Radon

The Effect of Retrofitting Thermal Insulation

Baden-Württemberg
MINISTERIUM FÜR UMWELT, KLIMA UND ENERGIEWIRTSCHAFT

Bavarian Environment Agency

UPPER AUSTRIA

AGES

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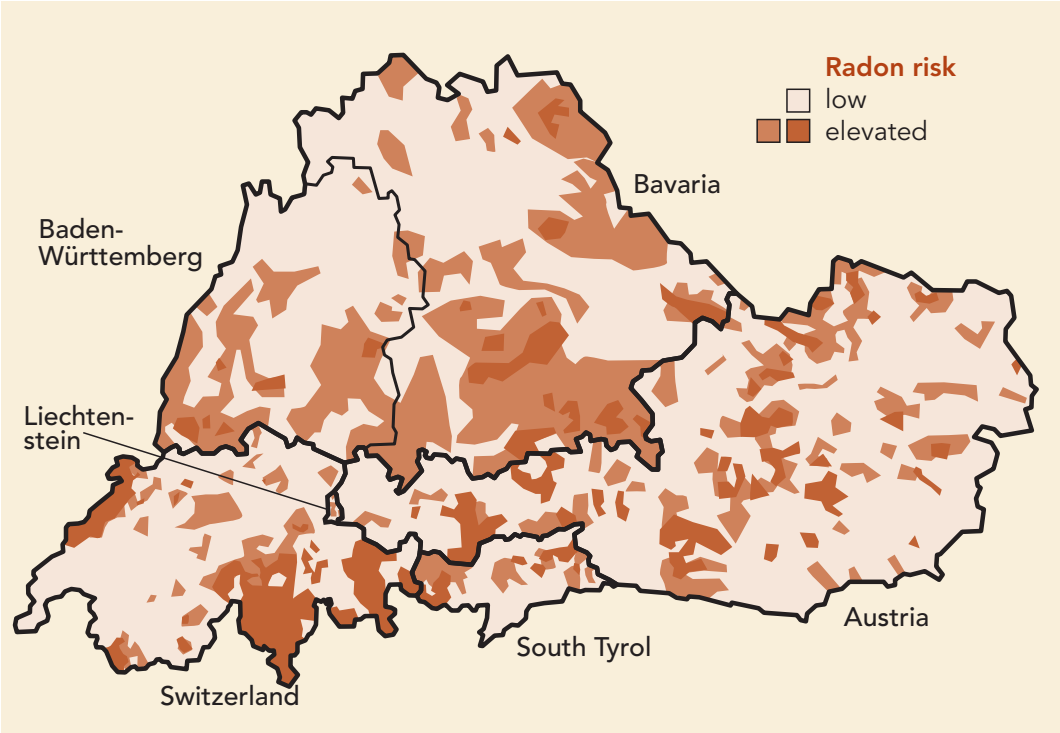
Properties, Occurrence and Effect of Radon

Properties and occurrence

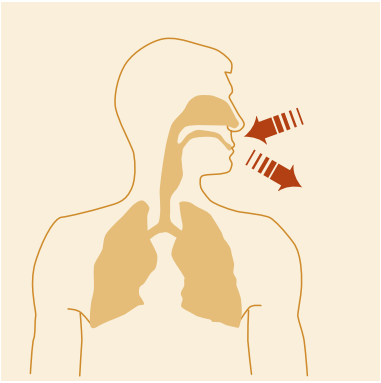
Radon is a natural, ubiquitous radioactive noble gas that is colourless, odourless and tasteless. It is a decay product of the radioactive heavy metal uranium, which is found in soil and rocks. Radon can escape relatively easily from soil and rocks, from where it is transported by soil gas or dissolved in water. By means of those processes radon can also enter buildings.

Radon potential maps and radon risk maps give initial information about the likelihood of elevated indoor radon concentrations in your region.

The illustration below is a greatly simplified representation of radon risk regions in Austria, southern Germany, South Tyrol, Liechtenstein and Switzerland.
More detailed information about radon can be found on the websites hosted by the individual countries. The corresponding internet addresses are on the back of this brochure.



Health impact



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

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

When a person inhales, the free decay products and aerosols are deposited in the lungs. Once inside the lungs, they emit ionising radiation which can damage the surrounding lung tissue and can ultimately lead to lung cancer.

Guideline and limit values

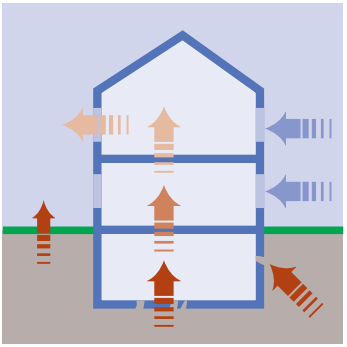
The following table shows the guideline and limit values for the annual mean radon concentration of inhabited rooms currently in force in various states.

