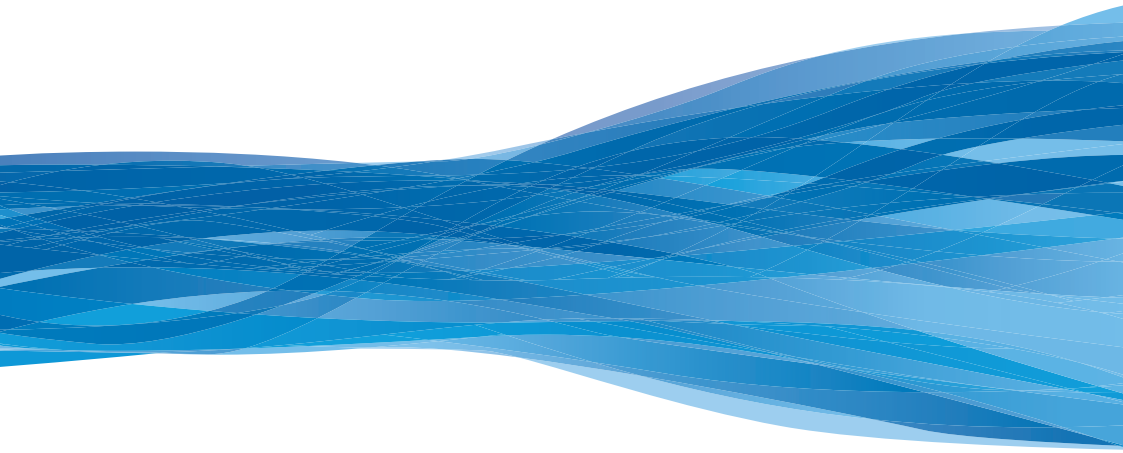
TRACERCO™ Radiation Monitor

Instruction and Maintenance Manual for Model No. T402



Customer Notice:
Please note that the T402 is NOT an Intrinsically Safe Monitor and should not be confused with the TRACERCO™ T202 Radiation Doserate Monitor which does meet Intrinsic Safety Standards.

Tracerco

CONTENTS

DOSE RATE RADIATION MONITOR

1. GENERAL DESCRIPTION

The T402 is a portable and battery operated radiation monitor, capable of measuring X and gamma radiation over a wide energy range down to 60keV. The monitor reflects Tracerco's 40-years of experience in Industrial and Environmental Radiation Measurement by combining novel design features with major advances in processor technology, to enhance versatility, accuracy and ease of operation in the field.

The radiation detection capability is based on robust Geiger Muller tube technology located in the head of the monitor.

The monitor has been specially designed to be lightweight but robust and comfortable when used over extended periods in the field. The outer protective case is manufactured from a high quality polymeric material to be chemically inert, sturdy and resistant to impact.

The instrument has a particularly high tolerance to humidity and generally wet conditions.

The monitor is a true "all weather" instrument and is suitable for use in demanding climatic and environmental conditions such as those found in industries involving Mining, Oil and Gas Exploration and Nuclear Decommissioning.

2. OPERATIONAL SAFETY

The T402 portable radiation monitor is battery operated with a typical battery life of around 100 hours (depending on exact mode of use). A "LO BATT" warning appears on screen when the residual battery capacity reduces to about 4 hours. When the battery is exhausted, the screen clears. The screen will remain blank when the internal circuitry identifies that battery condition is below the minimum required for effective operation:

A selectable backlight facility allows measurements to be made under dark or low light conditions (note that the use of this function will significantly reduce battery life). An audible response is also available to complement visual measurements.

In the event of a GM tube failure or circuit malfunction which interrupts the radiation detection signal, the screen will indicate the following warning message "ERR1".

3. POST DELIVERY CHECKS

All monitors supplied by Tracerco have been fully checked, tested and calibrated prior to shipping. The monitor will be fitted with a new battery and available for immediate operation.

Each monitor is supplied in a protective overpack for transportation. All monitors should reach the customer in perfect working order.

