Radon prevention and remediation in EU countries, RADPAR questionnaire study

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Outline

• Introduction
  – Typical radon remediation and prevention methods used to achieve a reduction of indoor radon concentration ($^{222}\text{Rn}$) in existing houses and in new buildings
  – RADPAR project, Objectives and work packages

• RADPAR Questionnaires

• Results
  – Current radon remediation and prevention status in Europe
    • Number of houses where radon remediation or preventive measures have been applied
  – Reduction efficiency of the remediation and prevention methods
Sub-slab depressurization (SSD)

- Common radon remediation and prevention method
  - Passive SSD: natural ventilation due to stack and wind effects
  - Active SSD: forced ventilation using an exhaust fan
- SSD creates under-pressure under the floor slab and lowers the soil air radon concentration
- In new construction: suction pit replaced by radon piping (network of flexible perforated pipes)
Improving ventilation

• Can be effective if the initial state of the house ventilation is poor
• Possible actions in living spaces
  – Opening or adding supply air vents
  – Increasing air change of the mechanical ventilation system
• Under-pressure in the house should be small
• Improving ventilation in cellar or in crawl space also common
Sealing entry routes

• Typical entry routes from the ground
  – cracks, gaps, holes and pipe penetrations in the floor slab and in the walls in contact with soil
  – For slab-on-ground foundation, most important: gap in the joint of floor slab and foundation wall due to drying shrinkage of the concrete
• Complete sealing often very demanding
• Easier in new construction than in old houses
RADPAR project

• Radon prevention and remediation (RADPAR), 2009-2012
• Partners from 14 countries
  – 11 Associate Partners and 7 Collaborative Partners
• Website: http://web.jrc.ec.europa.eu/radpar/index.cfm
  (or google RADPAR)
• Funding from the EU in the framework of the Health Programme
  – Executive Agency for Health and Consumers (EAHC or DG SANCO)

• **General objective**: to assist in reducing the significant public health burden of radon related lung cancers in EU Member States
RADPAR Work packages

WP 1: Coordination of the project
WP 2: Dissemination of the results
WP 3: Evaluation of the project
WP 4: Developing *policies and strategies* to promote effective radon prevention and remediation
WP 5: Establishment of an EU radon *risk communication* network
WP 6: Assessment and harmonization of *radon control technologies* in Member States
WP 7: Analyses of *cost-effectiveness* and health benefits of radon control strategies
RAPDAR WP 6 Objectives

• Assessment of potential conflicts between energy conservation in buildings and radon exposure reduction
  – Analyses and assessment of current techniques/technologies
    • reduction efficiency
    • potential impact on energy consumption (qualitative)
  – Examination of the potential for conflict or links between radon control technologies and energy conservation in standard, climatic/passive and low energy consumption house technologies

• Establishment of measurement protocols for radon control technologies

• Design of training courses for radon measurement, prevention, remediation, and cost effectiveness analysis

Topic of this presentation
Questionnaire

- A questionnaire was prepared in order to gather national information about the current remediation and prevention techniques
- Sent to all RADPAR partners
- Responses with varying amount of information

- Summary report of the questionnaire study
  “Assessment of current techniques used for reduction of indoor radon concentration in existing and new houses”
  – publication 2011
Questionnaire

- Status of radon control in each country
  - Action and target levels of radon concentrations
  - Number of dwellings exceeding the action level
  - Number of dwellings already remediated
  - Estimated number of houses with preventive measures

- Remediation and Prevention methods
  - Radon reduction factor
  - Potential impact on energy consumption (qualitative information)

- References to guides, brochures, research reports, website links, other relevant documents
## Status of the radon remediation

