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A nationwide radon survey in Finland – prevention in new construction.

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Aim

Exploring the prevalence and efficiency of preventive measures in houses constructed in 2006 - 2008

Background

EU countries

- research on the status of radon prevention is still quite inadequate
- many countries require radon prevention in new construction
- representative surveys on the prevalence and efficiency are lacking

- Reference: RADPAR (Radon Prevention and Remediation, EU DG SANCO) final reports

Radon in Finland

Reference values for radon concentration

- **new construction 200 Bq/m^3**
- **existing dwellings 400 Bq/m^3**

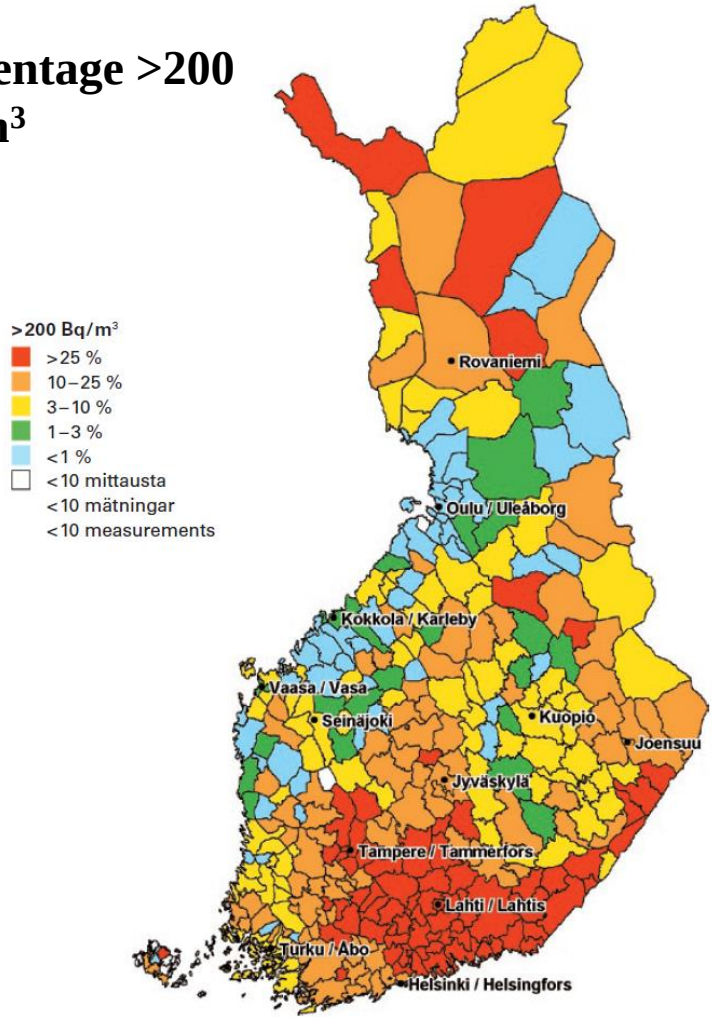
Previous nationwide random sample survey 2006

- **15.1 % (204.000) of low-rise residential houses > 200 Bq/m^3**
- **nationwide average**

