The RADPAR
(Radon Prevention and Remediation) Project.

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Health and Consumers
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11. National Radiation Protection Institute (SURO), Czech Republic
12. Joint Research Centre (JRC), Italy
THE ADVISORY GROUP
i.e. The Collaborating Partners

<table>
<thead>
<tr>
<th>a/a</th>
<th>Name</th>
<th>Organization</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ferid Shannoun</td>
<td>United Nations Scientific Committee on the Effects of Atomic Radiation</td>
<td>Austria</td>
</tr>
<tr>
<td>2</td>
<td>Martha Gruson</td>
<td>Federal Office of Public Health</td>
<td>Switzerland</td>
</tr>
<tr>
<td>3</td>
<td>Jane Bradley</td>
<td>Health Protection Agency</td>
<td>UK</td>
</tr>
<tr>
<td>4</td>
<td>Ollie Seppanen</td>
<td>Technical University of Helsinki</td>
<td>Finland</td>
</tr>
<tr>
<td>5</td>
<td>Luis Quindos</td>
<td>University of Cantabria</td>
<td>Spain</td>
</tr>
<tr>
<td>6</td>
<td>David Fenton</td>
<td>Radiological Protection Institute of Ireland</td>
<td>Ireland</td>
</tr>
<tr>
<td>7</td>
<td>Eduardo de Oliveira Fernandes</td>
<td>University of Porto</td>
<td>Portugal</td>
</tr>
</tbody>
</table>
Background

- Radon is a major contributor to the ionizing radiation dose received by the general population.
- Soil gas infiltration is recognized as the most important source of residential radon.
- Epidemiological studies confirm that radon in homes increases the risk of lung cancer in the general population. The proportion of all lung cancers linked to radon is estimated to lie between 3% and 14%.
- The majority of radon-induced lung cancers are caused by low and moderate radon concentrations rather than by high radon concentrations, because in general less people are exposed to high indoor radon concentrations.

SOURCE: WHO HANDBOOK ON INDOOR RADON, A PUBLIC HEALTH PERSPECTIVE (2009)
Aim of the RADPAR Project

The RADPAR project aims to assist in reducing the significant public health burden of radon related lung cancers in EU Member States (MS).
Project Specific Objectives

• Help improve the strategies that are currently in place and reduce the health burden from radon to the EU population;
• Develop radon risk communication strategies and approaches for different population target groups in the EU;
• Establish measurement procedures for radon control technologies and sources;
• Assess the cost-effectiveness of existing and potential radon prevention and remediation strategies in the EU;
• Design training courses for radon measurement, prevention, remediation, and cost effectiveness analysis;
• Assess the potential conflicts between energy conservation in buildings and radon exposure reduction.
• A MQ was designed and distributed to a wide range of radiation protection authorities and other relevant bodies. Its purpose was to gather information on existing strategies and policies in EU MS;
• The MQ, which is a most important information gathering tool, has primarily been sent to relevant contact persons in all 27 EU MS;
• In order to compare EU approaches with international approaches to radon control, the MQ was also distributed to authorities outside of Europe;
• The IAEA collaboration also used the RADPAR MQ to gather radon information from a number of non EU countries.
Contents of the MQ

• Indoor Radon Surveys
• National Policies on Indoor Radon Control
• Radon Risk Communication Strategies
• Training and Education
• References, Contacts and Any Other Comments
Creation of an EU Radon information web site at JRC linked to the DGSANCO Indoor Air Quality web site that includes a database consisting of radon concentrations, health burden on population, existing standards and control policies

http://web.jrc.ec.europa.eu/radpar/
Meeting of the Experts Group on Indoor Air Quality (IAQ) - Luxembourg 22 October 2012

The European Commission launched a European project on radon prevention and remediation (RADPAR) to reduce the number of lung cancer deaths due to radon exposure in Europe. The project aims to develop a national radon action plan that can be implemented in Member States. The project evaluates 13 different radon prevention and remediation measures to identify the most cost-effective and efficient solutions. It also engages national experts to participate in the development of the national radon action plans. The project provides information on the benefits of radon mitigation and available funding opportunities. It also offers updates on current and future radon action plans.
RADPAR Key Findings/Achievements(1)

