# ЗБОРНИК РАДОВА

## XXX СИМПОЗИЈУМ ДРУШТВА ЗА ЗАШТИТУ ОД ЗРАЧЕЊА СРБИЈЕ И ЦРНЕ ГОРЕ

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# EVALUATION OF DOSE RATE DATA PROVIDED BY NON-GOVERNMENTAL NETWORKS

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*ABSTRACT*

*In recent years, the number of non-governmental networks providing quasi real time dose rates is growing. This data is available to the general public via open access based platforms on the internet. The research on the non-governmental networks is scarce and the measurements represented there are mostly carried out using broadly available commercial simple hand-held devices. Without proper testing of these devices in metrological laboratories, there is a significant possibility for discrepancies between the official and non-governmental data, which may have wider implications. Within project 16ENV04 Preparedness, a systematic study of non-governmental networks produced a list of 16 types of dosimeters that are commonly used. Four dosimeters of each type were sourced and commissioned by project partners and are currently undergoing the testing. Test procedures are shortly described in this paper and preliminary results for 2 types of dosimeters are presented.*

## 1. Introduction

Government early warning networks have been in existence in Europe (EURDEP) for several decades [1]. An important event for their expansion was Chernobyl accident in 1986. As of 2017, there were more than 5500 stations monitoring ambient dose rate in Europe [2]. After the Fukushima accident, the number of non-governmental networks and monitoring stations started to increase rapidly. Proliferation of cheap equipment, which is usually sold on the internet, also helped the expansion of such networks. Large number of measurement locations can often rival or exceed the number of governmental monitoring stations. The main difference between instruments from governmental and non-governmental networks is that the former are in most cases subjected to regulatory control, testing and calibration, and the later are usually not. Some research has been conducted regarding the non-governmental networks [3, 4, 5, 6], but only a few networks and devices were studied. A comprehensive study is still needed.

Measuring instruments used in non-governmental networks (MINN) are studied within the EMPIR project "16ENV04 Preparedness, Metrology for mobile detection of ionising radiation following a nuclear or radiological incident”. In the first step, a survey of non-governmental networks was conducted and 16 types of commonly used MINNs were identified, sourced and commissioned. Currently, testing of the MINNs is being conducted [7].

After the MINNs are tested, it will be decided whether the data provided by non-governmental networks are metrologically sound. This conclusion will help answer two main questions:

1) Is it possible to use non-governmental data for official purposes, such as emergency response?
2) Is the data provided by non-governmental networks likely to cause unwarranted panic in general public or to cause public to lose confidence in official data?

One of the possible uses of the crowd sourced data might be for European Data Exchange Platform – EURDEP [1].

## 2. Instruments selected for testing

Within the project, extensive survey of citizen networks was performed. One of the tasks of the survey was to identify 16 types of MINNs in order to be sourced and commissioned by project partners. These MINNs are tested within the project in order to evaluate them and to check the feasibility of using non-governmental data for official purposes. The instruments that were selected are presented in Table 1.

**Table 1. List of MINNs selected for testing.**

| **Manufacturer** | **Type** | **Responsible Partner** |
|---|---|---|
| Gamma-Scout GmbH | Gamma Scout | PTB |
| Soeks | Quantum | PTB |
| Safecast | bGeigie Nano | PTB |
| MagnaSci | µRad Monitor Modell A | PTB |
| International Medcom | IMI Inspector Alert V2 | NPL |
| International Medcom | RAD100 | NPL |
| MagnaSci | µRad Monitor Modell A3 | NPL |
| DIY Geiger Counter | Geiger Kit GK-B5 | NPL |
| Quarta | RADEX RD1212-BT | ENEA |
| GQ Electronics | GMC-300E+ V4 | ENEA |
| MAZUR Instrument | PRM-7000 | ENEA |
| S.E. International Inc. | Radiation Alert Monitor 200 | ENEA |
| GQ Electronics | GMC-320+ | VINS |
| GQ Electronics | GMC-500+ | VINS |
| MagnaSci | µRAD Monitor model KIT1 | VINS |
| SE International | Monitor 4 Geiger Counter Kit | VINS |

## 3. Testing design and locations

MINN testing is performed in 4 different institutes: Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Italy, Physikalisch-Technische Bundesanstalt (PTB), Germany, National Physics Laboratory (NPL), England and Vinca Institute of Nuclear Sciences (VINS), Serbia.

Linearity test is performed by irradiating MINNs at different dose rates, between 300 nSv/h and 100 μSv/h. Each institute is performing irradiations on their own premises. For this purposes, S-Cs radiation quality is used, except in case of VINS, where S-Co radiation quality is used.

