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GAMMAPILOT FTG 470 Z
Setting-up Instructions BA 089 F/00/e
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Part No. 015882-1000

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Applications

Non-invasive level measurement in vessels (mixers, reactors, bunkers, silos and tanks) with flammable, poinsonous and aggressive bulk material and fluids.

Can be used in acid tanks, cookers, cement silos, ballast silos, dust chambers (cyclones), cupolas, rotary kilns, agitating mixers, mixers, etc. because the measuring detector does not come into contact with the material or the vessel inside or outside.

The source is a double-sealed radioactive nuclide which emits only gamma radiation. Thus neither the vessel nor the material can take on any radioactivity, and the instrument can therefore be used in food vessels.

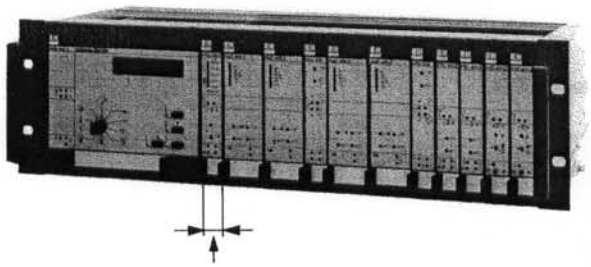
Measuring equipment

The measuring equipment consists of:

- a protective source housing QG (can be switched off manually, electrically or pneumatically) with radioactive nuclide cobald ^{60}Co or caesium ^{137}Cs (gamma radiation);
- a detector DG (see Technical Data for choice);
- detector cable, e.g. two cores of a four-core cable;
- the GAMMAPILOT FTG 470 Z;
- a 19" rack (DIN standard 41494, part 5), e.g. RACKSYST.

Contactors, solenoid valves, signal equipment, etc. can be connected at the potential-free relay contact of the GAMMAPILOT FTG 470 Z.

Measuring equipment



GAMMAPILOT FTG 470 Z
(4 UNITS WIDE)
SHOWN WITH THE MEASURING
EQUIPMENT INSTALLED IN
RACKSYST 19" RACK
(84 UNITS WIDE)

Fig. 1

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Technical data

GAMMAPILOT FTG 470 Z

Mechanical construction	plug-in card, european format 160 x 100 for 19" racks, DIN 41494
Front panel	black plastic with blue panel with handle and writing field
Width	4 units (20 mm)
Height	3 units (128.4 mm)
Plug-in connection	multipoint plug (DIN 41612) F-shaped
Protective type DIN 40050	front-panel IP 20 plug-in card IP 00
Dimensions	see Figure 2
Weight	2 kg
Permissible ambient temperature	0...+70°C
Power supply	24 V ±4 V
Input (detector connection)	intrinsically safe, galvanically separated from the rest of the circuitry
Connecting cable to detector	unscreened two-core cable, max. 25 Ω per core
Signal transmission	pulse-frequency modulation (current pulses)
Minimum attenuation of radiation	1.5 HVL
Switch delay	see Figure 13
Prolongation of switch delay	factor 1...6, adjustable
Outputs:	
Limit signal	a relay with a change-over contact max. 250 V, max. 2.5 A, max. 300 VA at cosφ > 0.7 switch for minimum-maximum safety
Fault signal	a relay with a change-over contact max. 250 V, max. 2.5 A, max. 300 VA at cosφ > 0.7
Dose rate related constant-voltage signal	0...5 V, R_L min. 5 kΩ
Display, test and calibration elements	see Figure 15

Detector DG...

Housing	Aluminium (option steel 1.4571)
Dimensions	see Figure 3
Protective system DIN 40050	IP 65
Permissible ambient temperature	-20°C...+60°C
Connection	3 m two-core cable (1.5 mm²)
Supply (from FTG 470 Z)	approx. 12 V, approx. 10 mA;
Signal transmission	pulse-shaped, superimposed on supply current
Pulse frequency	approx. 10...80 Hz, depending on ion dose rate
Accessories	see Figures 4...7

Detector types	DG 17	DG 27
Number of counting tubes	1	2
Adjustable range of ion dose rate	approx. 7...60 pA per kg (approx. 1 ... 8 µSv/h	approx. 3.5...30 pA per kg (approx. 0.5 ... 4 µSv/h
	with lateral radiation of the detector	
	approx. 14...120 pA per kg (approx. 2 ... 16 µSv/h	approx. 7...60 pA per kg (approx. 1 ... 8 µSv/h
	with frontal radiation of the detector	

Class of detector protection DG 17, DG 27	none

Note

1. For standard applications all detectors (DG 17, DG 27) can be operated together with GAMMAPILOT FTG 470 Z.

Regulations concerning maximum temperature und pressure must be observed when using detectors with cooling jacket or a tube detector (Figures 5, 6 and 7*) in explosion-hazard areas.

Further documentation

Project information for limit detection with GAMMAPILOT FTG 470 Z:

Technical information about RACK-SYST modular technique	No. E 11.83.01
Gamma nomograms and half-value layers	No. E 05.77.01
Protective source housing QG 020, QG 100	No. E 08.77.15
Protective source housing QG 006	No. 03.80.01
Radioactive specimens	No. E 10.75.01
Explanation of radiological terms	No. 11.73.08

PTB test certificate for protective source housing QG 020, QG 100

Dimensions are in mm.

Modifications to data reserved.

GAMMAPILOT FTG 470 Z, dimensions

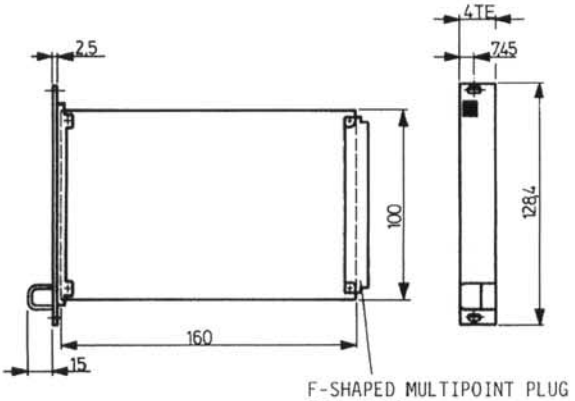


Fig. 2

Detector with steel cooling jacket

THE COOLING JACKET IS OPEN AT THE TWO ENDS. THE DETECTOR IS LOOSE IN THE COOLING JACKET AND IS KEPT IN POSITION BY SNAP RINGS. MAXIMUM AMBIENT TEMPERATURE +180°C WITH A FLOW RATE OF 30 L WATER (20°C) PER HOUR. ADDITIONAL ATTENUATION OF THE GAMMA RADIATION WITH LATERAL IRRADIATION ^{60}CO APPROX. 0.45 HVL
^{137}CS APPROX. 0.6 HVL

