Model T17

Ultrasonic Flow Transducer

Installation Guide
Model T17

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Installation Guide
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# Contents

**Chapter 1. Introduction**

1.1 Overview ........................................................................................................... 1

1.2 Transducer Construction ................................................................................... 1

1.3 Certification and Safety Statements .................................................................. 2

**Chapter 2. Installing the Pipe Nozzles**

2.1 Introduction ....................................................................................................... 3

2.2 Nozzle Installation - Diametrical Path .............................................................. 4

  2.2.1 Identifying the Nozzle Installation Kit Components - Diametrical ............... 5

  2.2.2 Selecting and Marking the First Nozzle Location - Diametrical .................. 6

  2.2.3 Determining and Marking the Second Nozzle Location - Diametrical ....... 8

  2.2.4 Installing the First Welding Boss - Diametrical ........................................ 12

  2.2.5 Installing the First Nozzle - Diametrical .................................................. 14

  2.2.6 Installing the Second Welding Boss and Nozzle - Diametrical .................. 16

  2.2.7 Hot Tapping the Pipe - Diametrical .......................................................... 17

  2.2.8 Cold Tapping the Pipe - Diametrical ........................................................ 17

2.3 Nozzle Installation - MR1 Mid-Radius Path ...................................................... 18

  2.3.1 Identifying the Nozzle Installation Kit Components - MR1 Mid-Radius ..... 19

  2.3.2 Selecting and Marking the First Nozzle Location - MR1 Mid-Radius ......... 20

  2.3.3 Determining and Marking the Second Nozzle Location - MR1 Mid-Radius 24

  2.3.4 Installing the First Welding Boss - MR1 Mid-Radius ................................ 29

  2.3.5 Installing the First Nozzle - MR1 Mid-Radius .......................................... 32

  2.3.6 Installing the Second Welding Boss and Nozzle MR1 Mid-Radius .......... 34

  2.3.7 Hot Tapping the Pipe - MR1 Mid-Radius .................................................. 35

  2.3.8 Cold Tapping the Pipe - MR1 Mid-Radius ................................................ 35

2.4 Nozzle Installation - MR2 Mid-Radius Path ...................................................... 36

  2.4.1 Identifying the Nozzle Installation Kit Components - MR2 Mid-Radius ..... 37

  2.4.2 Selecting and Marking the First Nozzle Location - MR2 Mid-Radius ......... 38

  2.4.3 Determining and Marking the Second Nozzle Location - MR2 Mid-Radius 42

  2.4.4 Installing the First Welding Boss - MR2 Mid-Radius ................................. 47

  2.4.5 Installing the First Nozzle - MR2 Mid-Radius .......................................... 50

  2.4.6 Installing the Second Welding Boss and Nozzle MR2 Mid-Radius .......... 52

  2.4.7 Hot Tapping the Pipe - MR2 Mid-Radius .................................................. 53

  2.4.8 Cold Tapping the Pipe - MR2 Mid-Radius ................................................ 53

**Chapter 3. Installing an Isolation Valve**

3.1 Introduction ....................................................................................................... 55

3.2 Valve Installation for 3-inch Flanges ................................................................. 55
Chapter 4. Inserting T17 Transducers into the Pipe

4.1 Introduction...........................................................................................................57
4.2 Inserting Transducers Using the Insertion Mechanism........................................57
  4.2.1 Preparing for Installation..............................................................................57
  4.2.2 Mounting the Insertion Mechanism..............................................................58
  4.2.3 Aligning the Downstream Transducer for Extended Range Installations........65
4.3 Connecting an XAMP .........................................................................................69

Chapter 5. Maintaining the T17 Transducers

5.1 Removing Transducers .......................................................................................75
5.2 Using the Insertion Mechanism ..........................................................................75

Chapter 6. Specifications

6.1 T17 Transducer Physical Specifications.............................................................79
6.2 T17 Transducer Certifications ............................................................................79
Information Paragraphs

Note: These paragraphs provide information that provides a deeper understanding of the situation, but is not essential to the proper completion of the instructions.

IMPORTANT: These paragraphs provide information that emphasizes instructions that are essential to proper setup of the equipment. Failure to follow these instructions carefully may cause unreliable performance.

CAUTION! This symbol indicates a risk of potential minor personal injury and/or severe damage to the equipment, unless these instructions are followed carefully.

WARNING! This symbol indicates a risk of potential serious personal injury, unless these instructions are followed carefully.

Safety Issues

WARNING! It is the responsibility of the user to make sure all local, county, state and national codes, regulations, rules and laws related to safety and safe operating conditions are met for each installation.

WARNING! For installations in potentially hazardous areas, be sure to read the Certification and Safety Statements document at the end of this manual before beginning the installation.

Auxiliary Equipment

Local Safety Standards

The user must make sure that he operates all auxiliary equipment in accordance with local codes, standards, regulations, or laws applicable to safety.

Working Area

WARNING! Auxiliary equipment may have both manual and automatic modes of operation. As equipment can move suddenly and without warning, do not enter the work cell of this equipment during automatic operation, and do not enter the work envelope of this equipment during manual operation. If you do, serious injury can result.

WARNING! Make sure that power to the auxiliary equipment is turned OFF and locked out before you perform maintenance procedures on the equipment.
Qualification of Personnel
Make sure that all personnel have manufacturer-approved training applicable to the auxiliary equipment.

Personal Safety Equipment
Make sure that operators and maintenance personnel have all safety equipment applicable to the auxiliary equipment. Examples include safety glasses, protective headgear, safety shoes, etc.

Unauthorized Operation
Make sure that unauthorized personnel cannot gain access to the operation of the equipment.

Environmental Compliance

Waste Electrical and Electronic Equipment (WEEE) Directive
GE Measurement & Control is an active participant in Europe’s Waste Electrical and Electronic Equipment (WEEE) take-back initiative, directive 2012/19/EU.

The equipment that you bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.

In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end life equipment in a sound way.

The crossed-out wheeled bin symbol invites you to use those systems.

If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.


RoHS Compliance
This equipment is fully compliant with the RoHS regulatory requirements.
Chapter 1. Introduction

1.1 Overview

The T17 ultrasonic flow transducer is used exclusively with the GE line of ultrasonic flowmeters. These transducers measure the flow rate of sonically-conductive gases through pipes having diameters between 12 in. (305 mm) and 120 in. (3000 mm). This manual provides details on the following topics:

- Transducer construction
- Nozzle installation
- Transducer installation
- Maintenance
- Specifications

Note: For installation on pipes ranging from 4 to 12 in. (100 to 300 mm), or for using the BIAS 90° configuration, please see the GE #916-117 Installation Guide.

1.2 Transducer Construction

Each T17 transducer assembly (see Figure 1 below) consists of the following components:

- A fully sealed, welded, all metal body made from grade 2 titanium as standard
- A transducer head that consists of piezoelectric elements wired to the BNC connector
- A BNC style connector for use in connecting the transducer to the flowmeter

The T17 transducer is available in standard lengths of 33 in. (840 mm) to 60 in. (1500 mm) and with either a 180° or 174° angled head.

Figure 1: General T17 Transducer (180° Head)
1.3 Certification and Safety Statements

To maintain DEKRA certification, the transducer is provided with an ATEX and IECEx certified compression fitting and/or adapter of either thread M25 X 1.5 (material: brass) or ¾” NPT (material: 316 SS), both with tube size of 0.50” O.D. For example: Tyco part number 496SSGL34Ex ATEX certified under BASEEFA 08ATEX0327X and IECEx BAS08.0107X, Peppers adapter part number ARB/NP/075NPT/M20 ATEX certified under SIRA09ATEX1322X or SIRA09ATEX4323X and IECEx SIR09.0121X and reducer Capri part number 740724 ATEX certified under LCIO8ATEX6085X and IECEx LC018.0035X or equivalent parts. ATEX/IECEx certified enclosure, Type Ex d IIC. For example: International Metal Engineering PTE Limited (IME) Type 8080, 8075, 8066 or 7080 certified under SIRA 07ATEX1331U and IECEx SIR 07.0111U or equivalent that complies with EN 60079-0:2012/IEC 60079-0:2011 and EN 60079-1:2007/IEC 60079-1:2007. For example: Cortem SL-26.1N certified under CESI 03ATEX032U or equivalent. A certified metric-to-NPT adapter (material: brass) may be used in addition to the compression fitting in applicable configurations. Both fitting and adapter to comply with EN 60079-0:2012/ IEC 60079-0:2011 and EN 60079-1:2007/ IEC 60079-1:2007 for Ex d IIC. For electrical connection, the transducer must be mounted into a certified metal enclosure with type of protection flameproof enclosure “D”, complying with EN 60079-1:2007 and IEC 60079-1:2007 Ex d IIC. Measures must be taken to ensure a good electrical contact and to prevent the threads from self-loosening. The compression fitting is suitable for temperatures –60°C to 250°C.
Chapter 2. Installing the Pipe Nozzles

2.1 Introduction

Before the T17 transducers can be installed into the pipe, you will need to install pipe nozzles. Nozzles may be installed as part of a fabricated spoolpiece, or by using a hot or cold tapping process with a GE Nozzle Installation Kit.

IMPORTANT: These procedures only apply if you are using a Nozzle Installation Kit. If you are tapping the pipe without using a Nozzle Installation Kit, refer to the supplied drawings in your shipment. This procedure is written and illustrated for installations on horizontal pipes. However, the procedure is the same for vertical pipe installations.

This chapter describes how to install pipe nozzles in the two available flow range options:

- Standard flow range operation of 0.1 to 328 ft/s (0.03 to 100 m/s):
  This configuration uses two 180° head T17 transducers.

- Extended flow range operation of 0.1 to 394 ft/s (0.03 to 120 m/s):
  This configuration uses one 180° head T17 transducer and one 174° head T17 transducer.

Either of the above flow range options may be used in one of three possible signal path configurations (Figure 2 below illustrates the mirror-image difference between the nozzles for the two mid-radius configurations):

- “Nozzle Installation - Diametrical Path” on page 4
- “Nozzle Installation - MR1 Mid-Radius Path” on page 18
- “Nozzle Installation - MR2 Mid-Radius Path” on page 36

![Figure 2: Top View of Mid-Radius Nozzles (MR1 on Left, MR2 on Right)](image)

CAUTION! The components in your Nozzle Installation Kit have been designed for one specific signal path configuration only. You must properly identify your kit components and then follow only those nozzle installation instructions in the appropriate section.
2.2 Nozzle Installation - Diametrical Path

A *diametrical signal path* is one in which the ultrasonic signal between the two transducers travels along a diameter of the pipe (see *Figure 3* below). Typically, the transducers are located at the 3 o’clock and 9 o’clock positions, when viewed from the downstream end of the pipe.

![Figure 3: Diametrical Path Configuration](image)

The *Diametrical* path nozzle installation procedure includes the following steps:

1. “Identifying the Nozzle Installation Kit Components - Diametrical” on page 5
2. “Selecting and Marking the First Nozzle Location - Diametrical” on page 6
3. “Determining and Marking the Second Nozzle Location - Diametrical” on page 8
4. “Installing the First Welding Boss - Diametrical” on page 12
5. “Installing the First Nozzle - Diametrical” on page 14
6. “Installing the Second Welding Boss and Nozzle - Diametrical” on page 16
7. Proceed to one of the following:
   - “Hot Tapping the Pipe - Diametrical” on page 17
   - “Cold Tapping the Pipe - Diametrical” on page 17
2.2.1 Identifying the Nozzle Installation Kit Components - Diametrical

The Nozzle Installation Kit includes all of the components required for your diametrical configuration. Before proceeding, you must identify these parts and verify that they are the correct parts for your installation.

