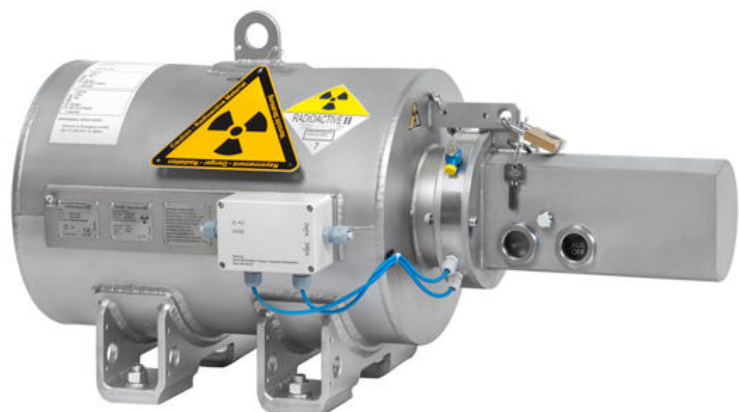
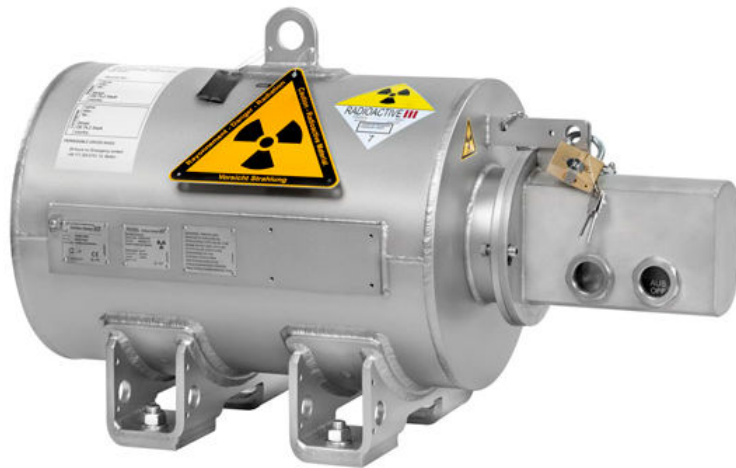
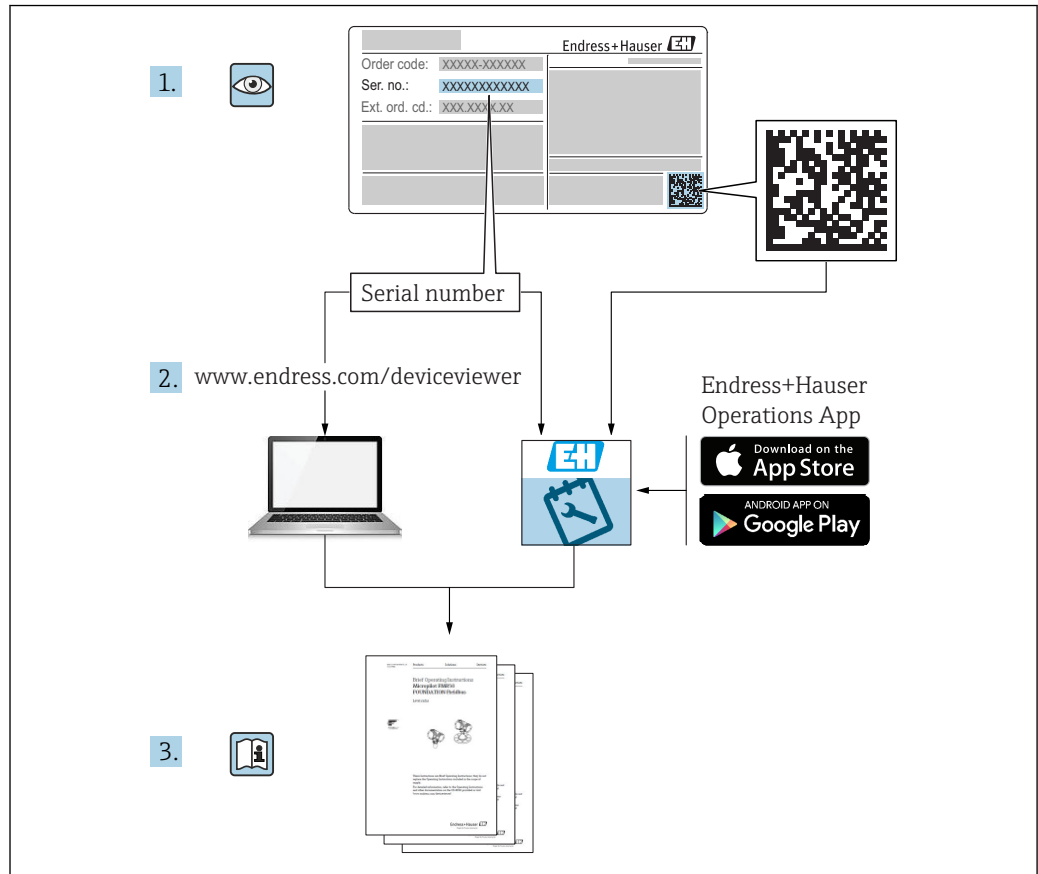


# Special Documentation Radiation Safety and Technical Reference Manual

U.S. Specific License  
For Source Container FQG66





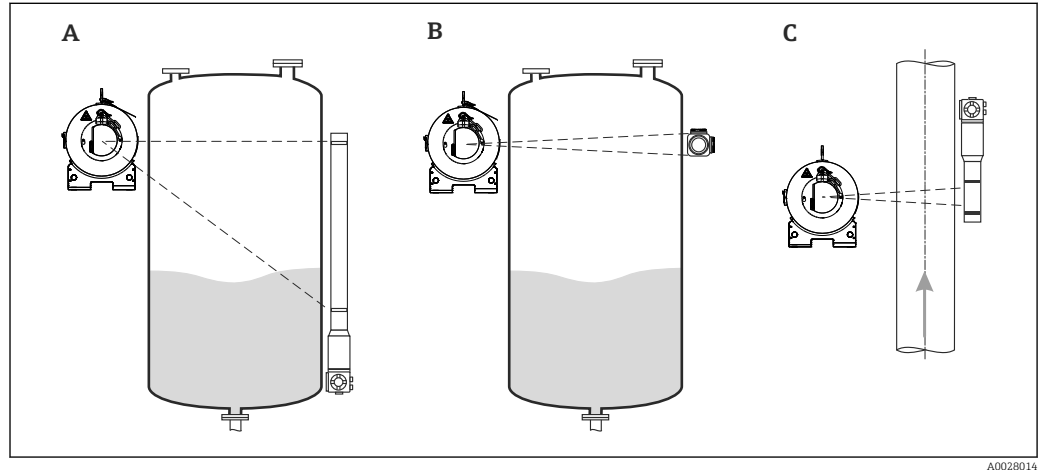
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# 1 General information

Radiometric measurement is based on the principle that radioactive materials - installed in a protective source container - emit gamma rays which are attenuated when they penetrate materials. The detector (Gammapiot) mounted on the opposite side of the vessel transforms the received radiation into an electrical signal. The parameters that can effect the measurement, and hence the signal, are the rising level (continuous/point level measurement) or changing densities of the medium inside the tank or pipe.



A0028014

- A *Level measurement*
- B *Point level detection*
- C *Density measurement*

## 1.1 Who we are

Endress+Hauser is a global leader in the provision of measurement instrumentation, services and solutions for industrial process engineering. Endress+Hauser was founded in 1953 by Georg H. Endress and Ludwig Hauser. The company has developed from an instrumentation specialist to a provider of complete system solutions. We offer a wide range of sensors, instruments, systems and services covering the areas of level, flow, pressure and temperature measurement, liquid analysis and recording, including the connection of field instruments to process control systems as well as automation and logistic solutions. Endress+Hauser can supply systems to perform a process measurement, monitoring or automation task accurately, cost effectively and with minimum disruption to your existing installations. Solutions are created in close cooperation with the customer. As early as 1962, Endress+Hauser brought its first radiometric measuring system to the market. Since then, more than four decades have passed and this technology continues to provide decisive advantages

## 1.2 U.S. License Types

An industrial nuclear gauge user in the United States must operate this device under a license from the U.S. Nuclear Regulatory Commission (NRC) or Agreement State. The license sets limits on what the user can do with the source container.

### 1.2.1 Specific License

A Specific License authorizes the possession and use of particular source containers. It specifies the models they may possess and authorized activities. The license identifies the Radiation Safety Officer (RSO). This individual is responsible for the radiation safety program and all required records. Alternate radiation safety officers may also be identified on the license. Application requirements for a Specific License are contained in 10CFR Parts 30.32 and 30.33. Part 30.33 (a) requires that the applicant be trained and

experienced in the use of devices and radioactive material being requested. This training is available through several authorized training companies. The Specific Licenses details requirements and authorized activities which can be performed by the licensee. These activities might include authorization for leak testing, installation, relocation or removal of source containers, etc.

## 1.3 Basic Radiation Safety

Gamma rays, which are emitted by radioactive materials such as  $^{137}\text{Cesium}$  and  $^{60}\text{Cobalt}$ , are electromagnetic waves similar to light. Gamma energies, however, are many times higher than the light rays. The ability of gamma radiation to penetrate materials is related to its particular wave length and energy. The actual measuring principle is based on the absorption of radiation by the product to be measured: Either the material absorbs almost all of the radiation (level or limit switch applications) or the absorption changes while a fraction of the original radiation still reaches the transmitter even at maximum density (density or interface measurement). Radiated energy affects the human body only when absorbed at an excessive rate.

Dose from this radiant energy depends on several factors:

- The activity of the source
- The distance from the source to part of the body
- The portion of the body in contact or closest to the source
- The presence of any shielding material between the source and the body
- The total time that the body was exposed

### 1.3.1 Safety Instructions

#### **WARNING**

**The source container contains radioactive material.**

- ▶ Observe the radiation safety rules.

#### **Designated use**

The source containers FQG66 described in these safety instructions contain the radioactive source, which is used for radiometric measurement of level, interface and density. It screens the radiation towards the surrounding and allow it to be emitted almost unattenuated and only in the direction of measurement. In order to guarantee the screening effect and to exclude damage of the radiation source, all instructions given in this manual for mounting and operation as well as all regulations for radioactive protection are to be followed exactly. Endress+Hauser accepts no responsibility for any damage caused by incorrect use.