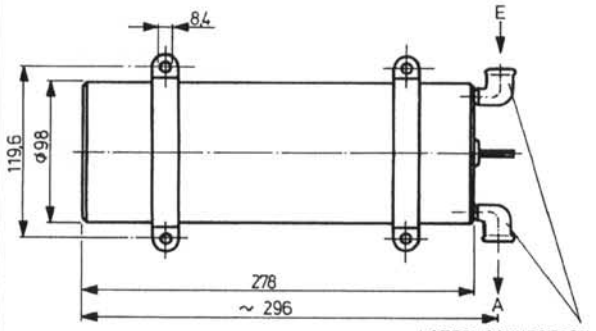


Fig. 5*

WEIGHT APPROX. 5 KG

Detector (standard version)

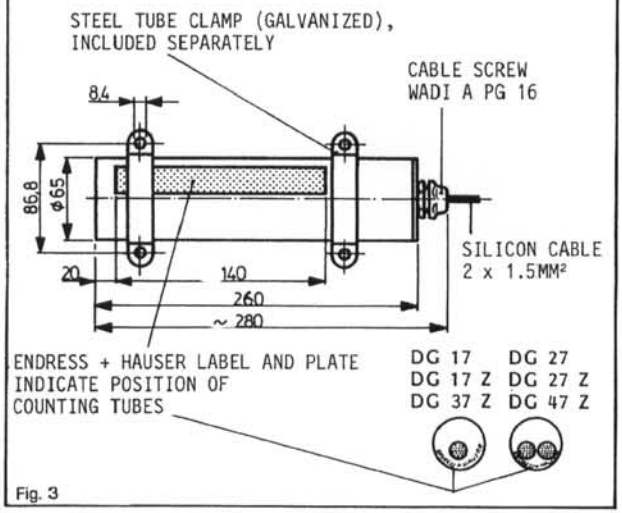


Fig. 3

Detector with cooling element (Flange: Steel)

BOTH ENDS OF THE COOLING JACKET WITH FLANGE ARE OPEN. THE DETECTOR IS LOOSE IN THE COOLING JACKET AND HELD IN PLACE BY SNAP RINGS. THIS VERSION IS NOT TO BE MOUNTED DIRECTLY IN THE VESSEL. MAXIMUM AMBIENT TEMPERATURE 180°C WITH A FLOW RATE OF 30 L WATER (20°C) PER HOUR. ADDITIONAL ATTENUATION OF THE GAMMA RADIATION WITH LATERAL IRRADIATION ^{60}CO APPROX. 0.45 HVL
^{137}CS APPROX. 0.6 HVL

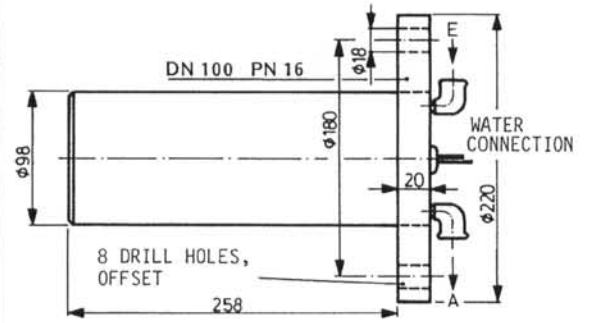
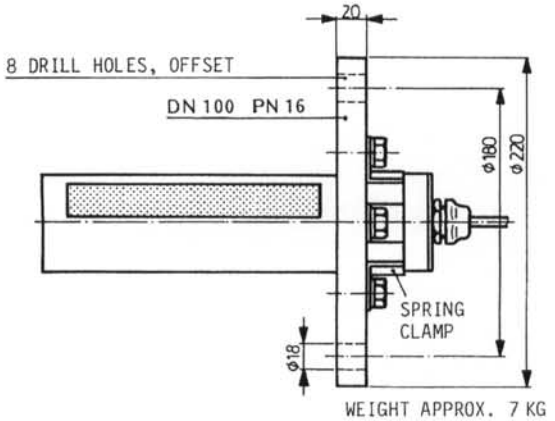


Fig. 6*

WEIGHT APPROX. 10 KG

Detector with mounting flange (steel)



WEIGHT APPROX. 7 KG

FLANGE NOT SEALED

Fig. 4

Tube detector

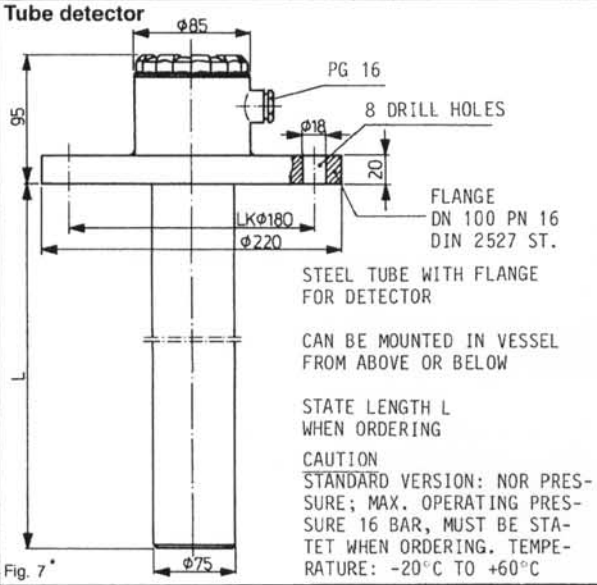


Fig. 7*

Function

On one side of the vessel a protective source housing is mounted in which there is a radioactive source, on the other side a detector with one or two counting tubes. The gamma radiation emitted by the radioactive nuclide penetrates the vessel walls and the vessel.
The counting tube in the detector converts these into current pulses which are transmitted along the two-cable circuit and integrated in the GAMMAPILOT as a current which switches the output relay.
When the level in the vessel exceeds the height of the radiation path, the radiation is attenuated by the material, and the output relay switches.
The relay can be operated in a minimum or maximum safety position. The GAMMAPILOT FTG 470 Z also monitors the function of the detector (including the counting tube), the two-cable connection to the detector, all connections and essential elements of the input circuitry.
During operation the instrument displays the dose rate on the detector, the position of the relay and whether the level is above or below the limit.
Failure are signalled by another relay and an LED on the front panel.

