CZECH REPUBLIC

GEOPHYSICAL GAMMA-RAY SPECTROMETER
GRM-260

Operating Manual
Version 2.0

Brno, October 2001
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Technical Specifications

Detector  NaI(Tl) or BGO 2”x2” with shielded photomultiplier geometrical center is placed in the middle of the casing at 45 mm distance from the front side

Energy resolution  better than 8.5% for NaI(Tl) (at 0.662 MeV)
better than 13.0% for BGO (at 0.662 MeV)

Energy range  to 3 MeV

Reference source  $^{137}$Cs, activity 10 kBq

Pulse shaping  Semi-Gaussian, 1 $\mu$s

Analyzer  256 channels, up to 70,000 pulses per second
4 ROIs
K, U, Th assays calibrated in %, ppm, ppm
dose rate measurement in nGy/h or U equiv

Working modes  single spectrum
profile measurement
dose rate indication

Control unit  numeric keyboard with graphic backlit screen
or user’s PC

PC interface  RS 232C

Power supply  rechargeable batteries (min. 15 hours life time)

Dimensions  270 x 130 x 180 mm (length, width, height)

Weight  3.1 kg

Ambient conditions  -10 to +60 °C
dropping  water resistant

Standard accessories  battery charger
cable for PC connection
software for  PC control and data transfer
operating manual
transport case

Caution!
Strong mechanic shocks may damage the detector inside the instrument.
1. Theory

The GRM-260 gamma-ray spectrometer is designed for spectral measurements of natural and artificial radionuclides in field and laboratory conditions giving the information about the kind and the concentration of radionuclides present in rocks, soil and water.

The gamma-ray spectrometry as the most common nuclear method is useful for raw material exploration, environmental radiation monitoring, geological studies of lithology and stratigraphy, geophysical mapping, borehole logging, laboratory assays of rocks and building materials.

The measurement is based on the capture of emitted gamma quanta in the scintillation detector. The gamma quanta of characteristic energies are transformed into electric pulses with heights that are proportional to those energies. The queue of electric pulses is analyzed consequently and separate pulses are sorted into individual channels of the measured spectrum. The spectrum of the GRM-260 consists of 256 channels with the channel width of 12 keV. The spectrum is divided into four parts – groups of channels called ROI (Region Of Interest) – with the respect to the peak positions of studied radionuclides and due to the real resolution of the scintillation detector.

Radioactivity of rocks is usually caused by one of three natural sources of gamma-radiation: potassium (K), uranium (U) and thorium (Th). Each of those elements in natural conditions contains a fraction of a radionuclide that can be detected in either direct or indirect way. The isotope $^{40}$K emits gamma-rays with the energy of 1.461 MeV thus the determination of K is direct one. The concentration of K is given in mass percentage. The determination of U is based on the detection of $^{214}$Bi radionuclide, which is a member of $^{238}$U decay series emitting the energy of 1.764 MeV. In the case of U the detection is indirect and the concentration is given in ppm eU (equivalent of uranium). The determination of Th contents is indirect as well – the $^{208}$Tl radionuclide with the energy of 2.615 MeV originating from the $^{232}$Th decay series is detected. The concentration of Th is given in ppm eTh.

Other sources of gamma-radiation may come from artificial activities as power stations, industrial enterprises, nuclear weapons. Those sources have various half times of the radioactive decay (e.g. 30 years in the case of $^{137}$Cs with the energy of 0.662 MeV) and their peak can be detected in the measured spectrum as well due to the possible contamination in field.

The total gamma activity of rocks can be judged by means of dose rate measurement, which is based on the evaluation of the total spectral count. The dose rate is given in nGy/h and can be automatically recalculated into U equiv concentration units (the dose rate unit of 1 U equiv corresponds with 1 ppm concentration of U).
The accuracy of the measurement is provided by the precise system of the spectrum stabilization with the use of digital circuitry. The built in algorithm for the determination of K, U, Th contents is based on the matrix calculation from K, U, Th spectral ROIs. More advanced spectral evaluation – the statistic method of spectral analysis – is available if an external PC is used. This method collects the information from all the measured spectra and thus the requirement for the measuring time is significantly reduced and the accuracy is improved at the same time.

