

Source container QG 2000 Radiometric Measurement

Operating Instructions

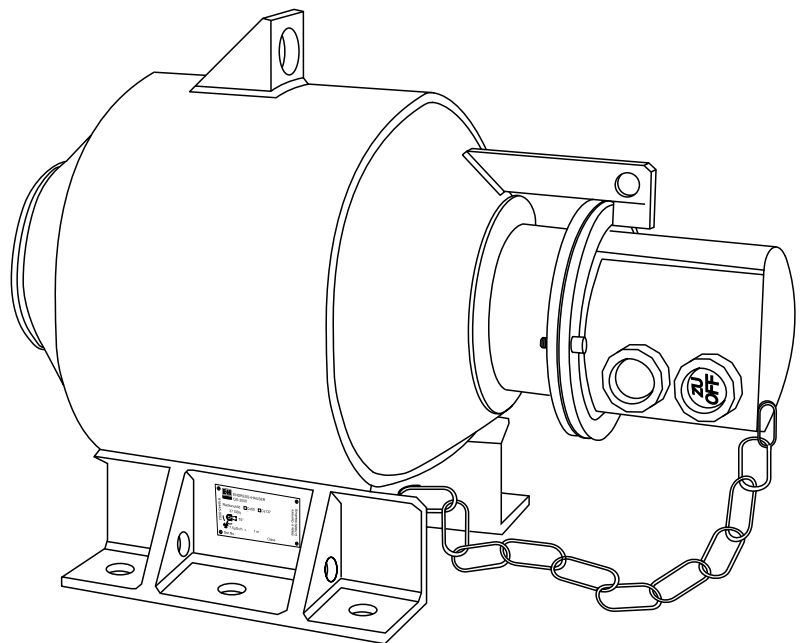


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1 Safety instructions

1.1 Designated use

The source container QG 2000 described in these safety instructions contains the radioactive source, which is used for radiometric measurement of level, interface and density. It screens the radiation towards the surrounding and allows 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 operating manual for mounting and operating 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.

1.2 Basic Instructions for Use and Storage

- Observe the applying rules and national/international 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 the manufacturer's instructions.
- 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) when operated or stored.
- Always safe the position of the source insert using the lock or padlock.
- Do not operate or store damaged or corroded devices. Contact the responsible radiation protection officer for appropriate instructions and measures when damage or corrosion occurs.
- Conduct the required leak testing procedure according to the applying regulations and instructions.



Caution!

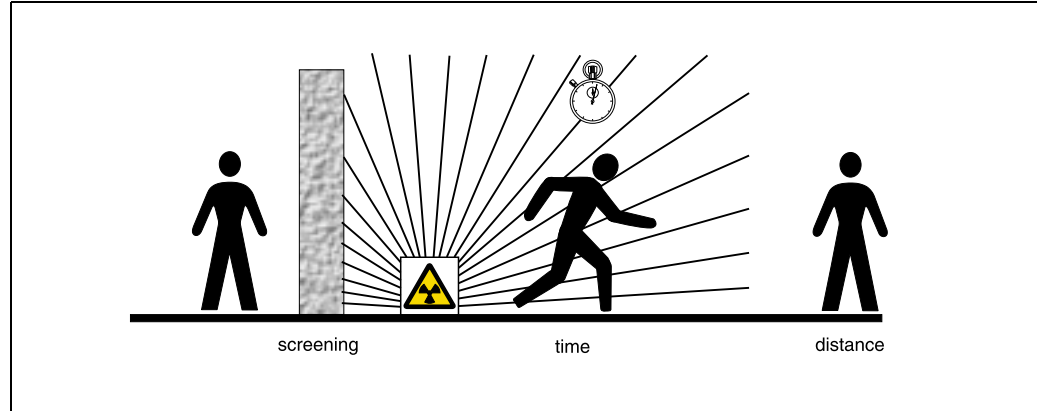
In case of doubt about proper condition of the device check the area around the device for leakage radiation and/or contact immediately the responsible radiation protection officer.

1.3 Basic regulations on radiation protection



Warning!

When handling radioactive sources, all unnecessary radiation exposure should be avoided. All unavoidable radiation exposure should be kept as low as possible. Three measures are used for this:



Distance

Keep the largest possible distance from the radiation source.

The local radiation dose rate decreases at the square-root of the distance from the radiation source.

Screening

Ensure the best possible screening between the radiation source and yourself as well as all other individuals.

Effective screening is provided by radiation protection containers (e.g. QG 2000) and all high-density materials (lead, iron, concrete).

Time

Stay as short as possible in the area exposed to radiation.

1.4 Legal requirements for radiation protection

Handling radioactive emitters is legally controlled. The radioactive protection regulations of the country in which the plant is to be operated are to be strictly observed. In the Federal Republic of Germany the current radiation protection requirements are applicable. The following important points derived from this for radioactive measurement are:

Handling permit

A handling permit is required for operating a plant which uses gamma radiation. Application for the permit must be made to the Land government or the authority responsible (Land Offices for Environmental Protection, Trade Inspection Offices, etc.). The Endress + Hauser Sales Organisation will be pleased to help you obtain the permit.

Radiological safety officer

The operator of the plant must nominate someone responsible for radiation protection who has the necessary specialist knowledge and who is responsible for observing all radiation protection regulations and procedures for radiation protection. Endress+Hauser offers training courses in which the necessary specialist knowledge can be acquired.

Control area

Only persons exposed to radiation during the course of their job may sojourn in control areas (i.e. areas where the local dose rate exceeds a specific value) provided they are subjected to official personnel dose monitoring procedures. For the Federal Republic of Germany the limit values for the control area are specified in the current radiation protection requirements.

