5900S radar level gauge with LPG/LNG antenna

BENEFITS

- Excellent for long measuring ranges and light products
- Custody transfer accuracy according to OIML R85:2008
- SIL 2 and SIL 3 certified according to IEC 61508-2 and 61508-3
- 2-in-1 functionality available for redundant level measurement
- Communicates via a 2-wire, low voltage Tankbus for easy and safe installation
- Built-in pressure sensor and ball valve options

Rosemount 5900S with LPG/LNG antenna is a premium non-contact radar level gauge made for measurements in pressurized or cryogenic tanks. Radar signals are transmitted inside the still-pipe which enables the gauge to have a sufficiently strong echo even under surface boiling conditions. The pressure seal is equipped with a double-block function, consisting of a quartz/ceramic window and a fire-proof ball valve. A pressure sensor enables correction due to vapor for best measurement performance.

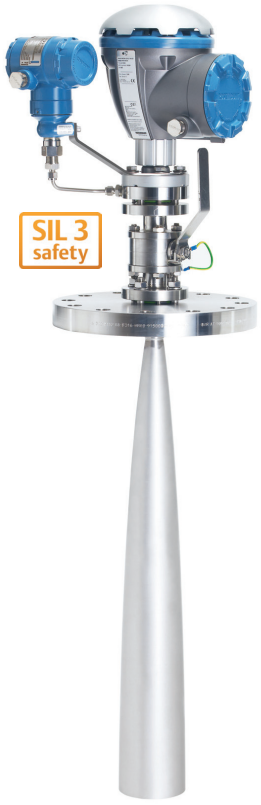
A patented reference device function enables measurement verification with the tank in service. Installation is made with the pressurized tank taken out of service.

Highest precision

The 5900S gauge uses state-of-the-art FMCW radar technology with digital reference giving a 0.5 mm (0.02 in.) custody transfer grade accuracy. The gauge is powered by the 2-wire intrinsically safe Tankbus.

Excellence in overfill prevention taking safety to a higher level

Raptor is SIL 2 and SIL 3 certified according to IEC 61508-2 and 61508-3. The 5900S Radar Level Gauge with SIL option is configured to activate a separate alarm loop at a preset liquid level. This alarm loop triggers the safety relay output on the Rosemount 2410 Tank Hub. SIL 2 safety is achieved with one 5900S, and a 2410 equipped with a SIL relay output. SIL 3 safety is achieved with a 2-in-1 5900S, and a 2410, both equipped with the SIL option.
Raptor is also tested by TÜV (Technische Überwachungsverein) and WHG approved as an overfill prevention device.



Rosemount 5900S with LPG/LNG antenna is designed for level measurement on pressurized or cryogenic liquified gas, such as LPG or LNG.

ROSEMOUNT® Tank Gauging

EMERSON™ Process Management

Emulation capability

It is possible to replace an outdated mechanical gauge with a modern Rosemount 5900S and a Rosemount 2410 Tank Hub in an existing tank gauging system, using the same tank opening, cabling and control system. The new units emulate the existing system's bus communication which makes step-by-step replacement of old gauges very easy.

A verification pin mounted in a still-pipe hole, and a deflection plate with a calibration ring at the lower pipe end provide reference echoes at fixed and well-known distances.

Specification for Rosemount 5900S with LPG/LNG antenna	
Measuring principle	FMCW (Frequency Modulated Continuous Wave)
Antenna type	High precision cone shaped antenna for 4 in. Schedule 10, Ø=107 mm (4.2 in.), 4 in. Schedule 40, Ø=101 mm (4.0 in.) and DN 100, Ø=99 mm (3.9 in.) still-pipe dimensions
Instrument accuracy	± 0.5 mm (± 0.020 in.)
Legal custody transfer type approval	OIML R85:2008
Measuring range	1.2 m to 30 m (3.9 to 100 ft) below flange. Possibility to measure 0.8 to 60 m (2.6 to 200 ft). Accuracy may be reduced. For longer measuring range, please consult your Rosemount Tank Gauging representative
Operating temperature at ball valve	-55 to 90 °C (-67 to 194 °F)
Operating temperature in tank	-170 to 90 °C (-274 to 194 °F)
Temperature stability	Typically < ± 0.5 mm (0.020 in.) in -40 to +70 °C (-40 to +158 °F)
Pressure range	-1 to 25 bar (-14.5 to 365 psig). Note! Flanges may have higher pressure rating than 25 bar, but maximum tank pressure is still 25 bar
Pressure sensor (option)	Rosemount 2051. It is available with different hazardous location certifications. For more information see the 2051 Product Data Sheet (document number 00813-0100-4101)
Ingress protection	IP 66/67 and Nema 4X
Material exposed to tank atmosphere	Antenna: Acid proof steel type EN 1.4436 (AISI 316), Sealing: Quartz and PTFE
Power supply	Powered by Rosemount 2410 Tank Hub (9.0-17.5 VDC, polarity insensitive)
Communication	Two-wire Tankbus based on self-configured FOUNDATION™ fieldbus
Cable entry (connection/glands)	½ - 14 NPT for cable glands or conduits. Optional: • M20 x 1.5 conduit / cable adapter • Cable glands in metal • 4-pin male Eurofast connector or A size Mini 4-pin male Minifast connector
Safety/overfill	One optional SIL 2/SIL 3 certified relay output is available via the 2410 Tank Hub for overfill protection. Consult your local Rosemount Tank Gauging representative for information about national approvals such as the WHG (TÜV) overfill protection option
Display	A Rosemount 2230 Graphical Field Display or Rosemount TankMaster can be used for read-out
Flange size	4 in. class 150/300, 6 in. class 150/300, 8 in. class 150/300
Housing	Polyurethane-coated die-cast aluminum
Weight	Appr. 30 kg (66 lbs) for 6-in. 150 psi, and 40 kg (88 lbs) for 6-in. 300 psi
Hazardous location certifications	ATEX, FM-C, FM-US, IECEx, and national certifications

Technical details are subject to change without prior notice. For more technical details, see Raptor Technical Description.

Emerson Process Management

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ROSEMOUNT® Tank Gauging

EMERSON™ Process Management

7 Liquefied gases

Topic Page

7. Liquefied gases

Radar tank gauging has been used on liquefied gas tanks since the 1980's. Today, several thousands of pressurized Liquefied Petroleum Gas (LPG) tanks and non-pressurized Liquefied Natural Gas (LNG) tanks are equipped with high performance radar tank gauges.

A successful radar level gauge design for liquefied gases should be based on using a still pipe in the tank. The radar gauge is bolted to a tank nozzle at the top of the tank. A still pipe, normally with a 100 mm (4 in.) diameter, is connected to the same nozzle and reaches down to the bottom of the tank.

The still pipe is equipped with one or more verification pins. These pins are mounted during the installation at known positions. The pins will generate small verification echoes used for gauge verification at normal working pressure in the tank. The radar tank gauge can perform a verification test at any time without interfering with the normal liquid measurement. The result of the automatic verification should be presented at a service window of the diagnostic software embedded in the user interface.

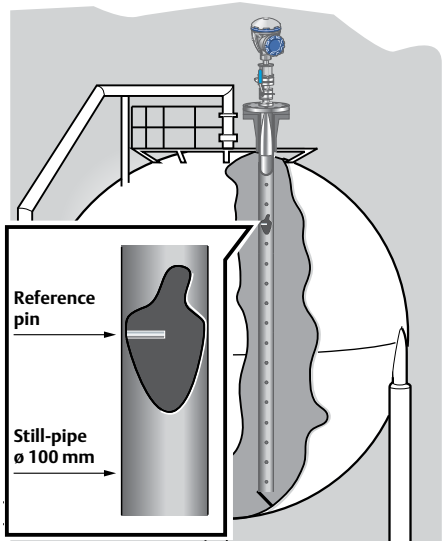


Figure 7.1: Level measurement in an LPG tank using a still-pipe with reference pins.

7.1 Radar tank gauging for LPG

The use of automatic tank gauging on pressurized tanks is described in API MPMS Chapter 3.3. Special considerations must be taken into account when designing radar tank gauges for pressure applications. Firstly, the unit must withstand the tank pressure and meet the safety standards written around pressure vessels. Secondly, the radar gauge must be manufactured so that it can effectively cope with the challenges that high vapor pressure may cause in such tanks. Thirdly, the radar tank gauge should have some means of performance verification during normal tank conditions.

Figure 7.2: A radar gauge for pressurized LPG tanks must cope with challenges caused by high vapor pressure.

Typical applications for this type of radar tank gauge are spherical and horizontal tanks used to store LPG or other liquefied gases.