The Nozzle Installation Kit should contain the following items:

- 2 Nozzles (if purchased)
- 2 Welding Bosses
- 1 Jig
- 1 Threaded Rod (1 in. diameter), with Washer and Nut

IMPORTANT: You will need to supply eight 5/8” studs with two nuts each (for 3”x 150# flanges), or eight 3/4” studs with two nuts each (for 3”x 300# flanges).

Use Figure 4 below to help identify each component.
2.2.1 Identifying the Nozzle Installation Kit Components - Diametrical (cont.)

Check the etched markings on the welding boss, as illustrated in Figure 5 below. The diametrical path code, the pipe OD and the mounting angle are engraved on the bosses.

CAUTION! Before proceeding, be certain that these values match your intended installation and that the etched markings are the same on both bosses.

![Figure 5: Welding Boss Etching](image)

2.2.2 Selecting and Marking the First Nozzle Location - Diametrical

CAUTION! Correct nozzle alignment is critical to the accurate operation of the Flowmeter. Therefore, all marking, positioning and welding operations must be carried out with the utmost attention to accuracy. The centerline of each nozzle must form an angle of 45° ±1° with the centerline of the pipe. The centerlines of the two nozzles must form an angle of 180° ±1° with each other, and the points where the two nozzle centerlines intersect the pipe centerline must be within ±1/16” (±1.6 mm) of each other. When the nozzle installation is complete, the raised faces of the two flanges must be parallel to each other.

WARNING! All hole cutting in live process piping must be performed using hot tapping equipment (see “Hot Tapping the Pipe - Diametrical” on page 17).
2.2.2 Selecting and Marking the First Nozzle Location - Diametrical (cont.)

To mark the first nozzle location, complete the following steps:

1. For optimum performance, you should select a location that has at least 20 pipe diameters of straight, undisturbed flow upstream and 10 pipe diameters of straight, undisturbed flow downstream from the measurement point (see Figure 6 below). Undisturbed flow means avoiding sources of turbulence such as valves, flanges, elbows, swirl and disturbed flow profiles.

2. We recommend that you install the nozzles on a diameter as near as possible to the horizontal plane (i.e., 3 o’clock and 9 o’clock positions) for a horizontal pipe.

**Note:** *If you cannot find a proper location, please consult with GE Flow Application engineering.*

3. At the 3 o’clock position, center punch the pipe to mark the position for the center of the first nozzle, as shown in Figure 7 below.
2.2.2 Selecting and Marking the First Nozzle Location - Diametrical (cont.)

4. Spray the area around the first nozzle location mark with a marking dye product. Using a metal straight edge, scribe 6” long vertical and a horizontal lines that intersect at the center punch mark (see Figure 8 below).

![Figure 8: First Nozzle Scribe Lines](image)

2.2.3 Determining and Marking the Second Nozzle Location - Diametrical

To mark the second nozzle location, complete the following steps:

1. The location for the second nozzle is typically a distance equal to one pipe outside diameter along the pipe from the first nozzle location and on the opposite side of the pipe (i.e., 180° around). Spray this area with a marking dye product.

Note: For angles other than 45°, the distance is equal to the pipe OD times the tangent of the installation angle.

2. Due to the possible variation in OD of the pipe, measure the outside diameter of the pipe at four locations between the nozzle centers (see Figure 9 below). Then, calculate the average OD from these measurements.

![Figure 9: Multiple OD Measurements](image)
2.2.3 Determining and Marking the Second Nozzle Location - Diametrical (cont.)

3. Using a roll of polyester film (or equivalent), cut a strip of film with the following width and length:

**IMPORTANT:** *Ensure that the sides of the film are cut parallel to each other.*

- **Width:** equal to the average outside diameter calculated in Step 2 on the previous page.
- **Length:** equal to 4 times the average outside diameter of the pipe.

![Figure 10: Polyester Film Dimensions](image)

4. Wrap the strip of film around the pipe with one edge running along the vertical scribe line at the first nozzle location. Make sure the strip overlaps squarely around the pipe and mark the overlap position of the strip, as shown in *Figure 11* below. This equals the circumference of the pipe.

![Figure 11: Polyester Film Overlap Mark](image)
2.2.3 Determining and Marking the Second Nozzle Location - Diametrical (cont.)

5. Remove the strip of film and fold it as shown in Figure 12 below to determine the position which is diametrically opposite the overlap position when the film is reapplied to the pipe.

![Figure 12: Folding the Film](image)

6. Mark the outside of the fold for reference, as shown in Figure 13 below.

![Figure 13: Marking the Film](image)

7. Place the strip of film back on the pipe. This time, line up the overlap mark with the horizontal and vertical scribe lines (see Figure 14 below). Again, make sure you wrap the strip of film squarely around the pipe.

![Figure 14: Placing the Film on the Pipe](image)
2.2.3 Determining and Marking the Second Nozzle Location - Diametrical (cont.)

8. The new position of the center of the second nozzle is now identified as the intersection of the fold line and the second edge of the strip of film (see Figure 15 below). Center punch this location prior to removing the film.

9. Remove the film from the pipe.

10. Scribe 6” long vertical and horizontal lines that intersect at the center-punch mark (see Figure 16 below).
2.2.4 Installing the First Welding Boss - Diametrical

To install the first welding boss, complete the following steps:

1. Before welding the first boss, you must add another scribe line to the pipe, known as the oblique center line. The oblique center line compensates for the slope or oblique angle of the boss. The oblique center line is offset from the true vertical center scribe line marked earlier by a distance $X$, which is dependent on the pipe outside diameter and the welding boss diameter as follows:

   \[
   X = \frac{D/2 - \frac{d/2}{\tan \left( \sin^{-1} \left( \frac{d}{D} \right) \right)}}{}
   \]

   where, \( D \) = pipe outside diameter
   \( d \) = welding boss outside diameter (1.660 in.)

   Using the above equation, values of $X$ for some common pipe sizes were calculated and are listed in Table 1 below.

<table>
<thead>
<tr>
<th>Pipe OD</th>
<th>X Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPS (inches)</td>
<td>DN (mm)</td>
</tr>
<tr>
<td>12</td>
<td>300</td>
</tr>
<tr>
<td>14</td>
<td>350</td>
</tr>
<tr>
<td>16</td>
<td>400</td>
</tr>
<tr>
<td>18</td>
<td>450</td>
</tr>
<tr>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>22</td>
<td>600</td>
</tr>
<tr>
<td>24</td>
<td>650</td>
</tr>
<tr>
<td>26</td>
<td>700</td>
</tr>
</tbody>
</table>

2. Scribe the oblique center line on your pipe at the calculated distance from the true center line for your pipe size. The oblique center line should be marked on the side of the true center line that is closer to the second nozzle location, as shown in Figure 17 below.
2.2.4 Installing the First Welding Boss - Diametrical (cont.)

3. Position the welding boss so that the four scribe lines on the welding boss are lined up with the horizontal scribe mark and the oblique center line on the pipe. Make sure you orient the tapered end of the welding boss against the pipe as shown in Figure 18 below.

4. Clamp the welding boss in place using a pipe strap or equivalent, so that it cannot move during tack welding.

5. Check the boss alignment, then tack weld the carbon steel welding boss to the pipe in each of the four grooves between the welding boss scribe marks.

6. Remove the clamp and check the welding boss alignment again. If the welding boss is misaligned by 0.02 in. (0.5 mm) or more, remove the welding boss, grind off the welds and reinstall it.

Figure 18: Welding Boss Orientation
2.2.5 Installing the First Nozzle - Diametrical

**CAUTION!** It is essential that the nozzle be set up and fixed in position using the jig and the 1-in. threaded rod provided in the installation kit, prior to welding the nozzle.

To install the first nozzle, complete the following steps:

1. Screw the threaded rod into either welding boss that has been welded to the pipe, as shown in *Figure 19* below. If necessary, remove the washer and nut from the threaded rod.

![Figure 19: Inserting the Threaded Rod](image1)

2. Slide the nozzle over the threaded rod, and align the contoured end of the nozzle so it matches the pipe arc. Then slide the jig over the threaded rod, fitting the jig into the welding boss (see *Figure 20* below).

![Figure 20: Inserting the Nozzle and Jig](image2)
2.2.5 Installing the First Nozzle - Diametrical (cont.)

3. Align the jig and nozzle bolt holes and then use the washer and nut to tighten the assembly in place (see Figure 21 below).

![Figure 21: Tightening the Nozzle and Jig](image)

4. Install four sets of studs, nuts, and washers in the jig bolt holes and tighten the nuts.

5. The jig, boss, and nozzle combination is designed to provide a 0.094 in. (2.4 mm) root gap between the beveled edge of the nozzle and the outside diameter of the pipe. If the 0.094 in. (2.4 mm) clearance does not exist all the way around, the nozzle must be removed and ground appropriately to provide the required clearance. If the root gap is larger than the 0.094 in. (2.4 mm) dimension, then suitably sized washers may be inserted between the jig and the nozzle on the four studs to reduce the root gap dimension.

**WARNING!** Only qualified personnel should weld bosses and nozzles, using a suitable ASME BPVC IX qualified welding procedure.

6. Tack weld the nozzle to the pipe at four diametrically opposed points, with each tack being approximately 0.6 in. (15 mm) in length. Allow the welds to cool for 30 seconds between tacks.

7. Proceed to complete the root pass and subsequent filler passes as required.

8. Allow the welds to cool, then remove the four studs. Then, remove the nut, washer, jig and threaded rod.
2.2.6 Installing the Second Welding Boss and Nozzle - Diametrical

Install the second welding boss and nozzle at the marked position (see Figure 22 below) as described in “Installing the First Welding Boss - Diametrical” on page 12 and “Installing the First Nozzle - Diametrical” on page 14.

The completed installation should appear as shown in Figure 23 below.
2.2.7 Hot Tapping the Pipe - Diametrical

**WARNING!** Hot tapping should be performed only by qualified personnel. Follow all applicable code and safety practices during these procedures.

**For 3 in. Flanges:**

1. Install 3 in. ANSI flanged isolation valves on both nozzles (full bore, 8 in. face to face for 150# RF or 11.125 in. for 300# RF) with a gasket and 5/8 in. (for 150# rated flanges) or 3/4 in. (for 300# rated flanges) diameter studs and nuts. Orient the valve handles to minimize interference.

2. Hot tap holes in the pipe using a hot tap machine equipped with a 3/4 in. (19.05 mm) drill bit. Then use a coupon retaining hole saw to cut a hole with a diameter of 2.50 in. (63.5 mm) minimum.

2.2.8 Cold Tapping the Pipe - Diametrical

**WARNING!** Cold tapping should be performed only by qualified personnel. Follow all applicable code and safety practices during these procedures.

