD350.H8
Hole size in mm (in)	16 (0.63)	28 (1.1)	65 (2.56)

Table 2.11 Hole Size

Note. Every flanged pipe fitting (stand-off) is shaped to fit the pipe and is self-aligning on two bolt holes as standard.

3. Referring to Fig. 2.17:
 - a. Place the flanged pipe fitting (stand-off) (A) centrally over the drilled hole (models FPD350.T3.E1; FPD350.T4.(E1/E2); FPD350.T5.(E1/E2); FPD350.H7.E2; FPD350.H8.E2) or mark (Flanged models FPD350.T3; FPD350.T4.(E1/E2) and FPD350.T5.(E1/E2)) and align it correctly to the axis of the pipe (angle X) according to the number of bolt holes in the flange. Ensure it is perpendicular to the pipe axis and square to the pipe plane.
 - b. Use suitable spacers (B) to raise the flanged pipe fitting (stand-off) off the pipe to establish the necessary gap for full-penetration welding.
 - c. Tack-weld at four points (C) midway between the crotch and the skirt sections of the fitting.
 - d. Using a suitable piece of pipe, ensure the flanged pipe fitting (stand-off) is correctly aligned with the pipe (see Fig. 2.2, page 4) and concentric with the hole.
 - e. Remove the spacers (B).
 - f. Apply a full penetration root run completely around the base of the flanged pipe fitting (stand-off) at the clearly defined weld preparation line (D).

- g. Make reinforcing welds at the crotch bevelled areas (E) of the flanged pipe fitting (stand-off) to provide maximum weld at the crotch tapering to a minimum at the skirt (F).

Caution. Weld only the bevelled portion of the flanged pipe fitting (stand-off) to prevent the integrity of the weld being compromised by any notch effect.

