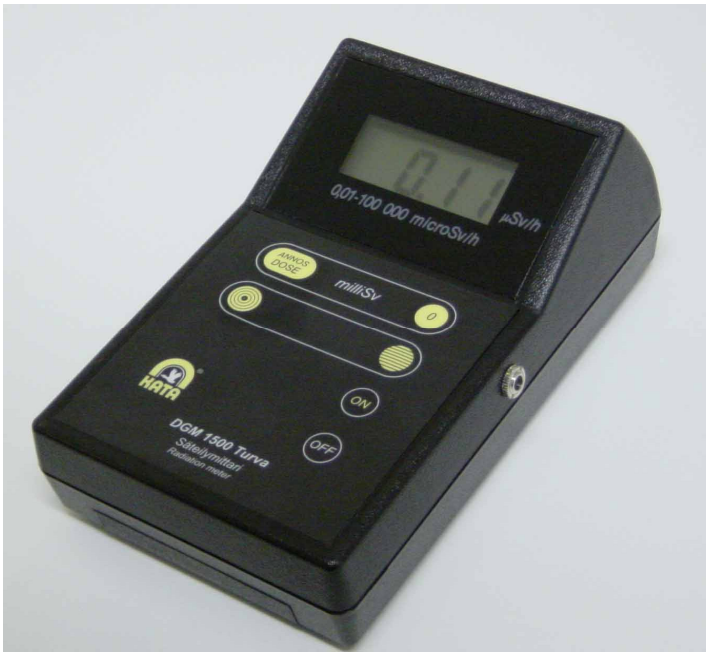
Manual

DGM-1500 Turva

Personal Survey Meter

Made in Finland (European Community)



THE DGM-1500 PERSONAL RADIATION METER

Safety is one of the most basic of human needs. In our modern day society of rapid technological change there is also a growing need to develop the means of ensuring this safety. The DGM-1500 is designed to improve the quality of radiation measurements both in the workplace and the home environment. In the event of a crisis or nuclear accident it becomes an invaluable tool.

The design of the DGM-1500 complies with official recommendations and requirements, and reflects the expertise and experience gained by the manufacturer over a long period of time in real life radiation measurement situations.

The DGM-1500 provides, in a single instrument, the means of performing an exceptionally wide variety of radiation measurements accurately and reliably. It is a true radiation multimeter with a wide field of application, encompassing the needs of state and civil defense authorities at one end of the scale and those of the private citizen at the other.

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2 PUSH BUTTON FUNCTIONS

2.1 Automatic dose rate and dose measurement

Power on — The meter is switched on by pressing the ON-button. Each time it is switched on the meter performs a self diagnostic routine, after which it automatically starts measuring both the radiation dose rate and the cumulative dose. Reliable measurement is obtained at normal ambient radiation levels (appr. 0.04–0.20 microSv/h) in about 3 minutes. At higher levels of radiation (from appr. 100 microSv/h) reliable measurement is obtained already in about 5 seconds. The measurement range for automatic operation is 0.07...100 000 microSv/h. When the measured level exceeds 9999 microSv/h the result is displayed in integer units of a thousand, rounded to the nearest thousand, followed by the exponential symbol 'E3' (= x 10 to the power 3). For example, a measured level of 55 425 microSv/h would be displayed as 55E3. The measurement result is always in microSv/h.

Dose — The dose register always contains the cumulative radiation dose whenever the meter is in operation. This register can be cleared by the user at any time if required. The measurement range of the dose register is 0.001...1000 milliSieverts. The cumulative radiation dose can be displayed by pressing the DOSE-pushbutton and holding it down. The dose register reading is always in milliSieverts (milliSv), where 1000 µS = 1 mSv.

Alarm tone — The alarm tone, which gives an indication of the radiation level, can be enabled or disabled by means of this pushbutton.

Backlight — The display backlight can be switched on for 5 seconds by momentarily pressing this pushbutton.

Clearing the dose register — First switch the meter off. The dose register can now be cleared by holding the O-pushbutton down and switching the meter on again.

Power off — When the meter is switched off all settings and the contents of the dose register are stored in non-volatile memory. This information is retained in the non-volatile memory for several years, even if the battery is removed from the meter.