Construction

There are 2 different detectors, according to the number of built-in Geiger-Müller counting tubes (1 or 2)

The detectors are fitted with a water cooling jacket for use in very hot surroundings.
The GAMMAPILOT is a very narrow RACKSYST plug-in card. With a width of 4 units, 21 instruments can be mounted on a RACKSYST rack. Instruments for use in explosion-hazard areas and others can be mounted with intervening space or partitions.
The very narrow form of the GAMMAPILOT is made possible by the miniature components used, e.g. mini-melf resistors.
However, all essential elements for adjustment are clearly visible on the front panel and easy to operate.
The GAMMAPILOT has a 24 V constant voltage supply.
The detector is separated galvanically by means of a DC/DC converter and supplied with 12 V constant voltage from the GAMMAPILOT:

Important note

For your convenience please study the following chapters as well as

- our planning instructions
- national radiation protection regulations

Installation

If you have instruments for simultaneous use on several pieces of equipment, care must be taken when installing them that the protective source housing, radionuclide and detector belong to the appropriate piece of equipment. Compare the type designation of the instruments as well as the type and activity of the radionuclide with your project documents.

Installation of the protective source housing QG...

Install the protective source housing precisely as you had planned when designing the project. Here are a few tips.

It should be mounted on the vessel or, if there are very strong vibrations or high temperatures, on a separate device at the same height as the planned level limit.
If you wish to detect two different levels which are not very far apart, you can install one protective source housing with an extra-wide beam exit channel at the upper limit so that both detectors are simultaneously irradiated.
Take into account the weight of the protective source housing.

Turn off the protective source housing if it is to be installed with the radionuclide already in place. Instructions on inserting the radionuclide are to be found in the Technical Information Sheet for QG ...
The QG 006 cannot be switched off. Either the radionuclide must be removed before installation or else ensure that no one gets in the way of the beam.
Ensure that the housing is locked, if this is possible. Put up any barriers or warning signs required by the radiation protection regulations.

Installation of the detector DG...

Install the detector precisely as you had planned when designing the project. Here are a few tips.
The detector has a built-in sensitive Geiger-Müller-counting tube which must be protected during transport and installation.

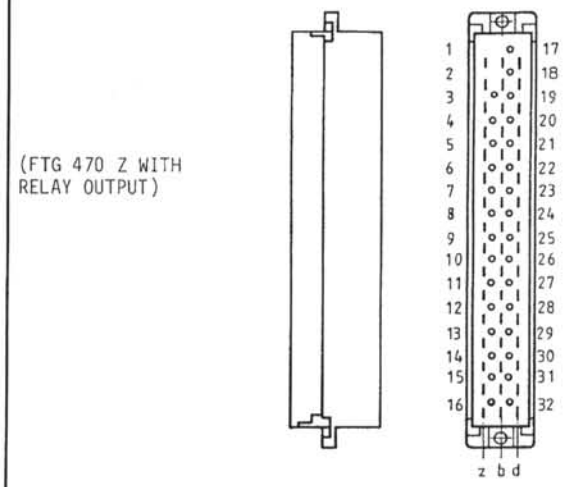
The detector can be mounted with a clamp or flange on the vessel or on a mounting device beside the vessel.
The detector is most sensitive to lateral irradiation. The switchpoint is most accurate when the detector is lying horizontally.
Turn the detector so that the Geiger-Müller counting tube is pointed at the vessel, thus preventing the beam from being further attenuated by components or the sand filling of the detector. The E+H logo and the identification plate indicate the position of the counting plate. See Figure 3.
Installation examples are given in Figures 8 and 9.
If the water-cooled detector is used for high ambient temperatures, water circulation should be monitored with a flow controller.

Installation of the GAMMAPILOT FTG 470 Z

The GAMMAPILOT FTG 470 Z is installed in a 19" rack, e.g. a RACKSYST rack (in which 21 instruments can be placed side by side) or in a watertight housing for a field installation. At any rate it must be installed outside the explosion-hazard area.

Please note that an F-shaped multipoint plug (DIN 41612) with coded pins must be mounted in the rack if intrinsically safe signal lines are laid into explosion-hazard zones.

Coded pins on the multipoint plug for FTG 470 Z



Standard installation Detector DG...

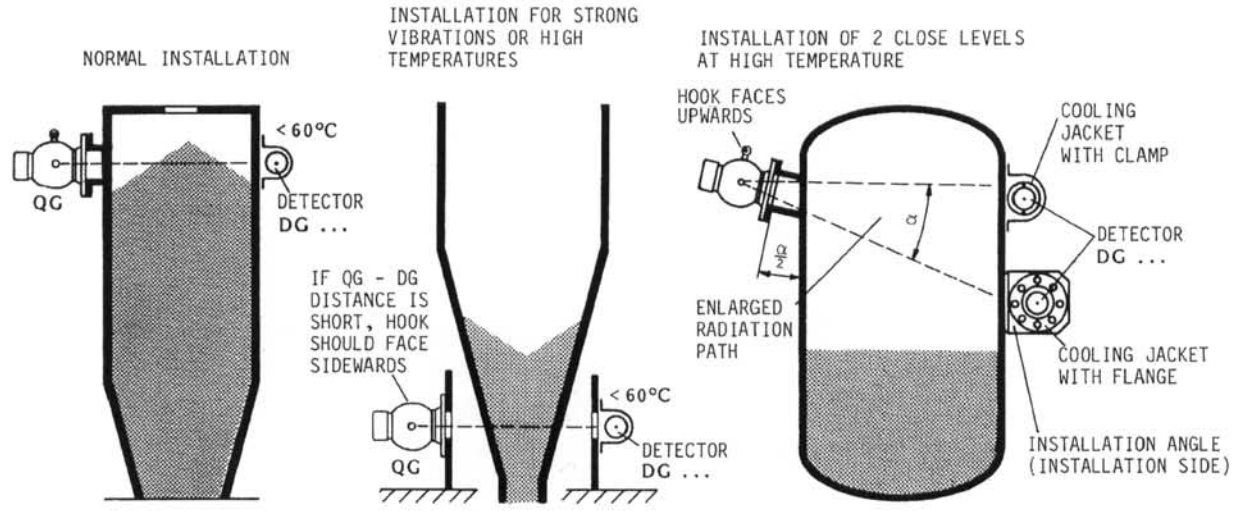


Fig. 8

IMPORTANT: PROTECTIVE SOURCE HOUSING AND DETECTOR MUST BE EXACTLY ALIGNED

Installation when there is a short distance between protective source housing and detector

