

Report on the ECE II Thoron Metrology and Dosimetry Workshop Niška Banja, Serbia, June 2005

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1. Abstract

The ECE II International Workshop on new perspectives for Thoron surveys and dosimetry, took place on June 6-10, 2005 in the radioactive spa town of Niška Banja in the south of Serbia. Participants from Europe, Asia and the USA attended and participated actively in the workshop. The aim and scope of the workshop was to address all thoron-related issues but in particular those of its metrology and dosimetry. A workshop such as ECE II has been long overdue as thoron gas has been very often neglected or has been just considered a disturbing factor for radon measurements. The aim and scope of the workshop was to address a number of important thoron-related issues such as thoron dosimetry, improvements in measurement techniques and their calibration. In addition to describing their research activities, an important practical aspect of the workshop was for the participants to take part in both indoor and outdoor field measurements, both in the air and waters of the spa town, using their own instrumentation. In addition to the main focus on thoron matters presentations on radon studies were also made.

2. Thoron calibration needs

In terms of thoron calibration, it was noted that there is a severe deficit worldwide of high quality reference chambers/facilities. Therefore, large efforts to improve this situation are currently being made both theoretically and experimentally in several countries (Japan, USA, Germany, India, Poland, Spain, etc.). It was agreed at the workshop as a priority that a primary standard source and calibration facility for thoron should be established. The configuration of a thoron calibration chamber is quite different from that of a radon chamber. Mainly because of its short half-life in order to achieve the necessary homogeneous distribution of thoron in a chamber its volume should be small (less than 200 liters would appear to be appropriate). There are essentially two ways to supply the thoron gas. In one method, a thoron source is externally connected to the exposure chamber. The thoron concentration can be controlled with different flow rates for gas supply and the number of sources to be connected. In the other method, the source is placed within the chamber. In order to produce a homogeneous thoron distribution, an internal fan should be installed in the chamber. In both cases the influence of the consequent air turbulence on the sensitivity of detectors, in particular for passive diffusion types, should be taken into

consideration. In addition to being able to create a uniform thoron distribution in a calibration chamber having an internal source there is also a need to use the chamber with the fan off. This is in order to obtain a thoron profile under steady state characteristics (more closely related to thoron behaviour in rooms for example) which is specially needed for the calibration of devices based on thoron profiles for thoron flux and/or exhalation measurements.

3. Presented data

Measurements of thoron and/or radon using both short and long term techniques in soil water and air were presented at the workshop. The following passive type of radon-thoron detectors were used: Ultratrack Monitor, 4 Leaf Monitor, Raduet, Radpot, Twin Cup Monitor, UFO type detectors, SSI Radon Detectors employing LR-115, CR-39 and Lexan Polycarbonate detectors. Authors also presented data on the continuous monitoring of radon and thoron by using Alphaguard, RAD7 and SARAD RTM 2100 monitors. Results were also presented on retrospective radon measurements in Niska Banja dwellings by simultaneously using surface and volume trap measurement techniques. Both the techniques were found to be in good agreement with each other.

Results were presented on the possible correlation between emanation of radon/thoron from soil and groundwater and the geology of the area. The results of the alpha spectroscopic measurements of thorium measurements in animals, plants and mushrooms were also presented. In this work a strong disequilibrium for thorium series in plants and animals was observed with radium being found to be more mobile than thorium and more easily taken up by animals and plants. The results of these measurements will be published, in due course, in the literature.

4. Dosimetric and epidemiological aspects

Accounts of the lung dosimetry of radon and thoron daughters were presented. Up to now the information required to obtain reliable Dose Conversion Factors (DCFs) for Thoron and Radon gas and their progeny is not sufficient. Improved information on DCF dependency on both air quality conditions (aerosol concentration, size distribution of aerosols, unattached fraction etc.) and physiological parameters (age, physical activity, type of breathing, anatomical parameters etc.) are needed. It was agreed that special attention should be paid to the estimation of uncertainties of the DCFs due to variability of air quality and physiological parameters. The influence of such factors as smoking, lung diseases etc. should also be investigated and included.

