Building protection against radon: Principles

International IAEA workshop, « Radon for Building professionals »
12-16 November 2018. Ciudad Rodrigo, Spain

Bernard Collignan, Senior scientist,

Building research intitute (CSTB), France

Member of the Executive Commitee of the European Radon Association (ERA)

CSTB : Building Research Center

Answering ecological and energy transition stakes : 4 key activities

Recognized scientific excellence at the national and European level.

Presence in European and international scientific networks.

Scientific and technical expertise in the field of innovation and prospective.

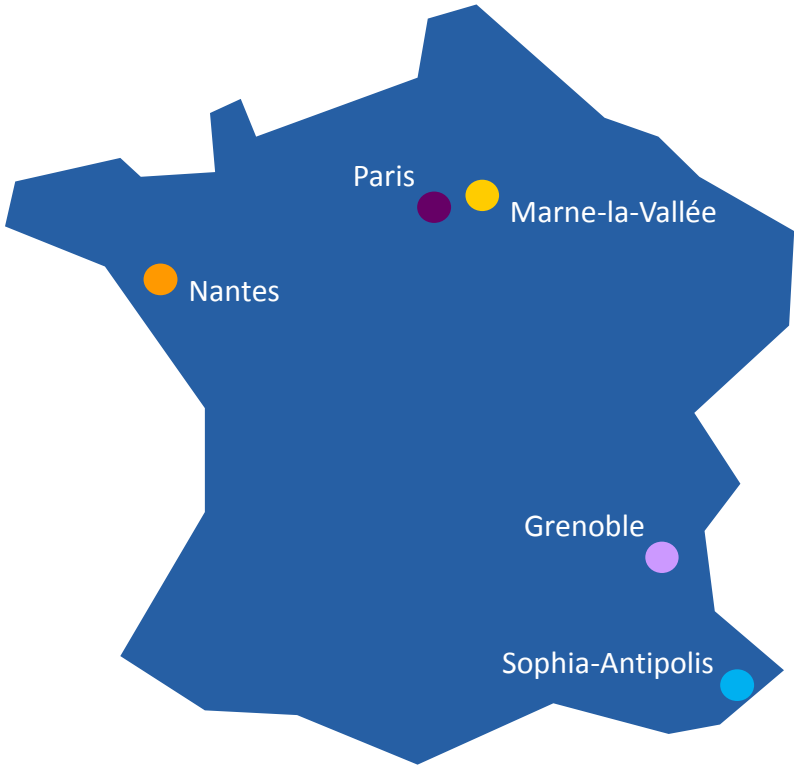
Supporting the professionals through dissemination of knowledge and training.

CSTB: a stakeholder trusted by business and public authorities.

→ More than 900 employees

CSTB : Building Research Center

Multi-disciplinary teams on the whole territory



Marne-la-Vallée

Head office

- Energy-Environment
- Health-Comfort
- Envelope and Roofing
- Insulation and Cladding
- Safety, Structures, and Fire performance
- Hydraulics and Sanitary Equipment
- Information Technologies and Knowledge Dissemination
- OQAI (Indoor Air Quality Observatory)

Bâtiment Bienvenüe

- Economics and Social Sciences

Paris

- Professional training centre
- Certivéa, Céquami, Cerway, subsidiaries of CSTB group

Nantes

- Climatology, Aerodynamics, Pollution and Purification
- Health-Comfort (lighting)

Grenoble

- Energy-Environment
- Health-Comfort
- Insulation and Cladding
- Envelope and Roofing
- Information Technologies and Knowledge Dissemination
- Acoustb, subsidiary of the CSTB group

Sophia-Antipolis

- Information Technologies and Knowledge Dissemination
- Envelope and Roofing
- Energy-Environment

ERA : European Radon Association

Objective: improving awareness and reducing risk of radon exposure accross Europe

1. To assist in reducing the health burden from radon in Europe

2. To promote public awareness of radon

3. To encourage the development of quality standards in indoor radon metrology, remediation, prevention and control technologies

4. To provide a communication net-work for all radon professionals and other relevant groups

5. To serve as a consultative body to national and international agencies in all matters relating to the reduction of the risk from exposure to radon

6. To assist in the organization of radon conferences and contribute to education and training in all aspects of the radon field

Website: www.radoneurope.org

Summary

1) PHYSICS OF RADON ENTRY IN BUILDINGS

2) PRINCIPLES OF BUILDING PROTECTION

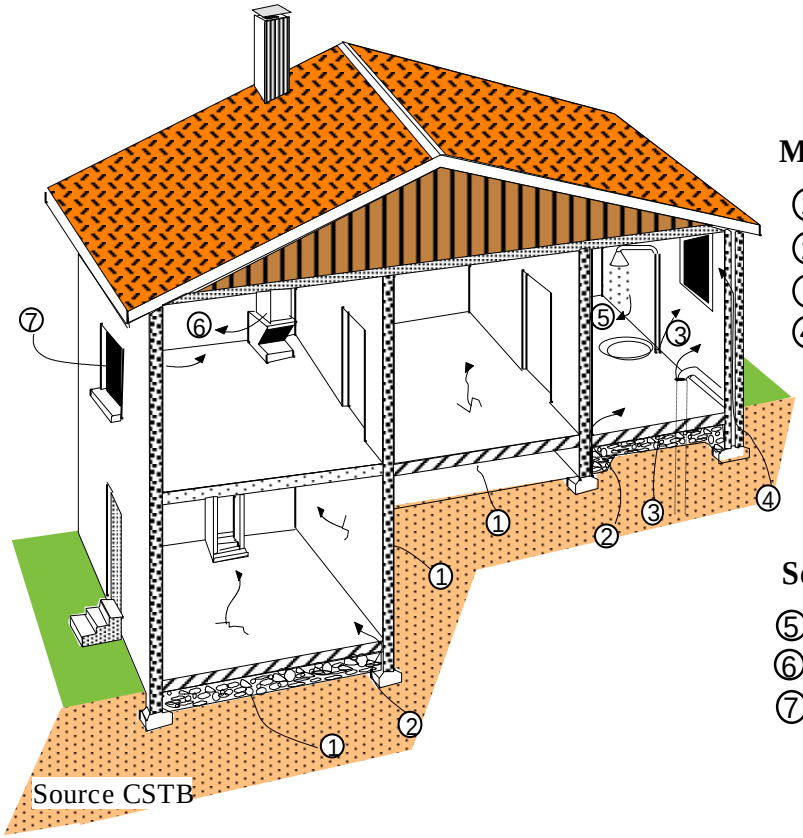
3) PREVENTIVE MEASURES IN NEW BUILDINGS

4) CORRECTIVE ACTIONS IN EXISTING BUILDINGS

1) Physics of radon entry in buildings

1) Physics of radon entry in buildings

In case of high radon level indoors (few hundreds Bq/m^3), main cause: radon from the ground



