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The Federal Department of Home Affairs FDHA  
**Federal office of public health FOPH**  
Consumer Protection and Healthcare Professions Directorate

# Prioritization of Radon Remediation in Existing Buildings

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## References for Radon Protection

<b>Legislation:</b>		
Total revision 2018:	<b>Radiological Protection Ordinance (RPO)</b>	Federal Council (= Swiss government)
	Technical ordinances (e.g. training, dosimetry)	Federal Department of Home Affairs (= Ministry of health)
<b>Recommendations / Strategy:</b>		
New since 2018:	<b>Radon Guidelines</b>	Federal Office of Public Health
New since 2021:	Action plan radon 2021-2030	





## Existing Exposure Situations (RPO)

**Risk-based graded approach**  
(proportionality principle)

**Optimisation**

*inappropriate*

**Reference level:**

- NORM/legacies: **1 mSv/year**

- Indoor radon: **300 Bq/m<sup>3</sup>** (annual average)

**Dose  
avoided**

**Optimisation**

*appropriate*

**Residual  
dose**



# Reference Level (General Population)

## RPO:

**Reference Level 300 q/m<sup>3</sup>**  
(annual average)

Rooms where people are regularly present for several hours per day

Dwellings

Workplaces  
(in buildings)

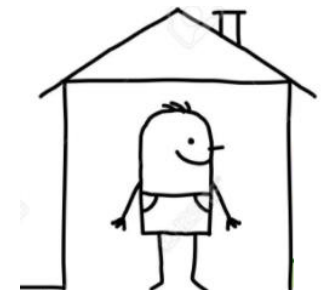
Schools/Nurseries

## Cantonal Authorities:



**Responsibility:**  
Building owner

**Swiss Code of Obligations**  
(tenants)





## Threshold Value (Workers)

### RPO:

**Threshold value 1000 Bq/m<sup>3</sup>**  
(annual average)



**Estimation of effective dose for worker**



**If >10 mSv/year :**  
→ Protection measures or  
→ Transition to planned exposure situation (dose limit 20 mSv/year)

### Authority:

Supervisory authorities for radiation protection (e.g. Suva in the field of industry)

### Responsibility: Employer

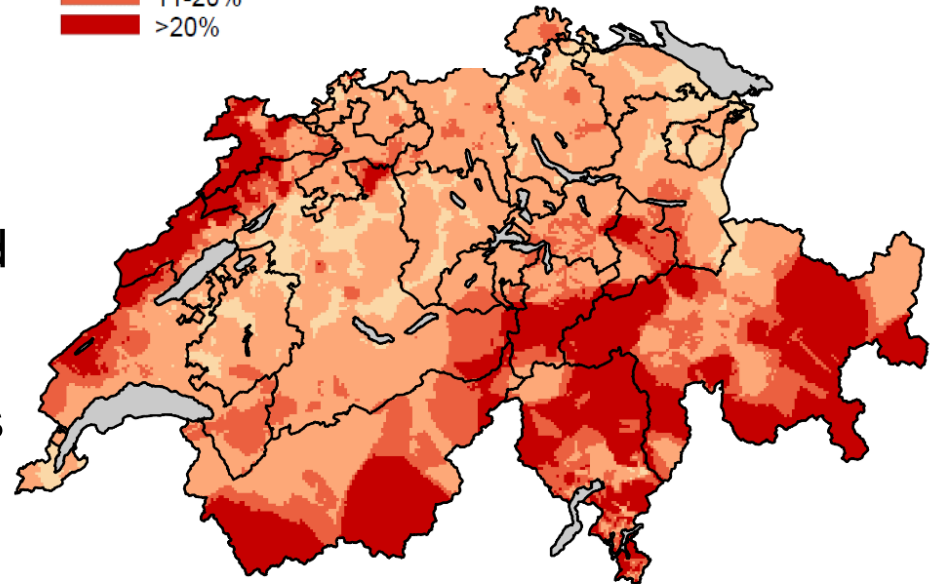
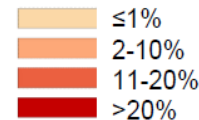




## Radon Measurements and Prevention

- Since the 1990s radon measurements have been carried out in about 150'000 buildings (6% of all buildings in Switzerland)
- About 10% of the measured buildings exceed RL
- RPO: Preventive measures for new/renovated buildings in the entirety of Switzerland

Probability of exceeding RL  
of 300 Bq/m<sup>3</sup> :



→ **Reasonable compromise**



# Radon Remediation

## RPO:

- If the RL is exceeded, the building owner shall take the necessary remedial measures
- Recommendations concerning the urgency of remedial measures shall be provided by the FOPH and the cantons  
→ **Radon guidelines Tolerability**
- If the building owner fails to take action, the canton may order radon remediation
- The building owner pays the remediation costs



# Recommendations : Urgency of Remedial Measures

## Remediation deadlines:

Measured radon concentration	Room with long occupancy duration	Room with short occupancy duration	Unoccupied room
>300-600 Bq/m <sup>3</sup>	10 years	30 years	No measures required
>600-1000 Bq/m <sup>3</sup>	3 years	10 years	
>1000 Bq/m <sup>3</sup>	3 years	3 years	

Reference: Radon guidelines





## Calculation Model

**Goal:** Ensure that remediation deadline does not lead to an additional exposure of  $300 \text{ Bq/m}^3$  (above RL) over 3 years.