<table>
<thead>
<tr>
<th>Country</th>
<th>Action level (Bq/m³)</th>
<th>No. of dwellings (in low rise residential and apartment buildings)</th>
<th></th>
<th>Exceeding</th>
<th>Remediated</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>Exceeding</td>
<td>Remediated</td>
<td></td>
</tr>
<tr>
<td>Austria</td>
<td>400</td>
<td>3 700 000</td>
<td>89 000 (2.4 %)</td>
<td>25 (0 %)</td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>400</td>
<td>5 040 000</td>
<td>20 000 (0.4 %)</td>
<td>1 000 (5 %)</td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>400</td>
<td>3 840 000</td>
<td>76 000 (1.9 %)</td>
<td>4 000 (5.3 %)</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>400</td>
<td>2 450 000</td>
<td>59 000 (2.4 %)</td>
<td>4 500 (7.6 %)</td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>400</td>
<td>5 630 000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>400</td>
<td></td>
<td>2.6 %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>300*</td>
<td>32 760 000</td>
<td>969 000 (3 %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>200</td>
<td>1 930 000</td>
<td>91 000 (4.7 %)</td>
<td>low number</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>200**</td>
<td>22 000 000</td>
<td>902 000 (4.1 %)</td>
<td>450 (0 %)</td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>200</td>
<td>2 270 000</td>
<td>162 500 (7.1 %)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>200</td>
<td>23 000 000</td>
<td>100 000 (0.4 %)</td>
<td>15 000 (15 %)</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>100</td>
<td>39 900 000</td>
<td>1 930 000 (4.8 %)</td>
<td>1 000 (0.1 %)</td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>1 000</td>
<td>4 000 000</td>
<td>7 500 (0.2 %)****</td>
<td>500 (6.7 %)</td>
<td></td>
</tr>
</tbody>
</table>

* FR: regulations only for public buildings, regulations for existing dwellings in preparation.
** IT: no official value, recommendation 200 Bq/m³.
*** NO: 427 000 (18.8%) exceeding the target level of 100 Bq/m³.
**** CH: 75 000 (1.9%) of dwellings exceeds 400 Bq/m³.
### Radon reduction factors, remediation

<table>
<thead>
<tr>
<th>Remediation method</th>
<th>Reduction factor (%)</th>
<th>Summary</th>
<th>AT</th>
<th>BE</th>
<th>CZ</th>
<th>FI</th>
<th>FR</th>
<th>IT</th>
<th>NO</th>
<th>CH</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub-slab depressurization</strong></td>
<td>60-95</td>
<td>80</td>
<td>90</td>
<td>85-95</td>
<td>65-95</td>
<td>89</td>
<td>60-95</td>
<td>50-95</td>
<td>90</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td><strong>Improving natural ventilation in living spaces</strong></td>
<td>10-50</td>
<td>&lt; 30</td>
<td>15-55</td>
<td>49</td>
<td>10-50</td>
<td>33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Improving mechanical ventilation in living spaces</strong></td>
<td>10-60</td>
<td>5-55</td>
<td>61</td>
<td>20-95</td>
<td>10-20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Replacing the existing natural room air ventilation by a mech. exhaust ventilation</strong></td>
<td>10-40</td>
<td>15-45</td>
<td></td>
<td></td>
<td>10-20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Installation of a new mech. supply and exhaust ventilation with heat recovery system</strong></td>
<td>30-60</td>
<td>60</td>
<td>30-60</td>
<td>30-65</td>
<td>10-80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Improving ventilation in cellar</strong></td>
<td>20-60</td>
<td>50</td>
<td>25-50</td>
<td>20-55</td>
<td>47</td>
<td>60-90</td>
<td>10-50</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Decreasing under-pressure</strong></td>
<td>20-70</td>
<td>50</td>
<td></td>
<td></td>
<td>10-50</td>
<td>25</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sealing entry routes</strong></td>
<td>10-60</td>
<td>10</td>
<td>10-40</td>
<td>10-55</td>
<td>55</td>
<td>10-60</td>
<td>25</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Improving crawl space ventilation</strong></td>
<td>40-60</td>
<td>50</td>
<td></td>
<td>40-65</td>
<td>47</td>
<td>60-90</td>
<td>10-80</td>
<td>75</td>
<td>47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition: other methods + typical combinations: 8 + 9 responses.
## Radon prevention, status

