
IT IS POSSIBLE TO LIVE FOR WEEKS
WITHOUT EATING
A FEW DAYS WITHOUT DRINKING
FEW MINUTES WITHOUT BREATHING
INDOOR
AIR POLLUTANTS
Radon:
issues and solutions
VORTICE

INDOOR AIR POLLUTANTS

There are mainly three types of indoor air pollutants.

CHEMICALS:

Carbon monoxide, volatile compounds (VOCs), pesticides, sulfur and nitrogen oxides, **radon**.

SOLID PARTICULATE MATTER:

Dust, combustion by-products (fumes), particulate matter (PM).

BIOLOGICAL AGENTS:

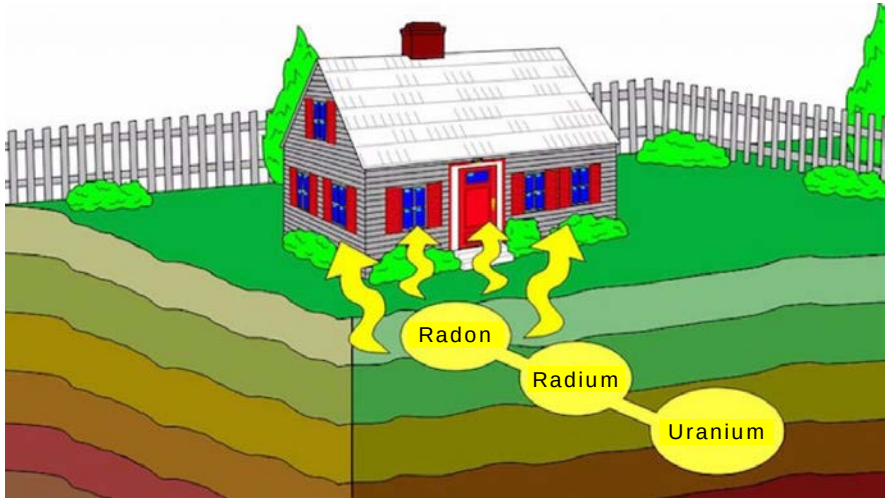
Bacteria, viruses, fungi/mould, bioaerosols.

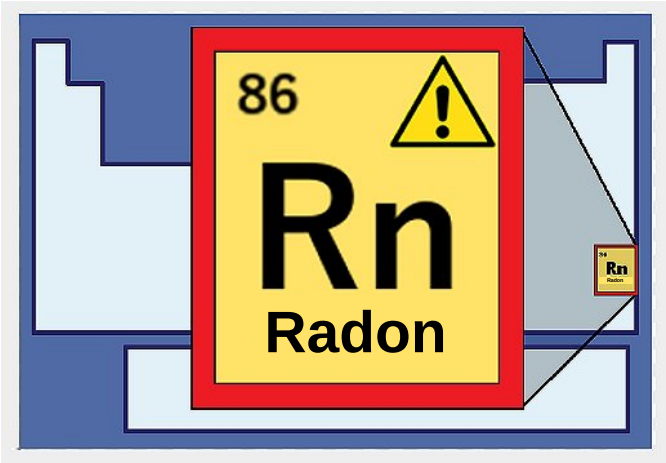
HUMIDITY

VORTICE

RADON

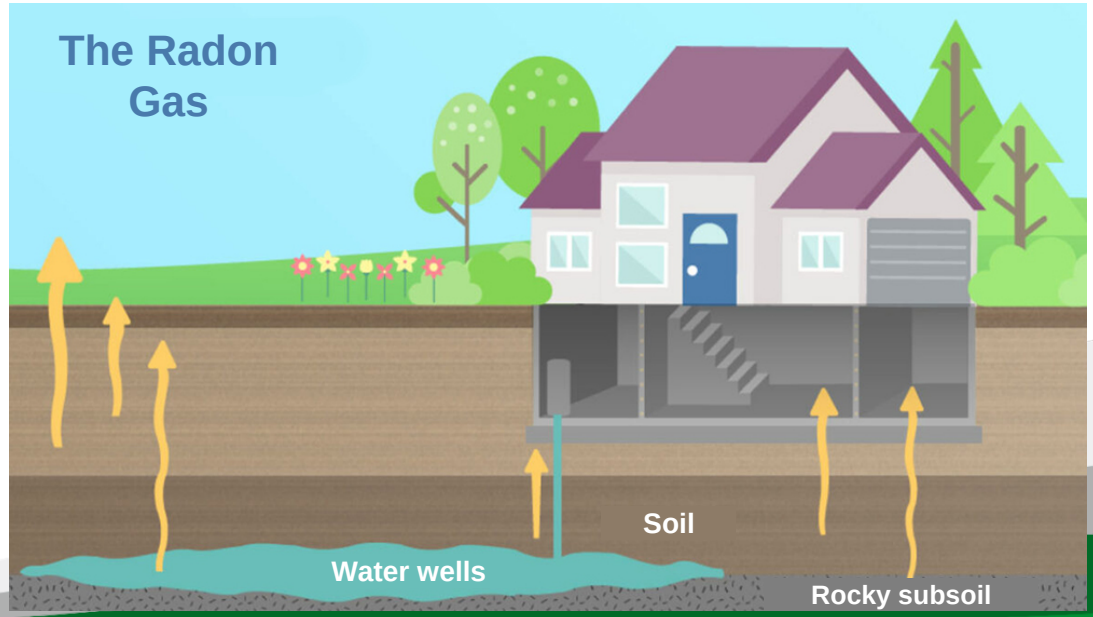
- Atomic number: 86.
- Derived from the radioactive decay of uranium in the earth's crust.
- It is a noble gas, unlikely to react with other elements.





RADON

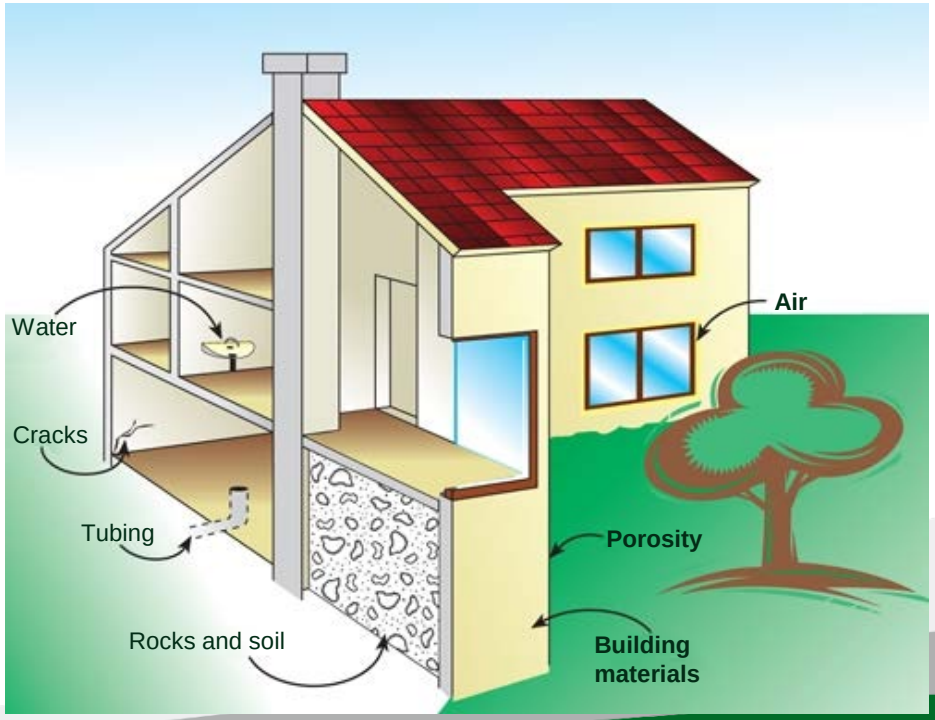
- It is released from soil and rocks (including building materials, especially if they are of volcanic origin... tuff, granite...).
- It may be present in groundwater.
- It is slightly present in the outside air (very diluted).