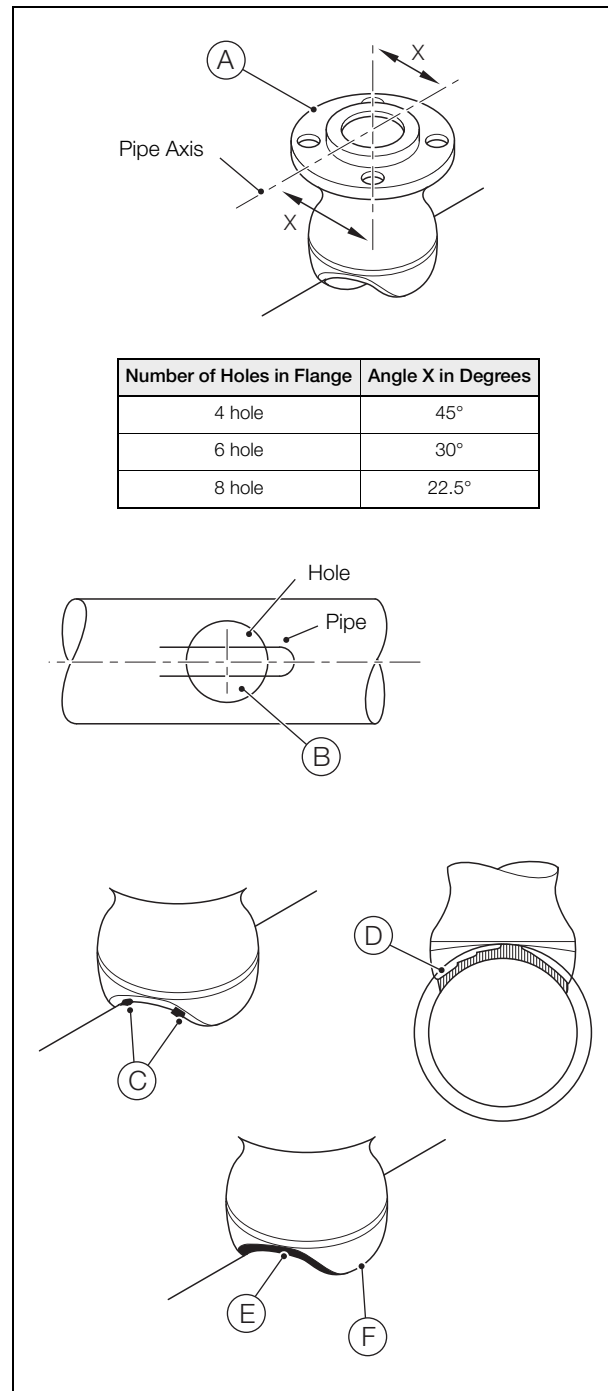


Fig. 2.17 Flanged Pipe Fitting (Stand-off) Installation

3 Torbar Removing and Refitting

3.1 Threaded Models FPD350.T3 and FPD350.T4.(E1/E2)

3.1.1 Removing

Remove the Torbar as follows:

Warning. Failure to reduce the pipe pressure to a safe level and remove all hazardous material prior to removing the Torbar could result in serious injury to personnel.

1. Reduce pipe pressure to a safe level and remove all hazardous material.
2. Remove the compression fitting.
3. Remove the Torbar.

3.1.2 Refitting

Refit the Torbar as follows:

1. Slide the compression-fitting assembly onto the Torbar.
2. Insert the Torbar through the threaded fitting into the pipe until it either touches the opposite internal wall (**models FPD350.T3.E1 and FPD350.T4.E1**) or enters the opposite fitting (**model FPD350.T4.E2**).
3. Apply appropriate sealant to the threads of the compression fitting.
4. Screw the compression fitting into the threaded fitting until hand-tight.
5. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
6. Holding the head of the Torbar with a wrench to maintain correct orientation, use a long wrench to tighten the compression fitting until approximately one thread is left exposed under the nut, ensuring the Torbar does not turn.
7. Check the Torbar is installed correctly and aligned.

3.2 Flanged Models FPD350.T3; FPD350.T4.(E1/E2) and FPD350.T5.(E1/E2)

3.2.1 Removing

Remove the Torbar as follows:

Warning. Failure to reduce the pipe pressure to a safe level and remove all hazardous material prior to removing the Torbar could result in serious injury to personnel.

1. Reduce pipe pressure to a safe level and remove all hazardous material.
2. Remove the flange securing bolts.
3. Remove the Torbar.

3.2.2 Refitting

Refit the Torbar as follows:

1. Position the gasket onto the Torbar flange and carefully insert the Torbar through the flanged pipe fitting (stand-off) (ensuring the tip of the Torbar enters the opposite fitting – **models FPD350.T4.E2 and FPD350.T5.E2**) until the two flanges mate squarely.
2. Turn the upper flange until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
3. Fit the flange securing bolts and tighten equally and evenly, observing correct procedures appropriate to the flange.
4. Check the Torbar is installed correctly and aligned.

3.3 Models FPD350.(L6/L7)

Warning. Do not position any part of the body in the Torbar's exit path when removing or refitting the Torbar.

3.3.1 Removing

Referring to Fig. 3.1:

1. Reposition chain link (A) to lengthen safety chain (B) to its maximum. Take care if the Torbar begins to exit from packing gland (C).
2. Slacken packing gland (C) slowly and just sufficiently to enable the slow, controlled exit of the Torbar.
3. When the Torbar is clear of isolation valve (D), fully close the valve.
4. Slacken packing gland (C) slowly to release the pressure in pressure chamber (E).
5. Remove the Torbar completely if required.

3.3.2 Refitting

Referring to Fig. 3.1:

1. Insert the Torbar into packing gland (C) and tighten the packing gland until it is fully sealed, ensuring the Torbar is able to slide through it.
2. Ensure safety chain (B) is securely attached to pressure chamber (E).
3. Attach chain link (A) to safety chain (B), ensuring the safety chain is tight.
4. Carefully open isolation valve (D) and check for leaks around packing gland (C).
5. Insert the Torbar through isolation valve (D) until it either touches the opposite internal wall of the process pipe (Models L601 and L701) or enters the opposite fitting (F) (Model L702).