Main causes

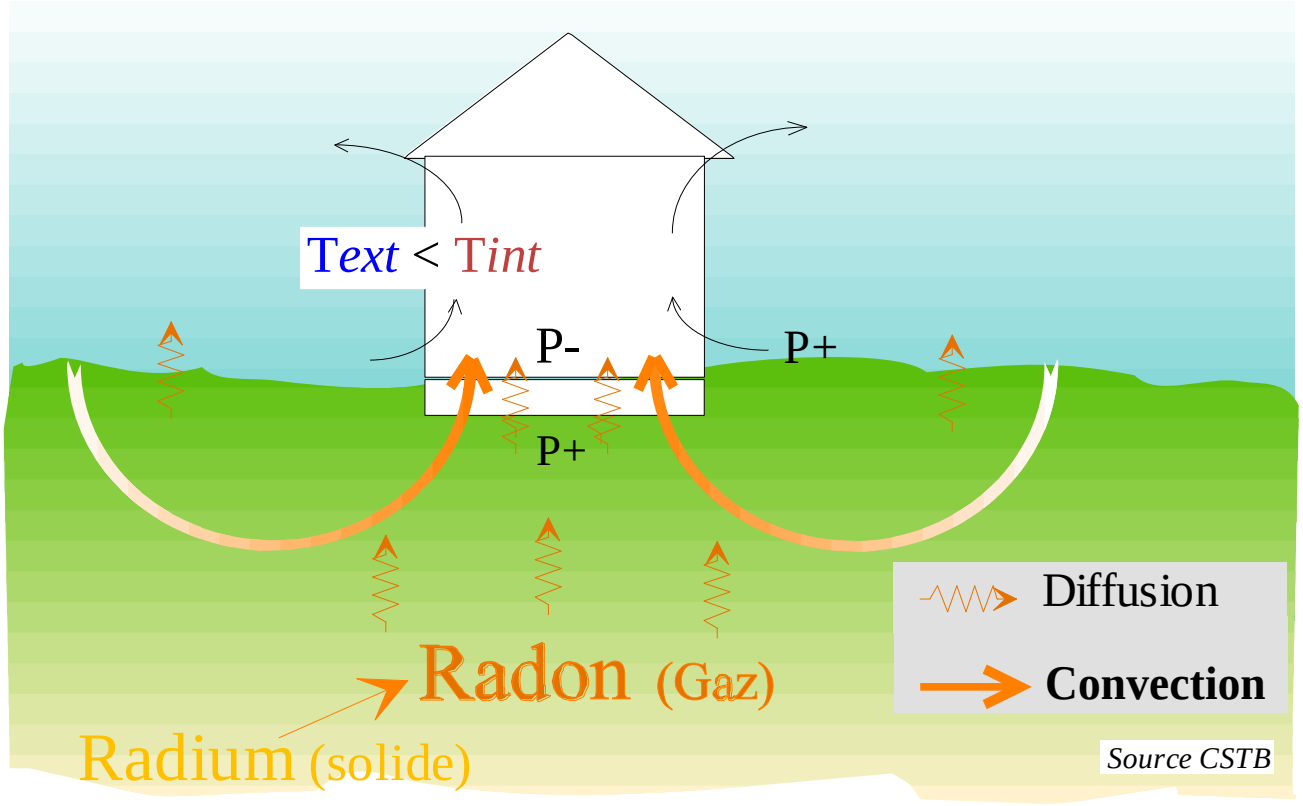
① Cracks
② Joints between components
③ Penetration networks
④ Cavities in walls

coming from the ground

Secondary causes

⑤ Use of water
⑥ Building materials
⑦ Outdoor air

1) Physics of radon entry in buildings



Entry mechanisms into building:

- Diffusion, linked with concentration differences
- **<u>Convection</u>, linked to slight depressurisation of building**

2) Principles of building protection

2) Principles of building protection

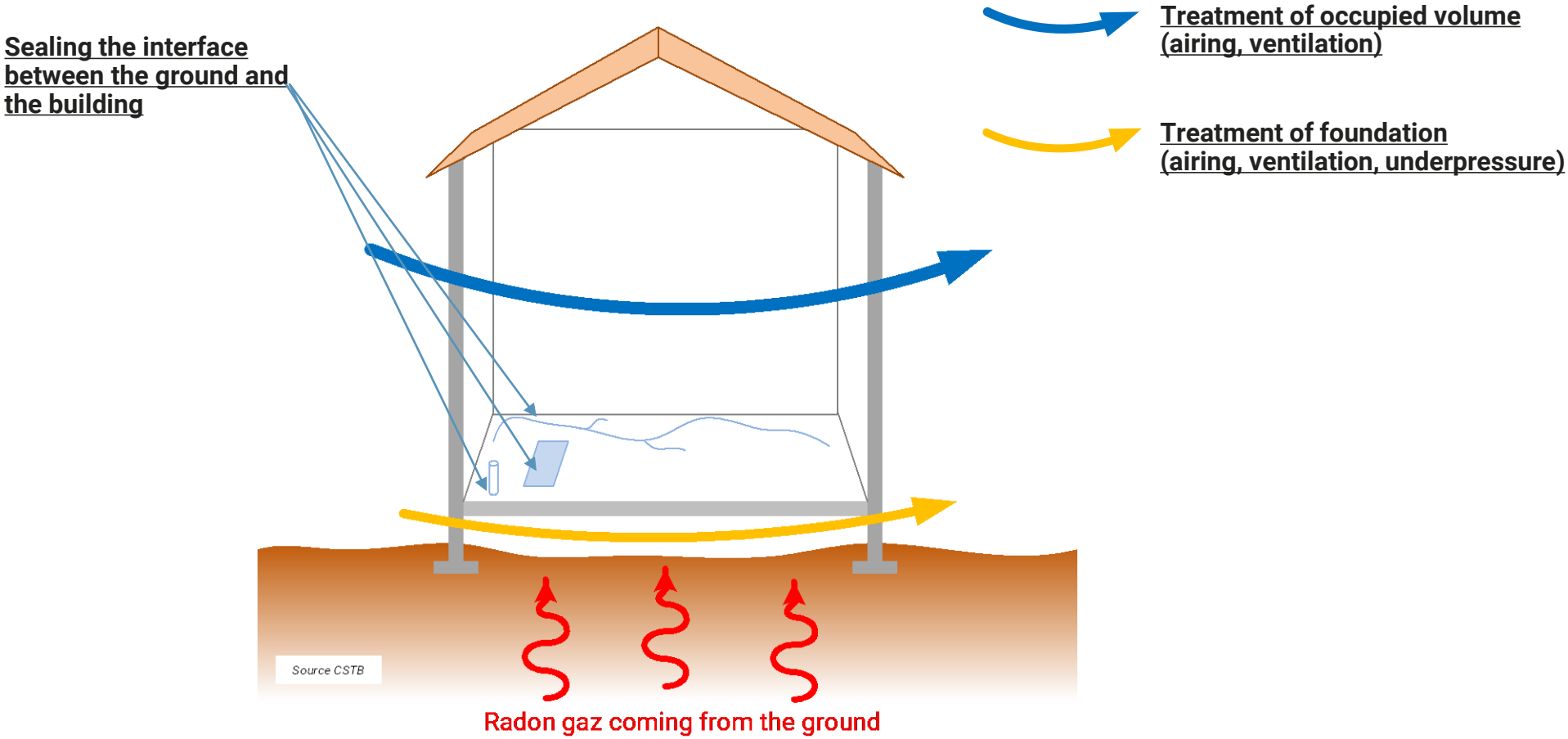
Two principles:

