



Action to reduce radon exposure at workplaces and in buildings with public access



Janez Marinko
Swedish Work Environment Authority

Regulating Governmental Authorities

Work Environment Act



**Swedish Work Environment
Authority**



All work factors



Radon



Workers

Radiation Protection Act



**Swedish Radiation Protection
Authority**



All radiation



Radon



General public

Workplaces with high Rn-concentration

- Mining (no public access)
 - water ingress/leak in shafts
- Water purification plants (no public access)
 - large volumes of water
- Churches (public access)
 - ridge
- Underground facilities like archives, storage, tunnels
 - short exposure
- Buildings with poor ventilation
 - radon from ground

Derivation of limit values Rn_{lim} for radon

- Starting point
 - The effective dose for ionizing radiation under 1 year = 20 mSv
 - ICRP Publication 103 (2007): 12 mSv/WLM for workers
 - A very rude approach, better wanted...

$$Rn_{lim} = B_{Rn} \cdot T = D \cdot c / (F \cdot K_{ICRP})$$

Where

B_{Rn} = radon concentration [Bq/m³]

T = radon exposure time [h]

D = effective dose [mSv]

c = constant = 170 · 3740 [h Bq/m³]

F = equilibrium factor

K_{ICRP} = ICRPs "dose conversion factor" = 12 mSv/WLM for workers

Bq/m³ versus Rn_{lim}

Limit values for Rn are given as total exposure over the course of 1 year

$$\sum_i B_i \times t_i \leq Rn_{lim}$$

where

Rn_{lim} = limit value for a given exposure situation [Bq h/m³]

B_i x t_i = ith exposure at Rn-concentration B_i during time t_i

Limit values for workers

SWEA (Swedish Work Environment Authority)

Limit values for radon in workplaces are stated in SWEAs ordinance

Occupational Exposure Limit Values (AFS 2011:18)

The Work Swedish Environment Authority's provisions and general recommendations on occupational exposure limit values

(available in English at www.av.se)

Underground work – no public access

- Underground work = rock and mining work, building work or similar which is carried out underground.
- May not exceed $Rn_{lim} = 2.1 \times 10^6 \text{ Bq h/m}^3$ @ annual working time=1600 h
 - Derived from 20 mSv
- Value is equivalent to an exposure of approximately 1300 Bq/m^3
- Sanction charges if Rn is not measured at least once a year
 - 40 000 SEK up to 400 000 SEK

Underground work – generally no public access

- Underground work = prepared and furnished rock shelters, facilities built into the rock, premises and similar, tunnels
- May not exceed $Rn_{lim} = 0.72 \times 10^6 \text{ Bq h/m}^3$ @ annual working time=1800 h
- Value is equivalent to an exposure of approximately 400 Bq/m^3

Other work – with public access

- May not exceed $Rn_{lim} = 0.36 \times 10^6 \text{ Bq h/m}^3$ @ annual working time=1800 h
- Value is equivalent to an exposure of approximately 200 Bq/m^3
- Value in line with recommendations for general public in Sweden

How to measure radon

Determination of radon concentration should be carried out in accordance with the Swedish Radiation Safety Authority's method describing procedures for the measurement of radon in workplaces.

Measurements in two-step

- Long-term measurements ($t > 2$ months, winter-season)
- Follow-up measurements if “positive”
 - Electret -> more than 5 working days
 - Film -> more than 8 working days

FAQ on radon exposure

- We have measured $X \text{ Bq/m}^3$, where $X > \text{limit value}$
 - Can we work there?
 - For how long?
 - How can we reduce the radon-concentration?
 - Close down the workplace?
 - Is there some sort of PPE?
 - We have been exposed to X for Y time, should we
 - Be worried?
 - Go to doctor?
 - Demolition of "blå betong" (blue concrete)

Example from mining

Present limit values of 1300 Bq/m³

1 ventilation system 150 m³/s

In one mining facility

11 systems required

New reference level of 300 Bq/m³

11 x 4 such systems

Investment cost: 200 – 250 million EURO

Annual operating cost: 30 – 40 million EURO

Challenges

- Risk-communication
 - Collective risk vs individual dose
- Risk-assessment
 - Radon is sometimes forgotten as a risk in risk-assessment
- What is dose?
- Radon in mines
 - The present limit values for Rn in mines are not "impossible"
 - Reduction to 300 Bq/m³ will put a heavy economical burden on the mining industry
- Non-stationary workers
 - Difficult to monitor Rn-exposure