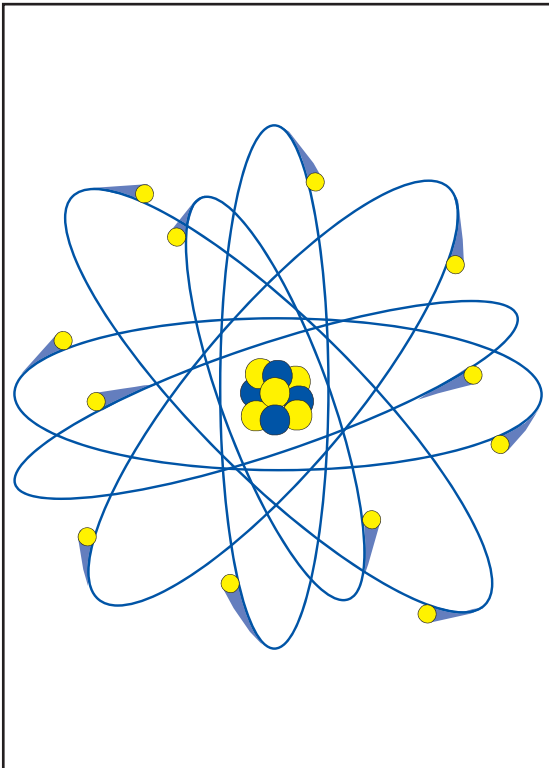


Technical Reference Manual

Radiation Safety

For North American General and Specific Licensees and Users



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Chapter

1

Introduction

A nuclear gauge measures the density, level, or weight of a process material by directing a beam of radiation through the process material to a detector assembly (sensor and amplifier) on the other side. Some of the radiation is absorbed during the passage through the material. This absorption is proportional to the mass of the material through which it passes. The detector measures the amount of radiation reaching the sensor and converts the measurement into amplified electrical pulses. A computerized electronic component receives this amplified signal. The computerized component converts the raw data into a useful format and then displays this data to the operator or applies it directly to the manufacturing process.

The ability of radiation to penetrate materials and be easily detected is the basis of nuclear instrument measurement. A detector that is capable of measuring the amount of radiation is calibrated so that it measures the mass of the process material. In a density gauge, the gauge measures the density of a process material flowing in a pipe by passing a beam of gamma radiation through the material. The process material partially absorbs the radiation, and the radiation not absorbed by the material is measured by the VEGA detector. In a level gauge, the gauge measures the position of the process material inside a vessel by correlating the position with the amount of radiation that is not blocked by the process. In a weigh scale, the gauge measures the mass of the material on a belt or inside a screw conveyor.

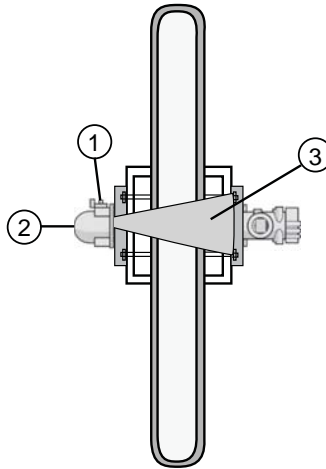


Figure 1.1: Typical Nuclear Density Gauge

- 1 Shutter On/Off
- 2 Radioactive Materials Tag
- 3 Collimated Radiation Beam

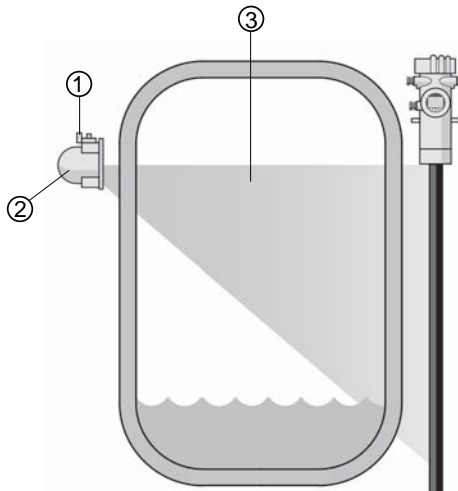


Figure 1.2: Typical Nuclear Level Gauge

- 1 Shutter On/Off
- 2 Radioactive Materials Tag
- 3 Collimated Radiation Beam

1.1 U.S. License Types: General versus Specific

A nuclear gauge user in the United States must operate under a license from the U.S. NRC or Agreement State. The license sets limits on what the user can do with the gauge. Licenses fall into two categories:

- General
- Specific

VEGA Americas can assist and guide you through the licensing process, but it is your responsibility as the Licensee to ensure compliance with local regulations.



Although Agreement State regulations must meet the intent of the NRC regulations, there could be more stringent requirements on the state level. Please check with the regulating authority for your state if you are uncertain of the requirements.

General License

The concept of a general license is often misunderstood. A general license has the effect of issuing a license under certain conditions with minimal documentation. The detailed requirements for general licensees are in Title 10, Part 31.5 of the Code of Federal Regulations.

This section establishes the criteria for who is allowed to distribute general license gauges, and the criteria for those who use one.

VEGA Americas General License Gauges

VEGA Americas operates under a specific license issued by the Director of the Ohio Department of Health to distribute general license devices. Gauges manufactured for distribution to a general licensee must have a radiation field low enough so that personnel are not likely to receive a radiation dose in excess of 500 mRem (5 mSv) in one year. In most installations, 5 mRem/hr (50 μ Sv/hr) at 12 in. (30 cm) from the surface of the gauge meets this requirement and is the accepted criteria.

The general licensee must abide by the conditions of the general license. A metal label attached to the source holder lists these conditions.

Specific License

A Specific License is a document issued to an applicant, authorizing a particular use of a gauge. The license outlines the type of device (or devices) the licensee may possess and the limits within which the licensee may use such devices. It names a specific individual as a Radiation Safety Officer who may define the individual users. The Radiation Safety Officer is responsible for keeping records required by the licensing authority.

Requirements and instructions for making an application for a Specific License are contained in 10 CFR, Parts 30.32 and 30.33. Part 30.33 (a) (3) requires that the applicant be qualified by training and experience to use the material for which the license is requested. This training is available at a VEGA training school.

The U.S. Specific License does not grant any privileges that are not actually stated. However, it is possible to grant the Individual User(s), and/or Radiation Safety Officer, the authority to do leak tests or to supervise the installation, relocation, or removal of gauges once properly trained. The User(s) or the Radiation Safety Officer may request these privileges in the original application or in a license amendment, provided they have documented training satisfactory to the U.S. NRC or Agreement State.

1.2 Canadian and International Users

Each country regulates the use of radioactive material. VEGA Americas designs their fixed gauges to international standards and for approved use in most countries. International users will need to check with the regulating entity of their country to ensure compliance with local laws and regulations.



For use and service of the device in Canada, see the Canadian Nuclear Safety Commission (CNSC) regulations, SOR/2000-207, "Nuclear Substances and Radiation Devices Regulations". Refer to section 7.4 for CNSC contact information.

1.3 Radiation Basics

Gamma-emitting radioactive materials such as Cs-137 and Co-60 emit electromagnetic energy, which is very similar to light. Gamma radiation is in the same electromagnetic spectrum as light, just at a much higher energy. So gamma radiation, unlike light, readily penetrates opaque materials and can pass through steel or other dense materials. Nuclear gauges use this ability to penetrate materials for measuring process variables such as density, level, and thickness. A change in detected radiation transmitted through a material indicates a change in the process variable.

The extent of exposure to gamma radiation is dependent on a number of factors. For example, the extent of injury from a hot, glowing incandescent light bulb depends on several factors such as:

- The power of the light bulb (measured in watts).
- The distance from the bulb to part of the body.
- The portion of the body in contact with the light bulb.
- The presence or absence of insulating material between the light bulb and the body.

Similarly, human exposure to a radioactive source is dependent upon items such as:

- The activity of the source (measured in curies or becquerels).
- The distance from the source.
- The percentage and portion of the body receiving the radiation.
- The amount of shielding between the source and body.

1.4 ALARA Principle: Time, Distance, Shielding

The goal of a radiation safety program is to keep personnel exposures As Low As Reasonably Achievable (ALARA). Three techniques to keep exposures ALARA are:

- Time
- Distance
- Shielding

Time

The radiation dose a person receives is directly proportional to the amount of time spent in a radiation field. An effective way to reduce total dose is to minimize the amount of time spent in a radiation field.

Distance

Distance from the source of the radiation is critical to keeping exposures low. The strength of the radiation field decreases by the square of the distance from the source. Moving just a few feet or meters from a radiation source can have a significant impact on reducing exposure.

Shielding

Shielding the radiation source greatly reduces the radiation field. VEGA sources are contained in source holders that shield the radiation to a very low field, except where the beam of radiation must pass through the process material. All VEGA source holder models have a shutter or other mechanism to shield the radiation beam limit exposure during installation, maintenance, or emergencies.

1.5 Dose Measurements

It is important to have some method for quantifying the dose of ionizing radiation. The term of interest to many users is the tissue absorbed dose quantity, which defines the effect of radiation on the body. The term for this dose quantity is the Rem (standard units) or Sievert (SI units). Typically, we talk in terms of milliRem (mRem) and microSieverts (μSv) or milliSieverts (mSv), which will be discussed later.

1.6 Radiation Exposure versus Contamination

You must treat exposure and contamination as two very different phenomena. Everyone receives radiation exposure every day. Exposure occurs when a person has been in a radiation field. For example, a Cs-137 source capsule produces gamma radiation strong enough to penetrate the body. However, once the source is shielded or you move a significant distance away from the source, the field is reduced and you no longer receive a radiation exposure from the source. Exposure to a radiation field is the primary safety concern for nuclear gauge users.

Contamination refers to the inhalation, ingestion, or absorption of radioactive materials. When using a nuclear gauge, contamination is only possible if the source capsule ruptures and the radioactive material leaks out. If such a breach occurs, a person not only has exposure to gamma radiation from a Cs-137 source, but they also experience contamination from direct contact with the actual Cs-137 material that was inside the source capsule. This is potentially very dangerous because if the radioactive material is in direct contact with the skin, or is inside the body, the distance from the person to the source is zero and the radiation field is quite high. In addition, the organs suffer internal damage through absorption of the radioactive material.



