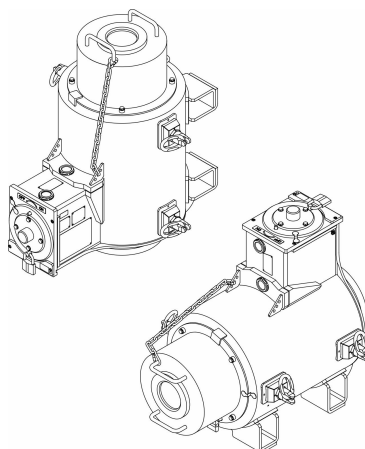
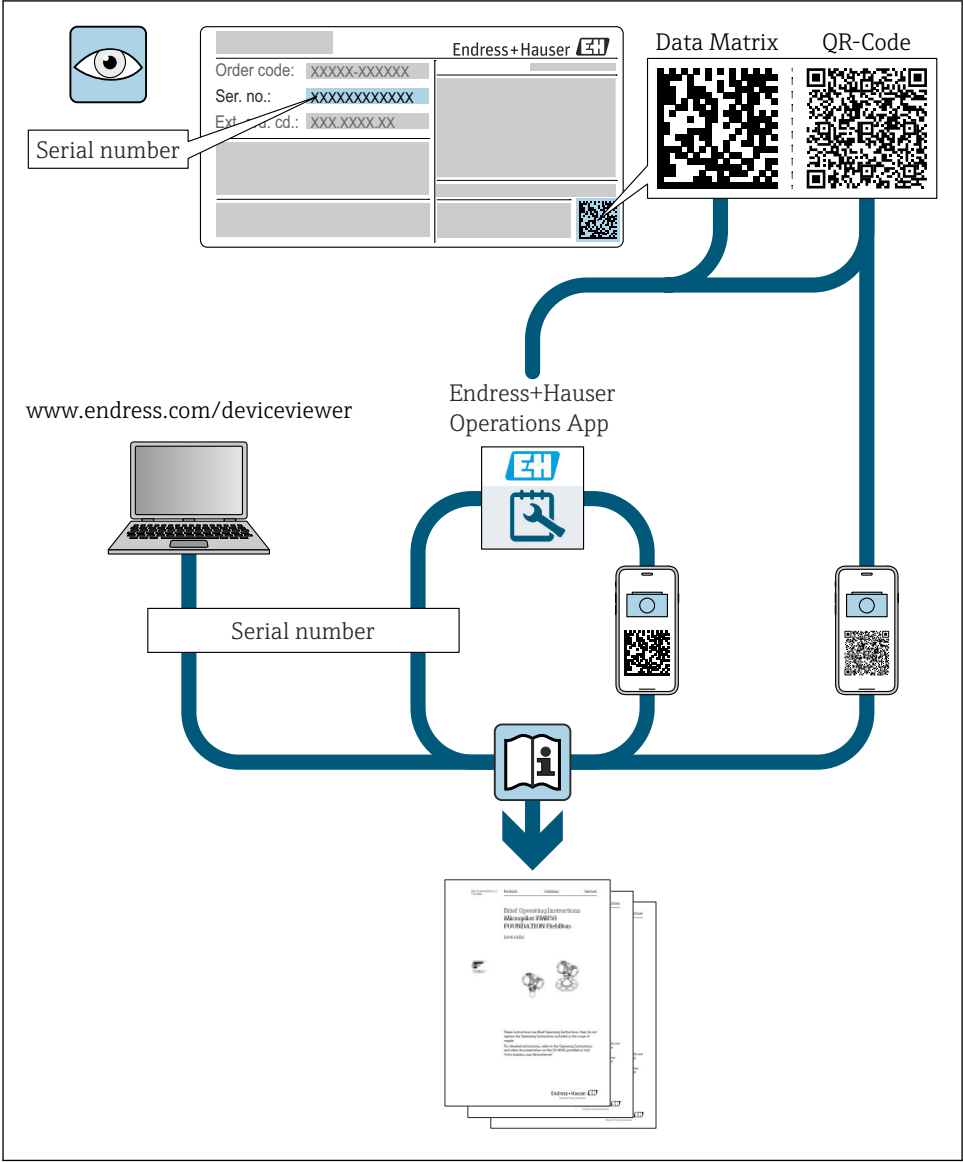


Special Documentation

Radiation safety and technical reference manual

US-specific license:
Source Container FQG74





A0023555

- Make sure the document is stored in a safe place such that it is always available when working on or with the device
- Avoid danger to individuals or the facility: read the "Basic safety instructions" section carefully, as well as all other safety instructions in the document that are specific to working procedures

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1 About this document

1.1 Document function

These instructions contain all the information that is relevant to the safe handling of the Source Container FQG74.

For additional and detailed information, see Operating Instructions BA02609F.

1.2 Symbols

1.2.1 Safety symbols

DANGER

This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING

This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION

This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE

This symbol alerts you to a potentially harmful situation. Failure to avoid this situation can result in damage to the product or something in its vicinity.

1.2.2 Radiation warning sign



Warning symbol for radioactive source according to ISO 7010

Warning sign for ionizing radiation

Identification of places and objects in and around which the presence of ionizing radiation is to be expected.



Warning symbol for highly radioactive source according to ISO21482

High radiation warning sign

- Warns of highly radioactive substances or ionizing radiation.
- Highly radioactive sources are marked separately on the source containers with the wording "highly radioactive source" and the supplemental warning symbol according to ISO21482.

1.2.3 Symbols for certain types of information and graphics

Permitted

Procedures, processes or actions that are permitted

Forbidden

Procedures, processes or actions that are forbidden

Tip

Indicates additional information



Reference to documentation



Reference to graphic



Notice or individual step to be observed

1, 2, 3

Series of steps



Result of a step

1, 2, 3, ...

Item numbers

A, B, C, ...

Views



Safety instructions

Observe the safety instructions contained in the associated Operating Instructions

1.2.4 Tool symbols



Phillips head screwdriver



Flat-blade screwdriver



Torx screwdriver



Allen key



Open-ended wrench



Wire cutter

1.3 Documentation



For an overview of the scope of the associated Technical Documentation, refer to the following:

- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

2 General information

2.1 Function and system design

Radiometric measurement is based on the following principle:

Radiation sources located in source holders emit gamma radiation.

The gamma radiation is attenuated when it penetrates materials.

The detector (Gammapilot), which is installed on the opposite side of the tank, converts the received gamma radiation into an electrical signal.

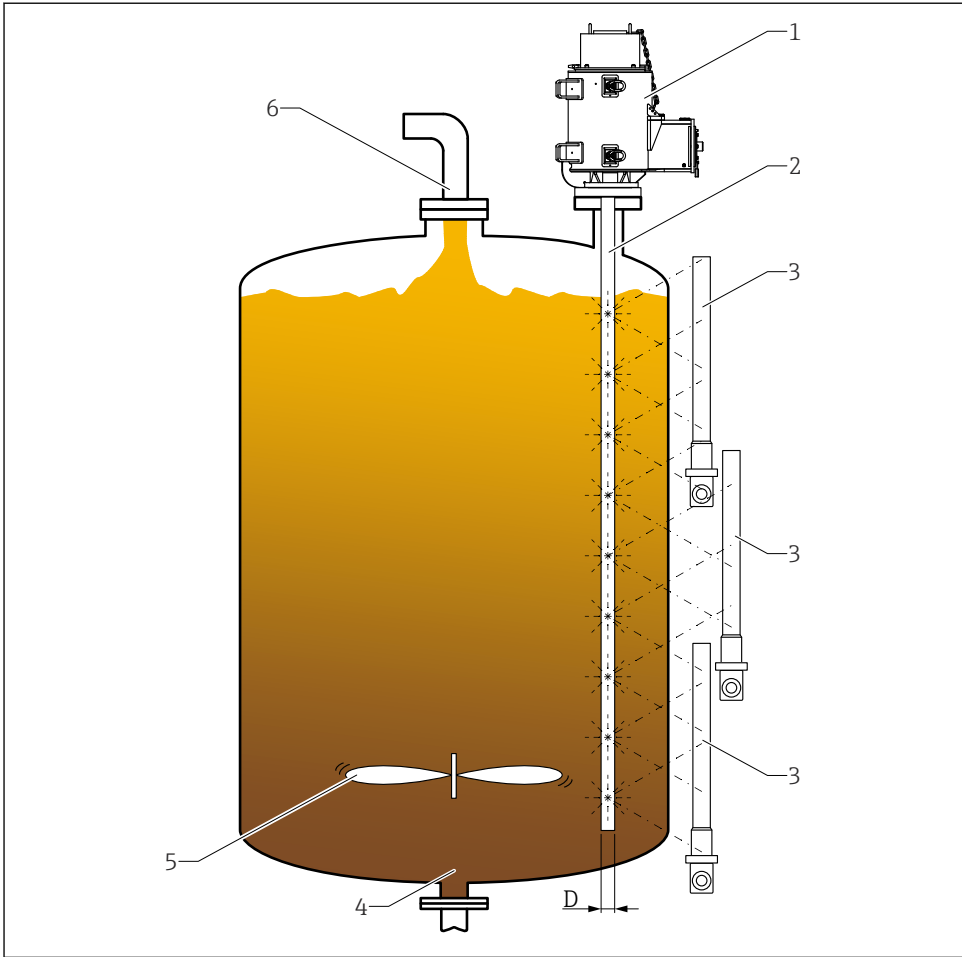
The parameters that can affect the measurement and therefore the signal are the increasing level (continuous or point level measurement) or the changing densities of the medium in the tank.

General information about the Source Container FQG74:

The Source Container FQG74 is designed for applications where the radiation sources are positioned inside the process vessel. For this purpose, the radiation sources can be lowered in a protection pipe in the process.

When switched off, the radiation sources are located in the source container. The lead shielding, enclosed in a stainless steel housing, reliably blocks gamma radiation.

When switched on, the radiation sources are located in a double-walled protection pipe inside the product container.



A0055455

1 Level measurement

- 1 FQG74
- 2 Straight protection pipe
- 3 Gammapilot FMG50
- 4 Medium
- 5 Agitator
- 6 Inlet
- D Minimum internal diameter of the protection pipe

2.2 Basic radiation safety

Gamma radiation emitted by radioactive materials, such as cesium-137 and cobalt-60, are electromagnetic waves similar to light.

However, the energy of the gamma radiation is far higher than that of the light beams. The ability of gamma radiation to penetrate materials is associated with their respective wavelength and energy.

The actual measuring principle is based on the absorption of the radiation through the product to be measured. The material either absorbs almost the entire radiation (level or point level applications) or the absorption changes while some of the original radiation reaches the detector (Gammapiot) even at maximum density (density or interface measurement).

The dose of this radiation energy depends on several factors:

- Activity of the radiation source
- Distance between radiation source and body
- Area of the body that is in contact with or closest to the radiation source
- Presence of any shielding material between the radiation source and the body
- Total time in which the body was exposed to the effect

2.3 Exposure to radiation and contamination

- **Natural radiation exposure:** cosmic radiation from space and terrestrial radiation from the earth's crust.
- **Artificial radiation exposure:** e.g. through medical X-ray images and medical treatment. Here, the highest radiation exposures usually occur on the human body.

Units of the radiation dose

The units of the radiation dose take into account different types of radiation and their potential effects on the human body.

- **Sievert**
- **Rem (roentgen equivalent in man)** is obsolete

Radiation doses can be reduced by time, distance and shielding, for example by using remote control instruments for handling radioactive materials.

Radiation exposure or radiation doses must be distinguished from radioactive contamination.

Contamination can only be caused by direct contact, inhalation or intaking radioactive substances.

Example: a campfire. If you feel the heat of the fire, this means you are in the range of the thermal radiation. Contamination occurs when part of the fire leaves the fire area.

At Endress+Hauser, radioactive material is double-encapsulated in source capsules. According to the ISO classification, typically C66646/ISO 2919, which meets the strictest safety criteria regarding voltage, extreme temperatures and pressures, as well as impact, vibration and perforation.

Contamination is only possible if the source capsule is failing and the radioactive material is distributed.

Stainless-steel-encapsulated radiation sources seldom fail even under emergency conditions.

Periodic leak tests are performed to check surface contamination.

2.3.1 Radiation range of the gamma radiation

Access to the radiation area of the gamma radiation is determined by the location and the installation parameters of the source container.

Ideally the tank is completely closed and the tank walls offer suitable shielding properties.

If the tank does not provide suitable screening, the surrounding area must be shielded, cordoned off and marked with suitable measures.

Access control methods must be planned and implemented at the time of commissioning the source container to ensure that exposure to persons does not exceed the legal limit values for the entire body or extremity dose.

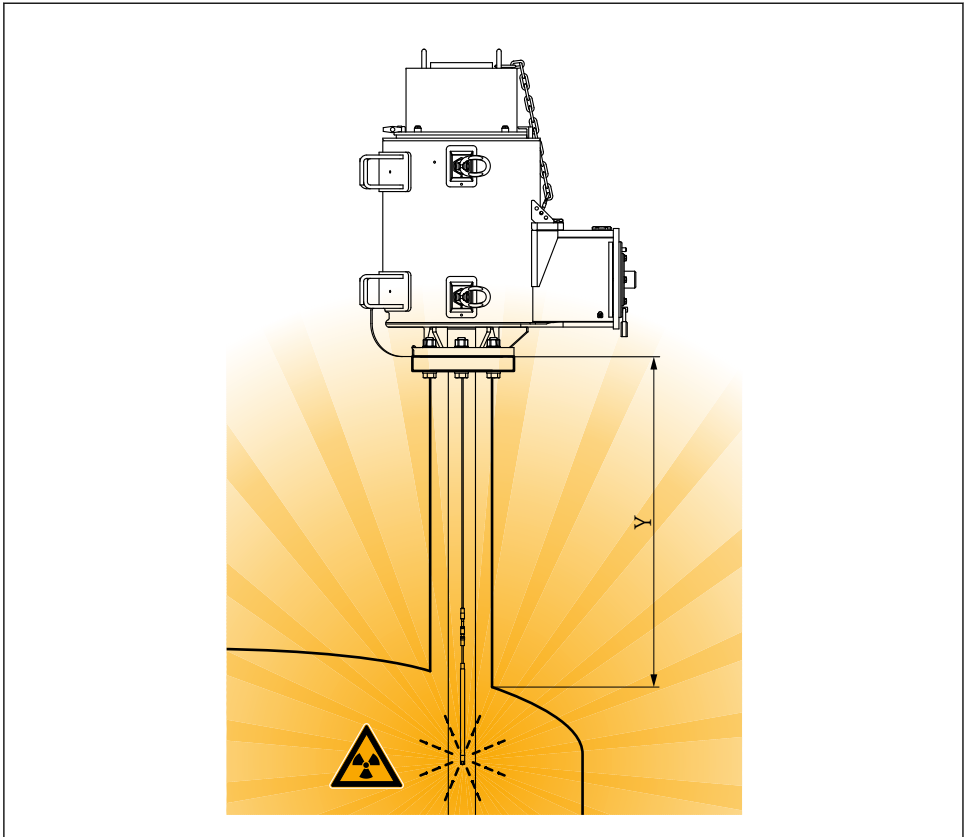
Access to the inside of the tank is prohibited unless the radiation sources are shielded. This means that the radiation sources are located in the source container and the source container is closed.