2.2 Additional functions

2.2.1 Measurement mode selection

In addition to the automatic mode there are two other user-selectable measurement modes available. The O-pushbutton is used to step through the modes (fast measurement - precision measurement - automatic measurement). Hold the O-pushbutton down for at least three seconds to switch from the current mode to the next mode in the cycle. The AUTO-message appears when the meter is in the automatic measurement mode.
The meter always returns to the automatic mode if it is switched off momentarily and then on again, regardless of the previous mode.

2.2.2 Fast measurement

When this mode is selected the FAST-message appears in the display. The fast measurement period is fixed at 1.25 secs, allowing fast pinpointing of radiation sources. This mode is not suitable for measuring low level (ambient) radiation.

2.2.3 Precision measurement

When this mode is selected the letter ‘h’ appears in the display, indicating that the measurement period is one hour (three hours). The radiation dose rate is displayed in microSv/h. The expiration of each one hour period is indicated by a change in case of the letter ‘h’ (h/H). This is the most precise measurement mode, and is particularly suitable for measuring low levels of radiation. The range of measurement is 0.01...9.99 microSv/h. If the dose rate momentarily exceeds this range the meter will immediately switch to the automatic mode. Precision measurement is operational at low dose rates only. This is necessary to meet the requirement for fast response when the dose rate increases.

2.2.4 Programming the alarm limits

Meter alarm levels for the dose rate and cumulative dose are user-programmable. If the dose rate or cumulative dose of the measured radiation reaches the alarm level programmed for it the meter will emit an alarm tone. When the dose rate alarm level is exceeded the meter emits a periodic double beep. When the cumulative dose alarm level is exceeded the meter emits a periodic single beep. The period of the double beep alarm tone is slightly shorter than that of the single beep tone.

The programming mode is entered by pressing the TONE- and LIGHT-buttons simultaneously. The O-button is then pressed to select the alarm level to be programmed: a ‘0’ in the display means dose rate alarm level, and a ‘1’ means cumulative dose alarm level. The programmed alarm level can then be incremented by pressing the DOSE-button or decremented by pressing the TONE-button. The rate at which the programmed level changes when one of these buttons is pressed is slow at first, but increases if the button is held down continuously. When both alarm levels have been set the O- and LIGHT-buttons are pressed simultaneously to exit the programming state.

3 ALARM TONES

The meter provides six different alarm tones. Only one of these can be emitted at a time. These alarm tones and their meanings are described below in order of importance:

Meaning of tone	Timing	Duration
1. Battery voltage too low.	- - - - - - - - - - - - - - - -	5 seconds
2. Radiation level exceeds measurement range.	— — — — — — — — …	continuous
3. Dose rate alarm level.	- - - - - - - - …	continuous
4. Cumulative dose alarm level.	— — ...	continuous
5. Button pressed.	-	single beep
6. Radiation pulse detected.	-	single beep

The symbols used in the timing chart above have the following meanings:

- = tone
  = space
... = sequence repeats

4 SPECIAL DISPLAY MESSAGES

: Low battery voltage warning. Appears in the display when the battery voltage drops below a certain level. This indicates that the meter will operate for only fifty more hours at the most, and that the battery should be replaced with a new one as soon as possible. If the battery voltage continues to drop the meter will emit an alarm tone for 5 seconds then switch itself off. This is done to ensure that data is retained in memory, and in the case of NiCd batteries, to prevent complete discharge of the battery.

OFL Out-of-range warning. This message will appear in the display when the dose rate exceeds the meter's measurement range. An alarm tone is also emitted.

xxE3 When the dose rate exceeds 9999 µSv/h it will be displayed in exponential mode in integer units of one thousand. For example, a dose rate of 55000 µSv/h will be displayed in the form 55E3.

Auto See section on measurement mode selection.

Fast See section on fast measurement.

h/H See section on precision measurement.

The meter executes a self-diagnostic routine to detect possible fault situations. If a fault is detected the meter displays an error message consisting of the letters 'Er' followed by a number. All error messages except Er1, which remains in effect until the fault has been corrected, can be cancelled by pressing any function button. The error messages are described below:

Er 1 Indicates that the meter cannot function and must be sent for repair immediately.

Er 10 Indicates loss of calibration coefficients. When this occur the internal average default values will be used. This fault does not render the meter unusable, but it may affect accuracy of the measurement. This message will always appear in the display when the meter is switched on until the fault is repaired. The meter should be sent for repair as soon as possible.