Warning. During step 6, maintain continuous pressure on the Torbar to ensure that it remains in contact with the opposite internal wall of the process pipe (Models FPD350.(L6/L7).E1) or in the opposite fitting (Model FPD350.L7.E2).

6. Reposition chain link (A) to tighten safety chain (B).
7. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
8. Fully tighten packing gland (C), ensuring the Torbar does not turn. Check for leaks.
9. Ensure that safety chain (B) is fully tightened and secure.
10. Check the Torbar is installed correctly and aligned.

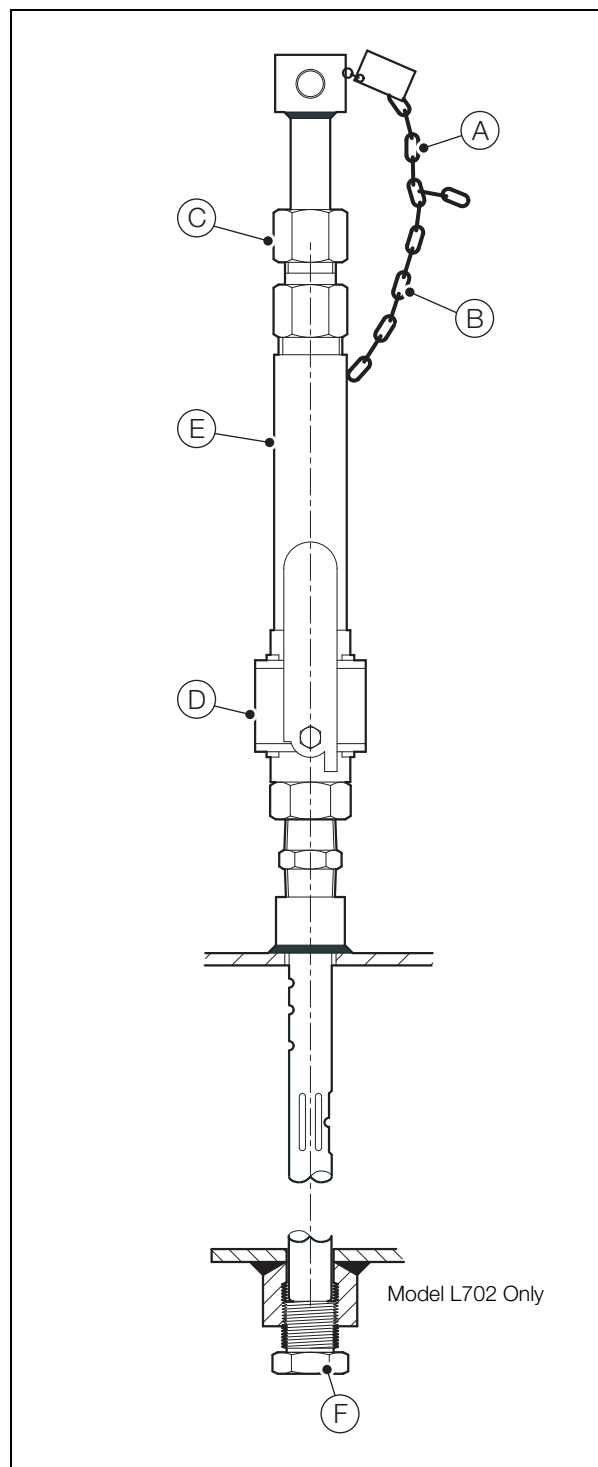


Fig. 3.1 Removing and Refitting Models FPD350.(L6/L7)

3.4 Threaded Models FPD350.(H6/H7)

Warning. Do not position any part of the body in the Torbar's exit path when removing or refitting the Torbar.