Rupturing of the source capsule is extremely rare. Check for leaking sources by completing regular, periodic leak tests.

1.7 Access to Radiation Beam

The location of the gauge on a pipe or vessel and the design of the process piping, vessel, or conveyor limit access to the radiation beam. The source holder is mounted against the pipe or vessel wall. The only access to the radiation beam is on the opposite side of the pipe or vessel at the detector. Access control procedures must be determined and implemented at the time of gauge startup to ensure that personnel exposure does not exceed the regulatory limits.

Some gauges mount on the vessel. The source moves into a dry well and creates a radiation field inside the vessel. Radiation fields on the outside of the vessel are minimal. You must perform and document a survey to determine the radiation fields. Do not enter the vessel unless the source is withdrawn and locked in the source holder.

Various user-maintained lockout procedures prevent access to the inside of the vessel until all safety conditions are met. Observe all OSHA regulations concerning confined space entry.

1.8 Regulations Applicable to Radioactive Devices

The regulations of the U.S. Nuclear Regulatory Commission (U.S. NRC), the Canadian Nuclear Safety Commission (CNSC), or the equivalent agency of an Agreement State control the use of this device. The applicable sections of the U.S. NRC regulations are numbered 10 CFR 31.5 and 31.12, 10 CFR 20.2201, 20.2202, Appendix D. Radioactive Device Users in Canada should refer to CNSC SOR/2000-202, SOR/2000-203, and SOR/2000-2007.



Although this document strives to provide a level of regulatory guidance, it is up to the licensee to ensure compliance with local regulatory requirements.

As of May 2012, the Agreement States are:

| | | | |
|------------|---------------|----------------|----------------|
| Alabama | Kentucky | New Hampshire | Rhode Island |
| Arizona | Louisiana | New Jersey | South Carolina |
| Arkansas | Maine | New Mexico | Tennessee |
| California | Maryland | New York | Texas |
| Colorado | Massachusetts | North Carolina | Utah |
| Florida | Michigan* | North Dakota | Virginia |
| Georgia | Minnesota | Ohio | Washington |
| Illinois | Mississippi | Oklahoma | Wisconsin |
| Iowa | Nebraska | Oregon | |
| Kansas | Nevada | Pennsylvania | |

*Indicates states that have filed letters of intent to join the Agreement States.

It is the responsibility of the gauge owner to be aware of changes in the regulations. Some states require registration of gauges using radioactive material. In those cases, the user must notify the state regulator or other appropriate agency. Contact your state regulator for additional information.

1.9 Reference Information

Refer to Chapter 7, References and the Reference Information CD for regulatory reference information.

NOTES

CHAPTER**2****U.S. General License**

Part 31.5 of the Code of Federal Regulation (10 CFR) states, “A general license is issued to users of certain gauges that have been approved for distribution by the U.S. NRC.” VEGA Americas has a specific license from the State of Ohio to distribute approved gauges to general licensees in U.S. NRC controlled areas and to those regulated by Agreement States.

The user of the gauge, the general licensee, must abide by the conditions of the general license. A metal label attached to the source holder shows these conditions. This section of the manual also provides a detailed explanation of the conditions. While there is no equivalent to a general license in countries other than the U.S., the procedures and practices described in this section provide a helpful guideline for the use of a nuclear gauge by anyone.



There is no General License in Canada.

2.1 Radiation Safety: Label for General Licensees

In order to comply with the U.S. NRC regulations, a metal label affixed to the gauge details the responsibilities of the general licensee. A copy of the General License Label is below:

FOR A DETAILED EXPLANATION OF THIS LABEL READ VEGA AMERICAS INSTRUCTION MANUAL.

RECEIPT, POSSESSION, USE AND TRANSFER OF THIS DEVICE ARE SUBJECT TO A GENERAL LICENSE OR EQUIVALENT AND REGULATIONS OF THE U.S. NRC OR AN AGREEMENT STATE.

ABANDONMENT OR DISPOSAL IS PROHIBITED UNLESS TRANSFERRED TO PERSONS SPECIFICALLY LICENSED BY THE U.S. NRC OR AN AGREEMENT STATE.

OPERATION IS PROHIBITED IF THERE IS INDICATION OF FAILURE OR DAMAGE TO SHIELDING, OR SOURCE CONTAINMENT.

ANY PERSON MAY MOUNT THIS DEVICE IN PLACE INITIALLY, PROVIDED THE ON-OFF MECHANISM IS LOCKED IN THE OFF POSITION. ALL OTHER DEVICE INSTALLATION, REMOVAL, DISMANTLING, RELOCATION, REPAIR AND TESTING INVOLVING THE RADIOACTIVE MATERIAL, ITS SHIELDING AND CONTAINMENT SHALL BE PERFORMED BY PERSONS SPECIFICALLY LICENSED BY THE U.S. NRC OR AN AGREEMENT STATE.

THIS DEVICE SHALL BE TESTED FOR RADIOACTIVE LEAKAGE AND PROPER FUNCTIONING OF ON-OFF MECHANISM AND INDICATOR AT INSTALLATION AND AT SOURCE REPLACEMENT BY PERSONS SPECIFICALLY LICENSED BY THE U.S. NRC OR AN AGREEMENT STATE. THEREAFTER, RADIOACTIVE LEAKAGE SHALL BE TESTED AT INTERVALS NOT TO EXCEED 3 YEARS AND TESTING OF THE ON-OFF MECHANISM SHALL BE TESTED AT INTERVALS NOT TO EXCEED 6 MONTHS, USING PROCEDURES STATED IN THE INSTRUCTION MANUAL.

LOSS, THEFT OR TRANSFER OF THIS DEVICE AND FAILURE OR DAMAGE TO THE SHIELDING, OR THE SOURCE CONTAINMENT, MUST BE REPORTED TO THE NRC OR AN AGREEMENT STATE.

THIS LABEL SHALL BE MAINTAINED ON THIS DEVICE IN A LEGIBLE CONDITION. REMOVAL OF THIS LABEL IS PROHIBITED.

The following section shows portions of this label with detailed explanations.

2.2 U.S. NRC Regulations for General Licensees

RECEIPT, POSSESSION, USE AND TRANSFER OF THIS DEVICE ARE SUBJECT TO A GENERAL LICENSE OR EQUIVALENT AND REGULATIONS OF THE U.S. NRC OR AN AGREEMENT STATE.

This refers to U.S. NRC regulations in 10 CFR 31.5. The Agreement States have similar regulations.

Abandonment/Disposal

ABANDONMENT OR DISPOSAL IS PROHIBITED UNLESS TRANSFERRED TO PERSONS SPECIFICALLY LICENSED BY THE U.S. NRC OR AN AGREEMENT STATE.

This means that the gauge cannot be abandoned, sold for scrap, or placed in the trash bin. If the gauge is no longer needed, it can only be removed by a person or company specifically licensed by the U.S. NRC or an Agreement State. It must be shipped to a person or company specifically licensed by the U.S. NRC or an Agreement State to receive the gauge. It cannot be shipped to another user under a general license.

Disposal

One benefit of a nuclear gauge is its long life. With reasonable care and maintenance, the gauge may operate for 20 years or more. However, there may come a time when the gauge will need to be replaced or removed. Because of the nuclear source, proper disposal procedures must be followed.

The U.S. NRC, Agreement State, or local regulatory authority will designate facilities that are qualified for proper disposal of the nuclear sources. If your nuclear gauge needs to be replaced or removed, contact VEGA Americas for the proper procedure.

In lieu of actual source disposal or burial, VEGA Americas offers a responsible method of source life cycle management. This method, called the ReSource Program, focuses on the reuse and recycling of radioactive sources used in industrial management systems.

Due to the restricted nature of handling and the proper shielding required for disposal, a nominal fee is associated with the disposal. Contact your VEGA Americas representative for more information about the ReSource Program and about source transfers and disposals.

For comments or inquires on regulations, contact your state Department of Health, or for Ohio's rules as an Agreement State, contact:

Ohio Department of Health

Radiation Protection

246 N. High Street

Columbus, Ohio 43215

614-644-2727

Damage/Failure

OPERATION IS PROHIBITED IF THERE IS INDICATION OF FAILURE OR DAMAGE TO SHIELDING, OR SOURCE CONTAINMENT.

If there is any damage to the gauge, or failure of the shutter mechanism, turn the shutter to the OFF position (if possible). Telephone VEGA Americas Field Service Department at (513) 272-0131 or (800) 367-5383.

Gauge Mounting

ANY PERSON MAY MOUNT THIS DEVICE IN PLACE INITIALLY, PROVIDED THE ON-OFF MECHANISM IS LOCKED IN THE OFF POSITION. ALL OTHER DEVICE INSTALLATION, REMOVAL, DISMANTLING, RELOCATION, REPAIR AND TESTING INVOLVING THE RADIOACTIVE MATERIAL, ITS SHIELDING AND CONTAINMENT SHALL BE PERFORMED BY PERSONS SPECIFICALLY LICENSED BY THE U.S. NRC OR AN AGREEMENT STATE.

You must exercise care when unpacking the gauge. Contact VEGA Americas for advice if any of the following problems occur:

- There is damage to the crate that indicates there is damage to the gauge.
- The lock is missing, broken, or not locked.



Do not remove the gauge from the crate or mount the gauge in position if the lock is missing, broken, or unlocked.

A person with a U.S. General License may perform the following:

- Mount the gauge in position on the process pipe, vessel, or conveyor.
- Perform the electrical wiring for the detector.
- Turn the electrical power switch for the detector ON, if the source holder shutter is locked in the OFF position.



When mounting the gauge in position, take the necessary precautions to assure that you do not drop or damage the source holder. Refer to the certified correct outline drawing of the gauge before mounting the gauge in position.

After performing these preliminary services, a person specifically licensed by the U.S. NRC or an Agreement State must perform the startup/ commissioning of the gauge. The startup involves the following:

- Unlocking the shutter and turning it ON.
- Testing for proper operation of the shutter and the shutter position indicator.
- Making the initial radiation field intensity survey and occupancy evaluation.
- Doing initial testing for leakage of radioactive material.