The procedure for cold tapping a pipe is the same as the hot tapping procedure. However, an isolation valve is not necessary during the process. The hot tapping medium can be applied directly to the nozzle. Isolation valves will be added after the tapping is complete.
2.3 Nozzle Installation - MR1 Mid-Radius Path

CAUTION! There are two different variations of the mid-radius nozzle installation. These are named the MR1 configuration, which uses p/n 591-338 bosses, and the MR2 configuration, which uses p/n 591-516 bosses. It is critical that you use the correct mid-radius configuration for the nozzles you have been provided. Failure to do so will severely degrade the accuracy of your system.

CAUTION! The instructions in this section are for the MR1 Mid-Radius path configuration only. If your Nozzle Installation Kit is for an MR2 Mid-Radius path, proceed immediately to “Nozzle Installation - MR2 Mid-Radius Path” on page 36.

A non-diametrical signal path is one in which the ultrasonic signal between the two transducers does not travel along a diameter of the pipe. For a mid-radius installation, the signal path is offset from the pipe diameter by a distance equal to 1/2 of the pipe radius (see Figure 24 below). Notice that the 1/2 radius offset can be applied either above or below the horizontal pipe diameter.

Note: As the installation procedures are identical, the instructions in this section will show the MR1 Top Mid-Radius configuration only, as an example.

Figure 24: MR1 Mid-Radius Path Configurations

The MR1 Mid-Radius path nozzle installation procedure includes the following steps:

1. “Identifying the Nozzle Installation Kit Components - MR1 Mid-Radius” on page 19
2. “Selecting and Marking the First Nozzle Location - MR1 Mid-Radius” on page 20
3. “Determining and Marking the Second Nozzle Location - MR1 Mid-Radius” on page 24
4. “Installing the First Welding Boss - MR1 Mid-Radius” on page 29
5. “Installing the First Nozzle - MR1 Mid-Radius” on page 32
6. “Installing the Second Welding Boss and Nozzle MR1 Mid-Radius” on page 34
7. Proceed to one of the following:
   • “Hot Tapping the Pipe - MR1 Mid-Radius” on page 35
   • “Cold Tapping the Pipe - MR1 Mid-Radius” on page 35
2.3.1 Identifying the Nozzle Installation Kit Components - MR1 Mid-Radius

The Nozzle Installation Kit includes all of the components required for your MR1 Mid-Radius path configuration. Before proceeding, you must identify these parts and verify that they are the correct parts for your installation.

The Nozzle Installation Kit should contain the following items:

- 2 Nozzles (if purchased)
- 2 Welding Bosses
- 1 Jig
- 1 Threaded Rod (1 in. diameter), with Washer and Nut

**IMPORTANT:** You will need to supply eight 5/8” studs with two nuts each (for 2” x 150# flanges, 2” x 300# flanges or 3” x 150# flanges), or eight 3/4” studs with two nuts each (for 3” x 300# flanges).

Use Figure 25 below to help identify each component.

![Figure 25: Components in Nozzle Installation Kit](image)

Depending on your configuration, a pair of one of the nozzles listed in Table 2 below is included in your kit:

**Table 2: Available Nozzles for MR1 Installations**

<table>
<thead>
<tr>
<th>Construction Type</th>
<th>ANSI Flange Rating</th>
<th>Material</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Piece Welded, with Welding Neck Flange Nozzle</td>
<td>150 lbs</td>
<td>Carbon Steel</td>
<td>591-320</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Carbon Steel</td>
<td>591-321</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS 316</td>
<td>591-322</td>
</tr>
<tr>
<td></td>
<td>300 lbs</td>
<td>Carbon Steel</td>
<td>591-323</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Carbon Steel</td>
<td>591-324</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS 316</td>
<td>591-325</td>
</tr>
<tr>
<td>1-Piece Forged, Reinforced Integral Nozzle</td>
<td>150 lbs</td>
<td>Carbon Steel</td>
<td>591-564</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Carbon Steel</td>
<td>591-565</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS 316</td>
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<tr>
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<td></td>
<td>SS 316</td>
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</table>
Chapter 2. Installing the Pipe Nozzles

2.3.1 Identifying the Nozzle Installation Kit Components - MR1 Mid-Radius (cont.)

Check the etched markings on the welding boss, as illustrated in Figure 26 below. The MR1 Mid-Radius path designation, the pipe OD and the mounting angle are engraved on the bosses.

![Figure 26: P/N 591-338 Welding Bosses for MR1 Configurations]

2.3.2 Selecting and Marking the First Nozzle Location - MR1 Mid-Radius

**CAUTION!** Correct nozzle alignment is critical to the accurate operation of the flow meter. Therefore, all marking, positioning and welding operations must be carried out with the utmost attention to accuracy. The centerline of each nozzle must form an angle of **45° ±1°** with the centerline of the pipe. The centerlines of the two nozzles must form an angle of **180° ±1°** with each other, and the points where the two nozzle centerlines intersect the pipe centerline must be within **±1/16” (±1.6 mm)** of each other. When the nozzle installation is complete, the raised faces of the two flanges must be parallel to each other.

**WARNING!** All hole cutting in live process piping must be performed using hot tapping equipment (see “Hot Tapping the Pipe - MR1 Mid-Radius” on page 35).
2.3.2 Selecting and Marking the First Nozzle Location - MR1 Mid-Radius (cont.)

To mark the first nozzle location, complete the following steps:

1. For optimum performance, you should select a location that has at least 20 pipe diameters of straight, undisturbed flow upstream and 10 pipe diameters of straight, undisturbed flow downstream from the measurement point (see Figure 27 below). Undisturbed flow means avoiding sources of turbulence such as valves, flanges, elbows, swirl and disturbed flow profiles.

![Figure 27: MR1 Mid-Radius Nozzle Locations](image)

Note: We recommend that you install the nozzles on a chord as near as possible to the horizontal plane for horizontal pipe. If you cannot find a proper nozzle location, please contact GE for assistance.

2. Locate the top of the pipe and put a center punch mark there as a reference mark.

![Figure 28: Punch Mark on Top of Pipe](image)
2.3.2 Selecting and Marking the First Nozzle Location - MR1 Mid-Radius (cont.)

3. Refer to Figure 29 below, and calculate the location for the center of the first nozzle as follows:

\[ Y_0 = \frac{D - 2W}{2} \times \text{(Chord Location)} \]

where, \( \text{Chord Location} = \frac{1}{2} \) (for mid-radius installations)

\[ X_0 = \sqrt{\left(\frac{D}{2}\right)^2 - (Y_0)^2} \]

\[ \frac{AS}{2} = \frac{D}{2} \times \beta \]

where, \( \beta \) (radian) = \( \tan^{-1}\left(\frac{X_0}{Y_0}\right) \)

**Note:** See Table 3 on page 23 for tabulated \( \frac{AS}{2} \) values calculated from the above equation for common pipe sizes.

**Note:** To clarify the use of the above equations, see the bottom of page 26 for a typical example calculation.

![Figure 29: Locating the MR1 Nozzles on the Pipe](image-url)
2.3.2 Selecting and Marking the First Nozzle Location - MR1 Mid-Radius (cont.)

Table 3: AS/2 Values for Common Pipe Sizes with 0.375” Wall Thickness

<table>
<thead>
<tr>
<th>Pipe OD inches</th>
<th>AS/2 Dimension mm</th>
<th>Pipe OD inches</th>
<th>AS/2 Dimension mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>650</td>
<td>13.829</td>
<td>351.26</td>
</tr>
<tr>
<td>28</td>
<td>700</td>
<td>14.876</td>
<td>377.86</td>
</tr>
<tr>
<td>30</td>
<td>750</td>
<td>15.924</td>
<td>404.46</td>
</tr>
<tr>
<td>32</td>
<td>800</td>
<td>16.971</td>
<td>431.06</td>
</tr>
<tr>
<td>34</td>
<td>N/A</td>
<td>18.018</td>
<td>N/A</td>
</tr>
<tr>
<td>36</td>
<td>900</td>
<td>19.065</td>
<td>484.26</td>
</tr>
<tr>
<td>38</td>
<td>N/A</td>
<td>20.113</td>
<td>N/A</td>
</tr>
<tr>
<td>40</td>
<td>1000</td>
<td>21.160</td>
<td>537.46</td>
</tr>
<tr>
<td>42</td>
<td>1050</td>
<td>22.207</td>
<td>564.06</td>
</tr>
<tr>
<td>44</td>
<td>1100</td>
<td>23.254</td>
<td>590.66</td>
</tr>
<tr>
<td>46</td>
<td>N/A</td>
<td>24.301</td>
<td>N/A</td>
</tr>
<tr>
<td>48</td>
<td>1200</td>
<td>25.349</td>
<td>643.86</td>
</tr>
<tr>
<td>52</td>
<td>1300</td>
<td>27.443</td>
<td>697.06</td>
</tr>
<tr>
<td>54</td>
<td>N/A</td>
<td>28.490</td>
<td>N/A</td>
</tr>
<tr>
<td>56</td>
<td>1400</td>
<td>29.538</td>
<td>750.25</td>
</tr>
<tr>
<td>60</td>
<td>1500</td>
<td>31.632</td>
<td>803.45</td>
</tr>
<tr>
<td>64</td>
<td>1600</td>
<td>33.726</td>
<td>856.65</td>
</tr>
<tr>
<td>66</td>
<td>N/A</td>
<td>34.774</td>
<td>N/A</td>
</tr>
</tbody>
</table>

4. Using the calculated or tabulated AS/2 dimension for your installation, center punch the pipe to mark the location for the center of the first nozzle (see Figure 30 below).
### 2.3.2 Selecting and Marking the First Nozzle Location - MR1 Mid-Radius (cont.)

5. Spray the area around the first nozzle location mark with a marking dye product. Using a metal straight edge, scribe 6” long vertical and a horizontal lines that intersect at the center punch mark (see Figure 31 below).

![Figure 31: First Nozzle Scribe Lines](image)

### 2.3.3 Determining and Marking the Second Nozzle Location - MR1 Mid-Radius

To determine and mark the second nozzle location, complete the following steps:

1. The position for the second nozzle is typically a distance equal to $S$ along the pipe and located on the other side of the pipe. For installation other than 45°, the distance is equal to $S$ times the tangent of the installation angle. Steps 2 to 7 on the following pages are for the second nozzle located at 45° from the first nozzle.

![Figure 32: Calculating the Second Nozzle Location](image)

**IMPORTANT:** As shown above, while looking down onto the header pipe with the flow direction from left to right, the second nozzle should be always located to the right of the first nozzle and the top reference point. The nozzles cannot be physically mounted on the header pipe if they are mistakenly located at the mirror image of the locations shown above.
2.3.3 Determining and Marking the Second Nozzle Location - MR1 Mid-Radius (cont.)

2. Due to the possible variation in OD of the pipe, measure the outside diameter of the pipe at four locations between the nozzle centers (see Figure 33 below). Then, calculate the average OD from these measurements.