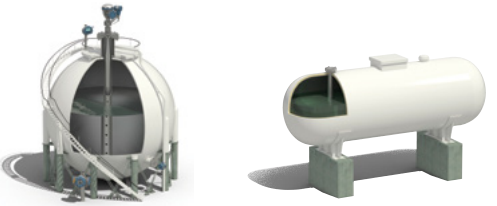


Figure 7.3: Spherical and horizontal tanks used for storing LPG.

7.2 Radar tank gauging for LNG

The basic gauge design used for radar gauging on LPG tanks is also used on LNG tanks. Radar based tank gauging is today widely used for level measurement and overfill prevention in LNG storage tanks. This non-contact method with no moving parts offers advantages in terms of reliability and a less frequent need for maintenance. Radar is particularly suitable in LNG applications where in-tank maintenance is only possible at scheduled maintenance periods which have several year intervals. Also, the often long measuring distances in this application make non-contact measurement an attractive alternative. Today most LNG storage tank building projects have a preference for radar technology in level measurement and overfill prevention.

Picture 7.4: Still-pipe cluster inside an LNG tank.

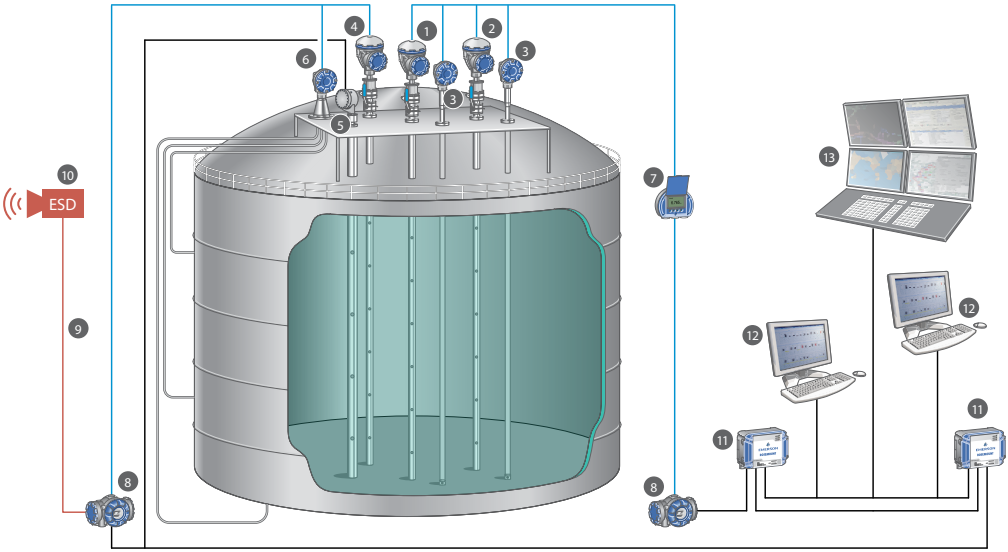
A typical storage tank for LNG holds more than 50 000 m^3 representing a value of around USD15 million. Both from an economic, operational and safety aspect, the data measured by the tank gauging system has a large impact. A precision radar tank gauge delivers accuracy in the range of one millimeter over the entire tank height.

7.3 Typical system configuration

A typical radar based LNG tank gauging system with a configuration focusing on high reliability combined with high measuring performance can have the following main components:

- One primary high precision radar gauge for level measurement.
- One secondary high precision radar gauge for level measurement.
- Two (2) temperature transmitters, each with up to 16 spot temperature sensors for average liquid temperature measurement.
- A third radar gauge allocated for independent high level alarm. The gauge gives output to an alarm panel via SIL 2/3 rated relay or 4-20 mA signals.
- Transmitters and temperature elements for skin temperature measurement.
- A separate device for temperature and density profiling (LTD).
- Graphical field display.
- “Tank hubs” for data collection from field instruments and data transmission to the control room area.
- Data concentrators in the control room area for providing data to DCS systems, HMI systems and communication with general IT systems.
- LNG management software for operator interface and reports. The workstations are configured in a network for data distribution and increased redundancy.

The radar level gauge antenna for LNG should be designed for measurements on cryogenic liquefied gas. Radar signals are transmitted inside a 4-inch still-pipe which enables the gauge to have a sufficiently strong echo even under surface boiling conditions. The tank seal is equipped with a double block function, consisting of a quartz/ceramic window and a fire-proof ball valve. A reference device function enables measurement verification with the tank in service.



1 Primary Radar Level Gauge
2 Secondary Radar Level Gauge
3 Temperature Transmitter and Cryogenic Multiple Spot Thermometer
4 Independent Level Alarm (Continuous Gauge)
5 Level, Temperature and Density (LTD) Gauge
6 Skin Temp Transmitter and Sensors
7 Graphical Field Display
8 Tank Hub
9 SIL 2/3 Relay or 4-20 mA Alarm Signal
10 Independent Alarm Panel
11 Data Concentrator
12 LNG Management System
13 DCS/Host System

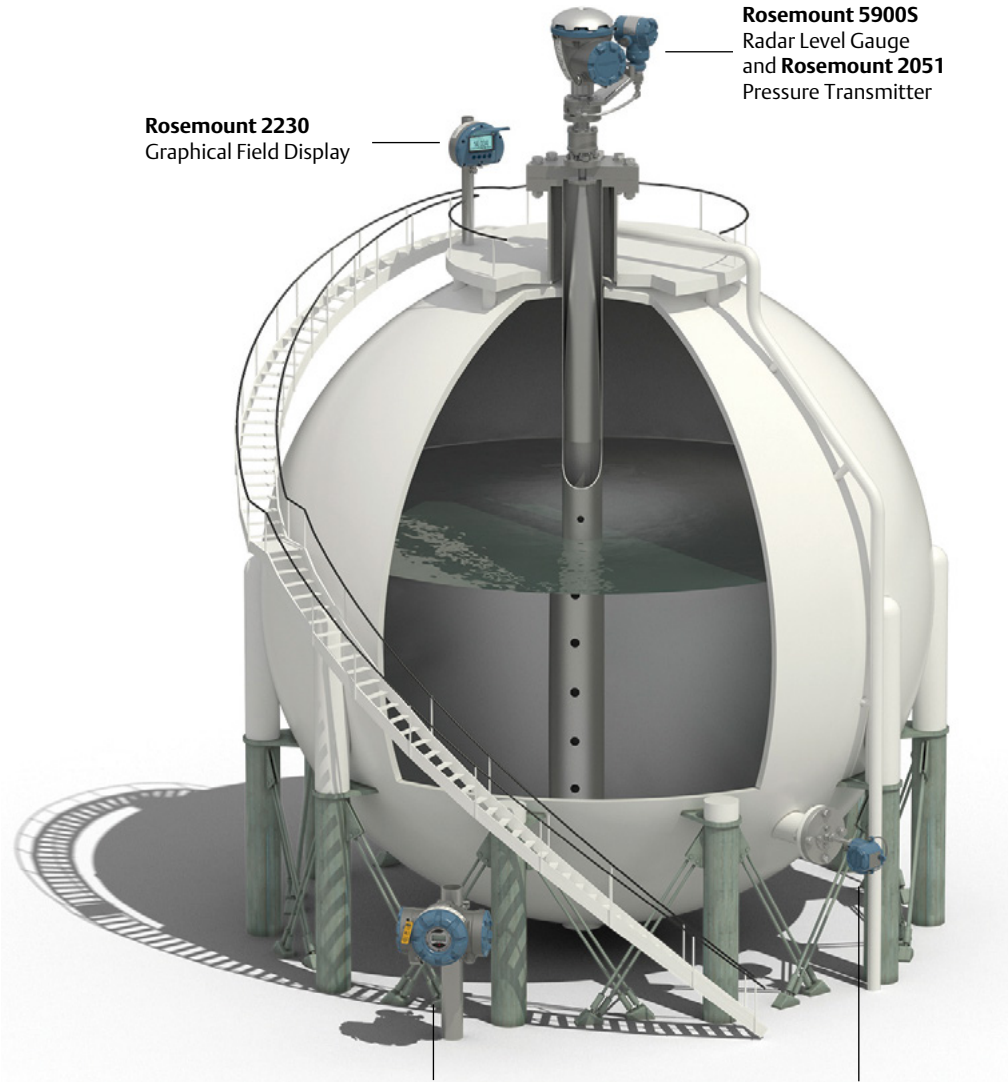
Figure 7.5: Example of a high performance LNG tank gauging system.