Suitable locking procedures must prevent access to the inside of the tank until all safety conditions are met.

All occupational safety and health administration (OSHA) regulations regarding entrance into closed rooms must be observed.



The dimension "y" must be selected so that the radiation sources are inside the product vessel when lowered. $y \leq LN$



A0056396

2 Installation dimensions

y: Length, from mounting flange to product vessel

LN: Variable rope length, depending on version

2.4 About us

Endress+Hauser was founded in 1953 by Georg H. Endress and Ludwig Hauser.

The company has developed from an instrumentation specialist into a supplier of complete system solutions.

Endress+Hauser is a global leader in providing measuring instruments, services and solutions for industrial process engineering.

Endress+Hauser provides accurate and cost-effective systems for process measurement, monitoring and automation. Solutions are developed in close cooperation with the customer.

As early as in 1962, Endress+Hauser released its first radiometric measuring system on the market. To this day, this technology still offers decisive advantages.

Endress+Hauser offers a wide range of sensors, instruments, systems and services, for example, for the following areas:

- Level measurement
- Flow measurement
- Pressure measurement
- Temperature measurement
- Liquid analysis and recording
- Connection of field instruments to process control systems
- Automation and logistic solutions

2.5 US license types

In the United States, the following applies to operators of an industrial radiometric measuring system:

The radiometric measuring system may only be operated under the license of the United States Nuclear Regulatory Commission or Agreement State.

The license limits what the operator may do with the source container.

There are two types of license:

- General license
- Specific license

The specific license applies to the Source Container FQG74.

2.5.1 Specific license

A specific license authorizes the possession and the use of certain source containers. The license sets the types that can be possessed, as well as the approved activities. The license indicates the radiation safety officer (RSO). This person is responsible for the radiation protection program and all required documents. Alternative radiation protection officers can also be specified in the license. The application requirements for a special license are in 10CFR Part 30.32 and 30.33. Part 30.33 (a) requires that the applicant is trained and experienced in handling the requested devices and radioactive materials. This training is available through several authorized training companies. The specific licenses describe requirements and authorized activities that can be performed by the Licensee. These activities may include the authorization of leak tests, installation, transportation or removal of source containers, etc.

3 Basic safety instructions

DANGER

Danger from ionizing radiation in case of incorrect handling or a defective source container

Hazard for persons and the environment posed by ionizing radiation and contamination. Ionizing radiation and contamination could increase the risk of cancer and the risk of genetic birth defects. Depending on the dose received, ionizing radiation could lead to immediate physical harm, such as nausea, vomiting, hair loss, changes to blood count, serious tissue damage and even death.

- ▶ **The instructions and warning notes in this manual relating to dangers to health posed by ionizing radiation and contamination must be strictly observed. Disregard for these instructions and warning notes could lead to serious injuries or death and hazards for the environment.**
- ▶ Observe applicable national requirements for radioactive radiation sources. Observe requirements for fire protection measures in particular.
- ▶ Observe the conditions of use of radiation sources with respect to environmental conditions (e.g. vibration or operating temperature).
- ▶ In cases of doubt, contact the responsible radiation safety officer, the responsible national inspectorate or the manufacturer.

In this manual, warnings about potential risks from ionizing radiation are marked with the warning symbol .

DANGER

Danger from ionizing radiation if radiation sources lost

If radiation sources are lost, there is a danger to the general public and the environment

- ▶ **The instructions and warning notes in this manual relating to dangers to health posed by ionizing radiation and contamination must be strictly observed. Disregard for these instructions and warning notes could lead to serious hazards for the environment and public safety.**
- ▶ Observe applicable national requirements for anti-theft measures for radioactive radiation sources throughout the entire life cycle (from delivery to disposal).
- ▶ There is a risk of radioactive material being used for criminal or premeditated unauthorized acts, which poses a threat to public safety.

⚠ WARNING**Risk of accident from heavy gross weight**

During assembly: If source containers are assembled incorrectly, there is an impact danger to persons in the event of a dropped load and a risk of serious damage to physical items. During transport: In the event of incorrect or unsecured transport of the source container and overpack (loads), there is a risk that persons could go unnoticed or suffer impact because it is not possible to stop in time. Due to a high center of gravity or uneven weight distribution, there is also the risk of the load tipping, which poses a serious risk of personal injury. For suspended loads: There is the danger of persons being impacted by falling loads or parts thereof, of being impacted by moving suspended loads or of bumping into stationary suspended loads. Parts of the overpack and attachment parts of the source container could weigh over 18 kg.

- ▶ Observe the assembly instructions.
- ▶ Inspect the assembly diligently and check at regular intervals.
- ▶ Observe safety instructions and transport conditions for heavy loads.
- ▶ Wear personal protective equipment.
- ▶ Lift source containers only at the defined lifting points.
- ▶ Use only appropriate lifting accessories for the load.
- ▶ During assembly and transport, only those persons who are directly involved and have knowledge of guidance and requirements may be present in the danger zone.
- ▶ During transport, the center of gravity of the packaging must be taken into consideration and a suitable surface must be ensured.

⚠ CAUTION**Risk of burns from hot components**

Components could heat up as a consequence of high temperatures in the process. These high component temperatures could lead to burn injuries.

- ▶ Wear personal protective equipment, such as correctly sized heat-resistant gloves.
- ▶ Define organizational measures for protection from hot parts (particularly process adapters, source magazine and flexible source holder extension). Operating personnel must be warned of the danger posed by hot parts on the source container, e.g. in the form of notices and training.
- ▶ The plant operator is responsible for ensuring that the radiation sources can be safely set to the "AUS/OFF" switch position in an emergency. A risk of injury from hot parts on the source container must be taken into consideration.
- ▶ If possible, allow the process to cool down before the ropes are retracted.

3.1 Requirements for the personnel

⚠ WARNING**Danger from inadequately qualified personnel.**

Physical damage and personal injury. Particularly as a consequence of incorrect handling.

- ▶ The requirements for personnel described below are mandatory for the plant operator.

Operating personnel

The operating personnel are responsible for operation and monitoring. They switch the radiation on or off, for example. The operating personnel

- ▶ must be instructed and authorized by the plant operator according to the requirements of the task, and
- ▶ must have a relevant qualification for this specific function and task, in accordance with the relevant national requirements.

Installation and service personnel

The installation and service personnel are responsible for installation, commissioning, maintenance, monitoring, and removal. They must strictly meet the following requirements:

- ▶ They must be trained, qualified specialists, having a relevant qualification for this specific function and task, in accordance with the relevant national requirements.
- ▶ They must be authorized by the plant operator.
- ▶ They must be familiar with federal/national regulations.

Authorized repair personnel

Authorized repair personnel are

- ▶ qualified specialists having the appropriate qualification for the relevant function and task and meeting the relevant national requirements,
- ▶ authorized by the plant operator and
- ▶ familiar with national regulations.

Maintenance personnel – radiation

Maintenance personnel (radiation) carry out any maintenance work affecting the radiation source, including disassembly and replacement. The maintenance personnel – radiation are

- ▶ accredited and monitored in relation to radiation exposure
- ▶ They must be trained specialists in radiation protection and
- ▶ authorized by the plant operator.

Transport personnel

Transport personnel transport the product or parts thereof from, for example, the manufacturer or storage location to the point of use. Transport personnel

- ▶ are qualified to transport "Class 7 dangerous goods".

Disposal personnel

Disposal personnel dispose of the product or parts thereof. Disposal personnel are

- ▶ accredited and monitored in relation to radiation exposure,
- ▶ specialists qualified in radiation protection and
- ▶ authorized by the disposal company.

Radiation safety officer

The radiation safety officer is responsible for compliance with all applicable laws and regulations. The company/plant operator must nominate a radiation safety officer in

accordance with applicable national legislation. The radiation safety officer is, among other things, responsible for

- ▶ monitoring the source container at the respective point of use,
- ▶ the training of employees in the context of radiation protection and
- ▶ developing and implementing measures in an emergency. The radiation safety officer is therefore reachable at all times.

The radiation safety officer is

- ▶ qualified for the task,
- ▶ a nationally recognized person for the task and
- ▶ a specialist authorized by the plant operator.

3.2 Intended use

The source containers shield the radiation from the environment, only allowing radiation to escape during measurement operations within the measuring application.

The source containers described in this document contain the radioactive radiation sources used for radiometric point level, level and density measurement.

The following are considered intended uses

- Use as a transport and storage vessel according to hazardous class 7 and as source container in the measuring application
- Exclusive use with radioactive, double-encapsulated materials in special form, in accordance with ISO 2919
- Replacement of radiation sources when using the same source capsule type
- Use in measurement operation within stationary processes.

For intended use, the following conditions must be met

- The instructions and handling guidelines in the Operating Instructions, particularly the radiation protection instructions, must be followed
- Areas of use must be within the limits of technical specifications
- Only the radiation sources specified in the technical specifications must be used, in compliance with the maximum activity levels specified there.

3.2.1 Foreseeable incorrect use

The following is not permitted:

- Operation outside the technical specifications
- Installing the source container on its feet in a vertical position
- Installing the source container in measuring applications with the flange not pointing downwards
- Transport of the source container on a pallet where the source container is not mounted on its transport feet
- Attaching the lifting gear to points not intended for this purpose
- Permanent process installation of the source container in a suspended state

- Commissioning or switching on radiation while the source container is in a suspended state
- Transporting the source containers with an open shutter
- Use with insufficient protection of the radiation sources against corrosion (see the following note).



Protection of radiation sources in measuring applications against corrosion is ensured through:

- Appropriate material selection of the protection pipe
- Monitoring or, if necessary, double-walled design of the protection pipe
- The operator is responsible for ensuring radiation source protection through the protection pipe

Endress+Hauser assumes no liability for damage resulting from improper use.

3.3 Workplace safety

For work on and with the device

1. In case of any doubt in relation to correct handling, contact Endress+Hauser Service.
2. Make detailed preparations to ensure that the source container is installed as quickly and efficiently as possible. Provide all necessary tools and equipment before starting work.
3. Observe all instructions in this manual when working on the source container.
4. When working with radiation sources, avoid any unnecessary exposure to radiation.
5. Keep all unavoidable radiation exposure to a minimum.
6. Implement suitable measures (e.g. blocking of access, shielding) to prevent danger to people.
7. Observe applicable national requirements.

Lowering or raising of source holders

When the source holders are being lowered or raised, the radiation sources are outside the source container. The source container does not provide shielding in this case.

1. Make detailed preparations to ensure that the source holders are lowered or raised as quickly and efficiently as possible.
2. Compliance with the required protective measures for personnel and the environment.
3. Only the required, authorized personnel are permitted in the danger zone.
4. The dimensions of the danger zone must be determined and cordoned off accordingly in accordance with the applicable national requirements.

Use of the lifting points

- The supplied safety instructions for the lifting points must be strictly observed.

3.4 Operational safety

The “protection from ionizing radiation” function could be affected by damage, tampering, modification or repair. There is a threat of radiation damage or extremely serious injuries.

In cases of doubt in relation to operational safety, the source container must not continue to be used under any circumstances.

The product's suitability as a source container and as a shipping package for the transport of radioactive materials of special form is ensured only when

- all tests and maintenance have been carried out to the manufacturer's specifications and
- no modifications or tampering have taken place.

The manufacturer offers no guarantee of after-sales service or take-back if modifications have been carried out.

Maintaining operational safety:

- ▶ By carrying out maintenance and formal periodic inspections, make sure that the device is in technically flawless and operationally safe condition.
- ▶ Check moving parts, particularly the closing mechanism, regularly. It must be possible for the radiation to be switched off at any time.
- ▶ If the application is designed to have radiation sources lowered into the process, retrievability of the radiation sources must be ensured at all times. In particular, the ropes and source holders must be checked for corrosion and correct operation.
- ▶ Adapt checking intervals to environmental conditions. Check more frequently in harsh and corrosive environments.

Conversion

Modifications and attachments to the source container are not permitted without the express written authorization of Endress+Hauser.

Repair

- Do not carry out any repairs unless they are permitted repairs. Permitted repairs are described in these Operating Instructions or reference is made in this manual to the appropriate repair documents.
- Use only original spare parts and original accessories.
- Observe notes on radiation protection, particularly self-protection, hazards to third parties, and compliance with legal requirements.

Tampering

- No tampering with the source container is permitted.
- For source containers with a flexible source holder extension, no tampering with the flexible source holder extension is permitted. If other rope lengths are required to be able to lower radiation sources into the process, only the original parts of Endress+Hauser may be used.
- Endress+Hauser offers no guarantee of after-sales service or take-back in this case.

3.5 Product safety

This state-of-the-art device is designed and tested in accordance with good engineering practice to meet operational safety standards. It left the factory in a condition in which it is safe to operate.

It meets general safety requirements and legal requirements.

3.6 Basic instructions for use, transport, and storage

The handling of radioactive radiation sources involves particular risks and dangers and therefore requires special care.

For safe and legal handling

1. Observe the applicable regulations and national/international standards.
2. Comply with radiation protection regulations when using, storing and working with the radiometric measuring system.

If there is any suspicion of improper condition of a plant with radiometric measuring system

1. Inform the radiation safety officer immediately.
2. Check the area around the device for signs of increased radiation or contamination. See section "What to do in an emergency"

In the event of defects

1. Inform the radiation safety officer immediately.
2. Do not continue to use the device, withdraw it from service as quickly as possible and exchange it.
3. Conduct the required leak test according to the applicable regulations and instructions.

Minimizing the hazard potential through good planning and careful conduct

1. The radiation may be switched on only by instructed personnel.
2. Before switching on the radiation, make sure that no-one is in the radiation zone (or inside the product vessel).
3. Heed warning signs and observe controlled areas.
4. When operating, transporting and storing the device, protect it against extreme influences (e.g. chemical products, weather, mechanical impacts, vibrations).
5. Carry out recurrent tests at regular intervals. These include, for example, checking for secure fastening of the source container, checking safety measures or checking for integrity.