State	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	1.000 Bq/m³
South Tyrol	200 Bq/m³	400 Bq/m³	500 Bq/m³ (at workplaces)

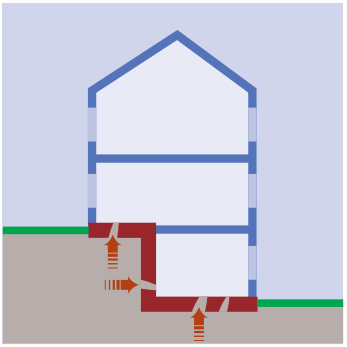
Annual mean radon concentrations are typically in the range of 50 to 500 Becquerel per cubic metre (Bq/m³) of air. However, concentrations may reach several thousand Bq/m³, especially in radon risk regions.

Factors Affecting the Indoor Radon Concentration

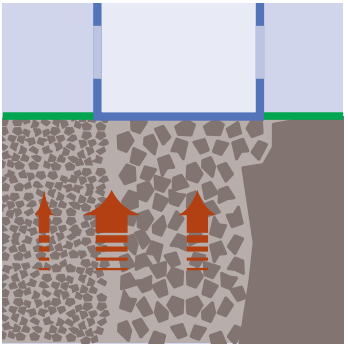
The indoor radon concentration depends on a number of factors:



- **Air exchange in the building:**
  The rate at which indoor air is replaced by outdoor air has a major effect on the radon concentration. Windows and doors which are not air-tight lead to a greater air exchange rate. If air exchange is reduced, however – for example by fitting windows and doors which close tightly – the concentration of radon in indoor air may increase substantially.



- **The condition of the building:**
  The fundamental factor is the permeability of the building to soil gas around the foundations and in walls which are in contact with the soil. Soil gas can penetrate through cracks, gaps and along wire and pipe conduits into the building. Radon-containing soil gas is sucked into the building by the depression zone that develops inside the building (stack effect as a result of temperature differences between indoor air and oudoor 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.



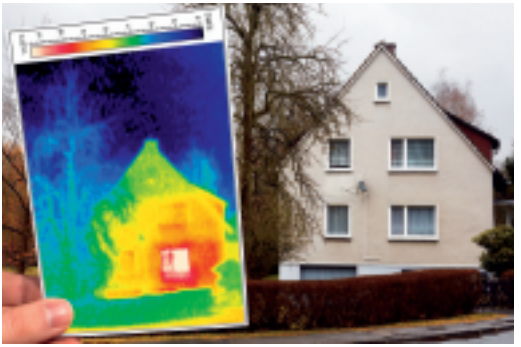
- **Type of ground beneath the building:**
  Apart from the composition of the soil and rock (uranium, radium content), other characteristics which play an important role are the particle size of the rock (which determines its ability to emit radon into the soil gas) and the permeability of the subsoil (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 soil. Very compact soil and clay soil require less caution.

Notes on Retrofitting Thermal Insulation

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

If the thermal insulation on the facade 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 leaks.

These effects can lead to a substantial increase of indoor radon concentrations.



Retrofitting thermal insulation affects the air-tightness of the building envelope

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

The Correct Procedure when Retrofitting Insulation

Determine the radon status of the building

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

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

Measures that can be applied to buildings with elevated radon concentrations are explained in more detail in the brochure «**Radon – Mitigation Measures in Existing Buildings**».

The Radon institution of your country/state (see back of brochure) will provide information about companies measuring radon in your region.

Devices used to measure the radon concentration

Facts and Notes

- Radon is the second leading cause of lung cancer after smoking
- Radon enters from the ground into buildings through leaks
- National radon risk maps provide initial information
- Only a measurement can give certainty about the radon concentration in a building
- Retrofitting thermal insulation can increase the radon concentration
- There are simple and established protective measures

Important information about radon protection

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

- If renovation 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 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 effect on radon by installing a special aperture to outdoor air to reduce the air depression 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 enters into the building through openings and cracks in the masonry. If insulation is fitted in accordance with the state of the art (for example, adhesive should be applied around the edges and at points in the centre of the insulation panel, or the entire surface of the panel should be coated) 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 energy saving and radon protection.
- Installation of controlled mechanical ventilation is beneficial in terms of radon mitigation. Care must be taken (and regular checks carried out) to ensure that a depression 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 ensuring 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 of the radon concentration. If an elevated radon concentration was found before the insulation was installed, another 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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Publishing details: Published jointly by the Radon Offices in Austria, Switzerland, southern Germany, South Tyrol
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Edition: First edition, October 2010.