• The identification of key points on the prevention and remediation policies on radon and the development of corresponding recommendations to improve such policies;

• In some MS coherent national radon control policies were well developed and long established while in others they were either non-existent or at a very embryonic stage;

• In many MS radon control policies were not very effective. The biggest problems facing the authorities were (1) to encourage the public to test their homes for radon and (2) to remediate their homes if the radon level was found to exceed the national radon. For future dwellings in the EU the situation was more promising;
RADPAR Key Findings/Achievements(2)

• The design, execution and analysis of public radon risk awareness studies in a number of partner countries (Belgium, Czech Republic, Germany, Greece, Norway and Switzerland

• Exhaustive state of the art on building protections against radon and their impact on the energy consumption;

• State of the art of new building characteristics and systems associated with an analysis on their impact on indoor radon exposure;
RADPAR Key Findings/Achievements(3)

• A protocol for the determination of the radon diffusion coefficient for membranes and sealants was proposed. This last protocol has been proposed to be an international standard and is now currently submitted at ISO level (ISO/WD 11665-10 standard).

• Establishment of measurement protocols for radon control technologies
RADPAR Key Findings/Achievements(4)

• The extremely tight building shell of passive houses is a good radon protection
• Mechanically controlled ventilation of dwellings plus tight building shell lead generally to very low radon levels
• Mechanically controlled ventilation with an air-soil heat exchanger may draw radon-laden soil gas directly into the dwelling if pipes in the soil are not tight
• Later modifications of the building shell at the foundation by the occupants (e.g. bore holes) can deteriorate the radon situation of a dwelling significantly.
• Analysis of cost effectiveness and health benefits of radon control strategies.
• The present analysis suggests that basic radon prevention measures, such as installing membranes in all new buildings, are likely to be cost-effective even in settings where the average radon level is quite low.
• Definition of the protocol for the characterisation of materials used on building protection (membranes, sealants).
RADPAR Key Findings/Achievements(6)

• Definition of the frame of courses for professionals training.
• The development of a spreadsheet-based model with sufficient flexibility to permit different MS to evaluate the cost effectiveness of a range of possible radon prevention and remediation strategies.
• Design of a training course to encourage the use of the spreadsheet model.
## Radon levels and Remediation in EU Countries

<table>
<thead>
<tr>
<th>a/a</th>
<th>Country</th>
<th>Indoor Radon concentrations (Bq/m³) (WHO, IAQ)</th>
<th>Action Level (Bq/m³)</th>
<th>Est. number of dwellings exceeding the national Action level</th>
<th>Est. number of buildings already remediated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Austria</td>
<td>99</td>
<td>400</td>
<td>89 000 (2.4%)</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>Belgium</td>
<td>48</td>
<td>400</td>
<td>20 000 (0.39%)</td>
<td>&lt; 1000</td>
</tr>
<tr>
<td>3</td>
<td>Czech Republic</td>
<td>140</td>
<td>400</td>
<td>76 440 (2.08%)</td>
<td>4000</td>
</tr>
<tr>
<td>4</td>
<td>Finland</td>
<td>120</td>
<td>400</td>
<td>59 000 (2.4%)</td>
<td>4500</td>
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<tr>
<td>5</td>
<td>France</td>
<td>89</td>
<td>300 (proposed)</td>
<td>&gt; 1 000 000 (3%)</td>
<td>no data</td>
</tr>
<tr>
<td>6</td>
<td>Germany</td>
<td>49</td>
<td>100 (voluntary)</td>
<td>&gt; 2 000 000 (5%)</td>
<td>no data</td>
</tr>
<tr>
<td>7</td>
<td>Greece</td>
<td>55</td>
<td>400</td>
<td>no data</td>
<td>no data</td>
</tr>
<tr>
<td>8</td>
<td>Ireland</td>
<td>89</td>
<td>200</td>
<td>91 000 (4.7%)</td>
<td>Low</td>
</tr>
<tr>
<td>9</td>
<td>Italy</td>
<td>70</td>
<td>none</td>
<td>902 000 (4.1%) (exceeding 200 Bq/m³)</td>
<td>450</td>
</tr>
<tr>
<td>10</td>
<td>Norway</td>
<td>89</td>
<td>200 (recommended)</td>
<td>162 503 (7.15%)</td>
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<tr>
<td>11</td>
<td>Portugal</td>
<td>62</td>
<td>400</td>
<td>2.6%</td>
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<tr>
<td>12</td>
<td>Spain</td>
<td>90</td>
<td>none</td>
<td>4 % (exceeding 400 Bq/m³)</td>
<td>no data</td>
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<tr>
<td>13</td>
<td>Switzerland</td>
<td>78</td>
<td>1000</td>
<td>50 000-100 000 (1.25-2.5%) (exceeding 400 Bq/m³)</td>
<td>~ 500</td>
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<tr>
<td>14</td>
<td>United Kingdom</td>
<td>20</td>
<td>200</td>
<td>100 000 (0.43%)</td>
<td>15 000</td>
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</table>