RADON

Rising to the surface, **it can penetrate homes**

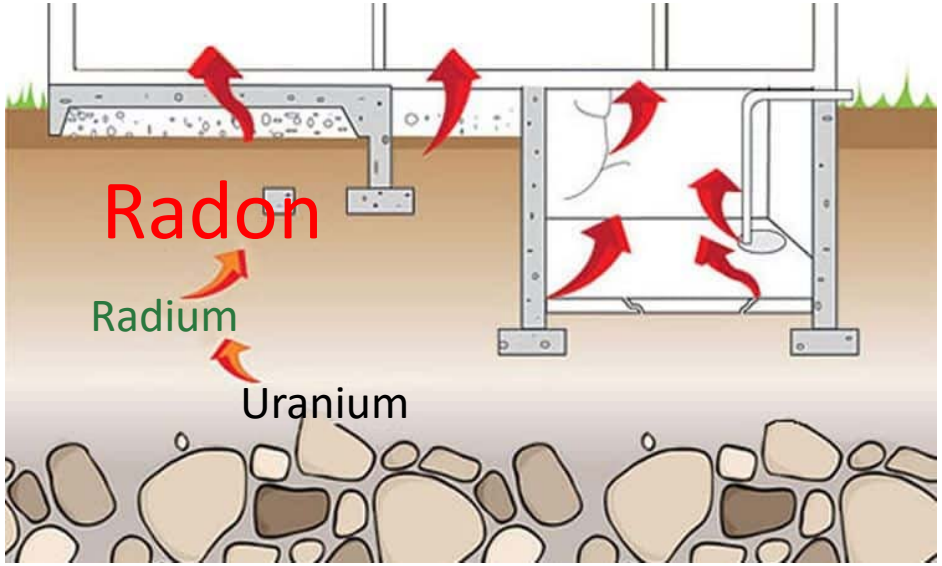
-directly from building materials
-through the porosity of the building envelope
-from the rocks in the soil
-from any cracks
-through domestic water
-through pipes
-(from outside air)



RADON

It is a heavy gas... about 8 times as heavy as air

Tends to stratify at the bottom



Radon concentration can become dangerous in rooms that are underground or in direct contact with the soil

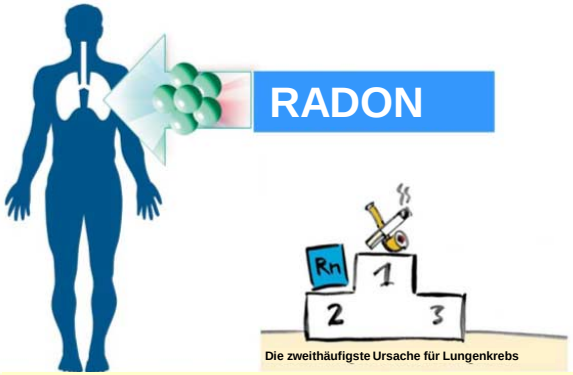
RADON: HEALTH RISKS

If inhaled it is not absorbed but expelled with exhalation...

But radioactive "descendants" are harmful if inhaled: they settle in the bronchial epithelium, cause carcinogenic diseases of the respiratory system

Radon is the second leading cause of lung cancer (after tobacco smoking) (*)

(*) source: WHO and AIRC epidemiological studies



Radon is ranked second, after smoking, as a cause for the occurrence of lung cancer
(Photo: Radon, Swiss Federal Office For Public Health - Bern, CH).

RADON: LEGISLATIVE FRAMEWORK

Radon concentration is measured in **Bq / m³**
(Bq = becquerel...
...activity of a radionuclide that has 1 decay per second)

RADON: HEALTH RISKS

USEPA (U.S. Environmental Protection Agency) estimates about **21,000 deaths per year in the U.S. attributable to residential radon**; **similar values have been estimated by studies in the European Union**.

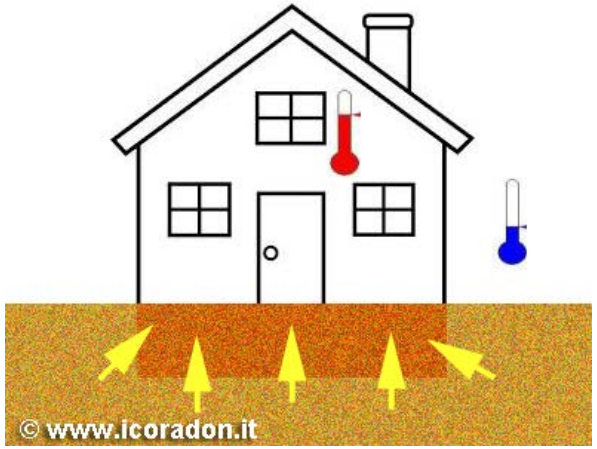
In **Italy**, it is estimated that approximately 1% of homes have a very high concentration of radon, greater than 400 Bq/m^3 and 4% greater than 200 Bq/m^3.
A **lifetime risk** is estimated to be around **0.5 percent** for lung cancer.
In addition, **5-15% of lung cancers occurring in Italy each year can be attributed to radon**.

RADON: PRESENCE IN BUILDINGS

The presence of radon in buildings depends on:

- Depression present in the premises (promotes the entry of radon-laden air)

- High airtightness "traps" radon inside

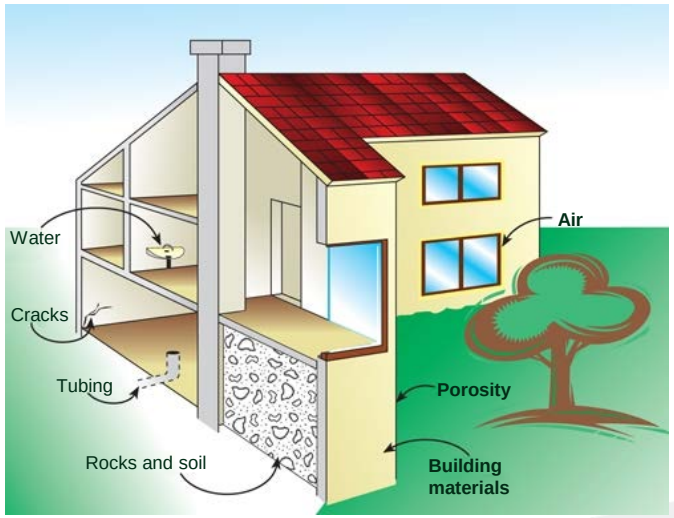


RADON: PRESENCE IN BUILDINGS

The presence of radon in buildings depends on:

- Microclimatic parameters (hindering the natural circulation of air)

- Building techniques
    - radon-containing materials (e.g., volcanic tuff, granite...)
    - cracks in the building envelope
    - technical systems



RADON: PRESENCE IN BUILDINGS

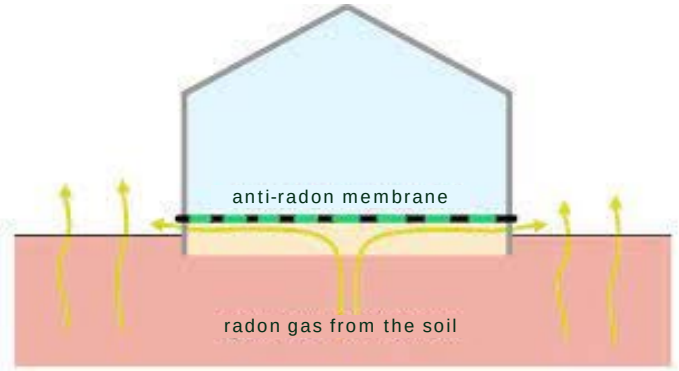
The concentration of radon in a home depends on many factors.
From the presence of uranium and radium in the soil and building materials, soil permeability, building techniques, and living habits.

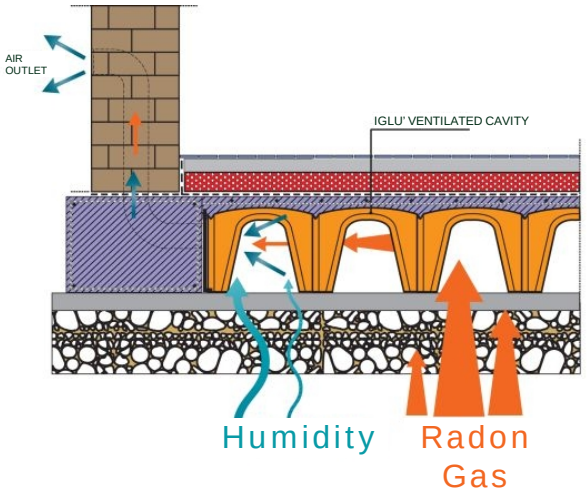
High levels of radon can be found everywhere.

RADON: HOW TO PROTECT YOURSELF

Preventing penetration from the ground and through the envelope
- Gas impermeable coatings laid at the foundation
- Sealing of cracks, fissures, joints
- Ventilated space
- **Subsoil air intake**

Ventilate the premises (window half-closed... or even better expulsion to the outside).