For storage and transport

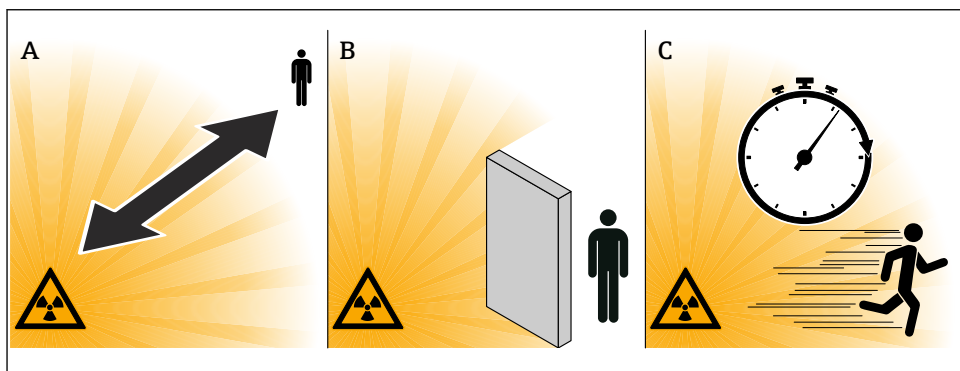
1. Before transporting: Retract the radiation source into the source container and set the source container to the "AUS/OFF" switch position.
2. Always secure the "AUS/OFF" switch position by using the transport lock and padlock.
3. Carry out recurrent tests before dispatch.
4. Observe the center of gravity and weight information on the packaging.

For use in a potentially explosive atmosphere

1. The use of the radiometric measurement method in potentially explosive atmospheres must be specially checked and implemented by the plant operator based on applicable national rules and regulations.
2. Integrate the device into the potential equalization system of the plant.

3.7 General instructions on radiation protection

When working with radioactive radiation sources, avoid any unnecessary exposure to radiation. All unavoidable radiation exposure must be kept to a minimum. Three basic concepts apply to achieve this:



3 Protective measures

- A Distance
- B Shielding
- C Time

Distance

Keep as far away from the radiation source as possible.

The local dose rate decreases in proportion to the square of the distance from the radiation source.

Shielding

Ensure the best possible shielding between the radiation source and personnel.

Effective shielding is provided by source containers and high-density materials (e.g. lead, iron, concrete).

Time

Keep the time spent in the area exposed to radiation as short as possible.

3.8 Legal regulations for radiation protection

The handling of radioactive radiation sources is regulated by law. The radiation protection regulations of the country in which the plant is operated are of overriding importance and must be strictly observed.

- **Germany:** the current version of the radiation protection act and the Radiation Protection Directive apply in Germany.
- **USA:** in the United States, nuclear meters may only use the license of the US Nuclear Regulatory Commission (NRC) or an Agreement State.

The following points derived from this Ordinance are particularly important for radiometric measurement:

Handling permit

A handling permit is required by the operator of a plant that uses gamma radiation. The Endress+Hauser sales organization will be happy to help you obtain the handling permit.

Radiation safety officer

The plant operator must appoint a radiation safety officer (RSO) who has the necessary specialist knowledge and who is responsible for observing the Radiation Protection Ordinance and all radiation protection procedures.

Endress+Hauser offers training courses in which individuals can acquire the necessary specialist knowledge.

Controlled area

Only persons who are exposed to radiation during the course of their job and are subject to official personal dose monitoring procedures may work in controlled areas (areas where the local dose rate exceeds a specific value). The limit values for the controlled area are specified in the current Radiation Protection Ordinance applicable for your area.

For further information on radiation protection and regulations in other countries, please contact the relevant Endress+Hauser sales organization.

3.9 Supplementary safety instructions

Fire and anti-theft protection

To design a safe installation, keeping and storage of the radiation sources, observe the safety measures for the radiation source with respect to fire and anti-theft protection. Implement requirements in accordance with applicable national legislation.

Handling of lead

This device contains more than 0.1% lead with CAS No. 7439-92-1. With the source container in undamaged condition, there is no direct contact with lead.

If the source container suffers damage, national regulations for the handling of lead must be observed.

4 Regulation of radioactive substances

4.1 General information

The use of radioactive materials, including radiation detectors, is regulated by the U.S. Nuclear Regulatory Commission (U.S. NRC) or the appropriate authorities made by the Agreement State.

The applicable sections of US NRC regulations are numbered with 10 CFR Part 20, 10 CFR 31.5 and 31.12.

Agreement States are states that have an agreement with the NRC for regulating radioactive substances within their own state.

NRC continues to control some materials and areas, such as nuclear power plants.

Agreement States' regulations must be compatible or more restrictive than the NRC regulations. The NRC and the Agreement States regularly update their regulations.

The licensee is obliged to keep informed of any changes in these Regulations.

In some states, the registration of radiation detectors is mandatory (irrespective of type of approval). In such cases, the Licensee must satisfy the state requirements.

4.2 Legal regulations for radiation protection

The handling of radioactive radiation sources is regulated by law. Comply with the radiation protection regulations of the state where the facility is located.

4.2.1 License requirements

A general or specific license is required to operate a plant that uses gamma radiation. The request for the license must be made with the NRC or the Agreement State in which the facility is located.

Radiation safety officer

The plant operator must select a person who is appointed as the radiation safety officer (RSO). The aim of the radiation safety officer is to develop and maintain the radiation protection program with procedures to ensure that all of us keep the professionally permitted radiation dose as low as possible.

The radiation safety officer takes on site-specific safety training courses for all employees and/or supervise them.

Controlled areas

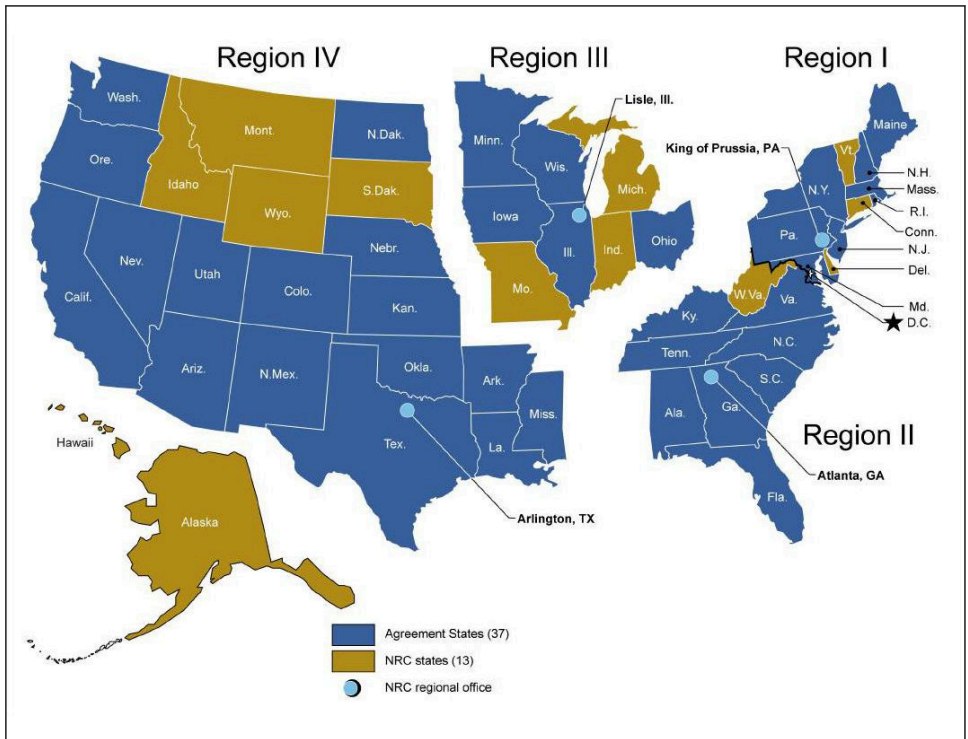
All controlled areas with radiation detectors must be clearly marked in an easy-to-read manner.

All persons entering the controlled area for performing any type of work should be monitored using a dosimeter in accordance with the security regulations and the radiation dose limits of the NRC and states.

4.3 NRC regional map

The Agreement States have concluded agreements with the NRC, which give them the authorization to approve and control byproducts, radiation sources or specialized radioactive materials that are used within their limits or are in your possession.

Every applicant, except a federal agency or a federally recognized indigenous community, who wishes to possess or use licensed material in any of these Agreement States should contact the state officials responsible for providing advice to prepare a request. These applications must be submitted to the state authorities, not to the NRC.



A0019229

4 Sources: GAO (Government Accountability Office); map resources (map).



Link to "Regulations and Guides"

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

4.4 Nuclear Regulatory Commission (NRC) offices and Agreement States (as of April 2026)



Link to "Agreement State Offices"

<https://www.nrc.gov/agreement-states>

4.4.1 Alabama

Brent Hatcher, Director
Office of Radiation Control
Alabama Department of Public Health
P. O. Box 303017
Montgomery, AL 36130-3017
Brent.hatcher@adph.state.al.us

4.4.2 Alaska

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5 Specific license

5.1 Conditions

The source container applications permitted for the Licensee are defined in their specific licenses.

The Licensee must read and understand the terms and conditions stated in their License.

The NRC and the Agreement States regularly adapt to the regulations. The Licensee is responsible for maintaining a current copy. Some states require the registration of measuring instruments with radioactive radiation sources.

The Licensee must ask the competent authority for the appropriate regulations to comply with the requirements.

Source container registration forms specify the required leak test interval. The sealed source capsules, which are used in the Endress+Hauser source containers, can be approved for intervals up to 36 months, if requested by the special license application.

5.2 Installation

The radiation sources are surrounded by a steel sleeve filled with lead in the source container, meaning that gamma radiation is shielded.

The radiation sources can be brought into the process on separate ropes in a protection pipe.

The "ON/OFF" position indicator signals whether the shutter is open or closed.

Source containers from Endress+Hauser are typically designed with a maximum dose rate of 50 $\mu\text{Sv/h}$ (5 mrem/h) at a distance of 30 cm (12 in) from the surface of the source container (with shutter closed).

5.2.1 Mounting check

- Is the device undamaged (visual check)?
- Are the measuring point identification and labeling correct (visual inspection)?
- Does the device comply with the measuring point specifications? For example:
 - Ambient temperature
 - Measuring height
 - Activity
- Are all the securing screws on the flange of the source container tightened securely?
- Are all the securing screws on the process adapter tightened securely?
- Has the source container been integrated into the potential equalization system of the plant?

5.3 Measuring the local dose rate

- Once mounting is complete, the local dose rate in the vicinity of the source container and the detector must be measured.
- Depending on the installation, ionizing radiation can also occur outside the actual beam exit channel as a consequence of scattering.
- Shield with additional lead or steel sheets.
- Cordon off and mark all controlled and exclusion areas.

5.3.1 What to do if the product vessel is empty

- If the product vessel is empty, after proper installation, measure the controlled area around the product vessel and, if necessary, cordon off and mark this area accordingly.
- If there any access points to the internal space of the product vessel, seal them off and mark them with a "Radioactive" warning sign.
- Only the responsible radiation safety officer may allow access after safety measures have been checked with the source container switched off.
- For work on the product vessel, switch off the radiation and, if necessary, implement additional shielding measures.

5.4 Personal dose monitoring

Based on the utilization studies on-site and the requirements according to 10 CFR20.1502 or the requirements specified by the Agreement State, the radiation safety officer decides whether personal dose monitoring is required.

Personal dosimetry can be displayed on occupationally exposed persons (based on their estimated annual dose).

5.5 NRC regulations for certain Licensees

As mentioned above, the conditions under which a Licensee is allowed to possess and use radioactive material are expressly defined in the licensing document.

Some of the items you need to know about are listed below.

5.5.1 Terminology

Licenses are usually issued for terms of five to ten years.

A radiation safety officer must be mentioned by name.

The radiation safety officer is responsible for ensuring that the license requirements are met and for the radiation protection program.

Every change of personnel requires a change to the license.

5.5.2 Radiation protection program

CFR Title 10, Part 20.1101, Subpart B indicates that each Licensee must develop, document and implement a radiation protection program.

The radiation protection program should include all approved activity, the manner in which the license holder is to follow the regulations of the approval and regulations.

The aim of a well-performed radiation protection program is to keep radiation doses as low as possible for occupationally exposed persons and the public.

One of the requirements is an annual check for the specially licensed radiation safety program. This involves checking the terms and procedures of the license while ensuring that they are current and relevant to the operation.

The records of the check must be kept for inspection.

The radiation protection program must contain at least the following information:

- Identity of the radiation safety officer and authorized personnel
- Activities approved by the license
- Training by authorized personnel
- Emergency procedure
- Operational procedures (leak tests, inspections, cordons, etc.)

5.5.3 Documentation

Endress+Hauser recommends that the documents are kept for as long as the device is your possession. The following are examples of records that have to be kept as part of the radiation protection program:

- Receipt of the source container
- Initial measurement of the radiation
- Results of the periodic leak test
- Periodic function check of the shutter
- User training
- Transportation or disposal of radioactive material
- Annual audits of the radiation protection program

Records must be retained over certain time periods. It is the responsibility of the Licensee to obtain information on the retention periods prescribed in the regulations.

5.5.4 Markings and notices

The following requirements apply to markings and notices

Nameplates must be attached to each source container.

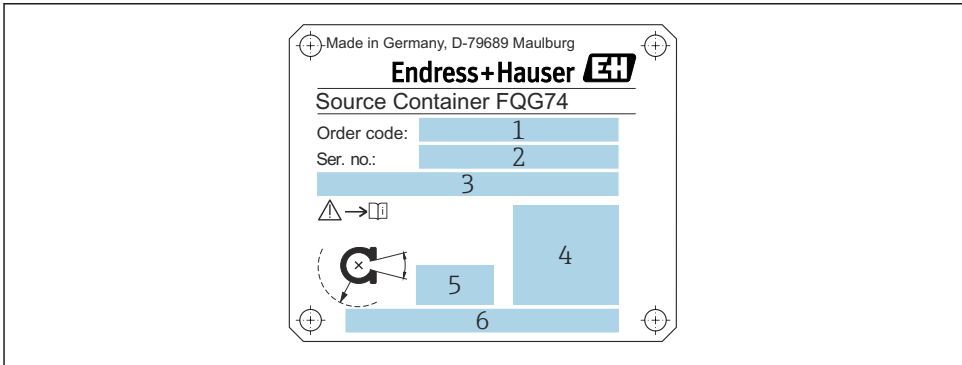
- The following information must be applied on the nameplates:
 - Type and activity of radioactive material
 - Test date of radiation source
 - Radiation symbol defined by law
- Endress+Hauser affixes an approved sign to the source container before shipment. It is the responsibility of the Licensee to keep the signs in good condition. The readability of the signs is an important aspect during inspections. The obligations to tender are defined in 10 CFR 20.1902 and each sign is expressly defined.
- The NRC-3 "Notice to Employees" form or the corresponding form of the Agreement State must be displayed.

The notice must be clearly visible to employees and clearly visible during regular working activities with measuring instruments.

5.5.5 Nameplates

The nameplates are located on the side of the shutter.

Device nameplate



A0061685

5 Labeling of the device nameplate

- 1 Order code of the source container
- 2 Serial number of source container
- 3 Degree of protection
- 4 2-D matrix code (QR code)
- 5 Beam exit angle
- 6 Local dose rate at a defined distance from the surface (when switched off, outside the path of the beam)

Radiation source nameplate

○

Gamma Source

Radionuclide: 1



Caution Radioactive Material!

