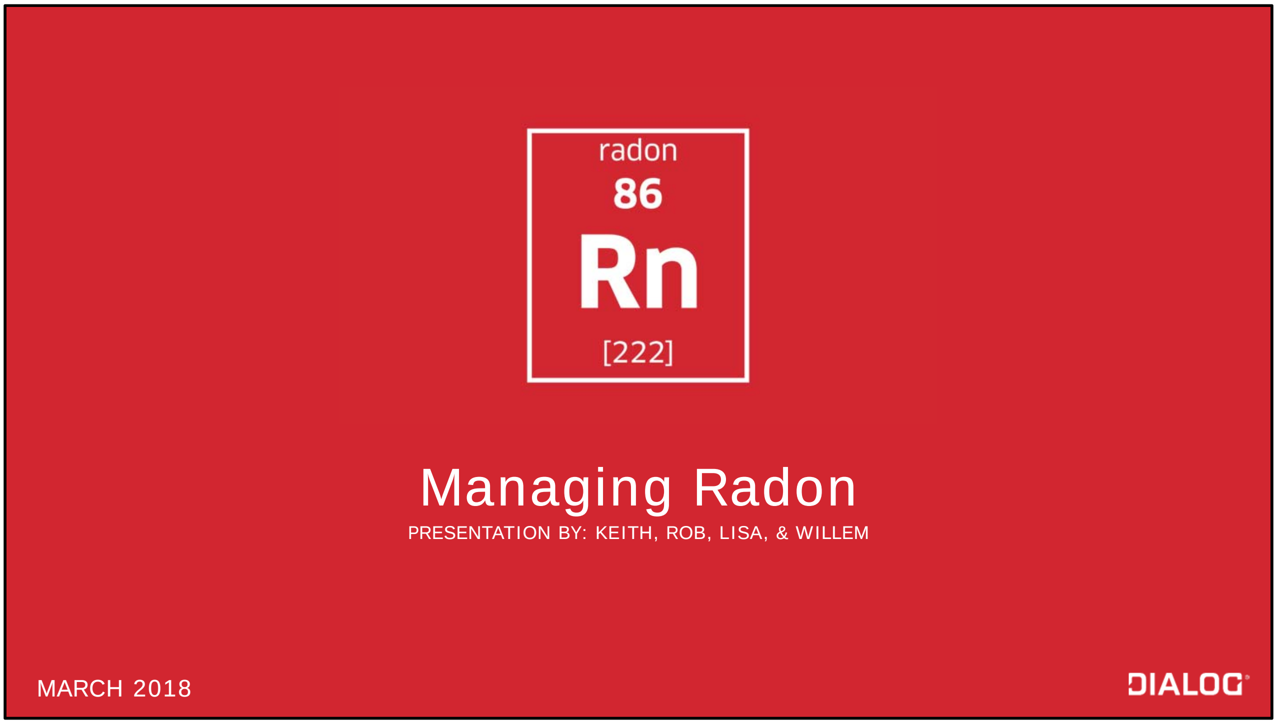


INTRODUCTIONS BY WILLEM

The focus for our presentation is requesting support for improvements to Building Code performance requirements and suggesting Alternative Risk Management strategies for large air-volume, low-occupancy building typologies.

- We share concerns with the quality of direction provided by the Building Code. Consultants need clear direction through clearly described performance attributes for the radon and soil gas control requirements.
- Code officials need to know that the consultant is creating their specifications and details from a position of knowledge and sound professional judgement.
- We would also like to share our thoughts about 'Alternative Risk Management' for large air volume, low building occupancy buildings based on an in-ground and in-air radon testing strategy as meeting the intent of the Building Code.

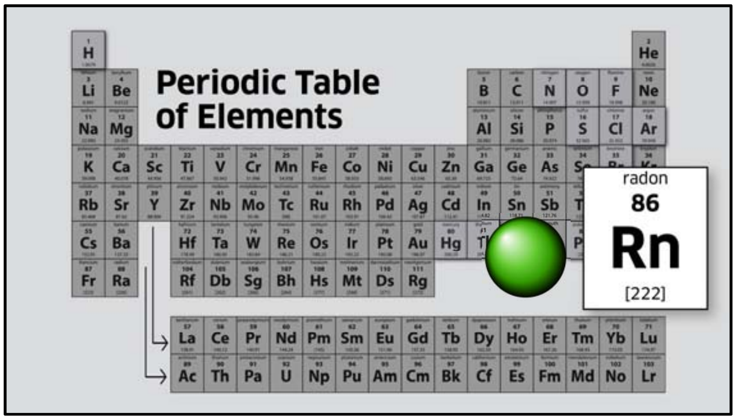
We need to address clarity in the Building Code and gain support to present requests for a STANDATA as a starting point towards providing a standard starting point, and to present a case to the National Research Council for changes to the upcoming 2020 Building Code.