Er 11 Indicates losing of dose register contents. The user is advised to check the value in the dose register and clear the register if required. The meter need not be returned for maintenance provided the fault does not recurr.

Er 12 Indicates that the user-programmed alarm levels have changed and must be reprogrammed. The meter need not be returned for maintenance provided the fault does not recurr.

5 USING THE DGM-1500 Turva Personal Survey Meter

5.1 General

The DGM-1500 is a versatile survey meter intended for measuring gamma- and X-radiation levels. Because of its wide range it can be used to perform many different types of radiation measurement.

The DGM-1500 functions on two levels. On the basic level it is an easy-to-use radiation meter which automatically measures both dose rate and cumulative dose. All the user need do is switch the meter on. In addition to this, fast measurement (FAST) and precision measurement (h) functions, which enable the meter to perform special measurements, are also available. There are separate user-programmable alarm levels for dose rate and cumulative dose. If these levels are exceeded an audible alarm is given.

Typical areas of application include measurements made by government authorities (monitoring, data acquisition, inspections), civil defence, private sector use (industry, business, institutions, offices), safety in the workplace (industry, X-ray laboratories), gamma measurement of foodstuffs, and use as a personal radiation meter.

5.2 Environmental measurements

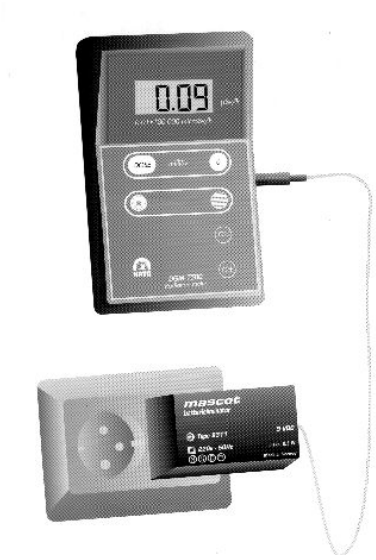
The DGM-1500 is ideal for mapping the radiation level in a given area. Small in size and battery operated it is easy to carry about. The fast measurement (FAST) function is used to pinpoint radiation sources. The closer the meter is brought to the radiation source the higher the reading obtained. Ambient radiation measurements must be carried out over a longer period of time. Radioactive fallout gives rise to radiation spots in the home environment. Attention should be paid to air conditioning filters, extractor fan filters, the base of roof gutter drainage pipes, car fenders and air filters etc. and other places where dust or rain water could collect.

5.3 Dose measurement

The DGM-1500 measures instantaneous dose rate and cumulative dose simultaneously. Whenever the meter is in operation the dose register contains the current cumulative dose. The cumulative dose can be displayed by pressing the DOSE button.

For example, in a location where the dose rate is 8 microSv/h, the cumulative dose over a period of 24 hours will be 0.192 milliSv. The contents of the dose register are saved in non-volatile memory when the meter is switched off, so the cumulative dose for the total time of operation of the meter is always available. The contents of the dose register can be cleared by the user whenever required (see the section on basic functions).

5.4 Continuous measurement of ambient radiation

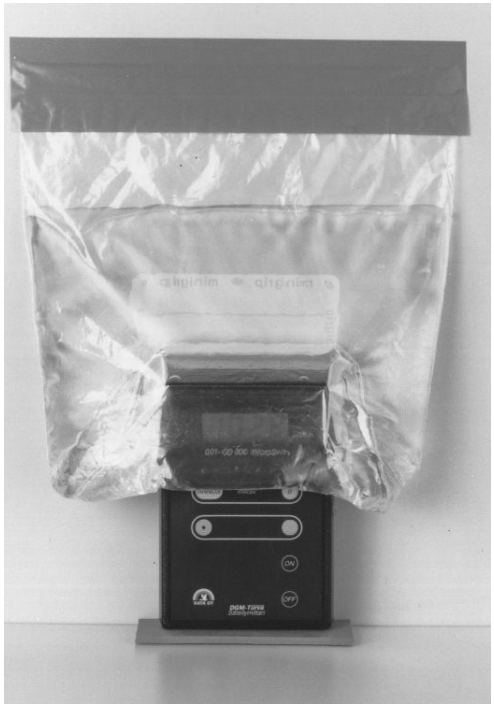


The DGM-1500 has a connector for a mains adapter, allowing it to be used for round-the-clock radiation monitoring. A wall mounting bracket for the meter is available as an optional extra, so the meter can be installed where it is always easily visible. The alarm level is user-programmable. If the level of the measured radiation exceeds the alarm level a warning tone is emitted (see the section on programming the alarm level).

