NT14/1.3

GAMMA LEVEL INDICATOR

INSTALLATION & OPERATING MANUAL

Nuklidtech Sweden AB

Klövervägen 16, 137 36 VÄSTERHANINGE / SWEDEN

Delivery & Visiting address: Dåntorpsvägen 33 H-I

Local nr: 6, 136 50 JORDBRO / SWEDEN

Telephone: +46 (0) 8 180845

www.nuklidtech.se @: info@nuklidtech.se

EC/EEA DECLARATION OF CONFORMITY

The undersigned, representing the manufacturer, Nuklidtech Sweden AB, herewith declares that the product Gamma Level Indicator Series Q4800 is in conformity with the provisions of the following directives:

Directive 2004/108/EC	EMC Compatibility
Directive 2006/95/EC	Low Voltage
Directive 2011/65/EU	RoHS: Restriction of the use of certain hazardous substances

Standards:

EN 61010-1:2010, Low Voltage Directive

EN 61326-1:2013, Electromagnetic Compatibility with immunity requirements according to table 2 of the standard and emission limits according to EN 55011 Class B.

And that the standards and/or technical specifications referenced overleaf have been applied.

Place:

Sweden, Stockholm, Jordbro.

Date:

2014-02-28

Signature:

Hans Eklund

Quality manager

Nukidtech Sweden AB

References of standards and/or technical specifications applied for this EC/EEA declaration of conformity, or parts thereof.

EMC test has been carried out 2014-02-17 at the Intertek Semko AB in Kista Sweden with immunity requirements according to table 2 of the standard and emission limits according to **EN 55011** Class B.

LVD test has been carried out 2014-02-26 by DELTA Development Technology AB in Västerås Sweden.

CONTENS:

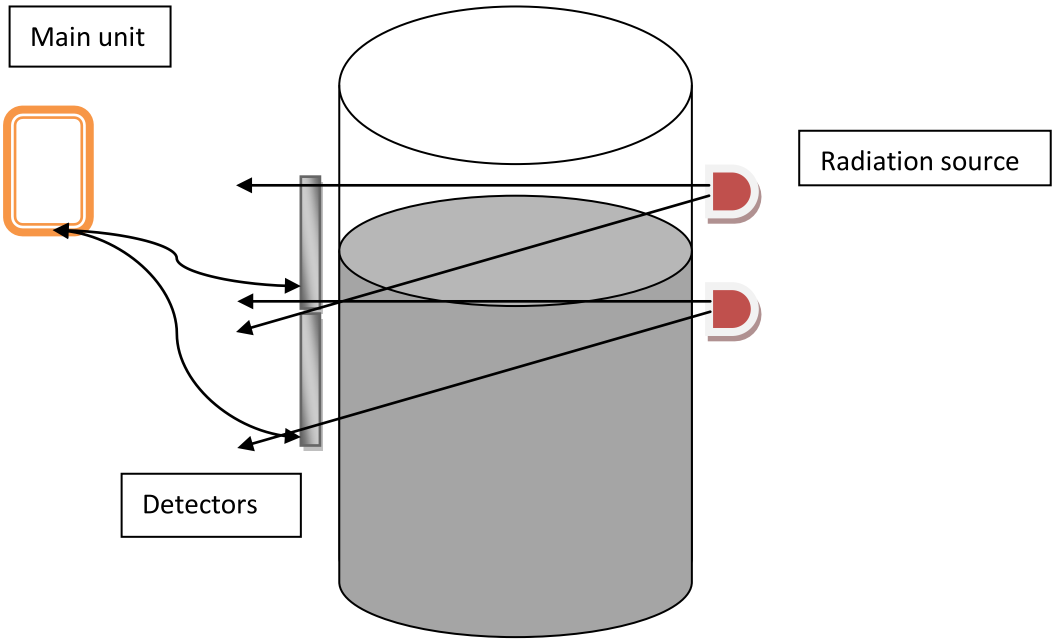
1: INTRODUCTION

1:1 Generally

The NT14/1.3 level indicator is based as previously models on the use of radioactive radiation, and it is used mainly for level measurements in closed vessels, vessels containing corrosive materials and applications that impose stringent reliability requirements. The radiation source unit is positioned on one side of the vessel, and the intensity of radiation is measured on the opposite side of the vessel.

The level indicator consist of one or more detectors provided with cables, an electric main unit and one or more source units. Each source unit contains a radioactive substance and a radiation shield.

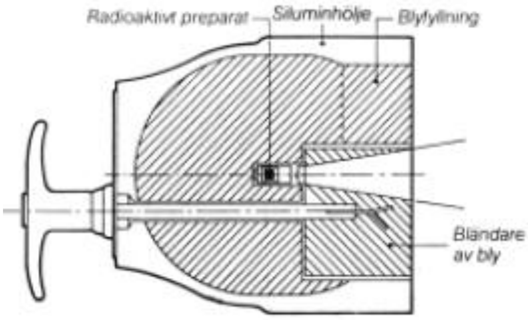
Since the equipment is mounted on the outside of the vessel, it is ideal for level monitoring at high pressures, at high temperatures and under severe corrosive conditions. The vessels can contain liquids, paper pulp, wood chips, crushed materials, etc.



Example of level measurement in vessels, 1 up to 12 detectors can be used to continuously measure a specified distance from 0,6 up to 7 meters.

1:2 Radiation source unit

The radiation source unit consists of a radioactive substance enclosed in a lead shield. The lead wall thickness is based on the strength of the radioactive substance. Radiation is allowed to emerge through a port in the lead wall. Different radiation spread angels can be obtained by providing different design. A lockable handle can be turned in ON and OFF positions.



Cross-section of radiation source unit.

Image of Q4582B source unit.

Radiation also ”leaks” through the lead container, thus making it necessary to limit the time throughout which anyone is allowed to remain in the immediate vicinity of the source unit. However, at a distance of one metre from the lead container, the dos rate is always less than 7,5µSv/h, except for the beam itself when the port is open. There is thus a radiation zone within one metre of the lead container, but outside this zone personnel can work fulltime without encountering any radiation hazard.

The radiation sources used in the unit are prepared in accordance with international regulations. Those usually employed are Co-60 (Cobalt) and Cs-137 (Cesium).
The Co-60 source consists of a solid cylindrical piece of cobalt about 4 mm in diameter enclosed in a stainless steel capsule.
The Cs-137 source consists of ceramic bonded Cesium in a dual wall stainless steel capsule.
The capsules for Co-60 and Cs-137 are tested and classified in accordance with the international ISO 2919-1980E standard.

Gamma radiation from the radioactive sources is harmless to all material except ling tissue, which is damaged by internal ionization. For this reason, the safety regulations set forth in chapter 2 must be rigorously observed. There is no risk of radiation damage to the vessel or its contents.

2. SAFETY REGULATIONS

2:1 Maximum dose rate

Under current regulations, personnel who are exposed to radioactive radiation in the course of their work must not receive a greater weekly dose than 300µSv. This is equivalent to a dose rate of 7,5µSv throughout a 40 hour work week.

For personnel engaged in radiological work who are provided with a personal dosimeter and who are examined medically at least every third year, the permissible radiation dose is three times higher than the figure stated above.
Since the dose rate does not exceed 7,5µSv/h at a distance of one metre from the shield, personnel can remain constantly beyond this distance without receiving more than the permissible weekly dose.

Even personnel who never work with the radiological equipment are exposed to radiation. Radioactive substances are present in nature, and these natural sources together with cosmic rays subject us to a ddose of about 10µSv per day. A radiation dose of up to 20µSv/h (gamma rays) has been recorded directly from wristwatches. Radiological examinations subject the body to quite heavy doses; a pulmonary X-ray, for example , provides about 10´000µSv.

2:2 Responsibility

Anyone planning to install a facility employing radioactivity sources must first obtain permission to possess and use the source unit. He must appoint a "responsible overseer" who will assume full responsibility for seeing to it that instructions are followed. Not until this is done will the radiation protection authorities grant permission for the possession and use of the equipment.

2:3 Moving a source unit

If, for any reason, the source unit must be moved, the responsible overseer must be so informed. Prior to dismounting, the source unit must be turned off and locked. During the period throughout which the source unit is removed, it must be kept in a locked and fireproof area.

2:4 Surveillance after installation

The responsible overseer must check that all source units are in place, that they are in good condition and they are in good condition and that they have been installed in accordance with the regulations. At the same time, a check must be made to see that the dose rate at the detector does not exceed 7,5µSv/h and that the warning signs are posted correctly.

2:5 Change of radioactive source

When the radioactivity of the source unit decayed to a certain level, replacement becomes necessary. This applies primarily to Co-60 which has a half-life of 5,3 years, and for which replacement can be necessary after about 10 years. Cs-137 has a half-life of 30 years and does not normally have to be replaced during the services of the equipment. For replacement, an approved supplier must be notified. He will install a new source unit having the same activity level as the old one had when it was delivered. If it seems advisable, the supplier can use the old radiation shield and simply recharge the unit with a fresh radioactive substance. If the activity is altered, a new application must be submitted to the radiation protection authorities.

2:6 Transportation of source unit

Always contact your equipment supplier for further information.
Dangerous goods regulations are applicable to radioactive materials when such materials must be transported.

ELECTRICAL SAFETY REGULATIONS

2:7 General

NT14/1.3 is designed and tested in accordance with regulations for electrical measuring instruments. **EN 61010-1:2010**

Pollution degree II
Material group IIIb
Class I product
Overvoltage category II

Max altitude 2000 m
Max power 20 Watt
Storage and transport -40 - +60 °C, 0 – 90% RH

WARNING!

When troubleshooting with power supply connected, hazardous voltages become accessible.

- When troubleshooting in operation, insulated tools shall be used.
- When replacing or repairing circuit boards, main voltage shall NOT be connected.
- Make sure that no dangerous external voltage is connected via relay contacts.