3.4.1 Removing

Referring to Fig. 3.2:

1. Slacken packing gland bolts (A) evenly and just sufficiently to enable the slow, controlled exit of the Torbar.

Note. During step 2, turn drive nuts (C) equally and evenly to prevent binding.

2. **Drawbolt retraction assembly only** – Loosen lock nuts (B) and turn drive-nuts (C) counter-clockwise alternately until the Torbar passes through isolation valve (D). Ensure the retraction assembly is in the fully retracted position (E).
3. **Geared retraction assembly only** – turn the integral handle counter-clockwise until the Torbar passes through isolation valve (D).
4. Close isolation valve (D).
5. Slacken packing gland bolts (A) slowly to release the pressure in pressure chamber (F).
6. Remove the Torbar completely if required.

3.4.2 Refitting

Referring to Fig. 3.2:

1. Insert the Torbar into packing gland (G).
2. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
3. Tighten the packing gland bolts (A) equally and evenly until the packing gland is fully sealed, ensuring the Torbar is able to slide through it.
4. Carefully open isolation valve (D) and check for leaks around packing gland (G).

Note. During step 5, turn drive nuts (H) equally and evenly to prevent binding.

5. **Drawbolt retraction assembly only** – turn each drive-nut (H) clockwise alternately until the Torbar passes through isolation valve (D) and contacts the opposite internal wall of the process pipe (Models FPD350.(H6/H7).E1) or enters the opposite fitting (F) (Model FPD350.H7.E2). When the Torbar is inserted fully, ensure the drawbolts (J) and stop nuts (K) are in the positions shown.
6. **Drawbolt retraction assembly only** – tighten lock nuts (B).

Note. The gear retraction handle is supplied loose and can be fitted to either side of the gears. However, ensure the handle is fitted so that the Torbar is inserted when the handle is turned clockwise.

7. **Optional geared retraction assembly only** – turn the integral handle clockwise until the Torbar contacts the opposite internal wall of the process pipe (Models FPD350.(H6/H7).E1) or enters the opposite fitting (F) (Model FPD350.H7.E2).
8. Fully tighten packing gland bolts (A), ensuring the Torbar does not turn. Check for leaks.