In the unlikely occurrence of a problem, please contact Tracerco immediately (contact numbers are provided within this manual).

PLEASE ENSURE THAT THE MONITOR RADIATION TEST AND CALIBRATION CERTIFICATE IS PRESENT IN THE PACK.

(Certificates should be filed in a safe place for future reference. In the event of difficulties, duplicate certificates can be provided by Tracerco free of charge).

4. OPERATIONAL FEATURES

The operator may also wish to refer to the functionality image in the front of this manual.

In certain parts of the world, natural background radiation values may be anomalously low e.g. Middle East and the operator may conclude that the monitor is non-operational. To minimise this risk, the monitor is programmed to recognise the following situations:

1. No recorded counts over a period of 20 seconds – the monitor will display a "lo BGnd" message on the screen.

2. No recorded counts over a period of 40 seconds – the monitor will recognise a detector problem and will display an "ERR" message on the screen.

4.1 Switch On

The monitor is activated by pressing the red **ON/OFF** switch. This has a toggle action – press for **ON** and press again for **OFF**. In the absence of any significant local radiation sources the monitor will register incident background radiation which will vary with geographical location.

A typical background reading might be expected to be in the region 0 to 0.5 μSv/h (See note above).

(Please note that there may be a slight delay between switching off the monitor and the screen clearing of information).

4.2 Speaker

Pressing the **GREY** switch with the speaker symbol activates the internal speaker. The speaker provides an audible clicking sound whose rate is proportionate to the amount of radiation registered by the detector.

The speaker may be silenced by re-pressing the **GREY** switch. The speaker symbol shows on the screen when the audible option has been selected. Battery life is extended with the speaker off.

4.3 Backlight

The monitor display is fitted with a backlight which is available for use in situations of low ambient light intensity. The **GREY** switch marked with the sunburst symbol is pressed to activate the backlight facility. Since the backlight significantly increases the current drain on the battery, the pushbutton switch is designed for contact operation only ie., depressing the switch activates the backlight and releasing the switch cancels the light.

4.4 Low Battery

The monitor is equipped to display a "LO BATT" message although it is recommended that the battery is replaced as soon as this message is activated, it might be anticipated that under normal conditions, the monitor is capable of operating for a further 4 hours.

4.5 **Pre-Set Alarm**

The monitor is equipped with an alarm function which the operator can, within prescribed limits, pre-set at any required level of doserate or integrated dose. The alarm provides a continuous high frequency tone whenever the measured radiation doserate or integrated dose exceeds the value set by the operator. The alarm may be deactivated by the operator A safety feature of the instrument is that there is no mute (accept facility) for the alarm. Alarm activation is indicated by a flashing loudspeaker icon.

To set the alarm trip level, the operator should refer to section 5.6.

4.6 **Calibration**

Current UK legislation requires that all operational radiation monitors are subject to annual inspection and testing. This requirement includes performance checks and where appropriate, recalibration of the monitor.

On switching on the radiation monitor, the next calibration check due date will register automatically on the main screen for approximately 2 seconds. This date will indicate the 12-month anniversary of the current calibration.

All Tracerco radiation doserate monitors are checked and calibrated immediately prior to despatch to the customer. Following this initial procedure (or the annual inspection and calibration check), Tracerco operatives will re-set the next calibration check due date within the software of the monitor.

Further information on the calibration procedure is provided elsewhere in this manual.

5 **MEASUREMENT OF RADIATION DOSERATE**
(It may be a help to read this section in conjunction with the function flow chart)

5.1 **Procedure**

Switching on the monitor will display all available segments for 2 seconds. A check should be performed for any missing segments.

For the following two seconds, the next “CAL DUE” date will show using a MM/YY format.

The monitor then enters normal operation. All previous information on peak radiation dose rate and accumulated radiation dose will have been re-set to zero following the power down.

5.2 Bargraph Display

The monitor provides a bargraph display which operators may find preferable to the digital display in providing an improved visual indication of doserate trends in the region of 0-1000μSv/h. It might be expected that in the majority of circumstances, the operator would record definitive doserate data based on the digital numeric display.

