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## RAM R-200 - A PORTABLE RUGGEDIZED RADIATION MONITORING SYSTEM

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### Abstract

RAM R-200, a new generation of ruggedized portable radiation-monitoring systems, is presented. The system which is a result of interdisciplinary research, was developed at the NRCN in collaboration with Ben-Gurion University. It consists of RAM R-200 - a portable radiation meter, and a variety of external probes for wide range gamma radiation fields and beta-gamma contamination detection and measurement. The meter or each one of the external probes can be used as a portable system or a stand-alone radiation measurement station. All the system's components were specially designed to meet severe environmental conditions.

### RAM R-200 Meter Description

The RAM R-200 is a portable gamma meter designed for measuring wide range gamma radiation fields. It is lightweight (approx. 500 g.), in small dimensions (80 × 35 × 130 mm), with emphasis on ease of operation and ergonomic structure.

The RAM R-200 meter contains an internal detector for gamma fields measurements which covers a wide dynamic range of 0.1  $\mu\text{Sv h}^{-1}$  to 1  $\text{Sv h}^{-1}$ . The meter includes two energy compensated GM tubes, high-voltage regulated power supply<sup>(1)</sup>, signal processing electronics and embedded microprocessor circuitry with dedicated software for data processing and display. A microprocessor-controlled auto ranging switch determines the appropriate GM tube to be used according to the dose rate. Additional functions include accumulated dose measurement, malfunction detection and appropriate alarm, auto recognition of external probes and three serial RS-232 communications channels. The RAM R-200 supports the logging of dose-rate measurements into its internal battery backed-up memory. The logged data includes location (provided by an external GPS or a Bar-Code reader) and acquisition time.

The sophisticated software enables smooth analog and digital display and fast response when abrupt changes in the dose rate measurements occurs. The meter readout is displayed on a large easy to read custom designed Liquid Crystal Display.

The RAM R-200 meter concurrently measures and analyzes radiation fields from both internal and external probes. This feature enables dose-accumulated and dose-rate alarms from the internal detector, also while the instrument measurements are performed with an external probe, thus improving the operator's safety.

A dedicated integrated circuitry was designed and implemented in order to achieve very low power consumption, yielding prolonged system operability, over 100 hours, using a standard 9V Alkaline battery. The RAM R-200 probes can be operated using the RAM R-200 meter or by direct connection to a PC computer via the serial port. Testability and calibration of the meter and the external probes are performed directly from a PC computer. This concept for testability significantly simplifies maintenance and operation.

### External Probes

The RAM R-200 system includes three external probes: RG-40 for high range gamma field covering a dose rate range of  $1 \text{ mSv h}^{-1}$  to  $100 \text{ Sv h}^{-1}$ , RG-12 and RG-10 end-window GM probes for beta/gamma contamination detection and measurement. Similar to the meter, these probes are designed to withstand vibrations, shocks and extreme temperature conditions.

All RAM R-200 external probes include an internal microcontroller circuitry, self regulated power supply for the internal electronics, high voltage power supply and GM output signal processing electronics. The external probe microcontroller performs data processing, enables RS-232 serial communication and executes a continual built in test for detection of malfunction conditions to increase reliability and easy maintenance.

After connecting the external probes to the meter, the latter performs automatic probe identification. No further calibration or operator's action is required.

### System Tests

The RAM R-200 meter and the RG-40 probe were tested over a wide range of gamma fields. The intrinsic error of the whole effective measurement range was less than  $\pm 10\%$ . The results meet international standard IEC1017-1 and ANSI N42 dose rate linearity response requirements for gamma radiation ratemeters. Energy and angular response are being tested.

Figures 1 and 2 show the RAM R-200 meter's internal detector measurement accuracy, from  $1 \mu\text{Sv}$  to  $1 \text{ Sv/h}$ . Adequate dose rate response from  $1 \mu\text{Sv}$  to  $10 \text{ mSv/h}$  was obtained with the low range GM tube<sup>[2]</sup>. The high range GM tube<sup>[2]</sup> test also shows adequate dose rate response from  $500 \mu\text{Sv/h}$  to  $1 \text{ Sv/h}$ . The meter's software enables a wide range of gamma radiation measurements from dose rate near background to  $1 \text{ Sv/h}$ , by selecting the appropriate GM without operator intervention. Dead time and calibration corrections are performed continuously by the meter's or external probes' microcontroller.