The Endress+Hauser sales office will be pleased to provide further information of radiation protection and regulations in other countries.

1.5 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, outer parts of source insert, lock/padlock
- check of the movability of the source insert (on/off function)
- visual check of the readability of the labels and the condition of the warning symbols.



Caution!

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

1.6 Behaviour in the Event of an Incident

1.6.1 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 immediately:

- Inform the radiation protection officer immediately.
- All employees must leave the danger area immediately. The area around the measuring point must be barred to access and labelled.
- Production must be halted immediately if there is a risk that the radioactive material has got into the material being measured. Possibly contaminated material must be secured and may not be further used before it has been tested.
- All persons involved in cleaning up (fire brigade, works security, etc) must be informed of the hazards of radiation.

1.6.2 Report to the responsible authority

As soon as the emergency measures have been initiated, the authorities responsible for radiation must be informed by the radiation protection officer.

1.7 Procedures after termination of the application

1.7.1 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 protection 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.

1.7.2 Return

FR Germany

Contact your E+H Sales Centre to organise the return of the radiation source for inspection with a view to reuse or recycling by Endress+Hauser.

Other countries

Contact your E+H Sales Centre or the appropriate authorities (government ministry) or regulating authority to find a way of returning the radiation source nationally. If return is not possible domestically, the further procedure must be agreed with the sales centre concerned. The destination airport for potential returns is Basle, Switzerland.

1.7.3 Conditions

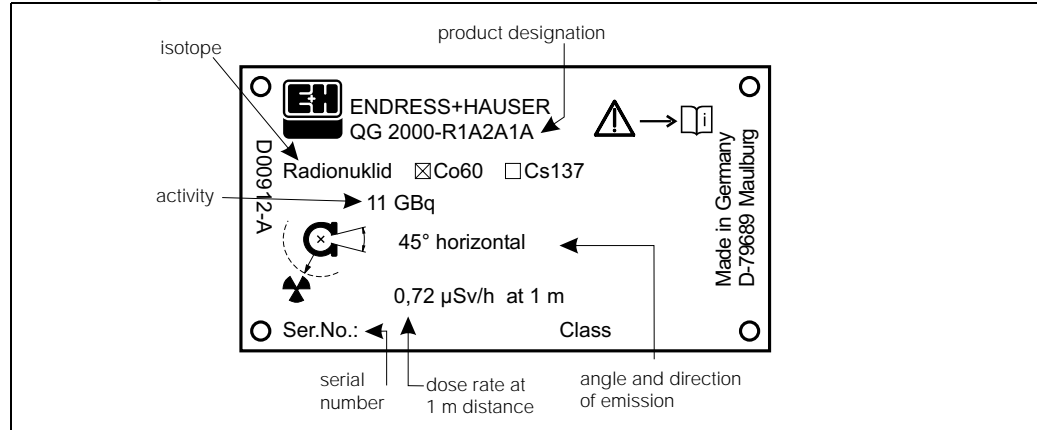
The following conditions must be met before returning the material:

- An inspection certificate no more than three months old confirming the leak-tightness of the radiation source must be in the possession of E+H (wipe test certificate).
- The serial number, type of radiation source (^{60}Co or ^{137}Cs), activity and model of radiation source must be specified. This data may be found in the documents supplied with the radiation source.
- The material must be returned in an approved secondary containment suitable for simple manipulation and in type-tested type-A packaging (IATA rules).

2 Identification

2.1 Device designation

The following technical data are shown on the nameplate:



2.2 Scope of delivery

Scope of delivery includes:

- QG 2000 source container
- radiation source (built in)
- radiation warning sign
- operating manual

3 Installation

3.1 Transport

Delivery and transport of loaded radiation protection containers are conducted by a company commissioned by Endress+Hauser and officially certified for executing this type of job.

Transportation shall take place in a Type "A" package which complies with the regulations of the European Agreement on the International Transportation of Hazardous Substances on Roads (GGVS/ADR and DGR/IATA).

3.2 Installation conditions

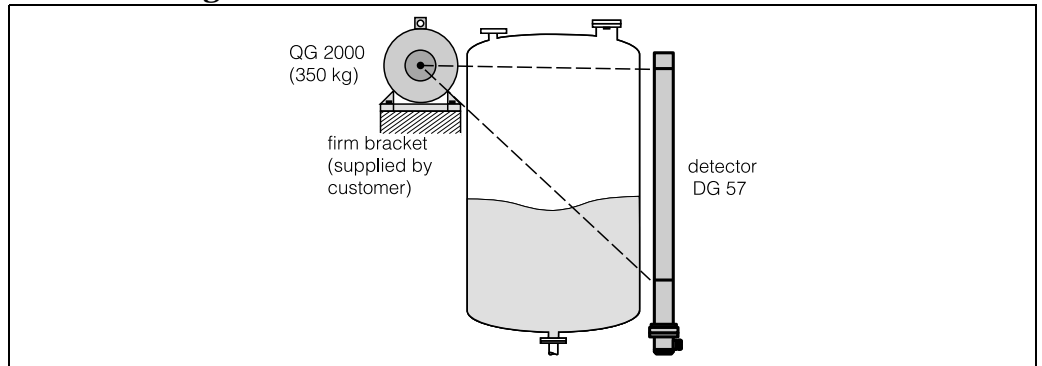


Caution!

For all applications, the mounting location for the QG 2000 and the angle of emission should be selected so that the complete length of the detector is radiated.

