



# M E E T I n s t r u m e n t s G.m.b.H.

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## Portable Radiation Scanner (PRS-backpack) model AT6101C Technical description

### I. General

Portable radiation scanner (PRS) model AT6101C is designed for mobile radiation screening of pedestrians, vehicles, cargo, environment etc. The PRS can be used as a primary tool for detection of orphan sources or radiological area reconnaissance.

The PRS features such functions as undercover detection of gamma and neutron radiation with high sensitivity, localization of radiation sources, dose rate indication and radionuclide identification.

### II. Essential Features

The PRS model AT6101C incorporates the NaI(Tl) scintillation gamma detector with built-in 1024 channel MCA and processing units, He-3 filled neutron detector, hand-held PC (PDA) for data collection and treatment with incorporated GPS receiver and rechargeable power supply adapters. The gamma and neutron detectors are communicated with the hand-held PC (PDA) via Bluetooth. The instrument housing (as a backpack) does not attract the public interest during an undercover survey. Alarm signals can be produced as an audio signal and voice output on the PDA speaker or headset.

The instrument can be shipped by air as a normal (not dangerous) goods due to absence of not-exempted radioactive calibration sources and highly pressurized gas-filled components.

The PRS has an MCS mode of operation provided raw count rate for gamma and neutron channels.

### III Type specific Requirements

#### 1. Startup

The PRS has the following start-up and shutdown characteristics:

- The startup and shutdown keys are protected against non-intentional operation;
- A fully automated start-up process, with system self test;
- Allowance for manual re-calibration of the PRS, based on a specified energy line of a supplied exempted calibration source;
- Display software version for a period of at least 5 seconds
- Ability to store the energy calibration data so as to shorten startup time.

#### 2. Dose rate

The PRS is capable of indicating the gamma dose rate ranging from normal background up to at least 100  $\mu\text{Sv/h}$ , over the energy range from 60 up to 1330 keV with a relative uncertainty of less than  $\pm 50\%$ .

#### 3. False alarm rate (FAR)

The FAR for gamma and neutron channels are no more than one per hour at a one-second sampling time.

## **4. Sensitivity to gamma radiation**

**Dynamic sensitivity:** the instrument produces alarm when it is exposed to an increase in the ambient radiation level greater than 0,05  $\mu\text{Sv/h}$  within 1 s of the step change. The PRS meets this requirement in a gamma energy range from 0.05 MeV to 1.33 MeV.

### **Static sensitivity:**

Am-241: 12700 cps/ $\mu\text{Sv/h}$

Cs-137: 1960 cps/ $\mu\text{Sv/h}$

Co-60: 1030 cps/ $\mu\text{Sv/h}$

Background: 270 cps at 0,08  $\mu\text{Sv/h}$

## **5. Sensitivity to neutron radiation**

### **5.1 Static and dynamic neutron detection efficiency**

**Dynamic sensitivity:** The PRS triggers an alarm when exposed to a  $^{252}\text{Cf}$  source with an emission rate of 12 000 n/s, moving with a speed of 0.5 m/s at the distance of 1 m.

**Static sensitivity:** 28 cps/(neutron/s $\cdot\text{cm}^2$ ) for Cf-252 (when backpack is carried by a person)

### **5.2. Gamma sensitivity of neutron detector**

The PRS does not trigger a neutron alarm when exposed to a Co-60 gamma ray source producing a dose rate at the neutron detector of not less than 100  $\mu\text{Sv/h}$  ( $\pm 30\%$ ). This test is done with the neutron threshold set to meet the FAR and sensitivity requirements. The neutron sensitivity during this test is not changed for more than 10%.