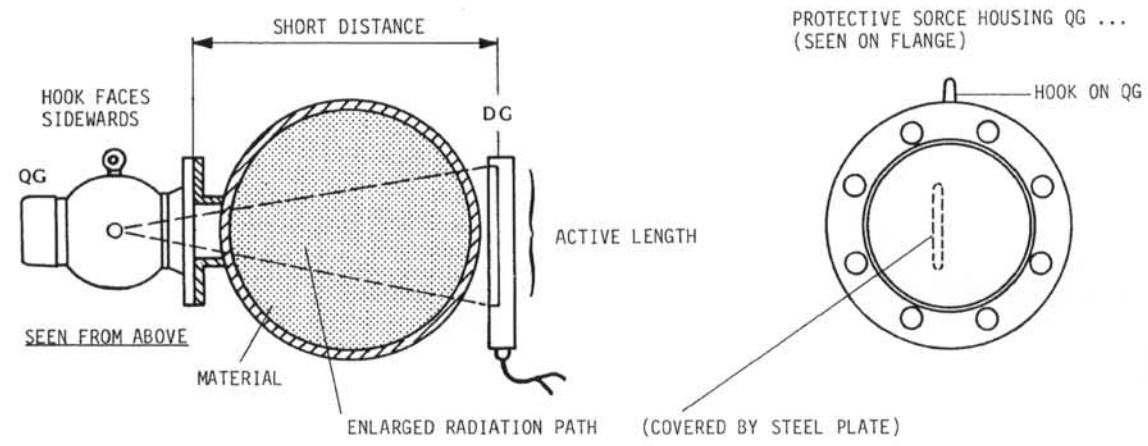


Fig. 9

Connection

The GAMMAPILOT FTG 470 Z has an F-shaped multipoint plug DIN 41612. For positions and wiring see Figure 10. No special protection is needed for the constant-voltage supply because the instrument is fitted with fine-wire fuses.

For connecting the GAMMAPILOT FTG 470 Z and the detector DG ..., two cores of a multicore signal cable at the vessel are sufficient. Max. 25 Ω per core.

The signal input is galvanically separated from the rest of the circuitry by a DC/DC converter and an opto-coupler.

The output relay contacts are also galvanically separated and potential-free.

The voltage output 0...5 V for display or recording of the dose rate at the detector may not be grounded. Normal voltmeters, recorders, limit indicators, etc. may be connected with R_i > 5 kΩ. The output voltage 0...5 V corresponds to

approx. 0...57 pA/kg for DG 17
approx. 0...28 pA/kg for DG 27
} lateral irradiation of the detector

or

approx. 0...114 pA/kg for DG 17
approx. 0...57 pA/kg for DG 27
} frontal irradiation of the detector

When connecting signal and control elements ensure that they function as a function of level and safety switch (see Figure 11) and check maximum contact ratings.

