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Appendix B: Terms and Definitions

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**NOTICE**

Read this manual before working with the product. For personal and system safety, and for optimum product performance, make sure you thoroughly understand the contents before installing, using, or maintaining this product.

For equipment service or support needs, contact your local Emerson Process Management/Rosemount Tank Gauging representative.

**Spare Parts**

Any substitution of non-recognized spare parts may jeopardize safety. Repair, e.g. substitution of components etc, may also jeopardize safety and is under no circumstances allowed.

Rosemount Tank Radar AB will not take any responsibility for faults, accidents, etc caused by non-recognized spare parts or any repair which is not made by Rosemount Tank Radar AB.
1.1 Safety messages

Procedures and instructions in this manual may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (△). Refer to the safety messages listed at the beginning of each section before performing an operation preceded by this symbol.

⚠️ WARNING

Failure to follow these installation guidelines could result in death or serious injury.

- Make sure only qualified personnel perform the installation.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.

Explosions could result in death or serious injury.

- Verify that the operating environment of the transmitter is consistent with the appropriate hazardous locations certifications.
- Before connecting a hand held communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Do not remove the gauge cover in explosive atmospheres when the circuit is alive.

Electrical shock could cause death or serious injury.

- Use extreme caution when making contact with the leads and terminals.
1.2 Introduction

The purpose of the safety manual is to document all the information, relating to the Rosemount Tank Gauging system, which is required to enable integration into a safety-related system, in compliance with the requirements of IEC 61508.

1.2.1 Purpose of the product

The Rosemount™ Tank Gauging Safety System is designed for high performance level gauging in various types of storage tanks. It measures the distance to a liquid in a tank for Safety Instrumented Systems. Two relays and one 4-20 mA analog output are available for alarm indication and overfill and dry run risk. Non safety-related instruments such as level transmitters, temperature sensors, remote display units, water level sensors, pressure sensors, and other instruments can be connected.

The Rosemount Tank Gauging Safety System is intended for use as a level measurement sensor in safety instrumented functions (SIF) designed per IEC 61511. It is comprised of the following main elements:

**Rosemount 5900**

The Rosemount 5900 is a radar level gauge developed for a wide range of applications at bulk liquid storage facilities. Different antennas can be used in order to meet the requirements of different applications. The 2-in-1 version of the Rosemount 5900 has two independent and galvanically isolated radar modules in the same transmitter enclosure using a single antenna.

**Rosemount 2410**

The Rosemount 2410 acts as a power supply to the connected Rosemount 5900 using the intrinsically safe Tankbus. The Rosemount 2410 provides the analog 4-20 mA outputs and relay output and digital communication allowing connection of configuration tools or safety control system.

1.2.2 Assumptions and restrictions

Note that the Rosemount 5900 is not safety-rated during maintenance work, configuration changes, or other activity that affects the Safety Function. Alternative means should be used to ensure process safety during such activities.

False echoes within the radar beam from flat obstructions with a sharp edge may lead to a situation where the Rosemount 5900 can no longer be used for safety related functions with the listed failure rates, Safe Failure Fraction and PFD\textsubscript{AVG}. However, reduced proof test intervals can help to detect such unwanted causes.
1.3 Safety Instrumented System (SIS) certification

The Rosemount Tank Gauging Safety System is designed for applications in high demand mode operation (demand rate of 1 per week).

The Rosemount Tank Gauging Safety System is certified to:

- Low and High Demand of operation
- Systematic Capability: SC 3 (SIL 3 capable)
- Random Capability for type B device:
  - 1 in 1 SIL 2 @ HFT=0
  - 2 in 1 SIL 2 @ HFT=0

**Note**
Refer to the 5900/2410 FMEDA report for failure rate data, assessment details, and assumptions regarding failure rate analysis.

It is important that the Rosemount Tank Gauging Safety System is installed and used in appropriate applications as described in relevant installation instructions. Otherwise the required functional safety may not be maintained.