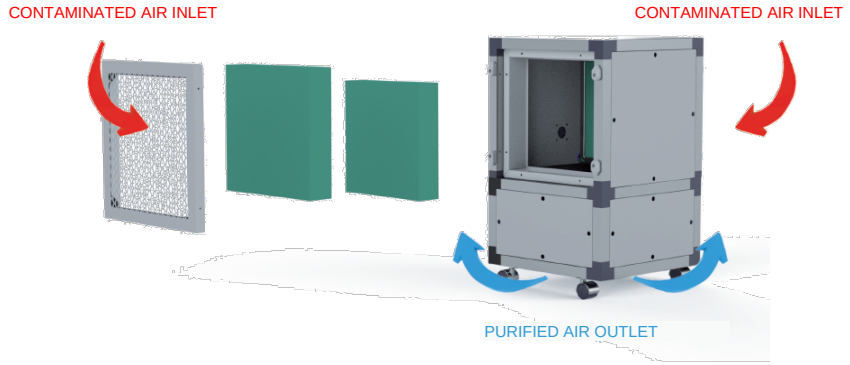




RADON: HOW TO PROTECT YOURSELF

PURIFICATION

Can control particulate matter, chemical pollutants, biological pollutants (FILTRATION)...
Does not remove CO2 and humidity...
Does not exchange air.



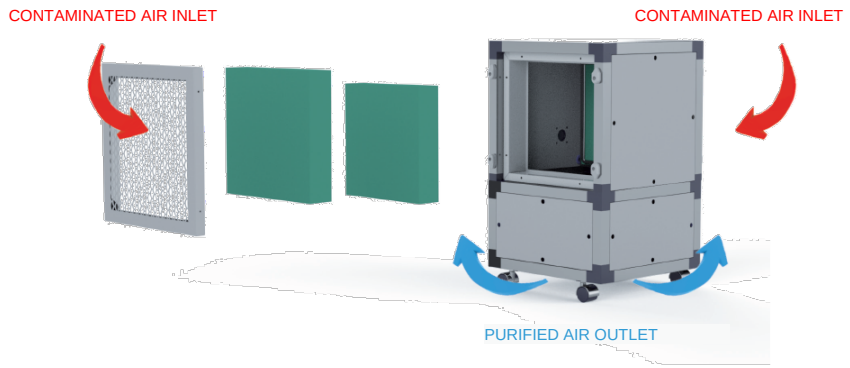
AERATION or VENTILATION

Can control pollutant level and relative humidity (DILUTION)...
Exchanges air (radon elimination).

RADON: HOW TO PROTECT YOURSELF

PURIFICATION

Can control [illegible]ter, chemical pollutants [illegible]nts (FILTR[illegible]...
Does n[illegible]remove CO2 and hu[illegible]idity...
Does not exchange air.



AERATION or VENTILATION

Can control pollutant level and relative humidity (DILUTION)...
Exchanges air (radon elimination).

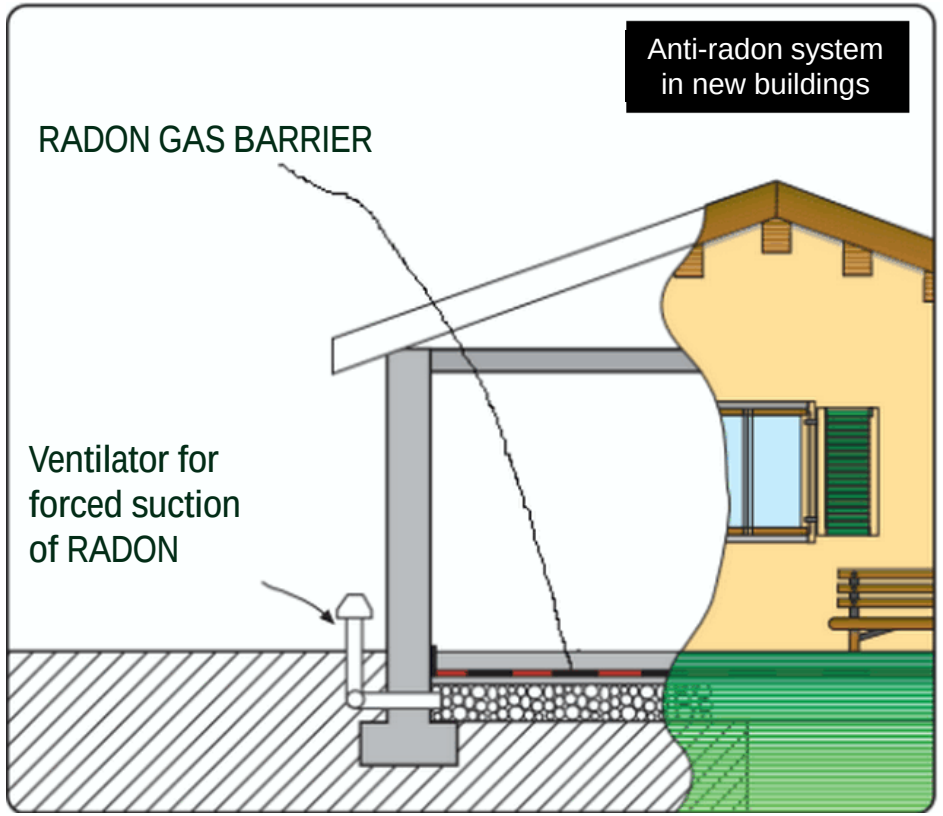
EXAMPLES OF VENTILATION SYSTEMS

In new buildings, the following measures can be used:

Radon gas barriers

Radon forced suction systems

Systems for radon inlet control by soil / indoor pressure difference



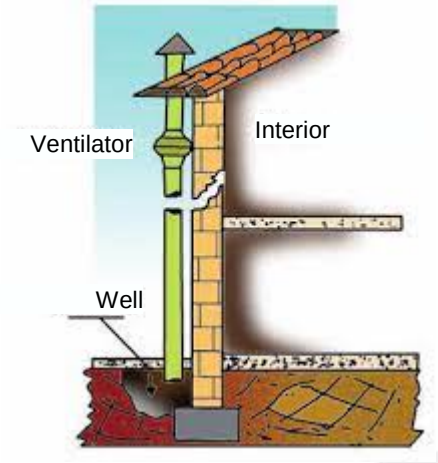
EXAMPLES OF VENTILATION SYSTEMS

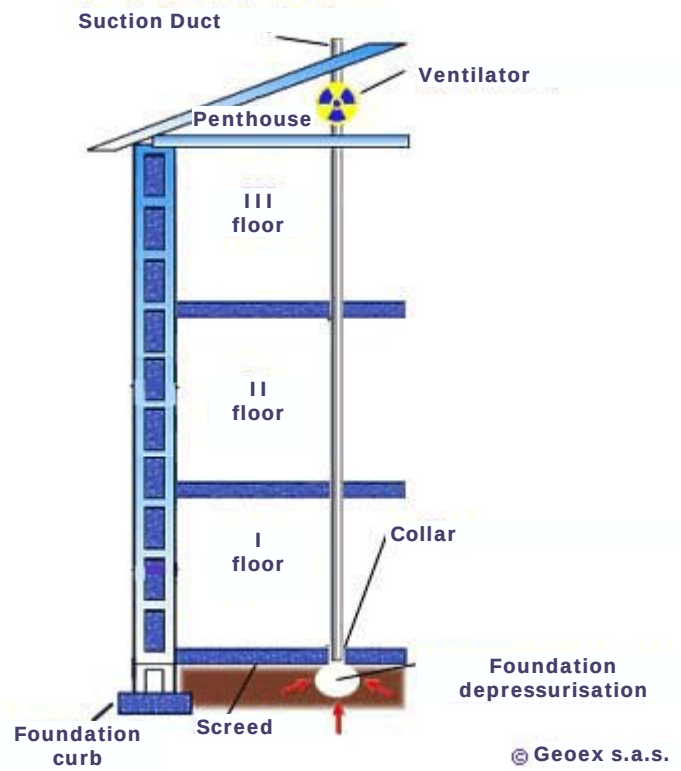
Foundation depressurisation

Ejection through an overhead duct

(Fans such as CA-RM RF ES can be placed at the end of a duct)

CA-RF





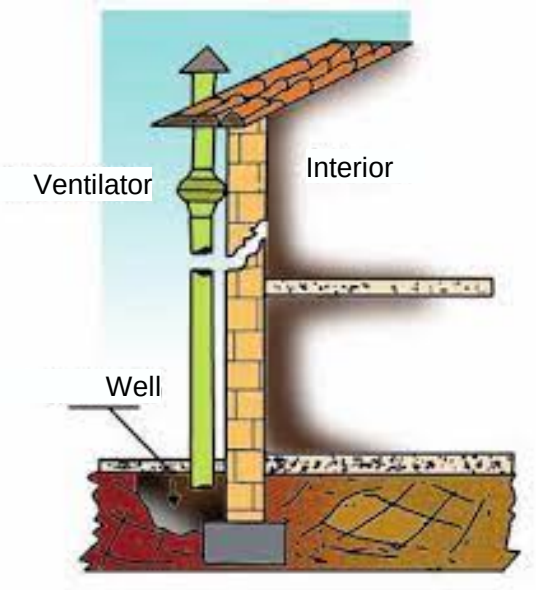
EXAMPLES OF VENTILATION SYSTEMS

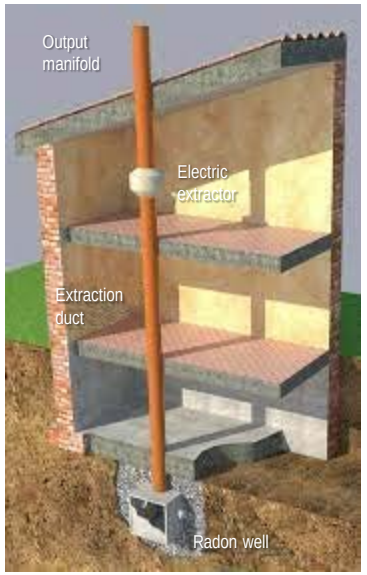
Insert photo

Air extraction from the ground

It has 2 effects:

- extracts radon-laden air from underground
- the depression created underground keeps radon-laden air from entering indoor environments

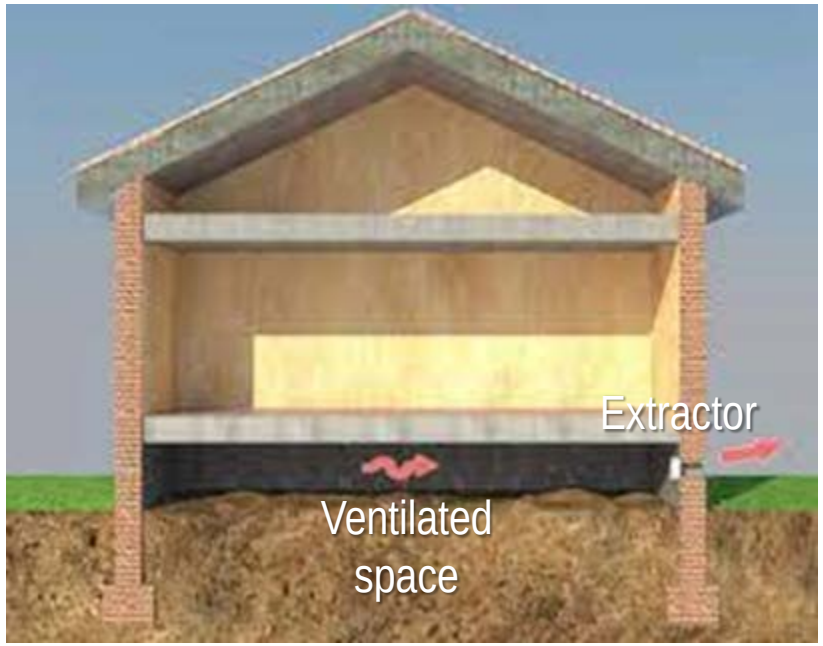




EXAMPLES OF VENTILATION SYSTEMS

Air extraction from the ventilated space

Free or ductable input ventilators
can be used

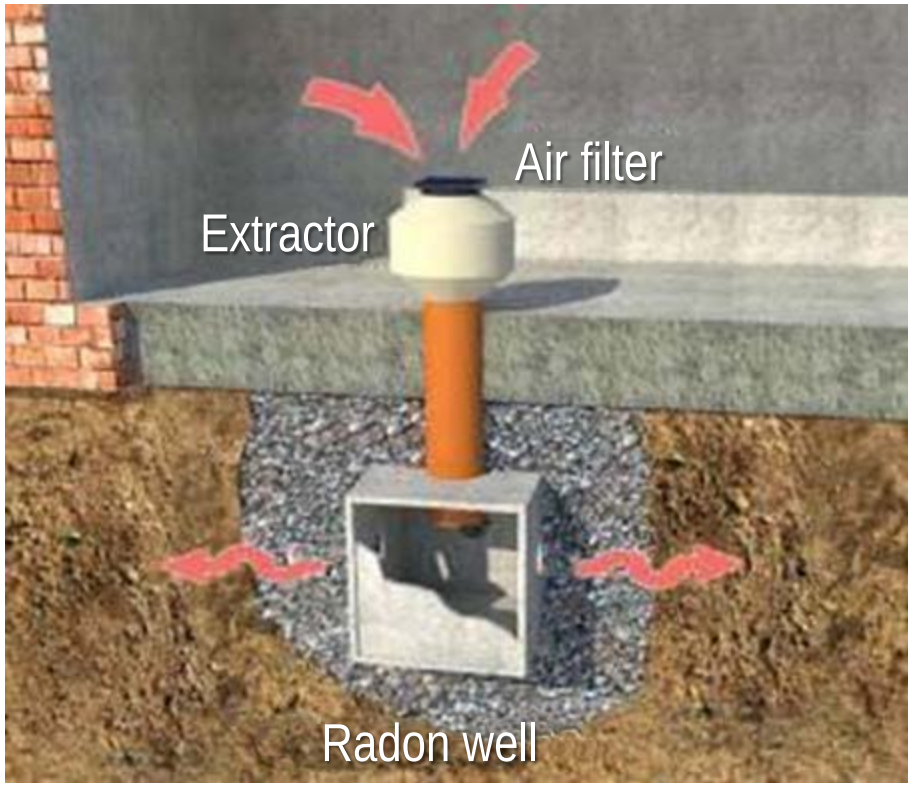


EXAMPLES OF VENTILATION SYSTEMS

Air extraction from interior rooms

- Expulsion through a radon well

(ventilators such as CA-RM ES can also be placed in the well)

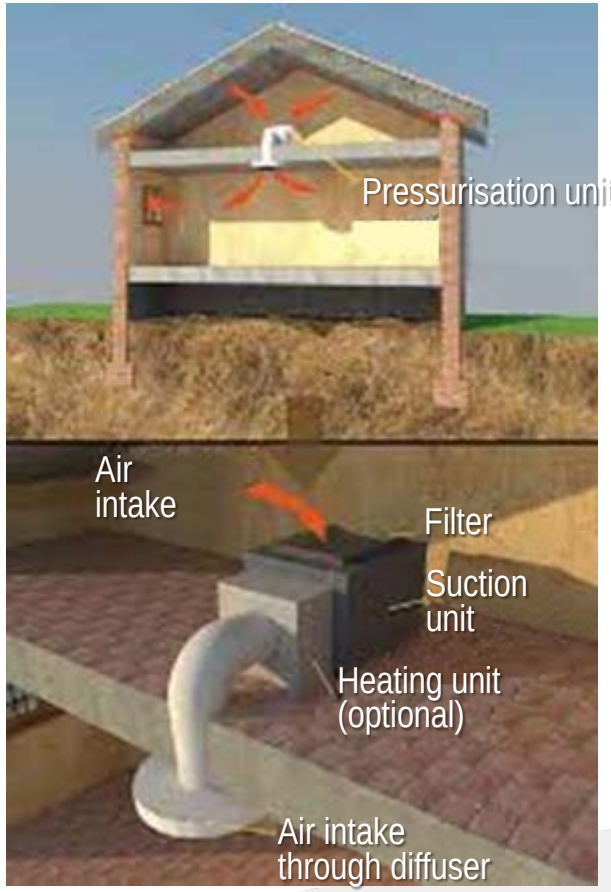


EXAMPLES OF VENTILATION SYSTEMS

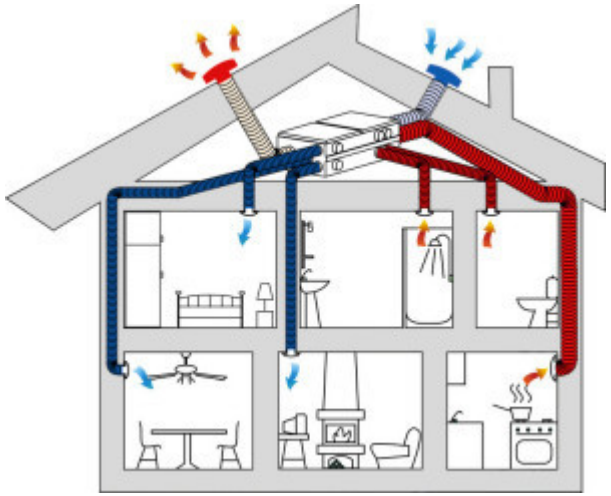
Indoor air intake

- overpressure in indoor rooms keeps out radon-laden air present underground

Free or ductable input ventilators can be used



EXAMPLES OF VENTILATION SYSTEMS



Controlled Mechanical Ventilation

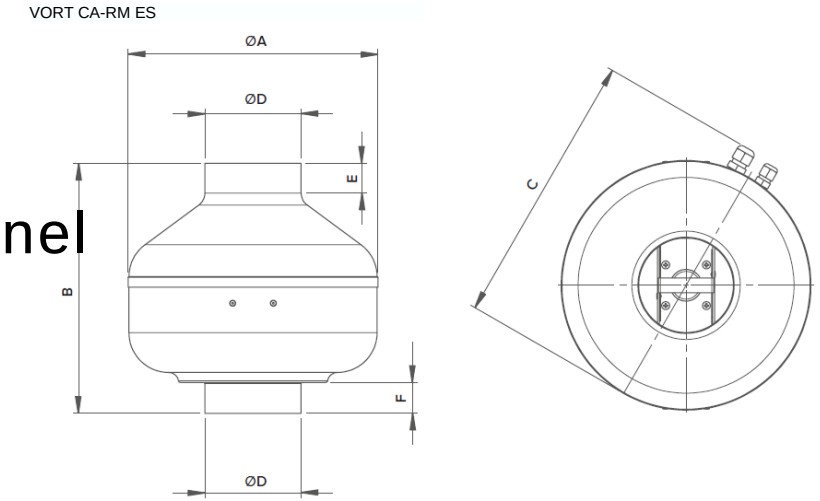
- Air exchange prevents the accumulation of radon gas in the rooms