The precise factory calibration of the GRM-260 instrument is made on high volume standards (etalons) for each of K, U, Th elements and for background. The GRM-260 is equipped with the easy possibility of user’s calibration, which can be used alternatively to the factory calibration.

Recommended literature:

   - Theory, problems and Facilities.
   Risö National Laboratory, Roskilde 1984.
4. IAEA : Radiometric Reporting Methods and calibration in Uranium Exploration.
   TRS No. 174, Vienna 1976.
Profile measurements

A very common way of the field gamma-spectrometry is so called profile measurement – values of counts in ROIs and concentrations are measured step by step along a marked profile line in terrain.

Several profile lines (usually of parallel direction) create the net of measuring points. The contour map with isolines (lines connecting points with the same value of counts or concentrations) can be constructed above this net of points to enable detection of radioactive anomalies in the terrain under study.

Used terms in GRM-260 software and their specification:
PROFILE – a number from 0 to 9999 for identification of the profile line.
POINT – a number from 0 to 9999 for identification of the starting position of the profile (in meters usually).
STEP – a number from –99 to +99 (not zero) that determines the distance (in meters usually) between measurement positions along the profile.

For example PROFILE, POINT, STEP with 10,0,5 enter means that the profile number 10 is measured from the starting position 0 with positive step 5, i.e. the next profile positions are 5,10,15,...
2. Operating Instructions

2.1. GRM-260 Preparation

GRM-260 set is delivered in the plastic transport case providing safety transport.

For the start of the measurement take the instrument out of the case and turn the switch on its rear side to the position labeled I. The welcome screen is shown while the circuitry is tested. Then the main menu screen (fig. 1) will appear. No other preparation is required. Then operate the instrument from the instrument keyboard. This operation is described in the following chapter 2.2.

For operation from external PC connect the GRM-260 connector (hidden under the small cover on the rear panel) with the PC serial port using the cable from instrument accessories when both GRM-260 and PC are turned on. The way of operation is described in the chapter 2.3.

After the measurement is finished turn the switch on the rear side of the GRM-260 to the position labeled 0 and cancel the PC cable connection if done. Current battery charging after each longer measurement or use with PC is the necessary condition of reliable work of the GRM-260 instrument.
2.2. Measurement

All the GRM-260 operation is designed in a simple interactive way with prompts on
the screen. After the instrument is turned on the menu shown in fig. 1 will appear.

1. SPECTRUM
2. DOSE RATE
3. VIEWER
4. CALIBRAT.

Fig. 1

You can decrease (8 key) or increase (9 key) the display contrast now or turn the
display backlight on (0 key).
Select the required item by appropriate number pressing.

2.2.1. Spectrum

This task serves for the spectral measurement with consequent K, U, Th
concentrations and dose rate analyses.

Put the instrument onto the chosen point and start SPECTRUM task. The screen
shown on fig. 2 will appear.

**MEASUR.TIME:**

<table>
<thead>
<tr>
<th>1↓ 2↑</th>
<th>3:00</th>
<th>3↓ 4↑</th>
</tr>
</thead>
<tbody>
<tr>
<td>5) CALIBRATION FACTORY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6) STABILIZATION ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7) SET AS DEFAULT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 2
You can set minutes (1 or 2 keys) and tens of seconds (3 or 4 keys) of the measured time. You can choose factory or user (if already created) calibration (5 key), turn the spectrum stabilization ON/OFF (6 key) and save set parameters as default for next measurement (7 key).

Pressing of the green key will start the measurement while the red key serves for the return to the main menu (fig. 1).

After a short period of the energy stabilization the measured spectrum is continuously collected during the given measuring time and it is currently shown in the left part of the display. (You can see the significant $^{137}$Cs reference peak there.) The x-axis represents pulse energies and is marked in MeV units (mega electron volt) while the y-axis represents number of pulses in cps units (count per second). Vertical lines in the spectrum show positions of K, U and Th ROIs. The rest of the measuring time in minutes and seconds is shown currently as well (fig. 3).

The measuring process can be interrupted before the measuring time is run out by pressing the red key - the main menu (fig. 1) will appear.