The level of ambient radiation at a given location is fairly stable, but the differences in levels at different locations are considerable. In Finland the level of ambient radiation varies in the range 0.04 ... 0.20 microSv/h. The lowest level (0.04 microSv/h) is encountered on a lake or at sea, where radiation emitted by the earth is absorbed by the water mass, and cosmic radiation remains as the primary source. Cosmic radiation accounts for about 0.035 microSv/h of the ambient radiation level measured at the earth's surface.

Official measurements of ambient radiation are made in Finland at a height of 1 m above the earth's surface in a relatively open space.

5.5 Gamma radiation measurement in foodstuffs



The DGM-1500's precision measurement function enables the measurement of extremely low dose rates, and therefore extends the area of application of the meter considerably.

When a nuclear disaster occurs radioactive substances may be carried in the atmosphere for thousands of kilometres. Radioactive dust is deposited on the earth's surface by rain and other precipitation to form an uneven radiation field. Radionuclides become part of the natural food cycle and eventually reach the dinner table via plants and animals. A large number of radioactive substances are released in a nuclear accident, a high proportion of these are gamma radiators. By screening foodstuffs before they are used excessive gamma radiation can be detected and the food cleansed. For example, Cesium-137 can be removed by soaking the food in purified water. Cesium is soluble in water so slivers of meat, for example, can be cleansed in this way. By monitoring the radiation level the effectiveness of the decontaminating process can be assessed and, if necessary, the cleansing process repeated with fresh purified water.

It should be noted that the authorities may impose limitations on the consumption of foodstuffs in situations in which there is no necessity for shelter against external radiation.

The rate at which radioactivity decreases is determined only by the half-life of the radionuclide in question. The half-life of Cs-137 is 30 years, which means it takes 30 years for the level of radioactivity of Cs-137 to decrease by one half. Because Cs-137 is soluble in water its so-called biological half-life is often quite short. This means that most of the Cesium in animals will be removed within a few weeks if they are fed uncontaminated food. The same applies to human beings.

To perform the measurement you will need

- a DGM-1500 radiation meter
- a 2-litre minigrip plastic bag
- a table
- a non-slip support for the meter
- some packing tape

Preparation

Position the table against a wall (not stone or brick). Place the meter on the table, with a suitable non-slip support (eg. foam rubber, rubber, styrox etc.) underneath it, and lean it upright against the wall.

Measurement of ambient level

The ambient radiation level must be measured first. The measurement is made for a periods of 1 or 2 or 3 hours. Press the O-button until the letter 'h' appears in the left hand side of the display (see the section on precision measurement). This signals the beginning of the long integration measurement period. The display shows the ambient radiation level. The accuracy of this reading increases with the time of the measurement and is greatest at the end of the 3 hour period. When the 1 hour period has elapsed the lower-case 'h' in the display changes to the upper-case 'H'. Make a note of the reading obtained, eg. 0.15 µSv/h.

Measurement of the sample

Fill the minigrip bag with exactly 1 litre or 1 kilogram of the foodstuff sample to be measured. This could be milk, water, meat or fish, for example. Put the bag inside another bag to make sure there is no leakage. Squeeze the air out of the top and close it carefully. Tape the upper edge to the wall so that it is draped over the top of the meter as shown in the diagram. The centre point of the meter's detector and its distance from the front end are marked on the meter with small dots. The detector should be as close to the centre of the sample as possible. This will ensure good measurement geometry around the detector. See photograph "Gamma measurement of foodstuffs".

The measurement is performed in the same way as the ambient level measurement. Press the O-button until the letter 'h' appears in the left hand side of the display. This starts the measurement. When the 1 hour period has elapsed, and the 'h' in the display changes to 'H' the first measurement is complete. You can continue to 3 hours to increase the mesuring accuracy. Make a note of the reading obtained, eg. 0.21 µSv/h.