The instruments in a Rosemount Tank Gauging System must be operated within specified environmental conditions. Operating conditions are available in the *Rosemount Tank Gauging System Data Sheet*, Document No. 00813-0100-5100.

If there are any echoes measured by the Rosemount 5900 which cannot be traced back to the product surface, note if there are any objects such as beams, heating coils etc. in the tank, that correspond to the found echoes. Appropriate action has to be taken if the disturbing echoes affect measurement performed, please contact Emerson Process Management/Rosemount Tank Gauging for advice.

1.3.1 Still-pipe Array Antenna with hinged hatch

The Rosemount 5900 Radar Level Gauge including the SIL alarm output is not safety-rated during maintenance work. This includes opening of the 5900 still-pipe array antenna, hinged hatch version during for example manual gauging (hand-dip) or product sampling.

During hatch opening, system may go to de-energized state (alarm). If needed, alternative means should be used to ensure process safety during opening of hatch.
1.4 Safety-certified identification

All Rosemount 5900 Radar Level Gauges and Rosemount 2410 Tank Hubs must be identified as safety-certified before installing into SIS systems. Table 1-1 lists the versions of the Rosemount 5900/2410 Series devices that have been considered for the functional safety assessment, to which this manual applies.

- Models with the S option code are IEC 61508 certified by an accredited 3rd party agency for use in safety instrumented systems up to SIL 2.

Table 1-1. Rosemount Tank Gauging System (4-20 mA Analog Output)

<table>
<thead>
<tr>
<th>Hardware</th>
<th>5900 Radar Level Gauge (type B)</th>
<th>2410 Tank Hub</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Field Bus</td>
<td>Model Code B</td>
<td>Model Code B</td>
</tr>
<tr>
<td>Secondary Field Bus</td>
<td>Model Code A, B, C, D</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Software/Firmware</th>
<th>5900 Radar Level Gauge (type B)</th>
<th>2410 Tank Hub</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5900 sw 1.85 and further</td>
<td>2410 sw 1.81 and further</td>
</tr>
</tbody>
</table>

Table 1-2. Rosemount Tank Gauging System (Standard K1/K2 Relay Output)

<table>
<thead>
<tr>
<th>Hardware</th>
<th>5900 Radar Level Gauge (type B)</th>
<th>2410 Tank Hub</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay Option 1xSPST</td>
<td>Model Code 1</td>
<td></td>
</tr>
<tr>
<td>Relay Option 2xSPST</td>
<td>Model Code 2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Software/Firmware</th>
<th>5900 Radar Level Gauge (type B)</th>
<th>2410 Tank Hub</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5900 sw 1.85 and further</td>
<td>2410 sw 1.81 and further</td>
</tr>
</tbody>
</table>

To identify a Rosemount 5900 and Rosemount 2410 safety-certified device:

- Verify the option code S in the model code, on the label affixed to the outside of the transmitter head.
- Check if a yellow label is affixed to the transmitter head for option code S.
- Before doing any configuration, write down the Device Id from the label, and make sure you are connected to the correct transmitter by verifying the same Device Id in your communication device.
1.5  Functional specification of the safety function

The safety function is based on the analog output 4-20 mA or K1/K2 relay outputs.

If a measured value goes beyond the measurement range, the transmitter enters saturation mode (limit alarm is disabled) or alarm mode, depending on the current configuration.

The Rosemount Tank Gauging Safety System provides either:

- one or two relay outputs, and/or
- one 4-20 mA output

and measures the distance from the Gauge reference point to the surface of a liquid in a tank.

The Rosemount Tank Gauging Safety System contains advanced self-diagnostics; internal monitoring features, and is programmed to go to de-energized state (alarm) upon detection of an internal failure.

1.5.1  Safety architecture

The Rosemount Tank Gauging Safety System offers various models in order to support different system configurations.

