

The image features the word "AYKOW" in a stylized, white, 3D block font. The letters are thick and have a slight shadow, giving them a three-dimensional appearance. The background is a solid, medium-blue color. To the left of the text, there is a faint, light-blue waveform or signal line that extends across the width of the image, suggesting a dynamic or data-related theme.

**Dynamic Radon Detection Over Measurement**

# Introduction

Nuclear Engineer, specialised in detection of nuclear particles, instrumentations and radioprotection.

**Person in charge of radioprotection.**

Worked for nuclear industries during 10 years, in field of Uranium enrichment, Nuclear power plant and Research.

I was specialise in Neutron Particles and Gamma-X radiation.

Funder of AYKOW in 2011



# Fact 1 : Radon concentration

Radon is dangerous at very low concentration.

Radon is detectable only because it is radioactive.

$200\text{Bq}/\text{m}^3 \approx 1 \times 10^{-11} \text{ppb}$

The carbon monoxide start to be dangerous for 40.000ppb.

If all radon in the air was caught at this moment, Radon atoms cannot fill a bottle of 1 liter under atmospheric pressure.



# Radioprotection Measurement

In Radioprotection; Dose is important,  
not the Activity.

Dose/Year  $\approx 0.125 \times A_r \times F \times R_{io}$  (for public - approximation using the **ICRP** and **UNSCEAR** data - dose conversion factor  $9.0 \times 10^{-6}$  mSv/h per Bq/m<sup>3</sup>)

$A_r$  : Radon Activity

$R_{io}$  : Ratio of indoor occupancy at home, generally define at 80% indoor

$F$  is the Equilibrium Factor

Typical values are 0.4 for indoors and 0.6 for outdoors.

Indoor, with 200Bq/m<sup>3</sup> the dose is about 8mSv/year if you spend 80% of your time at home.

# Classical Radioprotection for Radon?

Applying legislation of Radioactivity monitoring at work for a House with Radon.

## Radioprotection criteria :

If your home was a work place :

**100Bq/m<sup>3</sup>** of Radon = **Monitored area**

**1.300Bq/m<sup>3</sup>** of Radon = **Controlled Area**

Over **4.500Bq/m<sup>3</sup>** of Radon you need an **Authorisation** from a person in charge to go in.

<b>zone bleue</b>	de 0,5 à 7,5 $\mu\text{Sv}$ reçus en 1 h	zone surveillée	
<b>zone verte</b>	de 7,5 à 25 $\mu\text{Sv}$ reçus en 1 h	zone contrôlée	
<b>zone jaune</b>	de 0,025 à 2 $\text{mSv}$ reçus en 1 h	zone contrôlée (spécialement réglementée)	
<b>zone orange</b>	de 2 à 100 $\text{mSv}$ reçus en 1 h	zone contrôlée (spécialement réglementée)	
<b>zone rouge</b>	plus de 100 $\text{mSv}$ reçus en 1 h	zone interdite	

Generally, people spend more than 5.200h at home.

Doses receive with **200Bq/m<sup>3</sup>** at home => Necessity to have a licence for >6mSv/y with regular medical check-up.

More Radiation at home than at work. (EDF nuclear agent = 1.8mSv/y, in Canada all are <1mSv/y)

# An other approach of Radioprotection

May we use Radioprotection from nuclear industry for Radon?

Radioprotection rules :

1. Distance
2. Time of exposition
3. Radiation Shield

Radon is a specific problem of Radioprotection. Home is not a work place.

According the Canadian Cancer Society, 51% of Canadian are ready to move if their home had Radon.

**Other solutions are possible.**



# Limitation : Activity to Dose!

The Calculation of Dose is too much depending of the Equilibrium Factor.

No radon detector measure the Equilibrium Factor.