2:8 Installation

NT14/1.3 series must be installed as a fixed electrical installation in accordance with regulations.

2:9 Grounding

Ground lead shall always be connected to intended earth terminal this refers to all incoming ground wires.

2:10 Setting the mains voltage

The electronics have automatic detection of incoming line voltage.

2:11 Fuse

NT14/1.3 is equipped with a fuse 3.15 A slow blow 250V.

2:12 Recycling

When disposing of the unit could be submitted to Nuklidtech Sweden AB.
The electronics must be handled by the existing rules for electronic waste.

3. TECHNICAL DATA ELECTRONIC MAIN UNIT

3:1 Power requirements

Main voltage: 90-250 VAC
Frequency: 47-63Hz
Fuse: 3,15 A
Automatic recognition of input voltage.

3:2 Environment

Operating temperature: 0 - +50°C
Operating humidity: 0 – 90% RH

3:3 Output signals

mA output

Signal 4-20mA out depending on level 0-100%. Load: max 500 ohm.
The receiver of the 4-20mA signal, should be at the same potential of the Q4800. i.e. Connected to the same electrical network and phase. Otherwise, the use of an external galvanic isolator is required. Optional galvanic isolator.

High level alarm

Relay Signal set-point adjustable between 50-100% FS.

Low level alarm

Relay Signal set-point adjustable between 0-49% FS.

Relay signal for function monitoring

Functions monitored

1: The supply voltage is normal
2: Pulse flow to the main unit not broken
3: The signal ”Error” from all detectors
The single-pole changeover switch the relays can be loaded with max 1A 250V on resistive load. When inductive loads use spark arrester.
4,000 VAC, 50/60 Hz for 1 min between coil and switch.
1,000 VAC, 50/60 Hz for 1 min between switches of the same polarity.

3:4 Sensitivity

Minimum sensitivity of detectors NT14 / 5 at alarm level measurement is about 2µSv/h
With multiple detectors connected, the sensitivity is even higher. The natural background radiation is about 0,2 µSv/h limits the opportunity to work with lower sensitivity.

3:5 Max cable length

With standard delivered RKKB cable 4x0, $5mm^2$ is maximum cable length of 280 meters. For longer cables, the cable section is increased and the pulse signal go through coaxial cable.

3:6 Temperature operation

Measured on a 4-20mA output with a fixed pulse rate recorded.
Max +/- 0,05 % /C, typical value +/- 0,02 % /C.

3:7 Casing

NT14/3 is a grey powder coated wall cabinet in galvanized steel.
Measurment 350 x 250 x 155 (h x w x d) IP 66.

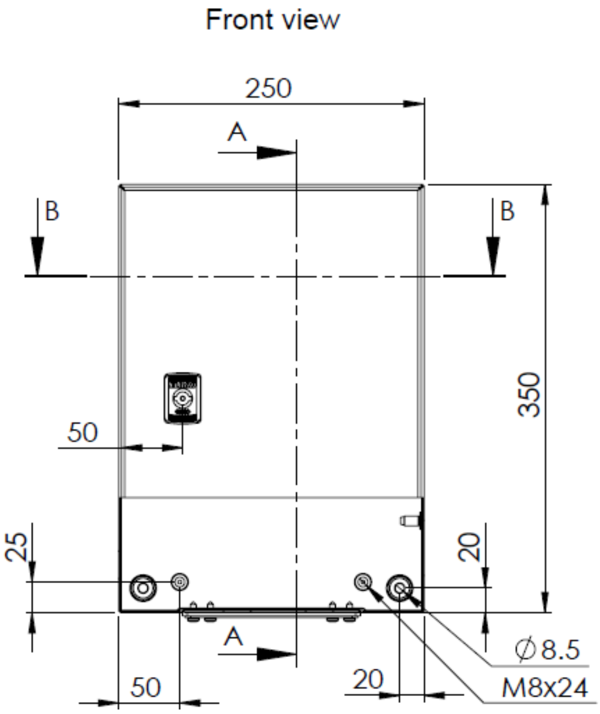


Image of the cabinet with electronic unit.

3:8 Connections

Mains voltage, other inputs and outputs are connected to terminals with max wire size 2.5 mm^2. There are three parallel detector inputs, each input can support up to a maximum of 4 pieces of detectors then with external access point for each incoming detector cable.

4. TECHNICAL DATA DETECTORS

TYPE NT14/5 & NT/9

4:1 Power voltage

+ 15 V DC, ±10%, max 50mA.

4:2 Environment & Electrical safety provisions

Ambient temperature while in operation: -40° - +70° C.
Relative humidity: 0 – 95% RH.
LVD low voltage directive EN 61010-1:2010 class 2

4:3 Output signals

PFM output. Pulse duration of 12± 2 µs, amplitude 10 mA.
Error signal, performance monitoring, normally +14 V. Error indication provides +6.5 V output signal.

4:4 Connectors

Circular 6 pole chassis connector according to MILC-26842-1.
Gold plated pins connector of bayonet type.

4:5 Casing

Detector Casing of stainless steel food grade, tightness class IP 67.

Image of detector.

4:6 Temperature drift

Pulse frequency drift at steady-state dose rate: Max ± 0,02 % / °C, typical value <0,01 % / °C.

4:7 Detector cable, type NT14/7

RKKB 4 core x 0.5 mm2 + function earth and foil shield, PVC jacketed with an outer diameter of 7 mm.
Normal delivered standard length of cable 10 meters.
Circular 6-pin connector of MILC-26482-1, gold plated socket with bayonet.

Image of 10 meters cable.

5. INSTALLATION

5:1 General

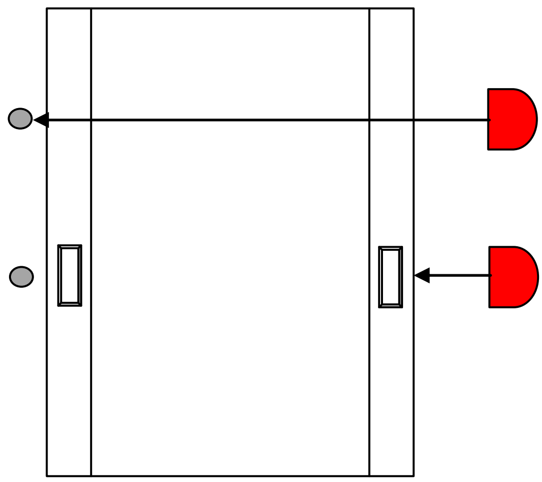
It is very important to have the source unit installed by personnel who have acquired the necessary knowledge about radioactive material. These personnel must be equipped with instruments that can measure the radiation dose rate. However, no restrictions are imposed for components other than the source unit.

Before the equipment is put into operation, the installation must be checked by the responsible overseer.
If any doubt should arise in connection with the relative positions of the radiation sources and detectors, ask your supplier for information. The relative positions can vary, depending upon the diameter of the vessel and the type of radiation shield being used.

5:2 Radiation source unit

Make certain that the radiation beam is turned off and locked before commencing installation.

You must see to it that the source unit is not mounted in such a way that it can be obstructed by a concealed structural beam or anything else that can significantly block the radiation.



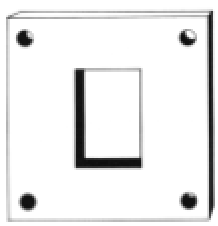
Full accessibility of radiation.

Limited accessibility due; obstacle of not including beams or other parts of the vessel.

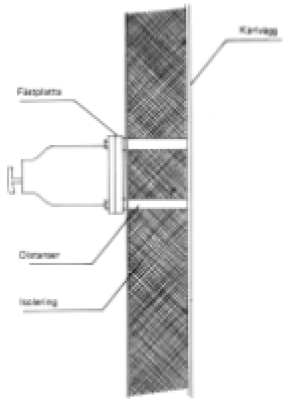
Schematic illustration of the accessibility of radiation.

All types of sources are provided with holes for mounting bolts. All types have four holes in the front panel, while the larger types also have a baseplate provided with retainer holes. See the dimension drawings. A retainer plate with mating holes and an opening for the radiation beam must be welded or secured in some other way to the vessel wall.

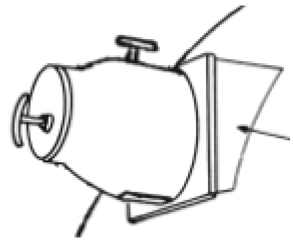
As each application is different, you get individually to ensure that the installation is sufficiently stable and that no one can come between radiation beam and vessels. One recommendation is to fabricate some kind of hood to the source shield, if will be mounted in a vulnerable environment, for radiation shielding should not take unnecessary damage, even in cases where the vessel has large vibrations may be appropriate to of vibrate the source shield mounting appropriately.



Example of retainer plate.

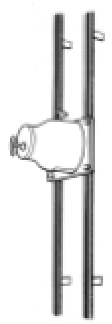


Example of spacers.



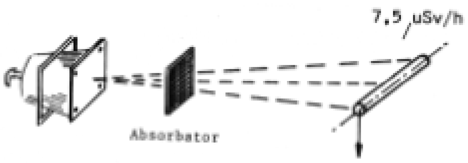
Example of contact protection.

Sometimes it is necessary to be able to adjust the equipment vertically in situations where production varies and where there is some uncertainty as to which working level is best. Here, the radiation source unit shall be mounted on slider bars. The detector must also be vertically adjustable, and thus must be mounted on similar bars.



Example of source unit mounted on slider bars.

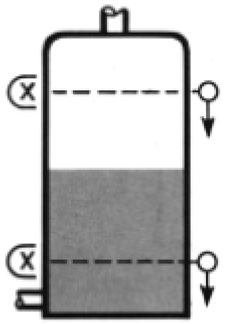
If, after installation, the radiation dose rate at the detector is higher than 7,5µSv/h, a steel or lead plate can be mounted in front of the source unit. It is recommended that this absorber plate be designed in the same way as the retainer plate, but without any opening for the radiation beam. It can then be inserted between the retainer plate and the source unit.