- ✓ To avoid radon entry into buildings
- ✓ To dilute indoor radon concentration

Three types or « families » for solutions:

- ➢ Sealing the interface between the ground and the building
- ➢ Treatment of occupied volume (ventilation, pressure)
- ➢ Treatment of foundation (ventilation, pressure)

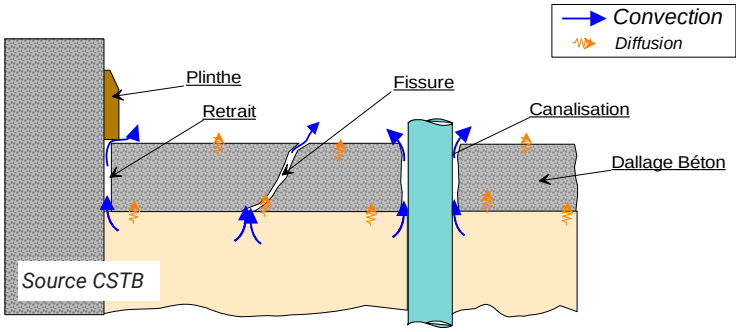
2) Principles of building protection

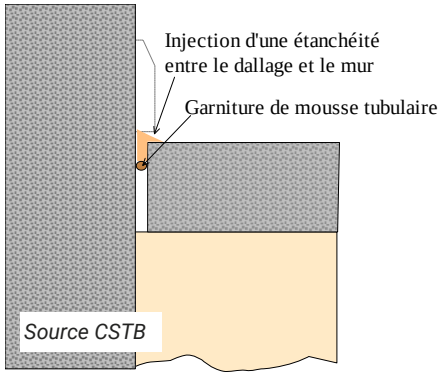


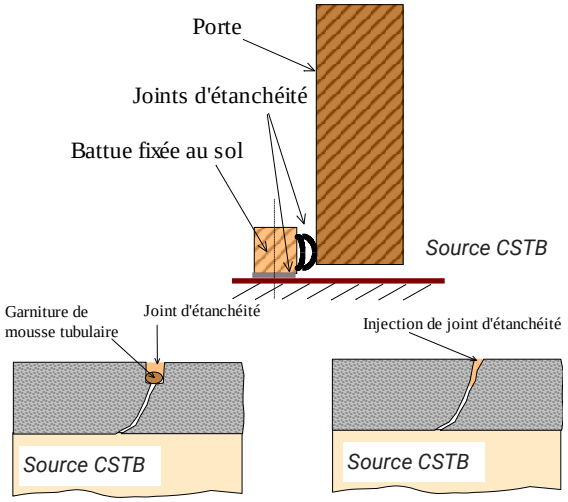
2) Principles of building protection

Sealing of interface

- Sealing entry points: cracks, network (water, electricity, gas, other pipes.), doors, ...







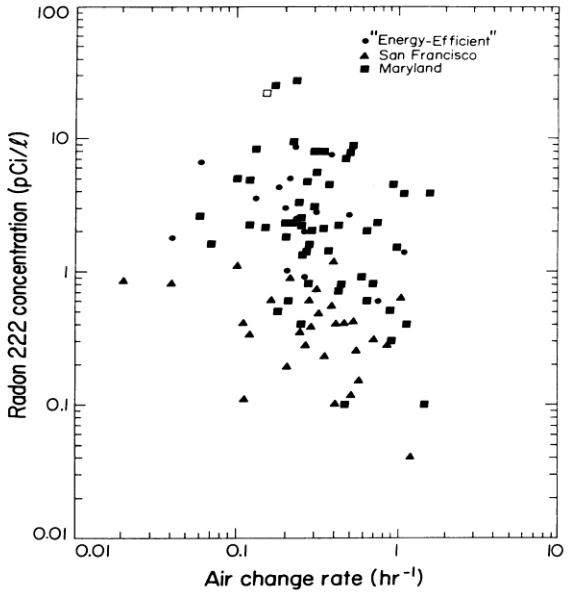
- Surface treatment: floor, Buried walls, direct ground in basement

2) Principles of building protection

Treatment of occupied volume

Dilution of indoor radon concentration with air renewal using ventilation (mechanical, natural, hybrid)

- Level of air renewal relevant with current regulation and practices
  - + : Associated with Indoor Air Quality objectives
  - - : Hazardous efficiency, dependant of occupant behaviour, energetic cost, possible disconfort



Radon, Technical Report Series, nov. 90

Particular case:

Insufflating mechanical ventilation or unbalanced mechanical double flow

- + : to diminish natural depressurisation of building or to produce pressurisation
  → to decrease radon source from the ground
- - : to possibly enhance moisture in walls, function of use of building and climate

2) Principles of building protection

Ventilation of building

Objectives

- Contribution to a good Indoor Air Quality
- Avoid building structure and components deterioration (condensation and mold development)

Means :

- Efficient extraction of pollutants emitted indoor (water vapor, VOC, odors, …)
- Efficient supply of outdoor air

→ Requirements depend on countries and on use of building

In France

For dwelling : requirement on extract airflow based on H_2O presence

For other buildings : requirements on supply air based on CO_2 presence

2) Principles of building protection

Principles for the ventilation of building

➢ Separated room ventilation

Outdoor air supply and indoor air extraction in the same room

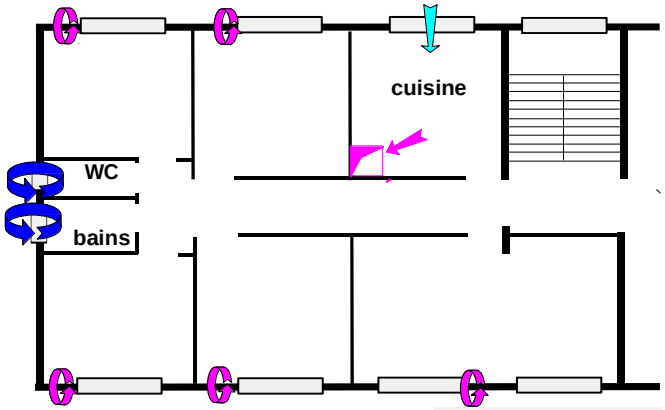


Illustration in dwelling

Source CSTB

➢ Sweeping ventilation

- Outdoor air supply in leaving rooms,
- Tranfer available between rooms,
- Indoor air extraction from technical room