After the measurement is finished the spectral graph disappears and the result table (fig. 4) is shown.
TOT           38.45 nGy/h
K              2.43 %
eU             3.23 ppm
eTh            8.95 ppm

Fig. 4

The measured dose rate and concentrations values are shown.
You can look at the measured spectrum after pressing the green key (fig. 5) or save values after pressing the red key.

ENERGY value shows the recent cursor position. The corresponding value of cps is given on the following line. The cursor (thick line) position can be changed using keys 1 – 5:
1 - coarse movement to the left, 2 - fine movement to the left, 5 - coarse movement to the right, 4 - fine movement to the right, 3 - return to the middle.
The cps scale can be increased (7 key) or decreased (6 key) to see the studied peaks in the spectrum. The 0 key turns the backlight ON.

You can see the cps result table (fig 6) after pressing the green key or save values after pressing the red key.

**Fig. 6**

<table>
<thead>
<tr>
<th>Component</th>
<th>CPS Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOT</td>
<td>571.38 cps</td>
</tr>
<tr>
<td>K</td>
<td>2.92 cps</td>
</tr>
<tr>
<td>eU</td>
<td>1.02 cps</td>
</tr>
<tr>
<td>eTh</td>
<td>0.37 cps</td>
</tr>
</tbody>
</table>

This table shows measured cps values in ROIs. The ROI energy borders are following:

<table>
<thead>
<tr>
<th>Component</th>
<th>Energy Borders</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>0.401 MeV - 3.001 MeV</td>
</tr>
<tr>
<td>K</td>
<td>1.360 MeV - 1.558 MeV</td>
</tr>
<tr>
<td>eU</td>
<td>1.564 MeV - 1.953 MeV</td>
</tr>
<tr>
<td>eTh</td>
<td>2.414 MeV - 2.804 MeV</td>
</tr>
</tbody>
</table>

You can return to the concentrations table (fig. 4) by pressing the green key or save values after pressing the red key.

**Data saving**

It is possible to save 200 result tables (values from measured points) in the internal memory of the instrument. The screen similar to fig. 7 shows the number following the last stored point and can be changed by writing another one. The green key pressing will save new result table while the red key pressing will cause no saving.

**SAVE AS:** 4

Input number 1-200

**Fig. 7**

The main menu (fig. 1) will appear consequently.
The saved data can be transferred to the PC using the GRM program as shown in the chapter 2.3.6. or can be seen later directly in the instrument using viewer (see chapter 2.2.3).

Measurement without spectrum stabilization

This way of the spectral measurement is useful for low concentrations of radionuclides or for low energy analysis when the presence of the reference source can influence the measured spectrum in a significant way. The instrument calibration is not valid at that way of measurement.

To begin this measurement start the spectrum task with the stabilization source several times to reach the stable temperature balance of the instrument. Then take the reference source from the instrument and turn the stabilization OFF while screen from fig. 2 is shown. The reference source is situated on the front side under the round black cover accessible after dismantling of two screws.

Do not forget to return the reference source to its place before the stabilization is activated again. In other case the error will be indicated by GRM-260 instrument.
2.2.2. Dose Rate

This task serves for immediate indication of the total dose rate.

Measured values are shown in graphic and numeric way. Dose rate indication is useful for a preliminary measurement on a locality, for search for lost gamma sources etc.. A picture similar to the fig. 11 will appear.

TOT  1202.48 nGy/h

Fig. 11

To terminate this task press (and hold) the red key. The main menu (fig. 1) will appear.
2.2.3. Viewer

This task enables to look at previously measured result tables stored in the GRM-260 memory.

The screen similar to the following one (fig. 12) will appear.

<table>
<thead>
<tr>
<th>No.</th>
<th>1</th>
<th>↓</th>
<th>2</th>
<th>↑</th>
<th>3</th>
<th>#</th>
<th>4</th>
<th>←</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOT</td>
<td>629.90 cps</td>
<td>146.48 nGy/h</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>13.51 cps</td>
<td>15.97 %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eU</td>
<td>0.66 cps</td>
<td>1.00 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>eTh</td>
<td>0.10 cps</td>
<td>2.15 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>360 s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAL. FACTORY,</td>
<td>STAB. ON</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 12

The table contains both ROI’s counts and calibrated values of the dose rate and concentrations as well as accompanying information about used calibration and spectrum stabilization.