This specifically licensed person must determine that the gauge is installed so that personnel working near the gauge will not receive a radiation dose greater than 2 mRem/hr (20 μ Sv/hr) or 100 mRem/yr (1 mSv/yr).

Only a person specifically licensed by the U.S. NRC or an Agreement State is allowed to remove the gauge from its mounted position or to dismantle the gauge.

The VEGA Americas manufacturing facility ships the gauge with the source holder shutter locked OFF with a padlock. The manufacturing facility does not ship the lock combination or keys with the gauge. VEGA Americas gives the combination or keys only to the specifically licensed person performing the startup and placing the gauge in service. Usually, this person is the service representative from the VEGA Americas Field Service Department.

Installation Testing

THIS DEVICE SHALL BE TESTED FOR RADIOACTIVE LEAKAGE AND PROPER FUNCTIONING OF ON-OFF MECHANISM AND INDICATOR AT INSTALLATION AND AT SOURCE REPLACEMENT BY PERSONS SPECIFICALLY LICENSED BY THE U.S. NRC OR AN AGREEMENT STATE. THEREAFTER, RADIOACTIVE LEAKAGE SHALL BE TESTED AT INTERVALS NOT TO EXCEED 3 YEARS AND TESTING OF THE ON-OFF MECHANISM SHALL BE TESTED AT INTERVALS NOT TO EXCEED 6 MONTHS, USING PROCEDURES STATED IN THE INSTRUCTION MANUAL.

After mounting the gauge in place, a specifically licensed individual must verify that the installation meets the requirements of the Sealed Source Device Registration (SSDR) approved by the State of Ohio. To do this, that person must perform the following:

- A radiation survey to verify that any exposures will be minimal.
- A leak test to verify that no loose radioactive material is present.
- A check of the ON-OFF or shutter mechanism to verify that the gauge is working correctly and that indicators showing the position of the shutter are visible and operating.

Most records must be kept for a minimum of three years. VEGA Americas suggests that you keep all records for as long as you have the device, plus three years minimum. Check your regulations for specific requirements.

Loss, Theft, Transfer, or Damage

LOSS, THEFT OR TRANSFER OF THIS DEVICE AND FAILURE OR DAMAGE TO THE SHIELDING, OR THE SOURCE CONTAINMENT, MUST BE REPORTED TO THE NRC OR AN AGREEMENT STATE.

In addition to notifying the U.S. NRC or the Agreement State agency, VEGA Americas should also be notified so that help can be provided.

If the gauge is involved in a fire or explosion, barricade or rope off the area around the gauge until a specifically licensed person evaluates the situation.

Removal of Label

THIS LABEL SHALL BE MAINTAINED ON THIS DEVICE IN A LEGIBLE CONDITION. REMOVAL OF THIS LABEL IS PROHIBITED.

Do not remove the label from the gauge. Keep the label clean and legible. If process conditions cause the label to become unreadable, contact VEGA Americas for a replacement and procedures for installation.

NOTES

Chapter

3

U.S. Specific License

3.1 License Conditions

Only those individuals specifically licensed to repair, relocate, install, and/or remove the part of the gauge containing the radioactive source may do so. Each specific licensee should carefully read their particular license to determine the exact conditions of their license. You may only perform the functions for your gauge that your license specifically allows.

When issuing a license, the regulatory agency, the U.S. NRC, or the Agreement State sends a copy of the regulations with the license. Keep the regulations with this instruction manual.

It is the responsibility of the user of the gauge to be aware of changes in the regulations. Some states require registration of gauges using radiation devices. In those cases, the user must notify the State Department of Health or other appropriate agency. VEGA Americas tries to maintain a file of all current regulations and can advise the user if questions arise.

Radioactive device users in Canada should refer to CNSC documents SOR/2000-202, SOR/2000-203, SOR/2000-207, and SOR/2000-208.

3.2 Leak Test Frequency Approval

The sealed source capsules used by VEGA Americas in density, level, and weigh scale gauges are approved for a source holder leak test at a maximum interval of 36 months. Some Agreement States require a specific request for a frequency interval of 36 months because six months is the normal interval. VEGA Americas can provide the documentation to present to the Agreement State as part of your request. Approval of a request for the 36 month frequency interval is usually a routine matter.

In Canada, leak tests are required at a maximum interval of 12 months. Canadian licensees should refer to SOR/2000-207 5.18 for leak test requirements.

3.3 Mounting and Startup

The source capsule is contained in a lead-filled or cast metal source holder with an OFF and ON position. Typically, the holder is designed so that the maximum radiation field is 5 mRem/hr (50 μ Sv/hr) at a distance of 12 in. (30 cm) from the surface of the holder when it is in the OFF position and mounted on the process equipment. The source holder must be locked in the OFF position during mounting on the process equipment.

Occupancy Evaluation

Whether or not personnel monitoring devices are needed should be determined at the gauge site at the time of startup in the form of an occupancy evaluation. Only people specifically licensed by the U.S. NRC or an Agreement State to startup a radioactive device are qualified to perform an occupancy evaluation.

When the source holder is mounted on the process and turned to the ON position, the pipe or vessel walls, the conveyor, the process material and the mounting brackets absorb most of the radiation. Usually the field intensity is 5 mRem/hr (50 μ Sv/hr) at a distance of 12 in. (30 cm) from the surface of the gauge. In such a restricted area, an occupationally exposed individual would have to be within 12 in. (30 cm) of the gauge for two hours per week, every week, before he would be required to have a personnel-monitoring device, such as a film badge or a dosimeter (10 CFR 20.1502). Canadian licensees should refer to SOR/2000-203 5.8 for personnel monitoring requirements.

Mounting Device in a Source Well

In some installations, it is necessary to insert the source into a source well. In these cases, the source holder mounts on top of the tank, and the source lowers into the well. As the source is moving from the source holder to the vessel, it is unshielded. Therefore, moving a source into a well should be done as rapidly as possible. No direct contact with the source is necessary and it must not occur under any circumstance.



The shielding in the space between the source holder and the source well may be minimal. You should not allow the source to remain in this area; the source should be either inside the source holder or inside the source well.

After the source is in the well, perform a radiation survey around the tank and the source holder. The radiation field inside the vessel can be greater than 100 mRem/hr (1 mSv/hr) when mounting an unshielded source in a vessel. Posting and lockout procedures are required in this case. Refer to your license and the regulations for details.

Lockout Procedure

Additional precautions are required when a gauge is used on a vessel large enough to permit entry of personnel. With the source holder in the ON position, or when the source is not removed from the source well, the radiation field intensity inside of the vessel can be high. A procedure must be established so that personnel cannot enter the vessel until the source holder is in the OFF position or the source is removed from the vessel. The use of padlocks on all manway and access port covers is acceptable. The key or combination for the locks should be kept by the person responsible for radiation safety. An appropriate warning sign indicating the requirement for proper lockout and confirmation with a survey instrument must be posted at the entrance to the manway cover.

In some cases when the vessel is not pressurized or the pipe is empty, the radiation field intensity on the outside of the pipe or vessel will be such that additional posting may be required. For installations using source holders with shutters, padlocking the source holder in the OFF position when these conditions exist can easily solve this problem. For installations using sources in source wells where the radiation cannot be shielded, the source or sources must be temporarily withdrawn into the source holder.

Tests Required at Startup

Before putting the gauge into operational use, perform the following tests:

- Radiation field intensity survey and occupancy evaluation
- Test for leakage of radioactive material
- Source ON/OFF shutter mechanism function
- Source ON/OFF indicator

Only a person with a specific license issued by the U.S. NRC or an Agreement State may perform these procedures. The license issued to the user of the gauge may, or may not, allow them to perform these procedures. The user should read their specific license to determine the exact conditions.

3.4 U.S. NRC Regulations for Specific Licensees

Some of the most important aspects of the U.S. NRC and CNSC rules and regulations are given below. Please note that these excerpts represent only part of the regulations and do not relieve the licensee from complying with the complete regulations. Because of periodic updates to regulations, make certain you are aware of current regulations. If you are in an Agreement State or outside the United States, your regulations may vary.

License Terms

- The Radiation Safety Officer listed on the Application for Byproduct Material License is responsible for the source. If this person transfers or changes to a position where they are no longer responsible for the source, the license must be amended prior to the assignment of the new RSO.
- Use of the source is usually licensed for a particular plant site. If the source transfers to a different plant site, the license must be amended prior to the transfer.

Radiation Protection Program

The Code of Federal Regulations Title 10, Part 20.1101 stipulates that each licensee shall develop, document, and implement a radiation safety program. The program should include education on all of the areas that would pertain to the licensed activities and ensure compliance with the provisions and with the regulations.

The goal of the radiation safety program should be to implement engineering controls and procedures to keep occupational doses and doses to the general public ALARA.

The regulations also state that the licensee shall at least annually review the radiation protection program content and its implementation, and retain documentation of these audits. VEGA Americas can perform these audits as a third party source.

The radiation safety program must cover at least the following topics:

- Who is in charge?
- Who can use the material?
- What can they do?
- What training is required to perform those duties?
- What emergency procedures are necessary?
- What operating procedures (leak tests, surveys, lockout, etc.) are required?

Canadian licensees should refer to SOR/2000-202, SOR/2000-203, and SOR/2000-207 for radiation protection program requirements.

Records

Most records are held for three years. VEGA Americas suggests that you keep all records for as long as you have the device, plus three years minimum. Check your regulations for specific requirements. You must retain the following records:

- Initial radiation survey (NRC Form 3)
- Periodic leakage test
- Periodic shutter test and shutter indicator tests
- Receipt of the gauge (shipping papers)
- User training
- Transfer or disposal of the material. Keep these records as long as you have a license.

Labeling Sources and Posting

The following requirements are for labeling and posting:

- The source holder must have a label that states the type and quantity of radioactive material and the date of manufacture. The label must bear the radioactive trefoil. VEGA Americas attaches an approved label to the source holder prior to shipment. It is the gauge user's responsibility to perform regular maintenance of the label(s) and keep them in a legible condition.
- You do not need to post a radiation warning sign in the area near the source if the dose rate is less than 5 mRem/hr (50 μ Sv/hr) at a distance of 12 in. (30 cm) from the surface of the gauge. If the area is not restricted, you must still comply with the exposure limits even though a sign is not required (10 CFR 20.1201, 1301).
- CNSC radiation warning sign posting requirements can be found in SOR/2000-203 S.21-23 and SOR/2000-207 S.23.
- All specific licensees in the U.S. must post U.S. NRC Form 3 "Notice to Employees" or the equivalent Agreement State form. The U.S. NRC regulations state that this form must be posted so that employees can observe a copy on the way to or from their place of employment. In addition, post U.S. NRC Form 3 at or near the entry into a restricted area (10 CFR 19.11).