For land based LNG level measurement, the two most common types of gauges used today are mechanical servo gauges and radar gauges. The mechanical servo-operated gauge relies on a mechanical displacer attached to a wire on a drum. The displacer is lowered by the servo motor to the liquid and follows the surface movements. Intrusive gauging, many moving parts and a significant maintenance program are challenges connected with servo based gauging systems.

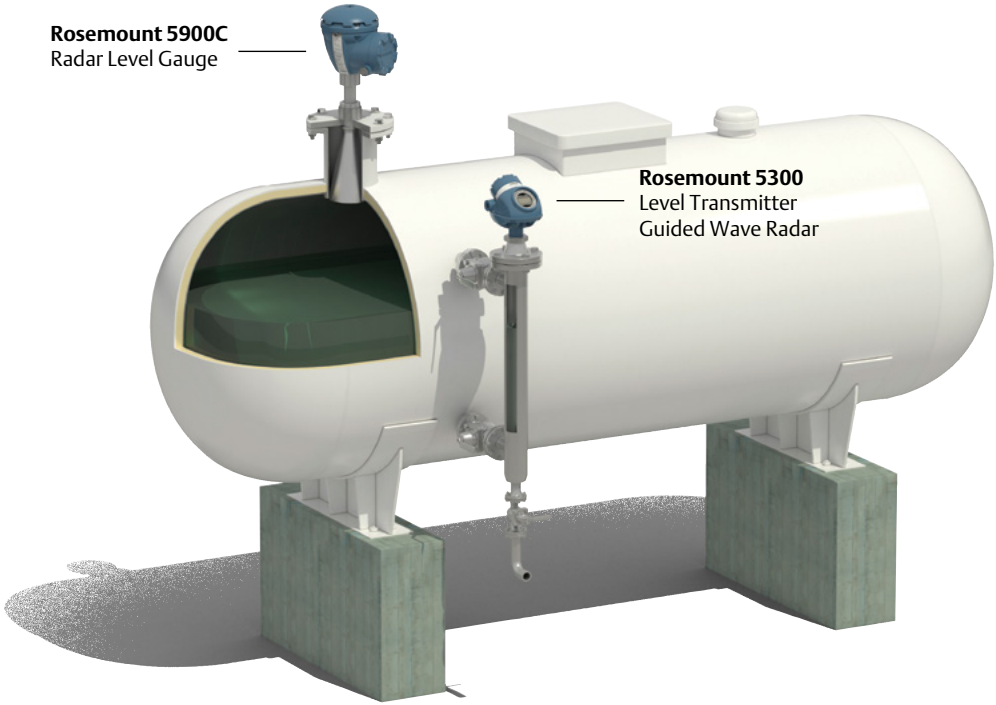
Safety and overfill prevention is a major concern for any tank facility used for bulk liquid storage of flammable liquids. Many of the first applications of radar on LNG was for independent overfill prevention, since the mechanical servo gauges used for regular level measurement did not meet the requirements. Today it is often required that the radar tank gauges have SIL 2 rated high level alarm capabilities. Multiple SIL rated radar gauges can be connected in a SIS loop so that voting between the high alarms is accomplished. It is also possible to utilize a 2-in-1 radar for the same purpose.

A typical instrument configuration on an LNG tank includes an LTD (Level Temperature Density) sensor. The LTD data is used by special software for roll over prediction. Roll Over is a phenomenon in a cryogenic tank that has the potential of causing large uncontrolled vapor emissions. By measuring the density and temperature profile the risk of a roll over can be predicted. Actions to mitigate the risk of roll over can then be initiated depending on the recommendations made by the software.

Pressurized spherical tank



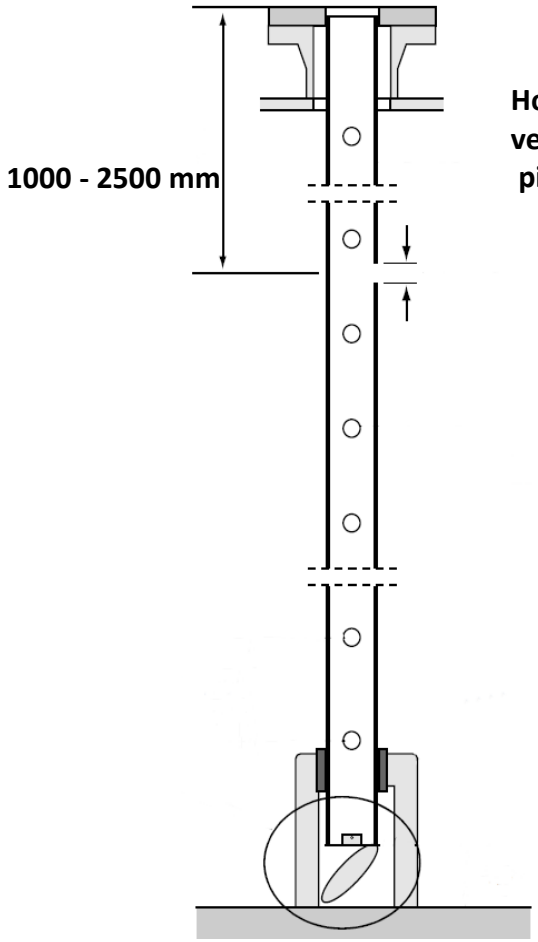
Pressurized horizontal tank



LNG/LPG Raptor

Antenna – 5900S LPG/LNG

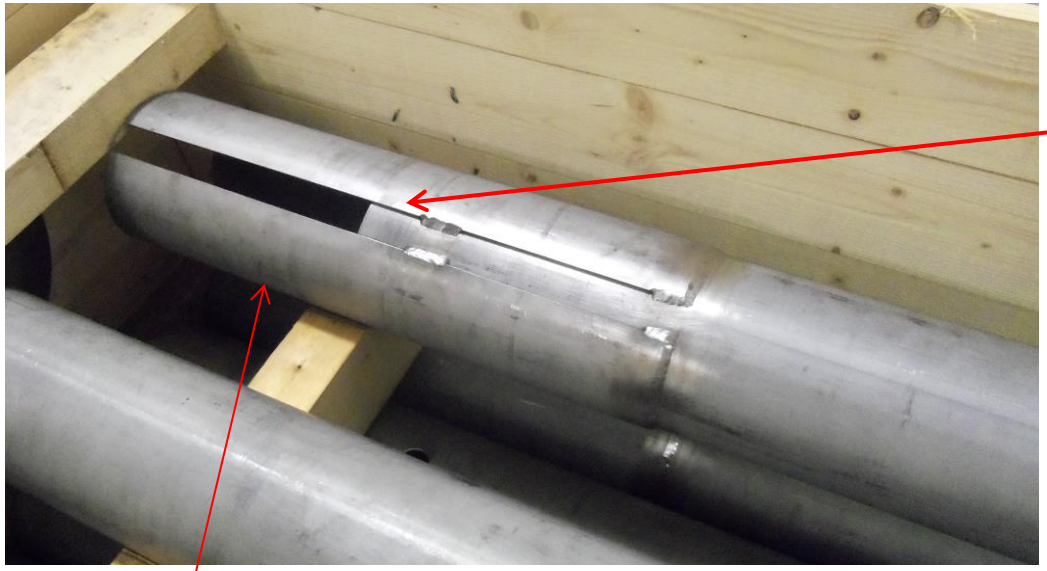
- Designed for
  - Liquefied gas in LPG/LNG tanks
  - 4 in still-pipes sch 10 or 40
  - 100 mm still-pipes
- Quartz/Ceramic window as pressure sealing
- Verification pin function
- Optional
  - Ball valve, fire-proof
  - Rosemount 2051 Pressure sensor
- Flange available in six versions
  - 4 in. class 150, class 300
  - 6 in. class 150, class 300
  - 8 in. class 150, class 300



Stilling Well optionally supplied by RTG

- 4” sch 10 stilling well
- Delivered in 126” (3.2m) sections
- The stilling well is made in accordance to drawing 9240 041-910 and has one row of ¾” (20mm) holes every 20” (500mm)
- All the pipe sections are the same except the top piece which includes the mounting flange.