If the bargraph full scale value is exceeded (1000μSv/h), the digital numeric display will continue to operate upto a maximum of 10,000μSv/h.

The bargraph display will remain at full scale deflection pending the removal of the radiation field.

5.3 Numeric Display

This display is self-ranging, providing a continuous numeric display of doserate from 0 to 10,000 μSv/h.

If the maximum radiation reading (10,000μSv/h) is exceeded on the digital numeric scale, the display will show the following warning "**OVER**". In this situation the monitor cannot provide a measurement of radiation dose exposure. If the radiation field exposure is reduced below 10,000μSv/h, the monitor will return to normal operation.

5.4 Accumulated Radiation Dose

An important feature of the monitor is the capability to record accumulated dose. Once the monitor has been switched on, the accumulated dose will be continuously updated in the monitor memory. The yellow "**MODE**" button allows the operator to view the accumulated dose in μSv on the digital display. The button allows the operator to toggle between digital readout of doserate μSv/h and accumulated dose μSv.

The operator can control the period over which the dose is integrated by simply pressing the "**SELECT / RESET**" button when in the accumulated (μSv) mode. The accumulated dose will return to zero and then automatically commence another period of dose integration.

This accumulated dose function allows the monitor to be effectively used as an integrating dosimeter and is useful in carrying out assessments of potential dose uptake by individuals during the performance of certain operations.

5.5 Peak Radiation Dose Rate

The monitor has the capability to record the highest doserate it has been exposed to since it was switched on. Switching off the monitor clears the memory of the previously held peak value.

Pressing the green "**PEAK**" button while in the doserate (μSv/h) mode will show the peak dose rate. A second press will return the display to normal reading mode. Pressing the "SELECT / RESET" button during this peak display will reset the peak value to zero, allowing a new peak reading.

5.6 **Setting Alarm Trip Levels**

The T402 is equipped with an alarm function which can be set by the operator. The alarm is a continuous high-pitched note and operates whenever the monitor reading exceeds the pre-set trip level. The alarm trip level can be set in either dose equivalent rate values or as integrated dose equivalent.
The incremental settings for the alarm are as follows:-

a) ***Integrated Dose Equivalent Function***

Range μSv	***Increment μSv***
0 → 10	1.0
10 → 400	10.0

Max alarm trip level : 400μSv.

b) ***Dose Equivalent Rate Function***

Range μSv/h	***Increment μSv/h***
0 → 50	1.0
50 → 100	5.0

Max alarm trip level : 100μSv/h.

Sounder Options

If the speaker symbol is pressed and released quickly, the speaker symbol will flash repeatedly at approximately 1-second intervals if the alarm setting is ON. The sounder should operate, providing audible clicks which are consistent with the level of radiation being measured. If the alarm setting is OFF, the speaker symbol will remain fixed on screen and the sounder will continue to operate as above.

If the speaker symbol is absent from the screen, it indicates that both audible response and alarm setting is OFF.