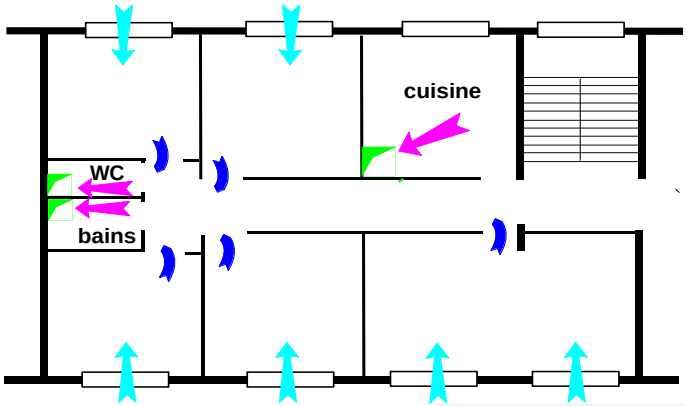
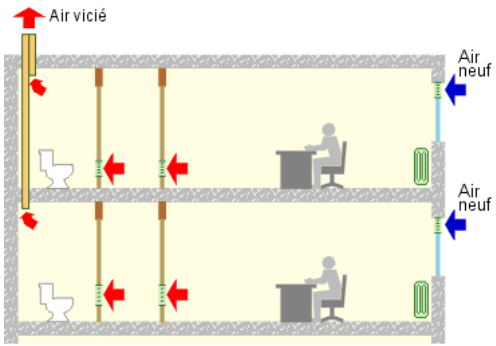


Illustration in dwelling

Source CSTB

2) Principles of building protection

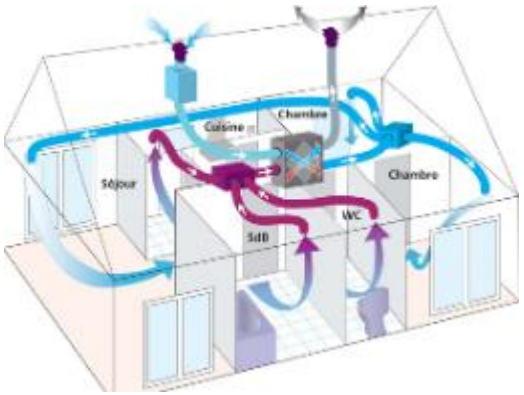
Ventilation systems



Natural ventilation system

Mechanical exhaust ventilation system

Mechanical supply ventilation system



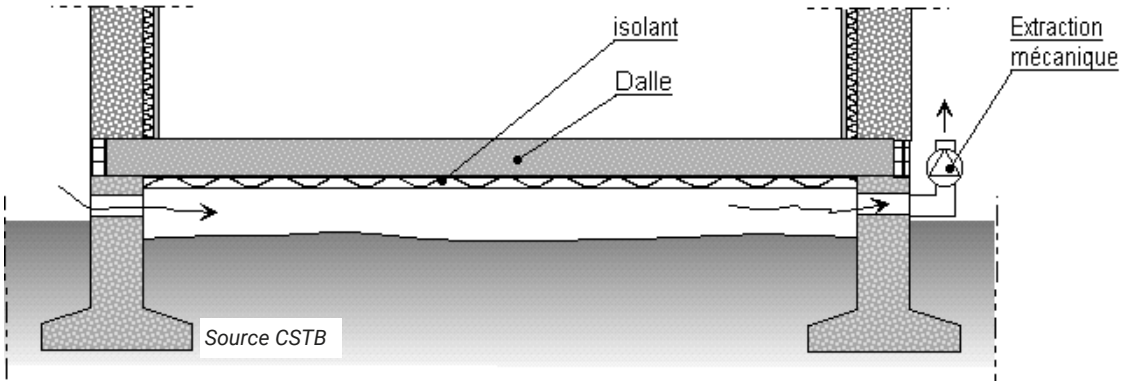
Double flux ventilation system

2) Principles of building protection

Treatment of foundation

Use of ventilation (natural or mechanical) to dilute radon in the interface before entry into building. Application to crawl space and basement

Example of ventilation in crawl space :

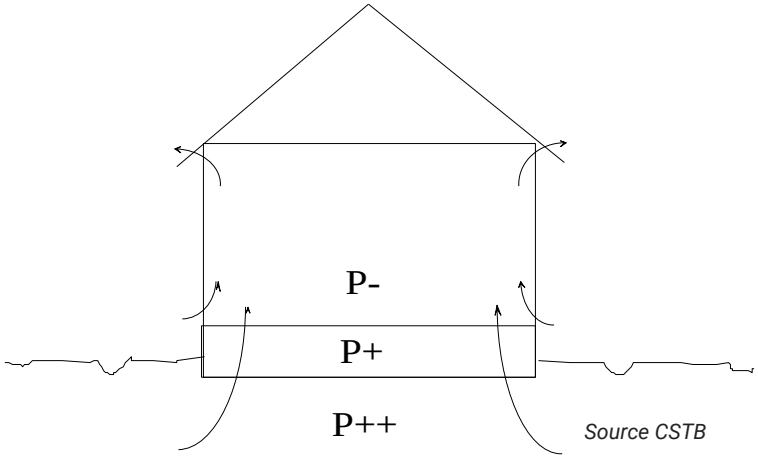


Important to ensure a good sweeping of the volume to avoid « dead zone »

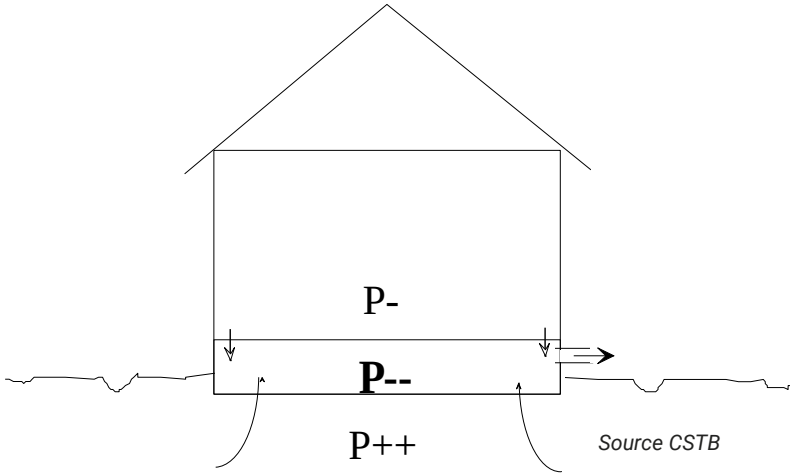
2) Principles of building protection

Treatment of foundation

Principle of Soil Depressurization System (S.D.S.)



Initial pressure field

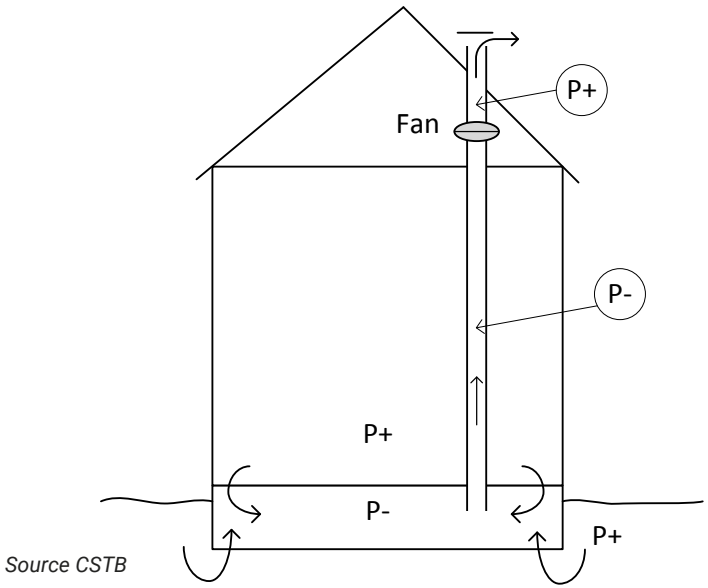


Pressure field generated with S.D.S.