#### **Basic instructions for use and storage**

- Observe the applying rules and national regulations
- Observe the radiation protection regulations in use, storage and for work on the radiometric measuring system
- Observe warning signs and safety areas
- Install and operate the device according to this manual and the relevant conditions as specified by the regulatory authority
- The device shall not be operated or stored outside the designated parameters
- Protect the device against extreme influences (i.e. chemical products, weather, mechanical impacts, vibrations) when operated or stored
- Always secure the "OFF" position by using a padlock, see Operating Instructions BA01327F
- Before switching on the radiation beam it is necessary to ensure that no personnel are within the area of the radiation (or, indeed, inside the vessel)

- The radiation beam may only be switched on by specially trained personnel
- Do not operate or store damaged or corroded devices. Contact the responsible radiation safety officer for appropriate instructions and measures when damage or corrosion occurs
- Conduct the required leak testing procedure according to the applying regulations and instructions

**⚠ WARNING****If the instrument is exposed to strong vibrations or mechanical impacts.**

- ▶ Check the source container especially its shutter mechanism for damage and deformation.

**⚠ CAUTION****In case of doubt about proper condition of the device**

- ▶ responsible radiation safety officer.

**Safety instructions for switching on the radiation**

Before switching on the radiation beam it is necessary to ensure that no personnel are within the area of the radiation (or, indeed, inside the vessel). The radiation beam may only be switched on by specially trained personnel.

### 1.3.2 ALARA Principles

When working with radioactive sources, one should minimize unnecessary exposure. Work related exposure to radiation must be kept to as low a as reasonably achievable (ALARA). As of 1994 ALARA is not just a good idea it is the law and all licensees must have ALARA as part of their radiation protection program, of which Endress+Hauser subscribes to. Three important measures help to achieve this:

**Shielding**

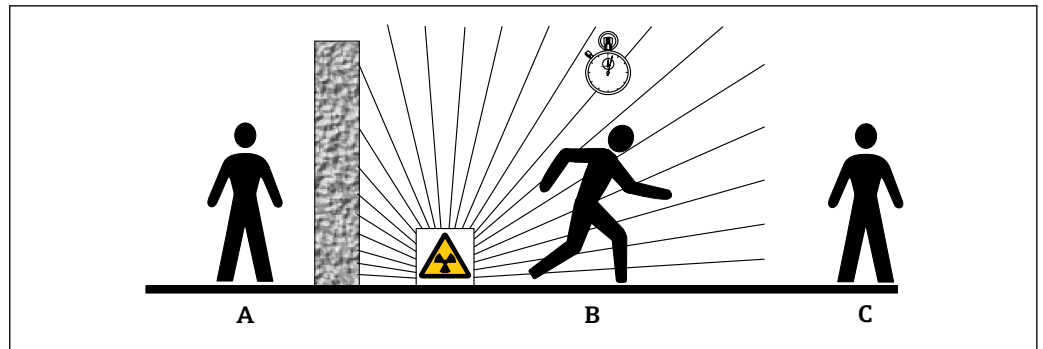
One should plan activities to keep as much shielding material as possible between the source and individuals working in the field. Source containers (e. g. FQG66) and other high-density materials such as lead, iron, and concrete can be used for effective shielding of gamma emitting sources. All Endress+Hauser models have a shutter or other mechanism to attenuate the beam during installation, maintenance, emergencies, etc.

*Time*

The dose a person receives is directly proportional to the amount of time spent in a radiation field. The Time spent in the exposed area should be kept to a minimum.

*Distance*

Distance from the source of the radiation is important in minimizing exposures. The exposure rate of the radiation field decreases by the square of the distance from an unshielded point source. This means when one increases the distance from an unshielded point source by a factor of two, the radiation field decreases by a factor of four. As with time, an individual should endeavor to work as far from a source as feasible.



A0016373

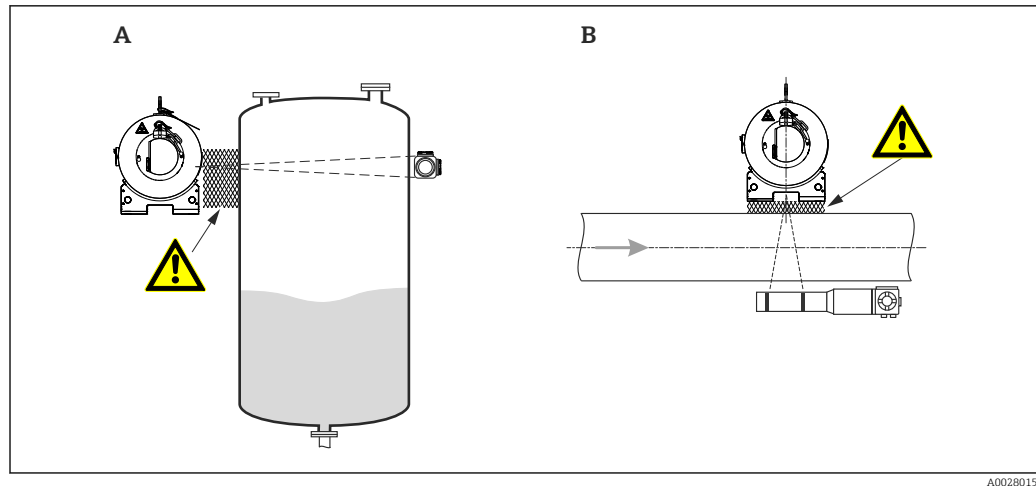
- A *Shielding*  
 B *Time*  
 C *Distance*

## 1.4 Exposure to Radiation and Contamination

From the beginning, people have lived with ionizing radiation coming from several origins; including space (cosmic) and, the earth's crust (terrestrial). Individuals are also subjected to artificially generated radiation, with the highest exposures due to medical x-rays and treatments. Radioactive dose is measured in units of Sieverts or Rems. These units take into account different types of radiation and their potential effects on the human body. Individuals can reduce potential radiation doses by utilizing time, distance and shielding, i. e. using remote control instruments to handle radioactive materials. Radiation exposure or dose is not the same as radioactive contamination. Contamination can only occur via direct contact, inhalation, ingestions or absorption of radioactive materials. Radioactive material in the Endress+Hauser devices is doubly encapsulated, in accordance with ISO classification, typically C66646 / ISO 2919 meeting the most stringent safety criteria in relation to stress, extreme temperatures and pressures as well as impact, vibration and puncture. Contamination is only possible if the source capsule fails and radioactive material is disbursed. An example of this would be a campfire. As you feel the heat of the fire you are in its radiation field. Contamination occurs if any part of the fire gets out of the fire area. Stainless steel encapsulated sources rarely fail, even under emergency conditions. Periodic leak tests are done to check for surface contamination.

### 1.4.1 Primary Radiation Beam

The potential for access to the primary radiation beam is determined by the location and installation parameters of the source container. Ideally, the pipe or vessel is completely enclosed with the source container mounted against the pipe or vessel wall. Access to the primary radiation beam should be limited to the opposite side of the pipe or vessel at the detector or inside of a tank. However, a distance between the source container and the product container often cannot be avoided if the measuring range is large and the container diameter small. If this space is sufficient for hands or other body parts to enter, this area must then be shielded.



A Horizontal radiation beam  
B Vertical radiation beam

The interior of most piping systems are inaccessible. Access control procedures must be structured and implemented at the time of source container "startup" to ensure that personnel exposure does not exceed the regulatory limits for whole body or extremity dose. Vessel entry is prohibited unless the source is shielded and the shutter is locked. Various user-maintained lockout procedures prevent access to the inside of the vessel until meeting all safety conditions. All Occupational Safety and Health Administration (OSHA) regulations concerning confined space entry must be followed.

## 1.5 Regulating Radioactive Materials

The use of radioactive material, including nuclear gauges, is regulated by the U.S. Nuclear Regulatory Commission (U.S. NRC) or the equivalent agency of an Agreement State. The applicable sections of the U.S. NRC regulations are numbered 10 CFR Part 20, 10 CFR 31.5 and 31.12. Agreement States are those which have an agreement with the NRC to regulate radioactive materials within the state. The NRC still maintains control of some material such as nuclear power plants. Agreement State regulations must be compatible or more restrictive than the NRC regulations. The NRC and Agreement States update their regulations periodically. It is up to the licensee to keep up with changes to these regulations. Some states require registration of gauges using radiation material, regardless of the license type. In those cases, the licensee must meet the state requirements.

### 1.5.1 Legal requirements for radiation protection

Handling radioactive emitters is legally controlled. The radioactive protection regulations of the state in which your plant is located are to be complied with.

#### License requirements

A general or specific license is required for operating a plant which uses gamma radiation. Application for the License must be made to the NRC or the agreement state in which the plant resides.

#### *Radiation Safety Officer*

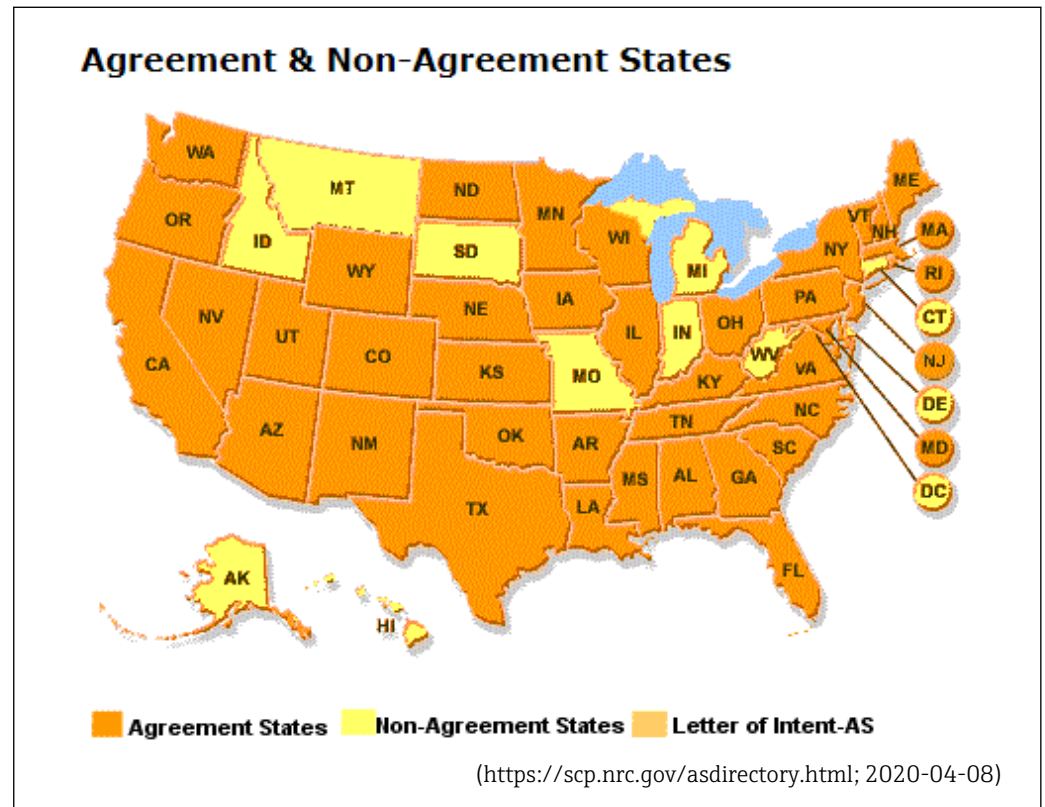
The operator of the plant must select an individual to become the Certified Radiation Safety Officer (RSO). The goal of the radiation safety officer is to develop and maintain the radiation safety program with procedures to keep the occupational doses to all people as low as possible. The radiation safety officer will administer and or oversee site-specific safety training for all workers.