Disposal

The U.S. NRC and CNSC policy is to issue high civil penalties for improper disposal of radioactive material.

When the source is no longer needed, you can contact VEGA Americas to discuss disposal options.

VEGA Americas can provide an estimate of costs for your specific disposal requirements. For a description of the ReSource Program, see Abandonment/Disposal.



The source may only be sent to a person or organization specifically licensed for that purpose.

Agency Notification

The U.S. NRC Operations Center and/or Regional Office must be notified of any incident in the U.S. that involves the radioactive material used in a gauge, such as a fire, explosion, abnormal levels of radiation, or loss or theft of a source.

For any of the previously listed incidents in Canada, the CNSC must be notified. Refer to “Nuclear Substances and Radiation Device Regulations, section 38 (1) & (2)” and “General Nuclear Safety and Control Requirements, section 29” for reporting requirements.

There are varying levels of notification depending on the severity of the incident. Consult your regulations for these levels.

VEGA Americas Nuclear Services may also be notified:

- At all times: 1-800-367-5383
- After hours, leaving a voice mail automatically pages the on-call individual

NOTES

Chapter 4

Routine Procedures Performed by User

This section includes guidelines for performing certain procedures that are common to users of nuclear gauges. General guidelines for removing a source holder are given for users who are specifically licensed to do so. This section also contains general guidelines for mounting in place, performing leak tests, completing surveys, and evaluating occupancy.



Remember, your license may not permit you to perform some of the following procedures. It is your responsibility to know the limitations of your license and to abide by them. Canadian regulations require that all handling of source holders must be performed by trained individuals and authorized by a license.

4.1 Receiving a Source Holder

The procedure below lists requirements and recommendations for receiving a source holder:

1. Visually inspect the source holder for damage.
2. Make sure the ON/OFF mechanism is closed and locked.
3. Check that the shipment is complete before the truck leaves.
4. If you are not installing the gauge immediately, find a storage area that is isolated and secure.



Low level radiation fields are always present around a source holder.

5. Allow access to authorized personnel only.
6. Maintain records of the shipping and receipt.
7. While not required, surveys and leak tests provide additional assurance that the package is in safe condition.

4.2 Mounting a Source Holder

Mounting a source holder on a process pipe or vessel can be done by anyone with basic radiation safety awareness training provided the source is locked in the OFF position and the following instructions are observed.

Mounting Checklist

Before mounting the source holder, perform the following steps:

1. Conduct a visual inspection of the source holder.
2. Ensure that the shutter is closed and locked.
3. Ensure that external surfaces are not damaged.
4. Check that the mounting position complies with the manufacturer's engineering drawings and specifications. (See certified correct drawings or contact VEGA Americas.)
5. Ensure adequate clearance to operate shutter mechanism.
6. Consider in advance any high temperature or corrosive environmental conditions. For example, you should consider the following items:
 - Adequate insulation to protect source holder from high temperature
 - Special cooling system required to reduce source holder temperature
 - Additional protection required to prevent corrosive material from settling on source holders
 - Excessive vibration
7. Have personnel and equipment, cranes, hoists, and supports available to mount the unit.
8. Be prepared to handle the weight of the unit. Remember, source holders are very heavy.

Installing a Source Holder



Installation and mounting are considered separate functions for licensing purposes.

Installation includes the actual process of unlocking the source holder and performing the following:

- Preliminary radiation survey
 - Leak test
 - Installation radiation survey
 - Shutter operation test
1. Only a specifically licensed individual can perform the installation.
 2. The specifically licensed person must use a calibrated survey meter and must be present at the site during the entire procedure.
 3. The licensee may perform future periodic tests by following the instructions in this manual.
 4. Regard each separate placement or relocation as a new installation.

Preliminary Radiation Survey

1. Ensure that the survey meter is calibrated and operational.
2. Conduct a radiation survey of the mounted unit by surveying the source holder and detector omni-directionally one foot from the surface.
3. If the radiation field is normal, less than 5 mRem/hr (50 μ Sv/hr) at 12 in. (30 cm) for most VEGA source holders, proceed with a leak test.
4. If the radiation field is greater than 5 mRem/hr (50 μ Sv/hr) at 12 in. (30 cm):
 - Special posting or restrictions of the area may be required.
 - Verify with the manufacturer that this condition is normal for the type of source and source holder you are installing.

Performing a Leak Test

You do not have to disassemble the source holder to perform a leak test. Testing the external surface of the source holder is all that is required. If the shutter is open, use caution to ensure that your hand is not in the radiation beam. Do not clean the source holder prior to performing the leak test.

1. Remove the zip-top bag containing the test swab.
2. Write the source serial number or other identification on the bag.
3. Open the zip-top bag and grasp the test swab by the end opposite the fiber tip.
4. Wipe the external surface of the source holder using the fiber-tipped end of the swab stick. Wipe the locations where contamination would be most likely to accumulate in the event the source capsule was leaking.
5. Place the test swab into the zip-top plastic bag and close.
6. Put the bag in an envelope and seal it.



Do not touch the fiber-tipped end or allow it to touch other objects, as this could spread contamination if the source were leaking. If the test swab contains a significant amount of radioactive material, send an emergency notification by telephone immediately. Contact the appropriate nuclear regulatory agency and VEGA Americas for assistance. You must make arrangements with VEGA Americas, or another specifically licensed person, to take the source holder out of service.

Radiation Survey after Installation

1. Complete survey sheets with measurements at 12 in. (30 cm) omnidirectionally to record the radiation field around the source holder/detector assembly.
2. Survey with the shutter in the closed (OFF) position and then with the shutter in the open (ON) position.
3. Perform an occupancy evaluation to determine the dose personnel can receive. There are two categories, each with a different limit:
 - Members of the general public can receive 2 mRem/hr (20 μ Sv/hr) not to exceed 100 mRem/yr (1 mSv/yr). These numbers include only individuals who are in the area infrequently and have no assigned reason for exposure.

- Occupationally exposed individuals can receive 5,000 mRem/yr (50 mSv/yr) with no specified per hour limit. This number includes anyone whose assigned duties require his or her presence in the vicinity of the gauge. Complete the evaluation to determine if the limit of 500 mRem/yr (5 mSv/yr), which would require monitoring, is potentially reachable.
4. Additional shielding is potentially required to prohibit members of the general public from receiving radiation dosages greater than 2 mRem/hr (20 μ Sv/hr).
 5. If there are radiation fields above 2 mRem/hr (20 μ Sv/hr) present on the detector side:
 - Notify the RSO of the problem so they can determine the precautions that must be taken to minimize exposure.
 - Add shielding on the detector side to reduce the radiation field after installation.
 6. Notify appropriate personnel of the presence of radioactive materials and precautions that they must take to minimize exposure.
 7. Restrict the area, if required.

Shutter Operation Test

The purpose of this test is to verify that the shutter is functioning and that the indicator is displaying the correct information. Specific information on how the shutter operates is on the certified drawing(s) and in the Shutter (ON/OFF) Mechanism section of this manual..

Radiation Fields Inside a Vessel

The following statements are the requirements for measuring radiation fields inside a vessel:

- Gauges that are mounted on vessels or have accessible air gaps need to have written lockout procedures to ensure that access to the high levels of the primary radiation beam is not possible.
- Many of these types of installations are considered by OSHA as confined spaces and the radiation is classified as “other known energy hazards.” These installations require lockout documentation consistent with OSHA rules.

- You may use this documentation to meet the requirements of the U.S. NRC, CNSC, or other regulatory agency.

At a minimum, follow the steps listed in the following procedure:

1. Prior to vessel entry, verify by signature that the source holder is locked in the OFF (shutter closed) position.
2. One person who is in control of individuals entering the vessel or air gap should hold the lock key.
3. Ensure that the radiation field is very low by using the gauge electronics or a survey meter.
 - The gauge electronics will show a high reading or maximum density, since no radiation is reaching the detector.
 - A survey meter will allow for quantitative measurements. The fields measured should match very closely to background readings.
4. After work is completed, ensure that the vessel is vacant and the entrance door is locked. Complete these steps before unlocking the source holder and returning it to the ON position.

4.3 Removing a Source Holder

Prior to Removal

Before removing a source holder, perform the following steps:

- Conduct a visual inspection of the source holder. The external surface should be smooth and not damaged.
- Corroded and rusted units, which have been in service under extreme environmental conditions, may require special removal, handling, and shipping procedures.
- Ensure that the shutter is closed and locked.
- Have personnel and equipment, cranes, hoists, and supports available to remove the unit.
- Inform all personnel involved in the removal of the procedures necessary to limit radiation exposure. For example, how to reduce exposure using time, distance, and shielding.

- Remember, source holders are very heavy. Be prepared to handle the weight of the unit. The approximate weight of the source holder is on the certified correct drawing(s).



This information refers to work that you should perform prior to the removal of a source holder.

Removal Requirements

1. Only a specifically licensed individual can perform the removal of a mounted source holder.
2. The specifically licensed person must use a calibrated survey meter and must be present at the site during the entire procedure.
3. Removal of the mounted source holder requires a radiation survey and a leak test, if shipping the unit

Radiation Survey after Removal

Perform the radiation survey procedure described in this manual. The radiation field should compare to the installation survey or less than 5 mRem/hr (50 μ Sv/hr) at 12 in. (30 cm) from the surface omni-directionally.

Performing a Leak Test

Perform a leak test as described in the Mounting a Source Holder section of this manual, if you are shipping the unit.

4.4 Required Periodic Tests

Inventory and Inspection

At a minimum, check each device annually for the following items:

- Location - Ensure that the source holder is in the correct location. A lost source requires immediate notification to your regulatory agency.
- Check the condition of the mounting brackets and hardware.
 - Check for loose mounting bolts.
 - Check for corrosion or rusting of mounting hardware.
- Make sure tags are in place and legible.