## **6. Minimum requirements for isotope identification**

The instrument is able to identify the following radionuclides within the times indicated after exposure to the radionuclide with produced dose rate of 0.5  $\mu\text{Sv/h}$  :

### **6.1 List of isotopes and test conditions**

Unshielded within 20 seconds:

- Nuclear Material: U-233, U-235, U-238 ((covering HEU, LEU, NU, DU), Np-237, Pu-239 (covering low and high burn up Pu).
- Medical Isotopes: Ga-67, Tc-99m, In-111, I-123, Cr-51, I-125, I-131, Xe-133, Tl-201 and F-18 indicated by message based on the annihilation
- Industrial used isotopes: Co-57, Co-60, Ba-133, Cs-137, Ir-192, Eu-152, Am-241, Se-75
- Natural Occurring Radioactive Material (NORM): K-40 (e.g. fertilizer, tiles, ceramics), Ra-226, Th-232s and daughter isotopes;

Shielded behind 5 mm steel within 20 seconds:

- K-40, Co-57, Co-60, Ga-67, Tc-99m, desirable I-125 and I-127, I-131, Ba-133, Cs-137, Ir-192, Tl-201, Ra-226, Th-232, U-233, U-235, U-238, Pu, Am-241

Shielded behind 10 mm lead within 20 seconds:

- Low and high burn up Pu, LEU (<20% U-235)

## 6.2 Mixtures

The following mixtures are identifiable by the PRS within one minute (unshielded, Pu filtered with 2 mm of Cd) with each isotope contributing  $0.5 \mu\text{Sv}\cdot\text{h}^{-1}$  ( $\pm 30\%$ ) above background measured at the detector reference point from each radionuclide:

- i) Cs-137+ U (natural and HEU);
- ii) I-131 + U (natural and HEU);
- iii) I-131 + Low and high burn-up Pu;
- iv) Co-57 + U (natural and HEU);
- v) Ba-133 + Low and high burn-up Pu; and
- vi) Ra-226 + Th-232.

## 6.3. Indication of isotope identification results

The PRS is capable of displaying the results of the measurement in terms of the isotope and confidence level. The category are indicated visually and acoustically. Unknown isotopes will be displayed such as “not identified”, “not in the library” or “?”. In any case it is possible to continue, also in the easy mode, the measurement without restarting.

## 6.4. False Indications

The PRS has the following performance characteristics for the identification:

For a single nuclear or industrial isotope the probability to misinterpret the isotope as medical or NORM isotope is less than  $10^{-2}$  with confidence level of 0.95.

## 7. Environmental and mechanical

The PRS meets the following performance requirements:

- a) The PRS withstands heavy duty day-to-day conditions experienced in remote ‘in-field’ use, such as at border crossing check points;
- b) In its shipping case the PRS withstands exposure to vibration and shocks, as shown in Table 3 below;
- c) The PRS in its shipping container survives without damage a drop test from a height of 1 m onto a concrete floor.

**Table 3 – Requirements for Vibration and Shock**

<b>Vibration</b>	Frequency (Hz)	10-500
	Maximum acceleration (m/s <sup>2</sup> )	10
	Number of axes	3
	Test duration	15 min/axis
<b>Shock</b>	Maximum acceleration (m/s <sup>2</sup> )	300
	Pulse duration (ms)	6
	Total number of shocks/direction	3
	Direction of shocks	6

- d) The PRS remains operational over a temperature range from -20° C up to + 50° C;
- e) The PRS remains functional in an environment of up to 90% of relative humidity measured at 35° C, and under non-condensing conditions;

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- f) The PRS is made of materials that are not corroded in environments specified in points 7(d) and 7(e) above.
- g) The complete system is designed to be used in rough conditions: rugged, moisture and rain-proof for several hours of operation . Protection class: Spectrometer - IP54; hand-held PC (PDA) – IP67.
- h) Electromagnetic compatibility: meets the requirements of EN 55022, EN 55024, EN 61000-4-2 and EN 61000-4-3

## **8. Physical Dimensions, Weight**

- a) Weight: no more than 8 kg
- b) Backpack volume : 25 liters.
- c) The PRS features no external detectors or cabling. There is wireless communication between the hand-held PC (PDA) and detection units

## **9. Graphical User Interface (GUI)**

The following information and control are provided at the user display:

- a) Strip-chart display of gamma and neutron counts
- b) Spectral display from gamma detector
- c) List of radionuclide identified
- d) Real-time access to data stored
- e) Real-time mapping with GPS data and alarm locations.
- f) English language

## **10. Signals and Alarms**

The hand-held PC (PDA) provides visual and acoustic information to indicate a detected radiation source, the actual dose rate, the identification results and instrument's status. If a head set is connected to the sound at the hand-held PC (PDA) loudspeaker is disabled automatically.