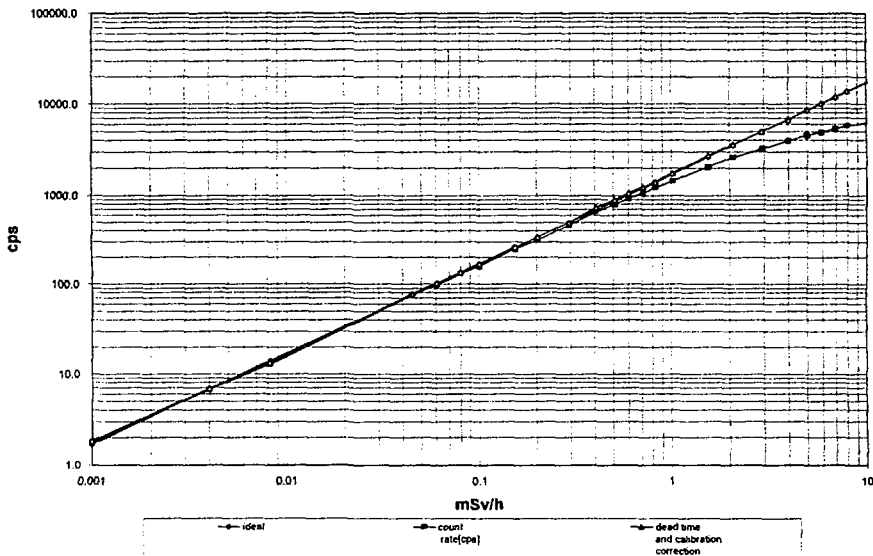


Figure 1: RAM R-200 Meter – Low Range GM Dose Rate Linearity

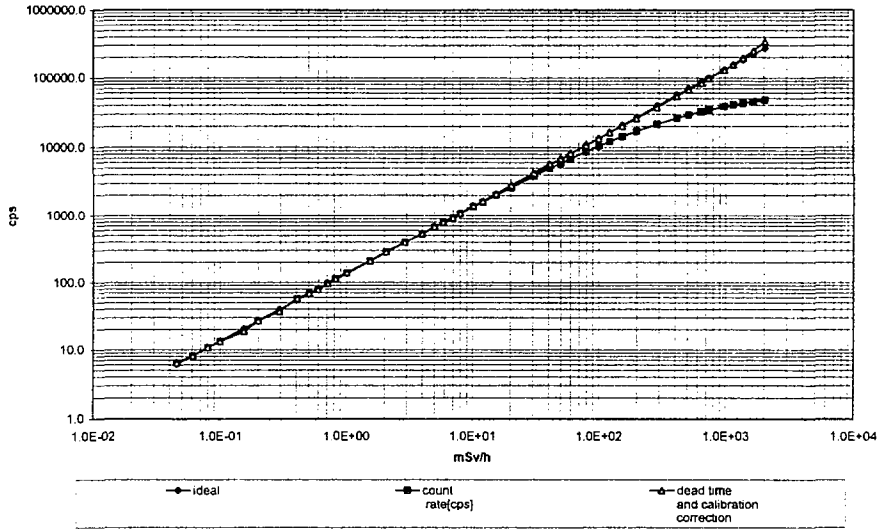


Figure 2: RAM R-200 Meter – High Range GM Dose Rate Linearity

The RG-40 dose rate linearity response was tested over a large range of gamma fields, from 1 mSv/h to more than 100 Sv/h. This probe operates in a similar way to the RAM R-200 meter by using two GM tubes. The lower range GM<sup>[3]</sup> measures from 1 mSv/h to 10 Sv/h. The higher range GM tube<sup>[3]</sup> measures from 10 mSv/h to a dose rate higher than 100 Sv/h. GM selection switching is performed by the RG-40 microcontroller according to the probe software.