**SIL 2 1-in-1 (1oo1D)**
- Single channel architecture (1oo1D) complying with SIL 2. This version includes one 5900 Radar Level Gauge, one antenna, and one 2410 Tank Hub.

**SIL 2 2-in-1 (1oo1D)**
- Single channel architecture (1oo1D) complying with SIL 2. This version includes one “2-in-1” 5900 Radar Level Gauge, one antenna, and one 2410 Tank Hub.
Section 2 Installation and Configuration

2.1 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (▲). Please refer to the following safety messages before performing an operation preceded by this symbol.

⚠️ WARNING

Failure to follow these installation guidelines could result in death or serious injury.

- Make sure only qualified personnel perform the installation.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.

Explosions could result in death or serious injury.

- Verify that the operating environment of the transmitter is consistent with the appropriate hazardous locations certifications.
- Before connecting a hand held communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Do not remove the gauge cover in explosive atmospheres when the circuit is alive.

Electrical shock could cause death or serious injury.

- Use extreme caution when making contact with the leads and terminals.

⚠️ WARNING

Any substitution of non-recognized parts may jeopardize safety. Repair, e.g. substitution of components etc., may also jeopardize safety and is under no circumstances allowed.
2.2 Installation in SIS applications

The Rosemount™ 5900 Radar Level Gauge and Rosemount 2410 Tank Hub should be installed and configured as described in the reference manual. The materials must be compatible with process conditions and process fluids. No special installation is required in addition to the standard installation practices outlined in the reference manuals:

- Rosemount 2410 Tank Hub Reference Manual (Document No. 00809-0100-2410)
- Rosemount 5900S Radar Level Gauge Reference Manual (Document No. 00809-0100-5900)
- Rosemount 5900C Radar Level Gauge Reference Manual (Document No. 00809-0100-5901)
- Rosemount Tank Gauging System Configuration Manual (Document No. 00809-0300-5100)

**Note**
Installation drawings must be considered for installation of devices in a Rosemount Tank Gauging Safety System.

**Note**
The Rosemount 5900 Radar Level Gauge and Rosemount 2410 Tank Hub are not safety-rated during maintenance work, configuration changes, or other activity that affects the Safety Function. Alternative means should be used to ensure process safety during such activities.
2.3 Configuration in SIS applications

2.3.1 Analog output configuration

Alarm and saturation levels

DCS or safety logic solver should be configured to handle both High alarm and Low alarm. It is also required that the transmitter is configured for High or Low alarm. Figure 2-1 identifies the alarm levels available and their operation values.

Figure 2-1. Alarm Levels and Operation Values

<table>
<thead>
<tr>
<th>Rosemount Alarm Level</th>
<th>Normal Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.75 mA(1)</td>
<td>4 mA</td>
</tr>
<tr>
<td>3.9 mA</td>
<td>20 mA</td>
</tr>
<tr>
<td>20.8 mA (2)</td>
<td>21.75 mA(2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Namur Alarm Level</th>
<th>Normal Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6 mA(1)</td>
<td>4 mA</td>
</tr>
<tr>
<td>3.8 mA low saturation</td>
<td>20.5 mA high saturation</td>
</tr>
<tr>
<td>3.9 mA</td>
<td>20 mA</td>
</tr>
<tr>
<td>20.5 mA (2)</td>
<td>22.5 mA(2)</td>
</tr>
</tbody>
</table>

1. Transmitter Failure, hardware or software alarm in Low position.
2. Transmitter Failure, hardware or software alarm in High position.

It is assumed that the current output signal is fed to a SIL 2-compliant analog input board of a safety logic solver.

Note
Only the High or Low Alarm Mode can be used for the safety function. Do not choose Freeze Current.