### Control Areas

All control areas containing Nuclear gauges are to be clearly marked for all people to easily read. All people entering to do any type of work within the control area should be badge monitored per all safe practices as per NRC / State guideline dose limitations.

## 1.5.2 NRC Regional Map



A0019229

 Links to the Regulations and Guides see  
<http://www.nrc.gov/>

## 1.5.3 U.S. NUCLEAR REGULATORY COMMISSION AND AGREEMENT STATE OFFICES AS OF April 2020

### Alabama

Office of Radiation Control  
 State Department of Public Health  
 201 Monroe Street  
 P.O. Drawer 303017  
 Montgomery, AL 36130-3017  
 PH (334)206-5391 FX (334)206-5387

### Alaska

Alaska State Public Health Laboratories  
 Department of Health & Social Services  
 5455 Dr. Martin Luther King Jr. Ave  
 Anchorage, Alaska 99507  
 PH: (907)-334-2107 FX: (907)-334-2161

**Arizona**

Arizona Department of Services  
Bureau of Radiation Control  
4814 South 40th Street  
Phoenix, AZ 85040  
PH (602)255-4840  
24 Hour (480)-202-4982

**Arkansas**

AR Department of Health  
Radioactive Control Section  
5800 West 10th Street, Suite 100  
Little Rock, AR 72204  
PH (501)661-2301 FX (501)280-4407

**California**

Radiologic Health Branch  
Div. of Food, Drug, & Radiation Safety  
CA Dept. of Health Services  
P.O. Box 997414, MS7610  
1500 Capitol Ave., MS 7610  
Sacramento, CA 95899-7414  
PH (916)440-7942 FX (916)341-7224

**Colorado**

Colorado Department of Public Health and Environment  
HMWM-RAD-B2  
4300 Cherry Creek Drive South  
Denver, CO 80246-1530  
PH (303)692-3371 FX (303)759-5355

**Connecticut**

Connecticut Dept. of Energy and Environmental Protection  
Radiation Division  
79 Elm Street  
Hartford, CT 06106  
PH (860)424-4190 FX (860)424-4065

**Delaware**

Division of Public Health  
417 Federal St., Jess S. Cooper Bldg.  
Dover, DE 19903  
PH (302)744-4729 FX (302)739-3839  
24 HR: 302-270-8390

**District of Columbia**

Department of Health  
HRLA/Radiation Protection Division  
899 North Capital Street, NE, 2nd Fl  
Washington, DC 20002  
PH: (202)724-4900 FX(202)727-8677

**Florida**

Bureau of Radiation Control  
Florida Department of Health  
4052 Bald Cypress Way, SE, Bin C21  
Tallahassee, FL 32399-1741  
PH (850)245-4266 FX (850)487-0435

**Georgia**

Radioactive Materials Program  
Air Protection Branch  
Department of Natural Resources  
4244 International Parkway, Suite 120  
Atlanta, GA 30354  
PH (404)363-7127 FX (404)363-7100

**Hawaii**

Radiation Section  
Department of Health  
Indoor & Radiological Health Branch  
99-945 Halawa Valley Street  
Honolulu, HI 96701  
PH (808)586-4700 FX (808)586-5838

**Idaho**

Emergency Response Coordinator  
Idaho Department of Environmental Quality  
1410 N Hilton St  
Boise, ID 83706  
PH (208) 373-0204 FX (208) 373-0143

**Illinois**

Illinois Emergency Management Agency  
Division of Nuclear Safety  
1035 Outer Park Drive  
Springfield, IL 62704  
PH (217)558-3945 FX(217) 558-7398

**Indiana**

Office of the Fire Marshal  
Indiana Department of Homeland Security  
302 West Washington Street, Room E-238  
Indianapolis, IN 46204  
PH (317)464-7043 FX (317)234-7234  
24-Hour Watch Desk: (800)669-7362

**Iowa**

Bureau of Radiological Health  
Iowa Department of Public Health  
Lucas Office Bldg., 5th Floor  
321 East 12th Street  
Des Moines, IA 50319  
PH (515)281-3478 FX (515)281-4529

**Kansas**

KS Dept of Health & Environment  
1000 SW Jackson, Suite 330  
Topeka, KS 66612-1365  
PH (785)296-4359 FX (785)559-4251

**Kentucky**

Cabinet for Health & Family Services  
Radiation Health Branch  
275 East Main Street HS1C-A  
Frankfort, KY 40621-0001  
PH (502)564-3700 ext 4181 FX (502)564-1492

**Louisiana**

Emergency and Radiological Services Division  
Louisiana Department of Environmental Quality  
602 North Street  
Baton Rouge, LA 70802  
PH (225)219-2966 FX (225)219-4044

**Maine**

Radiation Control Program  
Division of Environmental Health  
286 Water St, Key Plaza, 4th Floor, 11SHS  
Augusta, ME 04333-0011  
PH (207)287-5677 FX (207)287-3059

**Maryland**

Radiological Health Program  
Air & Radiation Management Adm.  
Maryland Dept of the Environment  
1800 Washington Blvd, Suite 750  
Baltimore, MD 21230-1720  
PH (410)537-3300 FAX (410)537-3198

**Massachusetts**

Department of Public Health  
Radiation Control Program  
Bureau of Environmental Health  
Schrafft Center, Suite 1M2A  
529 Main Street  
Charlestown, MA 02129  
PH (617)242-3035, x2001 FX (617)242-3457

**Michigan**

Radiological Protection Section  
Materials Management Division  
Michigan Dept. of Environment, Great Lakes, and Energy  
525 West Allegan Street  
PO Box 30241  
Lansing, MI 48909-7741  
PH (517)512-5859 FX (517)335-0564

**Minnesota**

Indoor Environments and Radiation Section  
Environmental Health Division  
Department of Health  
P.O. Box 64975  
St. Paul, MN 55164-0975  
PH (651)201-5826 FX (651)201-4606

**Mississippi**

Division of Radiological Health  
Mississippi State Department of Health  
3150 Lawson Street, P.O. Box 1700  
Jackson, MS 39215-1700  
PH (601)987-6893 FX (601) 987-6887

**Missouri**

Missouri Radiation Control Program  
Bureau of Ambulatory Care  
Division of Regulation and Licensure  
920 Wildwood, P.O. Box 570  
Jefferson City, MO 65102-0570  
PH (573)751-6083 FX (573)751-6158

**Montana**

Division Administrator QAD  
Montana Department of Public Health & Human Services  
P.O. Box 202953  
Helena, MT 59620-2953  
PH (406)444-2868 FX (406)444-3456

**Nebraska**

NE Dept. of Health & Human Services  
Office of Radiological Health  
301 Centennial Mall South  
P.O. Box 95026  
Lincoln, NE 68509-5026  
PH (402)471-0528 FX (402)471-0169

**Nevada**

Radiation Control Program  
Division of Public and Behavioral Health  
4150 Technology Way, Suite 200  
Carson City, NV 89706  
PH (775)687-7540  
24-hour phone: (877)438-7231 FX (775)687-7552

**New Hampshire**

NH Radiological Health Section  
Dept. of Health and Human Services  
29 Hazen Drive  
Concord, NH 03301-6504  
PH (603)271-4585 FX: (603)225-2325

**New Jersey**

Division of Energy Security and Sustainability  
New Jersey Department of Environmental Protection (NJDEP)  
P.O. Box 420; Mail Code 401-02H  
Trenton, NJ 08625-0420  
PH (609)633-7964 FX (609)777-1330

**New Mexico**

Radiation Control Bureau  
New Mexico Department of Environment  
Marquez Building-Suite 1  
525 Camino de Los Marquez Santa Fe, NM 87505  
or  
P.O. Box 5469 Santa Fe, NM 87502-5469  
PH (505)476-8604 FX (505)270-1930

**New York**

Bureau of Environmental Radiation Protection  
Empire State Plaza-Corning Tower-12th Fl.  
Albany, NY 12237  
PH (518)402-7550 FX (518)402-7554

**North Carolina**

Radiation Protection Section  
Dept of Health and Human Services  
5505 Creedmoor Rd First Floor  
Raleigh, NC 27612  
PH (919) 814-2250

**North Dakota**

North Dakota Dept of Health  
Radiation Control Program  
Division of Air Quality, 2nd Floor  
918 East Divide Ave.  
Bismarck, ND 58501-1947  
PH (701)328-5199 FX (701)328-5185

**Ohio**

North Dakota Dept of Health  
Bureau of Radiation Protection  
Ohio Department of Health  
246 North High Street  
Columbus, OH 43215  
PH (614)644-2727 FX (614)466-0381

**Oklahoma**

Radiation Management Section  
OK Dept of Environmental Quality  
P.O. Box 1677  
Oklahoma City, OK 73101-1677  
PH (405)702-5155 FX (405)702-5101

**Oregon**

Radiation Protection Services  
Oregon Health Services  
Department of Human Services  
800 NE Oregon Street, Suite 640  
Portland, OR 97232-2162  
PH (971)673-0499 FX (971) 673-0553

**Pennsylvania**

PA Dept. of Environmental Protection  
Bureau of Radiation Protection  
Rachel Carson State Office Building  
P.O. Box 8469  
Harrisburg, PA 17105-8469  
PH (717)787-2480 FX (717)783-8965

**Puerto Rico**

Radiological Health Division  
Department of Health  
P.O. Box 70184  
San Juan, PR 00936-8184  
PH (787)765-2929 FX (787)274-6829

**Rhode Island**

Center for Health Facilities Regulations  
Rhode Island Department of Health  
3 Capitol Hill, Room 306  
Providence, RI 02908-5097  
PH (401)222-4526 FX (401)222-3999

**South Carolina**

South Carolina Department of Health and Environmental Control  
Bureau of Radiological Health  
2600 Bull Street  
Columbia, SC 29201  
PH (803)545-0530 FX (803)545-4412

**South Dakota**

South Dakota Department of Health  
Licensure & Certification  
4101 W. 38th St.  
Sioux Falls, SD 57106  
PH (605)367-5672

**Tennessee**

Division of Radiological Health  
TN Dept of Environment & Conservation  
William R. Snodgrass Tennessee Tower-15th Floor  
312 Rosa L. Parks Avenue  
Nashville, TN 37243  
PH (615)532-0364 FX (615)532-0614

**Texas**

Consumer Protection Division  
TX. Dept. of State Health Services (DSHS)  
P.O. Box 149347, Mail Code 1986  
Austin, TX 78714-9347  
PH 512-834-6730 FX 512-834-6710

