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PORTABLE LABORATORIES FOR RADIOACTIVITY MEASUREMENTS

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ABSTRACT

The portable radiometric laboratories LARA-10, LARA-GS, LARA-86 and ALARA-10 designed, developed and produced at the Boris Kidrič Institute are described. Earlier models (LARA-1, LARA-1D, LARA-2 and LARA-5) are presented in brief. The basic characteristics of the devices and methods of measurements are given. All the instruments are battery operated and almost all can also use 220V/50Hz supply. They are a very suitable facility for radiological monitoring of soil, water, food, clothes etc., when working in field conditions.
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INTRODUCTION

Over the past twenty years, the Electronics Dept. of the Boris Kidrič Institute has, besides individual instruments for detecting and measuring radioactivity, also developed radiometric sets - laboratories - suitable for use in field conditions. The sets contain one or more electronic instruments, various tools, accesories and materials necessary for field work. They are packed in cases or boxes suitable for carring and transporting. The dimensions, weight and price of each set depends on its intended application, required accuracy etc.. They are all battery supplied and almost all use 220V/50Hz supply as well.

The first to be developed was LARA-1, a simple set containing a pocket detector, a small stand and some accesories. It is intended for use in schools but can also be applied in detecting real radioactive contamination. The next, more advanced version, was LARA-1D. It has an instrument with digital readout. LARA-2, which is based on the KOMO-TN

radioactivity monitor, has more accesories then the preceding two sets, It is intended for use in emergency conditions. LARA-5 is for the measurement of very low activity levels. LARA-10, packed in two large metal cases, is convenient for longer period of independent operation. LARA-GS, derived form LARA-10, is intended for quick routine control of food and other goods. LARA-86, developed after the Chernobyl catastrophe, has a GM detector with a large area window. All the preceding laboratories are also based on a GM counter. They are mainly for Beta activity measurements.

ALARA-10 is an expanded version of LARA-10. It has an additional set based on a semiconductor detector developed for Alpha activity measurements.

A description of the laboratories, methods of measrments, sensitivities achieved and some experience after Chernobyl will be given in the following text.

METHODS OF BETA AND ALPHA ACTIVITIES MEASUREMENT

The portable radiometric laboratories are intended for detecting and measuring the activities of the radioactive isotopes in diverse materials (food,. water, biological samples, etc.). All the laboratories use the absolute method of measuring the total mass specific activity (ref.1,2,3), ensuring a result with an estimated total error of about 40% (ref.4).

When operating in field conditions, which is unavoidable in the case of emergency situations, measurements are usually carried out using unprocessed samples. In order to increase sensitivity it is possible to utilize a method of concentrating the radioactivity. Depending on the situation and the set used, these can be:

-method of wet ashing,
-method of drying,
-method of evaporation
-method of burning

Only the wet ashing method can ensure the necessary high sensitivity (20 Bq/kg) when examining Alpha activity. This method is used in the ALARA-10 set.

Our radiometric laboratories were used for performing triage measurements on food and animal fodder following Chernobyl, the measurement range being between 300 Bq/kg and 30 KBq/kg.

PORTABLE LABORATORIES IN CURRENT PRODUCTION

LARA-10 Laboratory

The LARA-10 radiommetric laboratory is intended for measuring the specific activity of materials contaminated by fission products in accidental and emergency conditions, using the thick sample method. LARA-10 enables food, water, animal feed, biological and medical samples to be prepared and measured. A radiation monitor (KOMO-TM) included in the laboratory is used for the quick selection of samples, as well as the measurement of exposure rates and surface contamination (ref.6,7).

LARA-10 is packed in two hermetically-sealed metal cases (total mass less than 110kg) with tools, accesories and spare materials for handling up to 8000 samples included. LARA-10 uses 220V/50Hz power supply or its own 12V battery.