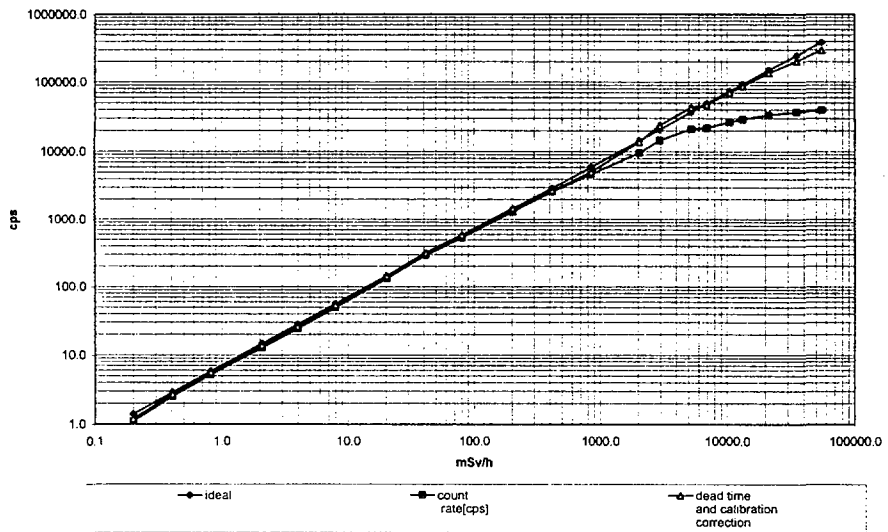


Figure 3: RG-40 Probe – Low Range GM Dose Rate Linearity

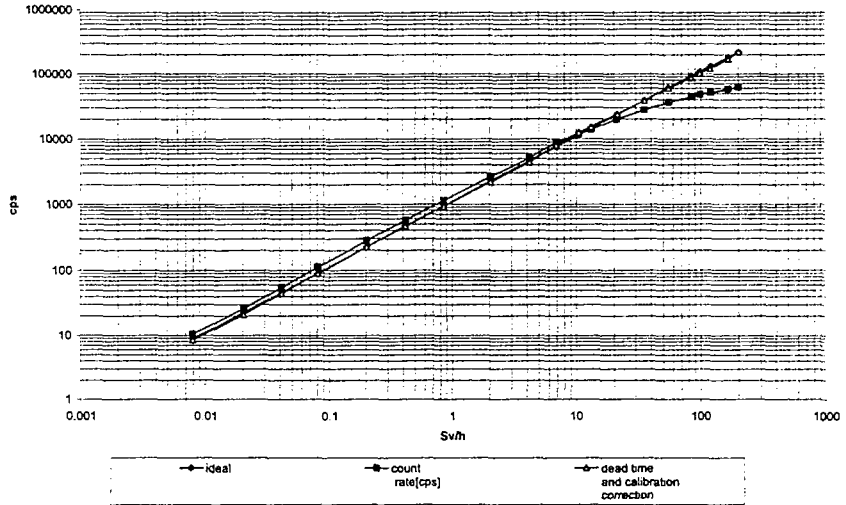


Figure 4: RG-40 Probe – High Range GM Dose Rate Linearity

### **Conclusion**

The RAM R-200 is a reliable, easy to use detection and measurement system for gamma dose rate and beta-gamma surface contamination. Special accessories were developed such as an extended length telescopic rod which includes a fast connection housing for the meter and an external probe. Using the telescopic rod enables reading of hard to reach areas or measurement of high activity sources where a safety distance must be kept between the survey points and the operator.

The rugged construction of all the RAM R-200 system components are specially designed to meet severe environmental conditions. The system simplicity of operation and small dimensions makes its ideal for medical applications, nuclear plants routine tests or stand alone measurement stations.

Tests results and calibration curves are shown in figures 1 to 4. As one can see, the response is linear over a wide range. Dead time effects are seen at dose rates higher than 100 mSv/h with the internal probe, and higher than 10 Sv/h with the RG-40 probe.

### **References**

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- [2] CENTRONIC, Geiger Muller data-book, 1997.
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