**Utah**

Division of Waste Management and Radiation Control  
Dept. of Environmental Quality  
Street Address:  
195 North 1950 West  
Salt Lake City, UT 84116  
Mailing Address:  
P.O. Box 144880  
Salt Lake City, UT 84114-4880  
Office PH (801)-536-0203 FX (801)-536-0222

**Vermont**

VT Department of Health  
108 Cherry Street  
P.O. Box 70, Drawer #43  
Burlington, VT 05402-0070  
PH (802)865-7730 FX (802)865-7745

**Virginia**

Division of Radiological Health  
Department of Health-James Madison Bldg.  
109 Governor Street, Rm 736  
Richmond, VA 23219  
PH (804)864-8151 FX (804)864-8155



**Washington**

Office of Radiation Protection  
Washington Department of Health  
P.O. Box 47827  
Olympia, WA 98504-7827  
PH (360)236-3210 FX (360)236-2255

**West Virginia**

Radiation, Toxics and Indoor Air Div.  
Office of Environmental Health Services  
350 Capitol Street, Room 313  
Charleston, WV 25301-1798  
PH (304)356-4299

**Wisconsin**

Radiation Protection Section  
Division of Public Health  
Dept of Health Services  
P.O. Box 2659  
Madison, WI 53701-2659  
PH (608)267-4792 FX (608)267-3695

**Wyoming**

Department of Environmental Quality  
Land Quality Division  
200 W. 17th Street, 2nd Floor  
Cheyenne, WY 82001  
PH (307)777-7757 FX (307)635-6017

## 2 Specific License

### 2.1 Conditions

The tasks that a licensee can perform with their source container are stated in their specific license. The licensee must read and understand the conditions stated in their license. The NRC and Agreement States periodically amend the regulations. The licensee is responsible for maintaining a current copy. Some states require registration of gauges containing radioactive sources. The licensee must check with the appropriate Agency or regulations for compliance requirements. Source container registry sheets will state the approved leak test interval. The sealed source capsules used in the Endress+Hauser source containers can be authorized for intervals up to 36 months, if requested on the specific license application.

### 2.2 Mounting

The source is loaded in a source holder which is inserted into in a lead-filled metal housing. All Endress+Hauser source containers have "ON/OFF" positions indicating the location of the source. Typically, Endress+Hauser source containers are designed with maximum radiation fields of 50  $\mu\text{Sv/h}$  (5 mrem/h) at a distance of 12 inches or 30 cm from the surface of the source container (non-beam port area, when shutter is off).

### 2.3 Post-installation check

#### 2.3.1 Measuring the local dose rate

The local dose rate in the vicinity of the source container must be measured immediately after it has been mounted.

**⚠ CAUTION**

**Depending on the installation, radiation can also occur through scattering.**

- ▶ It must be screened by the use of additional lead or iron shielding.
- ▶ Render or mark all control and exclusion areas as prohibited for unauthorized entry.

### 2.4 Personnel Monitoring

The Radiation Safety Officer will determine whether or not personnel monitoring is required, based upon occupancy studies performed on the site, and requirements stated in 10 CFR20.1502 or Agreement State regulations. Dosimetry may or may not be issued to Occupationally Exposed Individuals, based upon their estimated annual dose.

### 2.5 Entry into vessel

Special precautions are required when a source container is used on a vessel large enough to permit entry of personnel. A lock-out/tag-out procedure must be in place and followed prior to authorizing entry into any monitored vessel. An appropriate warning sign indicating the presence of radioactive material and the requirement for proper lock-out/tag-out procedure must be posted at the entrance to the tank.

## 2.6 NRC Regulations for Specific Licensees

As mentioned before, the conditions under which a licensee may possess and use radioactive material area specifically stated in the license document. The following are a few of the items about which licensees must be knowledgeable.

### 2.6.1 Terms

Licenses are generally issued for periods of five to ten years. A radiation safety officer must be identified by name. This individual is responsible for carrying out the requirements in the license and the radiation safety program. Any changes in personnel require an amendment to the license.

### 2.6.2 Radiation Protection Program

The CFR Title 10, Part 20.1101 Subpart B states that each specific licensee shall develop, document, and implement a radiation protection program. The program should include all of the licensed activity procedures and how the licensee will comply with the provisions in the license and with the regulations. The goal of a well run radiation protection program is to keep Occupationally Exposed and Members of the Public doses "as low as reasonably achievable" (ALARA). For the specifically licensed radiation protection program: one of the requirements is an annual review. This entails the review of the conditions and procedures of the license, making sure that they are up-to-date and relevant to the operations. Records of the review must be maintained for inspection.

The radiation safety program must include the following information at a minimum:

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

### 2.6.3 Documentation records

Endress+Hauser recommends that you maintain records for as long as you have ownership of the device. Following are examples of records which must be maintained as a part of the radiation protection program:

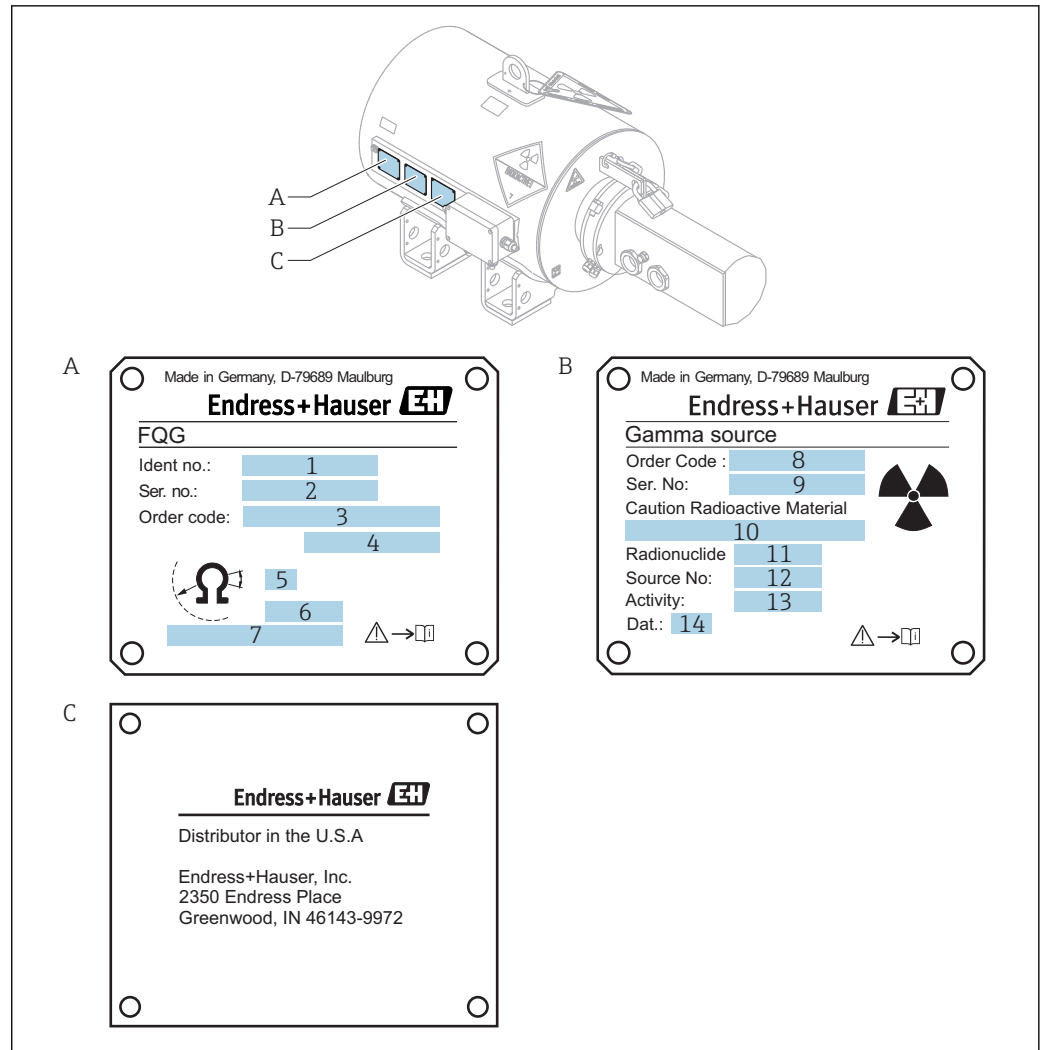
- Initial radiation survey
- Periodic leak test results
- Periodic shutter function tests
- Receipt of the source container
- User training
- Transfer or disposal of the material
- Annual Audits of the program

Records must be maintained for various intervals. It is the licensee's responsibility to know the intervals required by their regulations.

### **2.6.4 Labeling and posting**

The following requirements are for labeling and posting:

- Each source container must bear a label that states the type and activity of radioactive material and the assay date of the source. The label must have the regulatory defined radiation symbol. Endress+Hauser attaches an approved label to the source container prior to shipment. It is the licensee's responsibility to maintain the labels in a good condition. The legibility of the tags and labels are an important item during inspections.
- Posting requirements are stated in 10 CFR 20.1902, and each sign is specifically defined.
- Another posting that must be displayed is form NRC-3 "Notice to Employees" or the equivalent Agreement State form. This form must be posted in an area(s) where employees can easily observe it on their way to and from regular work activities involving gauges.



A0028005

- A Nameplate of the device  
 B Nameplate of the radiation source  
 C Distributer label  
 1 ID number of source container  
 2 Serial number of source container  
 3/4 Order code for source container as per product structure  
 5 Radiation angle of emission  
 6 Specification: horizontal or vertical  
 7 Local dose rate at a defined distance from the surface (when switched off, outside the radiation path)  
 8 Internal Endress+Hauser order code for the radiation source  
 9 Internal Endress+Hauser serial number for the radiation source  
 10 Wording "Caution Radioactive Material", if required  
 11 "Co60" or "Cs137"  
 12 Serial number of the radiation source (according to certificate of the supplier)  
 13 Activity including unit (MBq or GBq)  
 14 Date of loading (month/year)  
 15 Date of manufacture of radiation source  
 16 Order code of radiation source  
 17 Local dose rate at defined distance: 1 m (3.3 ft)  
 18 Date of container inspection  
 19 Material class of radiation source

## 2.6.5 Disposal or recycling


Regulations that govern the disposal of radioactive materials are covered in 10 CFR 20.2001 or compatible Agreement State regulations. When the source container is no longer needed, contact an authorized licensee to discuss transfer, disposal or recycle. Generally and specifically licensed material must be transferred to an authorized licensee for storage or disposal.

### **2.6.6 Agency Notification**

Regulations require Agency notification for specific incidents within specified time intervals which can range from immediate verbal notification to up to 30 days written notification. Required reportable incidents are identified in the regulations and include radiation exposures in excess of any limits, contamination, loss or theft of a source, etc. The Endress+Hauser service department may also be notified for assistance if needed.