You can go to the next table (1 key or green key), go to the previous table (2 key), choose a certain table number (3 key, write the table number and then the green key) or go to the last measured table (4 key).

The red key will terminate the viewer task.
2.2.4. Calibration

This task serves for creation of the user’s calibration.

It is possible to do the user’s calibration provided you have suitable K, U, Th, and background etalons (calibration pads) of sufficient dimensions and quality. The factory calibration was done on the surface of high volume etalons (standards with diameters of 2 m) and is related to the half-space under the instrument. In the case that you have etalons of smaller dimensions you have to correct the nominal K, U, Th concentrations of etalons by the multiplication by the geometric factor G before those values of the concentrations are included into the GRM-260.

\[ G = 1 - \frac{h}{r} \]

\[ h = 47 \text{ mm} \]

\[ r \text{ – the diameter of the etalon pad} \]

In all cases the precise knowledge of the concentrations of all three components in each etalon creates the basic condition of the valid user’s calibration. The occurrence of the foreign gamma sources near the etalon must be eliminated.

The calibration must be done with the same piece of the reference source, which is used for the measurement.

The measuring time for each etalon is preset to 20 min and cannot be changed by user. The calibration is done in the middle of the surface of etalons.

The calibration must be repeated periodically - at least once per year.

In the course of the calibration you are instructed to put the probe onto the destined etalon (K, U, Th, background and dose rate consequently). After the measurement of the spectrum you are asked to write the nominal concentrations of the etalon. You have to know all three components (K, U, Th) concentration for each etalon. A high volume background etalon made from pure SiO₂ sand is recommended.

Usually the U etalon is used as the dose rate etalon as well. In this case its dose rate value is \( U_{\text{equiv}} = 2.5 \times \% K + 1 \times \text{ppm U} + 0.5 \times \text{ppm Th} \), where \( \% K \), ppm U, ppm Th – are the concentrations of K, U, Th in the etalon. The nominal value can be given either in nGy/h or in U equiv (the choice by pressing 1 key before the nominal values for the etalon and for the background are written).

After all calibration data are ready the GRM-260 instrument calculate the calibration constants and replace the old user’s calibration with the new one.
2.3. Measurement using external PC

Installing the GRM-260 Software for Windows

We recommend you to close all applications you have been running before you start the installation procedure of the GRM-260 software.

1. Insert the floppy disk number 1 to your drive.

2. Visualize the content of the floppy disk on your screen (for example, by double clicking on "This computer" and then on the symbol of your floppy disk driver).

3. Double click on the "setup.exe" file. The installation procedure will start. Follow the instructions of this procedure: you will be asked to insert floppy disk number 2.

4. If some of the necessary file systems were out of date in your system the installation procedure would ask you to allow updating those files. In that case:

   4a. Click "Yes" to allow the updating.

   4b. Take the floppy disk out of your floppy disk driver.

   4c. Allow restarting Windows.

   4d. Follow these instructions again from the beginning (item 1).

5. Confirm that you have closed all other applications.

6. You can change the destination directory or use the offered directory "C:\Program Files\GRM260". If you are satisfied with this directory just click the big square button with the picture of a computer. Otherwise, click "Change directory", make the change, and, finally, click the mentioned square button.

7. You can customize your Program group box. You can either add the new item or create a new group. If you click only "Continue" the item "GRM260" is created.

8. The GRM-260 software for Windows installation is completed.

**ATTENTION:** During the installation procedure the file "St6unst.log" was created. Do not modify or delete this file. It will be used for uninstallation procedure (see below).
Uninstalling the GRM-260 software for Windows

Before uninstalling the GRM-260 software delete the directory "Data" and the file "User.con" (if exists). (If you did not change that during the installation process, you will find them in the "C:\Program Files\GRM260\" directory.)