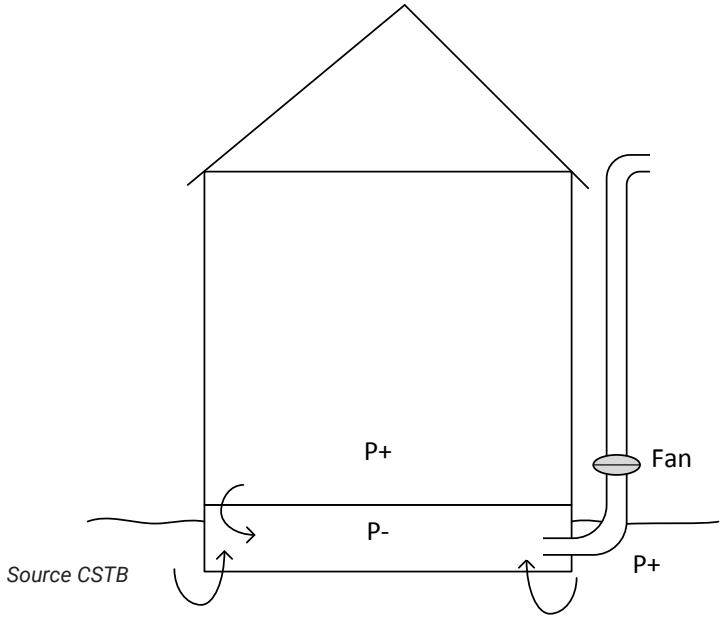
2) Principles of building protection

Treatment of foundation

Principle of Soil Depressurization System (S.D.S.)



Internal position for extraction

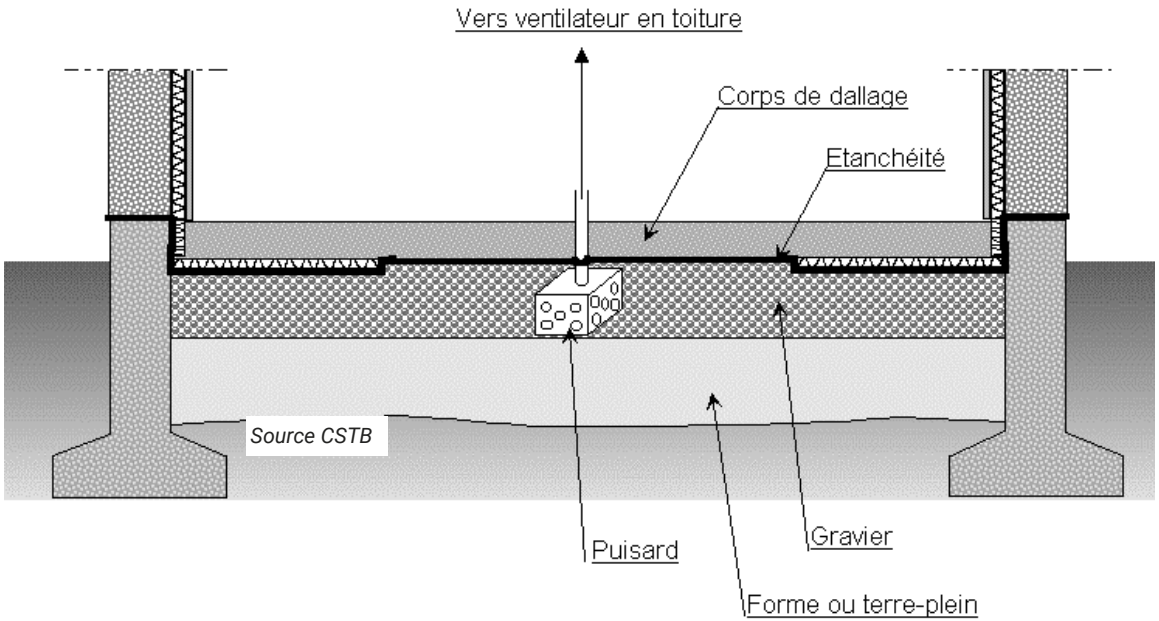


External position for extraction

2) Principles of building protection

Treatment of foundation

Principle of S.D.S.
- Example of installation in new building (or strong renovation)



- Could be tested in existing building, depending on nature of foundation (generally slab on grad with gravel layer below)

3) Preventive actions in new Buildings

3) Preventive measures in new Buildings

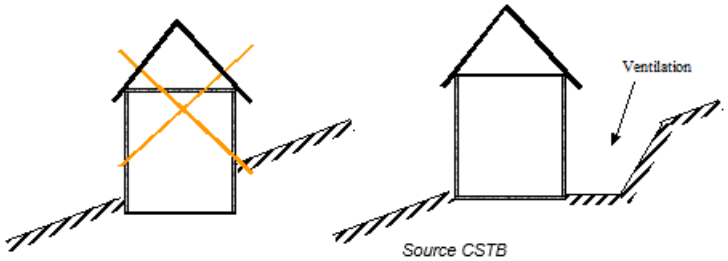
Integration of preventive measures at early stage of building conception

➢ Good efficiency, low cost

- Good practices
- Specific preventive measures

3) Preventive measures in new Buildings

Good practices



Source CSTB

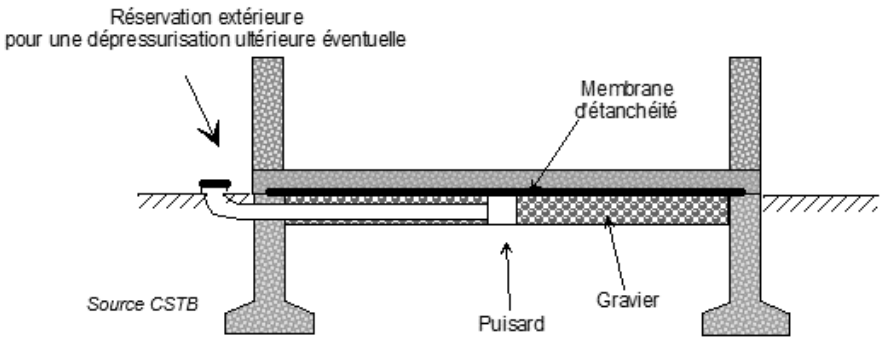
- ✓ Avoid backfills, buried walls, basements
- ✓ Limit networks through the interface soil/buildin
- ✓ Seal the interface soil/building and networks
- ✓ Prevent cracks in slabs
- ✓ Relevant ventilation of building
- ✓ Limit indoor depressurisation (configuration of building, systems, …)