## 3 Standard Routine Procedures

This chapter reviews procedures for routine activities to be performed on or with nuclear gauges containing radioactive material. As previously indicated, authorized activities for generally licensed and specifically licensed devices are not the same. It is the licensee's responsibility to make himself familiar with and understand which activities he is authorized to perform.

 Also observe Technical Information TI01171F and Operating Instructions BA01327F.

### 3.1 Receiving the Source Container

When receiving a source container from Endress+Hauser, refer to the following list to ensure the source container has arrived in proper condition.

1. Visually inspect the source container for damage.
2. Make sure the shutter mechanism is closed and locked.
3. Check to be sure that the shipment is complete.
4. If the source container is not to be installed immediately, place the package in a storage area that is isolated and secure.
5. Control access to the source container.
6. Maintain original receipt paperwork.
7. While not required, a survey and leak test can be performed if there is any concern regarding condition of the source container.

A radiation field can always be measured around the source container. You should expect to measure a low radiation field around the source container even if it is in perfect condition. One can compare the readings from the shipping paperwork to measured levels around the package to determine if some damage or shifting of the contents has occurred.

### 3.2 Source Container Mounting

The physical installation of the source container can be done by anyone with basic radiation safety awareness training and knowledge of source containers, provided the source is locked in the "AUS/OFF" position. The following are examples of proper procedures for the installation of the source container.

#### **NOTICE**

##### **Mounting instructions**

- ▶ The FQG66 series must be installed with the cover in the horizontal position.

#### 3.2.1 Checklist

The following items should be checked prior to beginning physical installation of a source container:

- Physical condition of the source container
- Confirm that shutter is closed and locked
- Check that the mounting bracket and area can accommodate the manufacturer's estimated weight and specifications of the source containers
- Check for sufficient room to disassemble the protective cap and to move the shutter
- Check for sufficient conditions to see the "EIN/ON", "AUS/OFF" indication

- Consider any high temperature, vibration, caustic, or other environmental conditions  
For example:
  - Is insulation needed to protect the source container from high temperature?
  - Is any additional protection required (i.e. hood or cover) to prevent caustic material from settling on source containers?
- Gather sufficient personnel and any special equipment necessary for installation
- This source container is very heavy. Plan for physical aspects/requirements of installation

### 3.2.2 Commissioning

Commissioning of a source container entails several mandatory steps. Treat each placement or relocation as a new installation requiring commissioning. Each time the source container/detector orientation (geometry) is broken/changed commissioning activities must be completed. Commissioning is the process of getting the mounted source container ready for use and consists of the following:

- Preliminary radiation survey
- Leak test
- Installation radiation survey
- Shutter operation test

Only a specifically licensed individual can perform the commissioning. A calibrated survey meter must be used during the entire procedure.

### 3.2.3 Radiation Survey

- A calibrated and operable survey meter must be used
- Measure and record the radiation levels in all directions around the source container and detector to identify any unusual radiation pattern
- Perform this survey with the shutter both "EIN/ON" and "AUS/OFF"
- If the radiation field is comparable, consistent with Endress+Hauser specifications, proceed with a leak test
- If the radiation field is greater than 50  $\mu\text{Sv/hr}$  (5 mrem/hr) at 12 inches (30 cm) from the installed container:  
Special posting or restrictions of the area may be required (10 CFR 20.1902)
  - Verify with the manufacturer that this condition is normal for the type and activity of source and source container installed
  - Estimate the dose personnel may receive based upon work requirements near the installed container

Personnel can be categorized into two groups, each with a different dose limit:

- Members of the Public can receive 20  $\mu\text{Sv/hr}$  (2 mrem/hr) and 1,000  $\mu\text{Sv/yr}$  (100 mrem/ year). This includes all individuals not specifically trained, and designated as Occupationally Exposed. They are usually individuals who do not work directly with the source containers.
- Occupationally exposed individuals can receive 50,000  $\mu\text{Sv}$  (5,000 mrem) per year with no specified rate limit. Individuals in this group have received appropriate training for work with or in the immediate vicinity of source containers.

Additional shielding may be required to prevent personnel from accessing the beam and/or to minimize the radiation dose in certain areas.

Notify personnel of the presence of radioactive materials and precautions necessary to minimize exposure (i.e. posting and training).

If the radiation fields are above 20  $\mu\text{Sv/hr}$  (2 mrem/hr) on the detector side of pipe or tank, shielding or area restrictions may need to be implemented.

### 3.2.4 Shutter Function Test

The purpose of this test is to verify that the shutter is functional, easily operable, and the indicator is in agreement with the shutter position.



### 3.2.5 Radiation Fields in or Around Vessels

Written lock-out/tag-out procedures must be written for source containers mounted on tanks, other accessible locations, or with enough space between the container and the vessel for someone to get a portion of their body into the beam. Many of these locations would be considered by OSHA to be a confined space, for other than radiation readings, requiring lock-out/confined space documentation consistent with OSHA rules. Mounted source containers must be evaluated to ensure that the gap between source container and vessel is not sufficiently large enough to allow any portion of an individual's body to access the radiation beam. If access is possible, the area should be blocked or restricted.

The following steps should be completed before a tank or vessel is entered:

- Verify that the source container is locked in the "OFF" (shutter closed) position
- The person in charge of individuals entering the tank should monitor the entryway
- Verify closed shutter with a calibrated survey meter or the system electronics. The detector will show off-scale readings. Measured fields should be very close to background.
- After work is completed, make sure the vessel is vacant and the entrance door secured before returning the source container to the "ON" position

## 3.3 Removal of a Source Container

### CAUTION

**All maintenance such as removal or replacement of the source container may only be carried out by supervised personnel, who have been specially trained in radiation procedures according to local regulations or handling approval.**

- ▶ Ensure that the contents of the handling approval is valid. Local conditions are to be observed. All work to be carried out may only be done from a safe (shielded!) location. Safety procedures must also be carried out to protect personnel from all possible risks. The disassembly of the source container can only be executed during "AUS/OFF" position. Make sure, the "AUS/OFF" position is secured with the locking bolt and the protective cap is secured with the padlock (see Operating Instructions BA01327F).

Before removal of the source container, perform the following steps:

- Make sure the source container is in good physical condition
- Severely corroded source containers may require special handling and shipping requirements
- Close and secure the shutter
- Lock the protective cap
- Have sufficient personnel and proper equipment available to remove the unit
- Provide appropriate training for involved individuals, based upon assigned duties
- Be prepared to handle the weight of the unit which may be sufficient to unbalance insufficiently supported elevated platforms or machines. The approximate weight of the source container is listed in the registry sheet.
- A radiation survey with a calibrated meter is to be performed in order to assess the radiation levels around source container. The radiation levels around the unit should be comparable to the original survey pattern.
- A current leak test on the source container is required. If the source container is to be moved to a new location or put in storage a current leak test certification is acceptable.
- The removal of a source container must be supervised by a specifically licensed individual

### 3.3.1 Dismounting

1. Secure the source container at the ring eyelet.
2. Unscrew the mounting screws of the device base.
3. Lift the source container by means of a suitable lifting tool.

### 3.3.2 Procedure after termination of the application

#### Internal measures

As soon as a radiometric measuring device is no longer required, the radiation source on the source container must be switched off. The source container shall be removed in accordance with all relevant regulations and saved in a lockable room having no through traffic. The responsible authorities shall be informed of these measures. The access to the storage room shall be measured out and signed. The radiation safety officer is responsible for protecting against theft. The radiation source in the source container must not be scrapped with the other parts of the plant. It should be returned as quickly as possible.

### 3.3.3 Return

To address the disposal sources call your local Endress+Hauser office for assistance and service if needed. There are no returns to Endress+Hauser from within the United States.

## 3.4 Periodic Tests

### 3.4.1 Inventory and Inspection

The following periodic tests have to be conducted at no longer than 6 month intervals. At least semi-annually, each device should be checked for the following items:

- Ensure that the source container location matches the location listed on the inventory sheet. If it doesn't, report immediately to the radiation safety officer for follow-up
- Physical inventory of the source container and device base
- The presence and legibility of the tags and labels
- General area condition. Make sure there is no build up of dirt, rust or corrosion on or around source container. If the inspection indicates that some aspect of the source container needs repairing or replacing, contact Endress+Hauser for assistance.

### 3.4.2 Test of Shutter ("EIN/ON", "AUS/OFF") mechanism

Inspect the container for proper shutter operation:

- To test the shutter mechanism, move the source holder rod several times between the "AUS/OFF" and "EIN/ON" positions.
- The rod should move easily but not freely. A shutter that moves too easily may be broken.
- Use one of the two methods listed below to ensure that the shutter mechanism is operational:
  - Use a calibrated portable radiation survey meter to take a measurement at the back of the detector housing. The readings should be significantly different when the shutter is "EIN/ON" (high) and "AUS/OFF" (low).
  - Use the gauge electronics to monitor the radiation levels while moving the shutter to the "AUS/OFF" position. In this case the readings should be higher (on a density application) when the shutter is "AUS/OFF" and drop when shutter is "EIN/ON".

The records of these tests should be maintained for a minimum of three years or as required by the regulations. Test documentation should include the date and name of individual performing the test. Two different tests are necessary when performing a shutter check. One determines whether or not the shutter actually closes and opens; and the second confirms that indicators on the source container agree with the physical position of the shutter.

### Manually operated source container

Remove the padlock (when in "AUS/OFF" position) and disassemble the protective cap acc. to the Operating Instructions. Perform the following procedure:

1. Remove the locking bolt and move the shutter several times from "AUS/OFF" to "EIN/ON" and from "EIN/ON" to "AUS/OFF" position acc. to the Operating Instructions.
  - ↳ The shutter shall be easily moveable and must not show corrosion at the visible area.
    - If the shutter is not movable from "EIN/ON" to "AUS/OFF" position follow the instruction in section "Emergency Procedures".
    - If the shutter is rough-running or indicating potentially malfunction secure the source holder in "AUS/OFF" position and contact the responsible radiation safety officer for further instructions.
    - In case of corrosion follow the instructions in section "Visual check"
2. When found the shutter mechanism in acceptable condition follow the instruction manual for correct positioning in "EIN/ON" or "AUS/OFF" position.

### Source containers with pneumatic actuator

Remove the padlock and disassemble the protection cap acc. to the Operating Instructions. Perform the following procedure:

1. Switch the shutter from "AUS/OFF" to "EIN/ON" position by pressurization. The shutter shall move uninterrupted to "EIN/ON" position.
2. Reduce pressure to ~ 0 bar. The shutter shall move back to "AUS/OFF" position.
  - ↳ - If the source holder is rough-running or indicating potentially malfunction secure the source holder in "AUS/OFF" position and contact the responsible radiation safety officer for further instructions.
  - If the shutter is rough-running or indicating potentially malfunction secure the source holder in "AUS/OFF" position and contact the responsible radiation safety officer for further instructions.
  - If the source holder is not movable from "EIN/ON" to "AUS/OFF" position follow the instruction in section "Emergency Procedures"
  - In case of corrosion follow the instructions in section "Visual check"
3. When found the shutter mechanism in acceptable condition follow the instruction manual for correct positioning in "EIN/ON" or "AUS/OFF" position.