Note
A Low Alarm will be triggered in case of a hardware fault on the Analog Output card.
Analog output configuration in TankMaster

To configure the 2410 Tank Hub analog output:

1. In the WinSetup workspace click the right mouse button on the 2410 Tank Hub icon and choose the Properties option.

2. Select the Configuration tab.

3. Click the Analog Output button to open the Analog Output Configuration window\(^{(1)}\).

4. Check the Enable box to activate the analog output option.

5. Configure Source Parameter, Value Range, and Alarm Mode. See Appendix C in the Rosemount 2410 Tank Hub reference manual\(^{(2)}\) for more information on how to configure the analog output.

Note
In case a Proof Test Reference Reflector is used, make sure that the Value at 20 mA is set above the position of the reflector.

---

1. Note that this button is available if the Analog Output option is activated for the 2410 Tank Hub.
2. Document No 00809-0100-2410
2.3.2 Relay configuration

To configure a 2410 Tank Hub Virtual Relay:

1. In the WinSetup workspace click the right mouse button on the 2410 icon, choose **Properties** and select the **Configuration** tab.

2. Click one of the **Virtual Relay No.** buttons. See Appendix C in the *Rosemount 2410 Tank Hub* reference manual\(^1\) for more information on how to configure the relays.

![Virtual Relay Configuration](image)

**Normally Open/Normally Closed**

Normally Open (NO) is the default setting for the Rosemount 5900 and 2410 in Safety Instrumented Systems. Verify the relay configuration by, for example, following the procedure in "Verification of the relay function" on page 15.

See the *Rosemount 2410 Tank Hub* reference manual\(^1\) for more information on the Rosemount 2410 relays.

**Note**

In case a Proof Test Reference Reflector is used, make sure that the relay set point is set below the position of the reflector.

---

1. Document No 00809-0100-2410
2.4 Write protection

A Rosemount Tank Gauging safety-certified system should always be write protected in order to avoid unintentional configuration changes. The Rosemount 5900 Radar Level Gauge as well as the Rosemount 2410 Tank Hub should be write protected.

It is recommended to use one of the following write protection options:

- Hardware switch
- Software password protected function

See the appropriate reference manuals listed in "Installation in SIS applications" on page 8 for more information on how to enable write protection.

2.5 Site acceptance

After installation and/or configuration, proper operation of the transmitter (including verification of all configuration changes) must be verified. A site acceptance test is therefore required. The proof test outlined in this document can be used for this.
3.1 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (△). Please refer to the following safety messages before performing an operation preceded by this symbol.

⚠️ WARNING

Failure to follow these installation guidelines could result in death or serious injury.
- Make sure only qualified personnel perform the installation.
- Use the equipment only as specified in this manual. Failure to do so may impair the protection provided by the equipment.

Explosions could result in death or serious injury.
- Verify that the operating environment of the transmitter is consistent with the appropriate hazardous locations certifications.
- Before connecting a hand held communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Do not remove the gauge cover in explosive atmospheres when the circuit is alive.

Electrical shock could cause death or serious injury.
- Use extreme caution when making contact with the leads and terminals.

⚠️ WARNING

Any substitution of non-recognized parts may jeopardize safety. Repair, e.g. substitution of components etc., may also jeopardize safety and is under no circumstances allowed.
3.2 **Proof test**

The Rosemount™ Tank Gauging Safety System should be checked at regular intervals in order to detect Dangerous Undetected (DU) failures.

The test must be repeated at regular intervals. The time periods depend on the $PFD_{avg}$ value. **Note!** Proof test for $PFD_{avg}$ calculations is only applicable for Low Demand mode.

The level measuring function can be verified via *TankMaster WinOpi* and *TankMaster WinSetup*.

For information about how to verify the relay function see “Verification of the relay function” on page 15.

Ensure that the proof test is performed with the same product type used when the tank was configured and approved for SIL Safety Alarm operation.

One or more of the proof tests described below are recommended.

Make sure to enable write protection as soon as you are finished.

**Note**
The Rosemount 5900 gauge is not safety-rated during maintenance work, configuration changes, or other activity that affects the Safety Function. Alternative means should be used to ensure process safety during such activities.