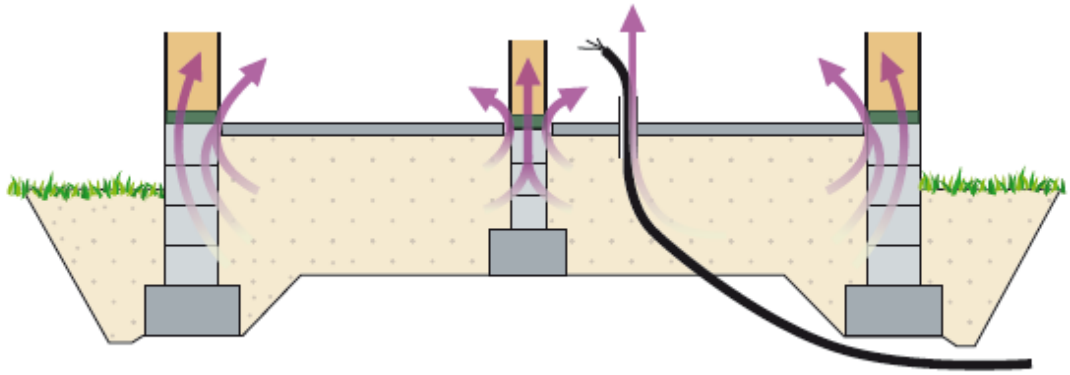
- all dwellings 96 Bq/m^3

- low –rise houses 121 Bq/m^3

Percentage >200 Bq/m^3



Entry routes, slab on-ground

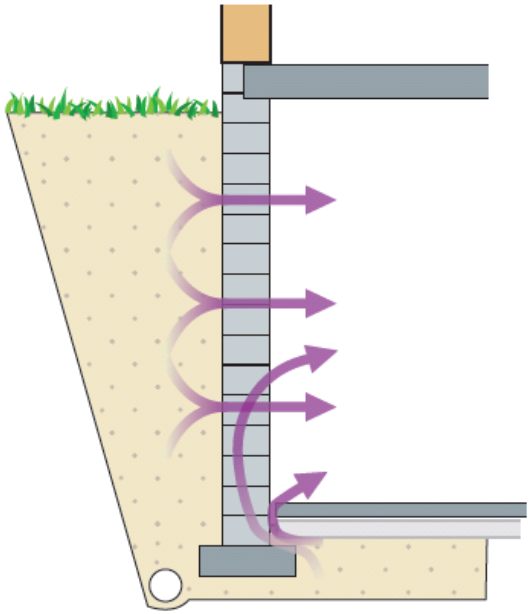


- **Prevalent type of foundation in Finland**
- **Gap between foundation wall and floor slab**
- **Permeable light weight concrete blocks increase air flows**
- **Non-sealed pipe penetrations**

Entry routes

Basement or semi- basement

Light-weight concrete blocks in non-sealed walls promote air-flows



Regulations, key changes in 2003 -2004

New guide for radon prevention in 2003

- **Use of a strip of bitumen felt for sealing**
- **Installation of radon piping (as already in the previous 1996 guide)**

New building code for foundations in 2004

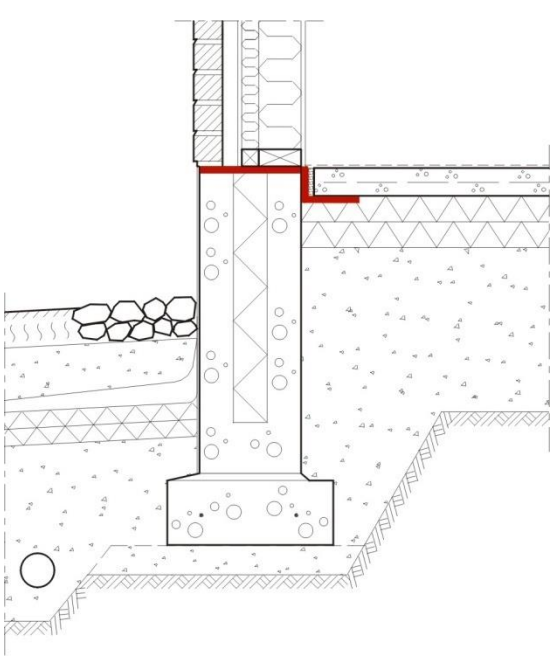
- **In the design and construction work, radon risks at the construction site shall be taken into account**
- **Radon-technical design documents are required**

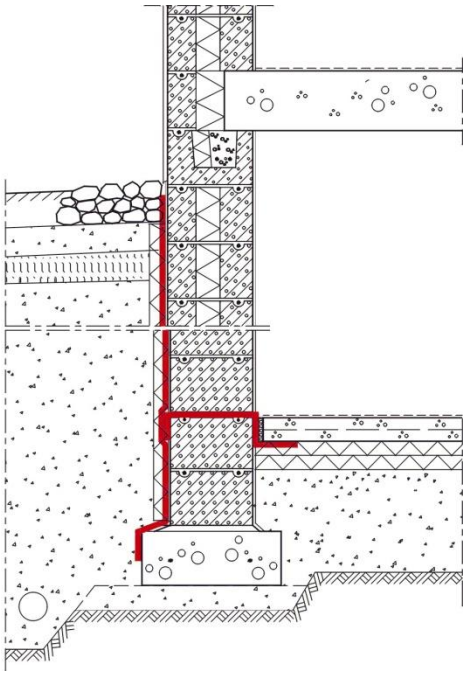
Radon resistant new construction, guideline