3

○

Pos.	Ser. No	Activity	Date	Length	TAG
4	5	6	7	8	9

○

○

A0056109

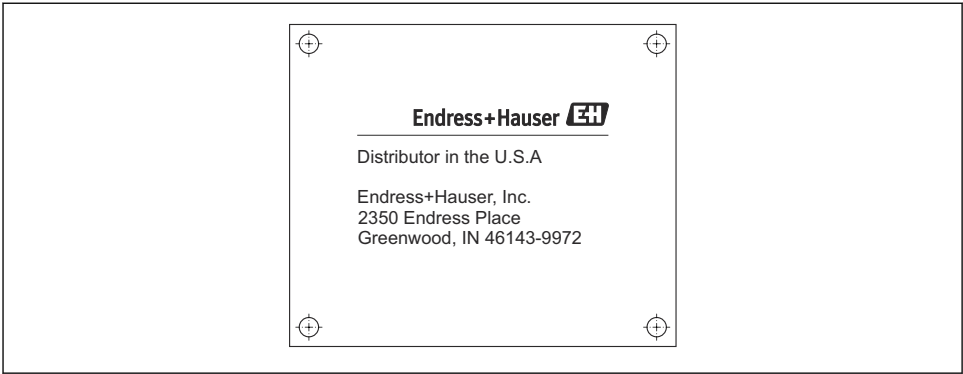
6 Marking of the nameplate for the radiation sources

- 1 Designation of the isotope
- 2 NOTICE: "Highly radioactive source", if required
- 3 2-D matrix code
- 4 Item number of radiation source
- 5 Serial number of the radiation source
- 6 Activity of radiation source with unit (MBq or GBq)
- 7 Date of manufacture of radiation source
- 8 LN, nominal length of the flexible source holder extension
- 9 Measuring point name/tag number

Supplementary nameplate

Supplementary nameplates are country-specific. The following nameplates are mandatory in the listed countries.

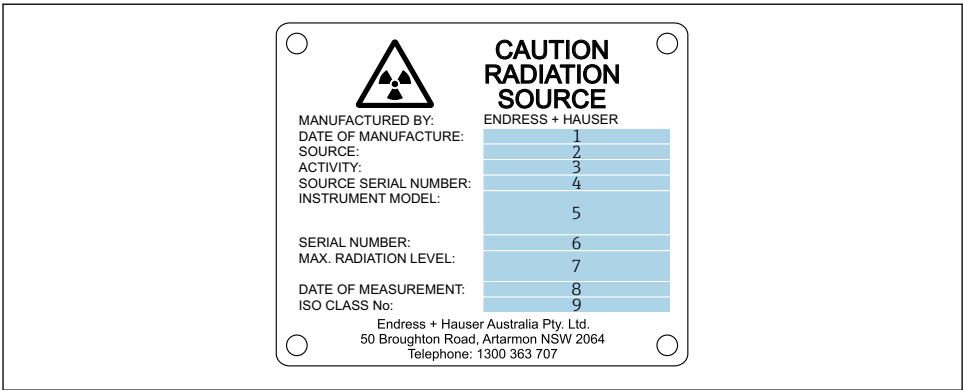
USA



A0027291

 7 *Supplementary nameplate for the USA*

Australia



A0062651

 8 *Supplementary nameplate for Australia*

- 1 *Date of manufacture of radiation source*
- 2 *Designation of the nuclide*
- 3 *Activity including unit (MBq or GBq)*
- 4 *Serial number of radiation source (according to supplier certificate)*
- 5 *Order code of the FQG*
- 6 *Serial number of the FQG*
- 7 *Dose rate at the surface and at a distance of 1 m (3.3 ft)*
- 8 *Test date of the source container*
- 9 *Radiation source material class*

5.5.6 Disposal or recycling

The disposal of radioactive materials is regulated by the provisions of 10 CFR 20.2001 or the compatible regulations of the Agreement States.

After the useful lifetime, the source container is disposed of or recycled. Contact an approved Licensee for transport, disposal or recycling.

Generally and specially licensed material must be given to an authorized Licensee for storage or disposal.

5.5.7 Notifying the competent authority

The regulations stipulate that certain incidents must be reported to the authority within defined periods, which may range from an immediate oral notification to a written notification within 30 days.

Reportable incidents are stipulated in regulations and include radiation exposure, exceeding limit values, contamination, loss or theft of a radiation source, etc.

In the event of uncertainty, contact Endress+Hauser Service for support.

6 Standard routine procedures

This section deals with the procedures for routine work on or with devices that contain radioactive material.

The permissible uses for devices with general approval and devices with a specific approval are not identical.

It is the responsibility of the Licensee to familiarize themselves with and understand the activities that they are authorized to perform.



The following sections (and others) are described in detail in the **Operating Instructions BA02609F**:

"Installing the source container"

"Removing the source container from the measuring point"

"Switching on the radiation"

"Switching off the radiation"



Further and more detailed information:

Operating Instructions BA02609F

Technical Information TI01798F

6.1 Delivery of source container

Once a source container from Endress+Hauser is received, use the following list to check whether the source container is in perfect condition.

1. Check the source container for damage.
2. Make sure that the shutter is closed and secured with a lock.

3. Check that the delivery is complete and nothing is missing.
4. If the source container is not to be mounted immediately, the packing unit must be stored in a separate and safe location.
5. Monitor access to the source container.
6. Keep all original documents.
7. If there are any doubts about the condition of the source container, carry out a local dose rate measurement and/or wipe test.

A certain amount of residual radiation can always be measured in the direct vicinity of the source container even if the source container is in a perfect condition.

Compare measured values in the shipping documents with the measured values around the packing unit to determine whether damage or changes to the contents have occurred.

6.2 Mounting the source container



Mounting requires qualified installation and service personnel. See the "Requirements for personnel" section

NOTICE

Installation instructions

- Only vertical flange mounting is permitted. The source container is installed vertically on the product vessel via the connecting flange.

6.2.1 Checklist

- Installation must always be carried out in accordance with local legislation or the handling permit. All local conditions must be taken into consideration.
- Installation and removal are only permitted in the "AUS/OFF" switch position. The switch position is secured by the cover of the shutter and lock.
- Use a load-bearing structure for installing the source container.
- Observe the weight and center of gravity of the source container: 780 kg (1 720 lb)
- Use lifting points and suitable lifting equipment.
- The device must be installed on the flange; other types of installation are not permitted.
- Install the source container vertically only.
- Optimum fire resistance is only guaranteed in the vertical position.
- Use in non-stationary plants is not permitted.
- Ensure that the process temperature is not transferred to the source container.
- Providing the protection pipe is the responsibility of the operator.



Temperature range during mounting or removal: -40 to +120 °C (-40 to +248 °F)

6.3 Commissioning



Commissioning requires qualified operating, installation and service personnel. See the "Requirements for personnel" section

Any change of location of the source container is considered a new installation that requires a new commissioning.

The alignment of the source container and detector must not be interrupted or modified during commissioning.

Commissioning is the process of making the mounted source container ready for operation and consists of the following prescribed steps:

- Measuring the local dose rate before commissioning
- Wipe test
- Measuring the local dose rate after commissioning
- Function test of shutter

A calibrated measuring instrument for ionizing radiation must be used during the entire process.

6.3.1 Measuring the local dose rate

- Use a calibrated and functional measuring instrument for ionizing radiation.
- Measure and record the local dose rate in all directions around the source container and detector to identify an abnormal radiation pattern
- Measure with an open and closed shutter (position of the shutter "EIN/ON" and "AUS/OFF").
- Perform a wipe test if the local dose rate complies with Endress+Hauser specifications.
- If the local dose rate is greater than 50 $\mu\text{Sv/h}$ (5 mrem/h) at a distance of 30 cm (12 in) from the mounted source container:
 - Special notice signs or access restrictions for the area may be required (10 CFR 20.1902)
 - Clarify with the manufacturer whether this condition is typical for the type and activity of the radiation source and for the source container.
 - Estimate the radiation doses that can be obtained by personnel. Based on the working requirements in the vicinity of the mounted source container.

Personnel can be classified into two groups, which each have different radiation dose limit values:

- The general public can receive up to 20 $\mu\text{Sv/h}$ (2 mrem/h) and 1 000 $\mu\text{Sv/a}$ (100 mrem/a). This includes all persons who are not specially trained and classified as non-occupationally exposed to radiation. They are usually persons who do not work near source containers.
- Maximum effective dose/year for occupationally exposed persons: 50 000 $\mu\text{Sv/a}$ (5 000 mrem/a)
 - No specific dose limit is set. This group of people has received appropriate training for working with source containers or in close proximity to them.

Additional shields may be required to prevent personnel from entering the gamma radiation danger zone. Or to minimize the radiation dose in certain areas.

Inform personnel about the presence of radioactive materials. Publish necessary precautions to minimize radiation exposure. Train personnel.

If the local dose rate on the detector side of the tank is above 20 $\mu\text{Sv/h}$ (2 mrem/h), shields or barriers may need to be mounted.

6.3.2 Function test of shutter

The purpose of this test is to check whether the shutter is fully functional and easy to operate. Check whether the display matches the position of the shutter.

6.3.3 Radiation in or in the vicinity of product vessels

Written lock-out (cordonning off) and tag-out (labeling) procedures must be formulated and implemented for source containers.

Cordonning off and marking areas prevents people from entering the danger zone of the gamma radiation. Examples of hazardous areas: interiors of product containers, areas between source containers and tank walls.

Some of these areas are considered as confined spaces by "Occupational Safety and Health Administration" (OSHA), except for radiation measurements, for documentation of cordonning off (lock-out) of confined spaces in accordance with OSHA regulations.

When the source containers are mounted, ensure that the distance between the source container and the tank is selected so that no part of the body can enter the danger zone of gamma radiation. If access is possible, this area must be locked or limited for access and labeled.

The following steps must be completed before entering a tank or container:

- Make sure the shutter of the source container is in the "OFF position" (closed) and secured with a lock.
- The person responsible for accessing the tank must monitor people entering
- Verify the closed shutter with a calibrated beam measuring device or the detector display. The radiation measured by the detector should typically be close to the background radiation.

After completing the work, make sure that no one is in the container and the entrance door is closed.

Only now may the radiation be switched back on by bringing the shutter into the "ON position" (open).

6.4 Removing the source container

CAUTION

All maintenance work, such as removing and replacing the source container, may only be performed by authorized personnel monitored in relation to radiation exposure.

Personnel must be specially trained in radiation protection processes in accordance with local regulations or relevant approval.

- ▶ Ensure that the content of the handling approval is valid
- ▶ Observe the local conditions
- ▶ All work must be performed from a safe (shielded!) location
- ▶ Take safety precautions to protect personnel from risks
- ▶ The source container may only be removed in the "AUS/OFF" position (shutter closed)
- ▶ Make sure that the "AUS/OFF" position of the shutter is secured with a lock (see Operating Instructions BA02609F)

The following steps must be carried out before removing the source container:

- Make sure that the source container is in good condition.
- Highly corroded source containers may require special handling and shipping regulations.
- Set the shutter of the source container into the "OFF position" (closed) and secure with a lock.

- Close the hood and secure with a lock.
- Provide sufficient personnel and equipment for removing the source container.
- Properly train the personnel in accordance with their tasks
- Observe the weight and center of gravity of the source container: 780 kg (1 720 lb)
- Measure the local dose rate with a calibrated radiation meter to determine the radiation values around the source container. The measured values should approximately match the previously measured local dose rate (before start up).
- A current wipe test on the source container is required. The wipe test certificate currently valid is also required in order to transport it to another location or to put it into storage.
- The removal of the source container must be supervised by a person who has been approved for this purpose.

6.4.1 Procedure at the end of the application

Internal measures

- The radiation must be switched off immediately after the application. To do so, close the shutter on the source container.
- Remove the source container from the measuring point in compliance with all applicable regulations and place it in a lockable room without through-traffic.
- The responsible authorities must be informed of these measures.
- The access to the storage room must be logged and signed.
- The radiation safety officer is responsible for protecting against theft.
- The radiation sources located in the source container must not be scrapped with other parts of the plant.
- Returns should be made as soon as possible.

6.4.2 Return

Please contact your local Endress+Hauser representative to support you if necessary regarding the disposal possibilities.

It is not possible to make returns to Endress+Hauser from the United States.

6.5 Recurrent tests

Recurrent tests depend on the type of use. In addition to being used as a source container, the container can also be used as a Type A package. Use as a Type A package requires specific tests. Recurrent tests and tests for use as a Type A package must be documented according to the test instructions.

Tests must be carried out by a qualified, technically competent person. The results of the recurrent tests must be documented in a container-specific test log.



- The user is responsible for maintaining a test log for documenting recurrent tests.
- A template for recurrent tests is provided below.
- A template for a test log is provided below.

6.5.1 Test intervals



- Observe national requirements as well as documentation requirements

Test situation	Interval	Test for
Before transport	Always	Condition of lifting points
After transport	Always	Condition of lifting points
In the process	Annually	Integrity Functional test
During storage in "loaded" condition*	Every five years	Integrity Safety
Before dispatch in "loaded" condition*	Always	Integrity Safety Compliance with all regulations
Before dispatch in "empty" condition**	Always	Integrity Functional test
Before loading	Always	Integrity Functional test

* There are radiation sources in the source container

** The source container is not contaminated

- 
- The time between dispatch and testing must not exceed six months.
 - The time between leak testing and dispatch must not exceed three months.
 - Use of a loaded source container in the process corresponds to storage in loaded condition from the point of view of transport, i.e. use as a Type A package.

6.5.2 Integrity tests

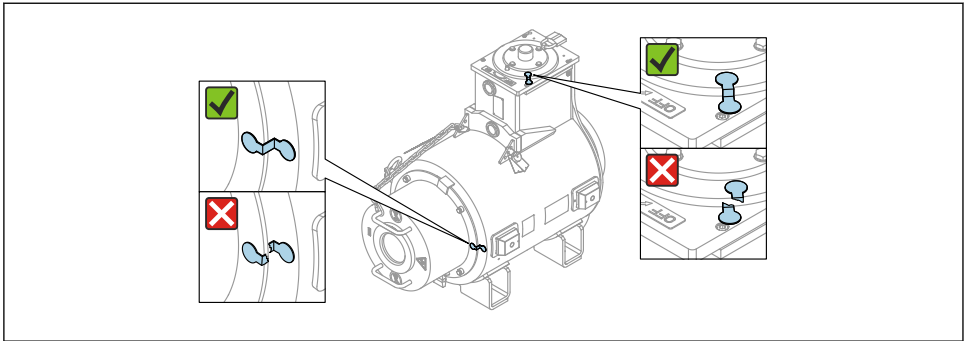
The following components are inspected: housing, cover, source magazine, source holder, shutter lid, transport lock, theft protection device, labeling, lifting points and seals.

Internal housing components and internal shielding cannot be directly inspected.