To uninstall the GRM-260 Software use Add/Remove Programs in Control Panel:

1. Click Start, Settings, and then Control Panel.
2. Double-click Add/Remove Programs. The Add/Remove Programs Properties dialog box appears.
3. From the list of programs, select GRM260.
4. Click Add/Remove. GRM-260 software removal will start.
5. The question "Are you sure you want to completely remove GRM260 and all of its components?" will appear.
6. Click "Yes" to complete the uninstallation process.

Starting the GRM-260 Software

Click Start, Programs, GRM260.

Installing and starting the GRM-260 Software for DOS

Install the GRM-260 software from the diskette “Gamma – ray Spectrometer GRM-260” into your computer. Cross onto the diskette driver containing that diskette and type install `enter`.

Run GRM-260 program in GRM-260 directory.
All the measuring software is designed in a usual interactive way – watch the prompts on the screen carefully. After the connection of the GRM-260 instrument with PC (see the chapter 2.1.) and after the GRM program start the menu screen shown in fig. 14 will appear.

**SINGLE SPECTRUM**

- PROFILE MEASUREMENT
- DOSE RATE INDICATION
- WORKING SETTINGS
- SPECTRUM VIEWER
- CALIBRATION
- DATA TRANSFER

  **CHOOSE AND PRESS ENTER, ESC = END OF WORK**

Fig. 14

Select the required item by arrow up/down keys and press enter. Before the start of SINGLE SPECTRUM, PROFILE MEASUREMENT and DOSE RATE INDICATION tasks the check of the working parameters (the WORKING SETTINGS task run) is recommended.

### 2.3.1. Single Spectrum

This task serves as a basic way of the spectral measurement.

Put the instrument onto the chosen point and start SINGLE SPECTRUM task. The screen shown on fig. 15 will appear.

The measured spectrum is continuously collected during the given measuring time and is currently shown in the left part of the display. The x-axis represents pulse energies and is marked in MeV units (mega electron volt) while the y-axis represents number of pulses in cps units (count per second). Vertical lines in the spectrum show positions of K, U and Th ROIs. The rest of the measuring time in minutes and seconds is shown currently as well.
The measuring process can be interrupted before the measuring time is run out by pressing the ESC key - the welcome screen and the main menu (fig. 14) will appear.

![Spectral Graph](image)

Fig. 15

After the measurement is finished the spectral graph disappears and the result table (fig. 16) is shown.

<table>
<thead>
<tr>
<th>Component</th>
<th>Count Rate (cps)</th>
<th>Equivalent (U equiv)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOT</td>
<td>578.86</td>
<td>25.8</td>
</tr>
<tr>
<td>K</td>
<td>2.76</td>
<td>2.3 %</td>
</tr>
<tr>
<td>eU</td>
<td>.90</td>
<td>2.9 ppm</td>
</tr>
<tr>
<td>eTh</td>
<td>.23</td>
<td>2.1 ppm</td>
</tr>
<tr>
<td>CC</td>
<td>.58</td>
<td></td>
</tr>
<tr>
<td>DT</td>
<td>.60 %</td>
<td></td>
</tr>
</tbody>
</table>

F1 = SPECTRUM VIEW  
F10 = SAVE TABLE & SPECTRUM  
ENTER = SAVE TABLE  
SPACE = NEW MEASUREMENT  
ESC = EXIT

Fig. 16
The TOT symbol represents the total spectrum count and dose rate value in nGy/h (or U equiv if required).
The K symbol represents the K ROI count and the K concentration in %.
The eU symbol represents the U ROI count and the U concentration in ppm.
The eTh symbol represents the Th ROI count and the Th concentration in ppm.
The CC symbol represents the cosmic count.
The DT symbol represents the dead time percentage.

Now you can put either the result table (ENTER key) or both the result table and measured spectrum (F10 key) into the memory. You will be asked to write the output file name (for the first time), the locality and the comment as shown on fig. 17.

To show the measured spectrum press the F1 key and screen shown on fig. 18 will appear.

You can continue to measure another single spectrum (not saving data) by pressing SPACE key or return to the welcome screen and the main menu by pressing ESC key.