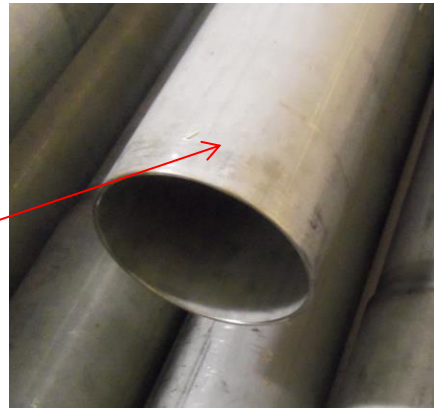
Stilling Well optionally supplied by RTG

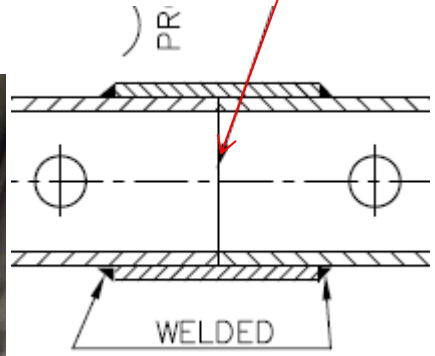


- Each 126” section has a sleeve welded onto one end of the pipe.
- Insert another pipe section into the sleeve and weld the sleeve and pipe together.
- Make sure to adhere to the pipe joint tolerances (no or minimal gap between the 2 pipe sections)

Sleeve

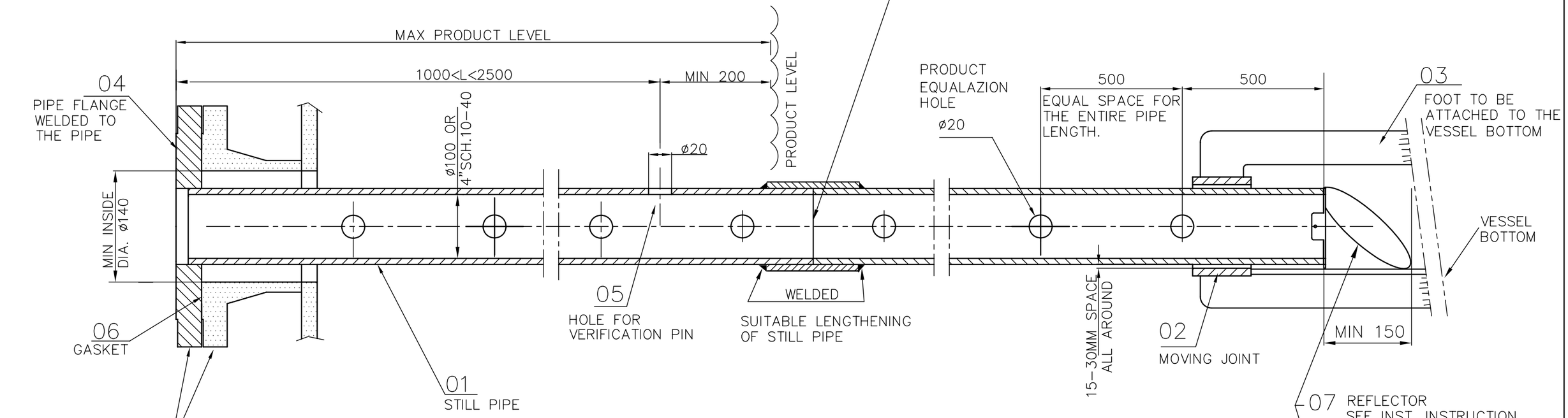
No Sleeve

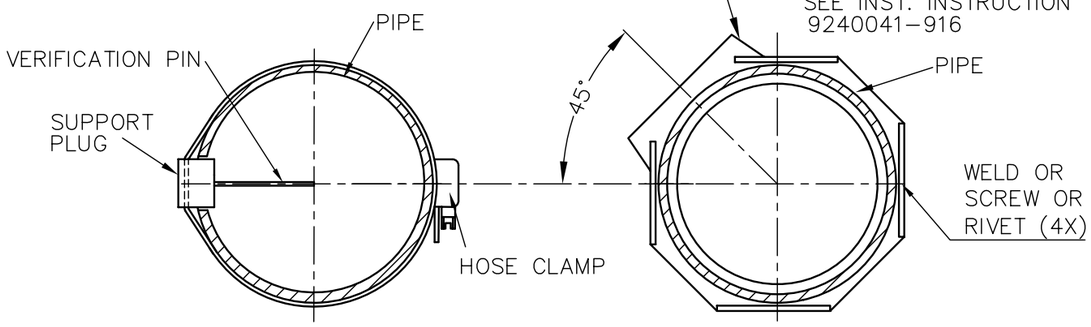


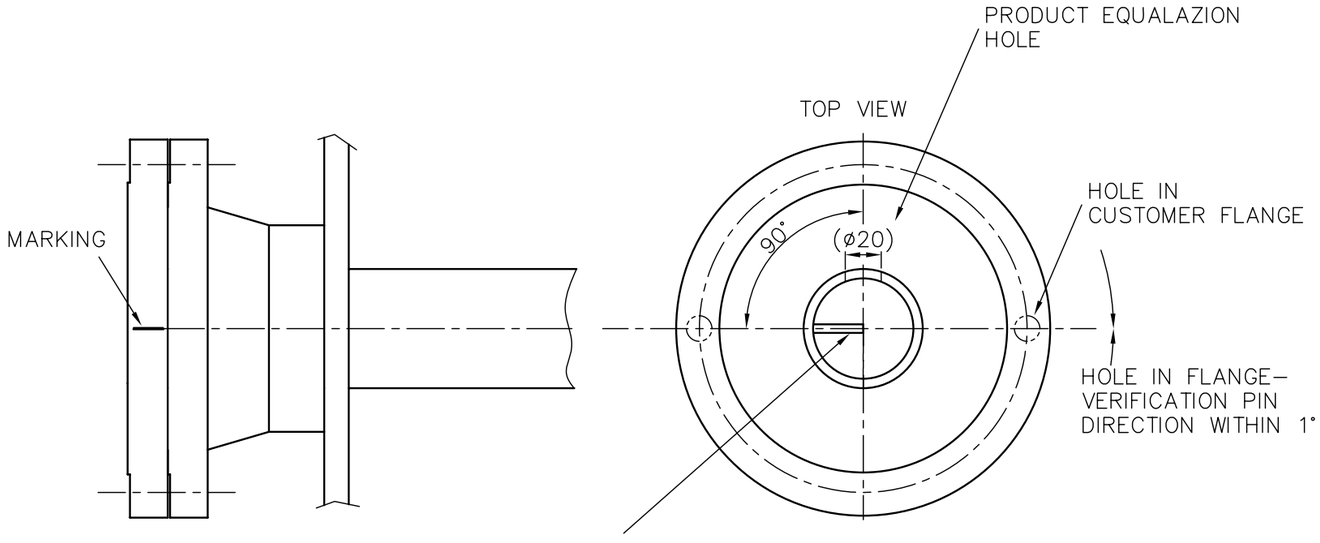


PIPE JOINT TOLERANCES	
END GAP	MAX 1MM
EXCENTRICITY	MAX 1MM
LINEAR DEVIATION	MAX 0.5:100

PIPE JOINT TOLERANCES	
END GAP	MAX 1MM
EXCENTRICITY	MAX 1MM
LINEAR DEVIATION	MAX 0.5:100







IMPORTANT:

VERIFICATION PIN MUST BE DIRECTED TOWARDS ONE BOLT HOLE IN CUSTOMERS FLANGE. MARKING MUST BE DONE TO INDICATE THE POSITION OF THE VERIFICATION PIN AND THE CORRESPONDING FLANGE HOLE WITHIN 1°. THIS MARKING IS TO BE USED DURING MOUNTING OF THE RTG.

FOR DETAILED REQUIREMENTS ON STILL PIPE INSTALLATION, REFLECTOR AND VERIFICATION PIN, SEE DWG 9240041-915.

POS	ITEM DESCRIPTION	QTY	REMARK	SUPPLIER
07	REFLECTOR KIT	1	STAINLESS STEEL	RTR
06	GASKET	1	SOFT OR FLEXIBLE METALLIC TYPE	CUSTOMER
05	VERIFICATION PIN KIT	1	STAINLESS STEEL	RTR
04	PIPE FLANGE	1	STAINLESS STEEL	CUSTOMER
03	FOOT	3	STAINLESS STEEL	CUSTOMER
02	MOVING JOINT (RING/PIPE)	4	STAINLESS STEEL	CUSTOMER
01	STILL PIPE Di ø100 OR 4"SCH.10 40	1	STAINLESS STEEL	CUSTOMER

ISSUED BY	WEEK	PRODUCT CODE	FILE
EMe-BL	1033	5900	ACAD
APPROVED BY	WEEK	ORIGINAL DWG NO.	SCALE
EMe-MH	1043	-	-

INSTALLATION DRAWING TITLE
MECHANICAL INSTALLATION DWG FOR ROSEMOUNT 5900S LPG/LNG STILL-PIPE

ROSEMOUNT® Tank Gauging

1 ST ANGLE

DOC TYPE	DWG NO.	ISSUE	SHEET
2	9240041-910	01	1/1

1. Summary

The still pipe used with Rosemount 5900S LPG/LNG antenna is not supplied by RTR but is to be manufactured by the customer according to the RTR drawing 9240040-910. Additional information is given in this instruction.