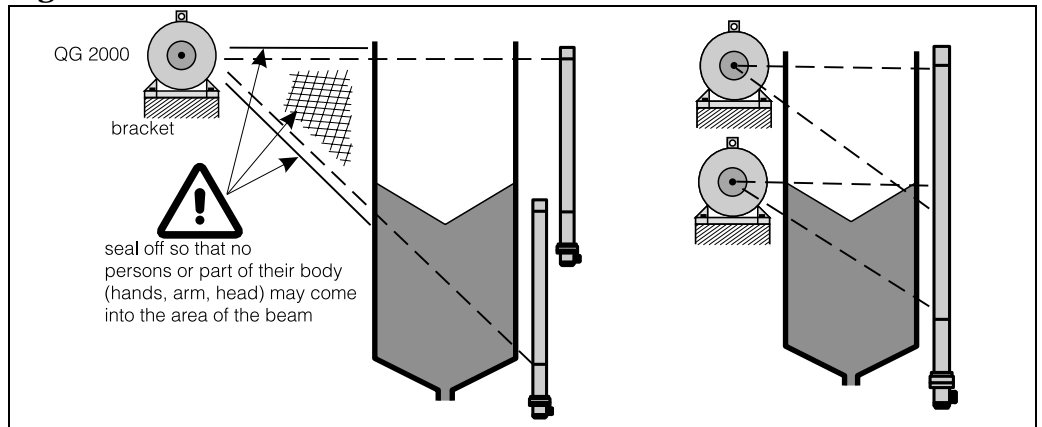
3.2.1 Level measurement

Standard Configuration



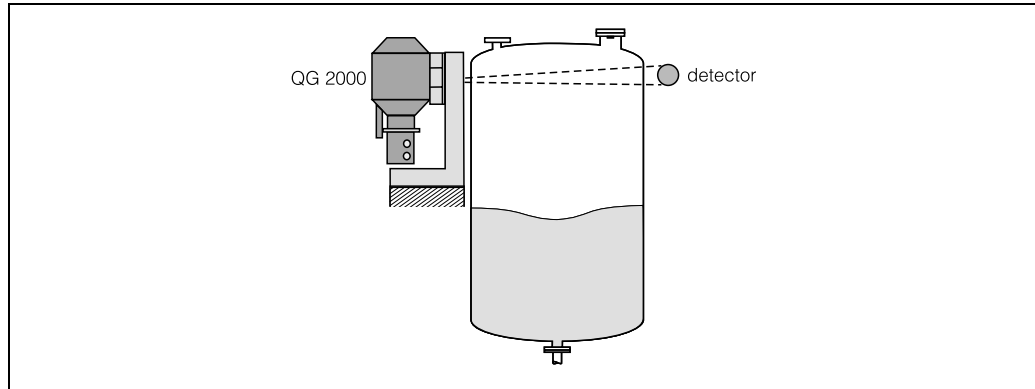
The source container must be mounted slightly above or at the same height as the maximum level. The radiation must be exactly directed towards the detector mounted opposite. To avoid control areas, the source container and detector should be mounted as near to the vessel as possible.

High and narrow vessels



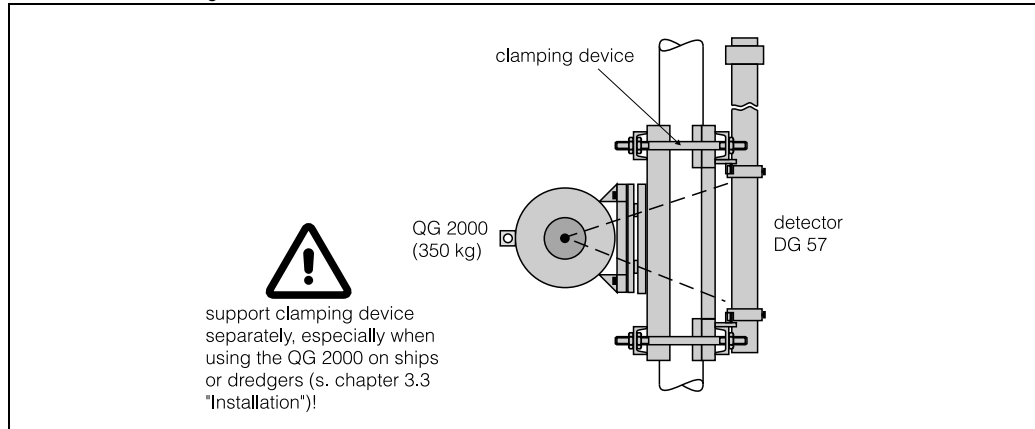
A space between the source container and vessel can often not be avoided for large measuring ranges or vessels with small diameters. The space must then be sectioned off and indicated. Two or more source containers are generally used for large measuring ranges. Using two source containers is not just a question of the measuring range but also of the increased accuracy they offer.

3.2.2 Level limit detection



Mount the detector in a horizontal position to detect the level limit. Also mount the QG 2000 so that the radiation runs horizontally.

3.2.3 Density measurement



Mount the sensor to vertical pipelines with the direction of conveyance from bottom to top to obtain the most constant conditions for density measurements in pipes. If only horizontal piping is accessible, then the radiation path should be horizontal to reduce the effects of air bubbles and build-up of material. A clamping device is available for mounting on piping. Support the clamping device separately to avoid the weight of the QG 2000 (350kg) from acting on the pipe.

3.3 Installation

3.3.1 Fastening for transport

There is a fastening for a crane on the QG 2000 for transporting it (see dimensional drawing, page 19).

3.3.2 Bracket



Note!

In order to ensure stable measurement and lasting radiation protection, the QG 2000 must be tightly screwed onto a rugged, low-vibration bracket that can withstand a weight of 350 kg under all operating conditions. Additional supports are generally required when mounting directly on the vessel.