Centralised and decentralised systems can be used

THE RADON-SPECIFIC VORTICE RANGE

VORT CA RM ES

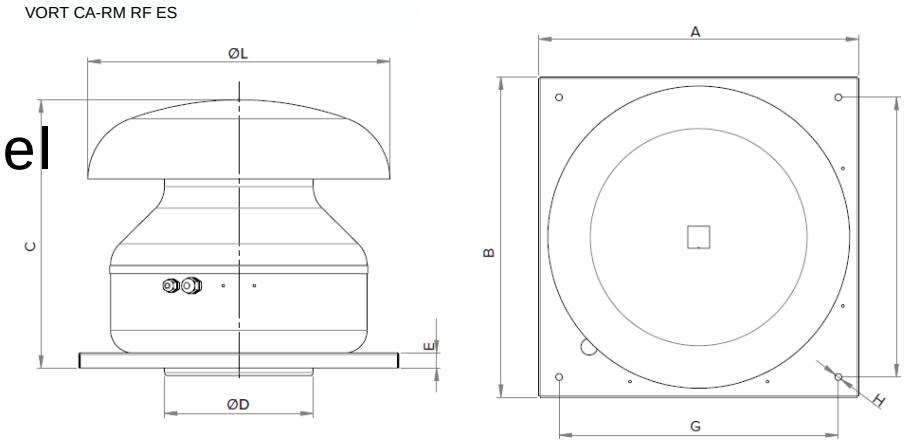
- Duct exhaust fan
- Diameters 100-125-150-160-200mm
- IPX7 (immersion watertight)
- Electronically controlled brushless motors
- Can be combined with dedicated control panel
- Possibility of installation in series



THE RADON-SPECIFIC VORTICE RANGE

VORT CA RM RF ES

- Rooftop suction unit
- Diameters 150-160-200mm
- IP45 (suitable for outdoor installation)
- Electronically controlled brushless motors
- Can be combined with dedicated control panel



THE RADON-SPECIFIC VORTICE RANGE

SICURBOX
remote control panel (optional)

- LCD display
- Independent performance control of 2 ventilators
- Ventilators power control
- Monitoring of regular ventilator operation
- Correct control of extracted flow (Flow switch supplied separately)
- Programming operation with weekly time slots
- Audible and visual signaling of operating errors
- Provision for connection to external alarm sirens

KINDERGARTEN AND LIBRARY RADON REMEDIATION OF THE MUNICIPALITY OF PIANTEDO (SO) - 2020

INITIAL DIAGNOSIS

SHORT DURATION MEASUREMENTS WITH CR39 DOSIMETRY

DOSIMETER EXPOSURE DURATION: 97 DAYS

Prog. No.	CODE DOSIMETER	START DATE	END DATE	LOCATION	EXPOSURE kBqh/m³	CONCENTRATION Bq/m³	UNCERTAINTY Bq/m³
1	96482	21-12-18 11:30	28-03-19 10:00	GR. FLOOR TOWN HALL - ARCHIVES	153	95	11
2	96474	21-12-18 11:30	28-03-19 10:00	GR. FLOOR TOWN HALL - MUSIC ROOM	215	93	14
3	96472	21-12-18 11:30	28-03-19 10:00	GR. FLOOR KINDERG. TEACHERS OFFICE	215	92	14
4	96450	21-12-18 11:30	28-03-19 10:00	GR. FLOOR KINDERG. KITCHEN	180	77	12
5	96551	21-12-18 11:30	28-03-19 10:00	GR. FLOOR PRIMARY TEACHERS OFFICE	151	65	11
6	96471	21-12-18 11:30	28-03-19 10:00	GR. FLOOR PRIMARY STORAGE ROOM	104	44	9
7	96468	21-12-18 11:30	28-03-19 10:00	GR. FLOOR CH.CARE OFFICE	3120	1340	140
8	96964	21-12-18 11:30	28-03-19 10:00	CH. CARE - MUNICIPAL LIBRARY	1300	558	61

VORTICE

KINDERGARTEN AND LIBRARY RADON REMEDIATION OF THE MUNICIPALITY OF PIANTEDO (SO) - 2020

PROJECT PLAN

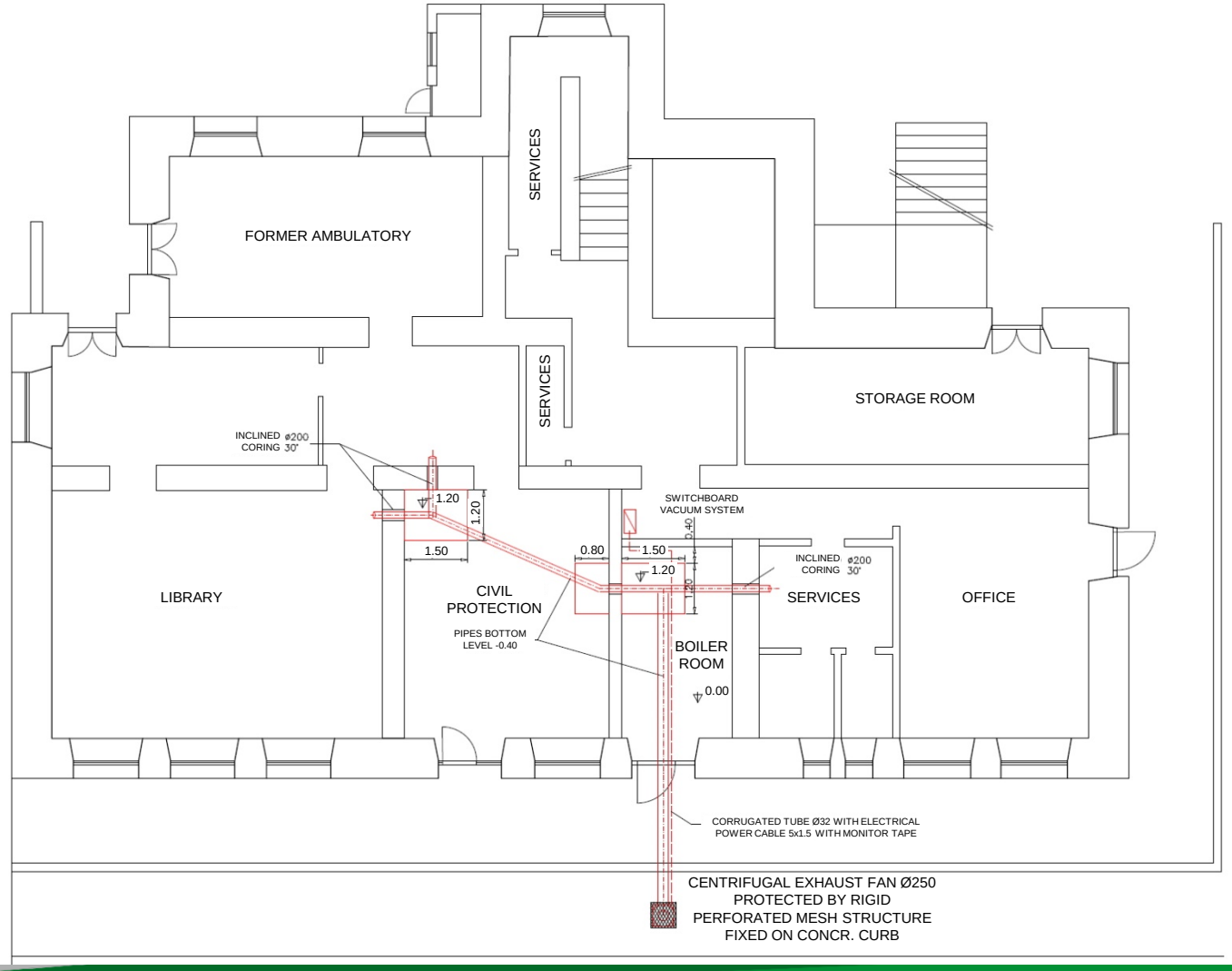
Urgent need for environmental remediation:

- *Design of interventions*
- *Research for funding - resources*

Single collection point with branched pipeline to increase the area affected by depression.