Source: RADPAR Deliverable 13.1
### RADPAR : Radon Awareness

<table>
<thead>
<tr>
<th>Country</th>
<th>National Survey Status</th>
<th>Mean Radon Bq/m³</th>
<th>Risk Communication Campaigns</th>
<th>Linked to other Public Health Actions</th>
<th>Radon Awareness Surveys</th>
<th>Estimated Percent Aware of Radon and its Effects</th>
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</thead>
<tbody>
<tr>
<td>Austria</td>
<td>C,PW</td>
<td>102</td>
<td>Y,GP</td>
<td>N</td>
<td>P</td>
<td>0-25%</td>
</tr>
<tr>
<td>Belgium</td>
<td>C,GE+GL</td>
<td>52</td>
<td>Y,GP,D,PG</td>
<td>N</td>
<td>Y,NA,R,M</td>
<td>0-25%</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>P</td>
<td>--</td>
<td>P for GP,D,PG</td>
<td>--</td>
<td>N</td>
<td>--</td>
</tr>
<tr>
<td>Czech Rep</td>
<td>C, GE</td>
<td>118</td>
<td>Y, GP,D,PG</td>
<td>N</td>
<td>Y,NA</td>
<td>50-75%</td>
</tr>
<tr>
<td>Denmark</td>
<td>C,GE,PW</td>
<td>77</td>
<td>Y,GP,PG,NA,R,M</td>
<td>N</td>
<td>--</td>
<td>----</td>
</tr>
<tr>
<td>Estonia</td>
<td>C,GE</td>
<td>102</td>
<td>Y,GP,D,M</td>
<td>N</td>
<td>Y,M</td>
<td>0-25%</td>
</tr>
<tr>
<td>Finland</td>
<td>C,PW</td>
<td>96</td>
<td>Y,GP,D,PG,NA,R,M</td>
<td>N</td>
<td>P</td>
<td>50-75%</td>
</tr>
<tr>
<td>France</td>
<td>C</td>
<td>90</td>
<td>Y,GP,D,PG,R</td>
<td>N</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Germany</td>
<td>C,GE,GL,PW</td>
<td>50</td>
<td>Y,GP,D,PG,NA</td>
<td>N</td>
<td>IP</td>
<td>0-25%</td>
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<tr>
<td>Greece</td>
<td>IP,GE</td>
<td>80</td>
<td>Y,GP,PG,NA</td>
<td>N</td>
<td>Y,M</td>
<td>25-50%</td>
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<tr>
<td>Hungary</td>
<td>IP,GE,GL</td>
<td>93</td>
<td>N</td>
<td>---</td>
<td>N</td>
<td>0-25%</td>
</tr>
<tr>
<td>Ireland</td>
<td>C,GE</td>
<td>89</td>
<td>Y, NA,R,G,P,D</td>
<td>Y</td>
<td>Y, NA, R</td>
<td>75-100%</td>
</tr>
<tr>
<td>Lithuania</td>
<td>C,GL,PW</td>
<td>55</td>
<td>Y,GP,D,PG,NA,R,M</td>
<td>N</td>
<td>N</td>
<td>0-25%</td>
</tr>
<tr>
<td>Malta</td>
<td>P</td>
<td>---</td>
<td>N</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Norway</td>
<td>C,GE,GL,PW</td>
<td>88</td>
<td>Y,GP,D,PG,NA</td>
<td>N</td>
<td>Y,NA</td>
<td>75-100%</td>
</tr>
<tr>
<td>Portugal</td>
<td>C,GE</td>
<td>62</td>
<td>IP,GP,R,M</td>
<td>N</td>
<td>N</td>
<td>0-25%</td>
</tr>
<tr>
<td>Spain</td>
<td>C,GE</td>
<td>82</td>
<td>Y,GP,D,PG,NA,R,M</td>
<td>N</td>
<td>P</td>
<td>0-25%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>C,GE,GL,PW</td>
<td>75</td>
<td>Y,GP,D,PG,NA,R</td>
<td>N</td>
<td>Y,NA</td>
<td>25-50%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>C,R</td>
<td>21</td>
<td>Y,GP,D,PG,NA,M</td>
<td>Y</td>
<td>N</td>
<td>----</td>
</tr>
</tbody>
</table>