3. Using a roll of polyester film (or equivalent), cut a strip of film with dimensions as follows:

**IMPORTANT:** Ensure that the sides of the film are cut parallel to each other.

\[
Y_0 = \left( \frac{D - 2W}{2} \right) \times (\text{Chord Location}) \quad \text{where, } W = 0.375 \text{ inches and Chord Location} = 0.5
\]

\[
\text{Width} = S = 2 \times \sqrt{\left( \frac{D}{2} \right)^2 - (Y_0)^2} \quad \text{where, } D = \text{Average pipe OD (see step 2)}
\]

\[
\text{Length} = L = 3.5 \times D \quad \text{where, } D = \text{Average pipe OD (see step 2 above)}
\]

- **Example:** To demonstrate the calculations, consider an MR1 installation for a STD Schedule, 48” pipe.
  a. From standard pipe tables: pipe OD = 48.000 in. and pipe wall thickness (W) = 0.375 in.
  b. From the 1st equation: \( Y_0 = (48.000 - (2 \times 0.375))/2 \times 0.5 = 11.813 \text{ in.} \)
  c. From the 2nd equation: Width (S) = 2 \times \text{SQRT} ((48/2)^2 - (11.81)^2) = 41.783 \text{ in.}
  d. From the 3rd equation: Length (L) = 3.5 \times 48.000 = 168.000 \text{ in.}
  e. Thus, one would cut a piece of film 41.783 in. Wide x 168.000 in. Long.

**Note:** In the above example, the tabulated pipe OD of 48.000 in. was used in the calculations for clarity. Ideally, the measured average pipe OD from step 2 above would be used instead.
2.3.3 Determining and Marking the Second Nozzle Location - MR1 Mid-Radius (cont.)

4. Mark a line on the piece of film at a distance AS from the left edge, as shown in Figure 34 below.

\[
Y_0 = \left(\frac{D-2W}{2}\right) \times \text{(Chord Location)} \quad \text{where, } W = 0.375 \text{ inches and Chord Location} = 0.5
\]

\[
X_0 = \sqrt{\left(\frac{D}{2}\right)^2 - Y_0^2} \quad \text{where, } D = \text{Average pipe OD (see step 2)}
\]

\[
\beta \text{ (radian)} = \tan\left(\frac{X_0}{Y_0}\right)
\]

\[
AS = D \times \beta \quad \text{where, } D = \text{Average pipe OD (see step 2)}
\]

**Example:** To demonstrate the calculations, consider an MR1 installation for a STD Schedule, 48” pipe.

a. From standard pipe tables: pipe OD = 48.000 in. and pipe wall thickness (W) = 0.375 in.

b. From the 1st equation: \(Y_0 = (48.000 - (2 \times 0.375))/2 \times 0.5 = 11.813 \text{ in.} \)

c. From the 2nd equation: \(X_0 = \sqrt{(48/2)^2 - (11.81)^2} = 20.892 \text{ in.} \)

d. From the 3rd equation: \(\beta = \tan(20.90/11.81) = 1.056 \text{ radian} \)

e. Thus, \(AS = 48.000 \times 1.056 = 50.697 \text{ in.} \) (Note that this is the same value listed in Table 4 on page 27.)

**Note:** In the above example, the tabulated pipe OD of 48.000 in. was used in the calculations for clarity. Ideally, the measured average pipe OD from step 2 on the previous page would be used instead.
2.3.3 Determining and Marking the Second Nozzle Location - MR1 Mid-Radius (cont.)

Note: For convenience, refer to Table 4 below for tabulated values of the AS dimension for some common pipe sizes. For any values not listed in the table, calculate your AS dimension with the equations on the previous page.

Table 4: AS Values for Common Pipe Sizes with 0.375” Wall Thickness

<table>
<thead>
<tr>
<th>Pipe OD</th>
<th>AS Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches</td>
<td>mm</td>
</tr>
<tr>
<td>26</td>
<td>650</td>
</tr>
<tr>
<td>28</td>
<td>700</td>
</tr>
<tr>
<td>30</td>
<td>750</td>
</tr>
<tr>
<td>32</td>
<td>800</td>
</tr>
<tr>
<td>34</td>
<td>N/A</td>
</tr>
<tr>
<td>36</td>
<td>900</td>
</tr>
<tr>
<td>38</td>
<td>N/A</td>
</tr>
<tr>
<td>40</td>
<td>1000</td>
</tr>
<tr>
<td>42</td>
<td>1050</td>
</tr>
<tr>
<td>44</td>
<td>1100</td>
</tr>
<tr>
<td>46</td>
<td>N/A</td>
</tr>
<tr>
<td>48</td>
<td>1200</td>
</tr>
<tr>
<td>52</td>
<td>1300</td>
</tr>
<tr>
<td>54</td>
<td>N/A</td>
</tr>
<tr>
<td>56</td>
<td>1400</td>
</tr>
<tr>
<td>60</td>
<td>1500</td>
</tr>
<tr>
<td>64</td>
<td>1600</td>
</tr>
<tr>
<td>66</td>
<td>N/A</td>
</tr>
</tbody>
</table>

5. Wrap the strip of film around the pipe with one corner edge lined up with the vertical and horizontal scribe lines at the first nozzle location (see Figure 35 below). Make sure the strip overlaps squarely around the pipe and that the marked line on the film from step 4 is on the outside of the film and is visible when wrapped.
2.3.3 Determining and Marking the Second Nozzle Location - MR1 Mid-Radius (cont.)

6. The new position for the center of the second nozzle is now identified as the intersection of the mark line on the strip of film and the second edge of the strip of film (see Figure 36 below). Center punch this location prior to removing the strip of film.

7. Remove the strip of film from the pipe.

8. Scribe 6” long vertical and horizontal lines on the pipe that intersect at the center punched area, as shown in Figure 37 below.

IMPORTANT: Follow the illustrations and instructions above carefully. Because of the non-symmetrical geometry of the off-diameter chord in a mid-radius configuration, a mirrored location of the two nozzles with respect to a plane either perpendicular to or parallel to the pipe in the above illustrations will not accommodate the nozzles supplied in the standard Nozzle Installation Kit (NIK).
2.3.4 Installing the First Welding Boss - MR1 Mid-Radius

To install the first welding boss, complete the following steps:

1. Before welding the first boss, you must add another scribe line to the pipe, known as the oblique center line. The oblique center line compensates for the slope or oblique angle of the boss. The oblique center line is offset from the true vertical center scribe line marked earlier by a distance $X$, which is dependent on the pipe outside diameter as follows:

   $$ Y_0 = \left( \frac{D - 2W}{2} \right) \times \text{(Chord Location)} $$

   where, $W = 0.375$ inches and Chord Location = 0.5

   $$ Y_1 = Y_0 + \frac{d}{2} $$

   where, $d =$ welding boss OD = 1.66 inches

   $$ X = \sqrt{\left( \frac{D}{2} \right)^2 - (Y_0)^2} - \sqrt{\left( \frac{D}{2} \right)^2 - (Y_1)^2} $$

   where, $D =$ pipe OD

Note: For convenience, refer to Table 5 on page 30 for tabulated values of the $X$ dimension for some common pipe sizes. For any values not listed in the table, calculate your $X$ dimension with the equations above.

*Example:* To demonstrate the calculations, consider an MR1 installation for a STD Schedule, 48” pipe.

a. From standard pipe tables: pipe OD (D) = 48.000 in. and pipe wall thickness (W) = 0.375 in.

b. From GE documentation: welding boss OD (d) = 1.660 in.

c. From the 1st equation: $Y_0 = (48.000 - (2 \times 0.375))/2 \times 0.5 = 11.813$ in.

d. From the 2nd equation: $Y_1 = 11.813 + 1.660/2 = 12.643$ in.

e. From the 3rd equation: $X = \sqrt{(48.000/2)^2 - 11.813^2} - \sqrt{(48.000/2)^2 - 12.643^2} = 0.492$ in.

Note: In the above example, the tabulated pipe OD of 48.000 in. was used in the calculations for clarity. Ideally, the measured average pipe OD would be used instead.
2.3.4 Installing the First Welding Boss - MR1 Mid-Radius (cont.)

Table 5: X Values for Common Pipe Sizes with 0.375” Wall Thickness

<table>
<thead>
<tr>
<th>Pipe OD</th>
<th>X Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPS (inches)</td>
<td>DN (mm)</td>
</tr>
<tr>
<td>26</td>
<td>650</td>
</tr>
<tr>
<td>28</td>
<td>700</td>
</tr>
<tr>
<td>30</td>
<td>750</td>
</tr>
<tr>
<td>32</td>
<td>800</td>
</tr>
<tr>
<td>34</td>
<td>N/A</td>
</tr>
<tr>
<td>36</td>
<td>900</td>
</tr>
<tr>
<td>38</td>
<td>N/A</td>
</tr>
<tr>
<td>40</td>
<td>1000</td>
</tr>
<tr>
<td>42</td>
<td>1050</td>
</tr>
<tr>
<td>44</td>
<td>1100</td>
</tr>
<tr>
<td>46</td>
<td>N/A</td>
</tr>
<tr>
<td>48</td>
<td>1200</td>
</tr>
<tr>
<td>52</td>
<td>1300</td>
</tr>
<tr>
<td>54</td>
<td>N/A</td>
</tr>
<tr>
<td>56</td>
<td>1400</td>
</tr>
<tr>
<td>60</td>
<td>1500</td>
</tr>
<tr>
<td>64</td>
<td>1600</td>
</tr>
<tr>
<td>66</td>
<td>N/A</td>
</tr>
</tbody>
</table>

2. Scribe the oblique center line on the pipe from the horizontal scribe line upward around the pipe, at the calculated or tabulated distance from the true center line. The oblique center line should be marked on the side of the true center line that is closer to the second nozzle location. One end of the oblique centerline should stop at the horizontal scribe line, as shown in Figure 38 below.
2.3.4 Installing the First Welding Boss - MR1 Mid-RADIUS (cont.)

3. Position the first welding boss such that the three scribe lines on the welding boss are lined up with the horizontal scribe mark and the oblique center line on the pipe. Make sure that you orient the boss as shown in Figure 39 below.

4. Clamp the welding boss in place using a pipe strap or equivalent, so that it cannot move during tack welding.

5. Check the welding boss alignment, then tack weld the carbon steel boss to the pipe in each of the four grooves between the welding boss scribe marks.

6. Remove the pipe strap and check the alignment again. If the welding boss is misaligned by 0.02 in. (0.5 mm) or more, you must remove the welding boss, grind off the welds and reinstall the welding boss.
2.3.5 Installing the First Nozzle - MR1 Mid-Radius

CAUTION! It is essential that the nozzle be set up and fixed in position using the jig and the 1-in. threaded rod provided in the installation kit, prior to welding the nozzle.

To install the first nozzle, complete the following steps:

1. Screw the threaded rod into either welding boss that has been welded to the pipe, as shown in Figure 40 below. If necessary, remove the washer and nut from the threaded rod.

![Figure 40: Inserting the Threaded Rod](image)

2. Slide the nozzle over the threaded rod, and align the contoured end of the nozzle so it matches the pipe arc. Then slide the jig over the threaded rod, fitting the jig into the welding boss (see Figure 41 below).

![Figure 41: Inserting the Nozzle and Jig](image)
2.3.5 Installing the First Nozzle - MR1 Mid-Radius (cont.)

3. Align the jig and nozzle bolt holes and then use the washer and nut to tighten the assembly in place (see Figure 42 below).

4. Install four sets of studs, nuts, and washers in the jig bolt holes and tighten the nuts.

5. The jig, boss, and nozzle combination is designed to provide a 0.094 in. (2.4 mm) root gap between the beveled edge of the nozzle and the outside diameter of the pipe. If the 0.094 in. (2.4 mm) clearance does not exist all the way around, the nozzle must be removed and ground appropriately to provide the required clearance. If the root gap is larger than the 0.094 in. (2.4 mm) dimension, then suitably sized washers may be inserted between the jig and the nozzle on the four studs to reduce the root gap dimension.