Example of absorber plate to reduce radiation dose rate to an acceptable value.

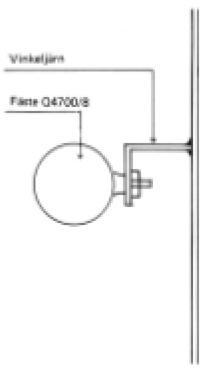
5:3 Detectors of type NT14/5, alarm level

The short detector is intended for alarm-level- measurement. This detector is mounted horizontally on the opposite side of the vessel and at the same height as the source unit. If both a high level and low level alarm are to be issued, one horizontal detector must be mounted at each alarm level.

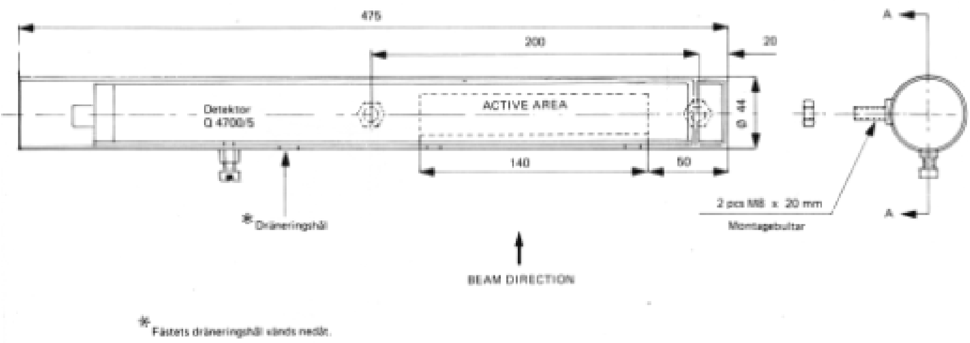


Example on high and low level alarm.

Stainless steel bracket NT14/8 for this detector is provided with two M8x25 mm bolts that are welded in place. See the dimension drawings. Two steel angles with holes for the aforesaid M8 bolts must be attached to the wall of the vessel. The holder can then be secured to the angles by means of nuts. The drainage hole in the holder must be at the bottom. ***NOTE! The detector bracket must be protective earth (PE) with ground wire.***



Example mounting of bracket to NT14/8.



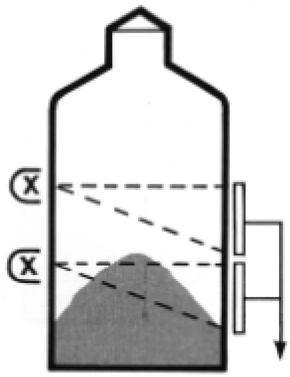
Dimension drawing over bracket NT14/8.

The detector itself is then inserted inside the bracket from the side and secured by means of a socket-head cap screw at the bottom of the bracket.

Image of bracket NT14/8.

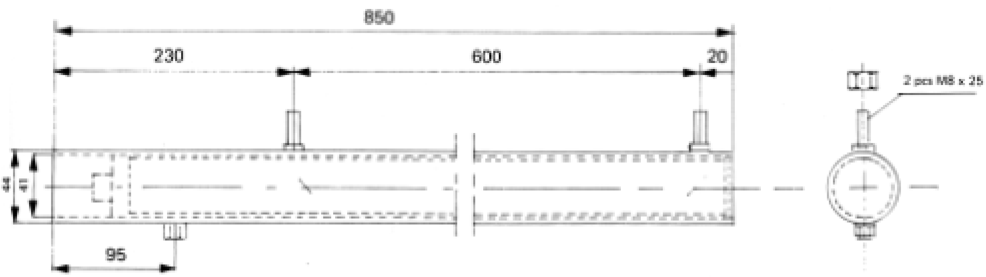
5:4 Detectors of type NT14/9 for continuous measurement

The long detector is intended for continuous level measurement. Frequently, a number of detectors and a number of source units are used to provide full coverage of the measurement range in question. The detectors are mounted vertically.



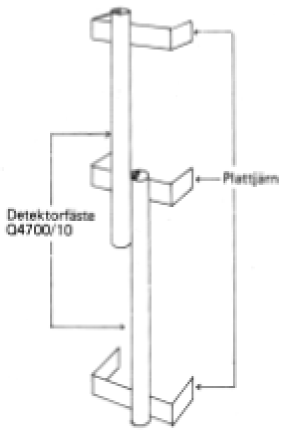
Example of continuous level measurement.

The stainless detector bracket are provided with two M8x25 mm bolts that are welded in place



Dimension drawing of the bracket NT14/10.

One U-shaped steel fitting must be secured to the vessel for each M8 bolt. The middle of these U-shaped fittings can be used to secure two detector brackets as shown below.

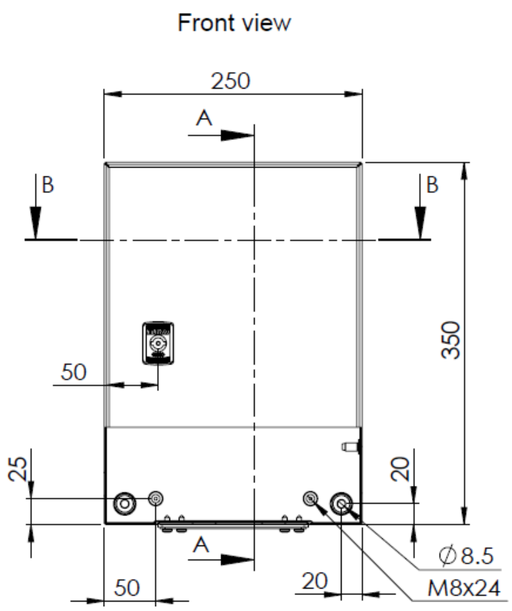


If a number of detectors are to be installed, the NT14/10 bracket must be mounted so that they overlap each other. The top of the lower bracket must be at the same level as the lower retainer pin on the upper bracket. The detector shall then be inserted into the bracket from beneath and secured by means of a socket-head cap screw on the bracket.

Frequently, the detectors can be spread out. Usually, they can be mounted one metre apart, although the resolution requirement is the determining factor.

5:5 Main unit NT14/1-3

The main unit is available in a version mounted in the electronics custom metal cabinet, dimensions H350 x B250 x D155 mm IP66 powder coated in grey paint.
The cabinet delivered with 5 stainless steel cable plugged glands mounted for 4-10mm diameter cable. With the cabinet comes 1st key.



5:5 Warning signs

A number of warning signs are delivered with the equipment. The radiation shield itself is delivered with all of the necessary signs already mounted.

The user must post at least two signs: one stating the regulations that apply and one at the manhole.

The sign stating the regulations that apply must be posted close (about 1 m) to the radiation source unit. The name of the overseer must appear on this sign.

A manhole sign must be mounted at all manholes or openings where it is possible for personnel to enter the vessel in question. Pay attention to where the signs are placed, the sign must be visible even if the manhole door are open.

Warning signs, item number IR1059 & IR 1060 A5 plastic are even available as stainless steel then item number IR1059SS & IR1060SS.

6. CONNECTIONS

6:1 Connection to the mains

Phase connects to J17: 1 and neutral to J17: 2 on the circuit board.
Ground wire is connected to PE terminal closest to the cable gland.
The equipment must be installed as an electrical fixed installation.

6:2 Relay outputs

Connections to the relay outputs are available on J7-9 on the PCB.
Load view technical specification.

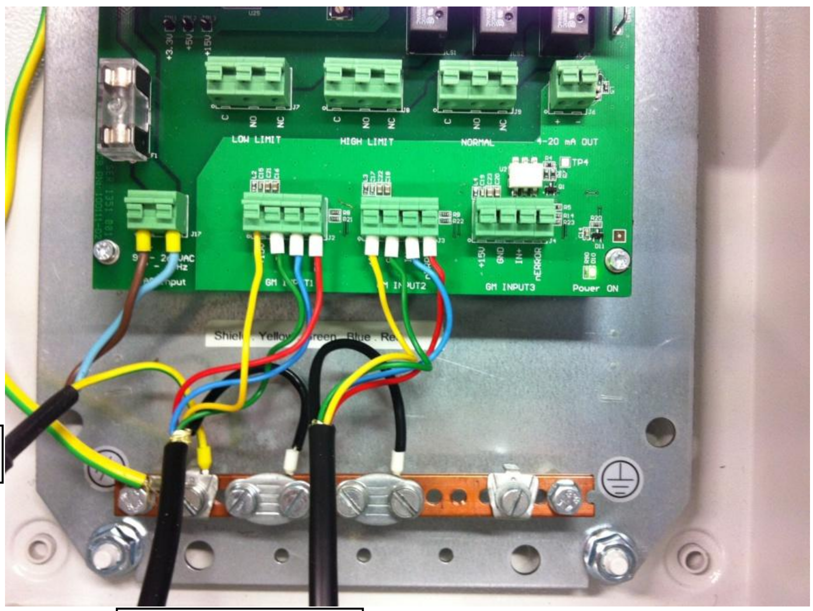
6:3 2-20 mA output

Plus (+) is connected to J6: 1 and minus (-) to J6: 2 on the circuit board.
To avoid interference a ground connection should be inserted, either at the unit or at the connected device. Maximum load is 470 ohms.

6:4 Inkoppling av detektorer

Numerous detectors can be connected to the electronic main unit. Terminal J2-4 is parallel connected inputs and the detectors can be arbitrarily distributed over these. The glands do not allows smaller diameter than 10mm cable, if several detectors are required a separate junction box outside the main unit cabinet, thereby obtaining interconnect the number of intended detectors to connect.