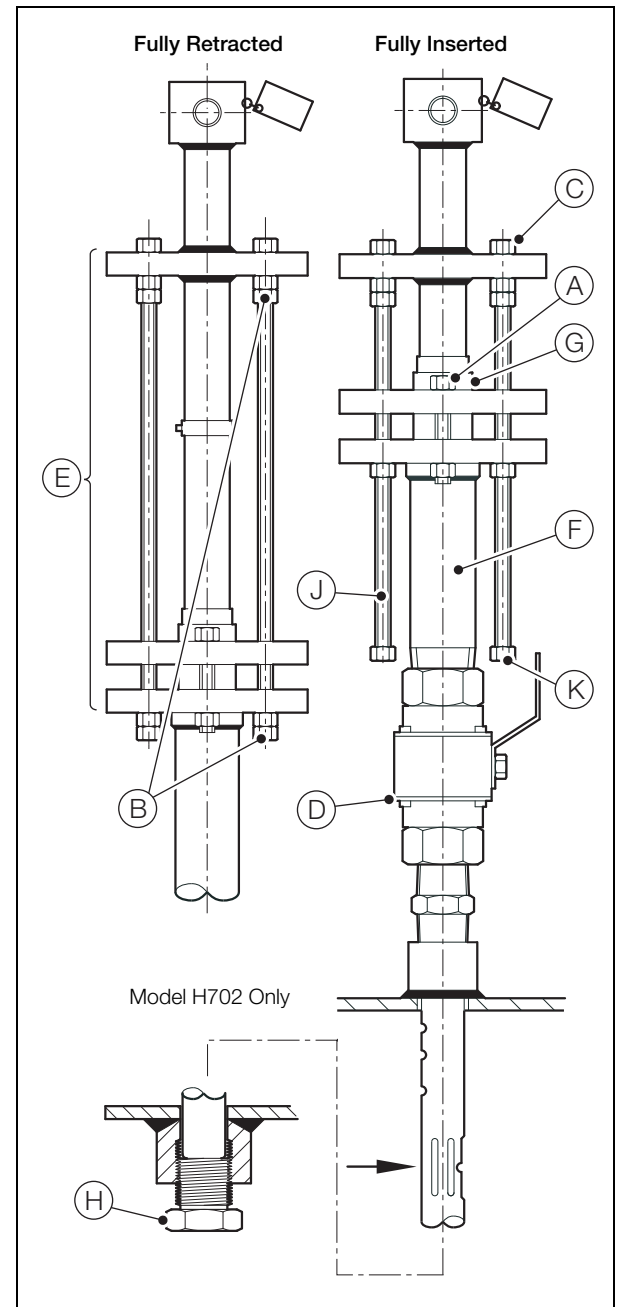


Fig. 3.2 Removing and Refitting Models FPD350.(H6/H7)

3.5 Flanged models FPD350.(H6/H7/H8)

Warning. Do not position any part of the body in the Torbar's exit path when removing or refitting the Torbar.

3.5.1 Removing

Referring to Fig. 3.2:

1. Slacken packing gland bolts (A) evenly and just sufficiently to enable the slow, controlled exit of the Torbar.

Note. During step 2, turn drive nuts (C) equally and evenly to prevent binding.

2. **Drawbolt retraction assembly only** – Loosen lock nuts (B) and turn drive-nuts (C) counter-clockwise alternately until the Torbar passes through isolation valve (D). Ensure the retraction assembly is in the fully retracted position (E).
3. **Geared retraction assembly only** – turn the integral handle counter-clockwise until the Torbar passes through isolation valve (D).
4. Close isolation valve (D).
5. Slacken packing gland bolts (A) slowly to release the pressure in pressure chamber (F).
6. Remove the Torbar completely if required.

3.5.2 Refitting

Referring to Fig. 3.2:

1. Insert the Torbar into packing gland (G).
2. Turn the Torbar until the indentation marks on the head are positioned downstream of the flow – see Fig. 2.1, page 3.
3. Tighten the packing gland bolts (A) equally and evenly until the packing gland is fully sealed, ensuring the Torbar is able to slide through it.
4. Carefully open isolation valve (D) and check for leaks around packing gland (G).

Note. During step 5, turn drive nuts (H) equally and evenly to prevent binding.

5. **Drawbolt retraction assembly only** – turn each drive-nut (H) clockwise alternately until the Torbar passes through isolation valve (D) and contacts the opposite internal wall of the process pipe (Models FPD350.(H6/H7/H8).E1) or enters the opposite fitting (F) (Models FPD350.(H7/H8).E2). When the Torbar is inserted fully, ensure the drawbolts (J) and stop nuts (K) are in the positions shown.
6. **Drawbolt retraction assembly only** – tighten lock nuts (B).

Note. The gear retraction handle is supplied loose and can be fitted to either side of the gears. However, ensure the handle is fitted so that the Torbar is inserted when the handle is turned clockwise.

7. **Optional geared retraction assembly only** – turn the integral handle clockwise until the Torbar contacts the opposite internal wall of the process pipe (Models FPD350.(H6/H7/H8).E1) or enters the opposite fitting (F) (Models FPD350.(H7/H8).E2).
8. Fully tighten packing gland bolts (A), ensuring the Torbar does not turn. Check for leaks.