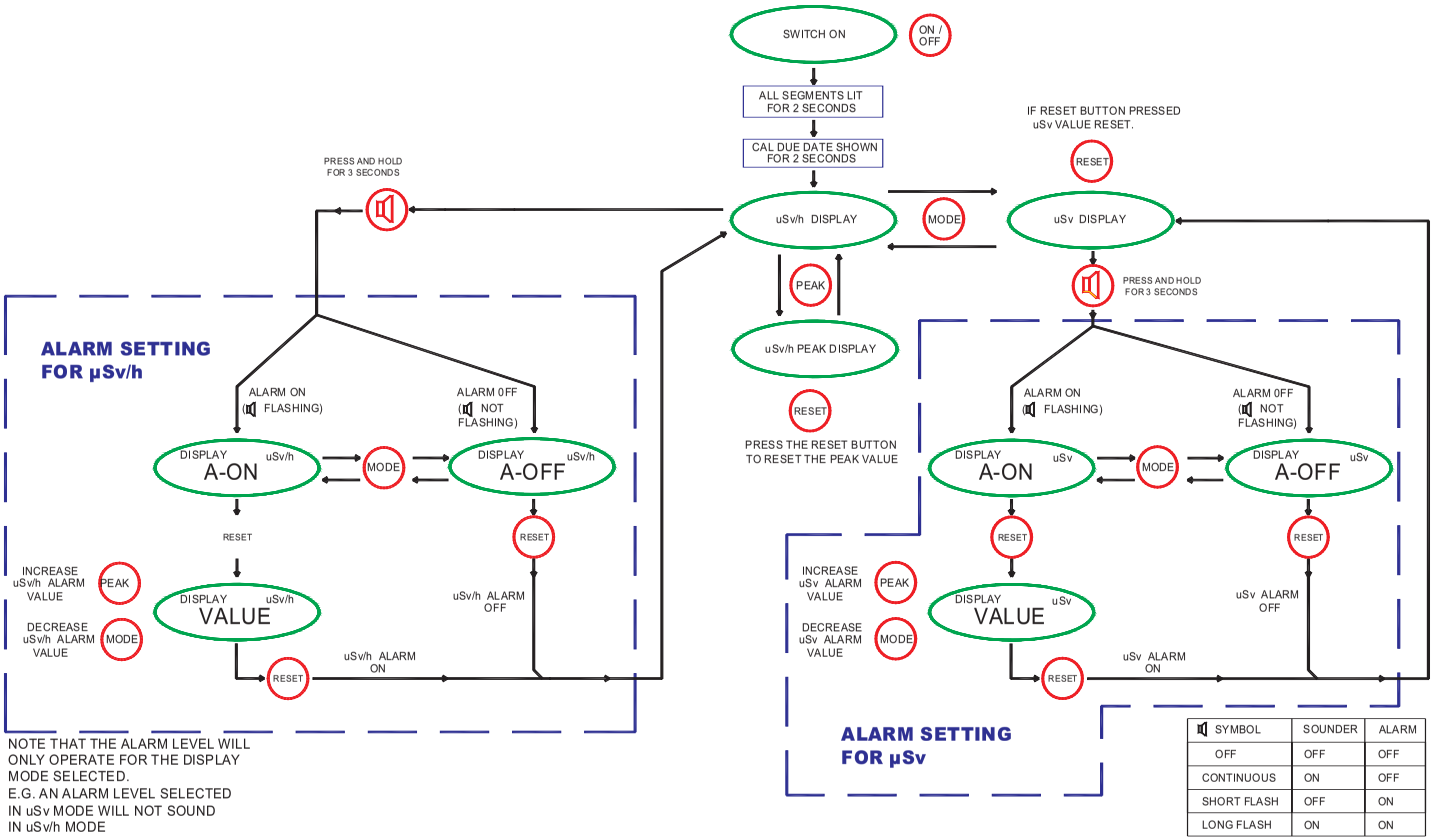
It should be noted that on switching on, the monitor will retain the previous alarm trip level settings and speaker status.

To Set the Alarm Trip Level

The following flowchart identifies the process for setting an alarm trip level in either μSv/h or μSv mode.

(NB: Pressing peak increases the trip setting (+) and pressing mode decreases the trip setting (-)).

T402 FUNCTIONAL DIAGRAM



6. MAINTENANCE & CALIBRATION

The T402 is a portable Radiation Monitor incorporating many design features which are based on Tracerco's 40-years of global experience in manufacturing radiation detection equipment for the chemical process industries.

The monitor has been designed for reliable operation in relatively hostile environments and should provide many years of effective service provided attention is paid to basic operational maintenance.

6.1 Battery Replacement

The condition of the battery is constantly monitored. Normal battery life is approximately 100 hours for continuous or intermittent operation. With about 4-hours of battery life left, a "LO BATT" warning appears on screen. When the battery power is too low for reliable operation, the screen will blank.

The internal battery compartment is clearly identified in the rear of the case. Recommended batteries are Alkaline Manganese MN1604 / MX1604.