FILE NAME:
SAMPLE01
LOCALITY:
BRNO, MEDLANKY
COMMENT:
GRANIT

TAB = CORRECT SHOWN DATA, SPACE = SAVE & NEW MEASUREMENT, ENTER = SAVE & EXIT

Fig. 17

SPACE will cause the measurement of a new single spectrum. After ENTER the welcome screen and the main menu (fig. 1) will appear. Pressing TAB you can change the written data.
CP value shows the recent cursor position. The corresponding value of cps is given on the following line. CW shows the preset cursor width. The cursor position can be changed using the left/right arrow keys.

Now you can put either the result table (ENTER key) or both the result table and measured spectrum (F10 key) into the memory. You will be asked to write the output file name (for the first time), the locality and comment as shown on fig. 17.

To show the result table press the F1 key and screen shown on fig. 16 will appear.

You can continue to measure another single spectrum (not saving data) by pressing SPACE key or return to the welcome screen and the main menu (fig. 14) by pressing ESC key.
2.3.2. Profile Measurement

This task is designed for radiometric mapping – creation of contour maps of K, U, Th concentrations and dose rate.

After the PROFILE MEASUREMENT task is started you are asked to write the output file name, the locality and the comment (fig. 19).

FILE NAME :
SAMPLE01
LOCALITY :
BRNO, MEDLANKY
COMMENT :
GRANIT

TAB = CORRECT SHOWN DATA, ENTER = CONTINUE

Fig. 19

Pressing TAB you can change the written data. After ENTER the instrument awaits the profile, point and step numbers (see the Theory chapter) as shown in fig 20.

PROFILE :
10
POINT :
0
STEP :
5

TAB = CORRECT SHOWN DATA, ENTER = CONTINUE

Fig. 20

After ENTER the screen shown on fig. 21 is shown.
Put the instrument onto the place with the picket of shown PF (profile) and ST (station) and press the SPACE key. The measurement starts and the collected spectrum is shown currently on the screen (fig. 22).

To close this profile press the F1 key. The screen given on fig. 20 appears and you can start the measurement of another profile.

The ESC key pressing will cause the return to the welcome screen and the main menu (fig. 14).
The left part of the screen shows the measured spectrum with K, U and Th ROIs position while the right part shows the rest of the measuring time. You can interrupt the measurement by pressing of the ESC key. The return to the previous screen (fig. 21) will follow.

After the measuring time is ran out the picture similar to fig. 23 is shown.
The left part of the screen shows concentration curves measured along the profile. The ppm units for \( eU \) and \( eTh \) concentrations are marked on the left y axis and the \% units for K concentration are marked on the right y axis. The x axis is marked in numbers of the profile positions. The K curve is marked with \( \sigma \), the U curve is marked with \( \tau \) and the Th curve is marked with \( \nu \). All curves are moving to the left if the right margin of the picture is reached.

The right part of the screen shows the picket – the profile (PF) and the station (ST). The F1 key pressing serves for the table view (similarly to fig. 16). The F4 key enables to view the measured spectrum (similarly to fig. 18).

The result table is saved after ENTER key pressing, the result table and the spectrum are saved after F10 key pressing, this measuring point is skipped after + key pressing. All those (ENTER, F10 and +) keys will cause the cross to the next profile picket and to the screen similar to fig. 21 containing the measured K, U, Th curves.

If you wish to repeat the measurement at the same point, press SPACE key.
2.3.3. Dose Rate Indication

This task serves for immediate indication of the total dose rate and of the count in one of the 8 ROIs. The number of the chosen ROI is entered after the DOSE RATE INDICATION is started. The positions of the ROIs is defined in the WORKING SETTINGS task.

Both values are shown in graphic and numeric way. Dose rate indication is useful for a preliminary measurement on a locality, for search for lost gamma sources etc.. A picture similar to the fig. 24 will appear.

![Graph showing TOT (nGy/h) and ROI 1 (cps)]

**TOT (nGy/h)**

1260.52

**ROI 1 (cps)**

826.28

ESC = RETURN

Fig. 24

To terminate this task press ESC. The welcome screen and the main menu (fig. 14) will appear.
2.3.4. Working Settings

This task serves for the definition of working parameters (fig. 25). The movement between them is controlled using the arrow keys.