Especially when using the QG 2000 on ships or dredgers, the fastenings on the piping must be able to take the weight of any loads placed on them and appropriate supports provided.

The screw joint dimensions are contained in the Technical Data (see Fig., page 19).

3.4 Post-installation check

The following measures are to be taken to ensure radiation protection after installation:

3.4.1 Measuring the local dose rate



Warning!

The local dose rate in the vicinity of the source container and the detector must be measured immediately after it has been mounted. Depending on the installation, radiation can also occur outside the actual beam-emitting channel through scattering. In such cases it must be screened by the use of additional lead or iron sheeting. Render or mark all control and exclusion areas as prohibited for unauthorised entry.

3.4.2 Limiting the area of the working beam



Warning!

Access to the working beam is to be sealed off. Parts of the body (hands, arms, head) must also not come into the area of the beam. Close off and mark any existing accesses to the container. The radiation protection officer must keep the key.

If control areas occur outside the working beam (to be measured!), then these too must be sealed off.

4 Wiring



Note!

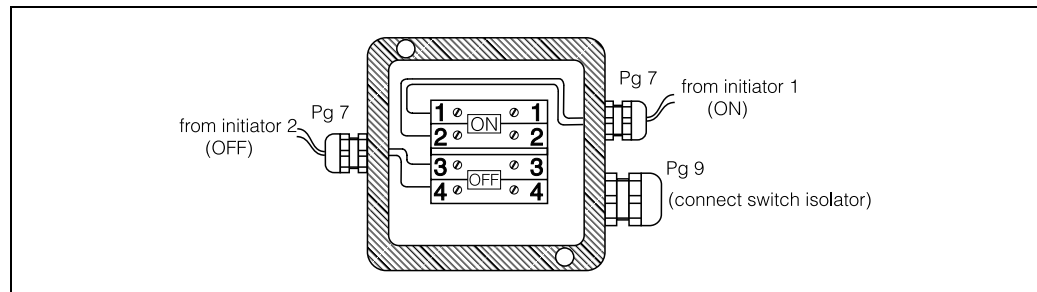
The instructions below apply only to the QG 2000 version with initiators for remote switching state display (ON or OFF).

4.1 Initiators and isolated switch amplifier

In addition to the sight glasses supplied with this version, the switching status is also detected by two proximity switches NJ4-12GK-SN supplied by Pepperl+Fuchs. For signal evaluation, the following isolating switch amplifiers from, e.g. Pepperl+Fuchs can be used:

- KFA6-SH-Ex1 (230 V AC)
- KFD2-SH-Ex1 (24V DC)

4.2 Connecting box



The Pg 7 cable glands on the connecting box are assigned to the initiators on delivery. The Pg 9 cable gland connects the isolating switch amplifier

The table below shows the pin assignment:

Terminals 1,2	Initiator for position "radiation ON"
Terminals 3,4	Initiator for position "radiation OFF"

The connecting diagram is also provided inside the connecting box cover.

