Radon

The effect of retrofitting thermal insulation

Schweizerische Eidgenossenschaft
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Swiss Confederation

Federal Department of Home Affairs DHA
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Baden-Württemberg
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AGES

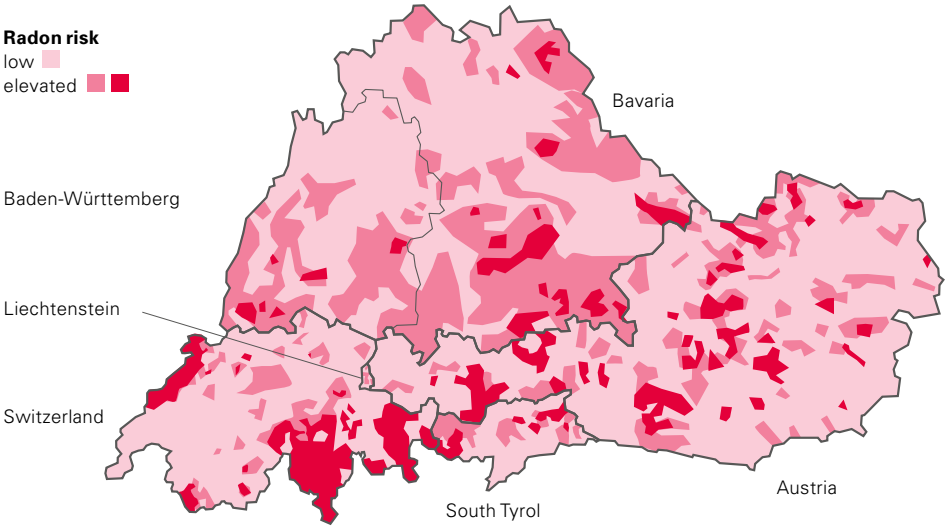
Properties, occurrence and effect of radon

Properties and occurrence

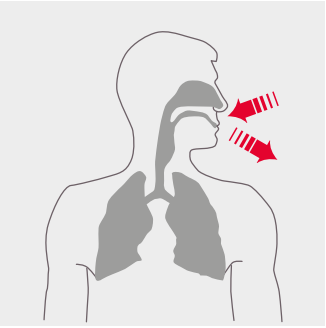
Radon is a natural, ubiquitous radioactive noble gas that is colourless, odourless and tasteless. It is a decay product of the radioactive heavy metal uranium, which is found in soil and rocks. Radon can escape relatively easily from soil and rocks, from where it spreads through gas in the soil or in dissolved form in water. In the process it can also penetrate the air inside buildings.

The radon potential maps and radon risk maps that have been produced for some countries will give you initial information about the likelihood of elevated radon concentrations being present inside buildings in your region.

The illustration below is a greatly simplified representation of the radon risk regions in Austria, southern Germany, South Tyrol, Liechtenstein and Switzerland.



More detailed information about radon can be found on the websites hosted in the individual countries. The relevant internet addresses are given on the back of this brochure.



Effect on health

Radon and its decay products are the second most common cause (approx. 10%) of lung cancer after smoking (approx. 85%).

Most of the radon gas inhaled in air is exhaled again straight away. The biggest risk to health is therefore not the radioactive noble gas radon itself, but its short-lived decay products – which are also radioactive heavy metals. The free decay products in the air inside rooms attach to particles floating in the air (aerosols).

When a person breathes in, the free decay products and aerosols are deposited in the lungs. Once inside the lungs, they emit ionising radiation which can damage the lung tissue in the immediate vicinity and can ultimately cause lung cancer.

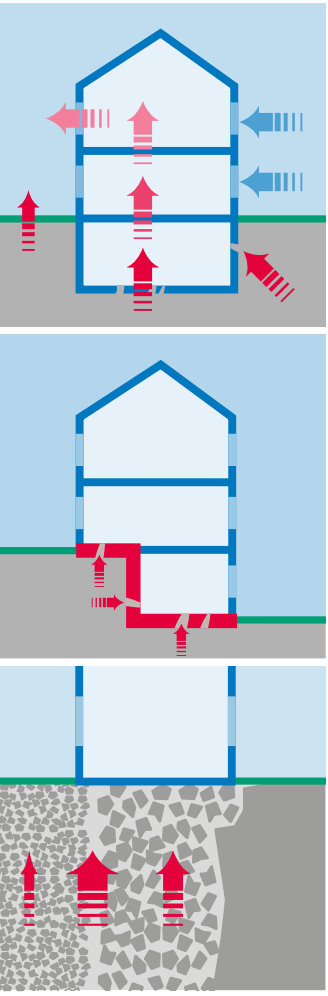
Guideline and limit values

The following table shows the guideline and limit values currently in force for annual mean radon concentrations inside inhabited rooms in the various countries.

Country	Guideline values		Limit values
	New buildings	Existing buildings	
Baden-Württemberg Bavaria	250 Bq/m³	250 Bq/m³	—
Austria	200 Bq/m³	400 Bq/m³	—
Switzerland	400 Bq/m³	400 Bq/m³	1000 Bq/m³
South Tyrol	200 Bq/m³	400 Bq/m³	500 Bq/m³ (for workplaces)

Annual mean radon concentrations normally range from 50 to 500 Becquerel per cubic metre (Bq/m³) of air. However, concentrations may reach several thousand Bq/m³, especially in regions where the radon risk is high.