During the Workshop two reports concerning epidemiology of Radon were presented. The first report was concerned with the assessment of recent results obtained with the three-pooled analyses of European, American and Chinese case-control studies. It was shown that, whereas both meta-analysis and pooled analysis increases the statistical power (i.e. reduces the confidence intervals of the estimated risk), with pooled analysis only it is possible to take into account confounding factors in a uniform way across the studies. All the three recent pooled analyses (in particular the European one, which was the largest) estimated a statistically significant increase of lung cancer, which was homogeneous among the studies. Moreover, a synergistic

multiplicative interaction between radon and cigarette smoking was observed in the European pooling.

In the report it was stressed that improvements in radon exposure assessment usually leads to improved estimates of radon relative risk values.

In another presentation it was argued that monofactor epidemiologic techniques are not sensitive enough to assess the weak effect of radon, especially on relatively small populations. The main reason for this is the strong confounding effect of other factors (smoking, sex, occupational exposure to carcinogens, lung diseases etc.). A new approach based on system multifactor analysis was described. which takes into account some tens of possible influencing factors and permits ranking them by relevance. The results of using this approach in three case-control studies in Russia were presented..

5. Radon remediation of buildings

An overview of principles and techniques of radon mitigation based on pressurisation / depressurisation, ventilation and sealing was presented. The avoidance of possible problems due to influences of humidity, low temperatures, aging etc. was highlighted. Results from test-cases utilising novel techniques based on local over-pressurisation combined with ventilation of indoor air were presented. These techniques often give multiple benefits, as they in addition to reducing radon levels also improve indoor air quality, thermal comfort or save energy. Other concerns influencing implementation of radon mitigation such as economical factors, energy consumption and human response related to remedial measures were also considered.

6. Workshop conclusions and recommendations

6.1 Thoron and thoron progeny measurement protocols

Because of its short half life (55 sec) thoron concentrations in a room generally fall off exponentially with distance from its source, which is usually internal room surfaces. Due to this, for comparability of thoron measurements it may be necessary for the measurement protocol to include a precise statement on measuring the thoron concentration at some specific distance (x-cm) from the source or as close as practicable to walls and other room surfaces. This latter recommendation has particular relevance to human exposure assessment as during sleep people generally breathe air close to walls. In this situation the lung dose due to the thoron gas itself may even be greater than that from the inhalation of thoron progeny. These may typically be present in room air at much lower concentrations and will be much more uniformly distributed in the air than the thoron gas itself. Since the correlation between thoron gas and its progeny Pb-212 cannot always be ensured a correct estimate of the dose may even require measurement of both the gas itself and its progeny. In many investigations, however, the particular scope in mind may only require one type of measurement to be made. Nevertheless, further studies on the spatial and temporal distributions of thoron and its progeny are needed in order to establish reliable protocols for measurements in the interests of comparability of measurement data. For thoron measurements in water, as in the case of radon in water measurements, it is recommended that procedures should be adopted to reduce thoron losses during sampling

6.2 The formalisation of protocols for international thoron calibration and intercomparisons at NIRS

In recent years the thoron calibration facilities at NIRS (National Institute of Radiological Sciences) Chiba, Japan have been often made available to many international laboratories involved in thoron and thoron progeny metrology. These arrangements have usually been made on an individual laboratory basis. It is now recommended that formal protocols should be established with and by NIRS to accommodate the calibration and intercomparison requirements (exposure ranges, thoron equilibrium factor etc) of the many different types of monitors, both passive and active that exist. In this way the NIRS facility would become an international centre for thoron and thoron progeny exposures. This would greatly help to ensure the comparability and accuracy of the measurements made by the wide variety of measurement techniques that presently exist.