OBJECTIVE: To reduce demolition within the building as much as possible.

Ejection towards the garden being impossible to apply piping to the facade.



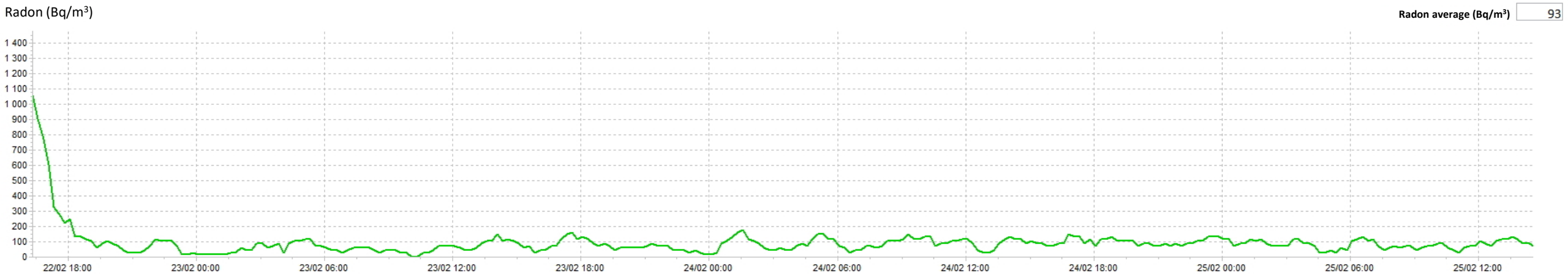
KINDERGARTEN AND LIBRARY RADON REMEDIATION OF THE MUNICIPALITY OF PIANTEDO (SO) - 2020

SITE IMAGES

Centrifugal duct exhaust fan normally for roof expulsion, adapted with insertion in perforated casing for protection against vandalism, for ground installation.

KINDERGARTEN AND LIBRARY RADON REMEDIATION OF THE MUNICIPALITY OF PIANTEDO (SO) - 2020

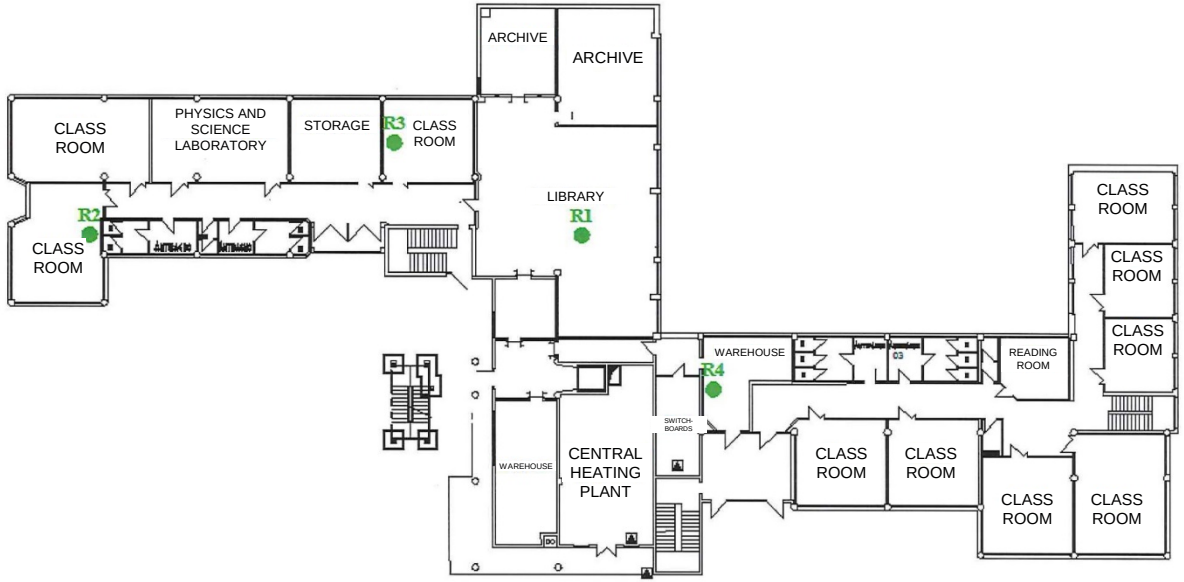
TESTING MEASURES:



GRAPH WITH ACTIVE MONITOR
OF RADON GAS CONCENTRATION IN THE LIBRARY
FROM THE SWITCHING ON OF THE SUCTION SYSTEM
(POWER 70%)

RADON REMEDIATION OF PROVINCIAL PRIMARY SCHOOL DE SIMONI (SO) - 2020

MEASURES BY AN EXTERNAL COMPANY:



Measurement No.	Location	Measurement start date	Measurement hours	Bq/m3	Error	Maximum value Bq/m3
R1	Library	17/12/2018 14.00 hrs	720	1,729 LTA	5% ± 5 Bq / m3	1815,40
				1,557 STA	5% ± 5 Bq / m3	1634,80
R2	Classroom	16/01/2019 8.30 hrs	338	142 LTA	5% ± 5 Bq / m3	149,10
				154 STA	5% ± 5 Bq / m3	161,70
R3	Classroom	06/05/2019 9.00 hrs	364	240 LTA	5% ± 5 Bq / m3	252,00
				154 STA	5% ± 5 Bq / m3	161,70
R4	Warehouse	21/05/2019 13.00 hrs	336	1,073 LTA	5% ± 5 Bq / m3	1126,65
				963 STA	5% ± 5 Bq / m3	1011,15

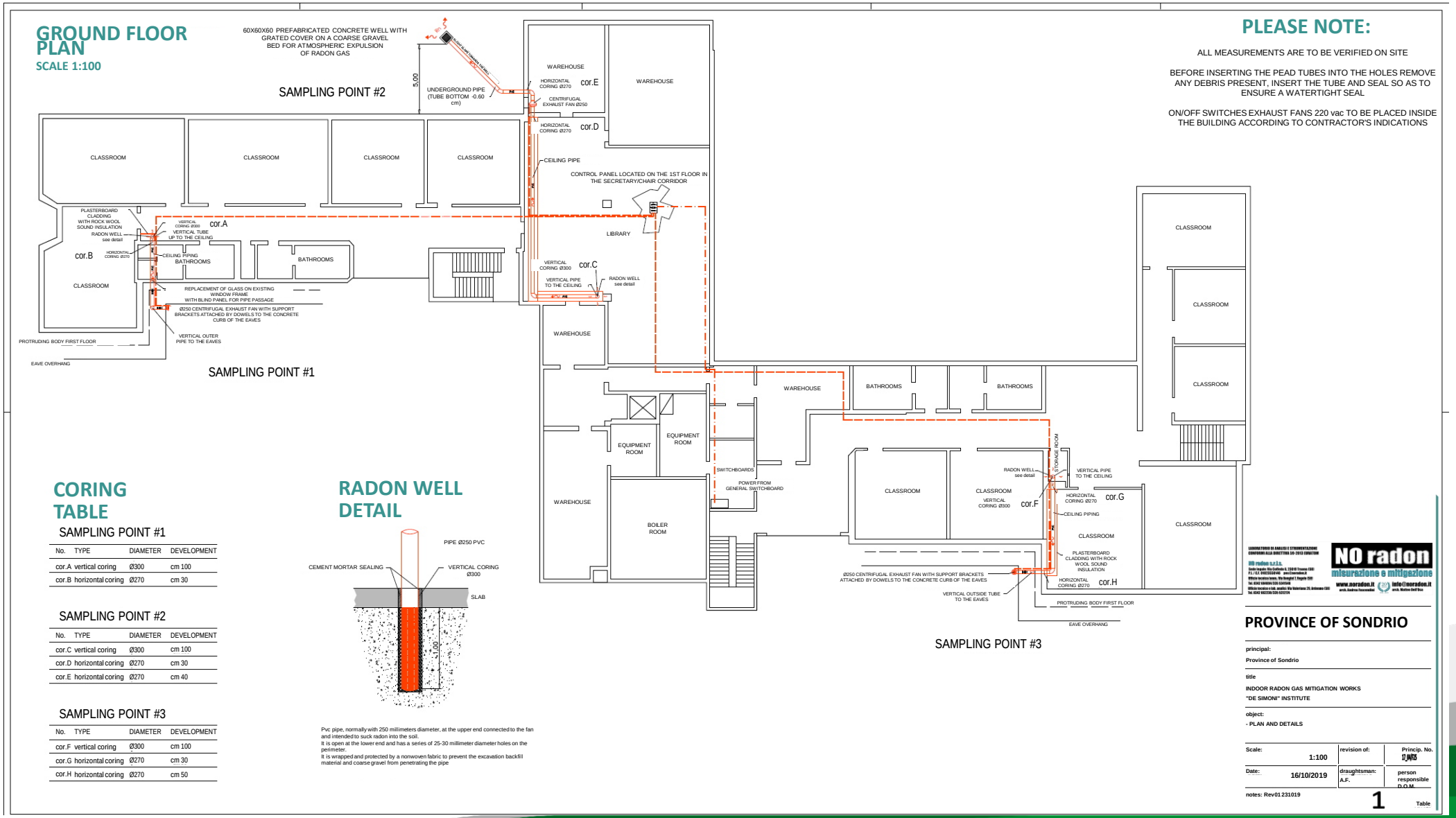
RADON REMEDIATION OF PROVINCIAL PRIMARY SCHOOL DE SIMONI (SO) - 2020