### 3.4.3 Visual check

If considerable corrosion is visible at the housing measure the radiation level around the device. If values occur exceeding the normal operation level, cordon of the area and contact immediately the responsible radiation safety officer for instructions. In every case corroded devices should be exchanged as soon as possible. Corroded interlocks, corroded padlocks or corroded components under the protective cap which are part of the shutter mechanism require immediate exchange.

## 3.5 Leak Test

### NOTICE

#### Leak test

- ▶ Leak tests are not only required as routine checkup but also whenever an incident occurs that may damage the sealed source or the shielding.
- ▶ In such a case the leak test procedure shall be defined by the responsible radiation safety officer observing the applicable regulations and considering the source container and all involved parts of the process vessel. The leak test shall be conducted as soon as possible after the incident.
- ▶ The following leak test procedure is intended to be conducted routinely during continuous operation, during continuous storage or when placing back the source container into operation after storage. It does not consider incidents that may have damaged the sealed source or shielding.
- ▶ Leak tests shall be performed every 36 month or according to the interval specified in the associated sealed source and device registration certificate.

The following statements deal with the leak testing of gauging devices:

- All sealed sources supplied by Endress+Hauser are welded double encapsulated stainless steel capsules
- Possibility of leakage from the source capsule is very small
- The source capsule is enclosed in a lead-filled container to provide shielding of the gamma radiation
- If the source capsule should fail, the design of the source container is such that the probability of external contamination is minimal
- Anyone may perform the wipe test on the source container, but only a person, or company, specifically licensed by the NRC or an Agreement State may do the analysis
- The general concept of the leak test is to determine if the source capsule has failed, resulting in radioactive material outside of the unit. The radioactive material will be removed by the wiping action and will be detected when it is analyzed. Follow the instructions on the specific leak test kits.
- Each individual source/gauge requires its own leak test kit
- The analysis of the leak test swab requires special instruments and must be performed by a specifically licensed company

### 3.5.1 Leak Test Procedure

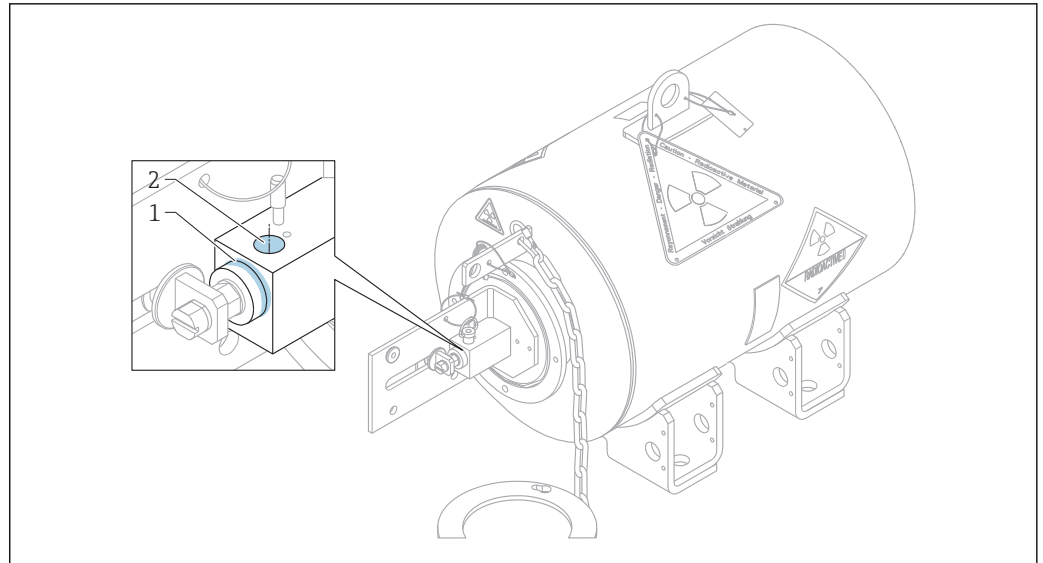
Leak tests shall be performed by a person or an organization authorized by NRC or an Agreement State to provide leak test services or using a leak test kit supplied by an organization authorized by NRC or an Agreement State to provide leak test kits. Leak test kits shall be used according to its supplier's instructions. Records of the leak test results shall be maintained.

The leak testing procedure can vary from supplier to supplier. One should follow the instructions included in each test kit. DO NOT clean the source container prior to taking the sample. The concept is to remove any loose radioactive material exterior to the unit. It is not necessary to disassemble the source container for the leak test. Wiping the external surface is sufficient. The wipe may be taken with the shutter "EIN/ON" or "AUS/OFF". If the shutter is in the "EIN/ON" position, use caution to ensure that your hand does not get in the radiation beam. If one is performing a leak test using an approved mailable kit, detailed instructions including a diagram of where to take wipes should be included and followed. If one does not elect to use an approved mailable kit, then contact Endress+Hauser for instructions.

Perform the following procedure unless otherwise instructed:

#### Manual version (order code 020, option A)

-  The wipe test can be performed when the source holder is in either the "EIN/ON" or "AUS/OFF" position.



A0027388

- 1 Wiping surface at border between source holder and housing block  
 2 Wiping surface in the bore hole of the lock pin

1. The wipe sample must at least be taken at the border between the source holder and the housing block, or in the bore hole of the lock pin if necessary.
2. Have the samples analyzed by an authorized organization. A source is considered to be leaking if more than 185 Bq (5 nCi) is detected in the leak test sample.

**i** This limit value applies for the US. National regulations may specify other limits.

In case of an indeed leaking source:

- Contact the responsible radiation safety officer for instructions
- Take appropriate measures to control a potential spread of radioactive contamination from the source. Secure the source
- Notify the authority of the fact that a leaking source has been detected

#### **⚠ CAUTION**

**Carefully follow all instructions. Radioactive material removed from the source container, if present, can spread contamination if it touches any other object.**

- ▶ Transfer the sample to the bag or container quickly but safely to prevent the spread of contamination. If the test result is positive, indicating the presence of radioactive material above the regulatory limit, the analyzing lab will notify you by FAX, email, or telephone. Contact the appropriate regulatory agency and Endress+Hauser for assistance. Arrangements must be made with Endress+Hauser, or another specifically licensed person, to remove the source container from service.

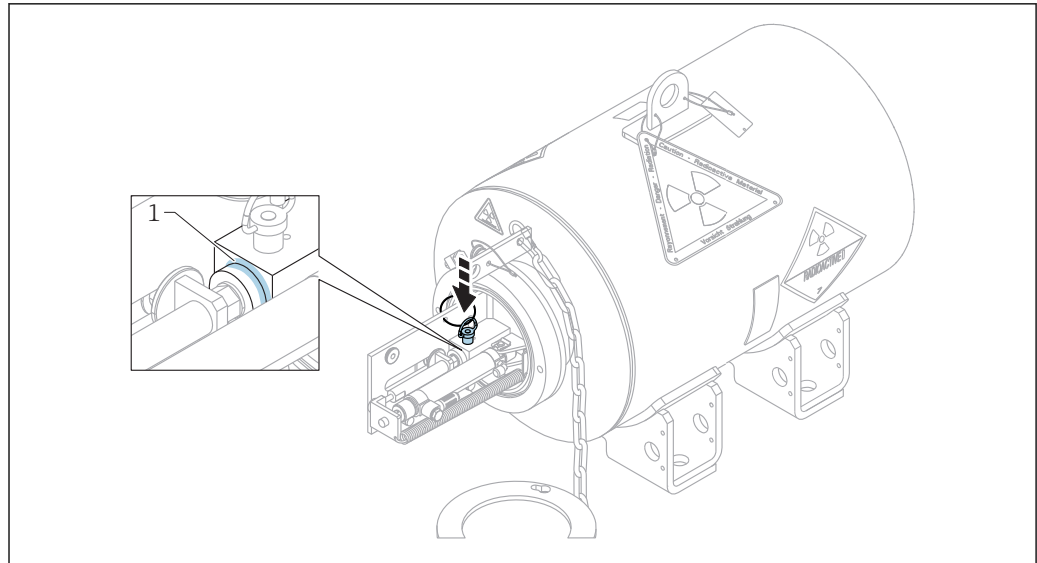
#### **Pneumatic version (order code 020, option L)**

#### **⚠ CAUTION**

##### **Risk of injury when cover is open**

- ▶ Make sure that the pneumatic drive is unpressurized for the entire time the cover is removed!

**i** Before performing the wipe test, disconnect the pneumatic drive from the compressed air supply and fix it in place in the "AUS/OFF" position with the lock pin.



A0026816

### 1 Wiping surface

1. The wipe sample must at least be taken at the border between the source holder and the housing block, or in the bore hole of the lock pin if necessary..
2. Have the samples analyzed by an authorized organization. A source is considered to be leaking if more than 185 Bq (5 nCi) is detected in the leak test sample.

**i** This limit value applies for the US. National regulations may specify other limits.

In case of an indeed leaking source:

- Contact the responsible radiation safety officer for instructions
- Take appropriate measures to control a potential spread of radioactive contamination from the source. Secure the source
- Notify the authority of the fact that a leaking source has been detected

### **CAUTION**

**Carefully follow all instructions. Radioactive material removed from the source container, if present, can spread contamination if it touches any other object.**

- ▶ Transfer the sample to the bag or container quickly but safely to prevent the spread of contamination. If the test result is positive, indicating the presence of radioactive material above the regulatory limit, the analyzing lab will notify you by FAX, email, or telephone. Contact the appropriate regulatory agency and Endress+Hauser for assistance. Arrangements must be made with Endress+Hauser, or another specifically licensed person, to remove the source container from service.

## 3.6 Servicing and inspection

In designated use, operated under the specified ambient and operation conditions, no inspection or servicing of the device is required.

If nevertheless inspection is considered as necessary - i.e. within the framework of routine inspections of the installation following checks are recommended on demand:

- Visual check regarding corrosion of housing, weld seams, protective cap, padlock, labels
- Check of the movability of the shutter ("EIN/ON", "AUS/OFF" function)
- Visual check of the readability of the labels and the condition of the warning symbols
- Check of the stability of the device base
- Check of the tightness of the sealings of the protective cap
- Check of good condition and tightness of the terminal box (types with proximity switches and types with pneumatic actuator)

- Visual inspection of the reference o-ring
- Check of readability of the "EIN/ON", "AUS/OFF" indication through the glass window of the protection cap
- Check of damage or loss of the safety chain between housing and protective cap.