3) Preventive measures in new Buildings

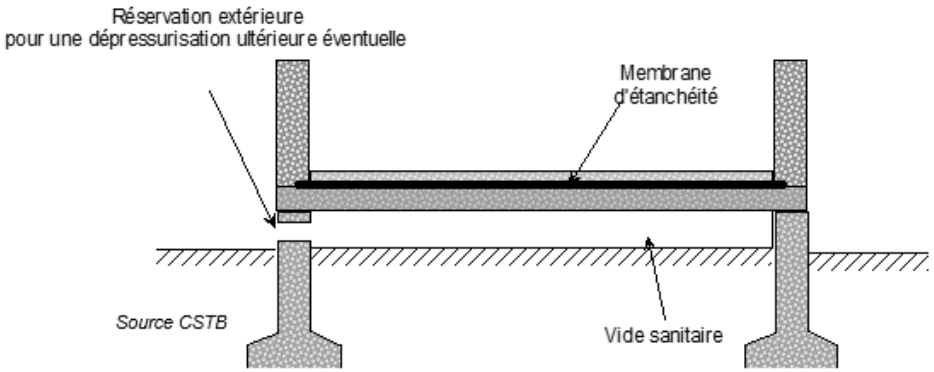
Specific preventive measures

- Intregration of S.D.S.

Slab on ground :



Crawl space :

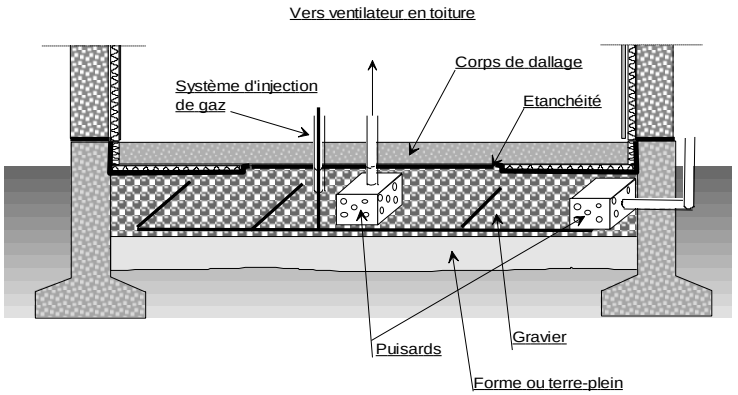


Example of foundation preparations able to activate a SDS if necessary

3) Preventive measures in new Buildings

Integration of a SDS in an experimental house at CSTB (MARIA)

Example of membrane implementation and anchor to foundations



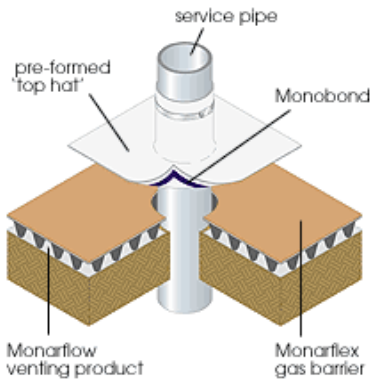
Treatment of singularity points

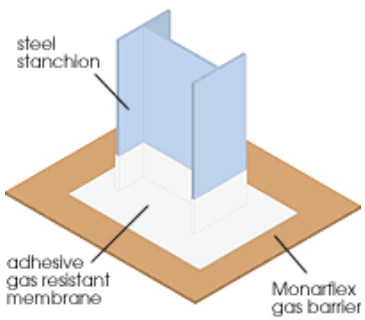
External extraction point before backfilling

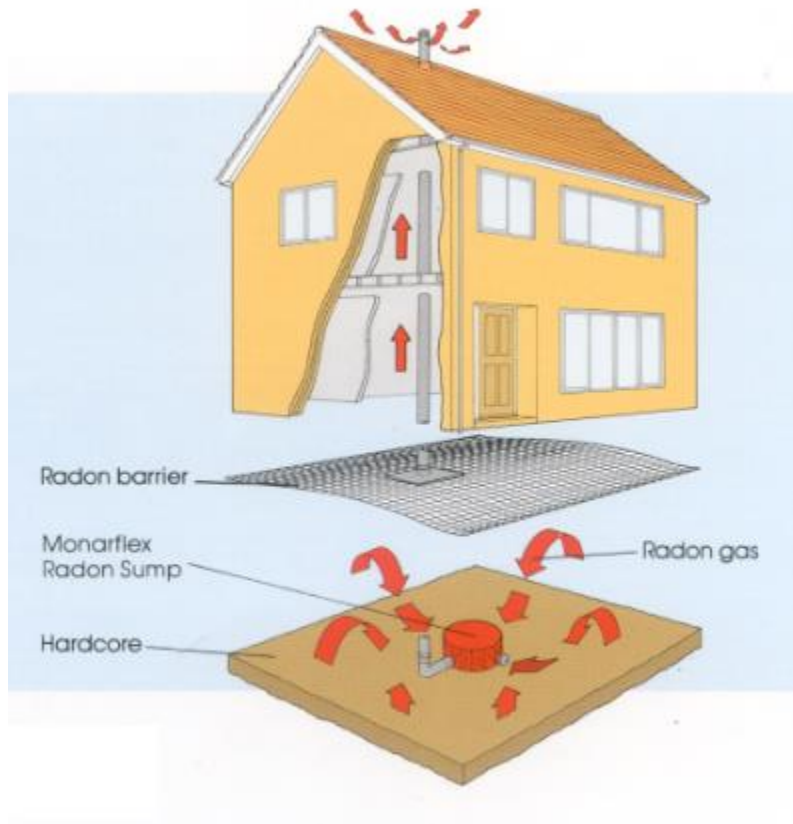
3) Preventive measures in new Buildings

Specific preventive measures

➢ Example of industrial SDS







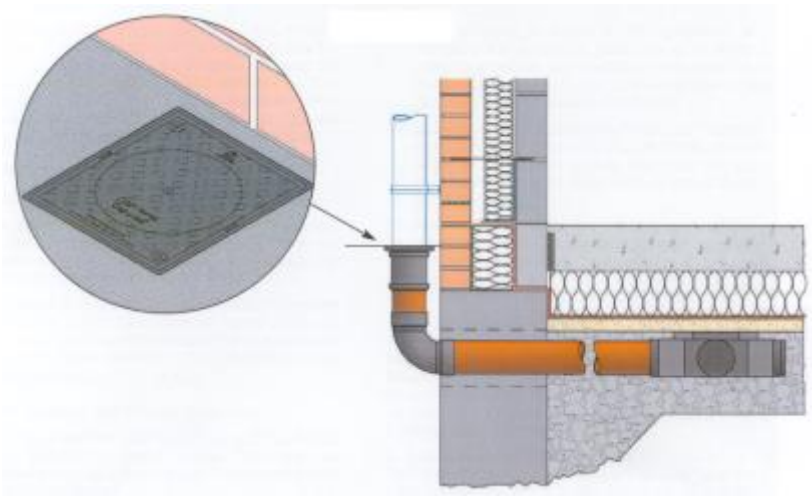
Source : Monarflex Radon Protection System