Sealing of slab-foundation wall joint and walls in contact with soil

Polyesther-reinforced bitumen felt

- **cast in direct contact with bitumen felt at least 15 cm**



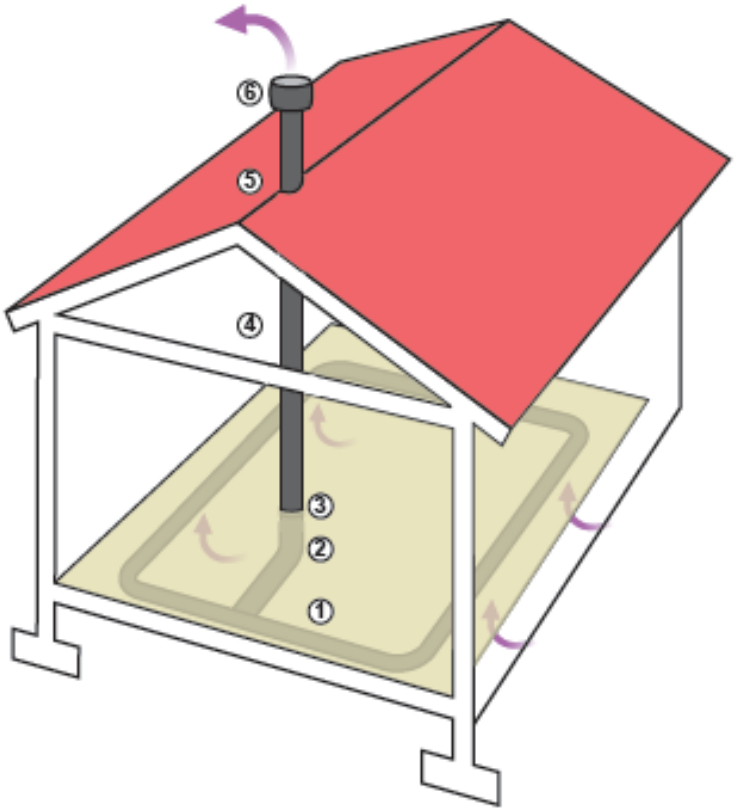


Figures from Guide RT 81-10791

Installation of bitumen felt

Radon resistant new construction, guideline

- **Install a passive piping system: discharge open above roof**



Install a radon fan when radon concentration

> 200 Bq/m^3

New construction survey 2009

Radon concentration was measured in 1561 randomly chosen dwellings (low-rise houses)

- **Building permission given in 2006**
- **Notice of removal before November 2008**
- **Houses completed in 2006 - 2008**
- **Single family houses, pair houses, terraced houses**

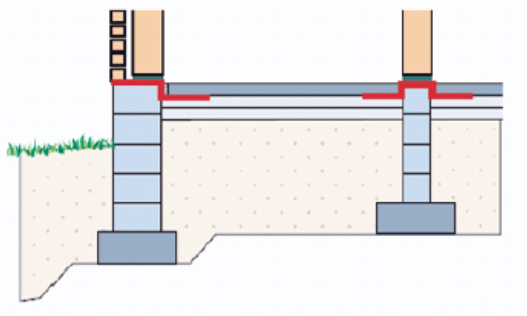
New construction survey 2009

- **Original sample 3000 dwellings**
- **7% of dwellings in low-rise houses that received building permission in 2006**
- **Positive reply 62%, received radon dosemeters**
- **Final participation 52 %**
- **Two months measurements in March - May 2009**

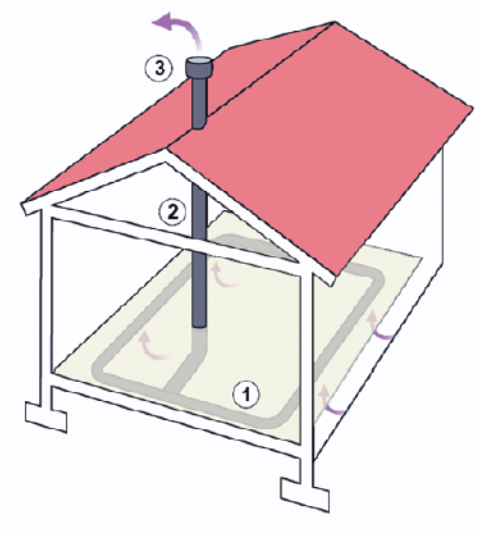
New construction survey 2009

- **Standard radon measurement questionnaire + special radon prevention questionnaire with figures**

Sealing work carried out?