MEASURING TIME  STAB. CHANNEL
CPS SCALE   CALIBRATION
CURSOR WIDTH  DATE
DOSE RATE UNIT  TIME
ROIS SETTING

CHOOSE AND PRESS ENTER, ESC = RETURN

Fig. 25

After the choice of the option and ENTER key pressing you can check and change the following working parameters (preset values are written in round brackets). A new numeric value is loaded and rounded (if needed) after the complete number is written. The choice of the requested parameter is done by the frame removal using left/right arrow keys.

MEASURING TIME – the measuring time in minutes and seconds (3 min 0 s)

CPS SCALE – the upper limit on the y axis of the spectrum (50 cps)

CURSOR WIDTH – the cursor width in MeV (0.012 MeV – one channel)

DOSE RATE UNIT – the dose rate unit nGy/h or U equiv (nGy/h)
**ROIS SETTING** – the ROI borders in MeV, the preset values are shown below

<table>
<thead>
<tr>
<th>ROI</th>
<th>Name</th>
<th>MeV Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TOTAL</td>
<td>0.401 MeV – 3.001 MeV</td>
</tr>
<tr>
<td>2</td>
<td>K</td>
<td>1.360 MeV – 1.558 MeV</td>
</tr>
<tr>
<td>3</td>
<td>eU</td>
<td>1.564 MeV – 1.953 MeV</td>
</tr>
<tr>
<td>4</td>
<td>eTh</td>
<td>2.414 MeV – 2.804 MeV</td>
</tr>
<tr>
<td>5</td>
<td>(Cs)</td>
<td>0.569 MeV – 0.755 MeV</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>1.360 MeV – 1.558 MeV</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>1.564 MeV – 1.953 MeV</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>2.414 MeV – 2.804 MeV</td>
</tr>
</tbody>
</table>

The set ROI borders have no influence on the calculated concentrations of K, eU and eTh and the dose rate value. Those quantities are taken from all spectra analysis as written in the introductory chapter.

**STAB. CHANNEL** – one of the stabilization channel 55, 30, 0 (55)

The 0 value eliminate the stabilization procedure and keep the previous gain of the electronics.

**CALIBRATION** – factory or user’s calibration (factory)

**DATE** – current date

**TIME** – current time

**Measurement without spectrum stabilization**

This way of the spectral measurement is useful for low concentrations of radionuclides or for low energy analysis when the presence of the reference source can influence the measured spectrum in a significant way.

For this measurement, start the single spectrum measurement with the stabilization source several times to reach the stable temperature balance of the instrument. Then take the reference source from the probe and set the stabilization to 0 channel as shown above. The reference source is situated on the front side under the round black cover accessible after dismantling of two screws.

Do not forget to return the reference source to its place before the stabilization is activated again. In other case the error will be indicated by GRM-260 instrument.
2.3.5. Spectrum viewer

This task enables to look at previously measured spectra stored in the PC.

In the first step the table of files is shown. Choose the requested file using arrow keys and press ENTER key.

In the next step the result table (similarly to fig. 16) is shown. You can view the measured spectrum (if exists) by pressing F1 key (screen similar to fig. 18). The next result table from the chosen file is shown by pressing ENTER key. The ESC key will cause the return to the table of files.
2.3.6. Calibration

This task serves for the creation of the user’s calibration.

It is possible to make the user’s calibration provided you have suitable K, U, Th, and background etalons (calibration pads) of sufficient dimensions and quality. The factory calibration was done on the surface of high volume etalons (standards with diameters of 2 m) and is related to the half-space under the instrument. In the case that you have etalons of smaller dimensions you have to correct the nominal K, U, Th concentrations of etalons by the multiplication by the geometric factor $G$ before those values of the concentrations are included into the GRM-260.

$$G = 1 - \frac{h}{r}$$

$h$ – the height of the detector middle above the pad surface

$h = 47 \text{ mm}$

$r$ – the diameter of the etalon pad

In all cases the precise knowledge of the concentrations of all three components in each etalon creates the basic condition of the valid user’s calibration. The occurrence of the foreign gamma sources near the etalon must be eliminated.