5 Operation

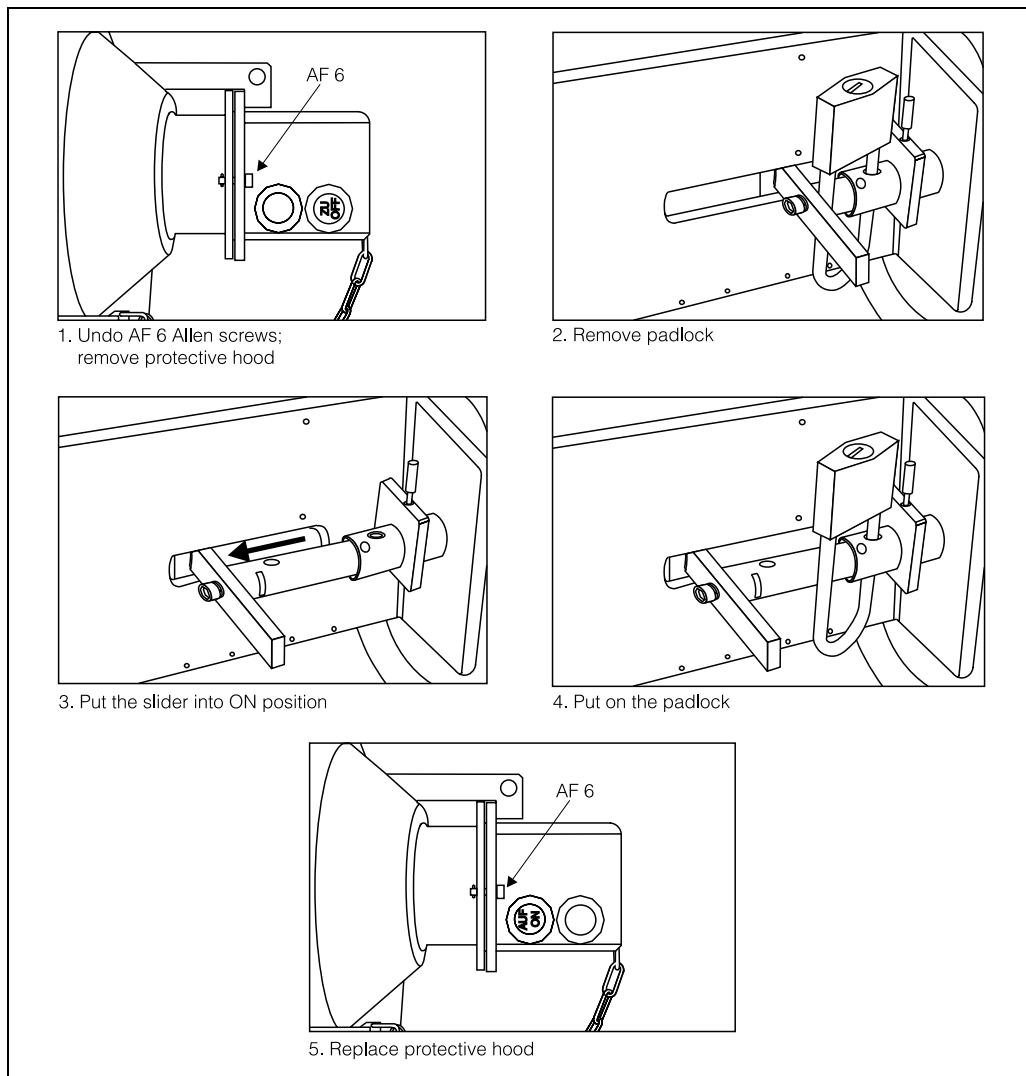
5.1 Switching on the radiation beam



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.

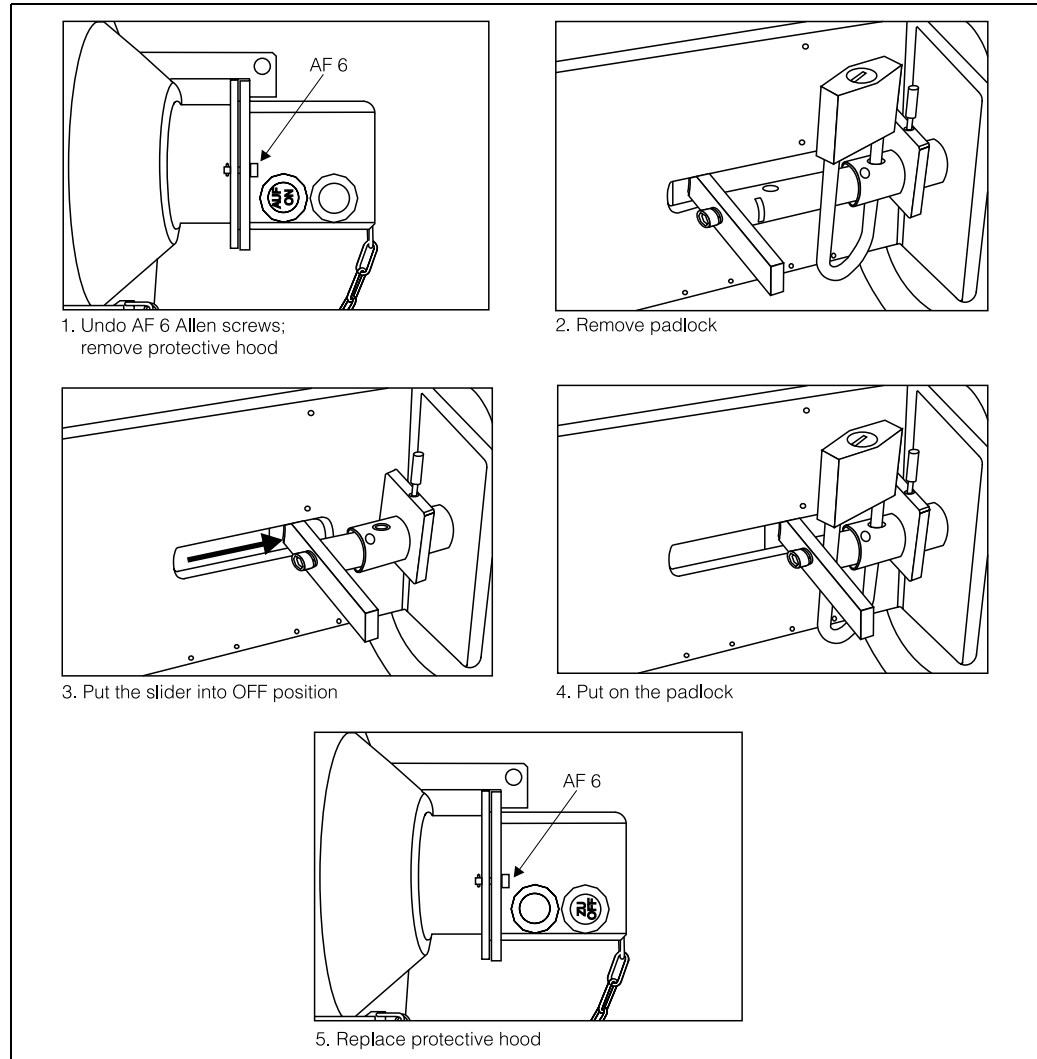
Procedure



1. Undo the 6 AF Allen screws of the protective hood and remove it.
2. Open and remove the padlock which puts the source support rod in the "OFF" position.
3. Using the slider, put the source support rod into the desired "ON" position: Label "ON" is visible, label "OFF" is covered.
4. Put on the padlock and lock.
5. Replace the protective hood and fasten securely with the screws.

5.2 Switching off the radiation beam

Procedure



1. Undo the AF 6 Allen screws of the protective hood and remove it.
2. Open and remove the padlock which puts the source support rod in the "ON" position.
3. Using the slider, put the source support rod into the desired "OFF" position: Label "OFF" is visible, label "ON" is covered.
4. Put on the padlock and lock.
5. Replace the protective hood and fasten securely with the screws.