- Make certain there is no build-up of dirt or process chemicals on operating handles, cables, or rods. Such build-up can impair the operation and measurement of the gauge.
- Check for corrosion or rusting of the housing and operating handle.

If the inspection indicates that a source holder needs attention, follow the instructions in the Routine Maintenance section of this manual or call VEGA Americas for assistance.

Shutter (ON/OFF) Mechanism (required every six months)

Shutter checks are normally performed at intervals not to exceed six months. Customers who have the ability to cycle shutters on a more frequent basis without disturbing production requirements are recommended to do so. The application of lubricating oil to the shutter mechanism will assist in maintaining the gauge in good working order.

Perform the following procedure to verify that the shutter mechanism is working correctly.

1. To test the shutter mechanism, move the actuator back and forth several times between the OFF and ON positions.



The actuator should move easily, but not freely. There will be some resistance to movement due to bearing friction and inertia of the mechanism.

2. Use one of the two methods listed below to ensure that the shutter mechanism is operational:
 - Method A - Using a calibrated portable radiation survey meter, take a measurement at the back of the detector housing.
 - Field intensity should be low when the shutter is in the OFF position.
 - Conversely, when the shutter is ON, the field intensity should increase.



Measurement around the source holder may not change.

- Method B - If a survey meter is not available, use the gauge electronics and monitor the display while moving the shutter to the OFF position.
 - Indication should go to the high process value on the display.
 - Move the shutter to the ON position and the reading should return to normal.

Keep the records of these tests, listing the date and name of the person performing the test, for at least three years.

At the first indication that a shutter mechanism is not working properly, contact the manufacturer for advice. A sticky shutter is a warning that proper shutter operation is being compromised and needs to be addressed.

If the shutter mechanism becomes inoperable, contact your regulator and manufacturer immediately for advice. DO NOT attempt to free up the shutter by mechanical means with the use of wrenches, hammers, channel locks, levers, etc. These devices may cause more damage and are prohibited. Such actions have been known to shear shutter handle bolts, damage shutter handles, and bend handle shafts.

If a device has an inoperable shutter, the gauge should not be removed without consulting the manufacturer.

ON/OFF Indicator (required every six months)

Testing the ON/OFF indicator means that the shutter indicator must indicate ON and OFF properly. You can observe this when testing the shutter as described above.

Radioactive Material Leak Test

The following statements define the concerns, requirements, and options for leak test performance:

- All VEGA Americas sealed sources are welded, double-encapsulated stainless steel capsules.
- The possibility of radioactive material leaking from the source capsule is very remote.
- The source capsule is enclosed in a source holder to provide shielding for the radiation.

- If the source capsule should leak, the possibility of the radioactive material migrating to the outside of the source holder is extremely remote.
- The licensee may perform the wiping procedure, but only a person or company specifically licensed by the U.S. NRC, CNSC, or an Agreement State may do the analysis for removing radioactive material.
- The leak test involves wiping the external surfaces of the source holder with the fiber-tipped end of a test swab and then analyzing the fiber end for the presence of radioactive material. Make certain you wipe the locations where contamination would most likely accumulate if the source were leaking.
- You must use a separate kit for each individual source.
- If you purchase the leak test service from VEGA Americas, we supply the following:
 - Leak test materials
 - Analysis of the leak test materials for the presence of radioactive material
 - Issuance of a report on the results of the leak test

Performing a Leak Test

To perform a leak test, refer to the Mounting a Source Holder section of this manual.

Typical Source Holder Models

For the source holder models shown below, wipe the areas designated with shading.

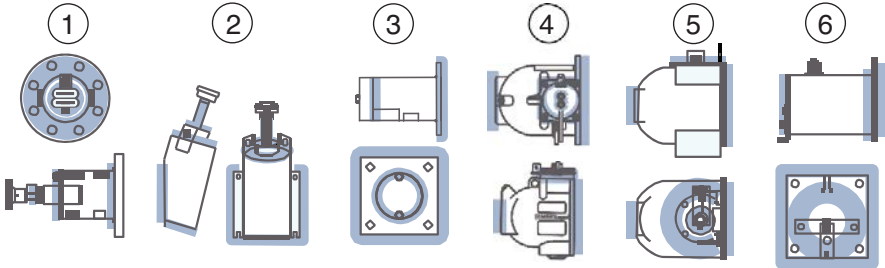


Figure 4.1: Typical Source Holder Models: Areas to Leak Test

- 1 SHLM
- 2 SHLG
- 3 SHGL
- 4 SHLD
- 5 SH-F
- 6 SR Series

4.5 Routine Maintenance

Cleaning a Source Holder

Cleaning may be required due to the build-up of foreign material, process elements, dirt or grease, etc. Failure to maintain a clean source holder will impair the ability to conduct a complete visual inspection. Maintain a clean source holder to aid in ensuring that the shutter mechanism remains operational.

While it is not required, a leak test to verify there is no removable contamination may be performed.

Use any conventional method of cleaning, such as steam, high-pressure water, and hand removal of debris. The source holder can be cleaned in place. Do not use solvents that are corrosive to carbon steel and stainless steel, and do not use any mechanical cleaning method such as sandblasting that can erode the materials.

If labels have become unreadable, contact VEGA Americas for replacements. The new label can be mounted on top of the original tag using

silicone or weather strip adhesive. Regulatory standards do not allow the removal of the old tag. No drilling is allowed to affix replacement tags.

Lubricating

There is no required lubrication of VEGA Americas source holders. However, because of the various environments in which source holders are mounted, it might become necessary to lubricate moving parts. Take care to ensure lubricant compatibly with process chemicals in the area.



Make certain as to the products used for lubrication if chloride-free cables or wells are present.

Painting

VEGA Americas source holders have been in service for many years and have not required painting. However, it is the responsibility of the licensee to maintain the device in reasonable condition. If painting is required because of rust or oxidation, clean as described above and paint using products that are compatible with your process. There is not a defined paint color, but the color should contrast with the process piping whenever possible. This practice increases the awareness of the device's presence. Do not paint the labels that are affixed to the source holder.

Replacement of Mounting Hardware

If the mounting hardware has weakened due to rust or corrosion, you should replace it. You can do this by replacing one bolt or threaded rod at a time. This replacement method maintains the gauge in the same position, which is necessary to ensure proper measurement and minimize exposure.

4.6 Non-routine Maintenance

In order to perform non-routine maintenance, you must have a specific license that states you have permission to do so. Examples of non-routine maintenance include welding to modify the source holder mounting, relocating the source holder, or repairing the source holder. These repairs include the replacement of any hardware or fasteners. With proper training and agency approval, you can modify your license to perform some of these procedures. Contact VEGA Americas for training needs.

CHAPTER

5

Emergency Guidelines

5.1 General Guidelines

The following guidelines are for general and specific license holders:

- Plan ahead to avoid accidents and to be prepared to deal with them.
- Make sure procedures are up-to-date and include plans for dealing with radiation-related incidents.
- Educate your staff and workers to recognize potentially dangerous situations and to know how to deal with an emergency in your absence.



Human safety is always the priority in any emergency situation.

The following table provides a guideline for the appropriate distance to initially cordon off an area in an emergency situation involving the source holder. The distance is based on setting the boundary at < 2 mRem/hr ($20 \mu\text{Sv/hr}$) considering the radiation levels for the Cs-137 and the Co-60 source activity levels listed. Radiation level readings at the boundary should be verified with a radiation detection instrument with an output reading in mRem or μSv per hour.

| Activity (mCi) | Distance (Feet) for Cesium (Cs-137) | Distance (Feet) for Cobalt (Co-60) |
|----------------|-------------------------------------|------------------------------------|
| 100 | 15 | 30 |
| 500 | 30 | 60 |
| 1,000 | 45 | 90 |

| Activity (GBq) | Distance (Meters) for Cesium (Cs-137) | Distance (Meters) for Cobalt (Co-60) |
|-----------------------|--|---|
| 3.7 | 5 | 10 |
| 18.5 | 10 | 20 |
| 37 | 15 | 30 |

1. Evacuate the immediate area while simultaneously ensuring that the radiation field and the extent of spread of contaminating radioactive materials are kept to an absolute minimum.
2. Control entry to the scene of the accident by placing a cordon at the 2 mRem/hr (20 μ Sv/hr) level and marking it with radiation hazard signs. This minimizes all subsequent exposures and additional contamination incidents.
3. Identify and immediately isolate all people who might have received any exposures or who could have been contaminated. In such cases, arrange for immediate:
 - Decontamination, if necessary
 - Evaluation of dosimetry devices
 - Collection of body fluids (blood, urine, etc.) for further analysis
4. Contain any contamination at the site of the accident by using the following recommendations.
 - With gloves and tongs, place plastic bags over anything you suspect to be contaminated.
 - When finished, place contaminated gloves, tongs, and clothing inside plastic bags; wash hands and arms immediately or shower as soon as possible.
 - Wear the appropriate respirator if there is any possibility of airborne contamination.
 - Be sure to shut off all fans, blowers, and air-conditioning.
5. Notify the appropriate authorities immediately by suitable media such as telephone or fax, and seek immediate advice on further steps to be taken.

6. Arrange for the immediate arrival of experts who are trained to deal with such accidental conditions. (Personnel responsible for radiation protection should know ahead of time which experts and organizations to contact).
7. Maintain complete records of the accident and follow-up procedures. This simple instruction is often forgotten, resulting in enormous complications during incident investigation and in adoption of subsequent remedial measures.

5.2 Typical Emergency Situations

This section discusses some of the most common emergencies that involve nuclear gauges.

Stuck Shutter

Stuck shutters can result from rust or build-up of materials around the shutter mechanism. Usually the discovery of a stuck shutter is under one of two circumstances:

1. A periodic shutter test
2. An attempt to turn off a source to work on the process line

Alone, a stuck shutter does not constitute an emergency. You should notify the manufacturer and regulatory authority for assistance. If you ignore the stuck shutter or handle it improperly, radiation exposure can become a risk.

Perform the following emergency response procedure if a shutter is stuck in the open position:

1. Leave the gauge where it is until you have contacted the manufacturer and the regulatory authority. One of the safest places for a gauge is in its mounted position.