2. Function

The still pipe guides the radar waves to ensure a safe measurement undisturbed by structures in the tank and by the possible boiling of the liquid gas. The still pipe is perforated with holes in one vertical line to equalize the liquid level on the inside and outside of the pipe. One additional hole oriented 90 degrees from the line of equalization holes is used to locate a verification pin which provides a possibility to verify a known distance while the tank is under pressure. Due to the function it is important that the still pipe is manufactured according to the drawing 9240040-910 with respect to holes, diameter, orientation etc. The still pipe is installed hung at the top flange according to that same drawing.

3. Still pipe design

The still pipe shall be manufactured according to drawing 9240041-910.
The antenna is installed according to installation drawing 9240040-983.
Use a 100 mm inner diameter stainless steel pipe with 2-3 mm wall thickness or a 4" Sch 10 stainless steel pipe may. The pipe size must be specified when ordering the Rosemount 5900S, since the antenna size is affected (i.e. different transition cones). The equalization holes can have a diameter of 20 mm or 3/4" and are located in one single row. One additional hole which is oriented 90 degrees from the line of equalization holes is used to locate a verification pin. This hole should also have a diameter of 20 mm or 3/4" and shall be positioned 1000-2500 mm from the flange with a minimum of 200 mm above the maximum product level.
For installation in small tanks where distance to max product level is < 1200mm an extended still pipe shall be considered, see drawing 9240041-909.

The orientation of the verification pin hole must be in the same direction, within 1^{o} as one of the bolt holes in the customer flange (pressure vessel, see Figure 3). The centre of the chosen bolt hole should be marked, since the position of verification pin must be possible to verify from the top of the still pipe. Mark the upper end of the pipe as well. This marking is later used for aligning with the 4 mm marking hole on the closing of the 5900S LPG/LNG antenna. The joints of the still pipe should be made with an outer sleeve to avoid burrs or irregularities which can cause disturbances on the measuring performance.

The still pipe should be vertical within 0,5^{o} (see Figure 1). If the 4” pipe is installed into a 6” pipe, then it must fit through the top flange opening.

Pipe inclination

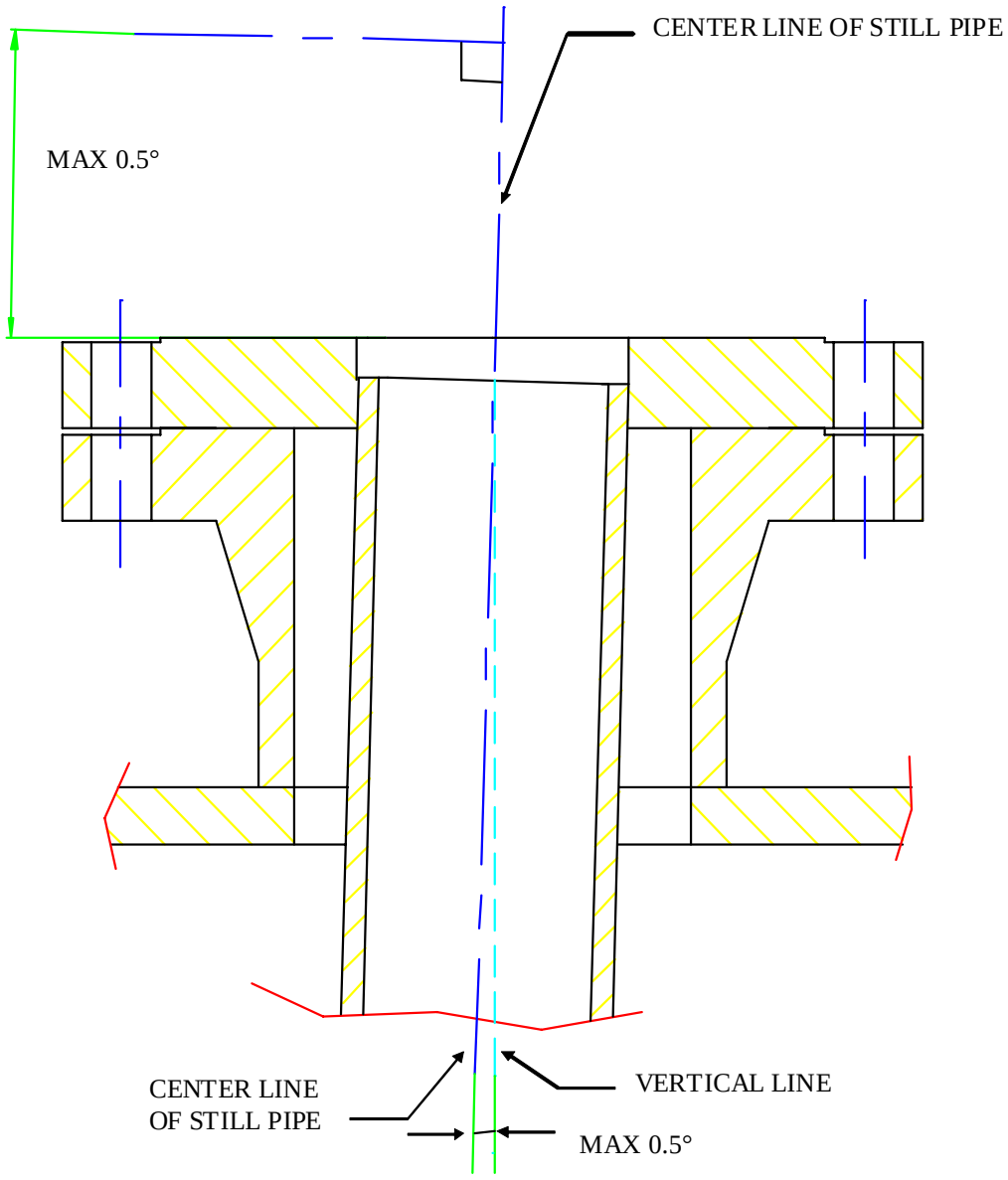


Figure 1. Alignment requirements for still pipe and vessel flange, pipe hung at vessel flange.

4. Mounting the verification pin

Rosemount delivers a *Reflector kit* and a *Verification pin kit* with each Radar Tank Gauge. These kits must be mounted on before installing the still pipe. The reflector is to be mounted at the end of the pipe (see Section 5). The verification pin consists of a small plate with a pin. The pin is mounted through the verification pin hole in the still pipe and attached to it by a hose clamp (supplied by RTR but most stainless models will do) ensuring that the plate is well aligned by the pipe around the hole (see Figure 1).