5.3 Changing the source



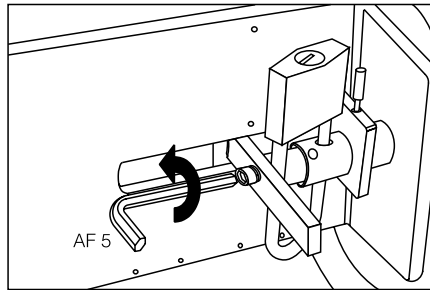
Safety instructions for changing the radiation source

- All maintenance such as removal or replacement of the radioactive source 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 are 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 risk.
- Detailed preparation are to be made to ensure that all procedures are carried out as quickly as possible. The following tools and equipment should be provided before starting work:
 - 6 AF allen key
 - 5 AF allen key
 - 14 AF spanner
 - pliers for radiation source
 - shielded vessels for old and new radiation source
- When changing the source, strictly observe all instructions given in this manual.

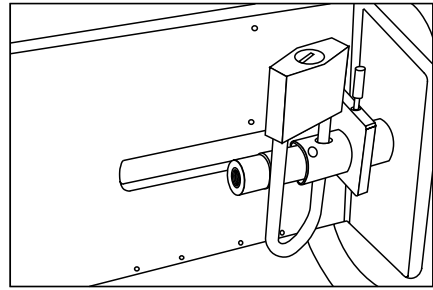
Procedure (see figure on page 18)

1. Undo the 6 AF Allen screws of the protective hood and remove it. The source support rod is in the "OFF" position and is secured by the padlock. Undo the two nuts using a 5 AF spanner or screw driver.
2. Take off the nuts and washer and remove the slider.
3. Undo the padlock and remove. Remove the source support rod until the marking groove 1 is visible. Turn the source support rod until the marking groove 2 is in line with the holding screw. Screw in the holding screw to secure the protective tube.
4. Unscrew the source support rod from the protective pipe using a 14 AF spanner.
5. Hold the source support rod above the transport container provided. Use a pair of pliers to extract the radiation source out of the source support rod (or use a suitable tool to unscrew the M4 thread radiation source) and place it in the transport container. Place the new radiation source in the bore hole of the source support rod until the nipple engages in the spring (or screw onto the M4 thread to a torque of 2+0,5 Nm). Immediately push the source support rod in the protective tube.
6. Screw the source support rod into the protective tube and secure using a 14 AF spanner.
7. Remove the holding screw from the bore hole until the complete source support rod is again easily movable. Slide the complete source support rod into the source container until the bore holes are in line for the padlock in the "OFF" position. Put on the padlock and lock.
8. Put the slider on the screw connection of the source support rod and secure with the washer and the 10 AF screw. Replace the protective hood and fasten securely with the screws.

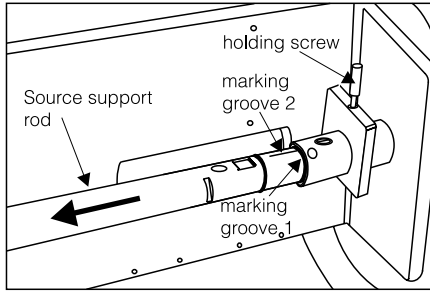
Changing the source: Procedure



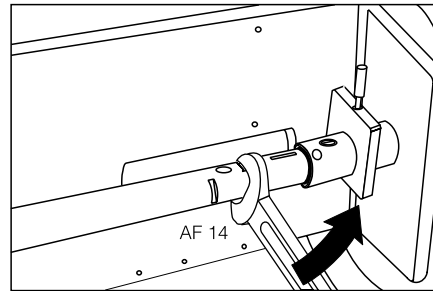
1. Undo AF 6 Allen screw



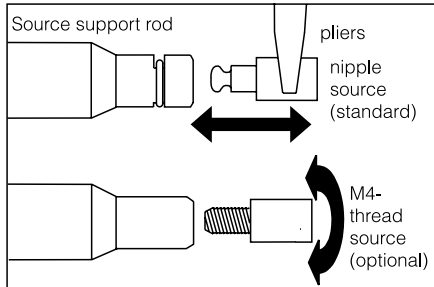
2. Remove slider.



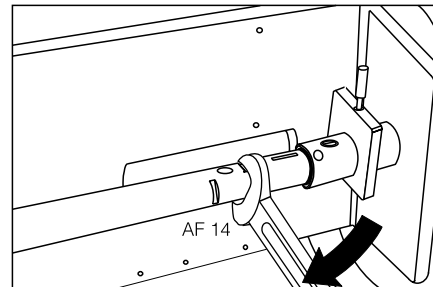
3. Remove padlock. Remove source support rod until marking grooves are visible. Screw in the holding screw to fix the protective tube.



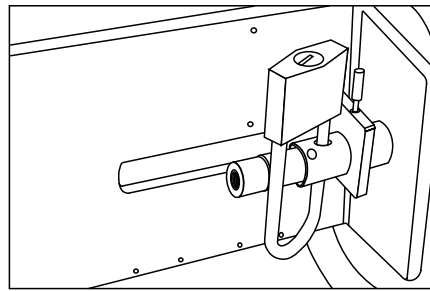
4. Unscrew source support rod from protective tube.



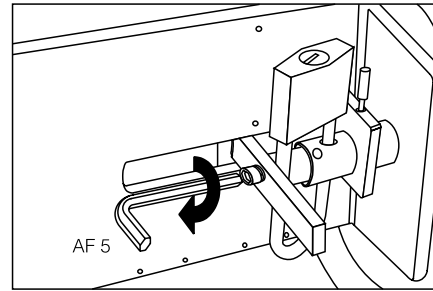
5. Remove (resp. unscrew) old source. Insert new source.