WARNING! Only qualified personnel should weld bosses and nozzles, using a suitable ASME BPVC IX qualified welding procedure.

6. Tack weld the nozzle to the pipe at four diametrically opposed points, with each tack being approximately 0.6 in. (15 mm) in length. Allow the welds to cool for 30 seconds between tacks.

7. Proceed to complete the root pass and subsequent filler passes as required.

8. Allow the welds to cool, then remove the four studs. Then, remove the nut, washer, jig and threaded rod.
2.3.6 Installing the Second Welding Boss and Nozzle MR1 Mid-Radius

Install the second welding boss and nozzle at the marked position (see Figure 43 below) as described in “Installing the First Welding Boss - MR1 Mid-Radius” on page 29 and “Installing the First Nozzle - MR1 Mid-Radius” on page 32.

The completed installation should appear as shown in Figure 44 below.
2.3.7 Hot Tapping the Pipe - MR1 Mid-Radius

**WARNING!** Hot tapping should be performed only by qualified personnel. Follow all applicable code and safety practices during these procedures.

**For 3 in. Flanges:**

1. Install 3 in. ANSI flanged isolation valves on both nozzles (full bore, 8 in. face to face for 150# RF or 11.125 in. for 300# RF) with a gasket and 5/8 in. (for 150# rated flanges) or 3/4 in. (for 300# rated flanges) diameter studs and nuts. Orient the valve handles to minimize interference.

2. Hot tap holes in the pipe using a hot tap machine equipped with a 3/4 in. (19.05 mm) drill bit. Then use a coupon retaining hole saw to cut a hole with a diameter of 2.50 in. (63.5 mm) minimum.

2.3.8 Cold Tapping the Pipe - MR1 Mid-Radius

**WARNING!** Cold tapping should be performed only by qualified personnel. Follow all applicable code and safety practices during these procedures.

The procedure for cold tapping a pipe is the same as the hot tapping procedure. However, an isolation valve is not necessary during the process. The hot tapping medium can be applied directly to the nozzle. Isolation valves will be added after the tapping is complete.
2.4 Nozzle Installation - MR2 Mid-Radius Path

**CAUTION!** There are two different variations of the mid-radius nozzle installation. These are named the MR1 configuration, which uses p/n 591-338 bosses, and the MR2 configuration, which uses p/n 591-516 bosses. It is critical that you use the correct mid-radius configuration for the nozzles you have been provided. Failure to do so will severely degrade the accuracy of your system.

**CAUTION!** The instructions in this section are for the MR2 Mid-Radius path configuration only. If your Nozzle Installation Kit is for an MR1 Mid-Radius path, proceed immediately to “Nozzle Installation - MR1 Mid-Radius Path” on page 18.

A non-diametrical signal path is one in which the ultrasonic signal between the two transducers does not travel along a diameter of the pipe. For a mid-radius installation, the signal path is offset from the pipe diameter by a distance equal to 1/2 of the pipe radius (see Figure 45 below). Notice that the 1/2 radius offset can be applied either above or below the horizontal pipe diameter.

**Note:** As the installation procedures are identical, the instructions in this section will show the MR2 Top Mid-Radius configuration only, as an example.

![Figure 45: MR2 Mid-Radius Path Configurations](image)

The MR2 Mid-Radius path nozzle installation procedure includes the following steps:

1. “Identifying the Nozzle Installation Kit Components - MR2 Mid-Radius” on page 37
2. “Selecting and Marking the First Nozzle Location - MR2 Mid-Radius” on page 38
3. “Determining and Marking the Second Nozzle Location - MR2 Mid-Radius” on page 42
4. “Installing the First Welding Boss - MR2 Mid-Radius” on page 47
5. “Installing the First Nozzle - MR2 Mid-Radius” on page 50
6. “Installing the Second Welding Boss and Nozzle MR2 Mid-Radius” on page 52
7. Proceed to one of the following:
   - “Hot Tapping the Pipe - MR2 Mid-Radius” on page 53
   - “Cold Tapping the Pipe - MR2 Mid-Radius” on page 53
2.4.1 Identifying the Nozzle Installation Kit Components - MR2 Mid-Radius

The Nozzle Installation Kit includes all of the components required for your MR1 Mid-Radius path configuration. Before proceeding, you must identify these parts and verify that they are the correct parts for your installation.

The Nozzle Installation Kit should contain the following items:

- 2 Nozzles (if purchased)
- 2 Welding Bosses
- 1 Jig
- 1 Threaded Rod (1 in. diameter), with Washer and Nut

**IMPORTANT:** You will need to supply eight 5/8” studs with two nuts each (for 2” x 150# flanges, 2” x 300# flanges or 3”x 150# flanges), or eight 3/4” studs with two nuts each (for 3”x 300# flanges).

Use Figure 46 below to help identify each component.

![Figure 46: Components in Nozzle Installation Kit](image)

Depending on your configuration, a pair of one of the nozzles listed in Table 6 below is included in your kit:

<table>
<thead>
<tr>
<th>Construction Type</th>
<th>ANSI Flange Rating</th>
<th>Material</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Piece Welded,</td>
<td>150 lbs</td>
<td>Carbon Steel</td>
<td>591-518</td>
</tr>
<tr>
<td>with Welding Neck</td>
<td></td>
<td>Low Carbon Steel</td>
<td>591-526</td>
</tr>
<tr>
<td>Flange Nozzle</td>
<td></td>
<td>SS 316</td>
<td>591-563</td>
</tr>
<tr>
<td></td>
<td>300 lbs</td>
<td>Carbon Steel</td>
<td>591-560</td>
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<tr>
<td></td>
<td></td>
<td>Low Carbon Steel</td>
<td>591-561</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS 316</td>
<td>591-562</td>
</tr>
<tr>
<td>1-Piece Forged,</td>
<td>150 lbs</td>
<td>Carbon Steel</td>
<td>591-570</td>
</tr>
<tr>
<td>Reinforced Integral Nozzle</td>
<td></td>
<td>Low Carbon Steel</td>
<td>591-571</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS 316</td>
<td>591-572</td>
</tr>
<tr>
<td></td>
<td>300 lbs</td>
<td>Carbon Steel</td>
<td>591-573</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Carbon Steel</td>
<td>591-574</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS 316</td>
<td>591-575</td>
</tr>
</tbody>
</table>
2.4.1 Identifying the Nozzle Installation Kit Components - MR2 Mid-Radius (cont.)

Check the etched markings on the welding boss, as illustrated in Figure 47 below. The MR2 Mid-Radius path designation, the pipe OD, the part number and the mounting angle are engraved on the bosses.

**CAUTION!** Before proceeding, be certain that these etched values match your intended installation and that the etched markings are the same on both bosses.

![Figure 47: P/N 591-516 Welding Bosses for MR2 Configurations](image)

2.4.2 Selecting and Marking the First Nozzle Location - MR2 Mid-Radius

**CAUTION!** Correct nozzle alignment is critical to the accurate operation of the flow meter. Therefore, all marking, positioning and welding operations must be carried out with the utmost attention to accuracy. The centerline of each nozzle must form an angle of $45^\circ \pm 1^\circ$ with the centerline of the pipe. The centerlines of the two nozzles must form an angle of $180^\circ \pm 1^\circ$ with each other, and the points where the two nozzle centerlines intersect the pipe centerline must be within $\pm 1/16"$ ($\pm 1.6$ mm) of each other. When the nozzle installation is complete, the raised faces of the two flanges must be parallel to each other.

**WARNING!** All hole cutting in live process piping must be performed using hot tapping equipment (see "Hot Tapping the Pipe - MR2 Mid-Radius" on page 53).
2.4.2 Selecting and Marking the First Nozzle Location - MR2 Mid-Radius (cont.)

To mark the first nozzle location, complete the following steps:

1. For optimum performance, you should select a location that has at least 20 pipe diameters of straight, undisturbed flow upstream and 10 pipe diameters of straight, undisturbed flow downstream from the measurement point (see Figure 48 below). Undisturbed flow means avoiding sources of turbulence such as valves, flanges, elbows, swirl and disturbed flow profiles.

2. Locate the top of the pipe and put a center punch mark there as a reference mark.

Note: We recommend that you install the nozzles on a chord as near as possible to the horizontal plane for horizontal pipe. If you cannot find a proper nozzle location, please contact GE for assistance.
2.4.2 Selecting and Marking the First Nozzle Location - MR2 Mid-Radius (cont.)

3. Refer to Figure 50 below, and calculate the location for the center of the first nozzle as follows:

\[ Y_0 = \frac{D - 2W}{2} \times \text{(Chord Location)} \]

where,

\[ \text{Chord Location} = \frac{1}{2} \] (for mid-radius installations)

\[ X_0 = \sqrt{\left(\frac{D}{2}\right)^2 - (Y_0)^2} \]

\[ \frac{AS}{2} = \frac{D}{2} \times \beta \]

where,

\[ \beta \text{ (radian)} = \tan^{-1} \left(\frac{X_0}{Y_0}\right) \]

**Note:** See Table 7 on page 41 for tabulated \( \frac{AS}{2} \) values calculated from the above equation for common pipe sizes.

**Note:** To clarify the use of the above equations, see the bottom of page 44 for a typical example calculation.
2.4.2 Selecting and Marking the First Nozzle Location - MR2 Mid-Radius (cont.)

Table 7: AS/2 Values for Common Pipe Sizes with 0.375” Wall Thickness

<table>
<thead>
<tr>
<th>Pipe OD inches</th>
<th>AS/2 Dimension mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>650 13.829 351.26</td>
</tr>
<tr>
<td>28</td>
<td>700 14.876 377.86</td>
</tr>
<tr>
<td>30</td>
<td>750 15.924 404.46</td>
</tr>
<tr>
<td>32</td>
<td>800 16.971 431.06</td>
</tr>
<tr>
<td>34</td>
<td>N/A 18.018 N/A</td>
</tr>
<tr>
<td>36</td>
<td>900 19.065 484.26</td>
</tr>
<tr>
<td>38</td>
<td>N/A 20.113 N/A</td>
</tr>
<tr>
<td>40</td>
<td>1000 21.160 537.46</td>
</tr>
<tr>
<td>42</td>
<td>1050 22.207 564.06</td>
</tr>
<tr>
<td>44</td>
<td>1100 23.254 590.66</td>
</tr>
<tr>
<td>46</td>
<td>N/A 24.301 N/A</td>
</tr>
<tr>
<td>48</td>
<td>1200 25.349 643.86</td>
</tr>
<tr>
<td>52</td>
<td>1300 27.443 697.06</td>
</tr>
<tr>
<td>54</td>
<td>N/A 28.490 N/A</td>
</tr>
<tr>
<td>56</td>
<td>1400 29.538 750.25</td>
</tr>
<tr>
<td>60</td>
<td>1500 31.632 803.45</td>
</tr>
<tr>
<td>64</td>
<td>1600 33.726 856.65</td>
</tr>
<tr>
<td>66</td>
<td>N/A 34.774 N/A</td>
</tr>
</tbody>
</table>

4. Using the calculated or tabulated AS/2 dimension for your installation, center punch the pipe to mark the location for the center of the first nozzle (see Figure 51 below).
2.4.2 Selecting and Marking the First Nozzle Location - MR2 Mid-Radius (cont.)