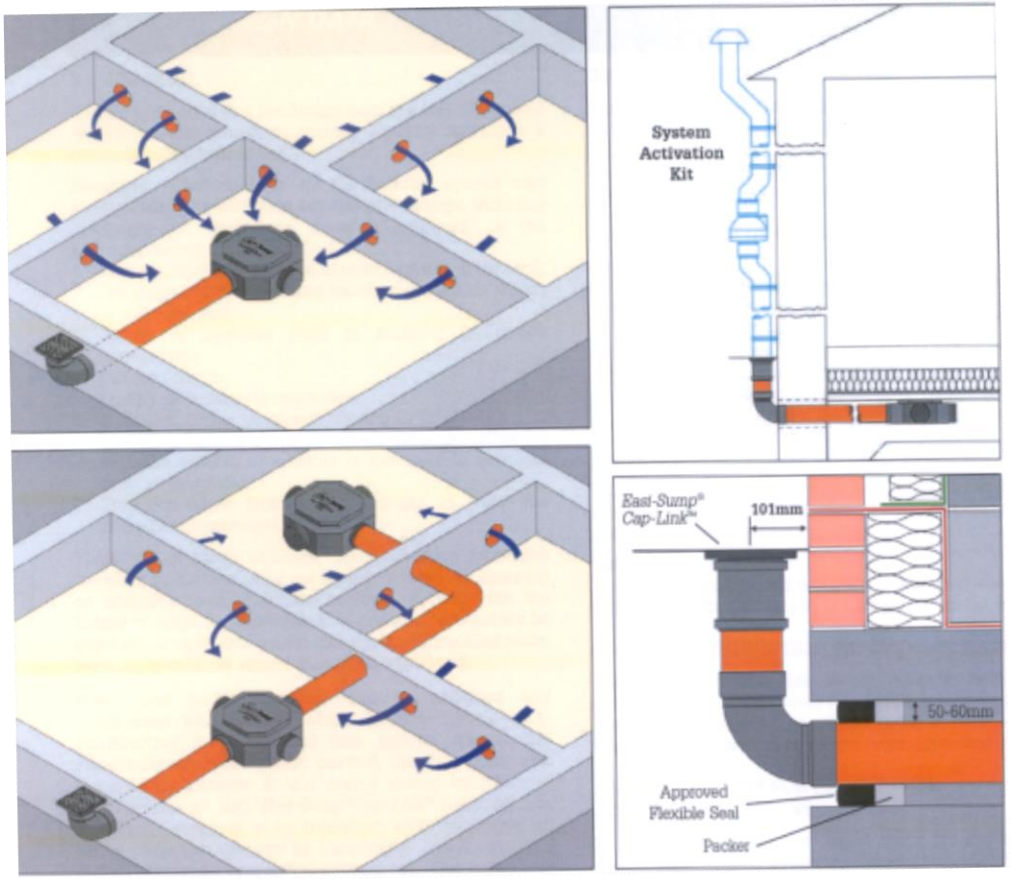
3) Preventive measures in new Buildings

Specific preventive measures

➢ Example of industrial SDS

Source : Easy-Sump
Irish Agrément Board





4) Corrective actions in existing buildings

4) Corrective actions in existing buildings

- Strong disparity of situations
- Solutions to implement have to be considered based on:
  - Level of screening measures
    (at least two months passive measurement, heating season, … Ex.: NF ISO 11665-8)
  - Characteristics and use of the considered building
- solutions defined case by case
- sometimes implemented iteratively
- appropriate combination:
  - sealing (always need)
  - ventilation of building,
  - Treatment of the foundation
- Many cases relatively simple (medium Rn, “classical building”)
- However, sometimes complicated

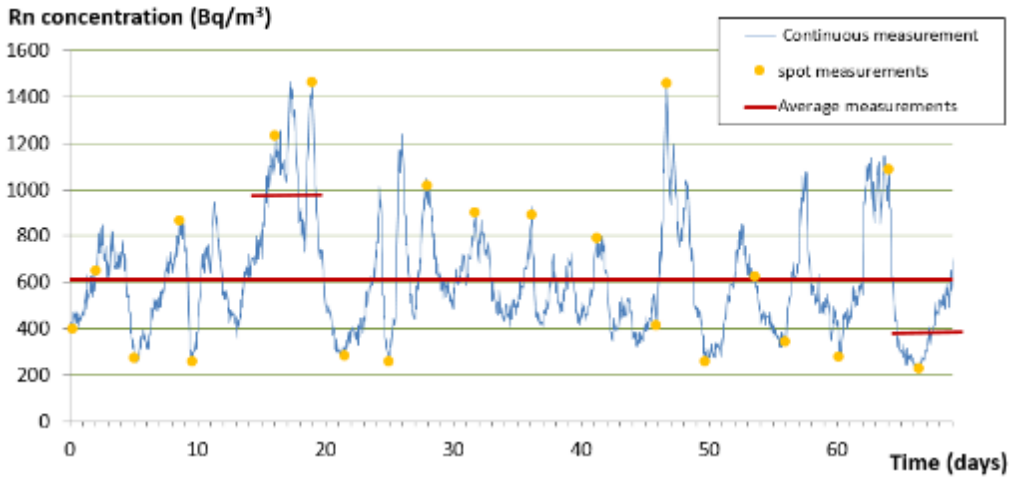
→ Technical diagnostic of the building (French standard: NF X 46-040)

4) Corrective actions in existing buildings

Indoor radon concentration results on many parameters :

- Ground potential (nature, permeability)
- Building characteristics (geometry, foundation, systems,…)
- Meteorological conditions (temperature, wind)
- Behaviour of occupants

→variable along time



Radon risk assessment based on averaged indoor radon concentration

→Difficulties to compare a given measurement to average value

4) Corrective actions in existing buildings

NF ISO 11665-8 January 2013

Measurement of radioactivity in the environment — Air: radon-222 — Part 8: Methodologies for initial and additional investigations in buildings

Scope

- Specifies requirements for the determination of the activity concentration of radon in all types of buildings.
- Describes the measurement methods used to assess, the average annual indoor radon activity concentration
  Initial investigation or screening
- Describes the measurement methods needed to identify the source, entry routes and transfer pathways of the radon in the building
  Additional investigations or additional measurements
- Outlines the applicable requirements for the immediate post-mitigation testing

4) Corrective actions in existing buildings

NF X 46-040 (experimental French standard), February 2011

Radon handling in buildings — Referential for technical diagnostic related to the presence of radon in buildings — Mission and methodology

Content

Description of the investigations needed:

- To identify the causes of the presence of radon in the building and
- To provide the necessary elements for the selection of adapted remediation

Method

Information collection and site visit:

→ Analysis of quality of the building structure, substructure, systems, behavior of the occupier.

Could be completed with:

- Additional radon investigations (NF ISO 11665-8),
- Ventilation measurements

4) Corrective actions in existing buildings

Considerations on technical diagnostic of building: field observations examples (1/3)

Cracks under the carpet.
Operation of an old floor heating system of floor,
"almost forgotten"

4) Corrective actions in existing buildings

Considerations on technical diagnostic of building: field observations examples (2/3)

Leaving room newly renovated.