6. Screw source support rod into the protective tube. Unscrew holding screw.



7. Lock source support rod in position "OFF"

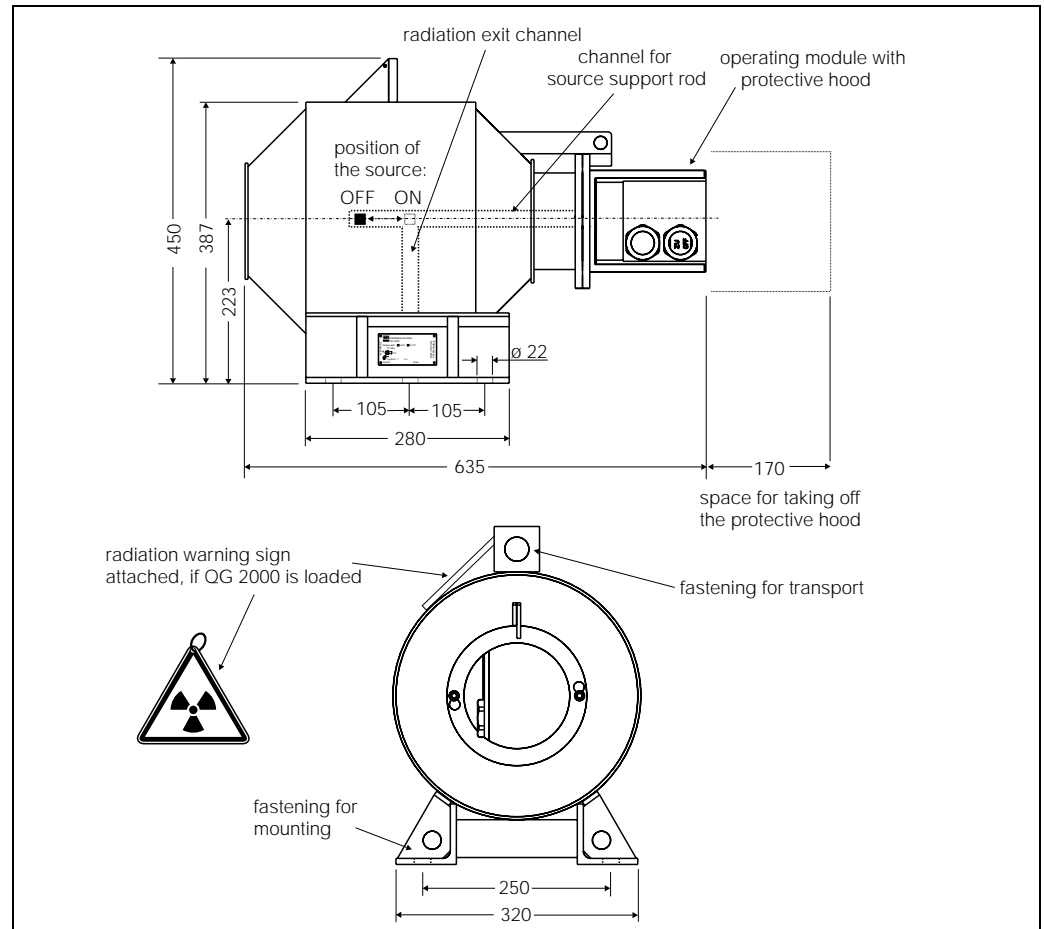


8. Insert slider and secure with washer and screw.

6 Technical Data

6.1 Design

6.1.1 Dimensions



6.1.2 Additional data

Weight

approx. 350 kg

Housing materials

Stainless steel 1.4571 (SS 316Ti),
the following surface treatment versions:

- glass bead blasted
- epoxy enamel coated
- seawater-resistant coated

Screening material:

Lead

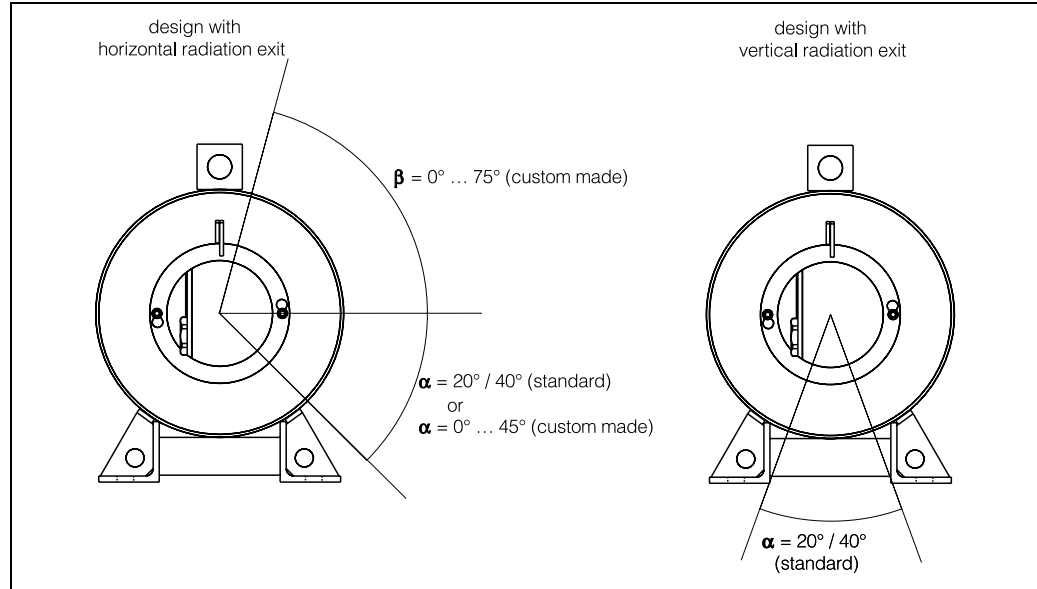
Switching device

The mechanical resistance of the switching device was tested to DIN VDE 0412-1, Section 9.4.