Color code for UNIRAD Q4800/7 cable:
Wires (colorless) = function earth which must be grounded in the intended land bridge.
Yellow = +15V
Green = 0V/GND
Blue = +IN
Red = Error signal

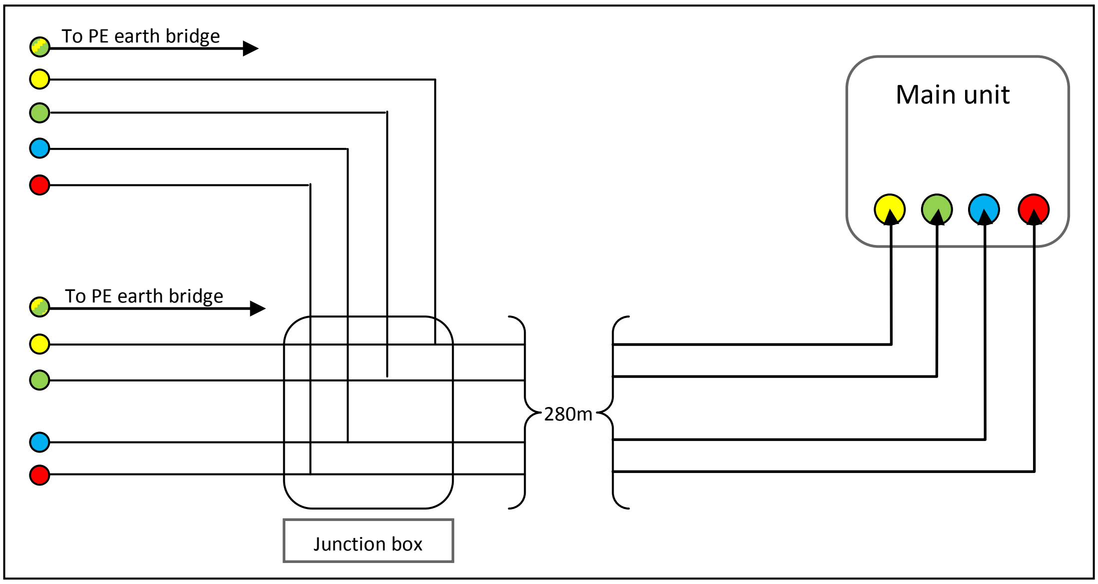


Phase, Neutral & PE

Detector cables

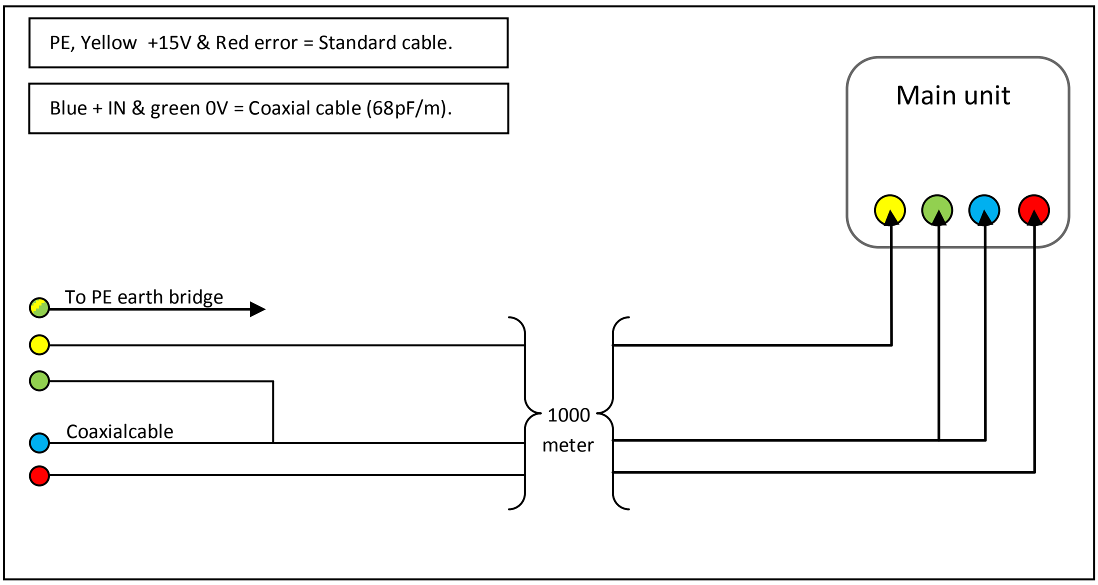
6:4 A Splicing detector cables

It is possible to splice a number of detector cables together. It also possible to connect them to a junction box. In such case, a common cable then runs from the splice or junction box to the electronic main unit. For use with other colors to splice cable, be careful to label the wiring harness for the right connection, so that connection in the main unit is as the original cable colors.

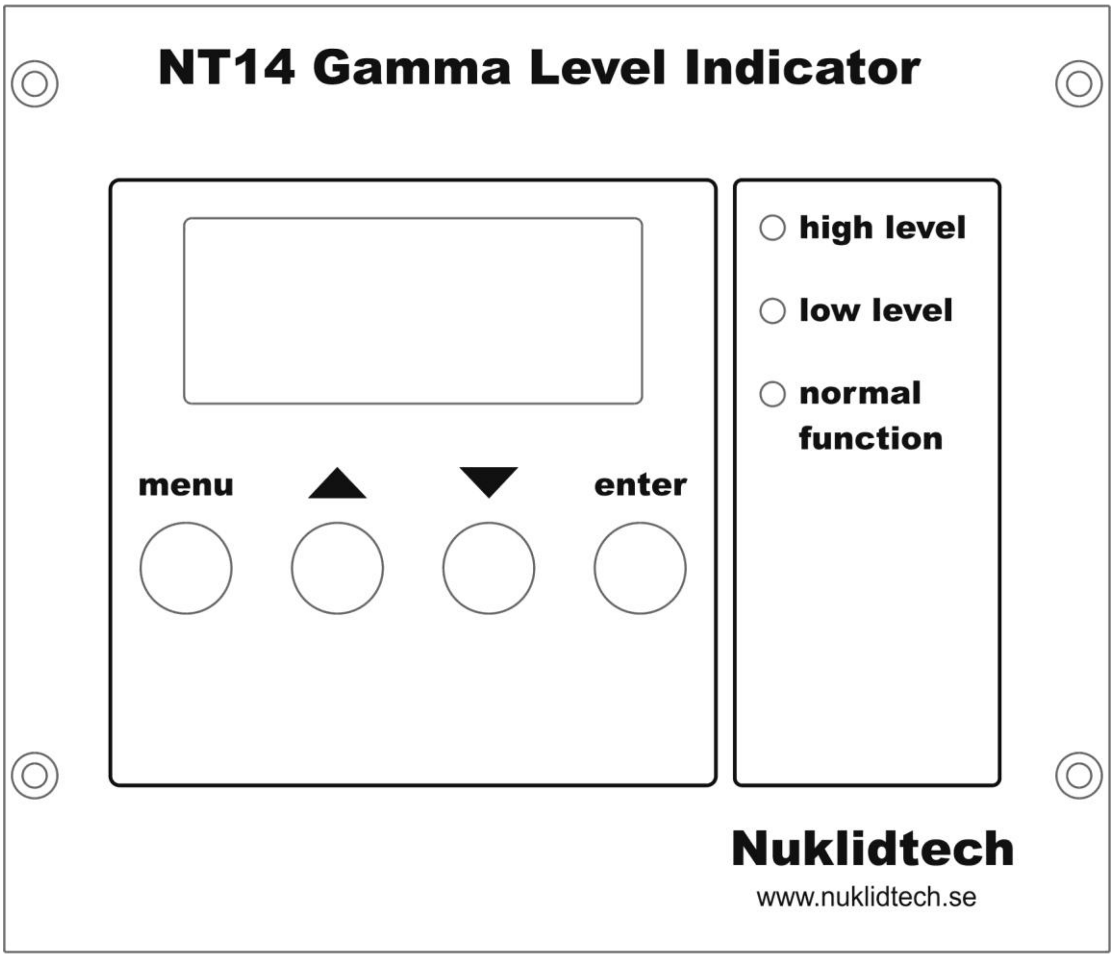


6:4 B extremely long detector cable

For distances longer than 280 meters between the detector and the main unit must PMF signal blue wire (+ IN) routed via coaxial cable (68pF / m), which methods allow a cable length of 1000 meters.



7. INITIAL ADJUSTMENT



7:0 General

Make sure the material level is below the radiation beam path alternately empty vessel. Measuring the radiation intensity at the receiver /detector which shall not exceed 7.5µSv/h (measured using an appropriate intensimeter / gamma meter).

7:1 Meny

7.1.1 Calibration

The system must be calibrated regarding beam power at different levels in the vessel prior to initial operation. This is done by calibrating the empty and full containers. Full containers can be simulated with the radiation source is turned off.

7.1.2 Cal.Empty

Press "Enter" to start a calibration at the empty vessel (max = max radiation from source container).
Wait until calibration is complete the display.

7.1.3 Cal.Full

Press "Enter" to start a calibration of the full vessel (minimum radiation = background radiation, closed source container).

7.1.4 Return

Press "Enter" to return one step in the menu to "Settings".

7.2.0 Settings

7.2.1 Alarm level

Alarm levels can be set to activate level relays in Q4800. Press "Enter" at location "Settings" and select "Alarm levels" with "Enter".

7.2.2 High level

The level can be set between 50-100%. Choose a level of up or down arrow to the desired alarm level.

After the selected alarm level, press "Enter" to return to the alarm levels.

7.2.3 Low level

Press the down arrow to get to "Low level" and press "Enter" key, repeat the procedure using the arrows to select the desired alarm level 0-49% and finish with "Enter" and you will step back in the menu.

7.3.0 Compensation

Here you can activate the function to compensate for the decay of the intensity of radioactivity. This means that you do not have to perform manual recurrent compensatory calibrations, but this is only done this once at the first start.

7.3.1 Radiation source

Please choose which type of source to be used for the application in question, alternatively, select "Off" to disable automatic slope compensation.

After selections press "Enter" key to go back one step in the menu.