Factors affecting the radon concentration inside rooms



The radon concentration in the air inside rooms depends on a number of factors:

Air renewal in the building
The rate at which the air inside rooms is exchanged for outside air has a major effect on the radon concentration in rooms. Windows and doors which are not air-tight lead to a greater rate of air renewal. If air renewal is reduced, however – for example by fitting windows and doors which shut tightly – the concentration of radon in the room air may increase substantially.

The condition of the building
The fundamental issue is the permeability of the building to gas in the soil around the foundations and in walls which are in contact with the soil. Gas can penetrate through cracks and gaps and along wire and pipe conduits. Radon-containing soil gas is sucked into the building by the low-pressure zone that develops inside the building (chimney effect as a result of temperature differences between room air and external air, and due to wind pressure) – see illustration at top left.
If the basement or other soil-contacting parts of the building are open to higher storeys, this makes it particularly easy for radon to spread upwards.

Type of ground beneath the building
Apart from the composition of the soil and rock (uranium, radium content), other characteristics which play an important role are the particle size of the rock (which determines its ability to emit radon into the soil gas) and the permeability of the subsoil (which determines how the radon-containing soil gas is transported).
Particular caution is required in buildings constructed on scree or other slopes, weathered granite, karst or gravelly soils. Very compact soils and clay soils require less caution.

Notes on retrofitted thermal insulation

Thermal insulation changes the air-tightness of the building envelope. Measures here include the fitting of air-tight windows and external doors or a vapour barrier under the roof. These features alter relative pressure, the rate at which air is exchanged and the rate at which radon penetrates.

If the thermal insulation on the façade of a building is not state of the art and has not been fitted correctly, soil gas containing radon can rise in cavities between the insulation and the external wall and penetrate into the building through places which are not air-tight.

These effects can lead to a substantial increase in radon concentrations inside the building.

Correct installation is the only way to prevent radon-containing soil gas from rising and penetrating.

Thermal insulation measures affect the air-tightness of the building envelope.

Determine the radon status of the building

The only way to determine the radon concentration inside a building is to measure it. Measurements inside buildings are normally carried out with passive radon dosimeters. These devices are small, and radon measurement is very simple and cheap to perform.

Ideally, radon should be measured in all buildings which are due for refurbishment. This applies especially to houses with inhabited rooms in contact with the soil and houses in radon risk regions.
If measurement shows that the radon concentration is elevated, this must be taken into consideration when planning refurbishment work.

Measures that can be adopted in buildings with elevated radon concentrations are explained in more detail in the brochure «Radon – Mitigation measures in existing buildings».

The technical offices in each country (see back of brochure) will be pleased to provide you with information about companies able to measure radon in your region.

Devices used to measure the radon concentration

Facts and notes

- Radon is the second most common cause of lung cancer after smoking
- Radon penetrates from the ground into buildings through places which are not air-tight
- National radon risk maps provide initial information
- The only way to be sure about the radon concentration in a building is by measuring it
- Retrofitted thermal insulation measures can increase the radon concentration
- There are simple and established ways of protecting yourself

Important information about radon protection
The following information should be taken into account and discussed with building experts and radon consultants:

- If rebuilding work is carried out to floors and walls in inhabited rooms which are in contact with the soil, it is considerably less expensive and more effective to implement radon mitigation measures as part of this work than after it has been completed. You will find the necessary information in the brochure «Radon – Mitigation measures in existing buildings».
- If only the lower half of the building is being sealed, it is recommended to mitigate the effects of radon by installing an outside air opening to reduce the low pressure in the basement (pressure equalisation).
- A situation must be avoided in which radon-containing soil gas rises through cavities between the insulation and the external wall or penetrates into the building through openings and cracks in the masonry. If insulation is fitted correctly in accordance with the state of the art (for example, adhesive should be applied around the edge and as points in the centre of the insulation panel, or the entire surface of the panel should be coated with adhesive) this situation will not arise.
- Preventing air from flowing from the basement into inhabited rooms by sealing – for example, air-tight doors between basement and inhabited rooms – has a beneficial effect in terms of both temperature regulation and protection against radon.
- Installation of controlled room ventilation is beneficial in terms of radon mitigation. Care must be taken (and regular checks carried out) to ensure that a low-pressure zone does not develop inside the building.
- An adequate supply of fresh air from outside is essential if a fuel-burning appliance is installed (such as a tiled stove, kitchen stove or fireplace). Where technically feasible, a direct external air intake is the best way of doing this.

Checking the radon concentration after retrofitting
Once construction work has been completed, it is recommended to measure the radon concentration to ensure that the retrofitted insulation has not caused an increase in radon levels.
If an elevated radon concentration was found before the insulation was installed, radon measurement must always be carried out after the work has been completed.

Information about radon

Brochures in this series

- Radon – Precautions for new buildings
- Radon – Measurement and evaluation
- Radon – Mitigation measures in existing buildings
- Radon – The effect of retrofitting thermal insulation

On the internet

Germany: www.bfs.de (search for *Radon*)
- Baden-Württemberg: www.uvm.baden-wuerttemberg.de (search for *Radon*)
- Bavaria: www.lfu.bayern.de (search for *Radon*)

Austria: www.radon.gv.at
- Upper Austria: www.land-oberoesterreich.gv.at/Thema/Radon

Switzerland and Liechtenstein: www.ch-radon.ch

South Tyrol: www.provinz.bz.it/umweltagentur (search for *Radon*)

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