A specific license is required to remove a gauge.

2. Contact VEGA Americas for advice. You can clean the source holder as described in the Routine Maintenance section of this manual.
3. Contact VEGA Americas for advice on whether to ship the gauge back or have a field service engineer come to repair it.

If you discover a shutter is stuck while attempting to work on the process line, perform the following procedure:

1. Do not proceed with the job.
2. As a temporary solution to service the process line, placing enough shielding material in front of the source opening to block the radiation is a possibility. (Use a survey meter to test the radiation field.)

You should only consider this method a temporary measure until the unit is repaired.



If you are specifically licensed to remove the gauge and it is necessary to do so, try to reduce any unnecessary exposure. For example, if you are lowering the source holder using a chain, attach a guide rope to the source holder to stop the radiation beam from pointing toward anyone. When the source holder is on the ground, lay it with the opening down and bolt shielding material to the opening as soon as possible. Be sure to cordon off the area and tag the source holder to alert others to the presence of a radioactive source.

Loss or Theft

If a source is lost or stolen, perform the following procedure:

1. Notify the U.S. NRC, CNSC, Agreement State, or appropriate regulatory authority immediately by telephone.
2. Search for the source holder using the following recommendations:
 - Know what you are looking for. Is the entire source holder missing, or just the stainless steel source capsule? Make sure others helping you in the search know exactly what they are trying to find.
 - Use a survey meter on the lowest scale during the search. You should first try to find any unusual radiation readings. After you have determined that there is a reading higher than background, you can concentrate your search in that area.
 - Check all places where you cannot view the source. Look through trash, scrap, dumping areas, trucks, and railroad cars.
3. Continue a diligent search until the regulatory agency directs otherwise.

Entering a Tank or Vessel

The following statements define the concerns, requirements, and recommendations for persons entering a tank or vessel with an installed source holder:

Perhaps the most avoidable accidental radiation exposure is caused by people entering a tank or vessel before the radioactive source is placed in the off position or drawn up into its protective housing. Exposures of this kind are potentially dangerous because they are whole-body exposures. In addition, the radiation field intensity inside a tank can be quite high.

- Preventing accidental radiation exposure is of the utmost importance. Tank lockout procedures, which typically include procedures for protecting against chemical, electromagnetic, and mechanical hazards, must also include procedures to protect against radiation hazards.
 - Mark each manway with a sign indicating the presence of radioactive sources as a simple preventive measure.
 - Before any person enters a vessel, make certain the source is in the "safe" position (OFF or drawn up into the protective housing). Make certain the person entering the tank is able to identify radiation source holders on tanks, and is able to determine if they are safe.
 - Make sure contractors hired to work on vessels are aware of the presence of radioactive sources.
 - If safety precautions are ignored and people enter a vessel while the source is still "ON", perform the following procedure:
 1. Get the people out of the vessel.
 2. Quickly determine how much time they spent in the tank and at what distance they were from the radioactive source.
 3. Calculate their exposure by measuring the radiation field in the tank or by using the equations in the Important Safety Calculations section.
 4. You can look up the activity and isotope in your records or check on the label on the source holder. Remember to take the shielding of walls or wells into consideration. Also, source decay will reduce the activity of the isotope.
 5. Arrange for medical examinations if the dose is greater than 25,000 mRem (250 mSv) or if you cannot determine the dose. In addition, arrange for medical examinations if the worker is concerned about his/her dose.
-

6. Notify your licensing agency immediately if anyone has received a dose greater than any allowable limit.

Fall or Collision

Falls and collisions of source holders may result in damage to the source holder. Following are some situations that may cause a fall or collision.

Fall

- Bolts can rust and cause a source holder to fall off its mounting.
- Source holders can fall off the back of a truck during transport.
- Chains break when used to hoist a source holder during installation.
- Bolts are not secured correctly during installation.
- A vessel that vibrates can shake the bolts loose or break welds.

Collision

- Forklift runs into the source holder.
- Collision of train or truck during transport.
- Hoist chains swing out of control, resulting in collision.

In case of a fall or collision, use your own judgment as to the extent of damage. The following procedure will help you assess the amount of damage:

1. Survey the source holder to check if the radiation pattern is normal. The radiation profile should measure less than 5 mRem/hr (50 μ Sv/hr) at 12 in. (30 cm) from the unit with the shutter closed (OFF).
2. Compare this reading with the installation survey and occupancy evaluation to determine if the reading is normal.
3. If the survey is normal, the shielding around the source is probably not damaged.
4. Ensure that the shutter ON/OFF mechanism is functioning properly. If it is working correctly, lock it OFF.



Make sure the radiation beam is pointed away from you and others.

5. If you cannot turn the shutter to the OFF position, block the opening with shielding material, and call the manufacturer for help.

6. Check for possible radioactive material leakage by leak testing the unit.
 - Check for gross contamination after wiping by taking the sealed zip-top bag, with the swab enclosed, to an area away from the source.
 - Use a survey meter to see if there is a radiation field around the zip-top bag.
 - If there is a radiation field around the bag, some of the radioactive material is on the swab and is emitting radiation.
7. Contain the contamination. Make every effort to prevent spreading the contamination.
8. If the radiation levels are within prescribed limits, the source shutter mechanism is operating properly, and there is no evidence of radioactive material leakage, the unit can return to service.
9. However, if it appears that there has been damage to the lead shielding, regard the unit as having a radiation field present above allowable limits.
10. Cordon off and mark the area with radiation hazard signs at the 2 mRem/hr (20 μ Sv/hr) radiation level. If a survey meter is not available, calculate the distance where the field intensity is 2 mRem/hr (20 μ Sv/hr), based on your records of the activity and type of source.
11. Obtain names of potentially exposed individuals.
12. Call the U.S. NRC, CNSC, Agreement State, or regulatory agency immediately and notify them of the situation. For your records, write down the name of the person at the agency to whom you spoke.
13. Contact the gauge manufacturer or other specifically licensed individual to arrange for safe removal, packaging, and shipment of the source holder. If permitted, place shielding materials around the source holder to decrease radiation levels.

Fire

In case of a fire, make certain that the immediate emergency is handled first. Inform fire-fighting personnel that radioactive sources are in the area and perform the following procedure:

1. If you do not have a fireproof source holder, assume that the lead shielding has melted.
 - Place a survey meter on the lowest scale and approach the unit with caution.
-

- Compare the readings to the radiation profiles as measured in the initial installation survey, then proceed to the next appropriate step.
2. If the radiation profile is as measured in the initial survey:
 - Check the shutter mechanism for proper functioning.
 - Leak test the source holder for removable contamination and perform a gross contamination check if possible.
 - Examine the source holder for any damage to the mounting structure (bolts, brackets).
 - Replace the insulation or cooling system, if either were supplied.
 3. If the radiation field is above normal levels:
 - Cordon off and mark the area with radiation hazard signs at the 2 mRem/hr (20 μ Sv/hr) level.
 - Record names of all personnel who may have received any exposure. If an employee wants a medical examination, or if you are in doubt as to the exposure level, arrange for a medical examination.
 - Contact VEGA Americas or other specifically licensed individual for assistance in removal, packaging, and disposal of the unit.
 - Leak test the unit for possible contamination. A typical Cs-137 or Co-60 source capsule should withstand a temperature of at least +1472°F (+800°C) before distorting and possibly leaking radioactive material.
 - Survey the area around the unit for possible contamination.
 4. If tests indicate the unit exhibits leakage, use plastic gloves and tongs, and place plastic bags over the unit to prevent spreading the radioactive material.



If the potential for fires in your plant is great, you may want to use fireproof source holders. VEGA Americas' SH-F Series of fireproof source holders are made of cast iron and contain no lead. They can withstand temperatures up to +1472°F (+800°C) for 30 minutes.

Emergency Equipment

It is usually very difficult to find what you need in the time of an emergency. Therefore, it is advantageous to set aside or know the location of the following items:

- Records indicating the radiation levels and occupancy evaluation when the source holder was installed
- List of emergency procedures and phone numbers for help
- Survey meters which have been calibrated regularly
- Batteries for survey meter
- Leak test kits
- Rope/tape (to isolate the area)
- Radiation hazard signs (to identify the area)
- Handling equipment (tongs and long pliers)
- Gloves
- Lead or steel sheets
- Shielded containers
- Dosimeters and film badges
- Plastic bags for contaminated items
- Tape measure

5.3 Important Safety Calculations

Dose Rate Measurement

The best method for determining an individual's dose rate is to measure the radiation field intensity with a survey meter. If the source is a gamma emitter (Co-60 or Cs-137), you can read the absorbed dose rate in $\mu\text{Sv/hr}$ directly from a meter that is calibrated in Sieverts. Most meters are still calibrated in the traditional unit of Roentgen, generally in the mR/hr range. For gamma energies, mRem/hr is equal to the radiation field intensity in mR/hr (measured with a meter). For example, if the measured radiation field intensity three feet from the source is 0.6 mRem/hr ($6 \mu\text{Sv/hr}$), a person standing three feet away from the source would absorb radiation at the rate of 0.6 mRem/hr ($6 \mu\text{Sv/hr}$).

Dose Rate Calculation

In cases where a survey meter is unavailable, you can approximate the absorbed dose rate from an unshielded source.

Fill in this equation to find the dose rate (R) from an unshielded source (bare source capsule):

$$R = \frac{A \times K}{d^2}$$

Where the terms in standard units (international units) are defined as:

| Terms | Description |
|-------|---|
| R | Dose rate in mRem/hr (μ Sv/hr) to be calculated |
| A | Activity of the source in mCi (GBq) which can be found on the source holder label |
| d | Average distance to the source in feet (meters) |
| K | Constant, which depends on type of isotope in the source capsule Cobalt-60: K = 14 (351) Cesium-137: K = 3.5 (88) |

Example

Suppose that for a certain emergency, the estimated exposure time to the unshielded source is 10 minutes at an average body-to-source distance of 3.28 feet (1 meter). The source is 10 mCi (0.37 GBq) of Cs-137.