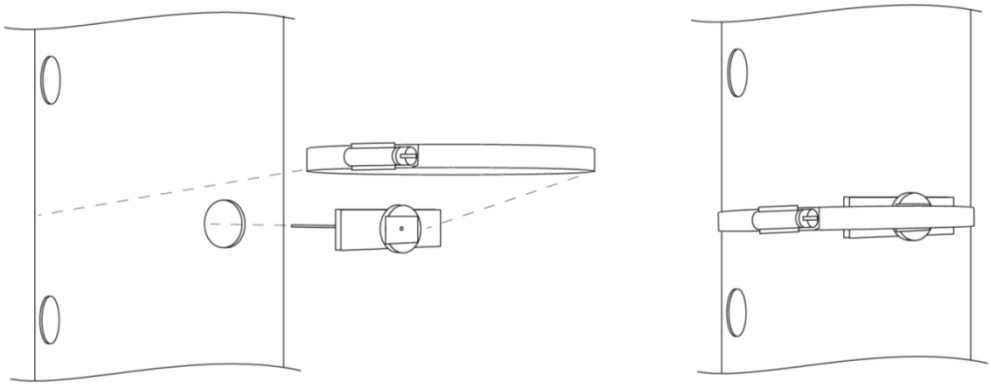


Figure 2. Verification pin assembly

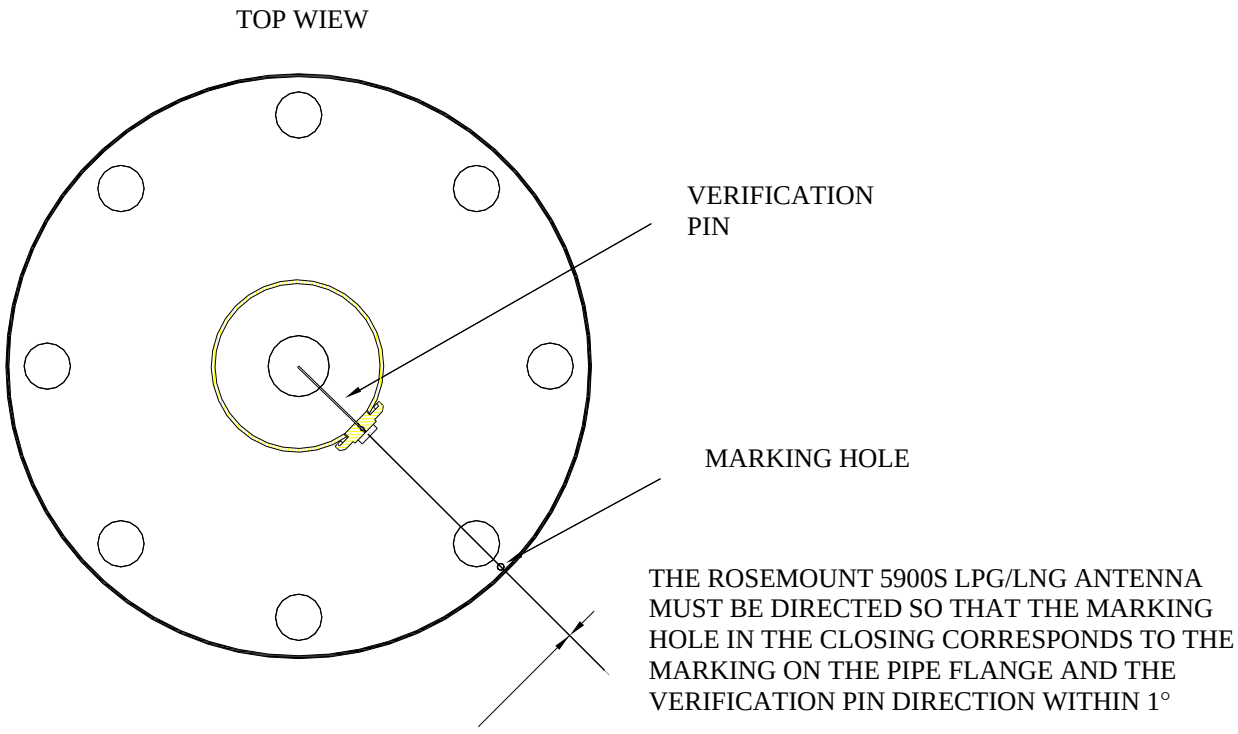


Figure 3. Alignment of the verification pin and marking hole

5. Mounting the reflector

The *Reflector kit* is mounted at the lower end of the still pipe in order to allow a small verification echo from the pipe end and to avoid echoes from the tank bottom.

This instruction shows how to install the Reflector at the pipe end. It is a complement to the installation drawings 9150072-924/-925 for REX and 9240041-910 for Rosemount 5900.
The pipe could be 4" schedule 10, 4" schedule 40 or DN 100.

There are three different ways to assemble the reflector at the pipe end:

1. Welding at the top of the reflector (above the ∅4,1 holes). Note: Recommended.
2. Screw M4 + Nut (in the ∅4,1 hole). Note: Hole ∅4,1 have to be drilled in the pipe.
3. Rivet ∅4 (in the ∅4,1 hole). Note: Hole ∅4,1 have to be drilled in the pipe.

Mounting at Pipe - 4" schedule 10:

Figure 4. Reflector part is mounted directly to the pipe.

Mounting at Pipe - 4" schedule 40:

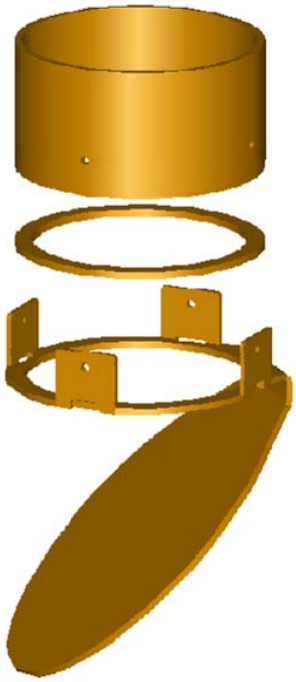


*Figure 5. Reflector is mounted to the pipe with the Ring marked **4" SCH 40**.*

Mounting at Pipe - DN 100:

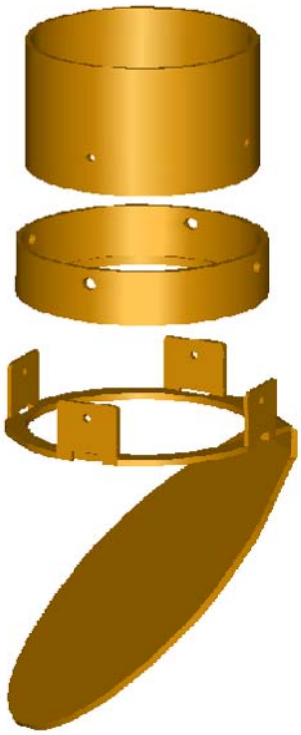
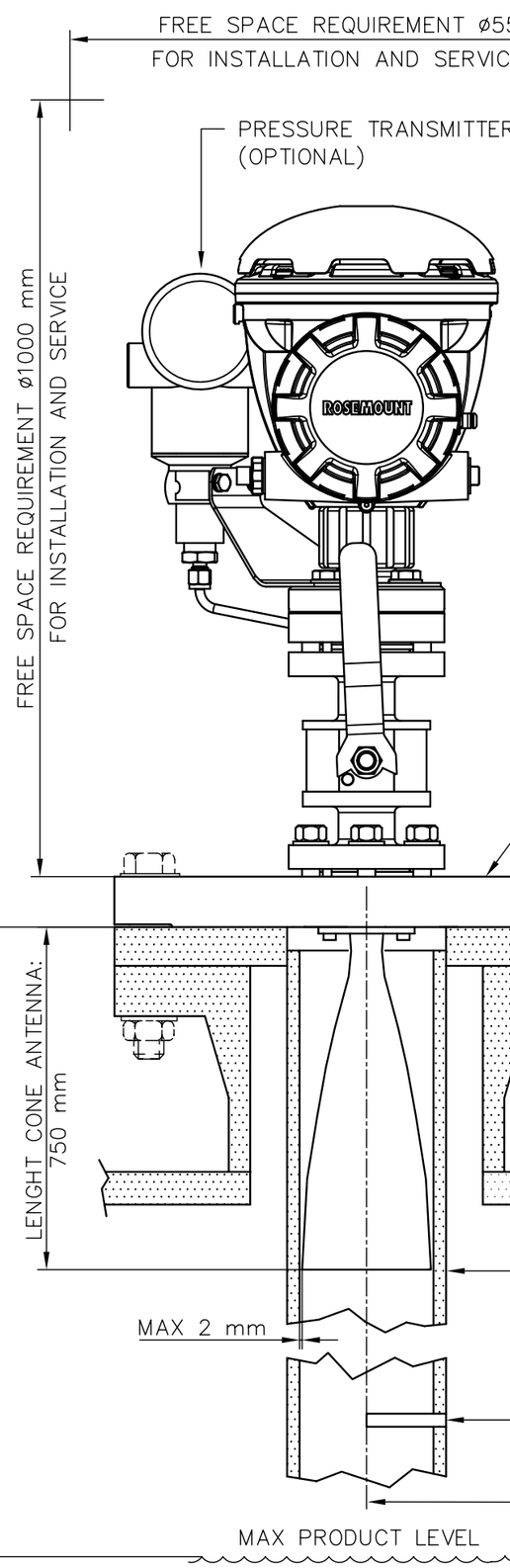
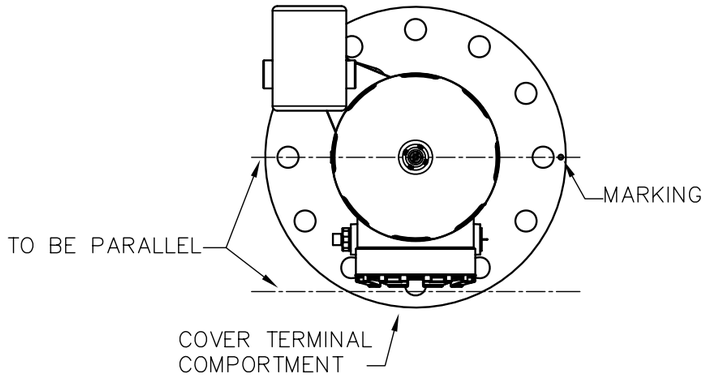
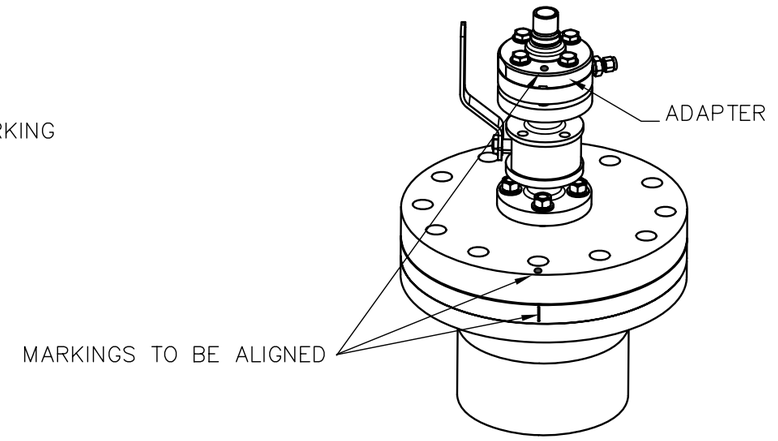
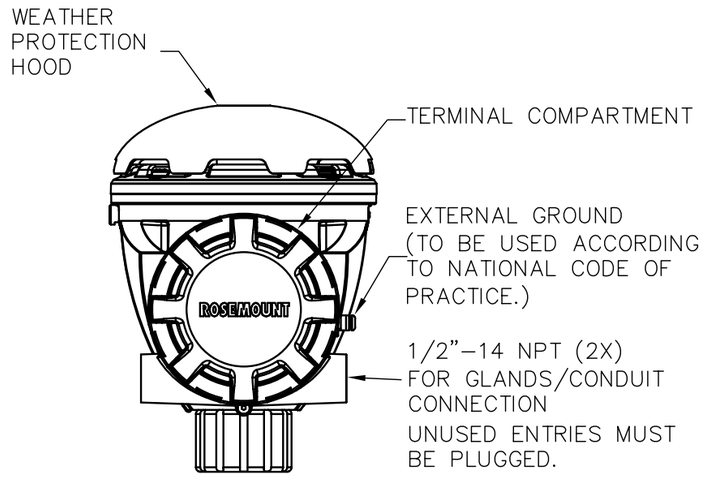