Radon piping installed?



Results, foundation and radon

Slab-on-ground, prevalent type of foundation

- **remarkable progress in radon prevention**

Highest concentrations

- **houses with semi-basement and basement, average 161 Bq/m^3 median 97 Bq/m^3**
- **main reason: defective measures for radon prevention in the block walls in contact with soil**

Lowest concentrations, rare foundation types

- **houses with crawl space, median 29 Bq/m^3**
- **houses with a monolithic floor slab, median 27 Bq/m^3**

Results

- **Preventive measures were taken**
  - **in 92 % of houses in six provinces with highest radon concentration (Area 1)**
  - **in 38 % of houses elsewhere in the country (Area 2)**
  - **in 54 % of houses, whole country**

- **Average radon concentration 95 Bq/m^3, median 58 Bq/m^3**

- **Percentage exceeding 200 Bq/m^3**

- 200 Bq/m^3	**10.6%,**	**previous nationwide survey**	**15.8%**
- 400 Bq/m^3	**2.1%**		**3.8%**

Results

Radon reduction compared with houses completed in 2000-2005 (previous nationwide survey in 2006)

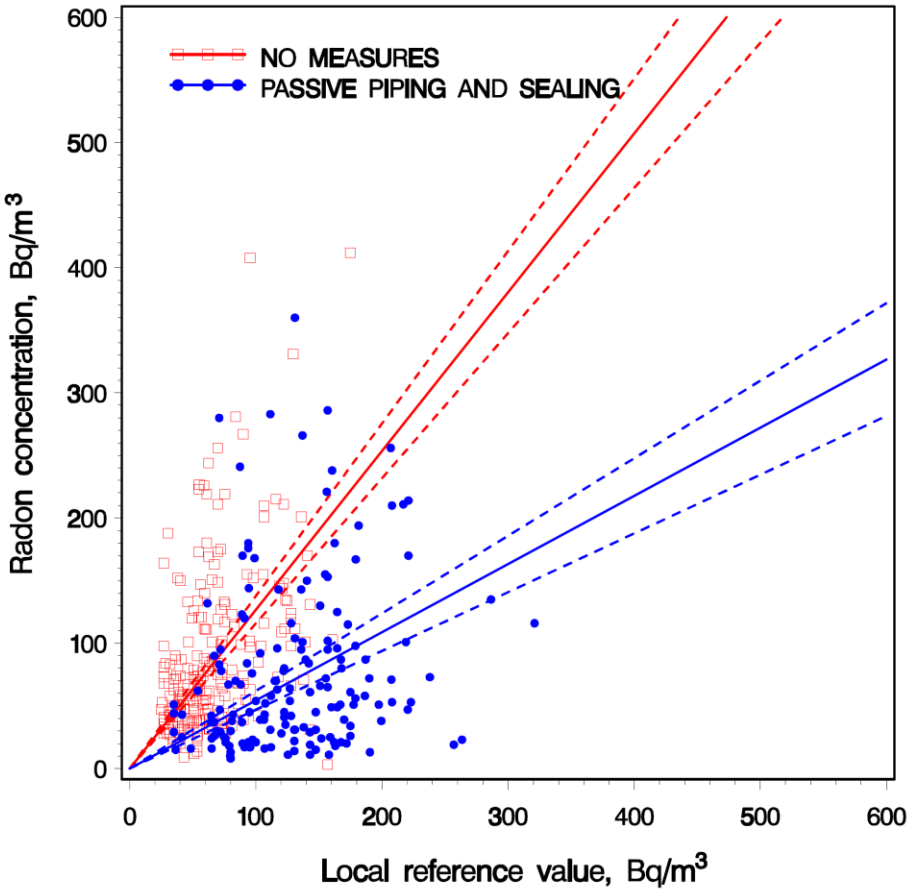
- **47% in area 1 (high radon provinces)**
- **26% in area 2 (elsewhere)**
- **33% whole country**

Radon reduction compared with houses with no prevention measures (slab-on-ground)

- **passive radon piping and sealing 57%**
- **passive radon piping without sealing 41%**

Effect of preventive measures

Radon concentration in houses with slab-on-ground and local reference values.