For the above example, the dose rate is:

$$R = \frac{(10)(3.5)}{(3.28)^2}$$

$$R = 3.25 \text{ mRem/hr}$$

Figure 5.1: Dose Rate Standard

$$R = \frac{(0.37)(88)}{(1)^2}$$

$$R = 32.6 \text{ } \mu\text{Sv/hr}$$

Figure 5.2: Dose Rate International

The dose received is:

$$\text{Total Dose} = \left(\frac{3.25 \text{ mRem}}{\text{hr}} \right) (10 \text{ min}) \left(\frac{1 \text{ hr}}{60 \text{ min}} \right) = 0.54 \text{ mRem}$$

Figure 5.3: Total Dose Standard

$$\text{Total Dose} = \left(\frac{32.6 \text{ } \mu\text{Sv}}{\text{hr}} \right) (10 \text{ min}) \left(\frac{1 \text{ hr}}{60 \text{ min}} \right) = 5.4 \text{ } \mu\text{Sv}$$

Figure 5.4: Total Dose International

Emergency Shielding Requirements

Providing additional shielding for a source is necessary under some circumstances. For instance, if you remove a gauge from its mounting, but the shutter ON/OFF mechanism is stuck open, you must place shielding in front of the opening to prevent exposures.

The following chart lists the approximate thickness of material needed to lower the radiation field down to half of its strength. These thicknesses are also known as half-value layers.



The material thickness varies with the type of radioactive material used in the source. The chart shows half-value layers for Cesium-137 and Cobalt-60.

| Approximate Shielding Half-value Layers | | |
|--|--------------|---------------|
| Material | Cs-137 | Co-60 |
| Dirt, Wood | 6" (152 mm) | 8 ½" (216 mm) |
| Water, Plastic | 3 ¾" (95 mm) | 7 ½" (190 mm) |
| Rubber, Brick, Coal | 2 ½" (64 mm) | 3 ½" (89 mm) |
| Concrete | 2" (51 mm) | 3 ¼" (83 mm) |
| Aluminum | 1 ½" (38 mm) | 3" (76 mm) |
| Steel, Brass | 1/2" (13 mm) | 1" (25 mm) |
| Lead | 1/4" (6 mm) | 1/2" (13 mm) |
| Tungsten | 3/16" (5 mm) | 3/8" (9.5 mm) |
| Gold | 5/32" (4 mm) | 9/32" (7 mm) |

Minimum Distance from Bare Source

When emergencies arise, it is best to have a plan of action laid out ahead of time. One important part of this plan is to know the distance to cordon off an area to keep personnel free from unnecessary exposure.

To calculate this distance ahead of time, plan for the worst case:

- The source is completely unshielded.
- It is your strongest activity source.
- You must make the area unrestricted, so the radiation field must be below 2 mRem/hr (20 µSv/hr).

The following equations are used to determine this worst case distance:

Standard Units

The minimum distance in traditional units is:

$$\text{Cesium-137 Sources: Distance in feet} = 1.3 \times \sqrt{(\text{activity in mCi})}$$

Figure 5.5: Cesium-137 Sources Standard

$$\text{Cobalt-60 Sources: Distance in feet} = 2.6 \times \sqrt{(\text{activity in mCi})}$$

Figure 5.6: Cobalt-60 Sources Standard

Example: If the strongest source is 100 mCi of Cs-137, then the Distance in feet =

$$1.3 \times \sqrt{100} = 13$$

According to this calculation, personnel should remain 13 feet from this source in the event of an emergency to receive a dose rate of less than 2 mRem/hr.

International Units

The minimum distance in international units is:

$$\text{Cesium-137 Sources: Distance in meters} = 2.1 \times \sqrt{(\text{activity in GBq})}$$

Figure 5.7: Cesium-137 Sources International

$$\text{Cobalt-60 Sources: Distance in meters} = 4.2 \times \sqrt{(\text{activity in GBq})}$$

Figure 5.8: Cobalt-60 Sources International

Example: If the strongest source is 3.7 GBq of Cs-137, then the Distance in meters =

$$2.1 \times \sqrt{3.7} = 4$$

According to this calculation, personnel should remain 4 meters from this source in the event of an emergency to receive a dose rate of less than 20 μ Sv/hr.

NOTES

CHAPTER

6

SHGL Source Holder

This chapter contains information specific to the VEGA Americas SHGL source holder.

6.1 Personnel VEGA Safety

Exposure Level

The Ohio Department of Health has reviewed this device. The device registration specifies that if you use the device as intended (VEGA Americas instructions), an annual dose in excess of ten percent (10%) of the limits specified in 10 CFR Part 20.1201(a) (SOR-203 S.12-S.14 for Canadian licensees) is unlikely.



Always limit exposure to the direct radiation beam when servicing vessels, weigh scales, and pipes. In case of suspected damage, contact VEGA Americas for instructions on returning the device for repair or disposal.

6.2 Introduction

Components

| Component | Description |
|-----------------|---|
| Source housing | A welded closed stainless steel housing containing stainless-steel source capsule that is heli-arc welded. |
| Source material | The source material is either Cesium-137 (Cs-137) or Cobalt-60 (Co-60). |
| Beam port | The front face of the source holder is the beam port. |
| Shipping cap | The SHGL does not have a shutter. During transportation, a stainless steel shield bolts over the beam port. During installation, the shield is removed from the front and bolted to the back of the device using two bolts. |
| Labels | An arrow label identifies the direction of the radiation beam. |



Gamma radiation is highly penetrating and excessive exposure can cause harm. It is necessary to comply with specific safety precautions to ensure safe use of this device. The SHGL source holder uses source material with a maximum activity of 2 milliCurie (mCi) or 74 MegaBecquerels (74 MBq) of Cesium-137 or 0.5 mCi (18.5 MBq) of Cobalt-60 per source holder.



You must not remove the stainless steel “Caution-Radioactive Material” label per 10 CFR 31.5 (SOR-203 S.20 for Canadian licensees). A radioactive material identification tag provides the isotope, activity, model number, serial number, date of assay, and the name of the distributor. If the device contains a source greater than 100 μ Ci (3.7 MBq), an additional label indicates the requirement for leak testing.

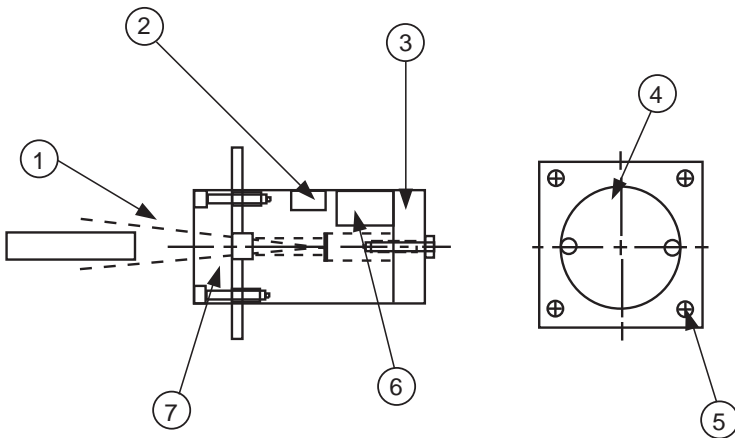


Figure 6.1: SHGL Components

- 1 Radiation Beam Collimated Angle
- 2 Radioactive Material Identification Tag
- 3 Shipping Cap in Storage Position “Unit Operable”
- 4 Radiation Beam Direction
- 5 Mounting Holes
- 6 Specific or General License Label
- 7 Location of Shipping Cap “Remove from this Position when in Use”

Limits and Considerations of Use

| Consideration | Limit |
|---------------------------------|---|
| Environmental conditions | |
| Life expectancy | The expected useful life of the device exceeds 20 years. However, devices containing Cobalt-60 are functionally limited by beam strength reductions from radioactive decay. |
| Temperature | Normal use: -40 to $+140^{\circ}\text{F}$ (-40 to $+60^{\circ}\text{C}$). ANSI N43.6 classification indicated that the SHGL was tested to operate up to a maximum temperature of $+392^{\circ}\text{F}$ ($+200^{\circ}\text{C}$) for one hour, and last five minutes in a $+1000^{\circ}\text{F}$ ($+538^{\circ}\text{C}$) without leaking radioactive material. The device may be used at a continuous operating temperature of $+392^{\circ}\text{F}$ ($+200^{\circ}\text{C}$). |
| Pressure | Atmospheric |
| Vibration | 0 to 40 Hz with 1.5 mm (0.06") peak to peak displacement. Apart from the normal use conditions, the device can operate in environments that do not exceed its ANSI N43.8 limits and a vibrational acceleration of 5g. |
| Corrosion | Mildly corrosive atmospheres suitable for stainless steel. |
| Fire | Accident conditions only |
| Explosion | Accident conditions only |
| Impact | Accident conditions only |
| Humidity | 0% to 100% relative humidity |
| Licensing | A general license for the use of this device must meet the requirements as outlined in OAC 3701: 46-05 (an equivalent to 10 CFR 31.5). Any other use of the device requires a specific license. (There is no general license outside the U.S.). |
| Testing | |
| Leak Test | At least once every 36 months (every 12 months for Canadian licensees). |
| Shutter Test | None |

| Consideration | Limit |
|---------------------------------------|--|
| Testing | |
| Transfer and disposal | You must transfer this device from one general licensee to another in the same location in accordance with OAC 3701: 46-05 (an equivalent to 10 CFR 31.5). If you need to transfer the device to another location or dispose of the device, specific licenses are required. |
| Handling, installation, and servicing | <p>In the United States, a general licensee can initially mount, install, and perform leak tests on the device in accordance with the manufacturer's instructions.</p> <p>The general licensee may also relocate the device following the manufacturer's instruction provided that the manufacturer or another specific licensee has evaluated the new location to ensure that all general license criteria are met.</p> <p>A general licensee may not service the device.</p> |
| Storage | When you remove the device from its mounted position, you must mount the shield on the back of the device to shield the front beam port using the captivated bolts in the shield. |
| Physical Inspection | Perform physical inspections of the device and its labeling at least once every six months for corrosion prevention and maintenance in accordance with the manufacturer's instructions. |
| Administrative Procedures | Establish administrative procedures to ensure that when the tank/vessel is not in use, you return the source to the shielded position and secure it until you fill the pipe or vessel again. Make certain the radiation levels to the accessible areas are acceptable. |

Initial Installation

In the United States and Canada, there are no requirements for radiation safety training to install this source holder. There is only one way to mount this source holder on a vessel, pipe, or frame. You must follow the installation instructions and drawings provided by VEGA Americas to ensure safe and proper operation of the measuring system.