Connection

SEEN FROM THE CONTACT BLOCK OF THE FTG 470 Z OR THE CONNECTION SIDE OF THE MULTIPOINT PLUG IN THE 19" RACK

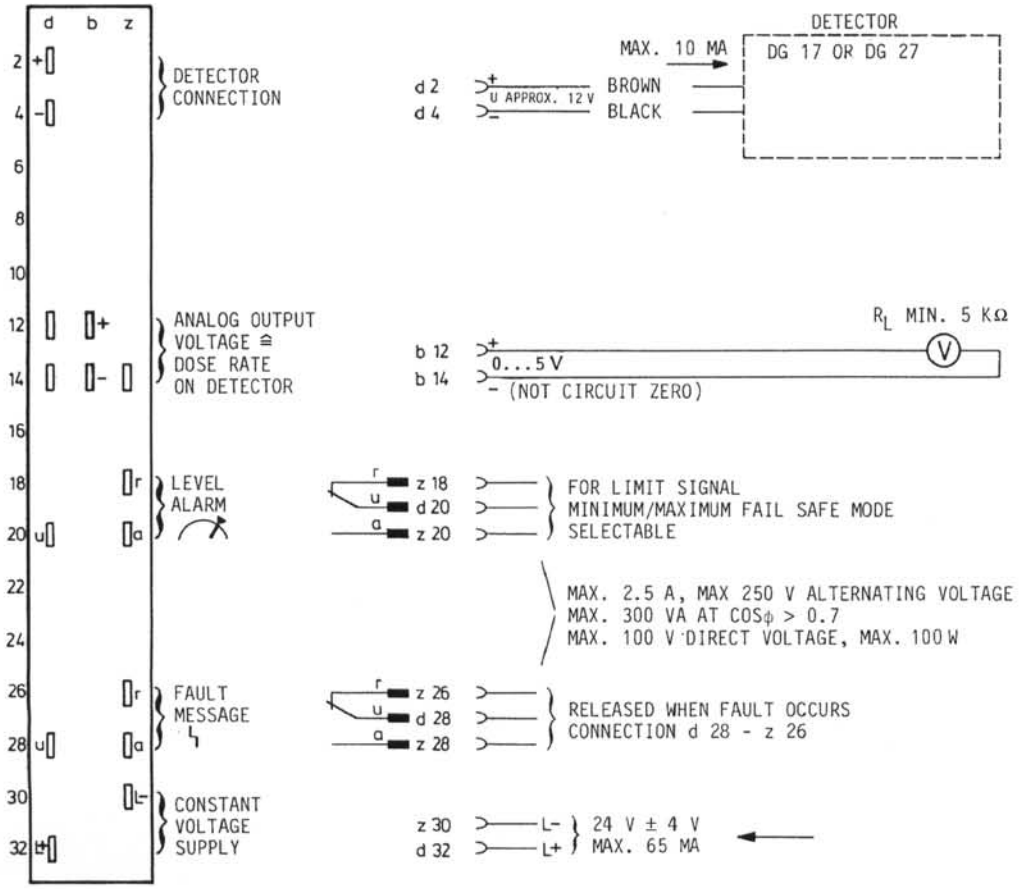


Fig. 10

Choose fail-safe mode for level alarm relay

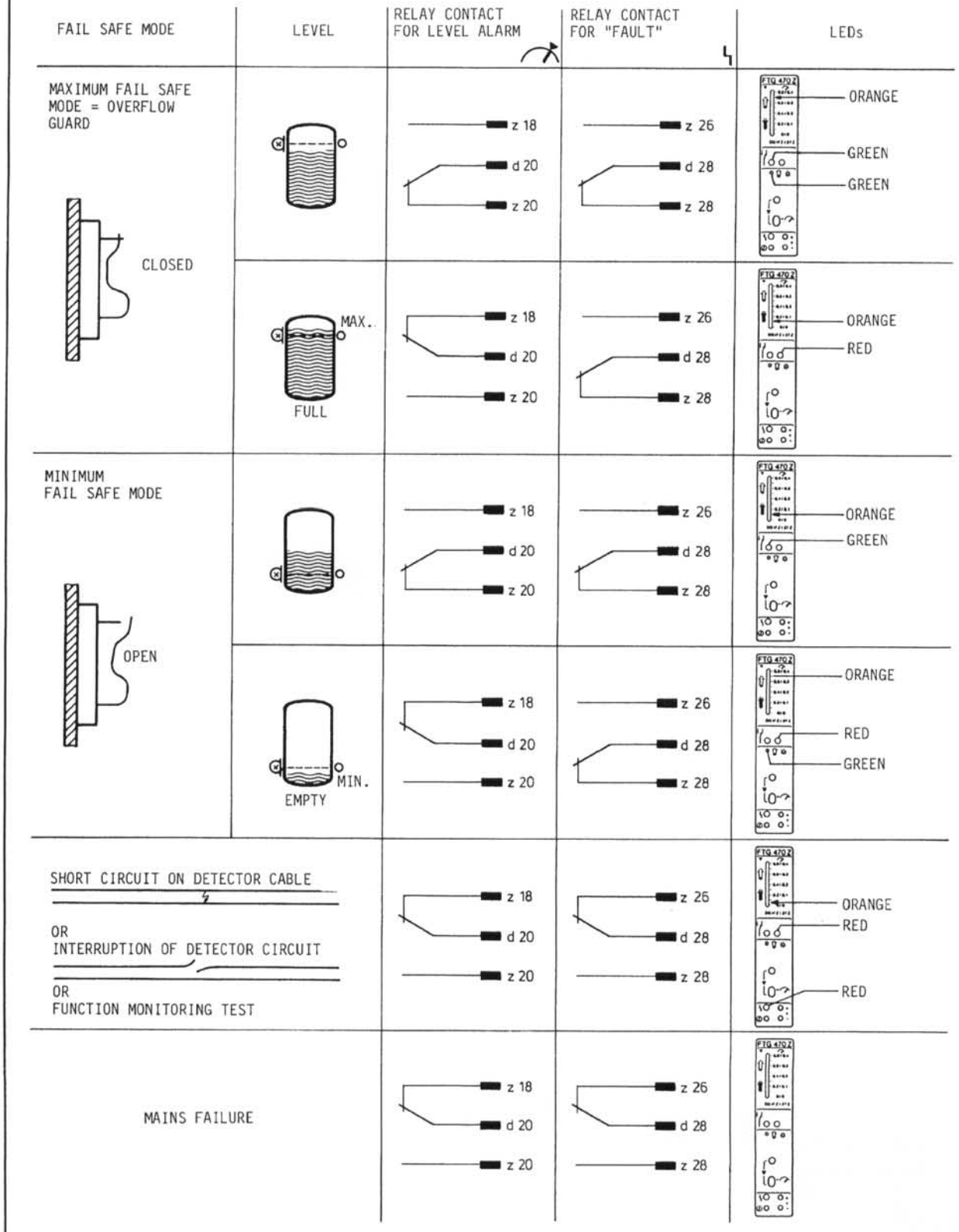


Fig. 11

Calibration

Only the GAMMAPILOT FTG 470Z need be calibrated. The next few chapters deal with adjustments which can be made before the instrument is mounted on the 19" rack.

Function of relays and LEDs depending on level and fail-safe mode

Maximum safety means that the relay is released when the level exceeds the limit setting, if there is a defect or if there is a mains failure.
Minimum safety means that the relay is released if the level does not reach the limit setting, if there is a defect or if there is a mains failure.

Miniature switch closed: maximum safety mode
Miniarture switch open: minimum safety mode

Select response time (switch delay)

The response time is the time which elapses between the interruption or release of the beam path between the source and the detector and the switch of relay in the GAMMAPILOT FTG 470 Z.
This response time depends on various factors:
It is longer when there is

- 1 counting tube in the detector
- low dose rate
- little attenuation by the material

It is shorter when there are

- two counting tubes in the detector
- a higher dose rate
- strong attenuation by the material.

Figure 13 shows the minimum response time which can be prolonged by as much as six times, according to your particular requirements.

Switch delay as a function of detector, ion dose rate on detector and attenuation