**Note**
Before every test, make sure you are connected to the correct transmitter by verifying $S$ in the model code on the label and your software version. Also verify that the Device Id on the label matches the one in your configuration tool.

**Note**
For a valid result, always perform the proof test on the product that will be stored in the tank while the device is in operation.

3.2.1 **System test**

This proof test will detect approximately 99% of the DU (dangerous undetected) failures not detected by the diagnostics in the Rosemount Tank Gauging Safety System. The test includes testing the relay response when the product surface reaches the relay set point.

The overfill and dry-run protection function should be checked by filling and emptying the tank in order to test the system response when the product surface reaches the relay set points.

In case the 4-20 mA option is used, verify that the analog output current from the 2410 corresponds to the level presented in the TankMaster configuration tool.
3.2.2 Check of relay output

By combining the two tests One-point level verification and Verification of the relay function approximately 88% of the DU (dangerous undetected) failures will be detected.

One-point level verification

This proof test will detect approximately 73% of the dangerous undetected (DU) failures not detected by the diagnostics in the Rosemount 5900:

1. Compare the level presented in the TankMaster configuration tool with a second reference such as the BPCS level sensor or a manual hand dip (see the Rosemount 5900S Reference Manual, Document No. 00809-0100-5900, for a description of how to perform hand dipping).

2. Verify that the relay output corresponds to the configured relay state at the current product level.

Verification of the relay function

This proof test verifies the Safety Relay function itself, i.e. whether the Safety Relay is able to open and close.

The test will detect approximately 18% of the dangerous undetected (DU) failures not detected by the diagnostics in the Rosemount Tank Gauging Safety System.

To test the relay function, follow the procedure described below:

1. In the TankMaster WinSetup workspace select the Rosemount 2410 icon.

2. Click the right mouse button and choose Manual Control Relay.

3. Select the virtual relay functions to be tested; Virtual Relay 1, Virtual Relay 2, etc. Up to ten virtual relay functions can be configured for a 2410 Tank Hub. See section "Advanced configuration in WinSetup" and "Relay output" in the Rosemount 2410 Tank Hub Reference Manual (Document No. 00809-0100-2410) for more information.

4. Specify a Safety Reset Time. This value specifies the time period for the relay to stay in the test state. When the specified period of time has elapsed, the relay automatically returns to the original state. The relay will reset even if communication with the TankMaster PC would fail.


6. Click the Set button. Now the selected relay changes state for the specified number of seconds and then returns to the previous state.

7. Verify the K1/K2 relay output:
   a. Verify correct Relay Status as presented in the TankMaster (WinSetup) configuration tool.
   b. Verify that the actual relay output corresponds to the relay state presented in the TankMaster (WinSetup) configuration tool.
3.2.3 Check of 4-20 mA output

By combining the two tests One-point level verification and 4-20 mA alarm test approximately 84% of the DU (dangerous undetected) failures will be detected.

One-point level verification

This test will detect approximately 84% of the dangerous undetected (DU) failures not detected by the diagnostics in the Rosemount Tank Gauging Safety System.

1. Compare the level presented in the TankMaster configuration tool with a second reference such as the BPCS level sensor or a manual hand dip (see the Rosemount 5900S Reference Manual, Document No. 00809-0100-5900, for a description of how to perform hand dipping).

2. Verify that the analog output current from the 2410 as presented in the TankMaster configuration tool, corresponds to the level presented.

3. Measure and verify the analog output current value from the 2410 to correspond to the current value presented in the TankMaster configuration tool.
4-20 mA alarm test

This test will verify that the 4-20 mA analog output responds to level measurement failure by switching to the configured alarm mode. See “Analog output configuration” on page 9 for more information on how to configure the Analog Output. The test will detect approximately 19% of the dangerous undetected (DU) failures not detected by the diagnostics in the Rosemount Tank Gauging Safety System.