Interpreting the result

Subtract the reading obtained for the sample from the ambient level reading:
0.21 - 0.15 = 0.06

A change in dose rate of 0.01 µSv/h is equivalent to 380 Bq/l (Becquerels/litre) Cs-137.

Therefore a difference in level of 0.06 µSv/h is equivalent to
6 x 380 Bq/l = 2280 Bq/l

Levels lower than 1000 Bq/l require no further action.

To summarize: First measure the level of ambient radiation then the sample level. Subtract the ambient level from the sample level and multiply the result (ignoring the decimal point) by 380 to get the radioactivity in Bq/l.

$$\text{Radioactivity} = \frac{(\text{sample level uSv/h - ambient level µSv/h}) \times 380\ \text{Bq/l}}{0.01\ \mu\text{Sv/h}}$$

5.6 Measurement of radon level in water

In households which take their water supply from a drilled well the water may contain the radioactive noble-gas radon. Radon is released from the water into the atmosphere inside the house, posing a health risk. Although radon is an alpha-emitter, and cannot be monitored directly with the DGM-1500, gamma rays are emitted when radon disintegrates. By measuring the level of this gamma radiation the water radon level can be determined.

Do not allow the water to foam or bubble when taking a sample for measurement, otherwise some of the radon gas in the water will escape. One litre of water is required, and the measurement must be made immediately after sampling since the short half-life of radon (about 3.8 days) causes a fairly rapid decrease in radioactivity.

The method of measurement is identical to that used for foodstuffs. The ambient radiation level is subtracted from the sample level and the resultant dose rate (µSv/h) multiplied by a coefficient obtained from the table below to get the level of radioactivity (Bq/l). The coefficient varies according to radiation level, and lies in the range 5500...8900.

Interpreting the results

If the level is below 2000 Bq/l no further action is required.
If the level is 2000 Bq/l further measurements should be made at a radiation laboratory.
A radiation level of 4000 Bq/l requires that atmospheric radon level measurements be made.
If the level is 10000 Bq/l it is recommended that the water be purified before use.

COEFFICIENT TABLE

Sample level minus ambient level (µSv/h)	Coefficient (Bq/l) / (µSv/h)	Radioactivity Bq/l
0,01...0,10	5500	55...550
0,11...0,33	6700	737...2211
0,34...0,60	7800	2652...4680
0,61...1,00	8400	5152...8400
1,01...3,50	8700	8787...30450
3,51...	8900	31239...

Example:

If the ambient radiation level is 0.08 µSv/h and the water radon level 0.44 µSv/h, the level of radioactivity in the water is calculated as follows:

$$0.44\ \mu Sv/h - 0.08\ \mu Sv/h = 0.36\ \mu Sv/h$$

$$\text{Radioactivity} = 0.36\ \mu Sv/h \times 7800\ \frac{Bq/l}{\mu Sv/h} = 2808\ Bq/l$$

Planning of results:

The mesuring result are indicative whitout individual radon calibration of the DGM-1500 Turva.

6 ABOUT RADIATION UNITS

At the beginning of 1988 radiation units complying with the international SI-standard were adopted in Finland, and the Röntgen (R) replaced by the Sievert (Sv).

The Röntgen/h is the unit of irradiation dose rate, and the dose is expressed in rem-units (Röntgen equivalent man). The Sievert is the dose equivalent unit. The concept of dose rate, expressed in Sieverts/h or the smaller units of milliSv/h and microSv/h, was adopted. The dose is expressed in Sieverts or the smaller units of milliSvs.

Anyone accustomed to using the old units will first have to convert the new units into the old in order to gain an idea of the radiation level. The conversion table given below (Table 2) facilitates this. The Röntgen/h is the irradiation dose rate into air, and therefore has no direct equivalent in the new units. However, when expressing radiation intensity the dose equivalent rate Sv/h is scaled to the irradiation rate R/h unit. Units of dose are directly comparable.