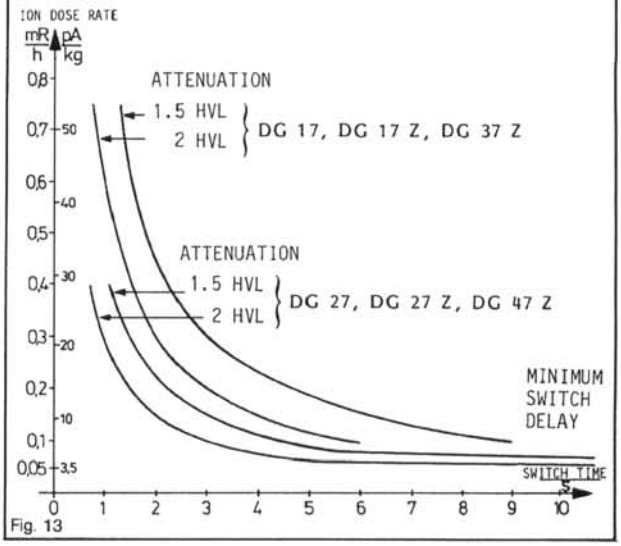


Fig. 13

Calibration elements on the printed circuit board of the GAMMAPILOT FTG 470 Z

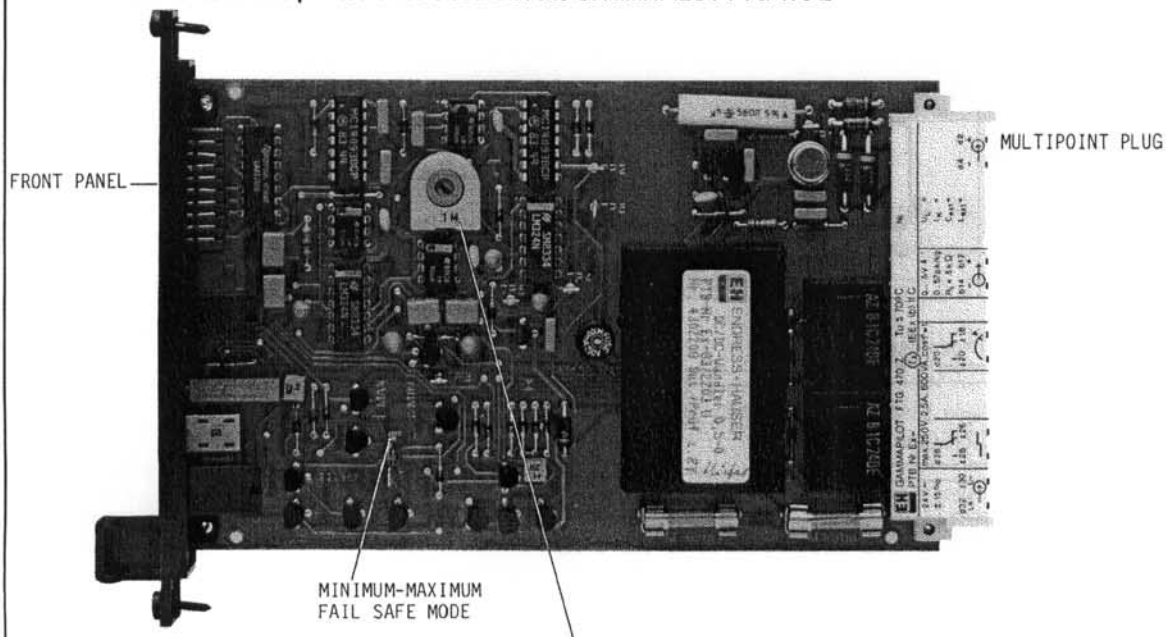


Fig. 12

Preparation of further calibration

Once you have selected the safety mode and response time, push the GAMMAPILOT FTG 470 Z into the right place on the 19" rack.

Turn on the mains voltage and check whether the level in the vessel is below the limit. Check too whether the protective source housing QG ... is switched on.
The other calibration elements are situated on the front panel of the GAMMAPILOT FTG 470 Z. See Figure 15 (overleaf).

Check calibration possibility

First check whether calibration is possible at all.
Slide switch upwards ↑, position ⌒= operation.
One of the LEDs in the LED row should light up between 0.1 und 0.7.

If the LED lights up at 0, check whether

- the protective source housing is switched on,
- the right radionuclide has been used,
- the radiation exit channel is exactly aligned with the detector, and
- the radiation is not interrupted by material

If the "Fault" LED lights up, check in the trouble shooting table for the possible cause.
If the values indicated in Table 14 are exceeded, the beam is too strong. Adjustment is still possible, but one control area must be blocked off if 54 pA/kg (0.75 mR/h) is exceeded.
Check whether the right radionuclide has been used and whether the right detector has been installed.
You can attenuate the beam by mounting a steel plate in front of the flange of the protective source housing.