*Figure 6. Reflector is mounted to the pipe with the Ring marked **DN 100**.*









FOR MORE INFO. SEE
Rosemount TankRadar 5900S
INSTALLATION MANUAL

07	CLOSING	RTR
06	STILL–PIPE FLANGE	CUSTOMER
05	ROOF FLANGE	CUSTOMER
04	GASKET, SOFT OR METALLIC TYPE	CUSTOMER
01–03	SCREW/NUT/WASHER ACC TO ASME B16.5 OR EN1092–1	CUSTOMER
POS	ITEM DESCRIPTION	SUPPLIER

ISSUED BY	WEEK	PRODUCT CODE	FILE	INSTALLATION DRAWING TITLE
EMe–BL	1035	5900	ACAD	MECHANICAL INSTALLATION DWG LPG/LNG ANTENNA
APPROVED BY	WEEK	ORIGINAL DWG NO.	SCALE	
EMe–MH	1043	–	–	

ROSEMOUNT® Tank Gauging

1 ST ANGLE

DOC TYPE	DWG NO.	ISSUE	SHEET
2	9240040–983	01	01/01

3.2.4 LPG/LNG Antenna Requirements

Temperature and Pressure Measurement

Measurements of temperature and pressure is a prerequisite for high accuracy level measurements in LPG/LNG tanks. A Raptor system may include 5900S Radar Level Gauges, 2240S Multi-input Temperature Transmitters, 644 Temperature Transmitters as well as pressure transmitters in order to obtain all necessary measurement variables.

Still-pipe and Verification Pin

A still-pipe must be installed prior to the gauge installation. The still-pipe is customer supplied and should be manufactured according to the installation drawings.

Three types of steel pipe are recommended:

- DN100
- 4 inch SCH 10 stainless steel pipe
- 4 inch SCH 40 stainless steel pipe

When ordering the level gauge specify the pipe type in the Required System Information (RSI) form.

The still-pipe must be vertical within ±0.5° and the customer flange must be horizontal within ±1° as illustrated in Figure 3-11 on page 3-14.

The still-pipe is manufactured with a number of holes to allow proper circulation of the product, and to ensure equalization of product density inside and outside the pipe. The hole diameter should be 20 mm or 3/4”. All holes in the upper still-pipe section must be placed along a line on one side of the pipe.

The **Verification Pin** allows you to verify 5900S level measurements when the tank is pressurized. It is mounted on the still-pipe in a hole oriented 90 degrees to the other holes.

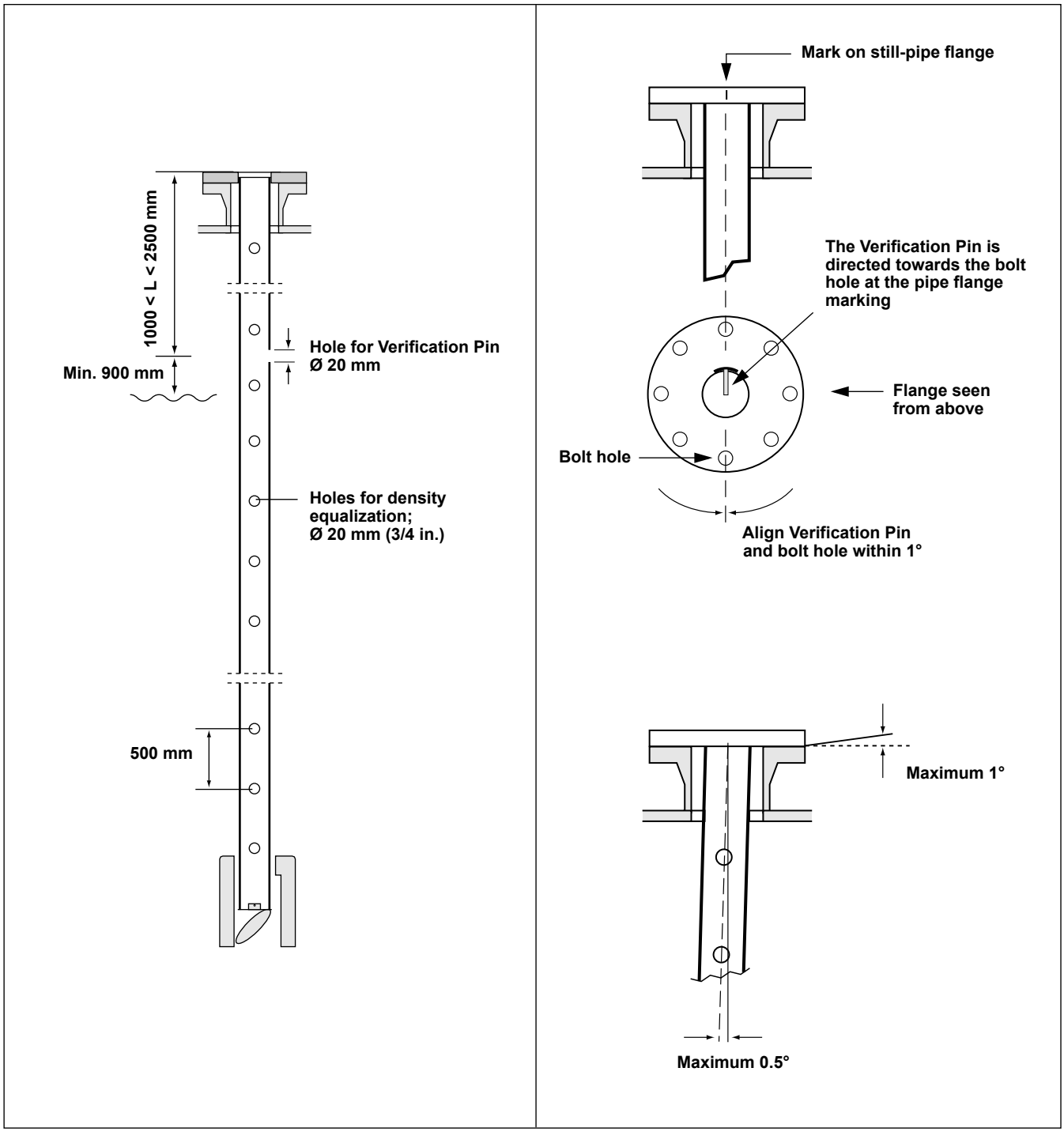
The Verification Pin should be placed at a position of 2500 mm below the flange as illustrated in *Figure 3-11 on page 3-14*. There must be a minimum distance of 900 mm between the Verification Pin and the maximum product level. In order to fulfill this requirement, the Verification Pin may be mounted higher, up to 1000 mm below the flange.