The battery cover can be removed by the single retaining screw.

The gasket seal is attached to the inner face of the cover for additional safety. This seal must not be damaged during removal and must be kept clean at all times.

If the seal is obviously damaged, further guidance should be sought from the Tracerco helpline (contact details are provided on page 14 of this manual) or via the Tracerco website under monitor sales, calibration and repair : www.tracerco.com.

6.2 General Maintenance

The liquid crystal display screen is sealed within the upper section of the case which provides a robust leak-tight fitting. The case is designed to minimised the opportunity for buildup of radioactive contamination and is easily cleaned and the case is constructed from a lightweight impact and chemical resistant polymer.

The only routine maintenance which is recommended is mild cleaning of the case and display to prevent the build-up of grease and other potential contaminants.
DO NOT USE SOLVENTS ON THE WINDOW.

6.3 Repair & Calibration

The T402 instrument incorporates special software for checking and calibrating the response of the monitor to radiation fields.

In order to comply with UK statutory regulations, the monitor must be inspected and tested on at least an annual basis. It is essential that such inspection and testing is carried out by Tracerco or an approved organisation working on their behalf which has access to the appropriate diagnostic software and has the necessary training and experience to ensure that the Operational Safety features of the instrument are not compromised during the procedure.

In addition to checking the physical condition of the monitor, Tracerco will check the response of the monitor to known gamma radiation fields of the isotope Caesium-137. The response of the monitor to low-energy gamma radiation fields will also be checked using a source of Americium-241.

The checks on gamma radiation response will be carried out using a specially designed calibration rig incorporating two sealed sources of Caesium-137. This rig has been independently checked for absolute calibration (±5%) by a recognised competent authority and allows checks to be made over the full working range of the monitor. If appropriate, the monitor will be re-calibrated using the specially configured internal software.

Battery replacement and seal renewal where appropriate is a standard element of this annual inspection procedure.

USA OPTION

A modified version of the T402 monitor is available which has been specially configured for use in the USA. The instrument is direct reading in mRem units and must be specified when placing an order. This monitor retains all of the same functionality as the standard T402 version.

7. INFORMATION DATABASE

To assist in providing customers with a more efficient and comprehensive service, Tracerco has developed a special database which holds records of all monitors supplied to customers, including details of inspections, repairs, replacements and calibrations. This database provides a life history for the tracking of radiation monitors.

8. TECHNICAL SPECIFICATION

Radiation Detected	:	X-rays and gamma rays in range 60keV to 1.25Mev
Sensor	:	Single halogen, energy compensated Geiger Muller tube.
Range Doserate (non USA)	:	Analogue display 0 → 1000 μSv/h Digital display 0 →10,000 μSv/h
USA Version	:	Analogue display 0 → 100 mRem/h Digital display 0 →1,000 mRem/h
Accumulated Dose (non USA)	:	Digital display 0 → 10,000 μSv
USA Version	:	Digital display 0 → 1,000 mRem
Peak Radiation Doserate (non USA)	:	Digital display 0 → 10,000 μSv/h
USA Version	:	Digital display 0 → 1,000 mRem/h
Over-range Response		Bargraph display - will read hard full scale Numeric display– at over 10000μSv/h shows “0UEr” (over)
Variation with Temp	:	Less than ±5% over temperature range -10°C to +40°C
Humidity Range	:	0 → 95%
Variation with Battery Voltage	:	Less than 2%
Battery Life	:	100-Hours typically with background radiation
Low Battery Indication	:	On 4 hours available life left.
Battery		Alkaline Manganese MN1604 or MX1604.
Case material		Chemical resistant polymer with surface clean properties.
Sealing		Sealed to IP65
Standard compliance		The monitor meets the following EU directives 89/336/EEC Electromagnetic Compatibility Directive (including amendments)
Weight	:	600 grammes (approx.)

8.1 Additional Information on Monitor Calibration

Tests involving the response of the T402 monitor to radiation doserate have been carried out using a specially designed calibration rig which allows the instrument to be exposed to a range of radiation dose equivalent rates by precisely varying the distance from two independent Caesium-137 sources.