The laboratory makes possible measurements of specific activities of samples contaminated by Beta-active materials in a range of between 4000 Bq/kg and 1 MBq/kg. In 10 hours it is possible to perform about 180 analysis of water and other liquid samples or 60 to 100 analyses of different solid samples. Using a long measuring interval (2h), measurements are possible of a total mass activity of about 300 Bq/kg .with a statistical error of ±100 Bq/kg

LARA-GS Laboratory

This portable laboratory contains the same digital instrument and GM counter as LARA-10 and a similar lead housing. It has a smaler case and fewer tools and materials. LARA-GS is a simplified version of LARA-10 which can be used efficiently for quick routine cheks of food and other goods for the presence of radioactivity.

LARA-86 Laboratory

This radiometric laboratory uses the RMK-10 unit, placing its detector in a suitably designed lead container. The set enables measurements as low as 300 Bq/kg to be made, with the measurement time of one hour for an unknown radioactive isotope and with 20 minutes for a known one. At higher activity levels, the measurement time decreases.

RMK-10 is a versatile radiological contamination meter. It is based on a GM detector with a thin window of large area, enabling beta radiation to be measured in a wide energy range (from 100 Kev upwards). It has three measurement modes: automatic sequential with one or five-second intervals, automatic longer duration with built-in timer - 100 or 1000 seconds - and manual operation using a separate clock.

Applied up to date technology makes LARA-86 reliable and simple to use. Its RMK-10 has a four-digit display and sound impulse indication. It is powered from the 220V/50Hz mains or a 12V battery.

ALARA-10 Laboratory

This portable laboratory is made up of a LARA-10 complete unit with an additional set for measuring Alpha radioactivity.

The Alpha set is designed for selective measurement of specific activity of food and water samples from 10 Bq/kg (for 24 hours of work) up to 14000 Bq/kg in accidental conditions. This set tohether with the LARA-10 radiometric laboratory makes a complete unit for measuring food and water alpha and beta contamination. It can be used in both laboratory and field conditions.

The Alpha set is based on a semiconductor detector. It also contains necessary tools, dishes and materials for sample preparation (ref.3,4).

The detector unit's operating temperature range is from $-25^{\circ}C$ to $+40^{\circ}C$. It is packed in two cases, with a total mass of 80 kilograms.

EARLIER LABORATORY SETS

LARA-1 Laboratory

A small set containing an MLZ-2 pocket detector, which has an

extremly low battery consumption. A single pair of 1.5V R6 batteries can last several months. The detector is intended for individual use and the set for the educational purposes. LARA-1 can be used for detecting radioactive contamination in real conditions.

LARA-1D Laboratory

Lara 1D is more advanced then LARA-1. It is intended for use in schools but also for actual measurements. Its instrument has a for-digit display. LARA-1D is packed in a suitable case which can easily be carred and used in field where 12V battery is available (ref.8).

LARA-2 Laboratory

LARA-2 contains a portable KOMO-TN monitor together with all necessary accesories for a long-term field work.

The portable radiation monitor is intended for measuring Gamma radiation exposure rates from the background to 50μC/kgs (700 R/h), divided into eight linear sub-ranges. The small dimensions (26x10x16 cm^3) and low mass (approx. 2kg) makes this unit suitable for field use. The unit's probe is intended for surface Alpha and Beta contamination measurements and is connected to it with a flexible cable. Two 1.5V R20 batteries power KOMO-TN for up to 80 hours, while the battery voltage can be checked at all times (ref.5,9).

LARA-5 Laboratory

This portable laboratory is suitable for measuring very low Beta activities. It contains two GM counters in an anticoincident connection which provides background level to be below 3 imp/min. It has a six digit counter and timer with 10, 100, 1000 and 10000 seconds. The mass of the lead housing is about 60kg.

CONCLUSION

These eight portable radiometric laboratories are the result of eforts of the Boris Kidrič Institute - Vinča to provide their users with both the reliable equippement and the metodologies for normal or emergency conditions All

laboratories LARA-type has been developed in the Electronics Department but the substantial total possibilities provided by the BKI have also enabled it. The laboratories primarily use the tick sample method for the total mass specific activity measurement. The detectors used are mainly GM type, which are the simplest and most reliable. Some instruments based on semiconductor detectors have also been developed.

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