The Verification Pin must be aligned with a bolt hole on the still-pipe flange as illustrated in *Figure 3-11*. The Verification Pin’s position must be clearly marked on the still-pipe flange (see *Figure 3-11)* to allow proper alignment of the 5900S gauge.

See installation drawing 9240 041-910 for LPG/LNG Still-pipe for information on how to install the Verification Pin on the still-pipe. Installation instructions are enclosed with the Verification Pin and Deflection Plate.

See *“LPG Configuration” on page 4-19* and the *Raptor System Configuration Manual*, Document No. 300510EN for further information on how to configure the 5900S for LPG/LNG measurements.

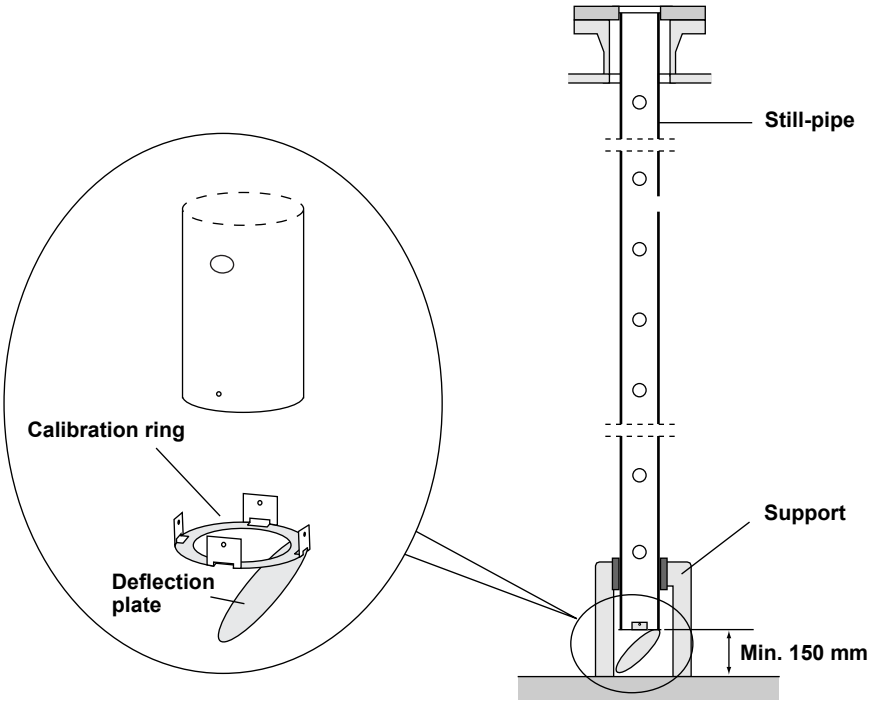
Figure 3-11. Installation of Verification Pin and inclination requirements for flange and still-pipe



Deflection Plate with Calibration Ring

A **Deflection Plate** is mounted at the lower end of the still-pipe and is integrated with a ring that is used for calibrating the gauge during the installation phase when the tank is empty. Installation instructions are enclosed with the Verification Pin and Deflection Plate.

Figure 3-12. Still-pipe with Deflection Plate and Verification Pin



The Deflection Plate can be attached to the still-pipe by using one of three methods:

- Welding
- M4 screw and nut
- Riveting

For pipe dimensions 4 inch SCH 40 and DN 100, an extra ring is needed for the Deflection Plate as illustrated in Figure 3-13 and Figure 3-14.

See “LPG Configuration” on page 4-19 and the *Raptor System Configuration Manual*, Document No. 300510EN for further information on how to configure the 5900S for LPG/LNG measurements.

Figure 3-13. Mounting the Deflection Plate on pipe 4 inch SCH 40

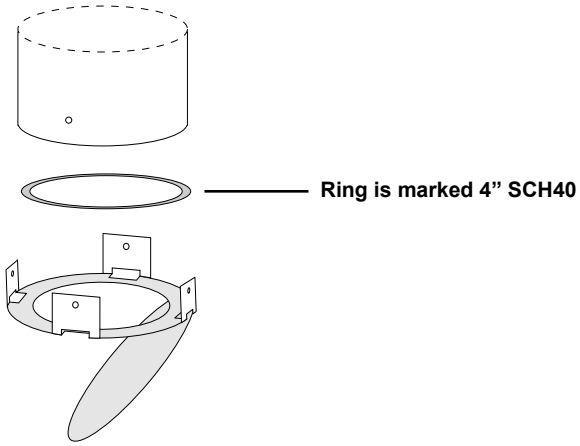
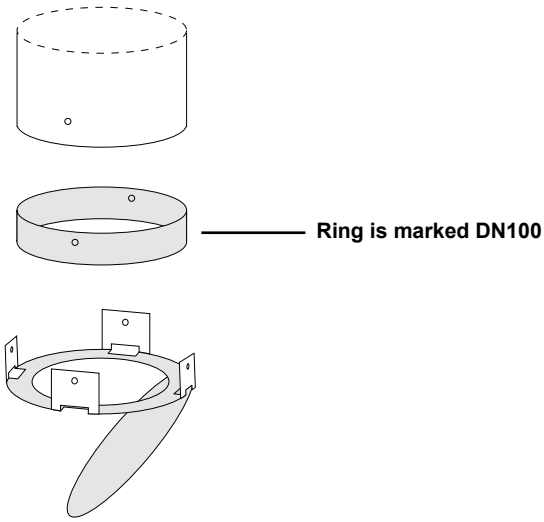


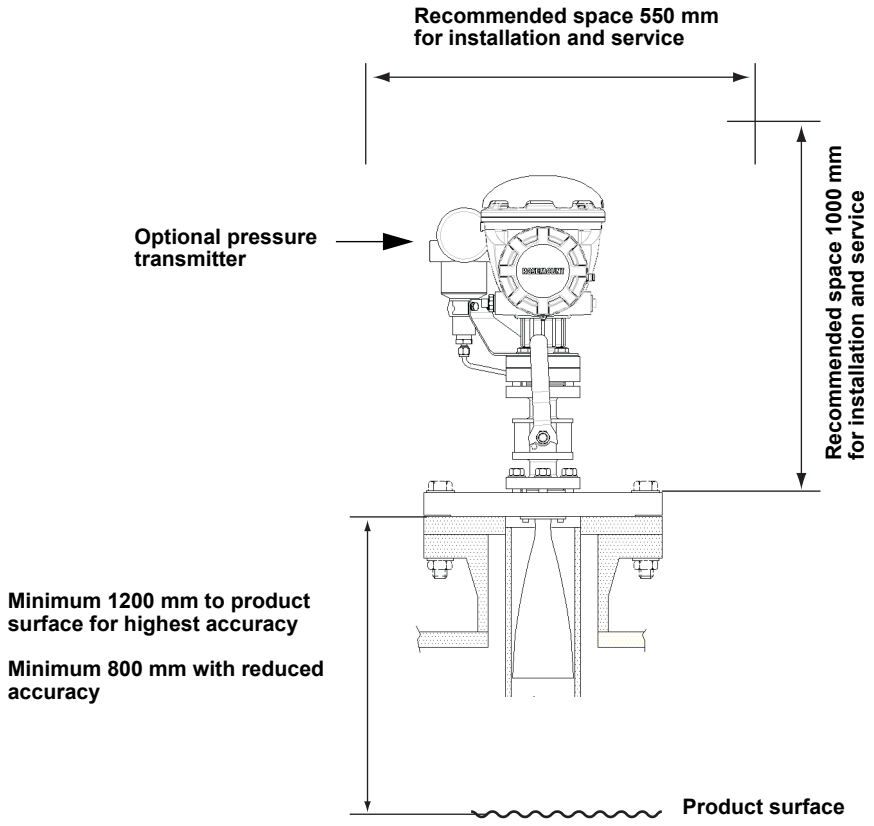
Figure 3-14. Mounting the Deflection Plate on pipe DN 100



Free Space

The following free space is recommended for mounting the 5900S with LPG/LNG Antenna:

Figure 3-15. Free space requirements for 5900S with LPG/LNG antenna



Extension Pipe for Minimum Distance

The 5900S Radar Level Gauge should be placed such that there is a minimum gap of 1200 mm between the flange and the maximum product level (see “Still-pipe and Verification Pin” on page 3-13). If necessary, an extension pipe can be used to raise the level gauge. This will allow measurements closer to the top of the tank than would otherwise be possible, as illustrated in Figure 3-16.

Figure 3-16. Rosemount 5900S with extension pipe