$$F = \frac{0.106 C_{Po218} + 0.514 C_{Pb214} + 0.380 C_{Bi214}}{C_{Rn-222}}$$

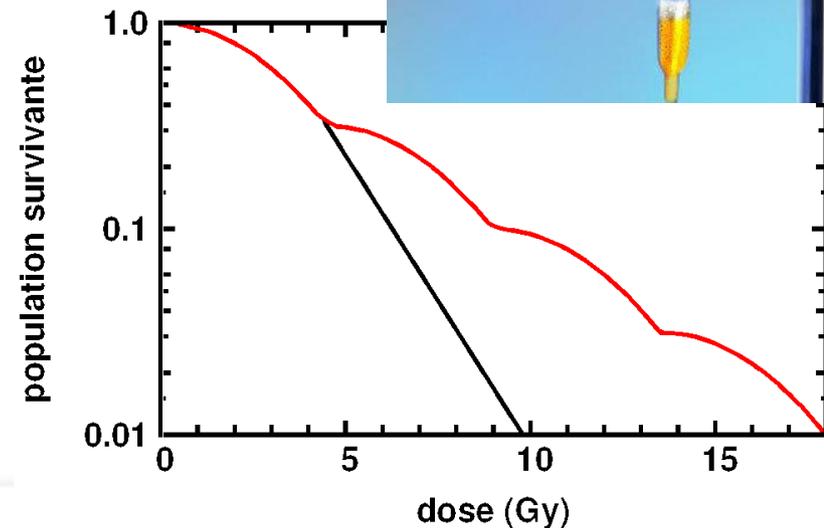
The dose is not received drop by drop.

But Radon is a dynamic gas.

For the same activity of Radon, a room ventilated with few dust is worst than in a room with a poor air ventilation.

200Bq/m<sup>3</sup> (F=0.6)= 11.9mSv/year

200Bq/m<sup>3</sup> (F=0.4)= 8mSv/year



# Radon Dosimeter ?

Radon Dosimeter measures the Activity, not the dose.  
They are “*Activitymeter*”, not dosimeter!

The Equilibrium Factor are generally considered at 0.4  
in the Calibration.

Most of Radon electronic sensors are measuring Radon  
level via the  $^{218}\text{Po}$ .

The Equilibrium factor is not measured, thus the value  
between 2 different technology of Radon dosimeters  
may change because of this factor.

Dosimeter are not adapted to the dynamic  
Variation of Radon.



LR115 open Dosimeter



CR39 Closed Dosimeter

# Measurement

Measure by dosimeter is very important in order to identify the problem and more it is done early more the risk could be reduce.

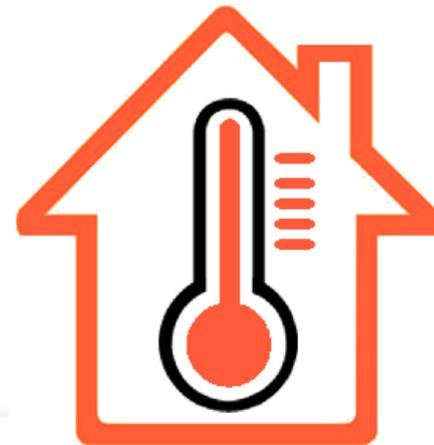
But this measure is just an indicator and not a real radioprotection value or a cure.

The measure is too long to obtain for the real estate market.

A new kind of Radon detector may improve the measure and be complementary for the mitigation approach.



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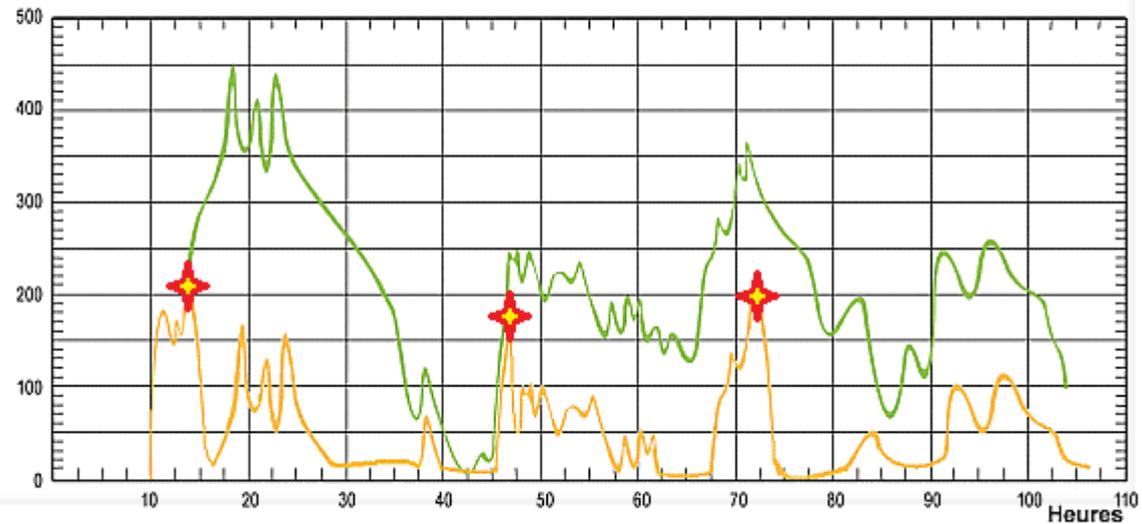
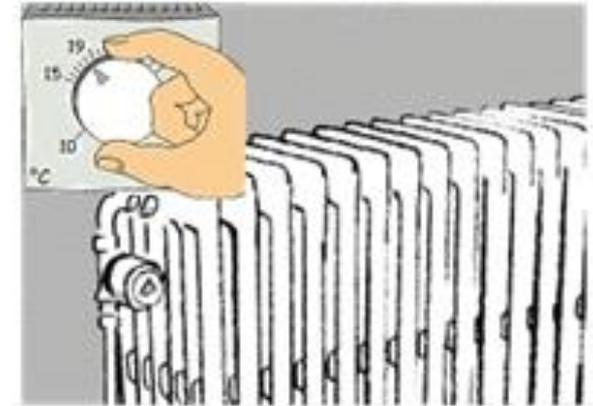
# Dynamic Detection without measure