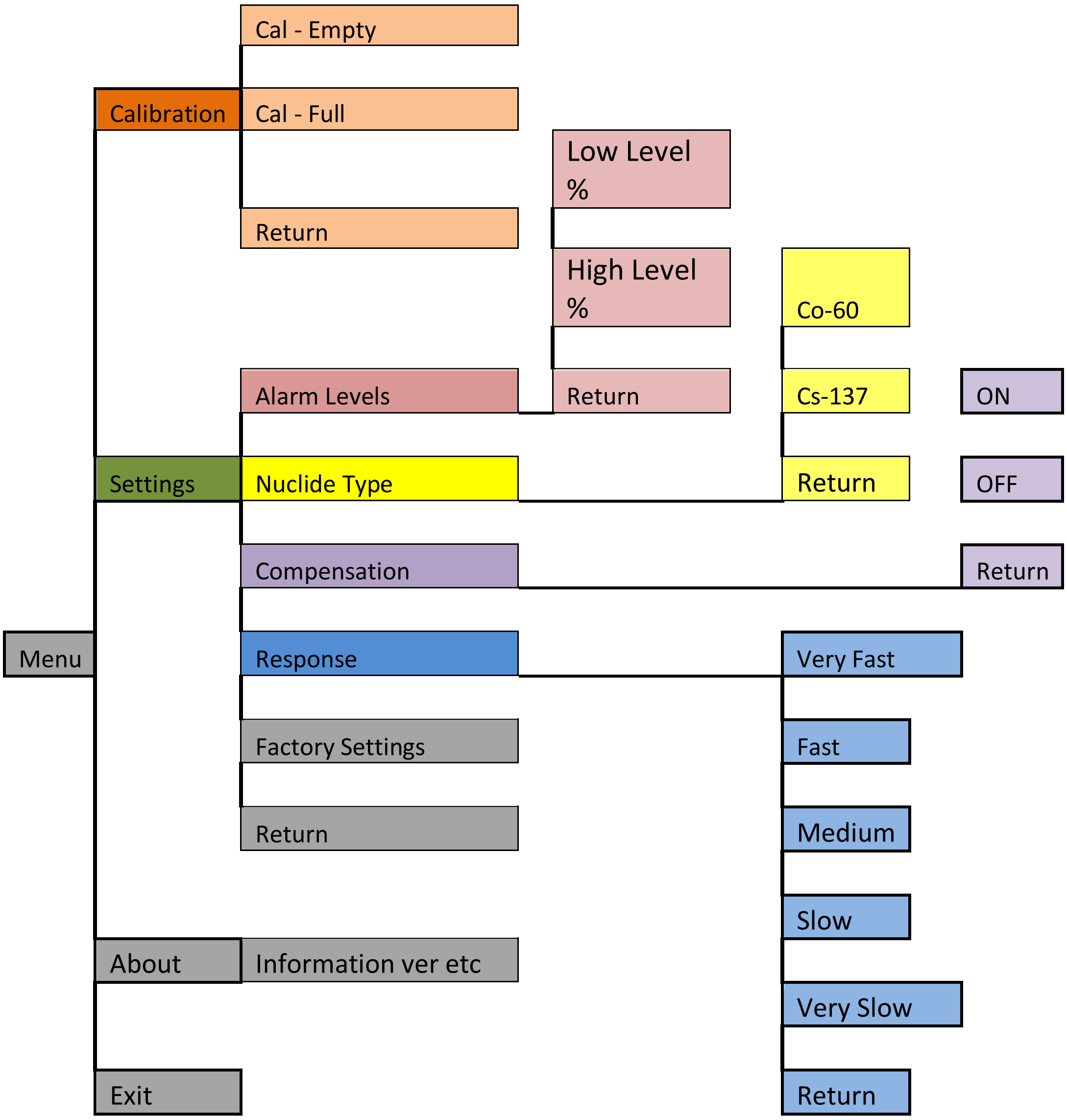
7.4.0 Sensitivity

7.4.1

Select a value from Very Fast to Very Slow where Very Fast gives the fastest reaction to changes in the level and / or radiation intensity. Then the radioactivity decays haphazard and not completely stable, then a high setting of sensitivity provide an unstable level indication. Choose a lower sensitivity to get a more stable signal.

7.5.0 Menu tree

NT14/1.3



8. CIRCUTIRY DESCRIPTION

8:1 General

The gamma level indicator consist one or more detectors that are connected by cables to the main unit.

Main unit designation is NT14/1-3, which consists of electronic cards NT14/1 and enclosure NT14/3.
The detectors are available in two variants depending on the feature being sought.
Detector NT14/5 short variant to the alarm level active part at 160mm, NT14/9 long variant for measuring function active part at 520mm.
The detectors should be mounted with a mounting bracket destined for the detector you choose. Long detector shall have mounting bracket NT14/10 and short detector NT14/8.
Detector cabling designated NT14/7.

8:2 Detector block diagram

The detector contains 1 or 2 pieces Geiger Muller tube (GM tube) is referred CT1/CT2.
These tubes are irradiated with ionizing radiation produces pulses having approximately 200µs length. The pulse frequency is proportional to the radiation intensity.

Pulse shaping circuit transforms the pulses to a length of 10 microseconds and about 10mA amplitude to fit the main unit input.

Out and error signals from the various GM tubes coupled with "wired OR", allowing parallel connection of a large number of detectors without loss of information.

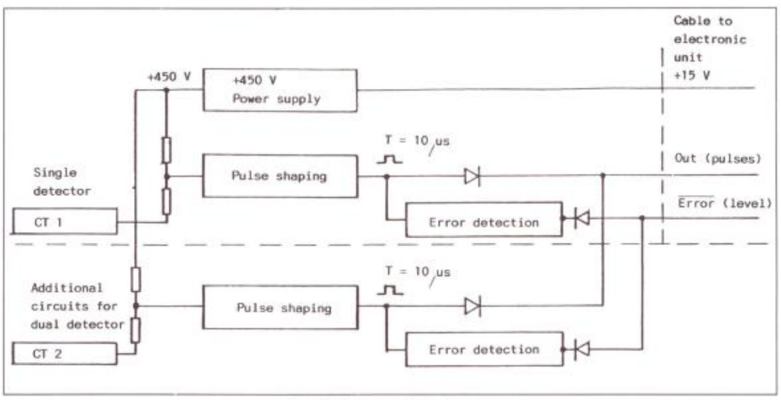


Fig. 28. Detector block diagram

9. TROUBLESHOOTING

9:1 General

Gamma level monitor NT14 is designed and manufactured with very high quality standards. Both detectors and main unit is equipped with monitoring circuits, which makes the operation safer and easier troubleshooting.

9:2 Troubleshooting

A: If the main unit goes out, check the fuse.
B: If the green indicator light "normal function" extinct and its relay fallen, replace the detector or detectors one at a time until the indicator light turns green again.
C: If the equipment does not respond to level changes, check with a radiation meter that radiation is, and that it strikes the detector / detectors.

If the fault could not be found with simple troubleshooting contact Nuklidtech Sweden AB for consultation by phone +46 (0) 818 08 45 or email info@nuklidtech.se

10. ABC´s OF RADIOACTIVITY

General

All matter is composed of atoms that in turn consists of a core with a number of positively charged protons. The core is surrounded by a cloud of negatively charged electrons, the same number as protons. The number of protons or electrons gives matter its atomic number, which is characteristic of each material (from 1 for hydrogen to 92 for uranium).

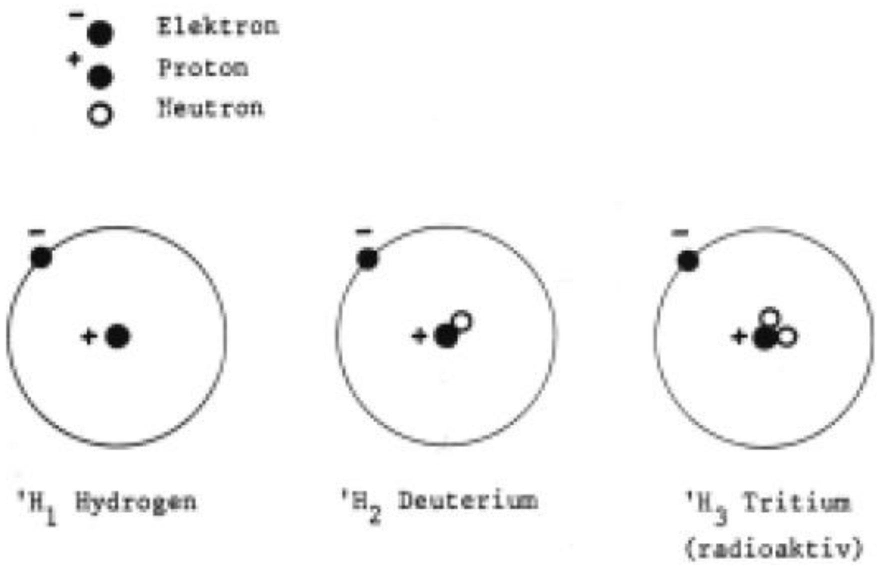


Figure 10.1 describes the various hydrogen isotopes

The core also contains neutrons whose number varies. Each neutron number corresponds to an isotope of the matter in question. Some of these isotopes are unstable and decay at random while they emit radiation.

Radioactive matter is made up of atoms that decay spontaneously during radiation regardless of the surroundings. The radiation can be of 3 types: Alpha, Beta or Gamma radiation. The first two consist of particles and is called particle radiation. Alpha radiation consists of positively charged helium nuclei and beta radiation of positive and negative electrons.

Gamma radiation often occurs along with the other two is an electromagnetic radiation, a wave of short wavelength and the same type as x-rays. The gamma radiation has a very high penetration.

The number of radioactive decay / time unit of a given amount of a radioactive substance given in number of becquerels (Bq), which corresponds to a decay / second. Previously, the unit Curie (Ci) was used. Each atom in the radiation source decays only once, why the activity decreases with time. The time necessary to reduce the radioactivity in matter half is called the half-life and is characteristic the isotope in question.
The half-life of radioisotopes varies from fractions of a second to millions of years.