100 rem = 1 Sv

Table 2. Conversion table for Röntgen and Sievert units.

microrem/h	1	10	100	1000					
millirem/h	0.001	0.01	0.1	1	10	100	1000		
rem/h				0.001	0.01	0.1	1	10	100
microSv/h	0.01	0.1	1	10	100	1000	10000	100000	
milliSv/h			0.001	0.01	0.1	1	10	100	1000
Sv/h						0.001	0.01	0.1	1

Eg. 10 microSv/h = 1 millirem/h

7 TESTS/APPROVALS

The DGM-1500 Turva Personal Survey Meter is designed to operate reliably in environments prone to electromagnetic interference. EMC (Electromagnetic Compatibility) tests carried out by the Finnish State Research Center (VTT) show that the DGM-1500 operates without error in different kinds of magnetic field and when subjected to interference voltages entering via the mains adapter. VTT has also measured the meter's immunity to EMP (Electromagnetic pulse - generated during a nuclear explosion) and subjected it to impact and vibration tests. Normal electronic equipment would be destroyed by an EMP. The complete VTT report TEL 9131 can be obtained from the manufacturer.

The radiation measurement characteristics of the meter have been tested at The Finnish Centre for Radiation and Nuclear Safety (STUK). The accuracy of the DGM-1500 is excellent even at very low dose rates. Special low dose rate calibration was used to verify the accuracy and reliability of ambient radiation measurements made with the DGM-1500. The meter was tested in a lead-lined chamber, where it was possible to achieve an ambient level of 0.02 microSv/h, and the validity of the meter readings at this low dose rate verified. This confirmed the meter's suitability for gamma measurements on foodstuffs.

The DGM-1500 is also capable of measuring dose rates as high as 100 000 microSv/h. The DGM-1500 meets the requirements laid down for radiation meters in Recommendation STUK-B69 "Radiation meters for use in radiation monitoring, civil defence applications and private radiation safety applications" (Finnish Centre for Radiation and Nuclear Safety). The type approval record number is STUK 55/322/89. STUK-B69 is based on the international standard IEC-846 "Beta, X and gamma radiation dose equivalent and dose equivalent rate meters for use in radiation protection", and the main requirements comply with it.

The DGM-1500 is approved by the Finnish Ministry of the Interior for civil defense purposes as a general purpose radiation meter for measuring both dose rate and dose, Ministry of the Interior Statement 1791/752/89.

8 TECHNICAL SPECIFICATIONS

Type	DGM-1500 TURVA Automatic radiation dose rate- and dose meter
Types of radiation	Gamma- and X-radiation
Energy range	35 keV ... 1.25 Mev
Detector compatible with SI-units	Ambient dose equivalent-energy compensated GM-tube
Measurement range	Dose rate 0.01 ... 100 000 microSv/h Dose 0.001 ... 1000 milliSv
Response time	Fast measurement: 2,5 sec. Automatic measurement: At ambient radiation levels 3 min, at increased radiation levels (² 100 microSv/h) 5 sec.
Accuracy	+ 5% of the reading when irradiated by Cs-137 at the calibration point at 20 deg. C
Linearity	+ 10% at 20 deg.C
Accuracy at low dose rates	Unequalled accuracy at ambient radiation levels. The meter reading is still valid at levels as low as 0.02 µSv/h. (Finnish Centre for Radiation and Nuclear Safety (STUK), calibration record 25/652/89).
Operating temperature	- 30 ... + 55 °C
Storage temperature	- 40 ... + 70 °C
Power supply	Single 9V alkaline battery Battery life approx. 300 h. in ambient radiation Mains adapter 9-12 V/2.5 W
Case	Shock-proof, splash-proof plastic case, IP 54
Dimensions	90 x 145 x 40 mm
Weight	250 g without battery 300 g with battery
Display	Results are displayed on an easy-to-read backlit LCD in microSieverts (dose rate) and milliSieverts (dose). (1000 microSv = 1 milliSv.)
External interfaces (optional)	Mains adapter Radon Box-10

Right to technical changes reserved without notice.

9 CALIBRATION

RADIATION METER DGM-1500 TURVA: CALIBRATION CERTIFICATE

Nro .....……

Calibration point	1000 µSv/h	at 20 deg.C, Cs-137 source
Reading at the calibration point		+ 5 %
Linearity		+ 10 % at 20 deg.C

Warning and alarm levels in Finland

0.70 µSV/h	Level requiring official notification and intensified radiation monitoring.
100 µSV/h	Public warning of increased radiation level must be issued.
1000 µSv/h	Immediate shelter from radiation must be taken.

Date ……Ylämylly

Inspected by……