RADON DIAGNOSIS

OBJECTIVE:

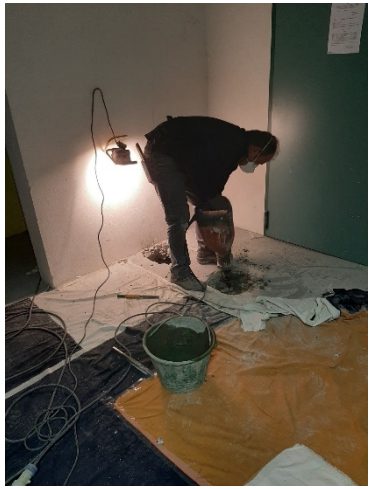
- *Identifying concentrations and entry points of radon gas into the building by active and passive short-term measurements in air and soil.*
- *Gathering necessary information about the building: presence or absence of ventilated spaces, crawl spaces, etc.*
- *Identifying the solutions to be proposed, with a thorough cost-benefit analysis.*
- *Final design.*

RADON REMEDIATION OF PROVINCIAL PRIMARY SCHOOL DE SIMONI (SO) - 2020



RADON REMEDIATION OF PROVINCIAL PRIMARY SCHOOL DE SIMONI (SO) - 2020

INSTALLATION OF 3 SYSTEMS



Creation of radon well

Piping

acoustic insulation

Control and diagnostic panel with siren and audible alarm

Internal exhaust fan with discharge into grated well

External exhaust fan with discharge beyond the eaves

VORTICE

RADON REMEDIATION OF PROVINCIAL PRIMARY SCHOOL DE SIMONI (SO) - 2020

PLANT TESTING WITH SHORT MEASURE

AIR RADON GAS CONCENTRATION ANALYSIS WITH ACTIVE MONITORS

Measurements made with: AERC monitors s/n 123-337-351-357
(instrumental testing and calibration on 25/02/2019)

AER C plus active monitors were placed as follows:

MEASUREMENT CAMPAIGN with AERC					
Prog. no.	INSTRUMENT SN	START DATE TIMETABLE	END DATE TIMETABLE	LOCATION	AVERAGE MEASURE (Bq/m^3)
1	337	30/04/20 10:30	08/05/20 16:00	LIBRARY	**51 Bq/m^3**
2	351	30/04/20 10:30	08/05/20 16:00	UNIVERSITY HALL	**54 Bq/m^3**
3	123	30/04/20 10:30	08/05/20 16:00	CLASSR. 19	**77 Bq/m^3**
4	357	30/04/20 10:30	08/05/20 16:00	CLASSR. 17	**94 Bq/m^3**

RADON REMEDIATION OF PROVINCIAL PRIMARY SCHOOL DE SIMONI (SO) - 2020

PLANT TESTING WITH SHORT MEASURE

DOSIMETER EXPOSURE DURATION: 7.23 DAYS											
Prog. no.	DOSIMETER CODE	INITIAL VOLTAGE	FINAL VOLTAGE	START DATE TIME	END DATE TIME	LOCATION	Range bottom (nGy/h)	Altitude ASL	Range bottom uncert.	MEASUREMENT (Bq/m^3)	UNC. %
1	SLJ325	608	559	30/04/20 10:30	07/05/20 16:00	CLASSR. 8	90	294	10	92	17
2	SLJ469	679	642	30/04/20 10:30	07/05/ 20 16:00	CLASSR. 6	90	294	10	60	21
3	SLJ324	617	570	30/04/20 10:30	07/05/ 20 16:00	CLASSR. 13	90	294	10	86	17
4	SLJ548	638	611	30/04/20 10:30	07/05/ 20 16:00	SOUTH WAREHOUSE	90	294	10	36	31
5	SLJ609	687	658	30/04/20 10:30	07/05/ 20 16:00	LIBRARY	90	294	10	40	29
6	SLJ524	698	656	30/04/20 10:30	07/05/ 20 16:00	CLASSR. 21	90	294	10	72	19
7	SLJ367	627	590	30/04/20 10:30	07/05/ 20 16:00	CLASSR. 18	90	294	10	61	21
8	SLJ623	699	671	30/04/20 10:30	07/05/ 20 16:00	BASEMENT OFFICE	90	294	10	37	30

Passive electret dosimetry E-Perm

VORTICE

RADON REMEDIATION OF PROVINCIAL PRIMARY SCHOOL DE SIMONI (SO) - 2020

MEASUREMENT OF ANNUAL AVERAGE RADON GAS CONCENTRATION IN AIR

Technical report in accordance with Leg. Decree of 31 July 2020 Article 17 paragraph 6

No. of report and issue date: **MA20-231 dated 06/10/2021**

Operator: **State Technical Institute "A. De Simoni - M. Quadrio" – Tax Code 93023670149**

Location of measurement: **Via Tonale, 14 - Sondrio**

Measurement laboratory: **MIAM Ltd. Via Bolzoni 30 - Piacenza (PC)**

The values of annual average airborne Radon concentration measured according to the following technical specifications are hereby reported:

Test method: **ISO 11665-4:2020**

Measurement technique: **Integration with SSNTD detectors type CR-39**

Device type: **Radon dosimeter model Radout® CR-39**

Analysis system: **Politrak® automatic reader**

Results refer to the Test Report with identifier: **CR21-0511**

Floor Room	Description Room	Code Device	Measurement Start Date	Measurement End Date	Radon concentration [Bq/m³]	Uncertainty [Bq/m³ - k=2]
UND. FL.	01 - Classroom 17	M138753	08/07/2020	08/07/2021	**50**	**9**
UND. FL.	02 - Classroom 17	M138701	08/07/2020	08/07/2021	**47**	**8**
UND. FL.	03 - Classroom 18	M139673	08/07/2020	08/07/2021	**68**	**11**
UND. FL.	04 - Classroom 18	M139698	08/07/2020	08/07/2021	**34**	**6**
UND. FL.	05 - Classroom 19	M138738	08/07/2020	08/07/2021	**45**	**8**
UND. FL.	06 - Classroom 19	M138746	08/07/2020	08/07/2021	**37**	**7**
UND. FL.	07 - Classroom 20	M138725	08/07/2020	08/07/2021	**41**	**7**
UND. FL.	08 - Classroom 21	M138714	08/07/2020	08/07/2021	**33**	**6**
UND. FL.	09 - Library	M138744	08/07/2020	08/07/2021	**76**	**12**
UND. FL.	10 - Library	M138742	08/07/2020	08/07/2021	**109**	**17**
UND. FL.	11 - Library	M138736	08/07/2020	08/07/2021	**59**	**10**
UND. FL.	12 - Classroom 13	M138723	08/07/2020	08/07/2021	**38**	**7**
UND. FL.	13 - Classroom 12	M136869	08/07/2020	08/07/2021	**36**	**7**
UND. FL.	14 - Classroom 10	M136842	08/07/2020	08/07/2021	**40**	**7**
UND. FL.	15 - Classroom 9	M136853	08/07/2020	08/07/2021	**54**	**9**
UND. FL.	16 - Classroom 9	M136856	08/07/2020	08/07/2021	**43**	**8**
UND. FL.	17 - Classroom 8	M136866	08/07/2020	08/07/2021	**85**	**14**
UND. FL.	19 - Classroom 6	M136854	08/07/2020	08/07/2021	**46**	**8**

References to current regulations:

The value of the reference level for the annual average concentration of Radon activity indicated by Leg. Decree of 31 July 2020, No. 101 is 300 Bq/m³ (Art. 12(1)(c).

If the reference level is exceeded, the operator sends a communication containing a description of the activities carried out and this technical report to the Ministry of Labour and Social Policy, as well as to ARPA/APPA, National Health Services bodies and the National Labor Inspectorate (INL) office with territorial jurisdiction. The communication and technical report shall be sent within one month after the issuance of the same by the body that carried out the measurement (Leg. Decree of 31 July 2020, No. 101, Art. 18(2)). If the reference level is exceeded, the operator is also required to comply with the provisions of Art. 17(3), (4) and (5) of the aforementioned decree.