Installing the Source Holder

The source holder is shipped attached to the mounting bracket.

1. Remove the source holder/bracket assembly from the shipping container.
2. An arrow label indicates the radiation beam direction. Make certain you cover the radiation beam port with the auxiliary shipping cover.
3. Position the source holder and bracket in alignment with the mounting location on the vessel or on the pipe.
4. Position the source holder so that the radiation beam aims away from your body.
5. Remove the shipping cover and attach the source holder and bracket assembly to the vessel or to the pipe.
6. Attach the shipping cover to the rear of the source holder for storage.



If removing the source holder from the vessel or pipe for any reason, MAKE SURE that the shipping cover is reattached to the source holder so it covers the radiation beam port. Observe the same precautions as in the installation.

Density Gauge

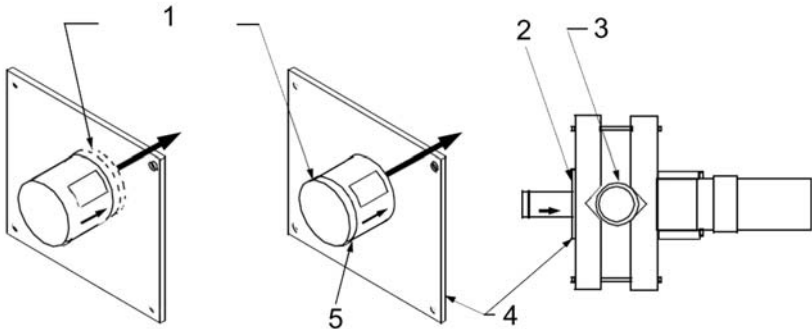


Figure 6.2: SHGL Source Holder and Density Gauge

- 1 Shipping Cover
- 2 Source Holder Positioning (See Step 4)
- 3 Process Pipe
- 4 Mounting Bracket
- 5 Remove Shipping Cover (See Step 5)

Level Gauge

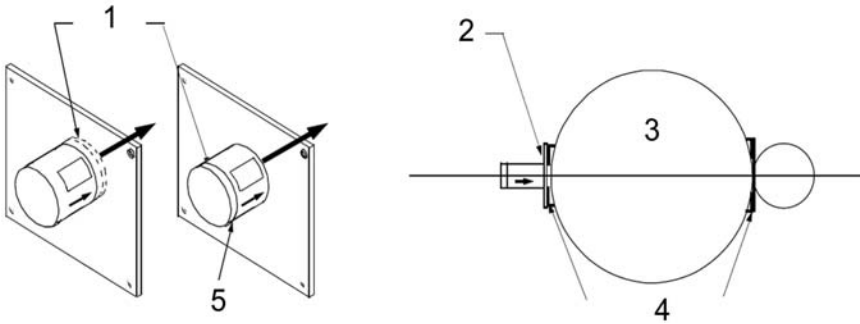


Figure 6.3: SHGL Source Holder and Level Gauge

- 1 Shipping Cover
- 2 Source Holder Positioning (See Step 4)
- 3 Process Vessel
- 4 Mounting Bracket
- 5 Remove Shipping Cover (See Step 5)

Weigh Scale

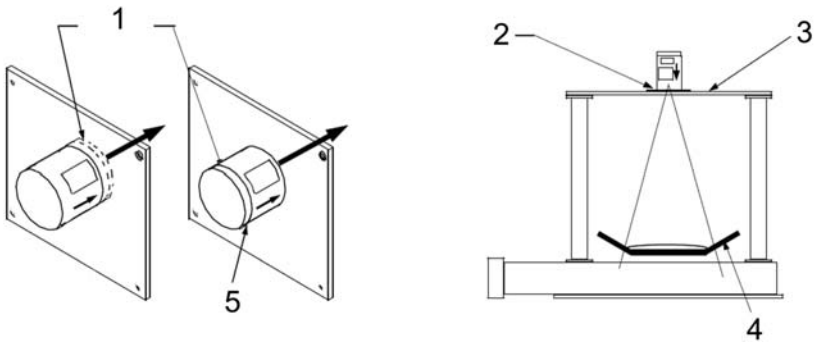


Figure 6.4: SHGL Source Holder and Weigh Scale

- 1 Shipping Cover
- 2 Source Holder Positioning (See Step 4)
- 3 Gauge Frame
- 4 Conveyor Belt
- 5 Remove Shipping Cover (See Step 5)

Relocation or Removal of Source Holder

The SHGL's design is for a specific application. Do not remove or relocate this source holder without prior approval from VEGA Americas.



Always ensure that the auxiliary shield is in place before removing or relocating the source holder.

Relocating the SHGL

When relocating the source holder, have the following information available:

- An illustration of the new installation on a vessel, pipe, or conveyor. The drawing should include dimensions, wall material(s) and thickness, and ambient conditions such as vibration, corrosiveness, etc.
- Process parameters including density of process material, ambient and process temperatures, measurement range, and available mounting structure(s).

VEGA Americas determines measurement and installation feasibility and provides any additional information necessary to ensure safe installation.

Prior to Removal

Before you remove the source holder, perform the following steps:

1. Conduct a visual inspection of the source holder. Make sure the external surface is smooth and not damaged.
2. Corroded and rusted units, which are in service under extreme environmental conditions, may require special removal, handling, and shipping procedures.
3. Ensure that you install the shipping shield.
4. Have personnel and equipment available to remove unit.
5. Inform all personnel involved in the removal process of the procedures necessary to limit radiation exposure. For example, the procedure to reduce exposure using time, distance, and shielding.

6. Be prepared to handle the weight of the unit. The approximate weight of the source holder is on the certified correct drawing.



Always ensure that the auxiliary shield is in place before removing or relocating the source holder.

Removal Requirements

1. Only an authorized licensed individual can perform the removal of a mounted source holder.
2. The authorized person must use a calibrated survey meter and must be present at the site during the entire procedure.
3. Removal of the mounted source holder requires a radiation survey and a leak test, if shipping the unit.

Remove the Source Holder

1. Remove the source holder and bracket assembly from the vessel or the pipe.
2. Position the source holder so that the radiation beam is aimed away from your body. An arrow label indicates the radiation beam direction.
3. Place the shipping cover on the front of the source holder so that the radiation beam port is covered.
4. Place the source holder/bracket assembly in the shipping container.



If removing the source holder from the vessel or pipe for any reason, MAKE SURE that the shipping cover is reattached to the source holder so it covers the radiation beam port. Observe the same precautions as in the installation.

Radiation Survey after Removal

Perform the radiation survey procedure described in this manual. The radiation field should compare to the installation survey or less than 5 mRem/hr (50 μ Sv/hr) at 12 in. (30 cm) from the surface omni-directionally.

Leak Test

Perform a leak test at least every 36 months (12 months for Canadian licensees) when a SHGL device has source material greater than 3.7 MBq (100 μ Ci).

- The general licensee may perform the leak test on the device (leak test kits are available from VEGA Americas).
- Send the leak test to VEGA Americas or another licensed facility for evaluation.
- Maintain the results of the leak test until three years after the next test.

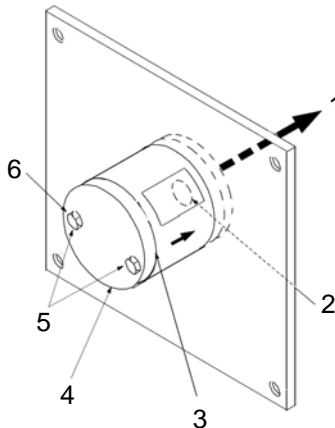


Figure 6.5: Leak Test Locations SHGL Source Holder

- 1 Beam Direction
- 2 Wipe Around this Seam, if accessible
- 3 Wipe Around this Seam
- 4 Auxiliary Shield
- 5 Wipe Around these Bolt Heads
- 6 Auxiliary Shield Mounting Bolts

NOTES

Chapter 7

References

7.1 Internet Sites and Information

The following sites are for reference purposes only.

Nuclear Regulatory Commission (U.S. NRC)

This site has links to the Regulations and Guides.

<http://www.nrc.gov/>

Consolidated Guidance About Materials Licenses: Program-Specific
Guidance About Fixed Gauge Licenses (NUREG-1556, Vol. 4).

<http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1556/v4/>

The Canadian Nuclear Safety Commission

<http://www.nuclearsafety.gc.ca/>

7.2 U.S. NRC Code of Federal Regulations

Go to <http://www.nrc.gov/reading-rm/doc-collections/cfr/> for more specific information about the regulations listed below:

10 CFR 20.1003

10 CFR 20.1004

10 CFR 20.2201

10 CFR 20.2202

10 CFR 30.51

10 CFR 32

10 CFR 31.5

7.3 Ohio Department of Health, Agreement State

Go to <http://www.odh.ohio.gov/rules/final/finalRules.aspx> to select the Ohio Administrative Code's O.A.C. listed below:

3701:1-38

3701:1-40

3701:1-46

3701:1-50

7.4 Canadian Nuclear Safety and Control Regulations

The address for the Canadian Nuclear Safety Commission is:

Canadian Nuclear Safety Commission Headquarters

280 Slater Street

P.O. Box 1046

Station B Ottawa, ON K1P 5S9

1-800-668-5284 (In Canada)

(613) 995-5894 (Outside Canada)

Fax: 613-995-5086

SOR/2000-202, General Nuclear Safety and Control Regulations

SOR/2000-203, Radiation Protection Regulations

SOR/2000-207, Nuclear Substances and Radiation Devices Regulations

SOR/2000-208, Packaging and Transport of Nuclear Substances Regulations

For the Regulatory Guide, G-129, Revision 1, "Keeping Radiation Exposures and Doses 'As Low As Reasonably Achievable' (ALARA) go to:

http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/G129rev1_e.pdf

<http://www.nuclearsafety.gc.ca./eng/lawsregs/actsregulations/index.cfm>

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