Another characteristic of radioisotopes is the energy with which the radiation is emitted. Nuclear Radiation energy is expressed in electron volts, which is defined as the energy an electron absorbs or loses when it passes a potential differential at 1V.It corresponds only 3,6 x 10^{-12} watt seconds.

Normal is a larger unit MeV (million electron volts).
The greater the energy of the radiation is the more effective is its penetrating ability.

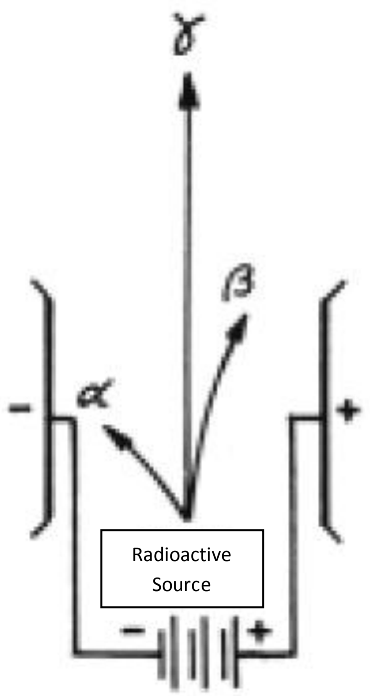


Bild 10.2 Alfa, Beta & Gammastrålarnas avböjning i elektroniska fält.

Alpha & Beta rays, which both consist of particles, has the air of a range of a few centimeters and several meters. The rays are absorbed, however, entirely of eg aluminum plate with a few millimeters thick. The gamma radiation on the other hand has a much greater range and can go through even very thick steel walls.

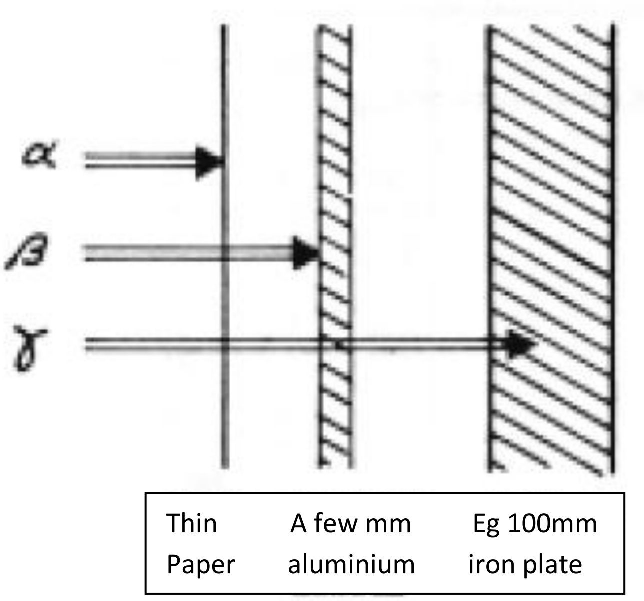


Figure 10.3 Alpha, Beta & Gamma beams absorption.

A matter which is normally inactive (e.g. cobalt) can be made radioactive by neutron bombardment in a reactor. Some matter is cleaved in the reactor, whereby a heavy substance can form two lightweight, various kinds of isotopes, e.g. Cesium 137 to get these fission products. Cobalt (Co-60) and cesium (Cs-137) is the radioactive sources they use most frequently for level measurement equipment.

When radioactive rays goes through a matter so ionized this to some extent. It separates the electrons from the atoms. One can measure the dose or amount of ionizing radiation received up from a radiant topic. The unit of absorbed dose is the Gray (Gy).

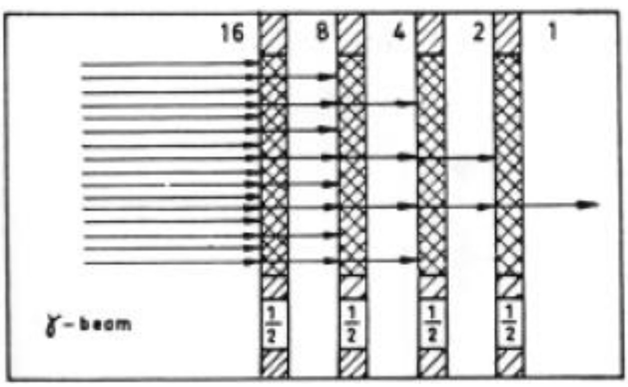


Figure 10.4 Gamma beams absorption is exponential.

The gamma radiation is measured in Sievert (Sv). The absorbing radiation dose in Gray multiplied by a specific quality factor gives the dose equivalent in Sievert.

The radiation intensity or dose rate measured in Sievert per hour (Sv/h) or microSievert per hour (Sv/h). Earlier before 1986 used other units such as Rem per hour (R/h), so 1MR/h today 10µSv/h.
Radiation intensities Tens value varies with the distance from the radioactive material together on the activity and energy of the emitted radiation.

Note that the dose rate varies with the square of the distance from the radiation source. Double the distance decreases therefore the dose rate to a quarter of its original value.

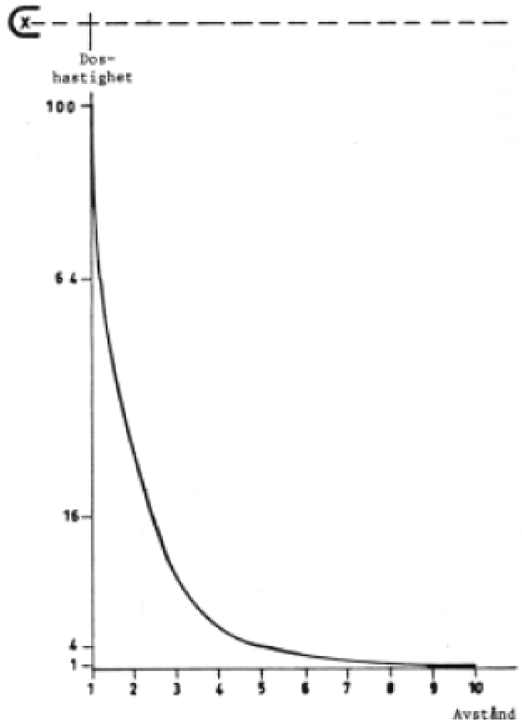


Figure 10.5 The dose rate decreases with the square of the distance.

The first table shows the dose rate at different distances from an unprotected radioactive source. It is stated in the new and old units.

New units					
Distance from source	10cm	1m	2m	5m	10m
µSv/h from 40MBq Co-60	1350	13,5	3,4	0,54	0,14
µSv/h from 40MBq Cs-137	350	3,5	0,9	0,14	0,04
Old units					
Distance from source	10cm	1m	2m	5m	10m
mR/h from 1mCi Co-60	135	1,35	0,34	0,054	0,014
mR/h from 1mCi Cs-137	350	3,5	0,9	0,14	0,04

Figure 10.6 New & old unit designations.

The table shows that the intensity is very high near the source surface. As a general rule, it is necessary to shield the source with a material that is able to absorb most of the radiation.

Among available metals lead is the most effective and useful when lead has high specific weight, is easy to work with and has affordable price.

Source	Shield thickness in mm					
	Lead D=11,6		Iron D=7,8		Concrete D=2,4	
	1/2	1/10	1/2	1/10	1/2	1/10
Co-60	12	41	22	74	69	230
Cs-137	6 1/2	21	17	57	53	180

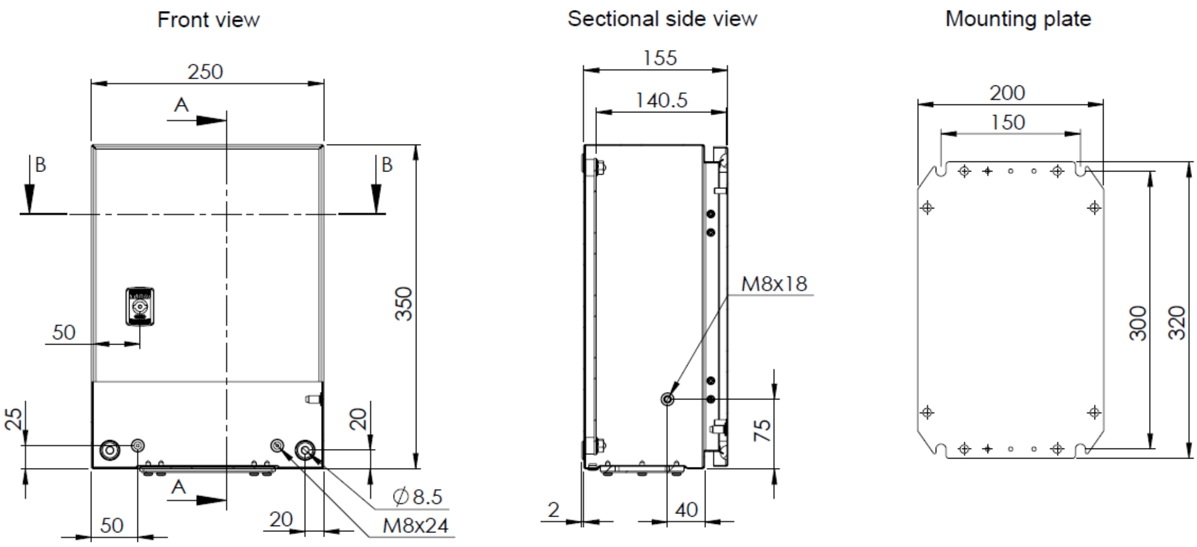
Figure 10.7 D = density in kg/dm3 or g/cm3.

The accompanying table shows the shielding capacity of a few different materials. The absorption has an exponential function, so that the two half-value layer reduces the dose rate to a quarter and so on. Half Be pleased thickness and 1/10-tjockleken are tabulated in millimeters for some common shielding material.