Old Chimney with flue pipe removed

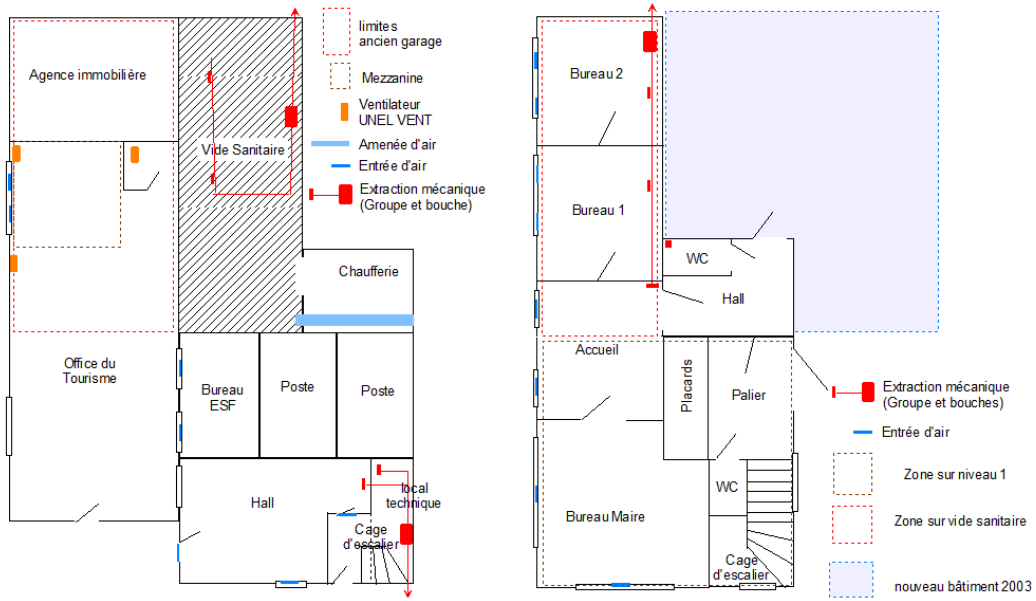
basis of the old flue in basement

Basis still crossing the slab, connected to the air space under the wooden floor

4) Corrective actions in existing buildings

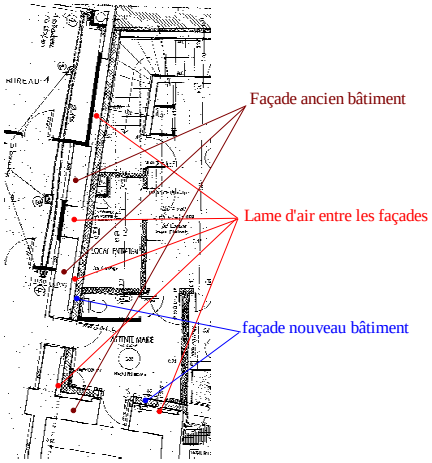
Considerations on technical diagnostic of building:

Adhesive tapes for cracks on thin plaster wall



Niveau 1 (rez-de-chaussée) *Niveau 2 (1er étage)*

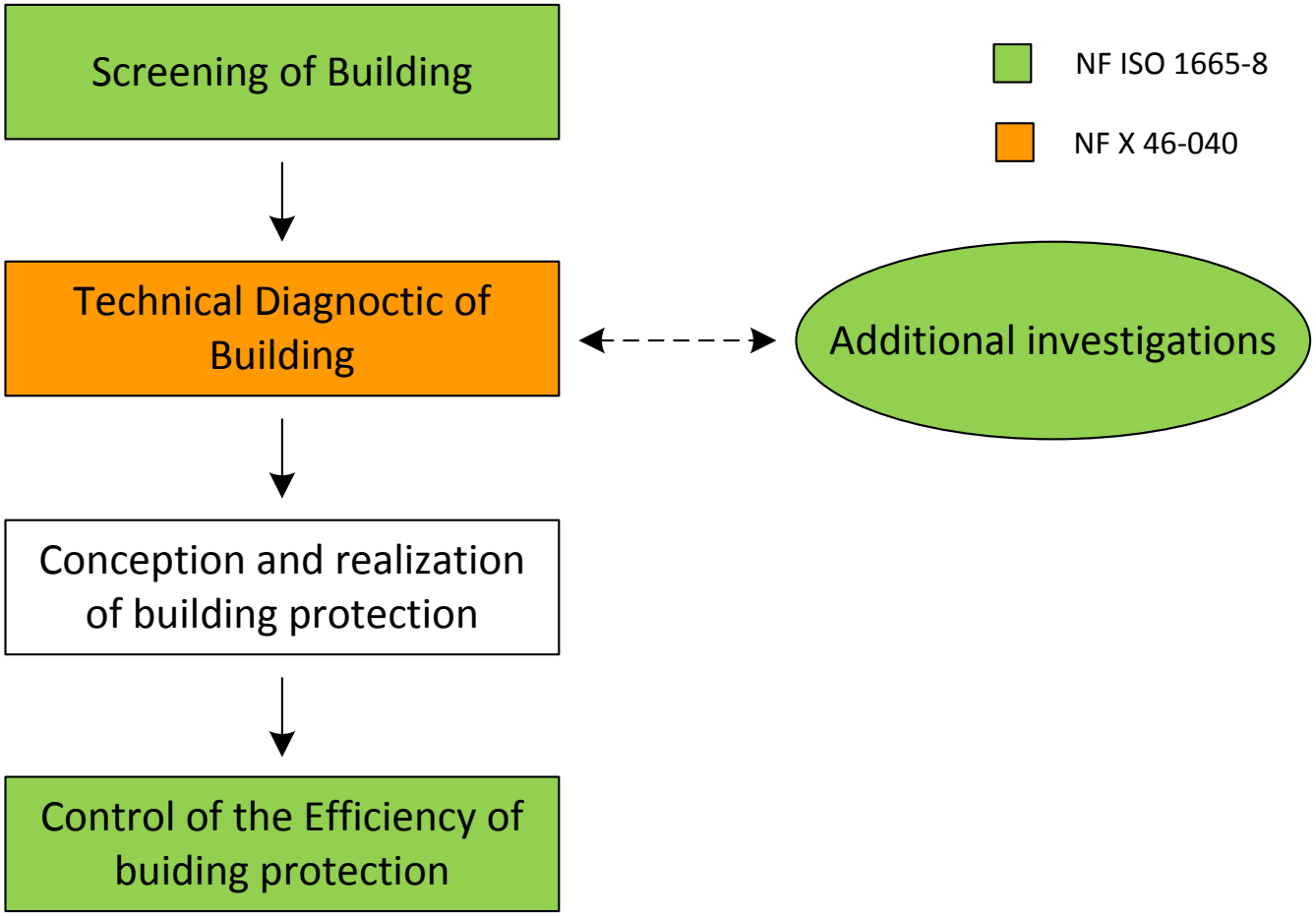
Old building on crawl space, associated with two new extensions and new adjoining building



Hidden Air layer between two facades

4) Corrective actions in existing buildings

Scheme of general approach to manage radon in existing building



Thank you for your attention!