#### **⚠ CAUTION**

##### **Incorrect function or improper condition of the device**

- ▶ If there is any doubt about correct function or proper condition of the device contact immediately the responsible radiation protection officer for advice.
- ▶ Repairs or maintenance work other than the usual inspection may be accomplished only by the manufacturer, by the supplier or by an authorized person.

Country specific regulations may require frequent inspections of the radiation source container.

## 3.7 Maintenance

Anyone possessing a source container is authorized to perform routine maintenance on the unit. Routine maintenance does not change the geometry of the source container-detector and does not interfere with the normal operation of the unit.

A preventative maintenance program should be implemented to prevent corrosion and wear on equipment. Routine maintenance of source containers and detectors could include but not be limited to the following activities:

- Cleaning and removal of foreign material from around source container or detector
- Collecting leak test samples (see above procedures)
- Opening or closing the shutter (see above procedures)
- Cleaning and painting the source container (if needed)

### 3.7.1 Cleaning a Source Container

Process material or dirt may build up in or around the source container or beam port area. This material may interfere with the process measurement and should be removed. Be careful when removing material so as not to interfere with operation of the gauge. One can use any method of cleaning, brushing or hand removal of material to clean the area. Additional, more aggressive methods may be used, such as high-pressure water or compressed air. It is not necessary or advisable to remove the source container to clean it. Do not use solvents that are corrosive to the source container. If labels have become unreadable, contact Endress+Hauser for replacements.

#### **NOTICE**

**Non-routine repair or maintenance must be performed by the gauge manufacturer or distributor or a person specially authorized by NRC or an Agreement State.**

▶

##### **Maintenance**

Not required when operated within specifications

##### **Cleaning**

- Clean from substances which may have impact on safety functions
- Maintain cleaning in appropriate intervals
- Clean the adhesive labels and - for version with pneumatic actuator or version with proximity switches - the terminal box only wet with water
- When cleaning the device, all instructions concerning radiation protection have to be observed

**⚠ CAUTION****Incorrect function or improper condition of the device**

- ▶ If there is any doubt about correct function or proper condition of the device contact immediately the responsible radiation protection officer for advice.

### 3.7.2 Painting

Endress+Hauser source containers have been in service for many years and have not required painting, but this is dependent on the environment. Though painting is not required the source container should be maintained in a fairly usable condition. After cleaning, painting can be used to address rust or surface corrosion issues. No specific color is mandated for the source container, but a color that is easy to see may help in the identification of misplaced source containers. Do not paint over the labels, tags, or indicators on the source container. Do not paint pneumatic components of models with pneumatic actuator. Do not paint the terminal box.

## 3.8 Non-Routine Maintenance

In order to perform non-routine maintenance, you must have a specific license that states you have permission to do so. Examples of non-routine maintenance are welding to modify the source container mounting, relocating the source container, or replacing corroded mounting brackets. If bolts, brackets or other fastening elements have been weakened due to rust, they need to be replaced. With proper training and agency approval, specific license authorizations may be received to perform some of these procedures. Major modifications which alter functional design of the source container are prohibited. Licensees requiring this type of assistance should contact Endress+Hauser.

## 3.9 Exchange of source

It is not allowed to exchange the source on site.



## 4 Incident Response

### 4.1 Emergency Measures

If the source container or the radiation source is damaged by accident or another unforeseen event or if the radiation source is lost by other means, the following emergency measures shall be initiated:

- Inform the radiation safety officer immediately
- Immediately evacuate, restrict and post the area, allowing access only to individuals authorized by the radiation safety officer
- Production must be halted immediately if there is a risk that the radioactive material has gotten into the material being measured. Potentially contaminated material must be secured and must not be further used before it has been tested.
- Response personnel should be advised of potential radiation hazards

As soon as the emergency measures have been initiated, the authorities responsible for radiation must be informed by the radiation safety officer. The radiation safety officer should document the incident and make any necessary reports.

### 4.2 Emergency Procedures

#### 4.2.1 Objective and Overview

This emergency procedure shall be put into effect immediately to minimize potential exposure to individuals and to secure an area in the interests of protecting personnel where an exposed source is known, or suspected, to exist. Such an emergency exists when a radioisotope is exposed either by it becoming separated from the source container or a shutter mechanism cannot be put into "AUS/OFF" position. This procedure will safeguard an area until an appropriate radiation safety officer can attend site and advise on corrective action.

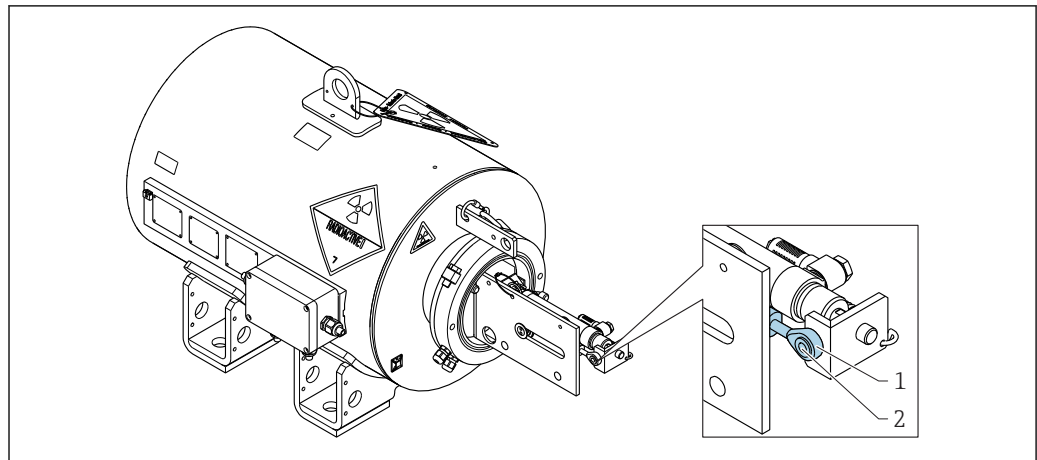
The custodian of the radioactive source (the customer's designated "authorized person") is responsible for observing this procedure.

#### 4.2.2 Procedure

- Determine the unsafe area by measurement (on site) or by calculation knowing the size and type of source installed from the records
- Restrict the area, placing barrier tape and appropriate warning signs at a distance where radiation levels exceed 20  $\mu\text{Sv/h}$  (2 mrem/hr)
- If the shutter will not close, keep individuals out of the radiation beam.
- If it is not practical to restrict the entire area or if the source is no longer in the source container, it may be necessary to secure and shield the source. Here the inverse square law should be observed; i.e. radiation intensity decreases inversely with the square of the distance. The source should only be handled using pliers or tongs and held as far away from the body as possible. The time taken to complete the activity should be minimized by rehearsal prior to execution.
- If part of the area is accessible (e.g. a vessel in the event of a level gauge installation where there is a possibility that a person might enter), the source housing should be unbolted from its mounting and
  - in case of radiation emission channel is located horizontally: put the emission channel towards a very thick wall, or
  - in case the radiation emission channel is located vertically: put the source container on its device base on the ground.

In case of a shutter that will not close due to failure of the pneumatic drive: Switch off or disconnect compressed air, remove supply lines if necessary. Remove the protection cap. Unscrew the connection screw between the eye bolt at the end of the source holder rod

and the pneumatic drive. Move the source holder rod to "AUS/OFF" position and secure it by the means of the locking bolt.



- 1 Eye bolt  
2 Connection screw

Personnel should at all times be behind the source housing, not in front of the emission channel. The lifting eye on the housing of FQG66 should facilitate safe handling.

#### **CAUTION**

##### **Risk of injury**

- ▶ Use lifting tools due to the weight of approx. 435 kg (959.18 lb).
- After the emergency has been resolved, the radiation safety officer should document the incident and make any necessary reports
- Make necessary notifications to local authorities as well as the NRC within 24 h  
**NRC's Operation Center: 301-816-5100 or 301-951-0550**
- After thorough assessment of the damage, the responsible radiation safety officer, in conjunction with NRC and/or local authorities and Endress+Hauser, shall agree a remedy to the specific problem

## 4.3 Potential Emergency Situations

The following are examples of possible problems that can be foreseen with source containers.

### 4.3.1 Stuck Shutter

Stuck shutters can result from several situations, such as physical damage, rust or dirt around the shutter. A stuck shutter is usually not an emergency situation in itself. If ignored or handled improperly, individuals may be at risk of unnecessary radiation exposure. A stuck shutter is usually discovered during a routine inspection or an emergency when the shutter needs to be closed.

The following procedure is to be performed only if the container does not exhibit major damages caused by fire, crash or collision:

- If the source container exhibits external dirt or rust such that the protection cap can not be disassembled in order to move the source holder rod into the "AUS/OFF" position, the dirt must be removed manually by a brush.
- If the two screws of the protection cap are rusty or stiff they must be sprinkled with a rust solving penetrating oil and loosened by three to four turns (see Operating Instructions BA01327F), chapter "Manual version with/without proximity switch").
- Cleaning by high-pressure cleaner or air compressor is admissible. If this does not succeed, please contact Endress+Hauser.
- After the protection cap has been removed dirty parts must be cleaned, preferably by compressed air.
- Observe possible damages (e.g. of the slide bearings). The affected parts must be replaced and documented.
- Move the locking bolt from the hole in the guide tube to the parking position.
- Try to move the source holder rod into the "AUS/OFF" position by pushing the rod towards the housing.
- If the pneumatic drive got stuck proceed as described in chapter "Procedure"
- If the source holder rod still does not close and one needs it shut for removal or for work in the vessel, leave the source container where it is until you have contacted the manufacturer. One of the safest places for the source container to be is in its mounted position.
- Do not proceed with the job.
- As a temporary solution to proceed with the work, one may be able to place enough shielding material in front of the source opening to attenuate the radiation field. (Use a survey meter to verify radiation levels.) This method should only be considered temporary until the unit can be repaired or replaced.

### 4.3.2 Lost or Missing

If for some reason a source container is believed to have been stolen or lost, the following actions should be taken:

- Begin a dedicated search for the lost or missing device.
- Interview employees who may have been in the area.
- Determine when the source container was last known to be present.
- Search all areas where the container could have been placed, i.e., storage areas, dumpsters, trash bins, etc.

Upon determination that the source container cannot be located, the radiation safety officer should immediately notify the appropriate regulatory agency by telephone or FAX and follow-up with a written report. Requirements of information to be included in the written notification are contained in the regulations.

Continue a diligent investigation to determine why the incident occurred, and what steps are required to ensure it is not repeated.

### 4.3.3 Entering into a Tank or Vessel

Perhaps the most avoidable unnecessary radiation exposure is caused by individuals entering a tank or vessel before the shutter has been closed or the radioactive source has been retracted into its protective housing.