5. Spray the area around the first nozzle location mark with a marking dye product. Using a metal straight edge, scribe 6’’ long vertical and a horizontal lines that intersect at the center punch mark (see Figure 52 below).

![Figure 52: First Nozzle Scribe Lines](image)

2.4.3 Determining and Marking the Second Nozzle Location - MR2 Mid-Radius

To determine and mark the second nozzle location, complete the following steps:

1. The position for the second nozzle is typically a distance equal to $S$ along the pipe and located on the other side of the pipe. For installation other than 45°, the distance is equal to $S$ times the tangent of the installation angle. Steps 2 to 7 on the following pages are for the second nozzle located at 45° from the first nozzle.

![Figure 53: Calculating the Second Nozzle Location](image)

**IMPORTANT:** As shown above, while looking down onto the header pipe with the flow direction from left to right, the second nozzle should be always located to the left of the first nozzle and the top reference point. The nozzles cannot be physically mounted on the header pipe if they are mistakenly located at the mirror image of the locations shown above.
2.4.3 Determining and Marking the Second Nozzle Location - MR2 Mid-Radius (cont.)

2. Due to the possible variation in OD of the pipe, measure the outside diameter of the pipe at four locations between the nozzle centers (see Figure 54 below). Then, calculate the average OD from these measurements.

3. Using a roll of polyester film (or equivalent), cut a strip of film with dimensions as follows:

**IMPORTANT:** Ensure that the sides of the film are cut parallel to each other.

\[ Y_0 = \left( \frac{D - 2W}{2} \right) \times (\text{Chord Location}) \quad \text{where, } W = 0.375 \text{ inches and Chord Location} = 0.5 \]

\[ \text{Width} = S = 2 \times \sqrt{\left( \frac{D}{2} \right)^2 - (Y_0)^2} \quad \text{where, } D = \text{Average pipe OD (see step 2)} \]

\[ \text{Length} = L = 3.5 \times D \quad \text{where, } D = \text{Average pipe OD (see step 2 above)} \]

**Example:** To demonstrate the calculations, consider an MR2 installation for a STD Schedule, 48” pipe.

a. From standard pipe tables: pipe OD = 48.000 in. and pipe wall thickness (W) = 0.375 in.

b. From the 1st equation: \( Y_0 = (48.000 - (2 \times 0.375))/2 \times 0.5 = 11.813 \text{ in.} \)

c. From the 2nd equation: Width \( S = 2 \times \sqrt{\left( \frac{D}{2} \right)^2 - (Y_0)^2} = 41.783 \text{ in.} \)

d. From the 3rd equation: Length \( L = 3.5 \times 48.000 = 168.000 \text{ in.} \)

e. Thus, one would cut a piece of film 41.783 in. Wide x 168.000 in. Long.

**Note:** In the above example, the tabulated pipe OD of 48.000 in. was used in the calculations for clarity. Ideally, the measured average pipe OD from step 2 above would be used instead.
2.4.3 Determining and Marking the Second Nozzle Location - MR2 Mid-Radius (cont.)

4. Mark a line on the piece of film at a distance AS from the left edge, as shown in Figure 55 below.

\[ Y_0 = \left( \frac{D - 2W}{2} \right) \times \text{(Chord Location)} \quad \text{where, } W = 0.375 \text{ inches and Chord Location} = 0.5 \]

\[ X_0 = \sqrt{\left( \frac{D}{2} \right)^2 - (Y_0)^2} \quad \text{where, } D = \text{Average pipe OD (see step 2)} \]

\[ \beta \text{ (radian)} = \arctan \left( \frac{X_0}{Y_0} \right) \]

\[ AS = D \times \beta \quad \text{where, } D = \text{Average pipe OD (see step 2)} \]

- **Example:** To demonstrate the calculations, consider an MR2 installation for a **STD Schedule, 48” pipe**.
  
  a. From standard pipe tables: pipe **OD = 48.000 in.** and pipe wall thickness **(W) = 0.375 in.**
  
  b. From the 1st equation: \( Y_0 = (48.000 - (2 \times 0.375))/2 \times 0.5 = 11.813 \text{ in.} \)
  
  c. From the 2nd equation: \( X_0 = \sqrt{((48/2)^2 - (11.81)^2)} = 20.892 \text{ in.} \)
  
  d. From the 3rd equation: \( \beta = \arctan (20.90/11.81) = 1.056 \text{ radian} \)
  
  e. Thus, \( AS = 48.000 \times 1.056 = 50.697 \text{ in.} \) (Note that this is the same value listed in Table 8 on page 45.)

**Note:** *In the above example, the tabulated pipe OD of 48.000 in. was used in the calculations for clarity. Ideally, the measured average pipe OD from step 2 on the previous page would be used instead.*
2.4.3 Determining and Marking the Second Nozzle Location - MR2 Mid-Radius (cont.)

**Note:** For convenience, refer to Table 8 below for tabulated values of the AS dimension for some common pipe sizes. For any values not listed in the table, calculate your AS dimension with the equations above.

Table 8: AS Values for Common Pipe Sizes with 0.375” Wall Thickness

<table>
<thead>
<tr>
<th>Pipe OD</th>
<th>AS Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches</td>
<td>mm</td>
</tr>
<tr>
<td>26</td>
<td>650</td>
</tr>
<tr>
<td>28</td>
<td>700</td>
</tr>
<tr>
<td>30</td>
<td>750</td>
</tr>
<tr>
<td>32</td>
<td>800</td>
</tr>
<tr>
<td>34</td>
<td>N/A</td>
</tr>
<tr>
<td>36</td>
<td>900</td>
</tr>
<tr>
<td>38</td>
<td>N/A</td>
</tr>
<tr>
<td>40</td>
<td>1000</td>
</tr>
<tr>
<td>42</td>
<td>1050</td>
</tr>
<tr>
<td>44</td>
<td>1100</td>
</tr>
<tr>
<td>46</td>
<td>N/A</td>
</tr>
<tr>
<td>48</td>
<td>1200</td>
</tr>
<tr>
<td>52</td>
<td>1300</td>
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<tr>
<td>54</td>
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</tr>
<tr>
<td>56</td>
<td>1400</td>
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<td>60</td>
<td>1500</td>
</tr>
<tr>
<td>64</td>
<td>1600</td>
</tr>
<tr>
<td>66</td>
<td>N/A</td>
</tr>
</tbody>
</table>

5. Wrap the strip of film around the pipe with one corner edge lined up with the vertical and horizontal scribe lines at the first nozzle location (see Figure 56 below). Make sure the strip overlaps *squarely* around the pipe and that the marked line on the film from step 4 is on the outside of the film and is visible when wrapped.

![Figure 56: Wrapping the Film on the Pipe](image-url)
2.4.3 Determining and Marking the Second Nozzle Location - MR2 Mid-Radius (cont.)

6. The new position for the center of the second nozzle is now identified as the intersection of the mark line on the strip of film and the first edge of the strip of film (see Figure 57 below). Center punch this location prior to removing the strip of film.

7. Remove the strip of film from the pipe.

8. Scribe 6” long vertical and horizontal lines on the pipe that intersect at the center punched area, as shown in Figure 58 below.

![Figure 57: Center Punch the Second Nozzle Location](image)

**Figure 57: Center Punch the Second Nozzle Location**

**Figure 58: Scribe Lines at the Punch Mark**

**IMPORTANT:** Follow the illustrations and instructions above carefully. Because of the non-symmetrical geometry of the off-diameter chord in a mid-radius configuration, a mirrored location of the two nozzles with respect to a plane either perpendicular to or parallel to the pipe in the above illustrations will not accommodate the nozzles supplied in the standard Nozzle Installation Kit (NIK).
2.4.4 Installing the First Welding Boss - MR2 Mid-Radius

To install the first welding boss, complete the following steps:

1. Before welding the first boss, you must add another scribe line to the pipe, known as the oblique center line. The oblique center line compensates for the slope or oblique angle of the boss. The oblique center line is offset from the true vertical center scribe line marked earlier by a distance $X$, which is dependent on the pipe outside diameter as follows:

$$Y_0 = \left(\frac{D - 2W}{2}\right) \times \text{(Chord Location)}$$

where, $W = 0.375$ inches and Chord Location = 0.5

$$Y_1 = Y_0 + \frac{d}{2}$$

where, $d =$ welding boss OD = 1.66 inches

$$X = \sqrt{\left(\frac{D}{2}\right)^2 - (Y_0)^2} - \sqrt{\left(\frac{D}{2}\right)^2 - (Y_1)^2}$$

where, $D =$ pipe OD

Note: For convenience, refer to Table 9 on page 48 for tabulated values of the $X$ dimension for some common pipe sizes. For any values not listed in the table, calculate your $X$ dimension with the equations above.

• Example: To demonstrate the calculations, consider an MR2 installation for a STD Schedule, 48" pipe.

a. From standard pipe tables: pipe OD (D) = 48.000 in. and pipe wall thickness (W) = 0.375 in.

b. From GE documentation: welding boss OD (d) = 1.660 in.

c. From the 1st equation: $Y_0 = (48.000 - (2 \times 0.375))/2 \times 0.5 = 11.813$ in.

d. From the 2nd equation: $Y_1 = 11.813 + 1.660/2 = 12.643$ in.

e. From the 3rd equation: $X = \text{SQRT} ((48.000/2)^2 - 11.813^2) - \text{SQRT} ((48.000/2)^2 - 12.643^2) = 0.492$ in.

Note: In the above example, the tabulated pipe OD of 48.000 in. was used in the calculations for clarity. Ideally, the measured average pipe OD would be used instead.
2.4.4 Installing the First Welding Boss - MR2 Mid-Radius (cont.)

Table 9: X Values for Common Pipe Sizes with 0.375” Wall Thickness

<table>
<thead>
<tr>
<th>Pipe OD</th>
<th>X Dimension</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>NPS (inches)</td>
<td>DN (mm)</td>
<td>inches</td>
<td>mm</td>
</tr>
<tr>
<td>26</td>
<td>650</td>
<td>0.502</td>
<td>12.76</td>
</tr>
<tr>
<td>28</td>
<td>700</td>
<td>0.501</td>
<td>12.72</td>
</tr>
<tr>
<td>30</td>
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<td>0.499</td>
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<td>800</td>
<td>0.498</td>
<td>12.65</td>
</tr>
<tr>
<td>34</td>
<td>N/A</td>
<td>0.497</td>
<td>12.62</td>
</tr>
<tr>
<td>36</td>
<td>900</td>
<td>0.496</td>
<td>12.59</td>
</tr>
<tr>
<td>38</td>
<td>N/A</td>
<td>0.495</td>
<td>12.57</td>
</tr>
<tr>
<td>40</td>
<td>1000</td>
<td>0.494</td>
<td>12.55</td>
</tr>
<tr>
<td>42</td>
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<td>0.493</td>
<td>12.53</td>
</tr>
<tr>
<td>44</td>
<td>1100</td>
<td>0.493</td>
<td>12.51</td>
</tr>
<tr>
<td>46</td>
<td>N/A</td>
<td>0.492</td>
<td>12.50</td>
</tr>
<tr>
<td>48</td>
<td>1200</td>
<td>0.492</td>
<td>12.49</td>
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<td>1300</td>
<td>0.491</td>
<td>12.46</td>
</tr>
<tr>
<td>54</td>
<td>N/A</td>
<td>0.490</td>
<td>12.45</td>
</tr>
<tr>
<td>56</td>
<td>1400</td>
<td>0.490</td>
<td>12.44</td>
</tr>
<tr>
<td>60</td>
<td>1500</td>
<td>0.489</td>
<td>12.42</td>
</tr>
<tr>
<td>64</td>
<td>1600</td>
<td>0.488</td>
<td>12.41</td>
</tr>
<tr>
<td>66</td>
<td>N/A</td>
<td>0.488</td>
<td>12.40</td>
</tr>
</tbody>
</table>

2. Scribe the oblique center line on the pipe from the horizontal scribe line upward around the pipe, at the calculated or tabulated distance from the true center line. The oblique center line should be marked on the side of the true center line that is closer to the second nozzle location. One end of the oblique centerline should stop at the horizontal scribe line, as shown in Figure 59 below.
2.4.4 Installing the First Welding Boss - MR2 Mid-Radius (cont.)