Detector: installation and display

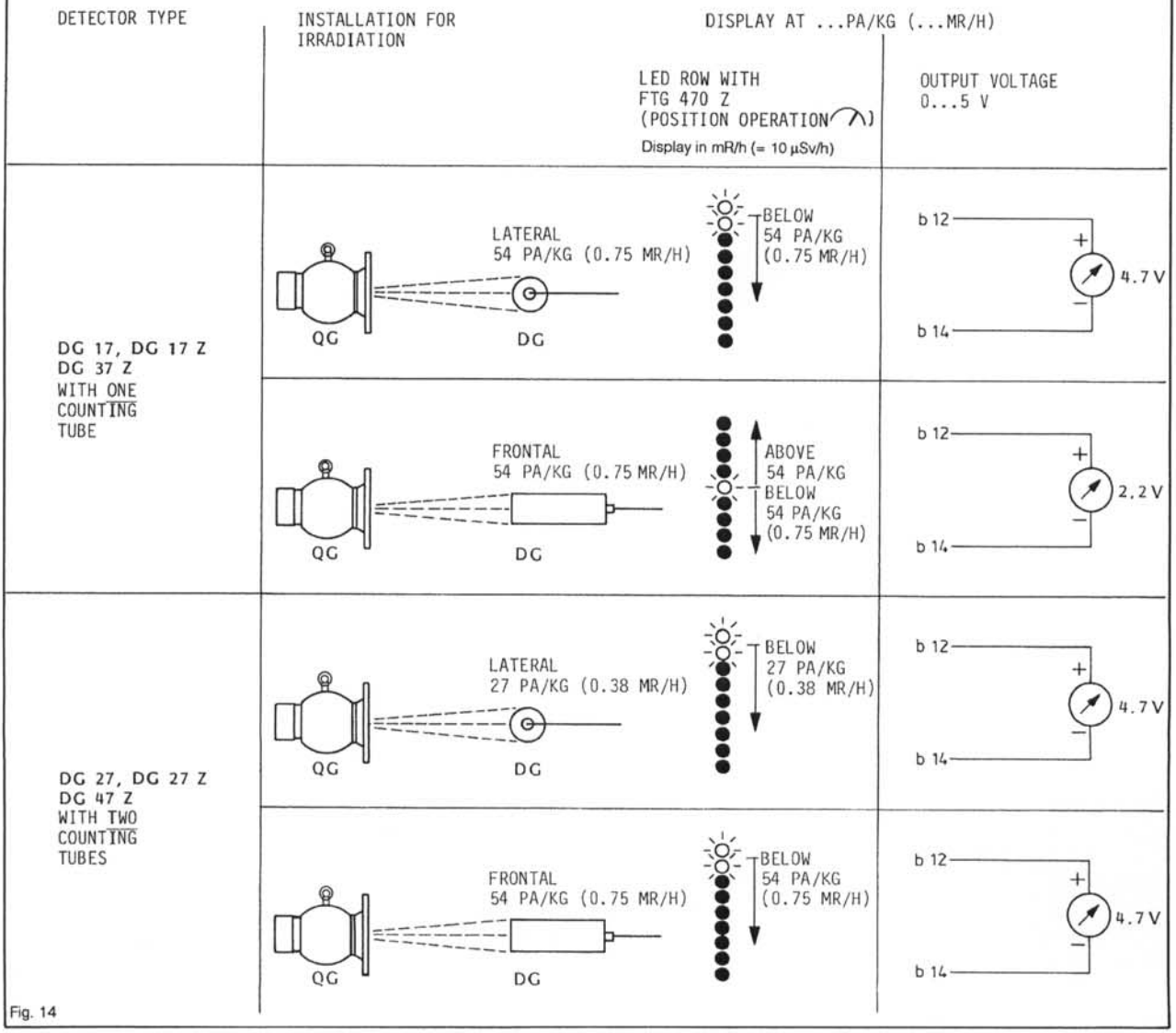


Fig. 14

Setting the switchpoint for free radiation path

Slide switch downwards ↓, Calibration position. Red LED "Fault" and green LED "Free radiation" light up.
By means of the adjuster (spindle potentiometer with 20 rotations), a particular LED is light up, depending on the anticipated attenuation by the material in the vessel.
Explanation: 1 HVL (half value layer) = the length of the material layer required to attenuate the dose rate by half. For information see Technical Information Sheet No. 05.77.01 "Gamma nomograms and half value layers".
Turn the adjuster clockwise: display rises.
If anticipated attenuation exceeds 1.5 HVL: set the display at 0.5...0.6.
If anticipated attenuation exceeds 2 HVL: set display at 0.5...0.6.
If anticipated attenuation exceeds 2 HVL: set display at approx. 0.7.

Setting the switchpoint for attenuated radiation

EMERGENCY SOLUTION
Only if it is not possible to empty the vessel to permit calibration with a free radiation path should you attempt calibration with an attenuated radiation (in this case it is not possible to check the calibration possibilities).
Slide switch downwards ↓. Position calibration.
Red LED "Fault" lights up.
With the calibration adjuster you cause a particular LED in the LED row to light up, depending on the calculated attenuation by the material in the vessel.
For attenuation exceeding 1.5 HVL: set display at approx. 0.2...0.3.
For attenuation exceeding 2 HVL: set display at approx. 0.1.

Calibration elements on the front panel

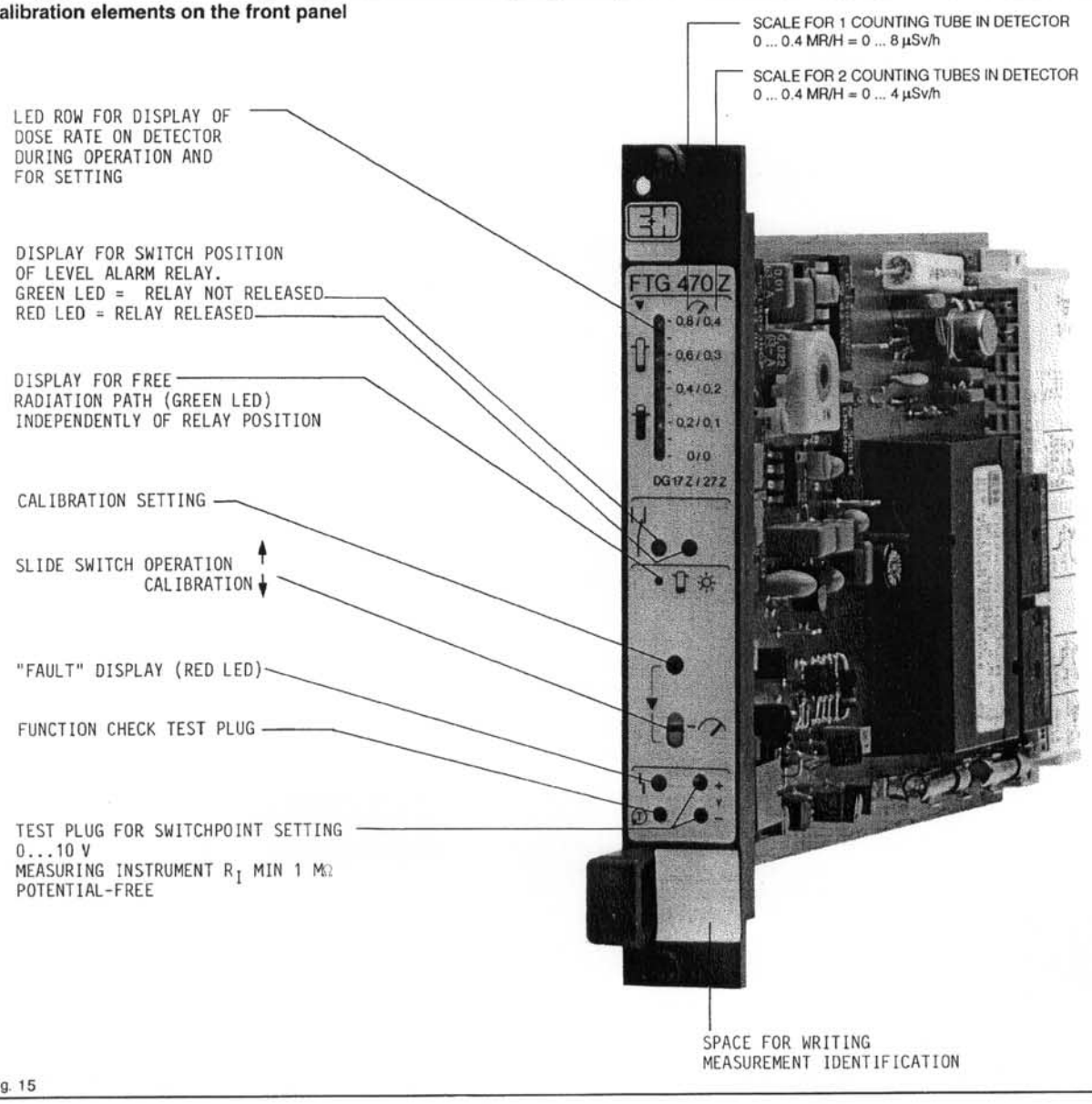


Fig. 15

Setting for operation

Slide switch upwards ↑. Position ◠ = operation.
The red LED "Fault" is extinguished. The limit switch is thus ready for operation.
The ion dose rate is displayed on the orange LED of the detector. A scale graduation of 0.1 equals approx. 7.2 pA/kg (1 µSv/h).

The left scale 0...0.8 shows the dose rate for a detector with one tube, the right scale 0...0.4 the dose rate for a detector with two counting tubes.
The green and red LEDs indicate function and switch position (see Figure 13).

Note switchpoint setting

On the test terminals of the front panel you can now measure a constant voltage 0...10 V, which corresponds exactly to the position of the spindle potentiometer. Note this value so that in case of exchange the same value can be set on the new instrument (switch position ◠ Operation) and so that the vessel does not have to be emptied for calibration.
Moreover, you can check whether the calibrated value has been displayed.