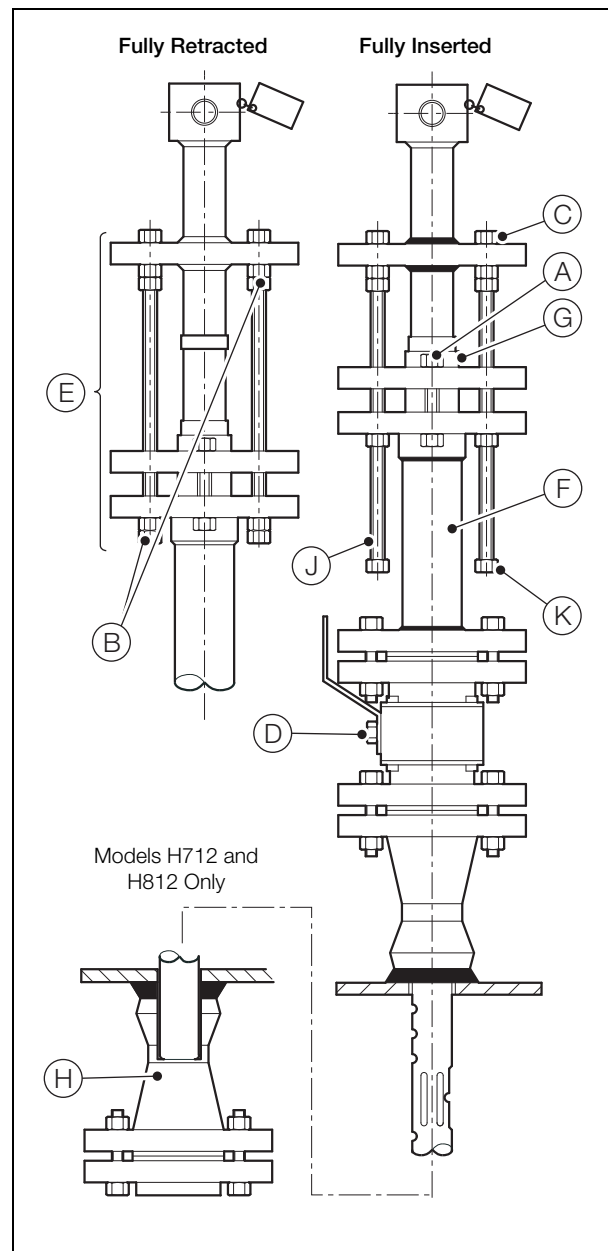


Fig. 3.3 Removing and Refitting Models FPD350.(H6/H7/H8)

4 Connecting a Differential Pressure Measuring Instrument

4.1 General

Before connecting a differential pressure measuring instrument, read the manufacturer's installation instructions.

The Torbar may or may not be supplied with isolating valves fitted to the two output connections. Check whether or not they are required.

Connect the Torbar's high-pressure connection (marked H) of the Torbar (see Fig. 2.1, page 3) to the high pressure side of the differential pressure instrument and the low pressure connection (marked L) to the low pressure side of the differential pressure instrument.

4.2 Impulse Tubing

- Use minimum 6 mm (0.25 in) ID piping. For steam flow measurement, use 13 mm (0.5 in) ID tubing.
- Keep tubing as short as possible but ensure the differential pressure measuring instrument can operate within its specified temperature limits.
- Support tubing over its entire length and isolate it from sources of vibration or damage.
- Route the tubing from the high and low pressure connections as close together as possible to maintain equal temperatures.
- Do not route the tubing in areas where the ambient temperature may fluctuate.
- **Liquid and steam applications** – mount the differential pressure measuring instrument **below** the level of the Torbar head, ensuring the tubing slopes **up** towards the Torbar connections at an incline of at least 25 mm per 300 mm (1 in per 12 in).
- **Gas applications** – mount the differential pressure measuring instrument **above** the level of the Torbar head, ensuring the tubing slopes **down** towards the Torbar connections at an incline of at least 25 mm per 300 mm (1 in per 12 in).
- **Liquid applications** – ensure the tubing from the high and low pressure connections are mounted at the same level in order to balance the head of liquid in both tubes and vent any gas build-up.

4.3 Purging

Torbars can be used successfully for measuring the flow of dirty fluids without purging.

If purging is necessary, periodic purging is the simplest method.