It is assumed that damage, e.g. due to corrosion, will already be clearly visible on externally accessible parts.

- 
- Observe national requirements as well as documentation requirements

After transport

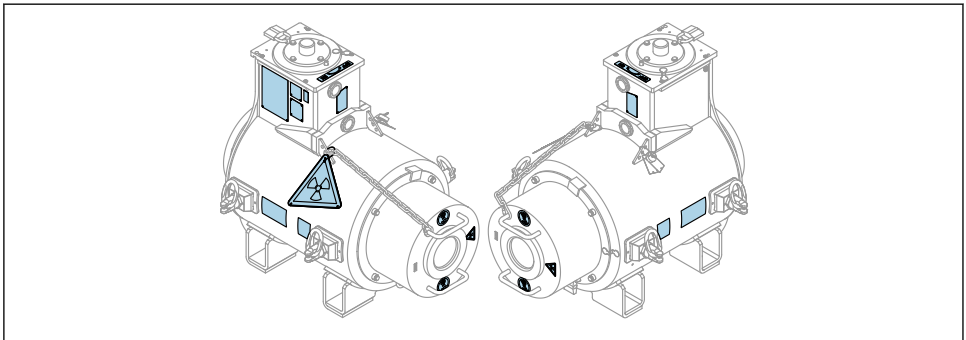


A0056171

9 Security seals on the source container

1. Check whether security seals are present.
2. Check that the security seal does not show signs of damage or cracks.

General



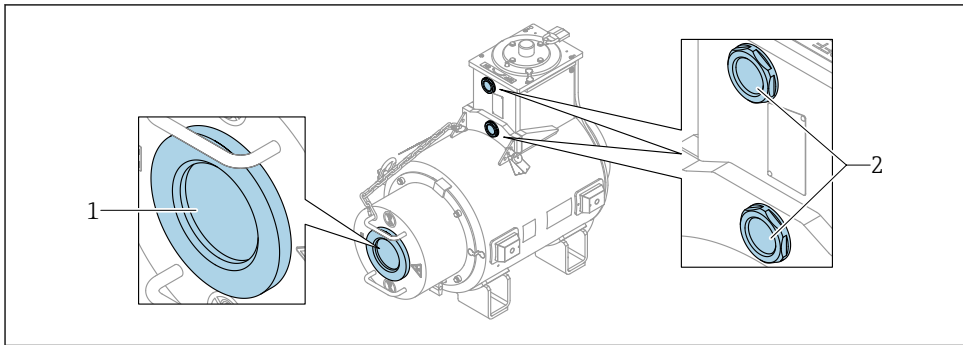
A0056842

10 Position of metal signs and stick-on labels

- For the position of the nameplates, see the "Product description -> Overview" section.
 - For an explanation of how to interpret the nameplates, see the "Incoming acceptance and product identification -> Product identification -> Nameplate" section.
1. Identify and document the source container and radiation sources based on the nameplates.
 2. Ensure that the correct markings are attached.
 3. Check that nameplates and warning signs are firmly attached and easy to read.

4. Check that the source container and the cover are externally sound.
5. Check that the source container shows no signs of significant corrosion that could compromise safe keeping of the radiation sources.
6. Check that the cover shows no signs of significant corrosion.
7. Check that the source container and cover show no signs of damage caused by fire, falls or collisions.
8. Check that the weld seams are intact.
9. Check that the shutter position is easy to read in the "ON/AN" and "OFF/AUS" position.
 - ↳ See section "Product description -> Shutter".

Windows



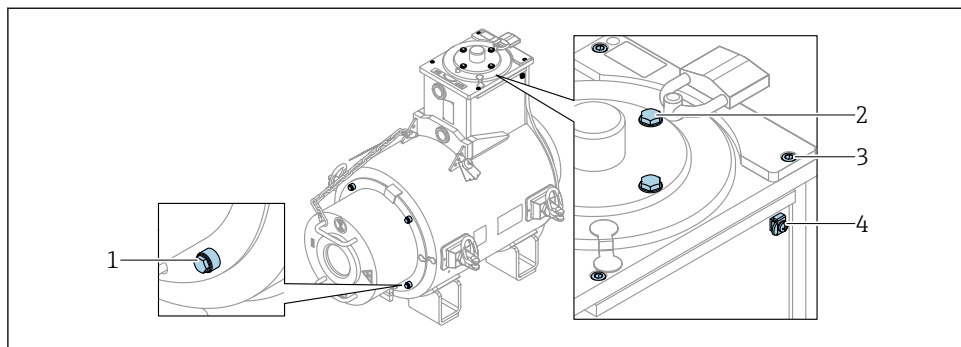
A0056838

 11 Position of the windows

- 1 Window on cover
- 2 Windows on shutter

1. Check that the cover window is transparent and not fouled.
2. Check that the windows for reading the shutter position are transparent and not fouled.

Threaded connections on the housing



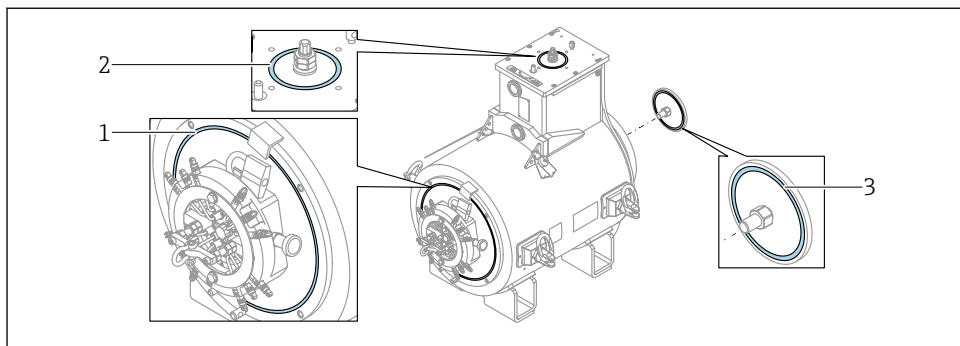
A0062230

12 Threaded connections on the housing

- 1 Screws for securing the cover
- 2 Screws of the anti-twist device cover
- 3 Screws of the shutter cover
- 4 Ground terminal

1. Check that all screws are present.
2. Check that all screws for securing the cover are securely tightened.
3. Check that all screws of the anti-twist device cover are firmly tightened.
4. Check that all screws of the shutter cover are firmly tightened.
5. If the ground terminal is being used, check that the ground cable is securely screwed into the ground terminal.

Seals



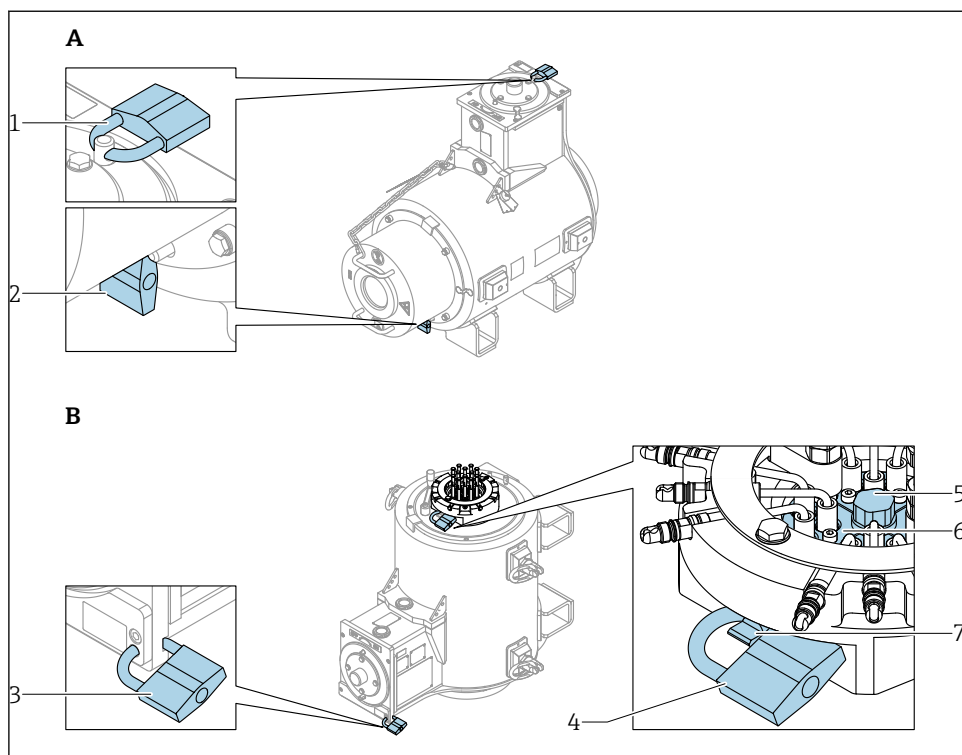
A0056857

13 Seals

- 1 Housing cover seal
- 2 Housing anti-twist device seal
- 3 Housing transport lock seal

1. Check whether the seals are mechanically damaged.
 - ↳ Exchange if necessary
2. Check whether the seals are worn.
 - ↳ Exchange if necessary

Theft protection



A00622B4

14 Anti-theft components

- 1 Anti-twist device lock when the shutter is in the "AUS/OFF" position
- 2 Cover lock when the shutter is in the "AUS/OFF" position
- 3 Anti-twist device lock in parking position when the shutter is in the "ON/AN" position
- 4 Cover lock in the parking position when the shutter is in the "ON/AN" position
- 5 Securing pin
- 6 Lock washers
- 7 Source security rod

1. Check that all components of the anti-theft device for preventing removal of the source holders are present, undamaged and in working order.
2. Check that the keys for the two locks are present.

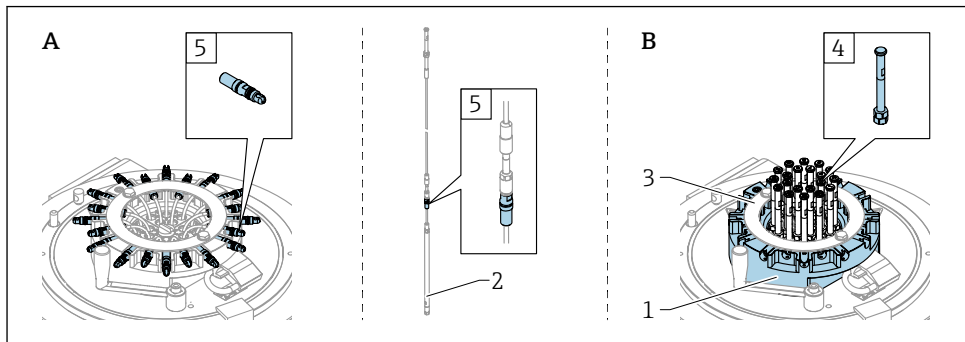
Source magazine and source holder

⚠ DANGER

Risk of injury from ionizing radiation!

Hazard for persons and the environment posed by ionizing radiation and contamination. Ionizing radiation and contamination can increase the risk of cancer and genetic birth defects. Depending on the dose, ionizing radiation can cause immediate physical harm such as nausea, vomiting, hair loss, changes in blood composition, and severe tissue damage that may lead to death.

- ▶ Never check the source holders directly.
- ▶ Carry out checks only on the rope separator and flexible source holder extension.



A0056598

15 Source magazine and source holder

- A Source holder in "OFF/AUS" position with retaining ring
- B Source holder in "ON/AN" position with retaining ring and mounted flexible source holder extensions
- 1 Source magazine
- 2 Source holder
- 3 Fixing ring
- 4 End of the flexible source holder extension
- 5 Rope separator

Checking the fixing ring

1. Check whether the fixing ring is securely installed.
2. Inspect the fixing ring for corrosion.
 - ↳ Visual inspection
3. Inspect the fixing ring for damage.
 - ↳ Visual inspection

Checking the source magazine

1. Check the source magazine for corrosion.
 - ↳ Visual inspection

2. Check the source magazine for damage.
 - ↳ Visual inspection

Checking the source holder indirectly for corrosion

The source holders are in the process:

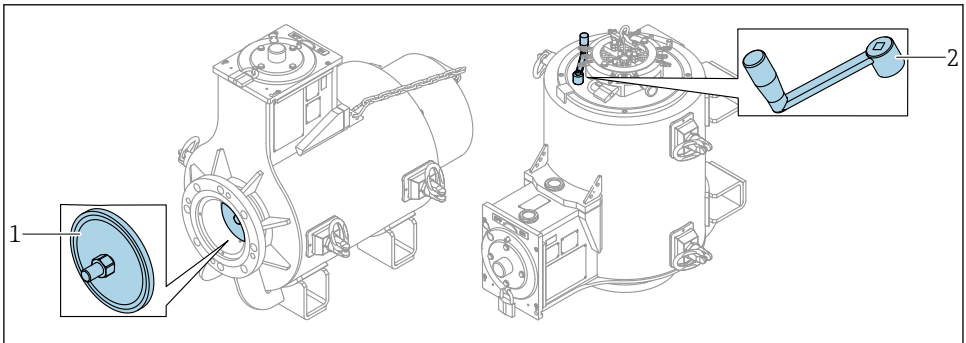
1. Check the end of the flexible source holder extensions for corrosion.
 - ↳ Visual inspection
2. Check the end of the flexible source holder extensions for damage.
 - ↳ Visual inspection
3. Perform a direct inspection as part of the leak test. See the section on "Leak testing"

Checking the source holder indirectly for corrosion

The source holders are in the source container:

1. Check the rope separators for corrosion.
 - ↳ Visual inspection
2. Check the rope separators for damage.
 - ↳ Visual inspection

Transport lock and crank



A0056877

- 1 Transport lock
- 2 Crank

1. Check that the transport lock is present.
2. Check that the crank for opening and closing the shutter is present.
 - ↳ After use, move the crank into parking position.
3. For storage, fasten the transport lock to the shutter.
4. During operation, reseal the exit opening with the transport lock or park the transport lock in the cover.

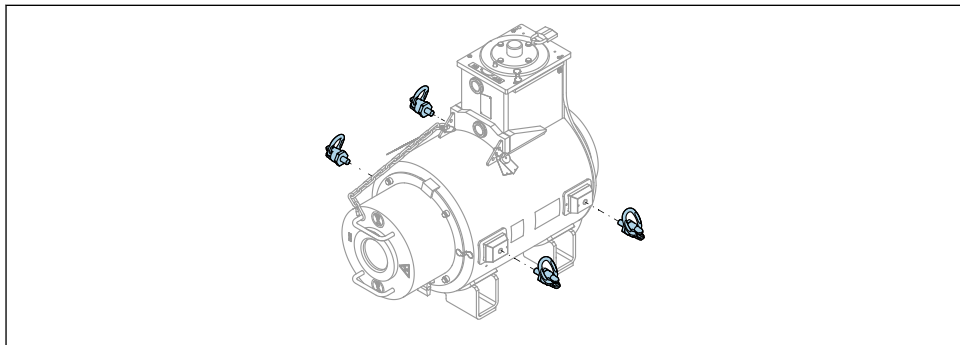
Checking the condition of the lifting points

⚠ WARNING

Lifting points corroded, leading to possible falling of the container.