**Otherwise: not acceptable**

Tolerance value (model) :  $6.3 \times 10^6 \text{ Bqhm}^{-3}$

### Justification:

- Calculation model corresponds to a cumulated effective dose over 3 years of  $\sim 70 \text{ mSv}$  (ICRP 115) or  $\sim 80 \text{ mSv}$  (ICRP 137)
- Cumulative effective dose remains  $< 100 \text{ mSv}$  (ICRP-approach)
- Conformity with the limit value for an occupationally exposed person ( $20 \text{ mSv/year}$ )



## Calculation Model

Remediation deadline [years]

$$D_R = \frac{6.3 \times 10^6 \text{ Bqhm}^{-3}}{[OT \times (Rn_c - 300)]}$$

Occupancy time [hours/week] × 52 weeks

Radon concentration before remediation [Bq/m<sup>3</sup>]

Reference level [Bq/m<sup>3</sup>]

Tolerance value (model)



# Calculation Model

## Occupancy time **OT** :

Definition of “rooms where persons are regularly present for several hours per day” (RPO)

3 categories :

	Room with <b>long</b> occupancy time	Room with <b>short</b> occupancy time	Unoccupied room
<b>Occupancy time</b>	>30 hours/week	15-30 hours/week	<15 hours/week

Reference: Radon guidelines



# Calculation Model

## Calculation of the Remediation Deadline [years]:

Measured radon concentration [Bq/m <sup>3</sup> ]		Room with <b>long</b> occupancy time (Range >30-168 hours/week)	Room with <b>short</b> occupancy time (Range >15-30 hours/week)
		100 hours/week	30 hours/week
Range >300-600	450 Bq/m <sup>3</sup>	8.1 years	26.9 years
Range >600-1000	800 Bq/m <sup>3</sup>	2.4 years	8.1 years
Range >1000-3000	2000 Bq/m <sup>3</sup>	0.7 years	2.4 years

representative value for each range



# Calculation Model

## Adjustment of the Remediation Deadline [years]:

Measured radon concentration (Bq/m <sup>3</sup> )		Room with <b>long</b> occupancy time (Range >30-168 hours/week)	Room with <b>short</b> occupancy time (Range >15-30 hours/week)
		100 hours/week	30 hours/week
Range >300-600	450 Bq/m <sup>3</sup>	10 years	30 years
Range >600-1000	800 Bq/m <sup>3</sup>	3 years	10 years
Range >1000-3000	2000 Bq/m <sup>3</sup>	3 years	3 years

Time needed to plan and execute the remediation

Periodicity of major building renovations



# Recommendations : Urgency of Remedial Measures

## Remediation deadlines:

Measured radon concentration	Room with long occupancy duration	Room with short occupancy duration	Unoccupied room
>300-600 Bq/m <sup>3</sup>	10 years	30 years	No measures required
>600-1000 Bq/m <sup>3</sup>	3 years	10 years	
>1000 Bq/m <sup>3</sup>	3 years	3 years	

Reference: Radon guidelines

## Revision of the Radon guidelines



# Reasonableness

## Basic Principles:

### Moderated State Intervention:

- Information during building permission procedure
- Promoting synergies with other renovation works / real estate transactions, ...
- Decision tools for the population
- Training of building professionals

### Individual responsibility (private sphere)

**Responsibility of construction industry** : comply with building standards



# Tolerability

## Basic Principle:

### State Intervention if Situation not Tolerable (Unacceptable):

- Cantons orders a radon remediation within 3 years if the RL of 300 Bq/m<sup>3</sup> is exceeded in **schools/nurseries**
- RPO sets specific protection measures for **workers** if threshold value of 1000 Bq/m<sup>3</sup> is exceeded
- Cantons should order a radon remediation if a building owner doesn't respect the deadline according to the "Radon guidelines"

### Swiss Code of Obligations (rented buildings) :

The situation of tenants living in dwellings with a radon concentration above 300 Bq/m<sup>3</sup> over the long term is not tolerable either (see "Radon guidelines")





## Still some Open Questions....

1. How to deal with situations where the canton remains inactive?
2. How to deal with extreme situations in the private sphere (e.g. family with children living in a house with  $>3000$  Bq/m<sup>3</sup>)?
  - Enforce immediate remedial measure?
  - Declaration of insalubrity and evacuation?
3. Is there a need for financial support from the state?

**Thank you for your attention!**  
**[www-ch-radon.ch](http://www-ch-radon.ch)**