To purge the Torbar, refer to the specific operating instructions and drawings supplied with the purge unit and:

1. Isolate the measuring instrument from the purge lines.
2. Connect a compatible pressurized medium to the Torbar output and blow it through the Torbar to force out contamination.

Torbar Purge Systems are available for intermittent air purging.

4.4 Steam Applications

Ensure both high- and low-pressure Torbar connections are at the same vertical height to maintain equal condensate levels above the secondary instrumentation – see Fig. 4.1, page 30. Mount the filling tees or condensate pots at the same level and as close as possible to the Torbar head to ensure no condensate forms in the lagged sections.

Mount the secondary instrumentation below the level of the Torbar and connect 13 mm (0.5 in) ID tubing (rated for continuous use at the steam pressure) to the bottom of the filling tee or condensate pot. Ensure the tubing has a minimum slope of 25 mm per 300 mm (1 in per 12 in) and ensure the two lines are close together to maintain equal temperature. Use a 3- or 5-valve manifold to interface the connections between the secondary instrumentation and the Torbar fitting. Ensure the condensate temperature does not exceed the temperature limit of the secondary instrumentation.

For information on start-up and operation procedures, refer to the manufacturer's instructions for the secondary instrumentation.

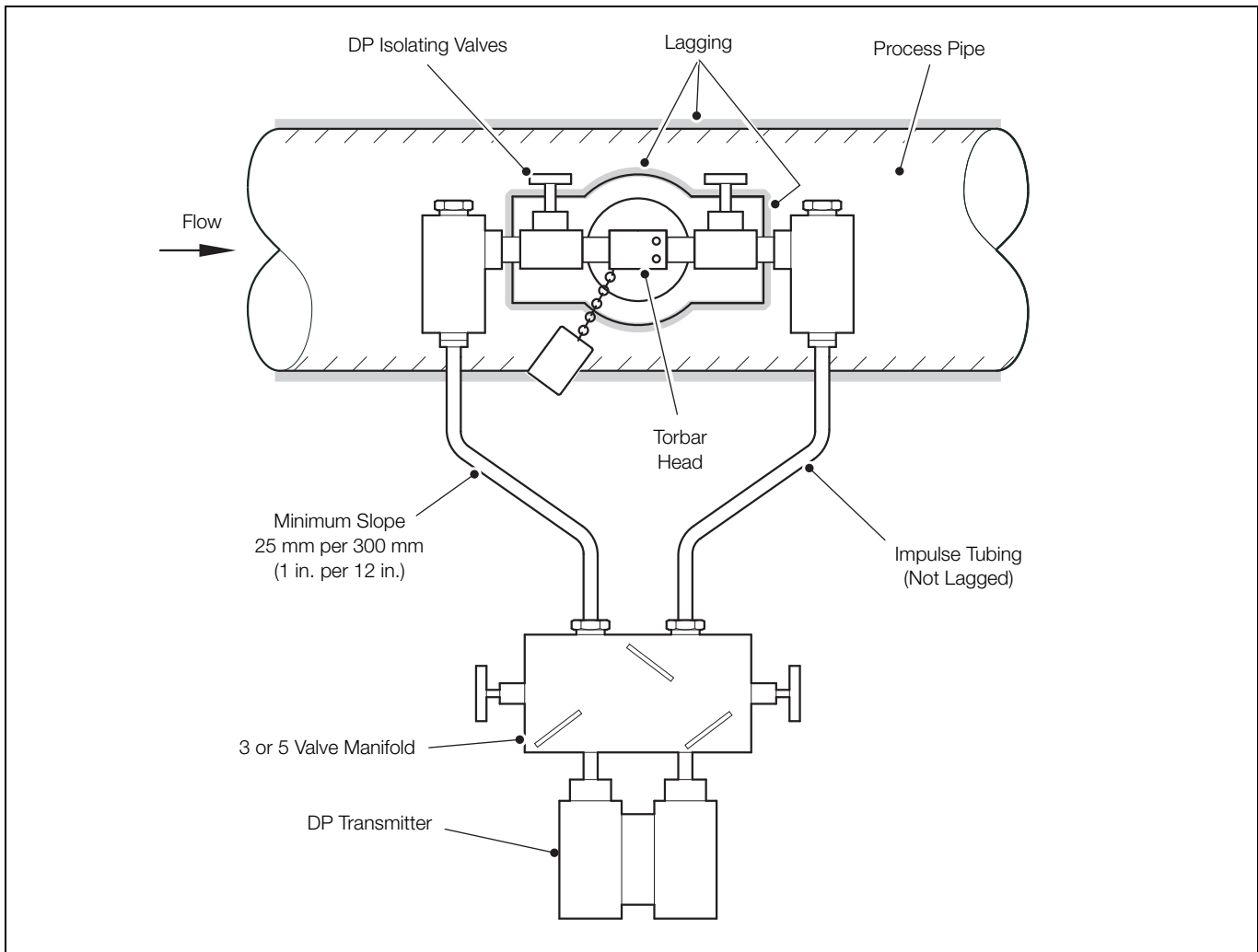


Fig. 4.1 Connection (steam applications only)

5 Maintenance

Torbar Averaging Pitot Tube elements have no moving parts, and do not normally require routine maintenance.

However, depending on process conditions, check Torbar periodically for signs of blockage, erosion or corrosion. If withdrawal is necessary, it must be carried out in accordance with the relevant procedure – see Section 3, page 25.

6 Troubleshooting

If a malfunction is suspected:

1. Check for leakage between the head of the Torbar and the transmitter or indicator.

Note. Compared to orifice plates and other primary flow elements, Averaging Pitot Tubes create small differential pressures. Therefore test all potential leak points carefully for leaks.

2. Check for partial or total blockages by testing that pressure is present at both outlets.