The Legal Representative

arch. Matteo Dell'Oca

The Technical Manager

Arch. Andrea Fascendini

NO radon srls
Sede Leg.: Via Coffedo 6 - 23019 Traona (SO)
P.I. e CF: 01023550146
Sede Amm.: Via Bongini 7 - 23010 Rogolo (SO)
Tel. 0342 684.694
Sede Tec.: Via Valeriana 29 - 23011 Ardenno (SO)
Tel. 0342 662.230
www.noradon.it - info@noradon.it

VORTICE

RADON REMEDIATION OF GORDONA (SO) KINDERGARTEN

BUILDING COMPLETELY ABOVE GROUND

DOSIMETER EXPOSURE DURATION: 21.02 DAYS

Prog. no.	DOSIMETER CODE	INITIAL VOLTAGE	FINAL VOLTAGE	START DATE TIME	END DATE TIME	LOCATION	Range bottom (nGy/h)	Altitude ASL slm	Range bottom uncert.	MEASUREMENT (Bq/m³)	UNC. %
1	LW1992	584	446	17-04-19 10:30	08-05-19 11:00	KINDERGARTEN SWITCHBOARD ROOM	90	300	10	1423	8
2	LW1925	511	489	17-04-19 10:30	08-05-19 11:00	KINDERGARTEN PANTRY	90	300	10	201	15
3	LV6060	601	335	17-04-19 10:30	08-05-19 11:00	PRIMARY SCHOOL WAREHOUSE	90	300	10	2814	8
4	LV5989	556	531	17-04-19 10:30	08-05-19 11:00	PRIMARY SCHOOL PRINCIPAL	90	300	10	230	14
5	LS0418	298	280	17-04-19 10:30	08-05-19 11:00	PRIMARY SCHOOL TEACHERS ROOM	90	300	10	173	17
6	LS0759	358	343	17-04-19 10:30	08-05-19 11:00	PRIMARY SCHOOL CONFERENCE HALL	90	300	10	135	20

INITIAL DIAGNOSIS

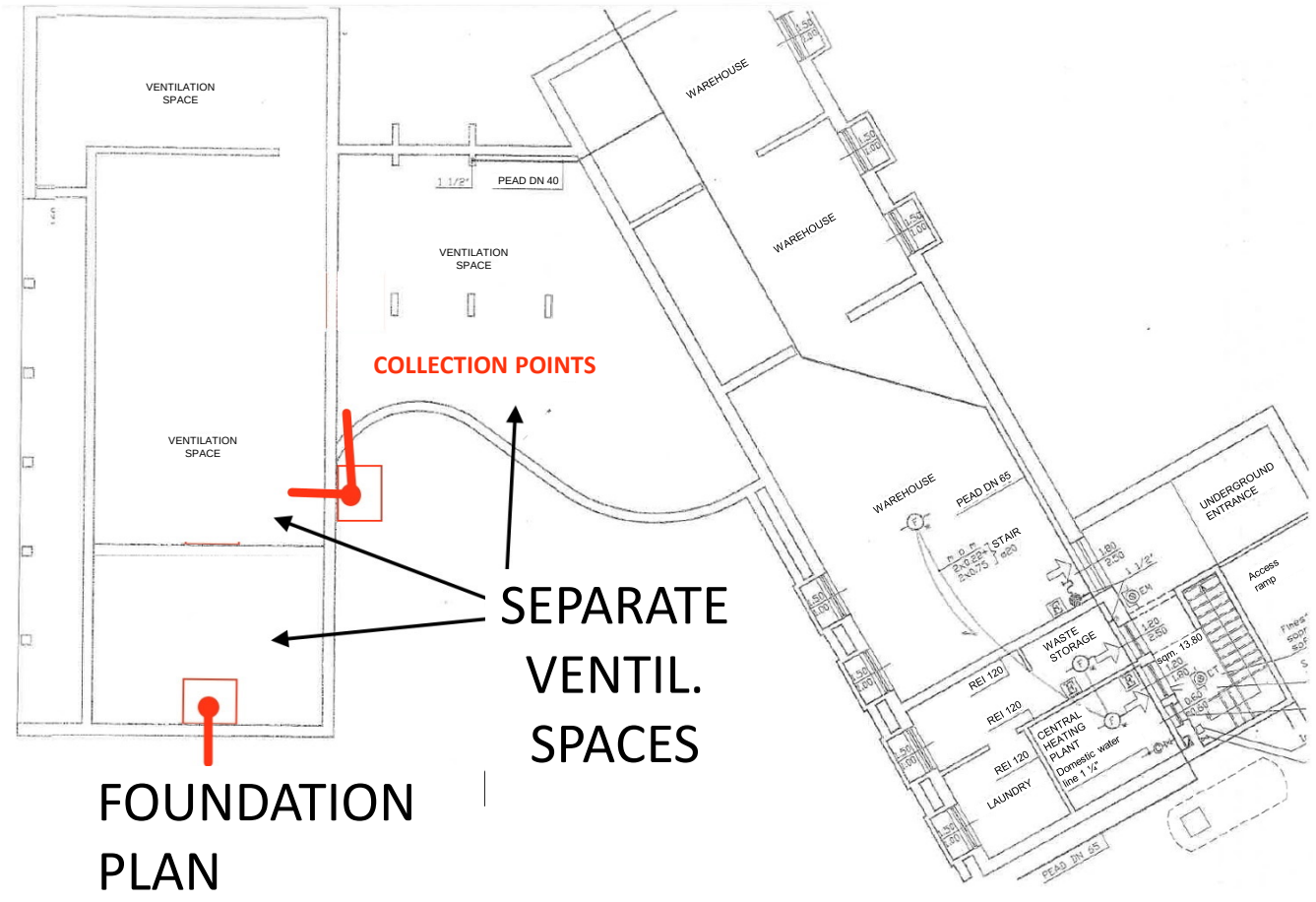
A short measurement with Eperm dosimetry of all municipal buildings is carried out, finding a high concentration on the ground floor of the Kindergarten and in the warehouse of the Primary School.

Renovation work is planned on the Primary School so it is decided with the administration to proceed with the remediation of the Kindergarten.

VORTICE

RADON REMEDIATION OF GORDONA (SO) KINDERGARTEN

BUILDING COMPLETELY ABOVE GROUND



FACT-FINDING SURVEY

A check in the archives leads to the design board showing three unconnected ventilation spaces:

- *The presence of ventilation spaces is clearly an advantage;*
- *The ventilation spaces, however, are separate so we plan three intake points, the first with double intake and discharge beyond the roof eaves, and the second with discharge into a ground grated well in the garden.*

RADON REMEDIATION OF GORDONA (SO) KINDERGARTEN

BUILDING COMPLETELY ABOVE GROUND

Corings

T-connection

RADON REMEDIATION OF GORDONA (SO) KINDERGARTEN

BUILDING COMPLETELY ABOVE GROUND

Sidewalk coring and cutting

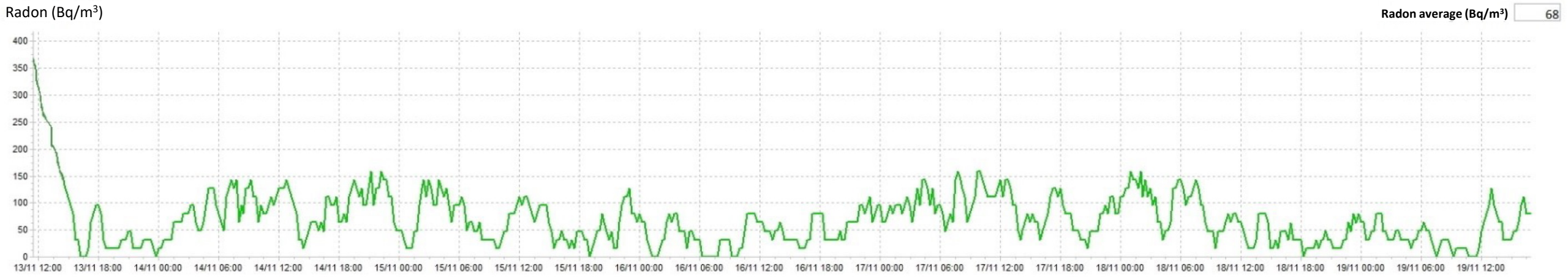
Laying of the well for exhaust fan housing and expulsion grated well

Work completed

RADON REMEDIATION OF GORDONA (SO) KINDERGARTEN

BUILDING COMPLETELY ABOVE GROUND

Testing - verification with active monitor



Measurement in the central atrium: since the system was turned on, there is a significant decrease in indoor concentration (60% power).

INDOOR AIR POLLUTANTS

Radon: issues and solutions