6.2 Radiation exit channel

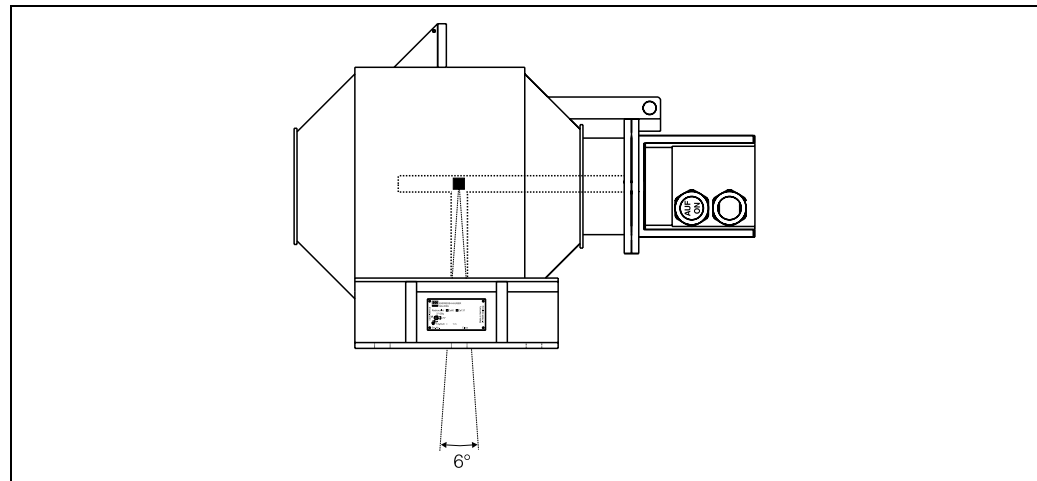
6.2.1 Position/angle of emission

standing/horizontal or standing/vertical



6.2.2 Width of beam emission channel

6° in all versions

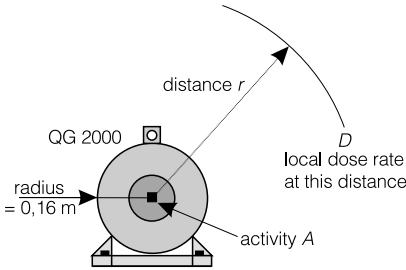


6.3 Radiation protection effects

6.3.1 Attenuation factor/half-value layers (when switched off)

	⁶⁰ Co	¹³⁷ Cs
Attenuation factor F_S	4.096	8.388.000
Number of half value layers	12	23

6.3.2 Calculating the local dose rate or control area



$$D = K \frac{A}{r^2 F_S}$$

D : local dose rate [$\mu\text{Sv/h}$]

r : distance from radiation source (control area) [m]

A : activity of radiation source [GBq]

F_S : attenuation factor (see the above table)

$$r = \sqrt{\frac{KA}{DF_S}}$$

$K = 357 \mu\text{Sv m}^2 / \text{h GBq} (= 13.200 \mu\text{Sv m}^2 / \text{h Ci})$ for ⁶⁰Co

$K = 95 \mu\text{Sv m}^2 / \text{h GBq} (= 3.550 \mu\text{Sv m}^2 / \text{h Ci})$ for ¹³⁷Cs

The control area is specified as being at what particular distance from the source container r , the local dose rate is attenuated to a value D when using a predetermined activity A .

Examples for calculating using ⁶⁰Co

$A = 11 \text{ GBq (300 mCi)}$ $r = 0,21 \text{ m } (\hat{=} 0,05 \text{ m above the surface})$	$\Rightarrow D = 22 \mu\text{Sv/h}$
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$A = 11 \text{ GBq (300 mCi)}$ $D = 2,5 \mu\text{Sv/h}$	$\Rightarrow r = 0,62 \text{ m } (\hat{=} 0,46 \text{ m above the surface})$
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Example for calculating using ¹³⁷Cs

$A = 185 \text{ GBq (5 Ci)}$ $r = 0,21 \text{ m } (\hat{=} 0,05 \text{ m above the surface})$	$\Rightarrow D = 0,048 \mu\text{Sv/h}$ (far below all limit values)
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There is no control area for any activities of Caesium sources used in radiometric measurement.

6.4 Ambient conditions

6.4.1 Protection against external influences

The source support rod of the QG 2000 is protected from external influences by an additional metallic sleeve with an O-ring seal.
(ingress protection IP 65 to DIN 40050, Page 1 and EN 60529 resp.).

6.4.2 Ambient temperature

without initiators for remote display

T = -20 °C ... 200 °C (Class 3 to DIN VDE 0412-01)

with initiators for remote display

T = -20°C ... 100 °C (Class 2 to DIN VDE 0412-01)

6.4.3 Fire resistance

tested to DIN VDE 0412-1, Section 6.4,
i.e. 30 min at 800 °C

6.5 Certificates and Approvals

PTB

Isodose curve with ^{60}Co (37GBq/1000 mCi)

Germanischer Lloyd

for applications on dredgers

Proximity switches supplied by Pepperl+Fuchs

- Ingress protection IP 67 to IEC 60529
- ATEX II 2 G EEx ia II C T6

CNSC Certificate

For application in Canada the following CNSC Certificate is available:

- QG 2000: No. 094-0159-0-2017



Note!

When using the CNSC Certificate, the additional Safety Instructions SD 142F have to be observed.

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