This could result in personal injury or even death as a consequence of impact.

- In an aggressive environment, remove the lifting points and store them safely.
- Check the lifting points carefully before each use.



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 16 *Lifting points on the source container*

Lifting points are not permanently in use. For this reason, the lifting points must be checked before each use instead of annually as specified by the manufacturer.

1. Check the lifting points before **each** use in accordance with the manufacturer's specifications.
2. Observe the operating instructions for the lifting points.
↳ <https://www.rud.com> Enter PP-B-1,5t-M16 in the search bar.
3. Before the lifting points are fitted, clean away dirt from all four threads on the housing.

6.5.3 Functional tests

The test may only be performed when the source container is in an unloaded condition. There must be no radiation sources inside the source container. The inspection window in the cover allows verification of whether radiation sources are present in the source container.

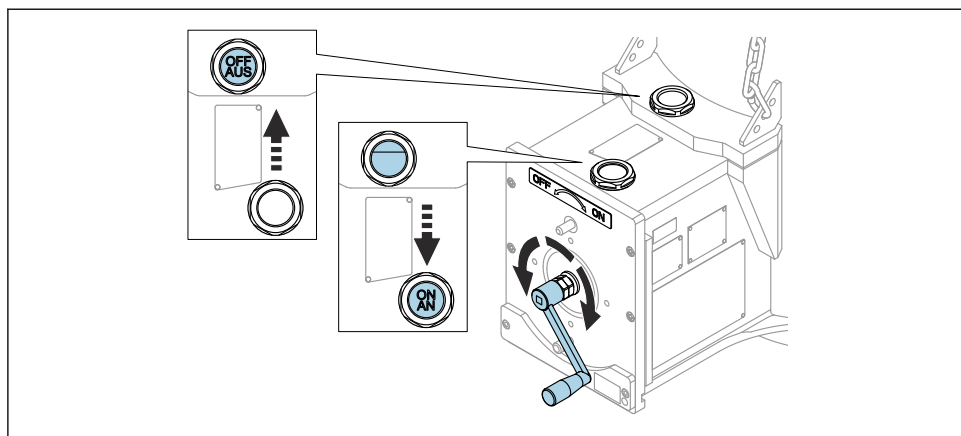
⚠ DANGER

Risk of injury from ionizing radiation.

Ionizing radiation could increase the risk of cancer and the risk of genetic birth defects.

Depending on the dose received, ionizing radiation could lead to immediate physical harm, such as nausea, vomiting, hair loss, changes to blood count, serious tissue damage and even death.

- Do **not** open the shutter if the radiation sources are in the source container.



A0062231

17 Checking the functional integrity of the shutter

Checking the functional integrity of the shutter

- Visually inspect through the inspection window in the cover to ensure that **no** radiation sources are inside the source container.

Close and reopen the shutter by turning the crank once.

- ↳ Ropes connected to the radiation sources in the protection pipe prevent complete closure.

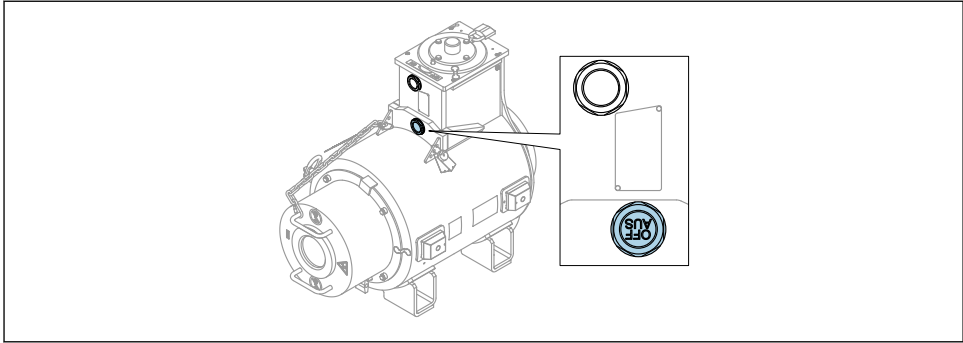
Checking the retrievability of the radiation sources (radiation sources are in process)

- Use a single source holder to check whether it can be pulled back into the source magazine.

Checking the retrievability of the radiation sources (before loading)

- Use a dummy rod to test whether the dummy rod can be moved smoothly in all source holder slots.

6.5.4 Checking the locking devices on the source container



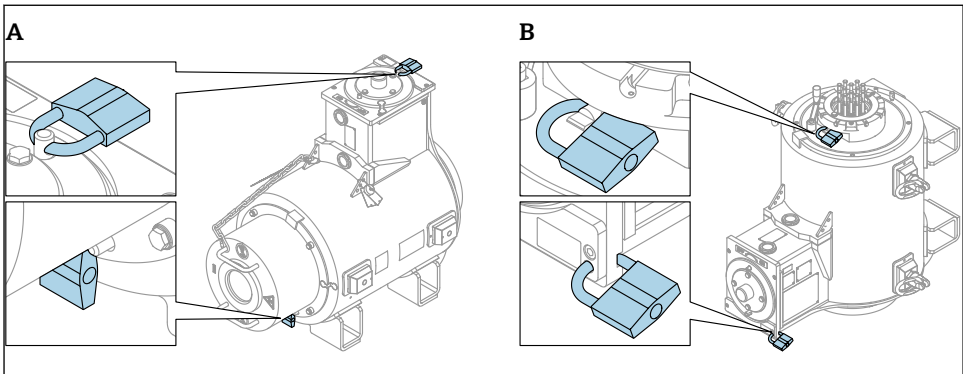
A0056878

18 Windows of the shutter

Check that the shutter is closed

Through the windows, it is possible to see the condition of the shutter

1. Check that the windows are transparent and not fouled.
2. Check that the "OFF/AUS" position is visible in the window.
 - ↳ The shutter is closed when the "OFF/AUS" position is visible.



A0062267

19 Locks

- A Position of the locks in the "OFF/AUS" position
 B Position of the locks in the "ON/AN" position

Check that the two locks are fitted and closed

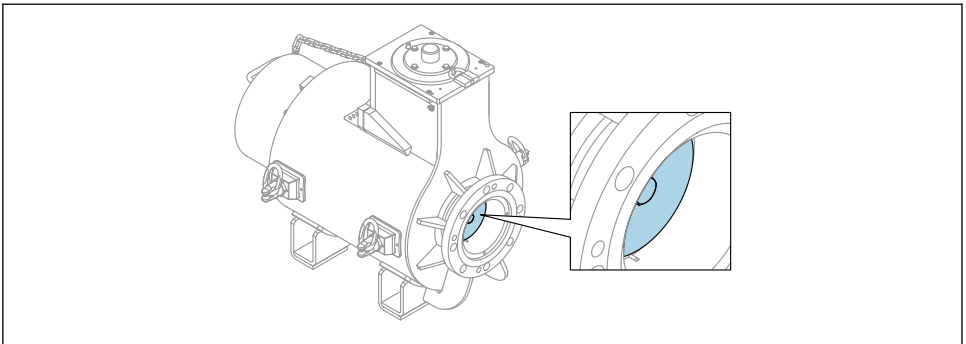
The two locks are repositioned depending on the position of the shutter.

1. Shutter in the "OFF/AUS" position:

- ↳ Check if the lock is attached to the cover.
Check if the lock is attached to the anti-twist device.

2. Shutter in the "ON/AN" position:

- ↳ Check if the cover lock is attached in the parking position (for theft protection).
Check if the anti-twist device lock is attached in the parking position (twist protection).



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20 Transport lock**Check that the transport lock is fitted and firmly fastened**

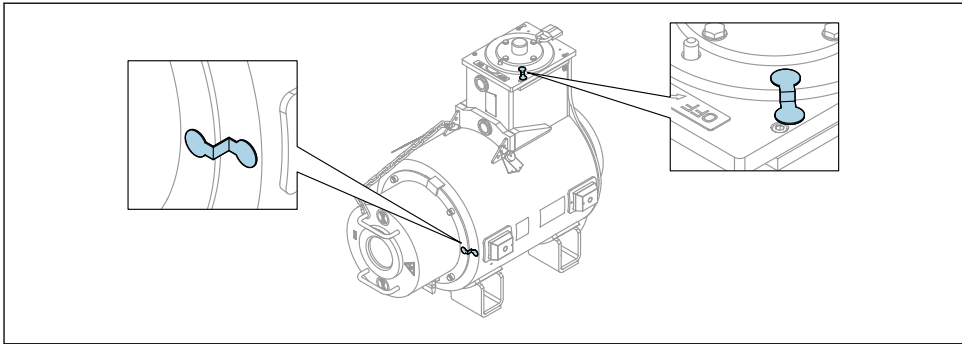
1. Fit the transport lock for storage and transport.
2. Fit the transport lock with the source magazine lowered.



Carry out a documented leak test, see the "Maintenance -> Maintenance tasks -> Leak test" section.

6.5.5 Checks for compliance with all regulations (for dispatch)

It is prohibited to dispatch the source container without valid and complete documents.



A0056839

 21 *Security seals on the source container*

Dispatch as Type A package:

1. Make sure that the source container is in the OFF position and the transport lock is fitted.
2. Make sure that the transport index is present and the category is correctly marked for the radiation source concerned.
3. Make sure that the source container is marked in accordance with international regulations concerning the transport of dangerous goods (ADR/RID, DGR/IATA).
4. Before dispatch, fit a security seal to the cover and anti-twist device.

6.5.6 Template for recurrent tests

Company	
Name	
Address	
Name of inspector and role	

Source container	FQG _- _____
------------------	--------------

Radiation source	
Isotope	☐ ¹³⁷ Cs ☐ ⁶⁰ Co
Serial number of the radiation source	
Nominal activity (MBq / GBq)	
Date of manufacture	

- A: ☐ After transport
- B: ☐ In process ☐ Before loading
- C: ☐ Before shipment ("empty")
- D: ☐ During storage ("loaded")
- E: ☐ Before shipment ("loaded")

A	B	C	D	E	Tests		
x				x	Seals are present and not broken.		
x	x	x	x	x	Markings are correct and clearly legible.		
x	x	x	x	x	There is no significant corrosion on the source container that could compromise the safe storage of the radiation source(s).		
x	x	x	x	x	There are no damages caused by fire, falls or collisions.		
x	x	x	x	x	The weld seams are intact.		
x	x	x	x	x	Inspection windows are clear, and the shutter position (ON or OFF) is clearly visible.		
x	x	x	x	x	Screw connections on the source container are secure, and all screws are present.		
x	x	x	x	x	Seals are in good condition and sealing surfaces are free from dirt.		
x	x	x	x	x	All components of the theft protection devices are present and functional.		

A	B	C	D	E	Tests		
x	x	x	x	x	Source magazine and source holder are free of corrosion.		
x	x	x	x	x	Fixing ring and securing plates are present and securely installed.		
x	x	x	x	x	transportation lock and shutter crank are present.		
	x	x			The shutter can be opened and closed with one crank rotation.		
	x	x			Source holder can be retracted into the source magazine.		
		x	x	x	The shutter is closed (in OFF position).		
		x	x	x	All locks are fitted and closed.		
		x	x	x	The transportation lock is securely screwed into the shutter.		
			x	x	Leak test has been carried out: The source container is sealed.		
				x	The leak testing report is no older than 3 months old and is included with the delivery documentation.		
				x	The transport index is available.		
				x	The source container is labeled according to international regulations concerning the transportation of hazardous materials (ADR/RID, DGR/IATA).		

Date

Signature

6.5.7 **Template for the creation of a logbook**

The following information should be stated on the cover sheet:

Logbook for a transport container	
Source container type	
Plant operator, user	
Identification number (nameplate)	
Date of acceptance certificate (initial check before commissioning)	
Manufacturer's details	

The following information should be stated inside the logbook:

- Certificate of suitability
- Acceptance certificate (check before commissioning)
- Handling instructions
- Technical data sheet
- Record of exchanged parts
- Logs of recurrent checks
- Records of miscellaneous incidents

6.6 Maintenance tasks

6.6.1 Overview of maintenance tasks



Risk of injury from ionizing radiation.

Ionizing radiation could increase the risk of cancer and the risk of genetic birth defects. Depending on the dose received, ionizing radiation could lead to immediate physical harm, such as nausea, vomiting, hair loss, changes to blood count, serious tissue damage and even death.

- ▶ Do **not** open the shutter if the radiation sources are in the source container.

Source container

1. Check source container for cracks, damage and severe corrosion.
 - ↳ - If cracks, damage, or severe corrosion are found, replace the source container.
 - Contact the manufacturer.
 - Do not use as Type A packaging.
2. Before mounting the lifting points, clean all four threads on the housing from contaminants.
3. Retighten the screws of the shutter cover, anti-twist device and housing cover fastening if necessary.

Cover

1. Check the cover for cracks and damage.
 - ↳ If cracks or damage are found, replace the cover.
 - Do not use as Type A packaging.
2. Check the cover for severe corrosion.
 - ↳ If severe corrosion is found, replace the cover.
 - Do not use as Type A packaging.

Inspection windows

Clean the inspection windows.

1. Clean the windows for indicating the shutter position using a wet or dry cloth. Replace if necessary.

2. Use a damp or dry cloth to clean the inspection window in the cover. Replace if necessary.

Source magazine and source holder

1. Check the source magazine for corrosion.
 - ↳ Do not load if corrosion is present.
Contact the manufacturer.
2. Check the source holder for corrosion.
 - ↳ Do not load if corrosion is present.
Contact the manufacturer.

If source holders cannot be retrieved or are corroded:

1. Initiate emergency measures.
2. Immediately inform the radiation safety officer.
3. Lower the source holder back into the process.
4. Contact the manufacturer.

Shutter

Shutter cannot be moved:

1. Immediately inform the radiation safety officer.
2. Inform the manufacturer.
3. Keep the radiation sources in the process.

Transport lock

Transport lock missing or defective:

1. Do not ship the source container.
2. The source container must not be used as a Type A package without a transport lock.
3. Order the transport lock as a spare part.

Theft protection

1. Check the lock for correct function and ease of movement.
 - ↳ If malfunctioning or difficult to operate, replace the lock (use the same type).
2. Check the lock for corrosion.
 - ↳ If there is excessive corrosion, replace the lock (use the same type).
3. Inspect all components of the anti-theft device for corrosion, damage, and completeness.
 - ↳ Order corroded, missing, or damaged parts as spare parts.

Labeling

- ▶ Check signs for legibility.
 - ↳ Replace signs promptly if they are no longer clearly visible.

Lifting points

1. In aggressive environments, dismantle the lifting points and store them appropriately.
2. Check the lifting points for corrosion, wear, damage, and completeness.
 - ↳ Replace corroded, worn or damaged lifting points.
If any parts are missing or damaged, order them as spare parts.