The accuracy of the calibration facility has been independently checked and shown that the Ambient Dose Equivalent Rate deviation from $1/r^2$ is less than 5% relative for the sources of Caesium-137 and Americium-241.

9. HINTS FOR RADIATION DOSERATE MONITORING

- Ensure audible output is selected when monitoring “radiologically unknown” environments. Minimises potential for exposure if attention is diverted from the monitor screen and provides an audible warning to other workers in the locality.

- Radiation detector is located parallel to the head of the monitor (approximately below the position of the Tracerco logo). For maximum accuracy and sensitivity point this face directly at the suspected source of radiation.

- Remember time and distance rules to minimise personal exposure. The accumulated dose and peak doserate options should reinforce safe working practices.

- Hold the monitor at a comfortable distance in front of the body. This approach maximises the response time to allow minimisation of the whole body dose.

- Wherever possible, check that the monitor is working before use by placing it in the vicinity of a known test source. Alternatively, ensure that sensible background radiation doserate values are being displayed.

10. WARRANTY

It would be expected that under prescribed usage the T402 monitor should give years of reliable operation. If, however, any fault arises with the monitor within twelve months of purchase and Tracerco can reasonably attribute this to a manufacturing defect, Tracerco will repair or replace the monitor free of charge.

If a fault occurs outside of the warranty period or if the monitor suffers damage as a result of an accident or inappropriate usage, Tracerco is able to provide a rapid repair service (usually within 7-days of receipt).

It is recommended that if the customer considers that there is a problem with the monitor, they should, in the first instance, contact our customer service helpline at the following address:-

Customer Services Helpline
Tracer Technology Centre (Monitor Dept)
Pavilion 10
The Moat
Belasis Hall Technology Park
Billingham
Cleveland TS23 4AZ.
Tel : +44 (0)1642 375450
Fax : +44 (0)1642 371813
E-Mail : adam.golightly@matthey.com

Please note that Tracerco cannot accept liability for any loss or damage during shipping and the customer should ensure that the instrument is suitably packaged.

11. HEALTH & SAFETY

The T402 Radiation Doserate Monitor has been extensively tested for accuracy and reliability in a designated application. Tracerco considers that it has taken all reasonable precautions to ensure that when used as prescribed, the monitor will not endanger the health and safety of the operator. It is important, however, that the following basic guidance should be taken into account by the operator when carrying out any form of radiation doserate monitoring.

1. Operators should receive appropriate practical training in the use of radiation doserate monitors.

2. Battery life should be checked before use, particularly where extended work programmes are to be carried out in particularly difficult to access locations.

3. The monitor has been designed and tested to EN60846:2004 to ensure that if the monitor is exposed to radiation levels well in excess of the full scale values (ie., up to 100 times), the readings will recover and normal operation resumed once the source of radiation has been removed. The digital numeric scale will read “OVER” when maxima values have been exceeded and the bargraph meter will sustain full scale deflection.

   The operator should never attempt to estimate a reading when over-range has occurred.

4. The monitor meets EN60846:2004 standard requirements for directional response. It is recommended that in normal use, the monitor is held with the scale horizontal and the audible response is operational. The operator should always be aware that exposure shine paths may exist where there is a marked variation in radiation doserates in both horizontal and vertical planes. It is strongly recommended that all operators receive adequate training for the type of radiation monitoring to be carried out.

5. In the event of a Geiger Muller tube failure an “ERR1” message will appear on the screen. In circumstances where the tube receives negligible background signal over a continuous counting period of 20 seconds, (and the tube remains operable), the monitor will display a “lo BGnd” message. If the monitor is exposed to a positive count rate the message will disappear and normal operation resumed.

Practical points

The preferred batteries are Duracell **MX1604 Alkaline manganese**

Or

MN1604 Alkaline manganese

Lock the battery compartment by the screw in the compartment lid. Do not over tighten.

Do not use solvents on the monitor window.

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