3. Position the first welding boss such that the three scribe lines on the welding boss are lined up with the horizontal scribe mark and the oblique center line on the pipe. Make sure that you orient the boss as shown in Figure 60 below.

4. Clamp the welding boss in place using a pipe strap or equivalent, so that it cannot move during tack welding.

5. Check the welding boss alignment, then tack weld the carbon steel boss to the pipe in each of the four grooves between the welding boss scribe marks.

6. Remove the pipe strap and check the alignment again. If the welding boss is misaligned by 0.02 in. (0.5 mm) or more, you must remove the welding boss, grind off the welds and reinstall the welding boss.
2.4.5 Installing the First Nozzle - MR2 Mid-Radius

**CAUTION!** It is essential that the nozzle be set up and fixed in position using the jig and the 1-in. threaded rod provided in the installation kit, prior to welding the nozzle.

To install the first nozzle, complete the following steps:

1. Screw the threaded rod into either welding boss that has been welded to the pipe, as shown in Figure 61 below. If necessary, remove the washer and nut from the threaded rod.

   ![Figure 61: Inserting the Threaded Rod](image)

   *Figure 61: Inserting the Threaded Rod*

2. Slide the nozzle over the threaded rod, and align the contoured end of the nozzle so it matches the pipe arc. Then slide the jig over the threaded rod, fitting the jig into the welding boss (see Figure 62 below).

   ![Figure 62: Inserting the Nozzle and Jig](image)

   *Figure 62: Inserting the Nozzle and Jig*
2.4.5 Installing the First Nozzle - MR2 Mid-Radius (cont.)

3. Align the jig and nozzle bolt holes and then use the washer and nut to tighten the assembly in place (see Figure 63 below).

4. Install four sets of studs, nuts, and washers in the jig bolt holes and tighten the nuts.

5. The jig, boss, and nozzle combination is designed to provide a 0.094 in. (2.4 mm) root gap between the beveled edge of the nozzle and the outside diameter of the pipe. If the 0.094 in. (2.4 mm) clearance does not exist all the way around, the nozzle must be removed and ground appropriately to provide the required clearance. If the root gap is larger than the 0.094 in. (2.4 mm) dimension, then suitably sized washers may be inserted between the jig and the nozzle on the four studs to reduce the root gap dimension.

**WARNING!** Only qualified personnel should weld bosses and nozzles, using a suitable ASME BPVC IX qualified welding procedure.

6. Tack weld the nozzle to the pipe at four diametrically opposed points, with each tack being approximately 0.6 in. (15 mm) in length. Allow the welds to cool for 30 seconds between tacks.

7. Proceed to complete the root pass and subsequent filler passes as required.

8. Allow the welds to cool, then remove the four studs. Then, remove the nut, washer, jig and threaded rod.
2.4.6 Installing the Second Welding Boss and Nozzle MR2 Mid-Radius

Install the second welding boss and nozzle at the marked position (see Figure 64 below) as described in “Installing the First Welding Boss - MR2 Mid-Radius” on page 47 and “Installing the First Nozzle - MR2 Mid-Radius” on page 50.

The completed installation should appear as shown in Figure 65 below.
2.4.7 Hot Tapping the Pipe - MR2 Mid-Radius

WARNING! Hot tapping should be performed only by qualified personnel. Follow all applicable code and safety practices during these procedures.

For 3 in. Flanges:

1. Install 3 in. ANSI flanged isolation valves on both nozzles (full bore, 8 in. face to face for 150# RF or 11.125 in. for 300# RF) with a gasket and 5/8 in. (for 150# rated flanges) or 3/4 in. (for 300# rated flanges) diameter studs and nuts. Orient the valve handles to minimize interference.

2. Hot tap holes in the pipe using a hot tap machine equipped with a 3/4 in. (19.05 mm) drill bit. Then use a coupon retaining hole saw to cut a hole with a diameter of 2.50 in. (63.5 mm) minimum.

2.4.8 Cold Tapping the Pipe - MR2 Mid-Radius

WARNING! Cold tapping should be performed only by qualified personnel. Follow all applicable code and safety practices during these procedures.

The procedure for cold tapping a pipe is the same as the hot tapping procedure. However, an isolation valve is not necessary during the process. The hot tapping medium can be applied directly to the nozzle. Isolation valves will be added after the tapping is complete.
[no content intended for this page]
Chapter 3. Installing an Isolation Valve

3.1 Introduction

If one has not already been installed, follow the instructions in this chapter to install an isolation valve on each transducer nozzle for applications using the flare gas insertion mechanism. As the procedure is identical for all path configurations and flange sizes, only one installation configuration is described here as an example.

3.2 Valve Installation for 3-inch Flanges

Refer to Figure 66 below and install 3-inch ANSI flanged full-bore isolation valves on both transducer nozzles with a gasket, studs and nuts. Orient the valve handles to minimize interference. Note the following requirements:

- **150# RF flanges**: 8 in. face-to-face distance, 5/8 in. diameter studs and nuts
- **300# RF flanges**: 11.125 in. face-to-face distance, 3/4 in. diameter studs and nuts

![Figure 66: Standard Isolation Valve Installation](image-url)
Chapter 4. Inserting T17 Transducers into the Pipe

4.1 Introduction

The T17 transducer is typically installed into a *meter body*, which is a section of pipe that contains the ports where the transducers will be mounted. The meter body may be prefabricated or created by installing ports on the existing pipe. The T17 is inserted using a packing gland-based, low-pressure insertion mechanism.

4.2 Inserting Transducers Using the Insertion Mechanism

The *Insertion Mechanism* is designed for manual (non-assisted) transducer insertion into operating or pressurized pipes. Before inserting the mechanism, you must have isolation valves mounted on the transducer nozzles in the meter body.

Inserting the transducers into the pipe consists of the following:

- “Preparing for Installation” on page 57
- “Mounting the Insertion Mechanism” on page 58
- “Aligning the Downstream Transducer for Extended Range Installations” on page 65

**WARNING!** The manual insertion mechanism system is for low-pressure applications (80 psig/5.5Bar or less) only. Use the appropriate safety precautions when inserting or withdrawing the insertion mechanism.

4.2.1 Preparing for Installation

Before you begin, you should find an area where you can place the insertion mechanism upright without placing any weight on the transducer (e.g., a bench with a cutout large enough for the transducer).

You will need the following items for installation:

- A packing tool (may be shipped with the flow meter electronics)
- A gasket to place on the isolation valve
- A straight edge ruler/scale
- A tag to place on the isolation valve
- Flange bolts, washers and nuts
4.2.2 Mounting the Insertion Mechanism

To mount the insertion mechanism, complete the following steps:

1. Refer to Figure 67 below to familiarize yourself with the following insertion mechanism components:
   - Junction box
   - Barrel
   - Packing gland
   - Transducer

Note: Explosion-proof junction boxes may not be mounted on the end of a transducer during shipment.

IMPORTANT: For an extended range operation flow meter, the upstream and downstream transducers are different, and it is crucial to flow meter operation that the correct transducer be installed in the correct location. The upstream transducer has a 180° head and the downstream transducer has a 6° offset 174° head. Also, the insertion mechanism and transducers have alignment marks.
4.2.2 Mounting the Insertion Mechanism (cont.)

2. Visually inspect the transducer to make sure the top Swagelok® fitting is not loose (see Figure 68 below).

CAUTION! The stop ring at the end of the barrel is supposed to be loose. **DO NOT** tighten the Swagelok® fitting or you could change the transducer alignment.

3. Remove the four bolts that fasten the barrel to the packing gland.

---

1. Swagelok® is a registered trademark of the Swagelok Company.
4.2.2 Mounting the Insertion Mechanism (cont.)

4. Retract the barrel from the packing gland so that the transducer head is recessed in the packing gland (see Figure 69 below). You will hear the stop ring click when the transducer is fully recessed.

5. Visually inspect the mechanism to make sure the transducer is recessed in the packing gland. Again, make sure that the top Swagelok fitting is secure and hand-tight.
4.2.2 Mounting the Insertion Mechanism (cont.)

6. Lift the gasket and insert the packing tool into the packing nut. By turning the packing tool clockwise, tighten the packing material so that the barrel stays up without support (see Figure 70 below).

![Figure 70: Tightening the Packing Material](image)

7. Place a gasket on the isolation valve (see Figure 71 below).

![Figure 71: Placing a Gasket on the Valve](image)
4.2.2 Mounting the Insertion Mechanism (cont.)

8. Identify the upstream and downstream transducer assemblies.

For Standard Velocity Range applications, the upstream and downstream nozzle designations are interchangeable because the system is bi-directional.

For Extended Velocity Range applications, the system is not bi-directional. Note which valve is designated as upstream and as downstream on the pipe. Then identify the upstream and downstream insertion mechanism assemblies. The downstream assembly is labeled with an alignment mark on the Barrel flange and an associated scribe line on the transducer tube near the connector end (see Figure 72 below). The downstream transducer head is angled 6° and must face into the flow.

Figure 72: Identify the Downstream Insertion Mechanism

9. Begin the insertion of either the upstream or the downstream assembly.
4.2.2 Mounting the Insertion Mechanism (cont.)

10. Lift the insertion mechanism by the barrel and place the insertion mechanism on the isolation valve (see Figure 73 below).

![](image)

Figure 73: Place Insertion Mechanism on Isolation Valve

11. Line up the flange holes and bolt the packing gland to the isolation valve.
4.2.2 Mounting the Insertion Mechanism (cont.)

12. Using the packing tool, tighten the packing nut again until the nut is recessed.

**WARNING!** The packing material must be properly compressed before the isolation valve is opened.

![Figure 74: Tightening the Packing](image-url)
4.2.3 Aligning the Downstream Transducer for Extended Range Installations

For extended velocity range applications, the head of the downstream transducer is angled at 6° so that it points upstream (into the flow) by 6°. This allows the ultrasonic signal to be pushed into alignment at very high flow rates. At low flow rates, the beam is wide enough to tolerate the initial 6° misalignment.

**Note:** Only the downstream transducer flange alignment is crucial to the functionality of the meter. For installation of the upstream transducer, see “Mounting the Insertion Mechanism” on page 58.

**Note:** This step of the installation requires two people. One person should support the barrel and one person should operate the alignment fixture.