2. Set Alarm Mode=High Alarm Current.
   a. In TankMaster WinSetup, open the 2410 tank hub Properties window.
   b. Select the Configuration tab and click the Analog Output button.
   c. In the Analog Output window, set Alarm Mode=High Alarm Current.
   d. Click the Advanced button and check the High Alarm current value.

3. Restart 5900 level gauge.
   a. In the WinSetup workspace, click the right mouse button on the 5900 device icon
   b. Click the Restart option.

4. Verify that the analog output, as presented in the TankMaster WinSetup configuration tool, switches to alarm mode High. Note that the 5900 will stay in alarm mode for about 15 seconds.

5. Measure the analog output current from the 2410 tank hub in alarm mode High. Verify that it corresponds to the High Alarm Current value.

   a. TankMaster WinSetup, open the 2410 tank hub Properties window.
   b. Select the Configuration tab and click the Analog Output button.
   c. In the Analog Output window, set Alarm Mode=Low Alarm Current.
   d. Click the Advanced button and check the Low Alarm current value.
7. Restart the 5900 level gauge.
   a. In the WinSetup workspace, click the right mouse button on the 5900 device icon
   b. Click the *Restart* option.

8. Verify that the analog output, as presented in the TankMaster WinSetup configuration tool, switches to alarm mode *Low*. Note that the 5900 will stay in alarm mode for about 15 seconds.

9. Measure the analog output current from the 2410 tank hub in alarm mode *Low*. Verify that it corresponds to the *Low Alarm Current* value.
   
   See the Rosemount 2410 Reference Manual (Document No. 00809-0100-2410) for more information on how to use the TankMaster WinSetup tool for configuration of the Analog Output

10. Ensure that the Alarm Mode is restored to the desired operational setting.

11. Enable Write Protection.
3.2.4 High level alarm test

Prior to running a Proof Test you will have to ensure that a Proof Test Reference Reflector is installed and properly calibrated and configured. Ensure that High Alarm is set to an appropriate level below the Proof Test Reference Reflector. A Reference Reflector can be used with Parabolic and Array antennas. See the Rosemount 5900 Manual Supplement (Document No. 00809-0200-5900) for instructions on how to install and configure a Proof Test Reference Reflector.

This test will detect approximately 84% (4–20 mA analog output) or 88% (relay K1 or K2) of the dangerous undetected (DU) failures not detected by the diagnostics in the Rosemount Tank Gauging Safety System.

To run a proof test for a Rosemount 5900 with Reference Reflector do the following:

1. Ensure that the TankMaster WinSetup program is up and running.

2. In the WinSetup workspace, click the right mouse button on the 5900 device icon and choose the Proof Test option.

3. The Proof Test window appears. It lets you perform various tasks such as performing Proof tests, viewing Proof Test history, and schedule future Proof Tests.
4. To perform a proof test of the Rosemount 5900 Radar Level Gauge; in the SIL Safety Alarm (SIS) pane click the Test button to open the Level Sensor Test window:

5. This window lets you start a Proof Test. In case the Start Proof Test button is disabled you will have to make a calibration of the Reference Reflector before a proof test can be performed(1).

1. See the Rosemount 5900 Manual Supplement Instruction for Installation, Configuration, and Operation of Proof Test Function with Reference Reflector (Document No. 00809-0200-5900) for more information.
6. The following measurement data is presented:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>Distance from the Zero Reference Point to the product surface or the Reference Reflect, respectively</td>
</tr>
<tr>
<td>Ullage</td>
<td>Distance from the Tank Reference Point to the product surface</td>
</tr>
<tr>
<td>Distance</td>
<td>Distance from the Gauge Reference Point to the Reference Reflect</td>
</tr>
<tr>
<td>Amplitude</td>
<td>Amplitude of the radar signal reflected by the product surface or the Reference Reflect, respectively</td>
</tr>
</tbody>
</table>

7. Specify duration of the test in the **Proof Test Time** field. It can be set to any value between 30 seconds and 60 minutes. The default value is 120 seconds. Ensure that enough time is provided for verification of relay state and 4-20 mA output as described in steps 12 and 13 below.