Energy dependence test is performed by irradiating MINNs in different standard radiation qualities, including S-Am, S-Cs, S-Co and X-ray qualities from narrow series (N-series). Each institute is performing irradiations on their own premises.

Other tests are performed only in PTB facilities. Inherent background of MINNs is determined in low background underground laboratory UDO II. Response to secondary cosmic radiation is performed on the floating platform on a lake in the vicinity of PTB Braunschweig. Sensitivity to small variations of ambient dose equivalent (several nSv/h) is tested at the plume simulation site in PTB, Braunschweig. Finally, dependence of MINN response on environmental conditions is tested in climatic test cabinet in PTB, Braunschweig.

## 4. Preliminary results and discussion

Preliminary tests were performed in VINS. First results were obtained for two types of dosimeters and include linearity and energy dependence. Range of dose rates was extended to 700 μSv/h, in order to perform non-linearity correction for energy dependence tests. Energy dependence tests were performed for mean beam energies between 33 keV (N-40) and 1250 keV (S-Co).

Both dosimeter types use the same GM-tube for the low dose rates corresponding to the tested range. There are three possible ways to read out the instrument indications: direct readout from the MINN display, using the program provided by the manufacturer for real time monitoring (the results can be saved) and by using the program to read the stored values from the MINN internal memory. All three ways were compared and have been shown to be equivalent, with one exception – the maximum indicated value is different for all three modes. Calibration coefficients are internally stored in the MINNs and can be read and changed by using the provided program. Instrument indications are not corrected for dead time in any of the three read-out modes.

Relative response for energy dependence test was corrected for instrument non linearity. Linearity and energy dependence graphs are shown in Figures 1 to 4.

The evaluation of the results was performed according to the criteria set in IEC 60846-1:2009 standard. The relative response due to the angle of incidence and photon energy should be within the range between 0.71 and 1.67, and due to the dose rate within the range between 0.85 and 1.22 [8].

Analysis of the results shows that all 8 MINNs have satisfying linearity within the tested range. For dose rates higher than 7 μSv/h, there is a clear trend of decreasing sensitivity, mainly due to the dead time. For lower dose rates, the statistical uncertainty becomes significant and no trend can be deduced.

Energy response of the instruments was normalized to response for $^{137}Cs$. GM tubes are not compensated, which causes high overestimates (up to 550 %) of dose rate for low photon energies. The energy dependence is satisfactory for all 8 instruments only for mean energies between 164 keV (N-200) and 1.25 MeV (S-Co), which is lower than the minimum rated range according to the standard [8].