**CAUTION!** Although the images in this section do not show the gasket referenced in “Preparing for Installation” on page 57, that gasket is crucial to sealing the assembly.

1. Locate the supplied alignment tool shown in Figure 75 below (part number 568-120). This tool is used to check and fine-tune (if necessary) the transducer alignment by rotating the Barrel Assembly prior to final tightening of the mounting nuts and studs.

**Note:** Although this process ensures optimum performance, it is not required for proper operation.

![Figure 75: Alignment Tool](image)

2. Find the scribe line on the downstream transducer tube near the transducer end with the BNC connector. This scribe line indicates the direction of the angled transducer head. Verify by direct observation that the scribe line on the transducer lines up with the alignment marking on the flange at the top of the Barrel. If it does not, contact GE for assistance.
4.2.3 Aligning the Downstream Transducer (cont.)

3. The primary method for ensuring that the angled transducer head is pointing in the correct direction uses the alignment marks on the downstream nozzle and the downstream Barrel assembly (see Figure 76 below). The alignment marking on the flange at the top of the Barrel must be in alignment with the nozzle, such that the marking falls between the bolt holes straddling the upstream to downstream centerline, as shown below.

![Figure 76: Transducer Alignment Marks](image-url)
4.2.3 Aligning the Downstream Transducer (cont.)

4. Before proceeding, verify that the valve and insertion mechanism are fully bolted in place (see Figure 77 below). Each stud should extend far enough beyond its nut to allow the alignment tool to rest on the stud. Fit the alignment fixture over the nozzle studs so that the two studs straddling the centerline on the nozzle are inserted into the holes on the fixture of the corresponding flange size and rating (3”, 150# or 300#).

5. Adjust the leveling wheel so that the bubble in the level is centered between the two tick marks on the vial.

6. Remove the alignment fixture from nozzle studs.

7. Place two sets of studs, washers and nuts into the flange at the top of barrel assembly, straddling the alignment mark. Nuts and washers should not be installed on the side of the flange with the serrated raised face.
4.2.3 Aligning the Downstream Transducer (cont.)

8. Place the alignment fixture over the two studs in the flange at the top of the barrel assembly, and rotate the barrel flange until the bubble aligns between the tick marks on the vial (see Figure 79 below). Slowly press the flange toward the insertion mechanism flange until the gasket and raised faces of both flanges are mated. The studs should also engage the holes in the insertion mechanism flange. If necessary, the barrel flange can be rotated slightly to maintain the bubble alignment on the gauge.

9. Remove the fixture and install the remaining studs, washers, and nuts. Tighten them to the correct torque.

10. Place a tag on the isolation valve stating the following:

   **DO NOT OPERATE (CLOSE) WHEN TRANSDUCER IS INSERTED INTO PIPE.**

11. Refer to the flow meter *Startup Guide* to make the transducer electrical connections.
4.3 Connecting an XAMP

This section explains how to correctly install and assemble an XAMP into a transducer junction box. Although one type of junction box is used as an example in the steps below, the procedure applies to all three possible junction box options (see drawing #752-063 in Figure 88 on page 73).

1. Place a 3/4” NPT compression fitting on the stem of the transducer closer to the BNC end.
2. Torque the fitting into one of the 3/4” NPT ports of the junction box, with at least five threads engaged. After the fitting is torqued into place, ensure that the BNC head of the transducer extends slightly past the ground screw bosses as shown in Figure 80 below:

   ![Figure 80: Torquing Reducer into NPT Port](image)

3. If the BNC head extends too far into the junction box, it will make the assembly more difficult by reducing the amount of area available to properly store the excess cable. If the BNC head is not positioned approximately where it is pictured in the image above, loosen the compression fitting and adjust the transducer. Then, re-tighten the compression fitting after this is completed.

4. Torque the cable gland coming from the electronics main housing into the other 3/4” NPT port until there are at least five threads of engagement (see Figure 81 below):

   ![Figure 81: Torquing the Cable Gland](image)
4.3 Connecting an XAMP (cont.)

With the transducer and the cable gland assembled, the junction box should now look like Figure 82 below:

![Figure 82: Assembled Transducer and Cable Gland](image)

5. Connect the right-angle male BNC plug to the exposed BNC cable from the cable gland assembly, as shown in Figure 83 below.

![Figure 83: Connecting BNC Plug to Cable](image)
4.3 Connecting an XAMP (cont.)

6. Connect the female BNC plug of the XAMP to the male BNC transducer head, as shown in Figure 84 below:

7. Wrap the extra length of cable around the perimeter of the junction box such that the BNC heads do not rest on other cables or on each other (see Figure 85 below).
4.3 Connecting an XAMP (cont.)

8. Place the XAMP body into the junction box (see Figure 86 below), resting the puck gently on the cables below it. Ensure that the cables of the XAMP rest naturally according to the slant at which they exit the epoxy, to reduce stress and strain on the joint. The XAMP should remain still, and the cap of the junction box should rotate freely around the XAMP.

![Figure 86: Junction Box Cap](image)

9. Place the cover of the junction box over top of the XAMP and tighten the cover until the unit is closed and secure. Engage the set screw to discourage tampering or removal (see Figure 87 below).

![Figure 87: Set Screw on Junction Box](image)

Note: To disconnect or uninstall the XAMP from the assembly, just reverse the procedures above.
4.3 Connecting an XAMP (cont.)

Figure 88: Transducer General Arrangement (dwg. #752-063, rev. L)
[no content intended for this page]
Chapter 5. Maintaining the T17 Transducers

5.1 Removing Transducers

After the transducers are properly installed into the pipe nozzles as described in Chapter 4. “Inserting T17 Transducers into the Pipe”, the T17 transducers require no additional adjustments. Periodic inspection of the installation to verify the torque on the mounting bolts may be required, if erratic flow rate measurements are observed. If you suspect something is wrong with a transducer or need to replace a transducer, use the removal procedure in this chapter.

5.2 Using the Insertion Mechanism

Use the steps below to remove transducers that have been installed with the insertion mechanism:

![WARNING!] Follow all applicable safety codes while performing the following procedures.

1. Disconnect the power from the flowmeter.

![WARNING!] Make sure the power is disconnected before performing the following steps.

2. Disconnect the transducer cables at the junction box.
5.2 Using the Insertion Mechanism (cont.)

3. On the insertion mechanism, remove the bolts that fasten the barrel flange to the packing gland flange (see Figure 89 below).

![Figure 89: Removing the Bolts](image)

4. Retract the barrel from the packing gland until the transducer head is recessed in the packing gland (see Figure 90 below). The stop ring will “click” when the transducer is fully recessed.

![Figure 90: Retracting the Barrel](image)
5.2 Using the Insertion Mechanism (cont.)

5. **CLOSE THE ISOLATION VALVE!**

**WARNING!** Make sure the isolation valve is closed before performing the following steps.

6. After closing the isolation valve, remove the bolts that fasten the packing gland flange to the isolation valve flange, and lift the insertion mechanism by the barrel to remove it from the isolation valve.

![Figure 91: Removing the Insertion Mechanism](image_url)
5.2 Using the Insertion Mechanism (cont.)

7. Install a new flange gasket on the isolation valve. Then, fasten a “blind” flange onto the isolation valve with the bolts removed in the previous step (see Figure 92 below).

8. Disconnect the junction box on the end of the transducer by loosening the compression fitting.

9. Repeat the process to remove the other transducer.
Chapter 6. Specifications

6.1 T17 Transducer Physical Specifications

Applications: Hazardous Area applications, Flare Gas, Hydrocarbon Gases using GE ultrasonic flow meter Models GF868 and XGF868i

Installation Type: Wetted

Materials of Construction: Standard: Titanium
Optional: 316 Stainless Steel, Monel® or Hastelloy®

Field Mounting: Flowcell, Hot or Cold Tap

Process Connection: Flanged, 3 in. (80 mm)

Holder Type: Insertion Mechanism

Holder Ratings: 150#, 300#

Electrical Rating: 200 V peak-to-peak, 5 mA

Operating Temperature: –67° to +300°F (–55° to +150°C)

Storage Temperature: –67° to +300°F (–55° to +150°C)

Operating Pressure: 12.7 to 1500 psia (87.6 to 10300 kPa)

Operating Frequency: 100 kHz

6.2 T17 Transducer Certifications

North American - Explosion proof: Class I, Division 1, Group C, D
Class II, Class III, Division 1, Group E, F, G
Single Seal

European/International - Flameproof: II 2 G Ex d IIC T6...T2 Gb (T code dependent on Process Temperature)
Tamb –40° to +140°F (–40° to +60°C)
KEMA 01ATEX2045X: IECEx KEM09.0009X

North American - Weatherproof: IP66, TYPE 4X
200Vpp, 5mA

European/International - Weatherproof: IP 66
[no content intended for this page]
**Warranty**

Each instrument manufactured by GE Sensing is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of GE Sensing. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If GE Sensing determines that the equipment was defective, the warranty period is:

- one year from delivery for electronic or mechanical failures
- one year from delivery for sensor shelf life

If GE Sensing determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by GE Sensing, the repairs are not covered under this warranty.

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The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties of merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

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**Return Policy**

If a GE Sensing instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify GE Sensing, giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, GE Sensing will issue a RETURN AUTHORIZATION NUMBER (RAN), and shipping instructions for the return of the instrument to a service center will be provided.

2. If GE Sensing instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.

3. Upon receipt, GE Sensing will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
- If GE Sensing determines that the damage is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner’s approval to proceed, the instrument will be repaired and returned.
[no content intended for this page]
GE Sensing

We, GE Sensing
1100 Technology Park Drive
Billerica, MA 01821
USA

declare under our sole responsibility that the

Models T3, T5, T8, T11, T14 and T17 Wetted Ultrasonic Flow Transducers
Series BWT1 / F...PA / XAMP... Ultrasonic Flowmeter Transducer Assembly

to which this declaration relates, are in conformity with the following standards:

- EN 60079-0: 2012
- EN 60079-1: 2007
- II 2 G Ex d IIC T6...615°C Gb
  - T3: KEMA06ATEX0052
  - T5: KEMA01ATEX2045X
  - T11: KEMA02ATEX2252
  - T14: KEMA04ATEX2054X
  - T17: KEMA01ATEX2045X
  - Series BWT1 / F...PA / XAMP...: KEMA01ATEX2051X; IEC Ex KEM09.0010X
  (DEKRA, Ultrechtseweg, 310 Arnhem, The Netherlands - NoBo 0344)
- EN 61326-1: 2006, Class A, Table 2, Industrial Locations
- EN 61326-2-3: 2006
- EN 61010-1: 2012, Overvoltage Category II

Other standards used:

- EN 50014: 1997 + A1, A2
- EN 50018: 2000

following the provisions of the 2004/108/EC EMC and 94/9/EC ATEX Directives.

Where products were initially assessed for compliance with the Essential Health and Safety Requirements of the ATEX Directive 94/9/EC using earlier harmonized standards, a subsequent review has determined that "technical knowledge" is unaffected by the current harmonized standards listed above.

The units listed above and any ancillary equipment supplied with them do not bear CE marking for the Pressure Equipment Directive. They are supplied in accordance with Article 3, Section 3 (sound engineering practices and codes of good workmanship) of the Pressure Equipment Directive 97/23/EC for DN<25.

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