At the origin, to control the temperature the thermostat was made with bimetel.

Dosimeter are too slow in measurement to be use to control the Radon Level.

Save energy by switching mitigation device only when it's useful.

Regulate the Radon level efficiently by straight actions.



## Fact 2 : Act in Real time

**Reduce Radon is the best solution for Radioprotection.**

Radon is increase fast on short time.

To reduce Radon efficiently no need to have windows open all the day.

**Radon is like the  
Smell of Cooking**  
Ventilating at the  
Good moment!



# From idea to smart sensor

Radon ventilation have low effect.

Detect the Radon and not the fission products of Radon.

Clever Threshold, and not just everything or nothing.

Anticipate the Radon Peak by smart algorithm.

Piloting mitigation device to save energy and increase life time of materials.

Simplifying the mitigation device and installations.

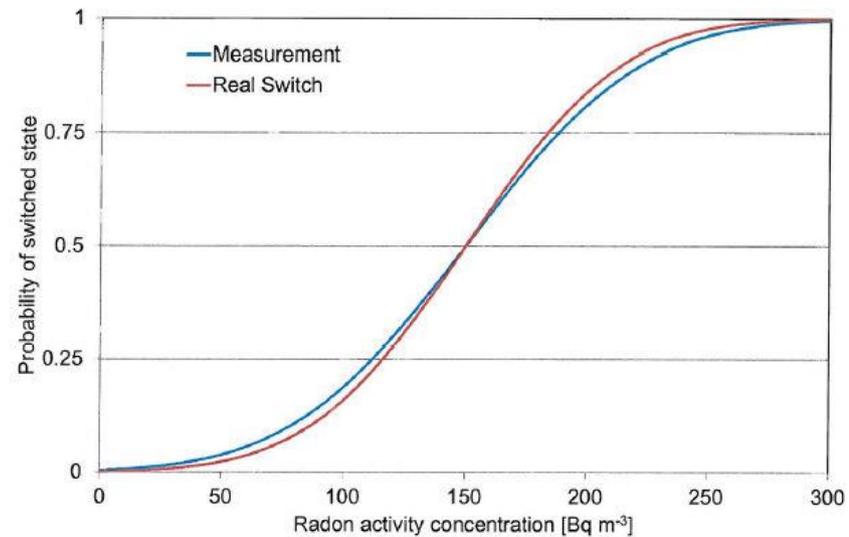
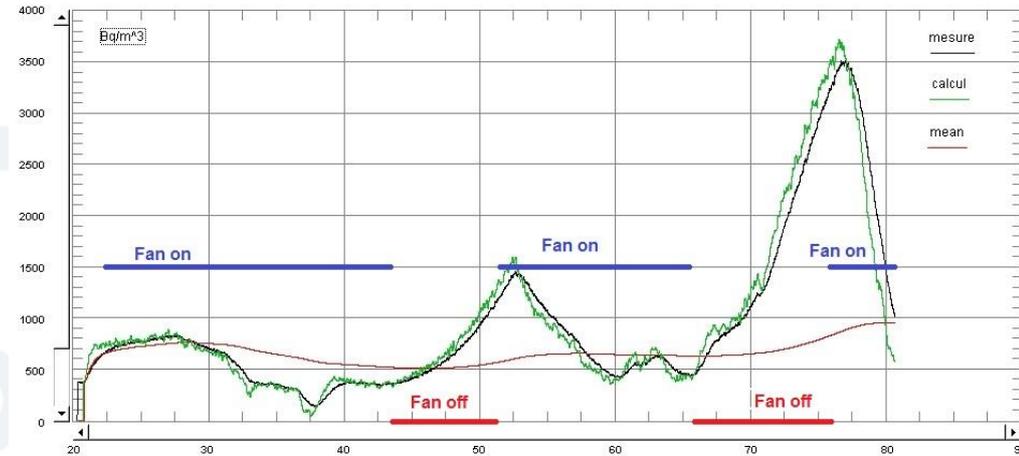


Figure 2: Model of the influence of measurement uncertainty on the switching behaviour for real switch

# Radon Alarm

Know if Radon level is over sanitary level without to wait result of measurement.