The calibration must be done with the same piece of the reference source, which is used for the measurement.

The measuring time for each etalon is preset to 20 min and cannot be changed by user. The calibration is done in the middle of the surface of etalons.

The calibration must be repeated periodically - at least once per year.

In the course of the calibration you are instructed to put the probe onto the destined etalon (K, U, Th, background and dose rate consequently). After the measurement of the spectrum you are asked to write the nominal concentrations of the etalon. You have to know all three components (K, U, Th) concentration for each etalon. A high volume background etalon made from pure SiO$_2$ sand is recommended.

Usually the U etalon is used as the dose rate etalon as well. In this case its dose rate value is $U_{\text{equiv}} = 2.5 \times \% K + 1 \times \text{ppm} U + 0.5 \times \text{ppm} Th$, where $\% K$, ppm U, ppm Th – are the concentrations of K, U, Th in the etalon.

After all calibration spectra and concentration values are ready the GRM-260 instrument calculate the calibration file and replace the old user’s calibration with the new one.
2.3.7. Data transfer to PC

This task serves for the transfer of result tables from the GRM-260 memory to a PC file.

After this task is run you are asked to give file name, locality and comment and then to choose the dose rate unit (nGy/h or U equiv).

Data transfer is running and when it is finished, the main menu (fig. 14) will appear. Appendix shows an example of the transferred file.
3. Maintenance

For reliable operation it is necessary to charge batteries regularly and enough. It is recommended to recharge batteries before each longer measurement (e.g. over night). A long charging time does not damage batteries. The battery discharge is indicated by software warning.

The battery charger from accessories is connected to the GRM-260 instrument by means of the connector under the small orange cover on the rear side of the instrument.

It is necessary to recharge batteries each 2 months at least once for one day – even in case the instrument was not used.

The battery charger from accessories is allowed to be used only for GRM-260 charging.

Keep the instrument clean

4. Trouble shooting

The display does not show any screen after turning ON.
Batteries are quite discharged – you should charge them thoroughly (one day approximately).

The prompt ATTENTION! THE BATTERY IS ALMOST DISCHARGED! is shown. It means that you should finish the measurement in a short time (minutes) and charge batteries.

The prompt THE STABILIZATION IS OUT OF RANGE.
Check whether the reference source is included in the instrument and whether the preset position of the stabilization peak corresponds with the used reference source (55 channel for $^{137}\text{C}$).

For warranty or after warranty repair contact the producer on the address:
GF Instruments, s.r.o.
Mr. Vit Gregor
tel.: +420 541 634 285, 366
Ječná 29a
fax: +420 541 634 260
621 00 BRNO,
E-mail: gregor@gfinstruments.cz
CZECH REPUBLIC
### An example of the output file:

File name: **TEST.SPE**  
Locality:  
Date: 11-25-2000  
Time: 17:38:23  
Comment:  
Ser. No. Serial number: **GRM-260 0010010**  

<table>
<thead>
<tr>
<th>No.</th>
<th>Time(s)</th>
<th>TOT(cps)</th>
<th>K(cps)</th>
<th>el(cps)</th>
<th>eTh(cps)</th>
<th>TOT(uequiv)</th>
<th>%</th>
<th>eU(ppm)</th>
<th>eTh(ppm)</th>
<th>Stb Cal F/U</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>360</td>
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<td>13.51</td>
<td>0.66</td>
<td>0.10</td>
<td>502.08</td>
<td>15.97</td>
<td>0.00</td>
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<tr>
<td>2</td>
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<td>605.04</td>
<td>3.37</td>
<td>3.40</td>
<td>0.18</td>
<td>344.81</td>
<td>0.28</td>
<td>28.25</td>
<td>1.51</td>
<td>ON</td>
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<tr>
<td>3</td>
<td>360</td>
<td>643.66</td>
<td>3.42</td>
<td>5.89</td>
<td>3.09</td>
<td>589.15</td>
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<td>0.12</td>
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<td>0.00</td>
<td>0.00</td>
<td>ON</td>
</tr>
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</tr>
<tr>
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<td>0.00</td>
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<td>ON</td>
</tr>
</tbody>
</table>