8. Enter a **signature**. This is for identification of the person who is responsible for the proof test.

9. Ensure that device status is OK.

10. Click the **Start Proof Test** button to perform the test for the specified Proof Test Time.

11. Note the Warning that appears when starting the Proof Test. Ensure that the necessary actions are taken in order to maintain safety during the test.

12. Verify the K1/K2 relay output:
   a. Verify correct Relay Status and Current Source Value\(^{(1)}\) as presented in the TankMaster WinSetup configuration tool.
   b. Verify that the actual relay state at the terminal changes to Alarm.

13. Verify the 4 - 20 mA analog output:
   a. Verify that the analog output current from the Rosemount 2410 tank hub as presented in the TankMaster WinSetup configuration tool\(^{(2)}\), corresponds to the product level, i.e. the position of the Proof Test Reflector.
   b. Measure and verify that the analog output current from the 2410 corresponds to the value presented in the TankMaster WinSetup configuration tool.

---

1. To open the 2410 Tank Hub Virtual Relay window; in the TankMaster WinSetup workspace right-click the Rosemount 2410 icon, choose Properties, select the Configuration tab and click the appropriate Virtual Relay button.
2. To open the Analog Output window; in the TankMaster WinSetup workspace right-click the Rosemount 2410 icon, choose Properties, select the Configuration tab and click the Analog Output button.
14. When the proof test is finished you will have to fill in a proof test form in order to create a report. A report in PDF format will be created automatically and will be available from the Proof Test History window(1).

15. After the proof test, when the system is in normal operation, measure and verify that the analog output current from the Rosemount 2410 corresponds to the value presented in the TankMaster WinSetup configuration tool.

3.3 Maintenance

The proof test procedure should be carried out at regular intervals as described in “Proof test” on page 14.

The devices in the Rosemount Tank Gauging Safety System may only be repaired or modified by authorized personnel trained by Emerson Process Management / Rosemount Tank Gauging.


1. See the Rosemount 5900 Manual Supplement Instruction for Installation, Configuration, and Operation of Proof Test Function with Reference Reflector (Document No. 00809-0200-5900) for more information.
Appendix A Specifications and Reference Data

SIS reference ................................................................. page 23
Product life ................................................................. page 23

For general specifications see technical documentation for the Rosemount 5900 Radar Level Gauge and the Rosemount 2410 Tank Hub:

• Rosemount 2410 Tank Hub Reference Manual, Ref. no. 00809-0100-2410

• Rosemount 5900S Radar Level Gauge Reference Manual, Ref. no. 00809-0100-5900

• Rosemount 5900C Radar Level Gauge Reference Manual, Ref. no. 00809-0100-5901

• Rosemount Tank Gauging System Data Sheet, Ref. no. 00813-0100-5100.

A.1 SIS reference

A.1.1 Failure rate data


A.1.2 Failure values

- Self-diagnostics test interval: at least every 90 minute
- Safety response time 20 seconds

A.2 Product life

50 years.

Based on worst case component wear-out mechanisms not based on wear-out of process wetted materials.
## Appendix B  Terms and Definitions