Alarm in Real time and open windows.

Transportable or in the place

Easy to understand like a carbon monoxide detector or fire Alarm.



# Radostat

Control in real time the Radon level.

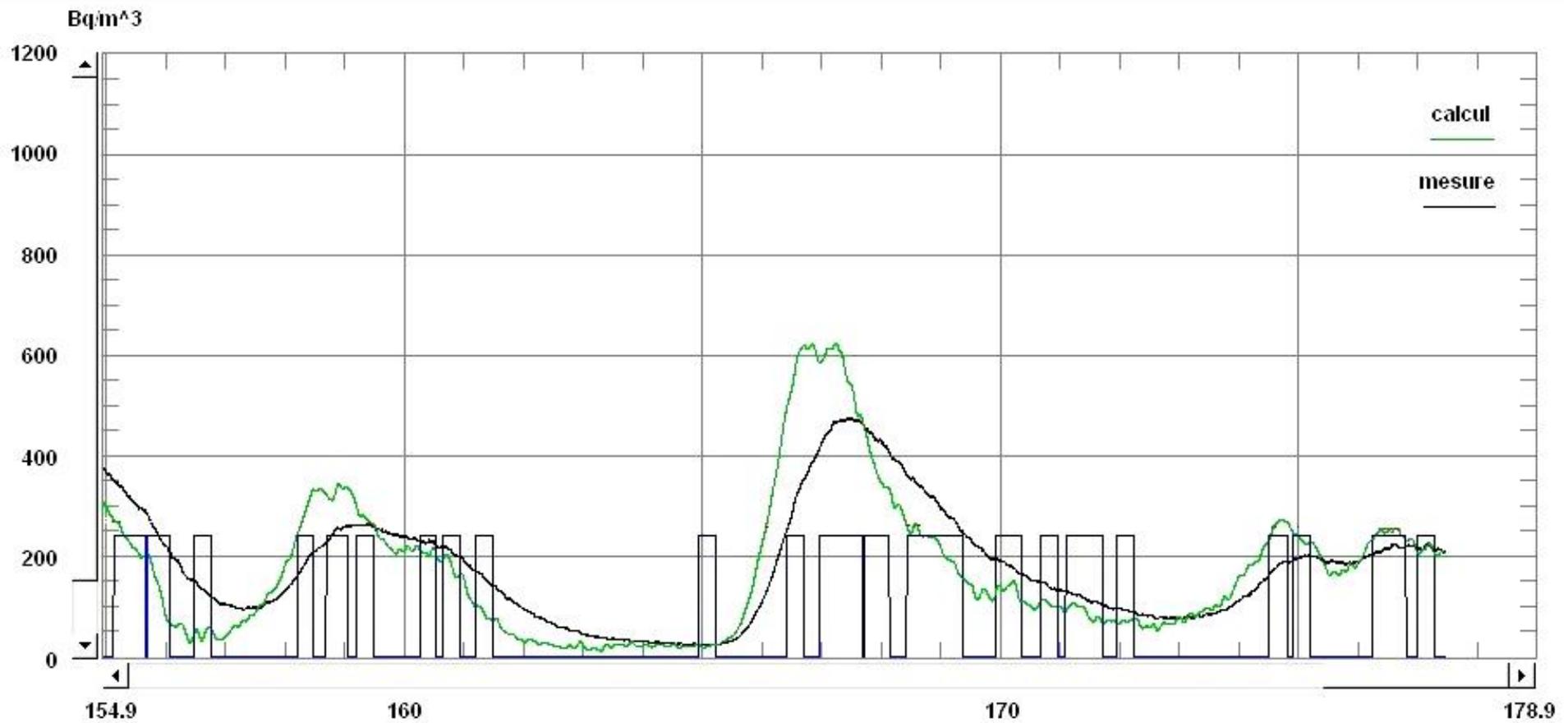
Drive mitigation device to save Energy and increase the mitigation device life time.

Propose a solution to make easy the installation of radon mitigation device.



# Radostat

aykow.



# Detection and Measure

Alarm Function

Dos

Rad

Rad

Dyn

Maj

Maj

Con