Seals

1. The "Shutter channel seal" is an adhesive seal. During maintenance of the shutter, the seal must always be replaced. Contact the manufacturer.
2. Replace the seals "housing anti-twist device seal", "housing transport lock seal" and "housing cover seal" as necessary, see section "Repair -> Spare parts".

Flange screws and nuts

1. Check all flange screws and nuts for damage.
2. Check the tightening torque and, if necessary, retighten to the specified torque.
3. Tightening torque 342 Nm.

6.6.2 Leak test

 The leak test requires instructed personnel. The radiation safety officer is responsible for compliance with all regulations and for how it is carried out.

See the "Requirements for personnel" section.

Check the leak-tightness of the source capsules at regular intervals. The frequency of the leak tests must correspond to the intervals specified by the authorities or handling permit.

WARNING

Risk of serious bodily harm if leak test not carried out.

A leak test is not only required as part of routine checks but must also be performed whenever an incident occurs that may impair the casing around the radiation source. In such cases, the leak test must be arranged by the responsible radiation safety officer, with due consideration to the applicable regulations. The leak test must comprise both the source container and all other affected parts of the process vessel and must be performed as soon as possible after the incident. The leak test procedure described below is intended for the following situations:

- ▶ For routine tests during continuous operation
- ▶ When the source container has been in storage for an extended period
- ▶ When the source container is to be put back into operation after storage
- ▶ If the source container is to be used as a Type A package

General information on leak testing

The process concept is to remove and analyze any loose radioactive material outside the unit.

- All the source capsules supplied by Endress+Hauser are double-walled and tightly welded. The stainless steel capsule for the source capsule encloses the radiation source safely.
- The possibility of the source capsule having a leak is very low.
- The source capsule is securely enclosed in a container filled with lead to safely shield the gamma radiation.
- Due to the design of the source container, the probability of external contamination is very low even if the source capsule fails (leakage).
- The leak test requires instructed personnel. The radiation safety officer is responsible for compliance with all regulations and for how it is carried out.
- Only persons or organizations authorized by the responsible authorities are allowed to perform the analysis.
- A leak test is carried out to determine if the source capsule has leaked. In the event of a leak, radioactive material can escape from the source capsule. The radioactive material is picked up by wiping it with a suitable wipe test material and is detected during analysis.
- Leak test devices are available for every type of source container. Make sure that the leak test equipment suitable for the source container is used.
- Wipe test kits must be used according to the manufacturer's instructions. Records of the test results must be stored.
- Have the wipe samples analyzed by an authorized organization

Leak tests are performed by persons or organizations authorized by the responsible authority.

These individuals or organizations provide leak test services, or use leak test equipment provided by providers authorized by the relevant authority.

Wipe test kits must be used according to the manufacturer's instructions. Records of the test results must be stored. The method of leak testing can vary from provider to provider. Follow the instructions for the corresponding leak test kit.

Do NOT clean the source container before taking the sample.

Wiping the outer surfaces is sufficient; the source container must not be disassembled for this purpose.

The leak test can be performed with the shutter open ("EIN/ON") or closed ("AUS/OFF").

With the shutter open ("EIN/ON" position), make sure that no body parts come into the danger zone of the gamma radiation.

When carrying out a leak test with an approved shipping set, detailed instructions should be provided with illustrations, with regard to shipping wipe samples.

When performing a leak test with a NON-approved shipping set, please contact Endress +Hauser for further instructions.



Authorities responsible for the United States: United States Nuclear Regulatory Commission (NRC) or the corresponding Agreement States.

Leak test procedure

⚠ WARNING

Be aware of the risk of possible contamination

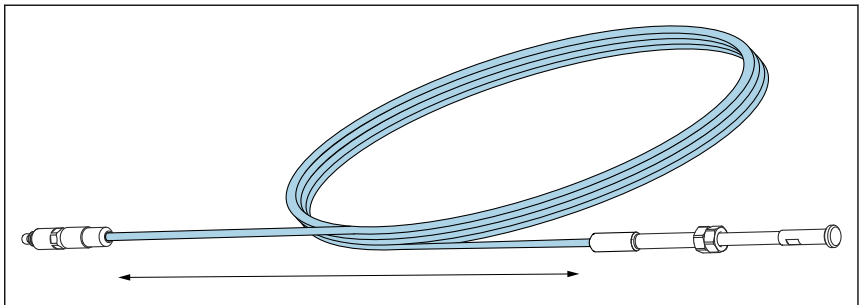
- ▶ Use appropriate personal protective equipment
- ▶ Follow safety measures when putting away the flexible source holder extensions

Leak tests must be performed by a person or an organization authorized to provide leak test services, or using a wipe test kit. Wipe test kits must be used according to the manufacturer's instructions. Records of the test results must be stored.

Perform the following leak test procedure unless otherwise instructed:

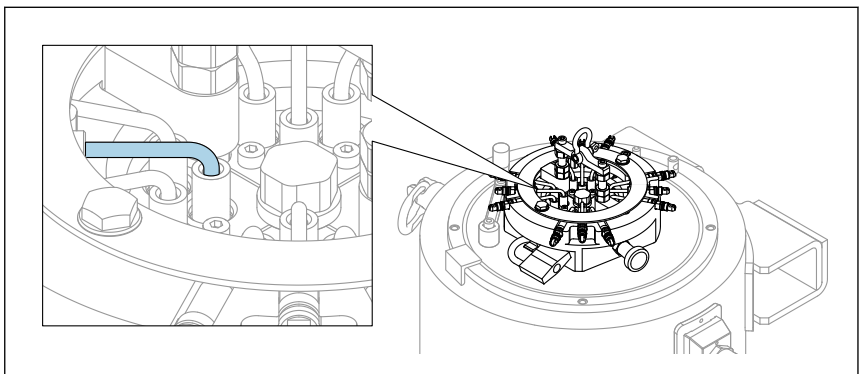
Source container is in the "Radiation switched on" state

1. Switch off the radiation (see the "Switching off the radiation" section)
2. When pulling back the flexible source holder extensions, wipe each rope along its entire length with suitable wipe test material



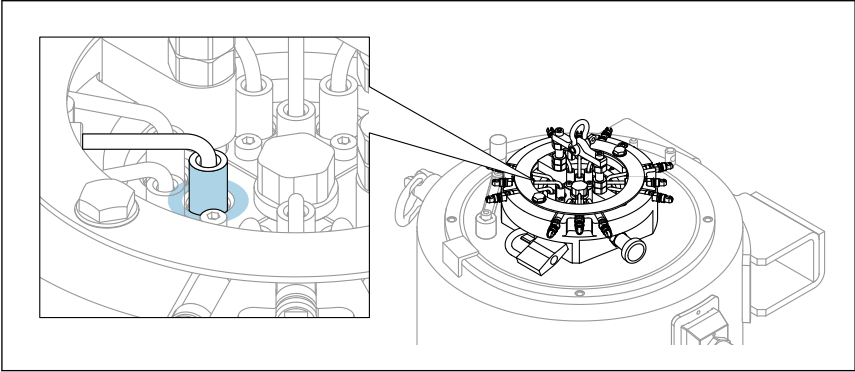
A0056014

3. When the "Switch off radiation" process is complete (cover not fitted), wipe the end of each source holder with suitable wipe test material



A0056015

4. Wipe around the insertion points of each source holder



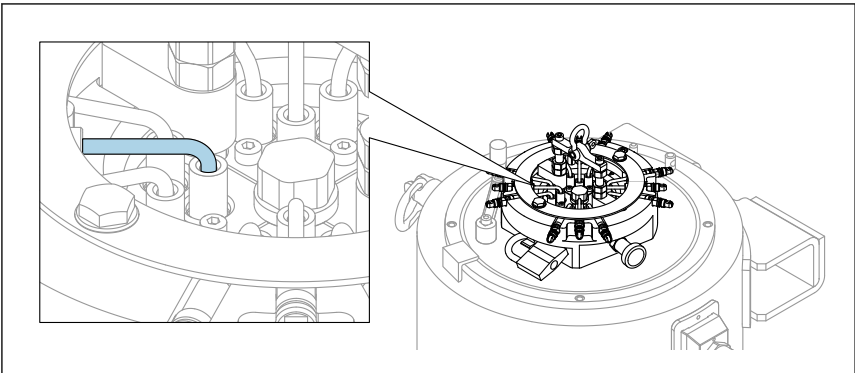
A0056016

5. Have the wipe samples analyzed by an authorized organization. A source capsule is considered to be leaking if more than 185 Bq (5 nCi) is detected in the leak test sample.

Source container is in the "Radiation switched off" state

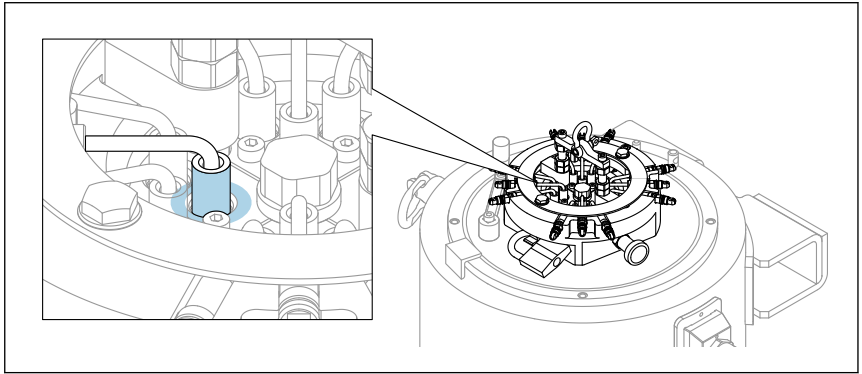
1. Remove the cover

2. Wipe the end of each source holder with suitable wipe test material



A0056015

3. Wipe around the insertion points of each source holder



A0056016

4. Have the wipe samples analyzed by an authorized organization. A source capsule is considered to be leaking if more than 185 Bq (5 nCi) is detected in the leak test sample.

- ↳ This limit value applies to the USA. National regulations may specify other limit values.

WARNING

The radiation source capsule is potentially leaking

- ▶ Inform the radiation safety officer immediately and follow his instructions.
- ▶ Take appropriate measures to prevent a potential spread of radioactive contamination from the radiation source. Secure the radiation source.
- ▶ Inform the responsible authority immediately that a leaking radiation source has been detected.
- ▶ Observe national requirements

6.6.3 Cleaning

DANGER

Risk of injury from ionizing radiation!

Ionizing radiation can increase the risk of cancer and genetic defects in offspring. Depending on the radiation dose, ionizing radiation can cause immediate physical harm such as nausea, vomiting, hair loss, changes in blood composition, and severe tissue damage that may lead to death.

- ▶ Follow all safety instructions during cleaning; see section "Basic safety instructions".

Measures: Clean the source container at regular intervals.

1. Clean the source container of any substances that impair its safety function.
2. Remove dirt, especially from sealing surfaces.
3. Keep labeling in legible condition.
4. Clean labels with a damp cloth.

6.6.4 Paintwork



A coat of paint is usually not required on the source container.

However, under certain environmental conditions it can be advisable to paint the source container.

- Rust or surface corrosion problems can be avoided by painting.
- Even without painting, the source container must be kept in a reliable and usable condition.
- Before painting, clean and degrease the source container.
- There is no specified color for the source container. However, a highly visible color can help to identify a source container more easily.
- Labels or position displays of the source container must not be painted over.
If necessary, the stickers can be removed before painting, reordered by Endress+Hauser Service and then refitted in the correct position.

6.6.5 Measures in case of corrosion

If there are clear signs of corrosion at the source container, the local dose rate around the device must be measured. If the value is significantly above the normal operation levels, cordon off the area and notify the radiation safety officer responsible.



What to do if the source container is damaged

- ▶ Corroded source containers must be replaced immediately.
- ▶ Replace damaged padlock.

6.7 Unplanned maintenance work

NOTICE

Unscheduled repair or maintenance work must only be carried out by the following:

- ▶ Source container manufacturer or distributor.
- ▶ Authorized representative.
- ▶ The required authority will be issued by the NRC or by an Agreement State.

Examples of unplanned maintenance work:

- Welding for changing the mounting device of the source container.
- Move the source container.
- Replace mounting brackets, screws or other mounting elements (in the case of advanced corrosion of these parts, a replacement is required).

Specific license approvals can be granted when carrying out some of these activities with appropriate training and official approval.

Changes that modify the functional design of the source container are not permitted.

Licensees that require assistance should contact Endress+Hauser.

6.8 Replacing radiation sources

It is not permitted to replace the radiation sources on site.

7 Emergency procedure

7.1 Emergency procedures

If the source container or the radiation source was damaged due to an incident or the radiation source was lost, the following emergency measures must be initiated:

- Inform the radiation safety officer immediately and follow their instructions.
- Evacuate, cordon off and label the affected area immediately. Access is only permitted with authorization by the radiation safety officer.
- The work must be stopped immediately if there is a risk that radioactive material has got into the product to be measured.
- Material that is probably contaminated must be secured and must not be reused before it has been inspected.
- Emergency services must be informed of possible radiation hazards.

Once the emergency measures have been initiated, the radiation safety officer must inform the authorities responsible for radiation protection.

The radiation safety officer must document the incident and make the necessary notifications.

7.1.1 Purpose and overview

This emergency procedure must be put into force immediately to minimize potential radiation exposure to persons and safeguard a known area to protect personnel, or if there is a suspicion that there is an exposed radiation source.

Such an emergency exists if radiation sources are exposed and unsecured or the shutter cannot be put in the "AUS/OFF" position.

This procedure is used to safeguard an area until the competent radiation safety officer is present on site and assigns measures for resolving the incident.

The person responsible for the radiation sources (the "authorized person" named by the customer) is responsible for complying with this process.

7.1.2 Procedure

- Determine the danger zone by taking measurements (on site) or by calculation, taking into account the activity and type of the installed radiation sources (see documents).
- Cordon off the danger zone (local dose rate 20 $\mu\text{Sv/h}$ (2 mrem/h)) and indicate it with warning signs.
- If the shutter cannot be set to the "AUS/OFF" position, keep people away from the radiation area.
- If it is not possible to cordon off the entire danger zone, it may be necessary to secure and screen the radiation sources.
 - Observe the distance rule: the dose rate is inversely proportional to the square of the distance to the radiation source (example: three times the distance $\rightarrow$ 1/9 of the dose rate).
 - Only pick up radiation sources with a long gripper and hold as far away from the body as possible.
 - Minimize the time required by repeatedly simulating (without a radiation source) the procedure.
- If part of the danger zone is accessible (e.g. a container with the possibility that persons could enter), remove the source container and direct it against a wall or floor.
 - Horizontal beam exit channel: align the source container with a thick (well-shielded) wall.
 - Vertical beam exit channel: put the source container on a thick (well-shielded) floor.

Personnel should always remain behind the source container and not in front of the beam exit channel.

Use the lifting points of the source container to ensure a safe procedure.