**KEY TO TABLE**

Y: Yes, N: No
C: Completed, P: Planned, IP: In Progress
GE: Geographical, GL: Geological, PW: Population Weighted
NA: National, R: Regional, M: Municipal
GP: General Public, D: Decision Makers, PG: Professional Groups
Radon School Measurements in Kozani, Greece within RADPAR

A radon measurement campaign was organized in the 56 public schools of Kozani. In October 2010 a total of 96 passive alpha track diffusion radon detectors (Gammadata type) were installed in these schools and remained there for almost 80 days. Measurement period: October 2010 – December 2010.

Arithmetic Mean = 50.01 Bq/m³
Maximum Value = 195 Bq/m³
Minimum Value = 5 Bq/m³
RADPAR & SINPHONIE Measurements in schools: Comparison

Radon Concentration, Bq/m³

- nh (9/2011-10/2011)
- h (1/2012-2/2012)
- h (10/2010-12/2012)
RADPAR Recommendations

Recommendations on:
1. Radon Policy and Strategy
2. Protocols for Indoor Radon Concentration Measurements
3. Improving Radon Risk Communication
4. Assessment of potential conflicts between energy conservation in buildings and radon exposure reduction
5. Establishment of measurement protocols for radon control technologies
6. Design of training courses for radon measurement, prevention, remediation
7. Analysis of cost effectiveness and health benefits of radon control strategies
Some Recommendations(1)

• A comprehensive strategy (developed with all stakeholders) has to be implemented and coordination with other related programs/activities (cigarette smoking, IAQ, energy saving) should be promoted.

• Unless it is shown to be not cost-effective, the installation of basic radon prevention measures in all new homes should be incorporated into the relevant building codes.

• For existing homes, the cost-effectiveness of radon remediation is strongly influenced by the average radon levels in the target areas, and by the reference level being used.

• Verification of preventive measure effectiveness should be done, by means of long-term (e.g. 1 year) radon concentration measurements, preferably 1–2 years after construction and when the building is normally occupied.
Some Recommendations (2)

• Surveys should be generally designed to be representative of population exposure, and checks of representativeness should be done on the actual sample included in the survey.

• Evaluations of radon distributions and maps should be based on representative data only.

• Radon-prone area can be a useful tool to optimize/prioritize the search for radon levels to be reduced.

• Protection from radon should not be restricted to Rn-prone areas only, especially if they contain a small fraction of the overall population.
RADPAR Publishable Documents

Two publishable documents were specially designed in order to disseminate RADPAR’s key findings and achievements. These are the following:

- RADPAR Final Scientific Report
- RADPAR Recommendation Booklet

Both documents can be downloaded from the RADPAR website’s Knowledge center-> RADPAR results and data at the following link:

http://web.jrc.ec.europa.eu/radpar/knowledge_results.cfm
Concluding Remarks

• Radon Prevention and Remediation is quite limited in the European scale

• There is a need to reduce the overall population risk as well as the individual risk for people living with high radon concentrations.

• It is clear that only a joint European effort can provide the necessary experience and diversity of circumstances to provide an insight into the complex radon problem and in how to deal effectively with it.

• By means of its deliverables and Recommendations it is expected that the RADPAR project will:
  – heighten awareness both of the public and of decision makers of the health burden of radon in the EU and of the technical means available to control radon.
  – transfer information to new and accession MS where radon control strategies are presently almost non-existent.
Thank you for your attention