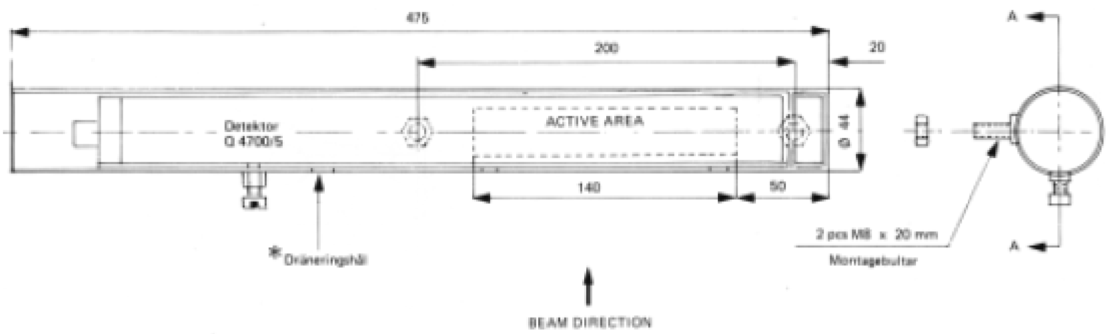
11. DIMENSION DRAWINGS

Casing:

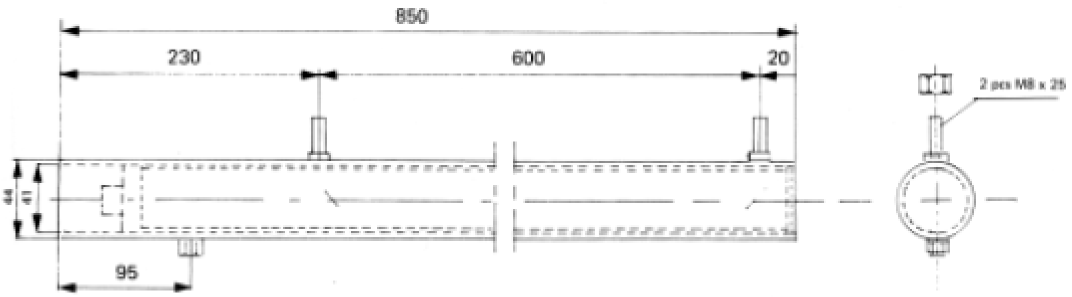
IP 66 grey powder-coated steel cabinet.