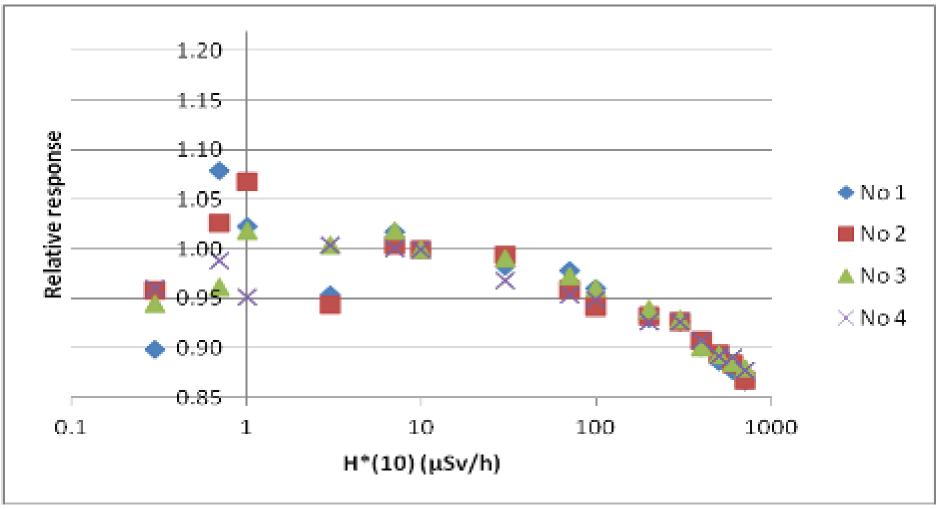


**Figure 1. Dosimeter type 1 linearity.**

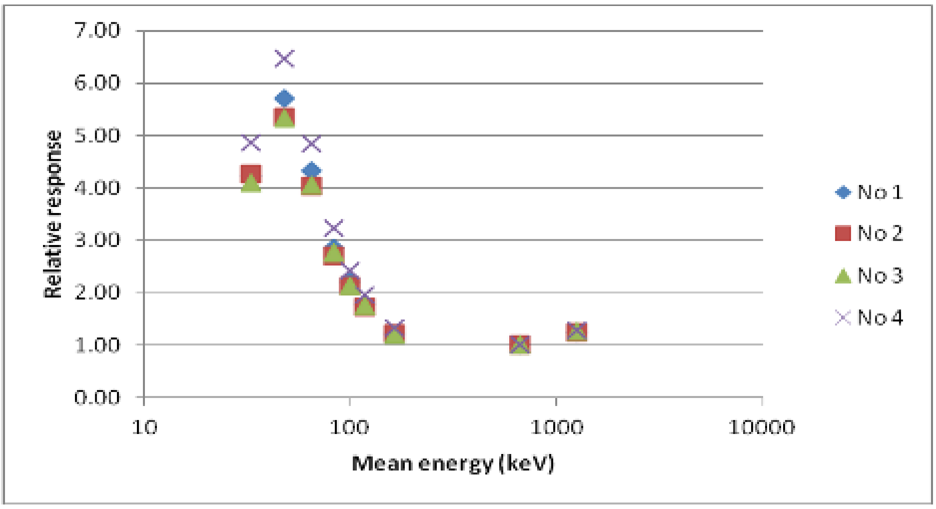


**Figure 2. Dosimeter type 1 energy dependence.**

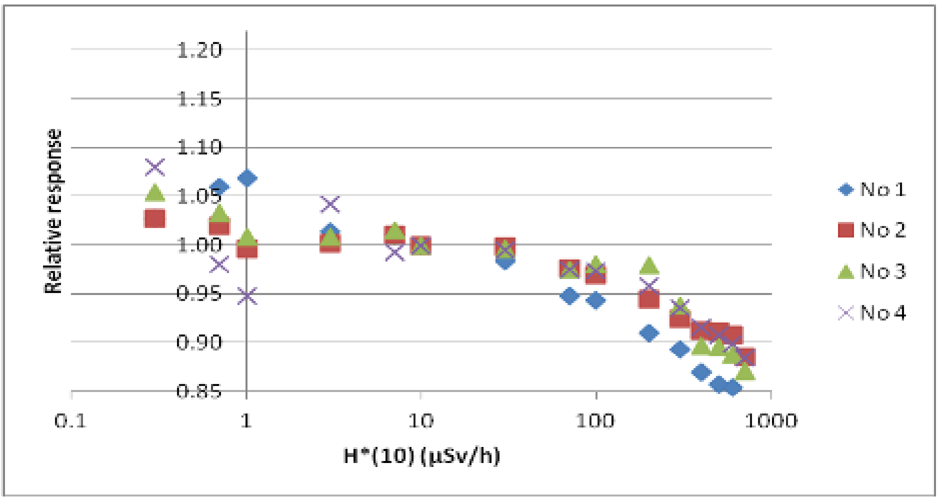


**Figure 3. Dosimeter type 2 linearity.**

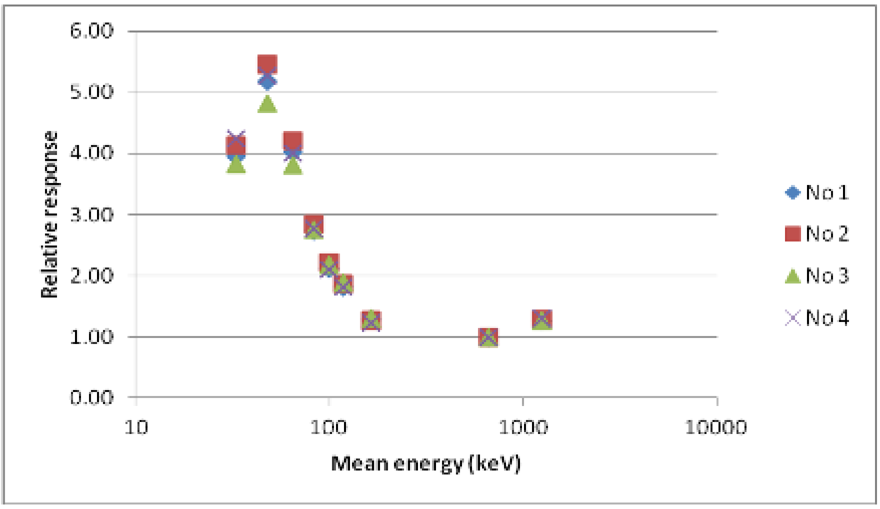


**Figure 4. Dosimeter type 2 energy dependence.**

## 5. Conclusion

Preliminary tests on MINNs commonly used in citizen networks show that at least some of the instruments have less than desirable properties and that further testing is needed. Even though many low cost instruments have good response in radionuclide fields ($^{137}Cs$ and $^{60}Co$) and good linearity, the situation is not so good when low energy photons are used. Other influence quantities, such as angle of incidence, temperature and humidity should also be considered to evaluate such instruments.

## 6. Acknowledgement

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