<table>
<thead>
<tr>
<th>Country</th>
<th>Target level (Bq/m³)</th>
<th>Number of dwellings***</th>
<th>In total</th>
<th>With prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>200</td>
<td>3 700 000</td>
<td></td>
<td>15 (0 %)</td>
</tr>
<tr>
<td>Belgium</td>
<td>200</td>
<td>5 040 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>200</td>
<td>3 900 000</td>
<td></td>
<td>210 000 (5,5 %)</td>
</tr>
<tr>
<td>Finland</td>
<td>200</td>
<td>2 450 000</td>
<td></td>
<td>60 000 (2,4 %)</td>
</tr>
<tr>
<td>Greece</td>
<td>200</td>
<td>5 630 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>200</td>
<td>1 900 000</td>
<td></td>
<td>699 000 (36,1 %)*</td>
</tr>
<tr>
<td>UK</td>
<td>200</td>
<td>23 000 000</td>
<td></td>
<td>Not known **</td>
</tr>
<tr>
<td>Portugal</td>
<td>400</td>
<td></td>
<td></td>
<td>a few</td>
</tr>
<tr>
<td>Switzerland</td>
<td>400</td>
<td>4 000 000</td>
<td></td>
<td>5 000 (0,1 %)</td>
</tr>
<tr>
<td>Germany</td>
<td>100</td>
<td>39 900 000</td>
<td></td>
<td>1 000 (0 %)</td>
</tr>
<tr>
<td>Norway</td>
<td>100</td>
<td>2 270 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>-</td>
<td>32 800 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td>-</td>
<td>22 000 000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* This is the number of dwellings built since 1998 when the law was enacted
** UK: guidelines for radon prevention since 1991
*** In low rise residential and apartment buildings
### Radon reduction factors, prevention

<table>
<thead>
<tr>
<th>Prevention method</th>
<th>Reduction factor (%)</th>
<th>Summary</th>
<th>CZ</th>
<th>FI</th>
<th>NO</th>
<th>PT</th>
<th>CH</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive sub-slab depressurization</td>
<td></td>
<td>20-50</td>
<td>30-50</td>
<td>0-20</td>
<td>20-50</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active sub-slab depressurization</td>
<td></td>
<td>70-95</td>
<td>70-90</td>
<td>70-95</td>
<td>40-70</td>
<td>95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radon proof insulation, membrane below floor slab</td>
<td></td>
<td>30-70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Radon proof insulation, membrane above floor slab</td>
<td></td>
<td>30-70</td>
<td>30-70</td>
<td>0-90</td>
<td>30-60</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Sealing the joint of floor slab and foundation wall using membranes</td>
<td></td>
<td>30</td>
<td></td>
<td>0-90</td>
<td>30-60</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sealing the lead-throughs in structures with soil contact</td>
<td></td>
<td>50</td>
<td></td>
<td>0-90</td>
<td>30-60</td>
<td>50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition: Other methods + typical combinations: 5 + 4 responses.
Conclusion

• Active sub-slab depressurization most efficient remediation and prevention method
  – reduction of radon concentration by 60 - 95 %
  – passive system: up to 50 % reduction
• Other methods less efficient, typically < 60 %
  – improving ventilation and sealing

• Particularly research data on current situation of radon prevention is currently still quite inadequate (i.e., the number of houses with preventive measures and the efficiency of the prevention measures)
• Assessment of the techniques and also the surveys aiming at exploring the impact of remedial and preventive measures is greatly needed in order to promote the work at national level in Europe

Report available at:
- www.stuk.fi, Publications
- RADPAR website
Acknowledgements

- This presentation arises from the project “Radon prevention and remediation” (RADPAR) which has received funding from the European Union, in the framework of the Health Programme

  – Executive Agency for Health and Consumers, EAHC, DG SANCO

Remember RADPAR website (type RADPAR in Google):
Acknowledgements, Questionnaire responses

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