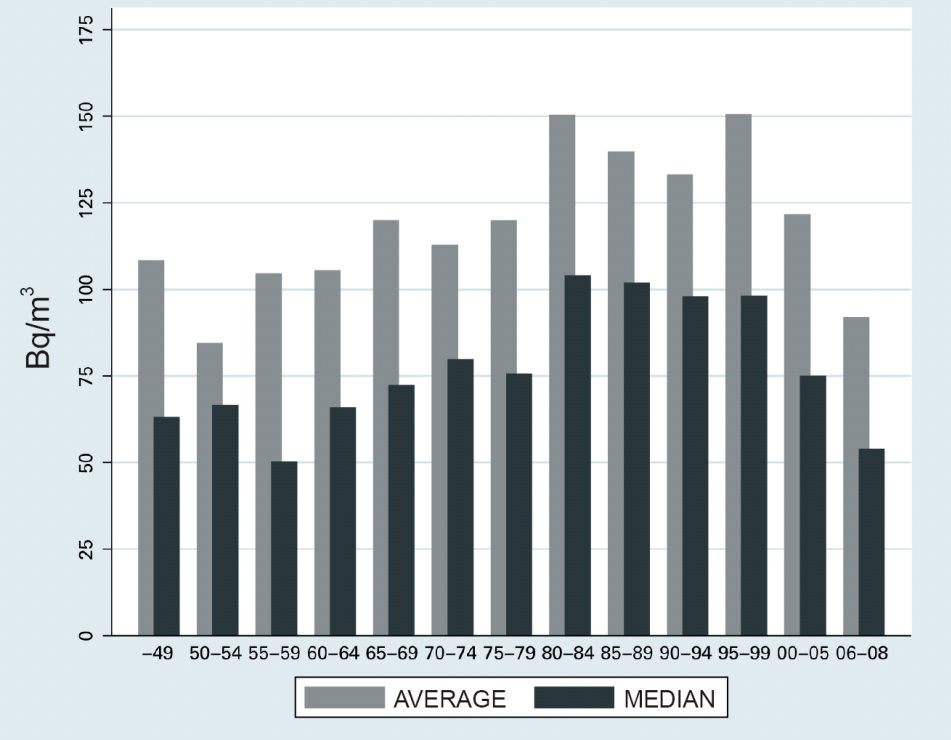
Regression lines are fitted for houses

- **without preventive measures**
- **with passive radon piping and sealing carried with a strip of bitumen felt**
- **local reference data is based on the STUK data base, 87.000 low-rise houses**

New construction survey 2009

Decreasing trend in radon concentration grouped by year of construction . Results of 1949 – 2005 are based on the Nationwide sample survey 2006 (STUK-A242, Mäkeläinen et al. 2009).

The last bar (2006-2008) represents the results of the new construction study.



Challenges

- **Widespread and skilled implementation of preventive measures throughout the country**

- **Sealing of pipe penetrations**

- **Sealing measures for block walls in contact with soil**

- **Increased use of foundation types with typically lower radon concentrations instead of slab-on-ground foundation**

Conclusions

- **The building code and prevention guidelines were revised in 2003 - 2004**

- **Nationwide prevention activity increased to 54%**

- **Reduction in radon concentrations of 33%, in provinces of highest concentration 47%**

- **The present prevention strategy provides a good basis for further work**

- **Directed random sample surveys provide an excellent tool for prevention studies**

Thank you

Reference

Arvela H., Holmgren O., Reisbacka H. (2011) Radon prevention in new construction in Finland: A Nationwide sample survey in 2009. Radiation Protection Dosimetry 2011; doi: 10.1093/rpd/ncr192.

www.stuk.fi www.radon.fi