### Table B-1.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPCS</td>
<td>Basic Process Control System</td>
</tr>
<tr>
<td>Demand rate</td>
<td>How often it will be required from a safety integrity system (or the safety function) to react on inputs from process to bring it into a safe state, i.e. to issue an alarm</td>
</tr>
<tr>
<td>FIT</td>
<td>Failure in Time (1 FIT = 1failure/10^9 h)</td>
</tr>
<tr>
<td>FMEDA</td>
<td>Failure Modes, Effects and Diagnostics Analysis</td>
</tr>
<tr>
<td>HFT</td>
<td>Hardware Fault Tolerance</td>
</tr>
<tr>
<td>High mode of operation</td>
<td>The safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and the frequency of demands is greater than one per year</td>
</tr>
<tr>
<td>Low mode of operation</td>
<td>The safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and the frequency of demands is no greater than one per year</td>
</tr>
<tr>
<td>Mode of operation</td>
<td>The way in which a safety function operates, which may be either low mode of operation or high mode of operation</td>
</tr>
<tr>
<td>PFD_{avg}</td>
<td>Average probability of Failure on Demand</td>
</tr>
<tr>
<td>PFH (average frequency of a dangerous failure per hour)</td>
<td>Average frequency of a dangerous failure of an E/E/PE safety related system to perform the specified safety function over a given period of time</td>
</tr>
<tr>
<td>SFF</td>
<td>Safe Failure Fraction summarizes the fraction of failures, which lead to a safe state and the fraction of failures which will be detected by diagnostic measures and lead to a defined safety action.</td>
</tr>
<tr>
<td>SIF</td>
<td>Safety Instrumented Function</td>
</tr>
<tr>
<td>SIL</td>
<td>Safety Integrity Level</td>
</tr>
<tr>
<td>SIS</td>
<td>Safety Instrumented System</td>
</tr>
<tr>
<td>Type B component</td>
<td>Complex component (using micro controllers or programmable logic)</td>
</tr>
<tr>
<td>1oo1D</td>
<td>Architecture consisting of a single channel with additional diagnostic capabilities.</td>
</tr>
</tbody>
</table>
Appendix C  Dry-run Configuration

This section describes the recommended procedure to configure the Safety System for Dry-run applications.

Prior to setting up the Safety System for Dry-run it has to be installed and configured as a standard Rosemount Tank Gauging system. The Dry-run configuration aims at specifying the Low Alarm Limit as well as optimizing the Hold Off Distance and Amplitude Thresholds.

The Hold Off Distance should be as large as possible to avoid impact from noise in the upper part of the tank.

It is recommended to use the Tank Scan\(^{(1)}\) function in TankMaster WinSetup for configuration of various amplitude thresholds. By creating an Amplitude Threshold Point (ATP) curve, noise will be filtered out to ensure that the product surface is detected at all times.

1. Define the Minimum Operation Distance for the application. This is the Distance from the bottom of the flange to the maximum filling point of the Tank in normal operation.

2. Specify a safety margin to ensure that there will be a sufficient gap between the Hold Off Distance and the Minimum Operation Distance. A margin of 50 - 100 mm should be sufficient in most cases. This will make sure that no false alarms are triggered in case of minor measurement errors near the maximum filling point.

3. Set the Hold Off Distance\(^{(2)}\) equal to the Minimum Operation Distance - safety margin.
4. Specify and configure the **Low Alarm Limit**.

5. Ensure that the Amplitude Threshold is less than 25% of the amplitude of the Product Surface echo. The default value is 400 mV.

   **Note!** The product surface should be slightly below the Low Alarm Limit in the Tank. There are two reasons for this:
   a) calibration should be performed at this point in the Tank to ensure highest accuracy at the Low Alarm Limit
   b) to make sure that appropriate Amplitude Thresholds will be set based on the signal strength at this point

6. Check the **Tank Scan** window to get an overview of how much noise that exists in the **Near Zone** region, the region below the Hold Off Distance.

   **Tip!** To open **Tank Scan**: right-click the 5900 icon and choose Properties>Advanced Configuration>Tank Scan.

7. Filter out noise in the Near Zone region by adding an ATP curve in TankMaster. The ATP should be approximately four times the amplitude of the noise amplitude.

8. Click the **Apply** button in order to download the ATP to the Rosemount 5900 level gauge.

---

1. To open the **Tank Scan** window: in TankMaster WinSetup, right-click the 5900 gauge icon, choose Properties, select the **Advanced Configuration** tab and click the **Tank Scan** button.

2. To set the Hold Off Distance: in TankMaster WinSetup, right-click the 5900 gauge icon, choose Properties, select the **Antenna** tab.
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