## **11. Setup Parameters Requirements**

The PRS has two operation modes – easy and expert modes.

The following information and control are provided in easy mode of operation:

- a) View operational status
- b) View alarm indication
- c) Ability to reset alarms, and
- d) View identified radionuclide result and categorization (user selectable through advanced or supervisory access).
- e) Ability to make a long term measurement with identification (RID mode)

The following information and control are provided for the supervisory user through the use of access controls or special commands in expert mode:

- a) Access to and control of operating parameters (radionuclide library, alarm control, etc.)
- b) Access to and control of data logging intervals
- c) Access to alarm history
- d) Visualization of the spectra
- e) Isotope library management
- f) Access to alarm selection criteria including the ability to select specific radionuclides

## **12. Spectrometers Requirements**

The gamma spectrometer unit is responsible to deliver information related search and detection, dose rate indication and spectra collection. The spectrometer unit meets the following requirements:

- a) Adequate detector size to fulfill sensitivity requirements e.g. NaI(Tl) detector size diam. 63x63 mm
- b) Fast response to changing radiation fields (update 300ms)
- c) Resolution for 662 keV : better than 8 %.
- d) Nonlinearity is less than 1 % for gamma energies up to 1 MeV and no more than 2 % for gamma energies up to 3 MeV.
- e) Built- in pile-up rejector
- f) Built- in temperature stabilization
- g) Tube based MCA with 1024 channels
- h) Energy range: 20 keV -3000 keV
- i) In scanning mode the system permanently records spectra with a minimum spectra acquiring time of 3 s (preset selectable).
- j) An identification process provides the radionuclide information in real time.
- k) The data collecting time for the identification process is selectable.
- l) Creation of a spectra summation file at the end of the identification cycle is provided
- m) A mode for visualization of the actual spectrum with the capability for long measurement times and radionuclide identification (RID mode) is provided
- n) The hand-held PC (PDA) provides a memory to store spectral data for 10 hours (for 3 s spectra acquiring time).
- o) The stored data (spectra) are in the IAEA standard ASCII \*.spe format. Files are compatible with the following post evaluation software: Spesian waterfall software and GBS-Spec and GBS identify software.
- p) Time stamp and GPS data are parts of the spectra file

## **13. Data Transfer and Software Requirements**

The instrument has the ability to transfer data to an external device, such as a computer. The transfer is based on a bi-directional port that meets the requirements of Ethernet, USB, wireless, or other electronic means, such as a removable media device. The technique used conforms to applicable IEEE protocols. Wireless techniques can be encrypted.

## **14. Power Supply Requirements**

Rechargeable battery lifetime guaranties continuous operation for 10 hours at normal temperatures. The instrument has a low battery indicator.

Each battery charger operates from 110 to 230 V ( $\pm 10\%$ ) with frequency from 50 to 60 Hz. The misuse of the plugs is avoided by usage of different plug sizes and special markers on the cables.

To extend the operational time in the field, a car charger for the hand-held PC (PDA) and a booster battery for the detectors (extend operational time 8 hour more) can be provided.

## **15. Documentation**

The following documentation are provided with the PRS in English and the other language options of the GUI of the PRS:

- a) User manual for the PRS with trouble shooting guide and examples for performance monitoring (e.g. fine gain, resolution of the K-40 or Cs-137 peak);
- b) Software manual including a description of the file format;
- c) Quick start up user guide for easy mode of operation; and
- d) Maintenance information

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## **16. Quality control/quality assurance ( QC/QA)**

The instrument is manufactured and tested under ISO 9001:2008 quality control system.

## **17. Warranty: 2 years on labor and parts**

The Technical Specification is confirmed

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