

REPORT

for a course held on the topic of “Building protection against radon: measurement, prevention and corrections measures” in the National Centre of Radiobiology and Radiation Protection on the PIANOFORTE program

Course with the title "Building protection against radon: measurement, prevention and corrections measures" was held during the period 27 - 31 March 2023 г. The course is organized with the aim of increasing knowledge and skills in the specific area of implementing corrective and preventive measures to reduce radon levels in buildings.

The training included 29 lectures lasting 45 minutes and 10 hours for field measurements and exercises on radon case studies. The main topics of the training included:

- Introduction: Radon – social and medical problem.
- Sources of Radon in the Environment: underground sources; building materials; water and gas supplies; and outdoor concentrations.
- Radon - basic facts: mechanisms of ingress and accumulation in buildings; a range of concentrations observed indoors.
- Health effects from exposure to radon.
- Radon and Basic Safety Standards: ICRP publication, MAAE standard, EU Directive, National regulation.
- Practical radiation physics for radon - definitions, quantities, and units.
- Regulation for building protection from radon.
- Radon action plan – goals and activities. Communication strategy.
- Principles of radon detection systems. Requirements for measurements: Traceability, determination of uncertainty, and quality assurance.
- Method for passive radon measurement.
- Method for continued radon measurement.
- Methodology for radon mapping. Result of Bulgarian map.
- Corrective measures on existing buildings – overview and principals.
- Method for measurement of radon in soil gas and permeability.
- Radon potential and radon index of a building site.
- Prevention measures for new buildings – overview and principals.
- Building investigation.

- Building New Homes with Radon-reducing Features.
- Technical requirements of the buildings for radon protection in Bulgaria. Classification of buildings by volume concentration of radon. Preventive and corrective measures and building codes and standardization in different buildings.
- Factors controlling radon in buildings Demonstration with the model.
- Radon-Resistant Construction Basics and Techniques. House Foundation Types. Corrective measures.
- Mitigation of radon, emitting from construction materials in buildings. Mitigation of radon, released from mineral water.
- Specific buildings – schools, kindergarten, sanatoriums. Short-term Actions and Long-term Actions.
- HVAC solutions - sub-slab depressurization installation.
- HVAC solutions - depressurization with the installation of a radon shaft.
- HVAC solutions - ventilation design without a fan.
- HVAC solutions - ventilation design with fan installation.
- HVAC solutions - ventilation with recuperation unit, micro ventilation
- HVAC solutions - house with Comfort ventilation.

The training was held in the hall of the NCRRP, and the lectures and exercises were presented by experts from the NCRRP and Chamber of Engineers in Investment Design. The scientific capacity of the teaching staff is one professor, three associate professors, one PhD doctor, and four MSc. Nine specialists participated as lecturers in the training, as follows 2 doctors, 3 physicists, 3 engineers, and one chemist, as follows:

Associate professor Kremena Ivanova, PhD: „Methodology for preparing a radon map. Results of the Bulgarian radon map“, „Survey of a building to prepare corrective measures“ and „Specific buildings - schools, kindergartens, sanatoriums. Short-term and long-term radon measurements“.

Associate professor Jana Djounova, MD, PhD: „Health effects of radon exposure“ and „Bulgarian National Radon Action Plan - objectives and activities. Communication strategy“.

Associate professor Nina Chobanova, MD, PhD: „Introduction: Radon - a social and medical problem“ and „Radon and basic safety standards: ICRP publication, MAAE standard, EU directive, national legislation“

Professor Ivaylo Banov: „Types of ventilation installations“, „Natural and mechanical ventilation. Operating principle“, „Soil ventilation systems below the contact surface of buildings“, „Systems for ventilation of the contact surface of buildings“ and „Comfortable ventilation“.

Bistra Kunovska, PhD: „Radon - basic facts: mechanisms of penetration and accumulation in buildings; radon variations in buildings“ and „Methods for measuring radon in soil gas and soil permeability“

Todor Yordanov: „Physical quantities and units of measurement. Definitions“ and „Principles of operation of radon measuring devices. Measurement requirements: traceability, uncertainty determination and quality assurance“

Desislava Djunakova: „Sources of radon: rocks under building foundations; building materials; water and gas; outdoor radon levels“, „Passive methods for measuring radon concentration“ and „Direct methods for measuring radon concentration“.

eng. Irena Koleva: „Ordinance on the technical requirements for buildings for the protection of buildings from radon. Classification of buildings by volumetric radon activity“, „Remedial measures for existing buildings - overview and principles. Preventive measures for new buildings - overview and principles“ and „Passive and active measures in specific buildings“.

eng. Stefan Kinarev: „Methodology for the design and implementation of connection connections, elements of underground installations and equipment and access through the contact structure of buildings for protection against radon penetration“ and „Protection of buildings from radon due to gamma radiation from building materials“.

The lectures were provided to the participants of the USB together with the Ordinance on the Protection of Buildings from Radon (book) and information materials on radon. Radon potential and radon index of a construction site. Specific buildings - schools, kindergartens, sanatoriums. Short-term and long-term radon measurements.

The following practical exercises and demonstrations took place during the course:

- A demonstration of radiation monitoring devices of radon and newly purchased apparatus for measuring metrological characteristics of air TESTO 400 with two probes
- Field measurements of radon in soil gas and permeability.

- Participants work in groups on radon case studies – exercises, examples, solutions, and discussion.
- Radon Video films and demonstration of a model for radon pathways.

The TESTO 400 is the universal measuring instrument for parameters Indoor Air Quality which was purchased with project implementation funds. TESTO 400 is high-quality measuring technology, intuitive measurement assistants, versatile documentation options and a comprehensive selection. One probe is for the measurement of air velocity, volume flow, and temperature (TESTO 410 i is a vane anemometer with smartphone operation). The other probe is for measuring humidity and temperature indoors and outdoors.

After completing the course, participants acquired knowledge and skills for:

- Describing the origin of radon and the health risks associated with it;
- Radon measurement and use of measuring devices;
- Working with national and international standards related to radon;
- Application of radon reduction methods in existing buildings and its prevention in new construction.

The training developed and updated the competence of the participants in the field of protecting the population from radon exposure. Seventeen persons participated in the training course as follows: MSc students (4), PhD. students (1), young investigators (4), and specialists in the different fields of construction (8). Course participants were from the capital and the province, for whom hotel accommodation was provided.

The training ended with the distribution of certificates to the participants, prepared by a technical associate of the NCRRP and filling in the feedback of the participants (according to Annex II for an exemplary template).



K. Ivanova, responsible organizer

This partnership has received funding from the European Union's "EURATOM" research and innovation program under the 101061037 grant agreement.