- This unnecessary exposure can be prevented by following lock-out/tag-out procedures.
- A simple preventive measure is to mark each manway with a sign indicating the presence of radioactive sources.
- Before any person enters a vessel, the source shutter must be in the "OFF" position. Individuals should be trained in advance to recognize postings identifying monitored vessels.
- Contractors hired to work on vessels must be made aware of the presence of radioactive sources and procedures to be followed.

If safety precautions are ignored and people enter a vessel while the shutter is still "ON", perform the following procedure:

- Evacuate the vessel.
- Interview involved individuals to determine how long they were in the vessel and at what location.
- Calculate exposure by measuring the radiation field in the vessel and accounting for time in the radiation field; or by using the equations in the "Important Safety Calculations" section of this manual.
- Determine the isotope and its current activity based upon the container label or records.
- In making dose calculations, one must also take into consideration the materials and thickness of vessel side walls. Contact Endress+Hauser for assistance in making these calculations.
- If involved workers express a concern or want medical evaluation, such should be provided.
- The radiation safety officer should notify the appropriate regulatory agency if exposures exceed any regulatory limit.

#### 4.3.4 Damage on Fall or Collision

Source containers may be damaged as a result of falls or collisions. Personnel should be made aware of potential damage due to the following:

##### Falls

- Rusty bolts or weld failures resulting in containers falling from installed locations.
- Support equipment failing during installation or removal of source container.
- Bolts that have vibrated loose or were not installed properly at time of installation.

##### Collisions

Vehicle runs into source container.

##### Recommended Actions

- Survey the source container and compare results with the installation survey pattern.
- If the survey is comparable, the shielding is probably intact.
- Test to see if shutter mechanism is working properly. If it is, lock it "AUS/OFF".
- If the shutter cannot be moved to the "AUS/OFF" position, please refer to the stuck shutter procedures, and call the manufacturer for assistance.
- Perform a leak test to confirm the source has not been compromised.
- If contamination is present, take steps to contain it. A simple method of containing contamination is to cover the source container with a plastic bag.
- If the radiation pattern is comparable to the original, the source shutter mechanism is operating properly, and there is no evidence of contamination, the unit can be returned to service.
- If the survey indicates the source container has been damaged or shielding compromised, it must be taken out of service.
- Contact the source container manufacturer or a specifically licensed individual to arrange for or advice on the safe removal, packaging, and shipment of the source container. If warranted, place shielding materials around the source container to decrease radiation levels.

#### 4.3.5 Damage on Fire

Evacuate and restrict the area to emergency response individuals. Priorities would include treatment and removal of injured employees, and fighting the fire. After these activities are completed, the radiation safety officer should evaluate the condition of source containers involved in the fire.

- Assume that some of the lead shielding has melted.
- Survey the damaged source container and compare results with initial installation survey.
- Examine the source container environment for any damage to the mounting structure (bolts, brackets) replacement of insulation or cooling system if such was supplied.

- Secure the source container at its ring eyelet by suitable means.
- Leak test the source container for removable contamination.
- Check the shutter mechanism for proper function.
- If the survey results indicate an elevated radiation field:
  - Rope and post the area at 20  $\mu\text{Sv/hr}$  (2 mrem/hr)
  - Record names of all personnel who may have been in the restricted area
- Contact Endress+Hauser or a specifically licensed individual for further assistance.

Endress+Hauser designed FQG66 to withstand most fires. The probability of a source capsule failing, even under fire or explosion conditions, is extremely rare.

#### 4.4 Equipment for Cases of Emergency

Items that may be useful in a time of a major emergency include:

- Initial radiation surveys of source containers
- List of emergency procedures and phone numbers for help
- Calibrated survey meters
- Leak test supplies
- Radiation signs and rope
- Gloves
- Temporary shielding materials
- Dosimeters and film badges
- Plastic bags for contaminated items
- Batteries for survey meter
- Tape measure
- Suitable allen key and wrench for opening the protective cap

#### 4.5 Important Safety Calculations

The best method for determining an individual's dose rate is to measure the radiation field intensity with a survey meter. From a  $^{137}\text{Cs}$  or  $^{60}\text{Co}$  source, which are gamma emitters, the exposure rate in  $\mu\text{Sv/h}$  (mR/hr) can be read directly from a calibrated meter. Most meters are still calibrated in the traditional unit of Roentgen, more than likely in milliroentgens (mR) or microroentgens ( $\mu\text{R}$ ). For gamma rays, mrem/hour would be equal to the radiation field intensity in mR/hour. For example, if the measured radiation field intensity three feet from the source is 0.6 mR/hr, a person standing three feet from the source would have a dose equivalent of 6  $\mu\text{Sv}$  (0.6 mrem). Some meters are calibrated in units of  $\mu\text{Sv}$ .

##### 4.5.1 Dose Rate Calculation

In cases where a survey meter is unavailable, the exposure rate from an unshielded point source can be calculated. Complete this equation to find the exposure rate (mR/hr) from an unshielded point source. This can be from a source capsule itself or from the beam port of a source container. This formula will not work from a shielded source.

$$R = (k) \times (A) / d^2$$

Where the terms in international units (traditional units):

- R= dose rate in  $\mu\text{Sv/hr}$  (mrem/hr) to be calculated
- A= Activity of the source in GBq (mCi) which can be found on the source container label
- d= Average distance to source in meters (feet)
- k= Constant, which depends on type of isotope in the source capsule
  - $^{60}\text{Cobalt}$ ; k = 350 (14.4)
  - $^{137}\text{Cesium}$ ; k = 88 (3.6)

**Example**

Suppose the estimated exposure time in a radiation field from an unshielded point source is 10 minutes at a distance of 1 meter (3.3 feet) with a  $^{137}\text{Cs}$  source activity of 0.74 GBq (20 milliCuries).

*The calculated dose rate would be:*

International units	Traditional units
$R = (88) \times (0.74) / (1)^2$	$R = (3.6) \times (20) / (3.3)^2$
$R = 65 \mu\text{Sv/hr}$	$R = 6.6 \text{ mrem/hr}$

*Total effective dose equivalent would be:*

International units	Traditional units
$63 \mu\text{Sv/hr} \times 10 \text{ min} \times 1\text{hr}/60\text{min} = 10.8 \mu\text{Sv}$	$6.4 \text{ mrem/hr} \times 10 \text{ min} \times 1\text{hr}/60\text{min} = 1.0 \text{ mrem}$

**4.5.2 Emergency Shielding Material**

Lead is used as shielding material in source containers based on its density. But in emergency situations lead may not always be accessible. Several materials can be used as temporary shielding. The following table states the thickness of several materials which can be used to decrease the radiation intensity to one half its original value. These thicknesses are also known as half-value layers.

*Approximate Shielding Half-value Layers*

Material	$^{137}\text{Cs}$	$^{60}\text{Co}$
Concrete	2" (51 mm)	3 1/4" (83 mm)
Aluminium	1 1/2" (38 mm)	3" (76 mm)
Steel, Brass	1/2" / 13 mm)	1" (25 mm)
Lead	1/4" (6 mm)	1/2" (13 mm)
Tungsten	3/16" (4.7 mm)	3/8" (9.5 mm)

**4.5.3 Suggested Distance From Unshielded Sources**

Having a pre-planned course of action prior to an emergency occurring enables authorized individuals to promptly respond to any incident. The following data will assist in determining distances for restricted access.

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

- Assume the source is completely unshielded
- Use the highest activity source
- Plan to restrict at dose rates of 20  $\mu\text{Sv/hr}$  (2 mrem/hr).

**International units**

- $^{137}\text{Cesium}$  Sources: Distance in meters =  $2.1 \times \sqrt{\text{activity in GBq}}$
- $^{60}\text{Cobalt}$  Sources: Distance in meters =  $4.1 \times \sqrt{\text{activity in GBq}}$

*Example:*

If the highest activity source is 3.7 GBq of  $^{137}\text{Cs}$

Distance in meters =  $2.1 \times \sqrt{3.7} = 4 \text{ meters}$

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

**Traditional units**

- <sup>137</sup>Cesium Sources: Distance in feet =  $1.3 \times \sqrt{\text{activity in mCi}}$
- <sup>60</sup>Cobalt Sources: Distance in feet =  $2.6 \times \sqrt{\text{activity in mCi}}$

*Example:* If the highest activity source is 100 mCi of <sup>137</sup>Cs

Distance in feet =  $1.3 \times \sqrt{100} = 13.0$  feet

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

## 5 Source Container Models

### 5.1 Applications of FQG66

The FQG66 source container is used in combination with a gamma detector in measuring systems for level measurement, level limit detection, density and concentration measurement. All types are intended for fixed installations and do not move during use. The housing provides a device base to attach the source container to a vessel or a frame. For safe handling, e.g. during installation, a ring eyelet is provided on the housing. The source container does not come into contact with the medium to be measured. The physical form of the isotope is either metal (in case of  $^{60}\text{Co}$ ) or a solid ceramic pellet (in case of  $^{137}\text{Cs}$ ). The isotope material is covered by a hermetically sealed, double walled stainless steel source capsule. The source capsules have ANSI/ISO classifications, see Technical Information TI00439F. The capsule is included into a stainless steel source holder rod, which is assembled inside the source container housing (stainless steel). In the proximity of the source capsule (stainless steel) chemical compatible materials (stainless steel) only are used. Steel/stainless steel combinations are not applied.

### 5.2 Scope of delivery and Operating and Safety Instructions

- Source Container FQG66
- Radioactive source (built in)
- Radiation warning sign
- Operating Instructions BA01327F
- Technical Information TI01171F
- Radiation Safety Manual SD01561F (this document)

 Observe Operating Instructions, Technical Information and Safety Manual.

### 5.3 Delivery

The source container must be shipped with the radioactive source already installed. The shutter will be secured in the "AUS/OFF" position with a lock pin under the protective cap. The protective cap is secured by a padlock and security seal. The shipment will be a "Type A" package and all marking, labeling and documentation will comply with U. S. Department of Transportation (DOT) regulations. Transport will be by common carrier, or other entity authorized to carry radioactive material. Shipments to Specific Licensees cannot be made until we have a copy of the Specific License authorizing receipt, possession and use of the radioactive material. Endress+Hauser will be happy to assist with procuring this license if desired. Shipments to General Licensees (a regulatory license issued for certain inherently safe devices containing sealed sources) cannot be made. Contact our local sales center for questions or assistance.



## 6 References

### 6.1 Internet Sites and Information

#### 6.1.1 NRC Home Page

This site has links to the Regulations and Guides

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

#### 6.1.2 Listing of Agreement State Programs with Phone Numbers

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

#### 6.1.3 Of Particular Interest

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

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

#### 6.1.4 Radiation Technology Inc.

<http://www.radiationprograms.com>

#### 6.1.5 Occupational Safety & Health Administration

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







[www.addresses.endress.com](http://www.addresses.endress.com)

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