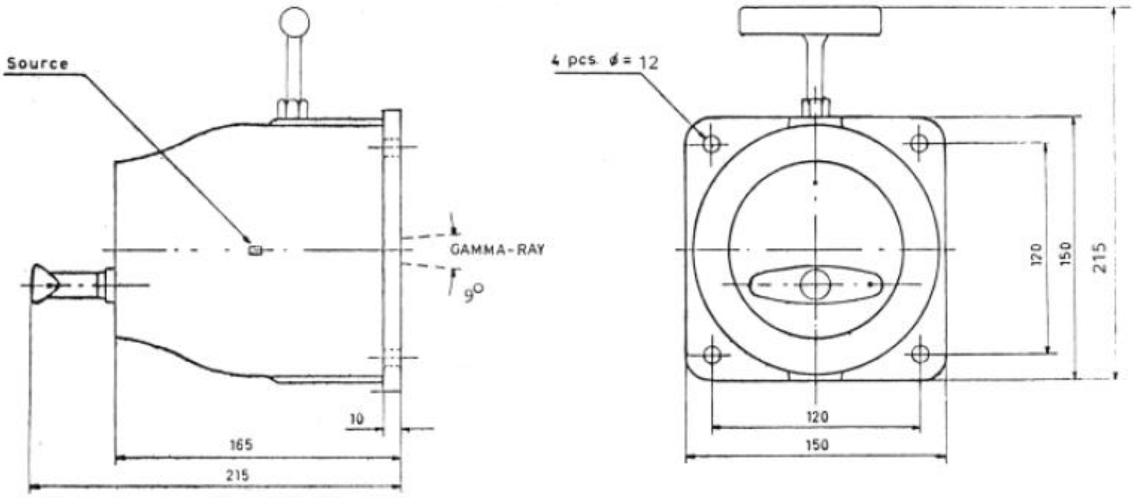
Detector bracket short model NT14/8



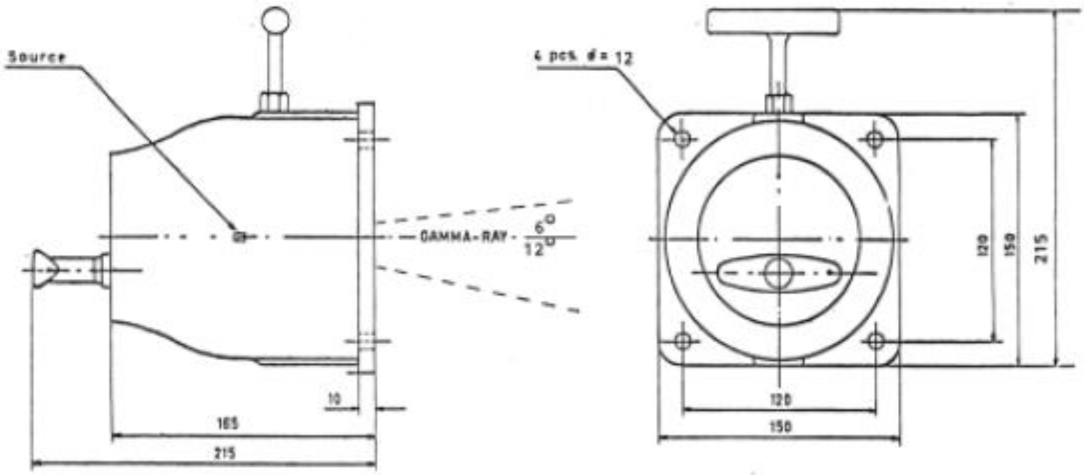
Detector bracket long model NT14/10



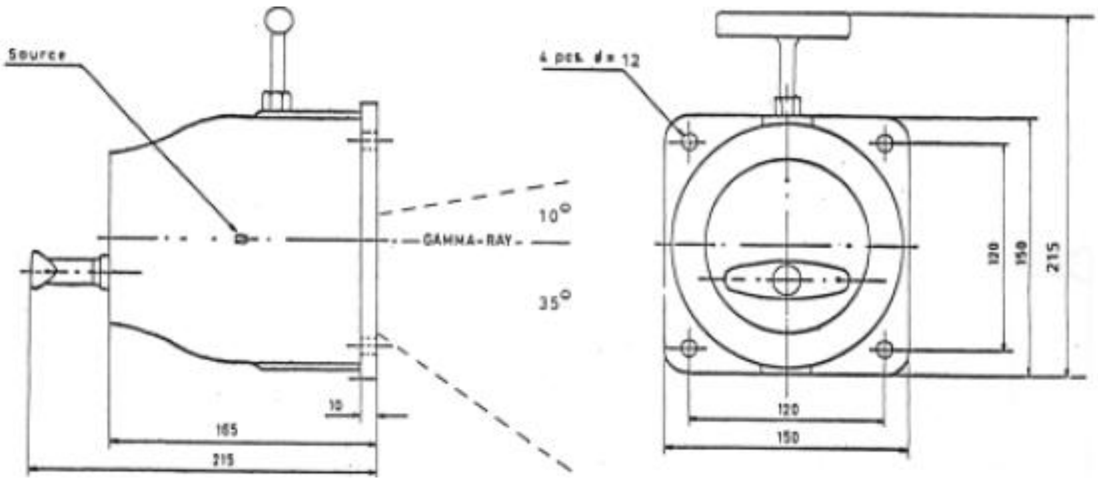
Radiation shield Q4582B



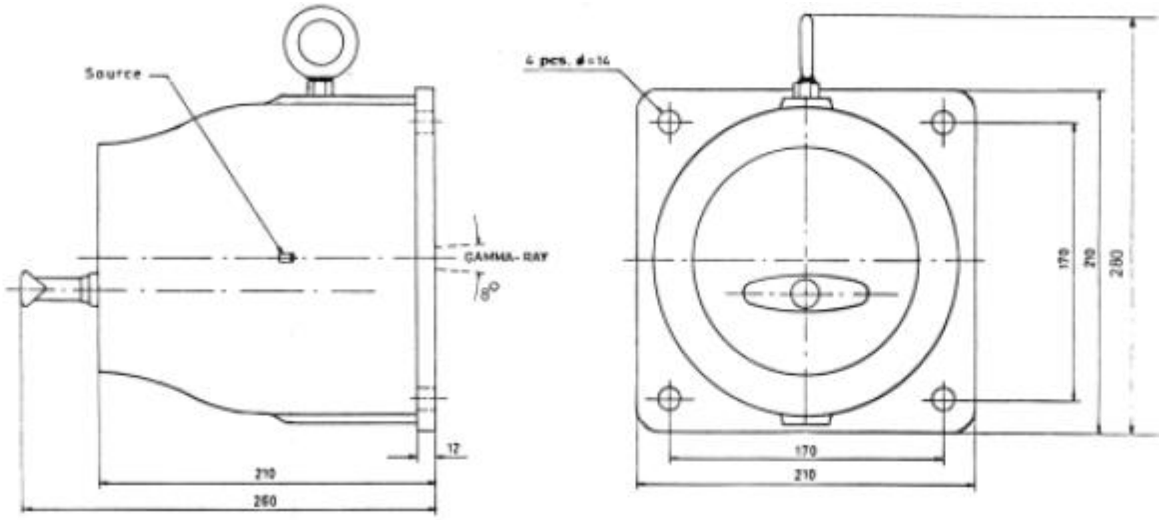
Radiation shield Q4521



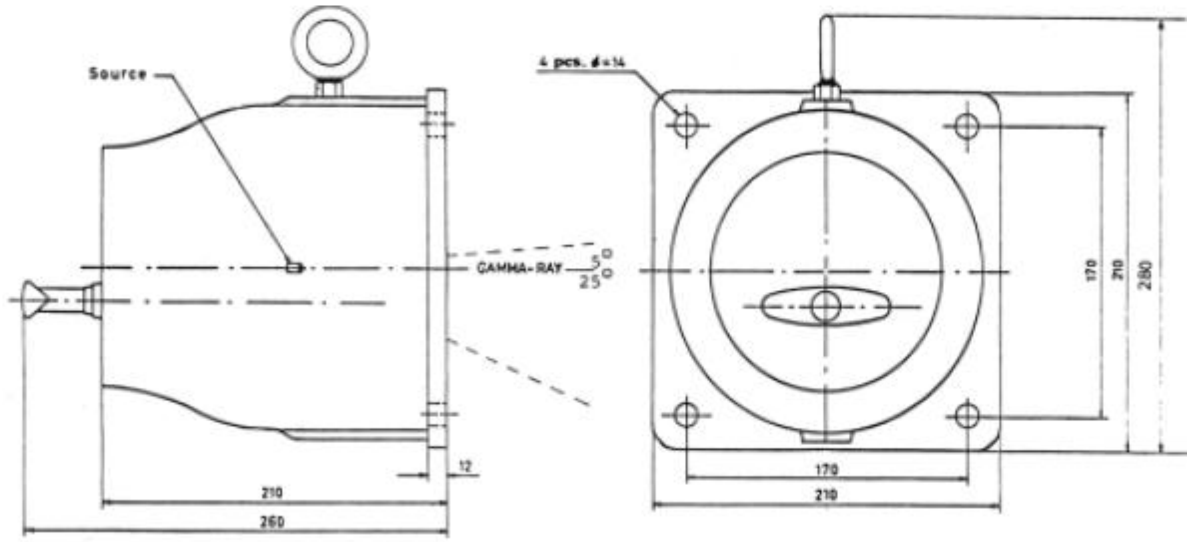
Radiation shield Q4521 S



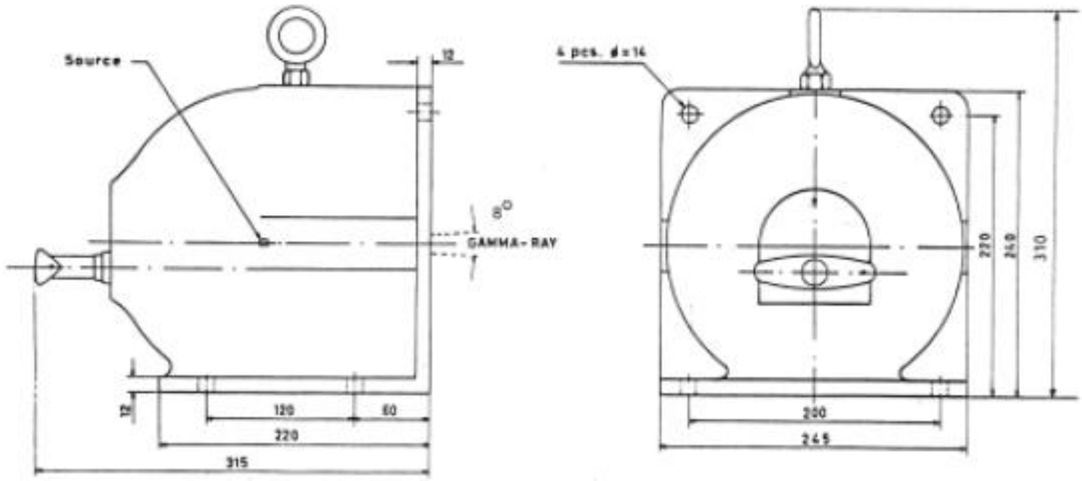
Radiation shield Q4583



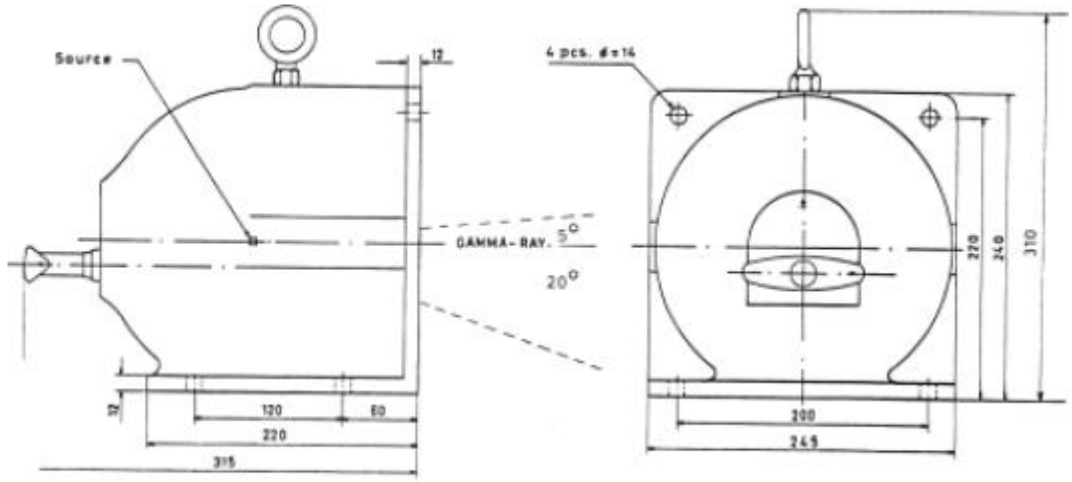
Radiation shield Q4583 S



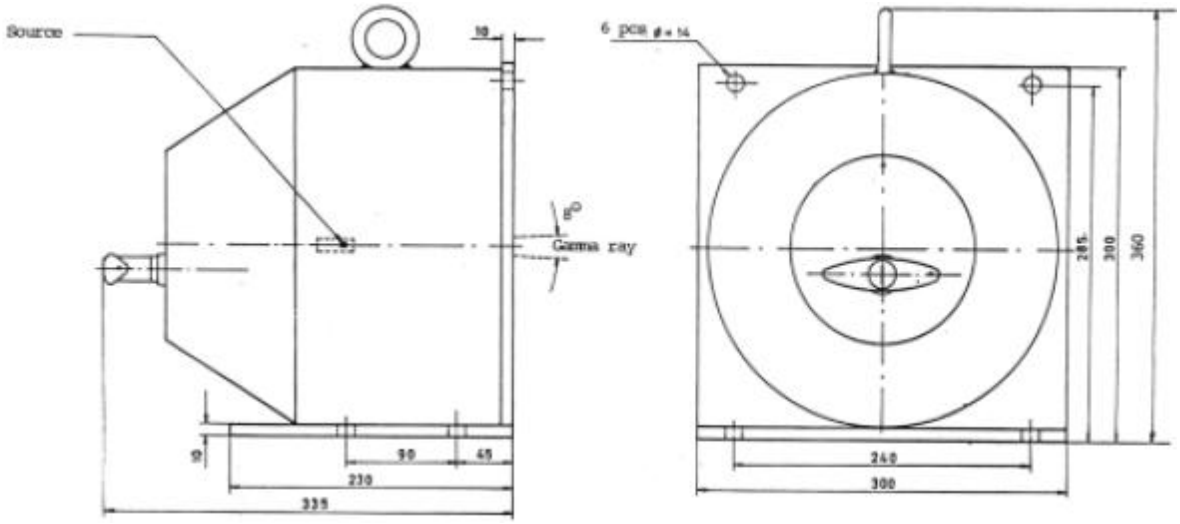
Radiation shield Q4584



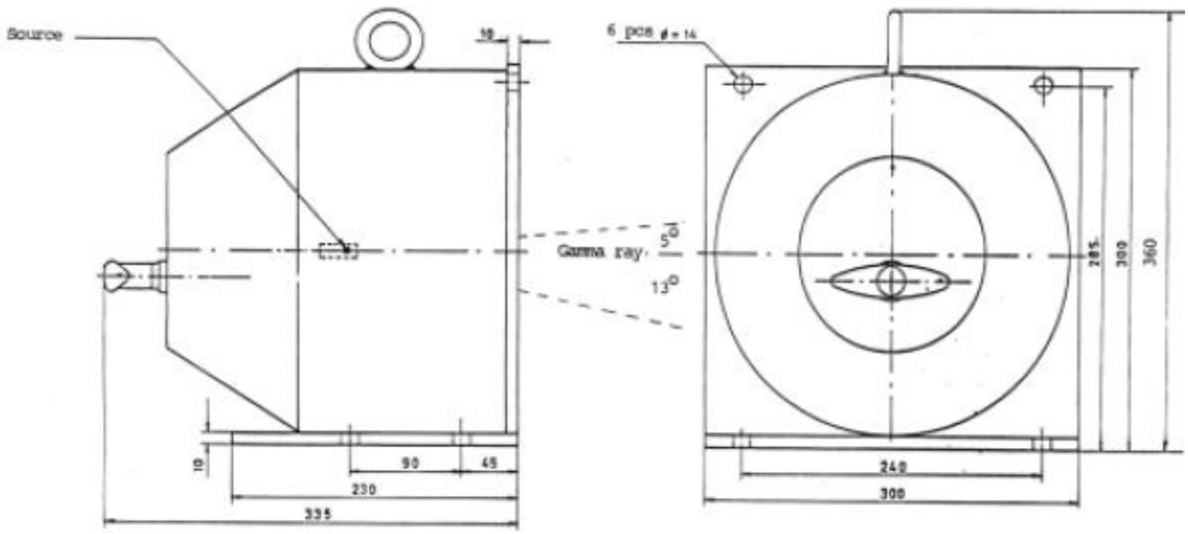
Radiation shield Q4584 S



Radiation shield Q4610



Radiation shield Q4610 S



2015-08-31

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