CAUTION

Risk of injury

- Use lifting equipment.
- Consider the weight and center of gravity. 780 kg (1 720 lb).
- After the emergency has been rectified, the radiation safety officer must document the incident and issue the required messages.
- Required notifications must be sent to the local authorities and to the NRC within 24 hours.
NRC's Operation Center: 301-816-5100 or 301-951-0550
- After a thorough assessment of the case of damage, the competent radiation safety officer shall work together with the NRC and/or the local authorities and with Endress+Hauser to solve the specific problem.

7.2 Possible emergency situations

Examples of possible emergency situations are provided below.

7.2.1 Shutter cannot be moved into the "OFF/AUS" position

The shutter may be blocked for various reasons, such as mechanical damage, rust or contaminants.

A blocked shutter generally does not represent an emergency.

A blocked shutter is usually detected during a routine inspection or in an emergency if the shutter must be closed.

In the event that the instructions are not observed, there is the danger of unnecessary exposure to radiation.

The following procedure must only be carried out if the source container does not show signs of serious damage caused by fire, falls or collisions:

- If the source container shows external dirt or rust, preventing the cover from being removed and, as a result, unable to move the shutter to the "AUS/OFF" position.
Remove dirt and rust with a brush.
- If the screws of the cover are stuck, spray them with a rust-dissolving penetrating oil and loosen them.
- Cleaning with a high-pressure cleaner or with compressed air is permissible. If this does not rectify the problem, contact Endress+Hauser.
- After the cover has been removed, contaminated parts must be cleaned, preferably with compressed air.
- Check for possible damage. The parts in question must be replaced and documented.
- Try to set the source holders to the "AUS/OFF" position by pulling the source holders up.
- If the source holder cannot be moved and the radiation needs to be switched off (when working on the source container or in the process vessel), leave the source container in its mounting position and contact Endress+Hauser. The source container is in a safe position when mounted.
- Work must not be continued. Make sure that no one can enter the process vessel.
- The radiation sources can be additionally shielded as a temporary solution for continued working. This minimizes radiation exposure. (Measure the local dose rate using a radiation measuring device).
This method should be considered temporary, to be used only until the source container can be repaired or replaced.

7.2.2 Lost or missing

If you suspect that a source container has been stolen or lost for any reason, take the following measures:

- Start a targeted search for the lost or missing source container.
- Ask employees who may have been in the vicinity.
- Determine when the source container was last demonstrably available.
- Search all areas where the source container could be parked, i.e. storage spaces, waste containers, garbage bins, etc.

If it is determined that the source container cannot be found, the radiation safety officer must immediately inform the responsible supervisory authority by telephone or fax and then submit a written report. The requirements for the information contained in the written notification are set out in regulations.

Conduct careful analysis to determine why the incident has occurred and what actions are required to make sure that it is not repeated.

7.2.3 Entering a vessel or tank

The most frequently avoidable radiation exposure is caused by persons entering a container or tank before the radiation source was pulled back into the source container or before the shutter was closed.

- This avoidable exposure to radiation can be prevented by means of cordoning off and marking procedures (lockout/tagout).
- A simple safety measure is to mark every access to the vessel with a sign indicating the presence of radiation sources.
- Access to the container only after the radiation sources are in the source container and the shutter is closed ("OFF" position).
In advance, staff must be trained to recognize markings that refer to monitored containers.
- Contractors operating in vessels must be informed about existing dangers caused by radiation sources and the safety precautions to be observed.

If safety precautions are ignored and persons enter a container even though the shutter is open ("ON" position), perform the following procedure:

- Evacuate the container.
- Ask the affected persons to determine how long they have been in the container for and in what position.
- Calculate the radiation exposure by measuring the local dose rate in the container, taking into account the dwell time in the radiation field. Or use the equations in the "Important safety calculations" section of this documentation.
- Determine the isotope and the current activity based on the nameplate on the source container or on records.
- When calculating the radiation dose, the materials and the thickness of the vessel wall must also be taken into account. Contact Endress+Hauser if you need help with these calculations.
- If affected persons express concern and wish to obtain a medical examination, arrange this.
- The competent radiation safety officer must notify the responsible supervisory authority if the radiation exposure exceeds one of the specified limit values.

7.2.4 Damage caused by falling or collisions

Source containers can be damaged by falling or collisions. The personnel must be informed of possible damages caused by the following:

Falling

- Rusty screws or broken weld seams.
- Failure of auxiliary equipment when mounting or removing source containers.
- Screws that have become loose due to vibrations or have not been properly attached during installation.
- Falling source holders into the protection pipe due to multiple serious operating errors.

Collision

Vehicle collides with a source container.

Recommended measures

- Examine the source container and compare it with test samples. Perform comparison measurements.
- If the measured values are comparable, the shielding is probably intact.
- Check that the shutter is working correctly, then close the shutter ("OFF" position).
- If the shutter cannot be closed, follow the instructions for a clamping shutter. Contact Endress+Hauser for support.
- Perform a leak test to ensure that no contamination is present.
- If contamination is present, take measures to limit it. A simple way of reducing contamination is to cover the source container with a plastic film.
- If the radiation diagram is comparable with the original, the shutter is functioning properly and no contamination is present, the source container can be put back into operation.
- The source container must be taken out of service if the results of the tests indicate that the source container or the shielding are damaged.
- Contact Endress+Hauser or a specially approved body for safe removal, packaging and shipping of the source container or for advice in this regard. If necessary, provide shielding materials around the source container containing the radiation sources to reduce radiation values.
- If a source holder has detached from the flexible source holder extension and is located in the protection pipe of the product vessel. Immediately contact the manufacturer for assistance.

7.2.5 Damage caused by fire

The area is to be cleared and access is to be restricted to the emergency services. The priority measures include providing supplies to and rescuing injured employees, as well as fighting the fire.

On completion of these measures, the radiation safety officer must assess the condition of the source containers that were affected by the fire.

- Part of the lead shielding could be melted.
- Examine the source container and compare it with test samples. Perform comparison measurements.
- Inspect the source container for damage to the securing construction (screws, holders). Replace the insulation or the cooling system if these have been supplied.
- Secure the source container at its lifting points.
- Perform a leak test to ensure that no contamination is present.
- Check that the shutter is working correctly, then close the shutter ("OFF" position).
- If the radiation sources cannot be pulled back into the source container. Depending on the situation, appropriate measures must be taken.
- If the test results indicate increased radiation values:
 - Cordon off the danger zone (local dose rate 20 $\mu\text{Sv/h}$ (2 mrem/h)) and indicate it with warning signs.
 - Document the names of all employees who may have been in the danger zone.
- Contact Endress+Hauser or a specially approved body for further assistance.

The Source Container FQG74, designed by Endress+Hauser, withstands most fires. The probability of a source capsule failing, even in the event of fire or explosion, is extremely low.

7.3 Equipment for emergencies

Examples of the tools that might be useful in an emergency situation include:

- Initial radiation measurements on source containers.
- List of emergency measures and important emergency telephone numbers.
- Calibrated radiation meters.
- Batteries for radiation meters.
- Leak test kits for seal checking.
- Barrier tapes and warning signs for ionizing radiation.
- Gloves.
- Auxiliary shield materials for temporary screening.
- Dosimeters and radiation exposure badges.
- Plastic films or bags to cover contaminated objects.
- Tape measures for distance.
- Suitable tool to open and remove the cover.

7.4 Important safety calculations

The safest way to determine the personal dose is to measure the radiation intensity with a radiation meter.

For a cesium-137 or cobalt-60 radiation source (gamma radiation), the dose rate can be read directly from a calibrated radiation meter in $\mu\text{Sv/h}$ (mR/h).

Most radiation meters are still calibrated in the traditional unit roentgen, most likely in milliroentgen (mR) or microroentgen (μR). Some measuring instruments are calibrated in μSv units.

In the case of gamma radiation, mrem/h corresponds to the radiation intensity in mR/h.

Example: a radiation intensity of 0.6 mR/h is measured at a distance of 1 m (3.3 ft) from the radiation source.

In this example, a person located at a distance of 1 m (3.3 ft) from the radiation source would receive an equivalent dose of 6 μSv (0.6 mrem).

7.4.1 Calculating the local dose rate

If a radiation meter is not available, the radiation intensity of an unshielded point radiation source can be calculated.

Complete the equation to determine the dose rate (mR/h) of an unshielded point radiation source (source capsule or radiation source channel of the source container).

This formula does not apply to a shielded radiation source.

$$\dot{H}_0^*(10) = \frac{\Gamma_{H^*} \cdot A}{r^2}$$

A0056466

$H'_0(10)$: The local dose rate in $\mu\text{Sv/h}$ to be taken into account at the location to be protected, without shielding. ¹⁾

Γ_H^* : Dose rate constant as per Appendix A1 for (DIN 6844-3, 2020-07).

A: activity in GBq

r: clearance in m

For gamma radiation source FSG60 (cesium-137 + $^{137\text{m}}\text{Ba}$), dose rate constant Γ_H^* : 92.7 (3.7)

For gamma radiation source FSG61 (cobalt-60), dose rate constant Γ_H^* : 354 (14.3)

Example

Assumption: the estimated exposure time in a radiation field of an unshielded point radiation source is 10 min at a distance of 1 m (3.3 ft) with a cesium-137 radiation source with an activity of 0.74 Gbq (20 mCi).

The calculated local dose rate is:

International units	Traditional units
$R = (92.7) \times (0.74) / (1)^2$	$R = (3.7) \times (20) / (3.3)^2$
$R = 68.6 \mu\text{Sv/h}$	$R = 6.86 \text{ mrem/h}$

The effective equivalent dose is:

International units	Traditional units
$68.6 \mu\text{Sv/h} \times 10 \text{ min} \times 1\text{h}/60\text{min} = 11.4 \mu\text{Sv}$	$6.86 \text{ mrem/h} \times 10 \text{ min} \times 1\text{h}/60\text{min} = 1.14 \text{ mrem}$

7.4.2 Emergency screening material

Lead is used as shielding material in source containers because of its density.

However, in emergencies, lead is not always available. Various materials can be used as temporary shielding.

The following table indicates the thickness of various materials used to reduce the radiation intensity to half of its original value.

These layer thicknesses are also referred to as half-value layers.

Half-value layers of the shielding (reference values)

Material	Cesium-137	Cobalt-60
Concrete	2" (51 mm)	3 1/4" (83 mm)
Aluminum	1 1/2" (38 mm)	3" (76 mm)
Steel, brass	1/2" (13 mm)	1" (25 mm)

1) These values are physically consistent with Peplow, Douglas E. "Specific gamma-ray constants with current emission data". Health Physics 118.4 (2020): 402-416.

Material	Cesium-137	Cobalt-60
Lead	1/4" (6 mm)	1/2" (13 mm)
Tungsten	3/16" (4.7 mm)	3/8" (9.5 mm)

7.4.3 Recommended distance from unshielded radiation sources

If a prefabricated operating plan exists before an emergency occurs, authorized personnel can respond in good time to any incident.

The following data is used as the basis for determining distances for restricted access.

Always assume the worst case for the pre-calculation:

- Assume that the radiation source is completely unshielded.
- Use the radiation source with the highest activity.
- Specify the limit values for the dose rate of 20 µSv/h (2 mrem/h).

International units

- Cesium-137 radiation sources: Distance (m) = 2.1 × √ (activity in GBq)
- Cobalt-60 radiation sources: distance(m)= 4.1 × √ (activity in GBq)

Example:

If the cesium-137 radiation source with the highest activity is 3.7 GBq.

Distance in meters = 2.1 × √ 3.7 = 4 meters

According to this calculation, personnel should maintain a distance of 4 m from this radiation source to achieve a dose rate of less than 20 µSv/h in an emergency.

Traditional units

- Cesium-137 radiation sources: distance(m)= 1.3 × √ (activity in mCi)
- Cobalt-60 radiation sources: distance (ft)= 2.6 × √ (activity in mCi)

Example:

If the cesium-137 radiation source with the highest activity is 100 mCi.

Distance in feet = 1.3 × √ 100 = 13.0 ft

According to this calculation, personnel should maintain a distance of 13 ft from this radiation source to achieve a dose rate of less than 2 mrem/h in an emergency.

8 Source container types

8.1 Applications for Source Container FQG74

The Source Container FQG74 is a source container with up to 20 radiation sources for a radiometric measurement method (e.g. level measurement or density measurement). Stable measurement conditions are ensured over large measurement distances.

The Source Container FQG74 is used in demanding industrial applications, particularly in the petrochemical, oil and gas industries.

Its main function is to safely accommodate, position and shield up to 20 radioactive radiation sources.

The radiation sources can be moved individually by ropes so that their position can be flexibly adapted to the respective application (e.g. in long or curved protection pipes).

The Source Container FQG74 features a robust shielding made of 150 mm thick lead and a solid stainless steel shutter to reliably reduce downward radiation and increase radiation safety during operation and maintenance.

With its compact design, Type A approval for transport and modular variants (various source magazines and source holders), the Source Container FQG74 is more versatile, easier to handle, install and maintain than traditional solutions with multiple radiation sources.

The Source Container FQG74 is not in contact with the medium.

The nuclide is either present in metallic form (in the case of cobalt-60) or as a solid ceramic pellet (in the case of cesium-137).

The nuclide is surrounded by a hermetically sealed, double-walled stainless steel enclosure (source capsule). The source capsules are equipped with ANSI/ISO classifications, see Technical Information TI00439F.

Only chemically compatible materials (stainless steel) are used in the vicinity of the source capsule (stainless steel).

8.2 Scope of delivery and operating and safety instructions

- Source Container FQG74
- Lifting points
- Source holder extensions
- Radiation sources (installed)
- Radiation symbols
- Operating instructions (BA02609F)
- Safety manual (this document)



See the operating instructions, the technical information and the safety manual.

8.3 Delivery

The source container must be shipped with the radioactive radiation sources that have already been installed.

The shutter must be in the "AUS/OFF" position and secured with a lock.

The cover must be closed and secured with a lock and with a seal.

The shipment is sent as a "Type A" packing unit. All markings, signage and accompanying papers comply with the regulations of the U.S. Department of Transportation (DOT).

Transportation is carried out by a transport company or another body approved for the transportation of radioactive substances.

Deliveries to certain Licensees cannot take place until we have a copy of the special licenses approved to receive, own and use the radioactive material.

Endress+Hauser is more than happy to assist in procuring this license.

Deliveries to General Licensees (an official license for certain intrinsically safe devices which contain enclosed radiation sources) are not permitted. Contact our local sales center for questions or assistance.

9 References to Internet pages and information

9.1 NRC home page

This page contains links to regulations and guidelines

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

9.2 List of Agreement States with telephone numbers

<https://scp.nrc.gov/asdirectory.html>

9.3 Summary information on material licenses

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

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

9.4 Radiation Technology Inc.

<http://www.radiationprograms.com>

9.5 Occupational Safety & Health Administration

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



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www.addresses.endress.com