3. Using a reliable differential pressure source such as a manometer or a calibrated differential pressure cell, check the actual differential pressure while flow is present.

Products and customer support

Automation Systems

For the following industries:

- Chemical & Pharmaceutical
- Food & Beverage
- Manufacturing
- Metals and Minerals
- Oil, Gas & Petrochemical
- Pulp and Paper

Drives and Motors

- AC and DC Drives, AC and DC Machines, AC Motors to 1kV
- Drive Systems
- Force Measurement
- Servo Drives

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- Single and Multi-loop Controllers
- Circular Chart and Strip Chart Recorders
- Paperless Recorders
- Process Indicators

Flexible Automation

- Industrial Robots and Robot Systems

Flow Measurement

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- Mass Flowmeters
- Turbine Flowmeters
- Wedge Flow Elements

Marine Systems & Turbochargers

- Electrical Systems
- Marine Equipment
- Offshore Retrofit and Refurbishment

Process Analytics

- Process Gas Analysis
- Systems Integration

Transmitters

- Pressure
- Temperature
- Level
- Interface Modules

Valves, Actuators and Positioners

- Control Valves
- Actuators
- Positioners

Water, Gas & Industrial Analytics Instrumentation

- pH, Conductivity and Dissolved Oxygen Transmitters and Sensors
- Ammonia, Nitrate, Phosphate, Silica, Sodium, Chloride, Fluoride, Dissolved Oxygen and Hydrazine Analyzers
- Zirconia Oxygen Analyzers, Katharometers, Hydrogen Purity and Purge-gas Monitors, Thermal Conductivity

Customer support

We provide a comprehensive after sales service via a Worldwide Service Organization. Contact one of the following offices for details on your nearest Service and Repair Centre.

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Tel: +44 (0)1453 826661
Fax: +44 (0)1453 829671

USA

ABB Inc.
Tel: +1 215 674 6000
Fax: +1 215 674 7183

Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification. Periodic checks must be made on the equipment's condition. In the event of a failure under warranty, the following documentation must be provided as substantiation:

- A listing evidencing process operation and alarm logs at time of failure.
- Copies of all storage, installation, operating and maintenance records relating to the alleged faulty unit.

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