Test of function monitoring

Insert a test plug (uninsulated pin, 2 mm diameter, at least 10 mm long) into the test terminal (T). The red LEDs for "Fault" and "Switch position display" light up immediately. The two relays are released.
Tip: If you do not have a test plug, a piece of uninsulated copper wire (2.5 mm²) will do.

Maintenance

Please observe national regulations governing radiation protection.
Check from time to time whether the protective source housing is closed and whether the warning signs are in place. In the maximum safety position, the equipment requires no service. It automatically indicates when the radiation is shut off, if the activity of the radionuclide diminishes and if the detector (incl. the counting tube) or circuits are defective.
At minimum safety, you must occasionally adjust the calibration to the diminished activity of the preparation.

^{60}Co and attenuation	1.5	HVL every year
^{60}Co and attenuation	2	HVL every 2 years
^{137}Cs and attenuation	1.5	HVL every 4 years
^{137}Cs and attenuation	2	HVL every 8 years

If the activity has diminished so much that calibration is no longer possible, the radionuclid must be exchanged and the instrument recalibrated. With water-cooled detectors, check the lime content of the water to prevent blockage.

Calibration

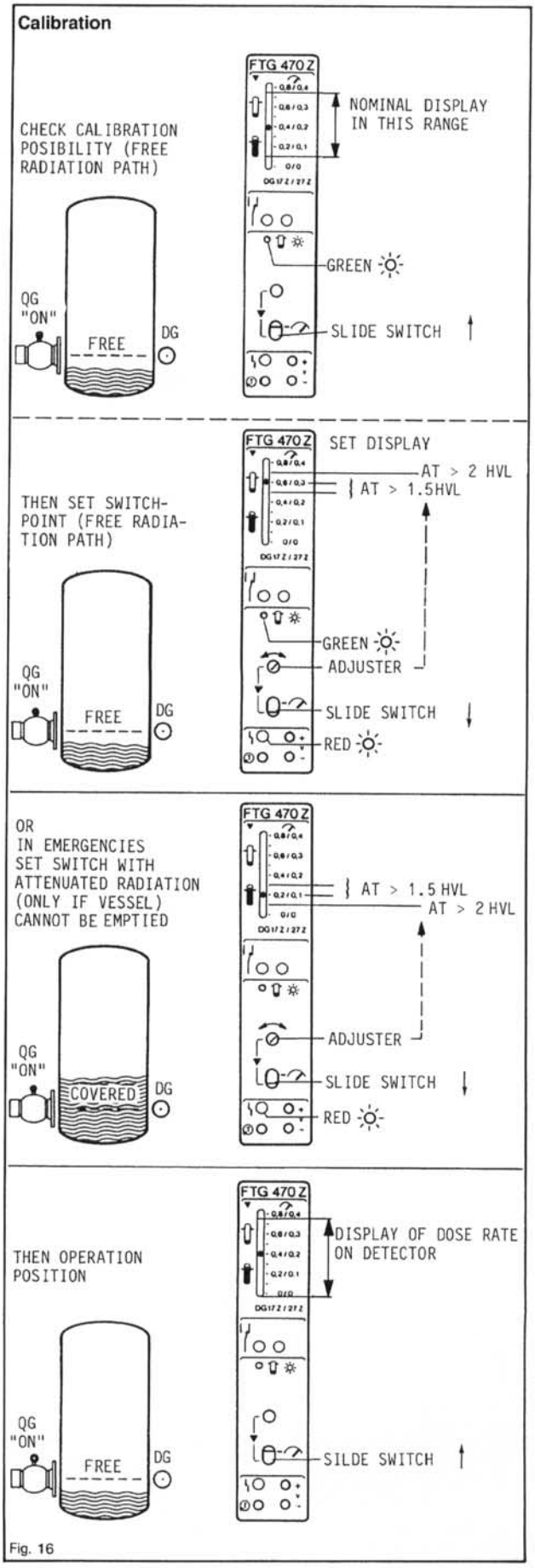
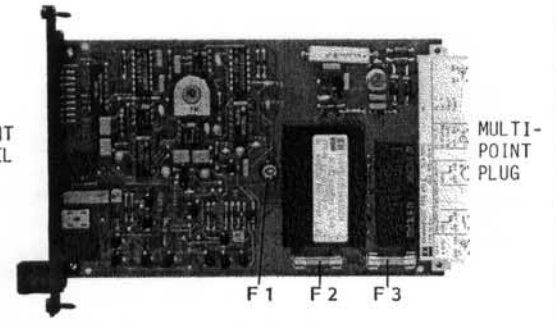


Fig. 16

Trouble shooting

Defect	Possible cause	What to do
Dose rate display for free radiation too low	Protective source housing switched off	switch on
	No radionuclide ^{137}Cs	Put in fresh material
	^{137}Cs radionuclide instead of ^{60}Co	Put in ^{60}Co
	Detector with 1 counting tube	Mount detector with 2 counting tubes
	Counting tube facing wrong direction	Turn detector
	Detector mounted at end	Mount detector sideways
	Protective source housing not precisely aligned with detector	Align precisely
	Enlarged beam path twisted	Turn in the right direction
	Installation in vessel not considered in project design	Recalculate radionuclide
	Build-up of deposit in tube	Close installation tube
	Strong build-up of deposit in vessel	Remove deposit
Dose rate display for free radiation path too high	^{60}Co instead of ^{137}Cs	Put in ^{137}Cs
	Radionuclide too active	Exchange radionuclide or attenuate radiation (e.g. mount steel plate in front of flange)
	Detector with 2 counting tubes	Mount detector with 1 counting tube or attenuate beam
	Counting tube defective	Exchange detector
Display "Defect ↳ "	Slide switch on "Calibration"	Slide to operation position 
	Connection to detector broken	Check connection
	Connection to detector wrongly connected	Check connection
	Connection to detector has a short circuit	Check connection
	FTG 470 Z input defective	Check fuses F1, F2, exchange FTG 470 Z
	Detector defective	Exchange detector

FUSES IN GAMMAPILOT FTG 470 Z



FUSE F 1: 100 MA, MEDIUM-BLOW (PULSE GENERATION)

FUSE F 2: 63 MA, MEDIUM-BLOW (DC/DC CONVERTER) FOR INTRINSICALLY SAFE INPUT)

FUSE F 3: 100 MA, MEDIUM-BLOW (VOLTAGE SUPPLY TO OTHER CIRCUITS)

Fig. 17

BA 089 F/00/en/05.03
Part No. 015882-1000
Printed in Germany/HD