Agenda

1. Why we’re concerned
2. What’s currently being done
3. What we are proposing
4. Next Steps

DIALOG

AGENDA BY WILLEM

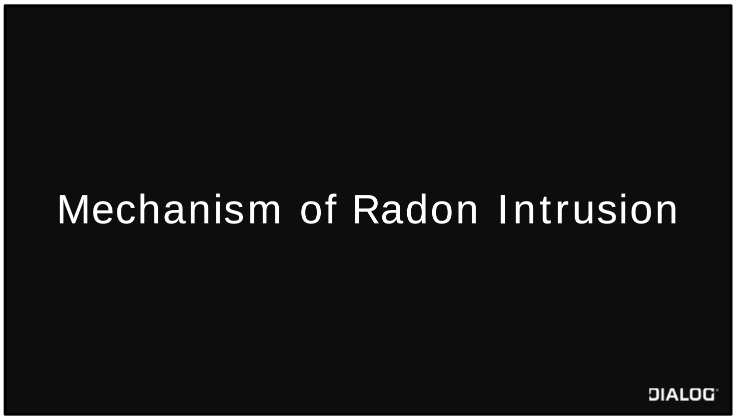


KEITH PRESENTS SLIDES 3 TO 8

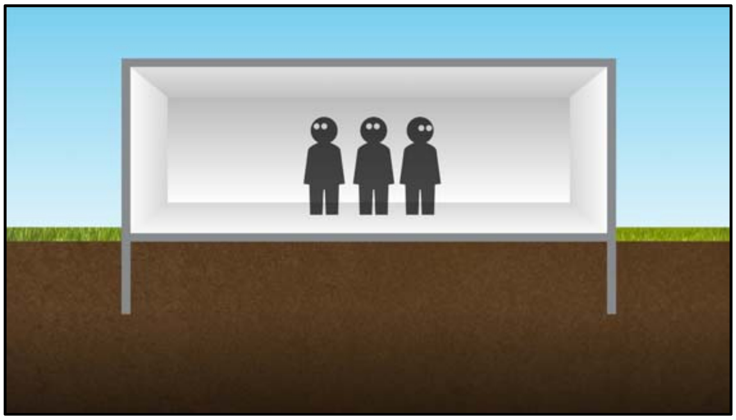
There are literally hundreds of soil gases that need to be addressed and that have potential to harm building occupants. The Building Code requirement for soil gas separation is not being questioned, but does need clarification.

They are compounds comprised of basic elements from the periodic table, combinations of which run the range of hydrocarbons to organic compounds which are either toxic (cause death), carcinogenic/mutagenic (cause harm) or poisonous (cause sickness)… or a combination – as in makes you sick and then you die. Other soil gases are benign but do not have any deleterious effects on building occupants; such as water vapour, but could affect material performance.

Most of our conversation will focus on one gas – **Radon**.



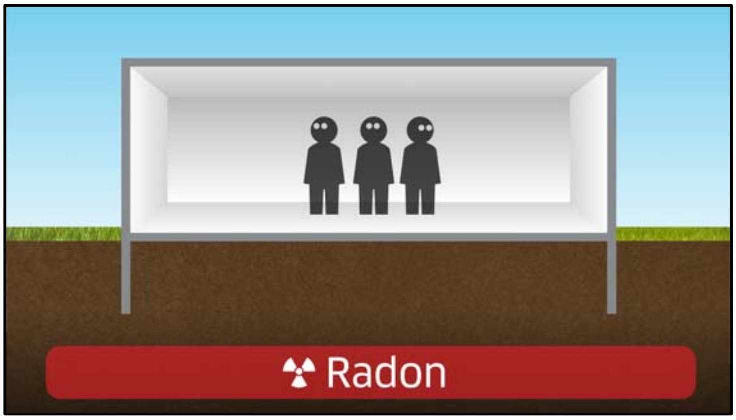
LISA PRESENTS SLIDES 9 TO 22



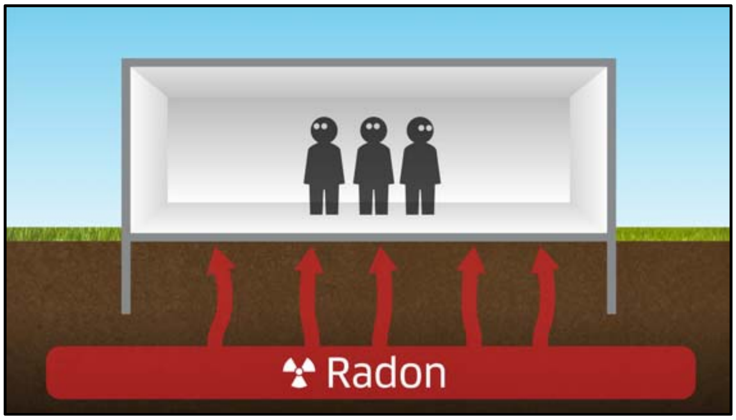
The DO NOTHING scenario – business as usual from previous Building Code.

Occupied building with no soil gas barrier or depressurization layer.

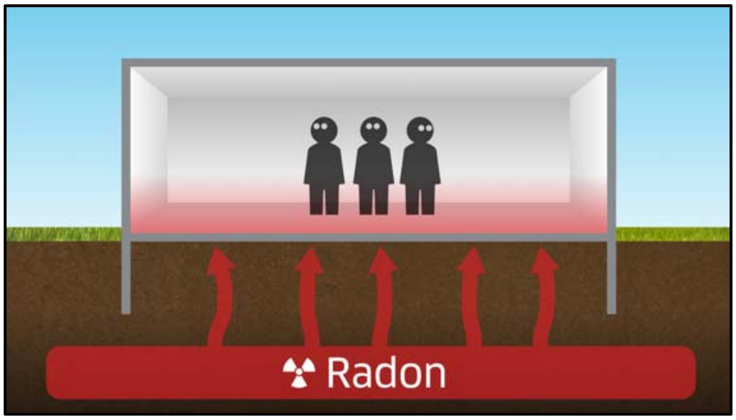
No Radon → No Problem



Radon is a naturally occurring colourless and odorless radioactive gas, and that is prevalent everywhere (it can be measured in small quantities regardless of where you live on the planet).



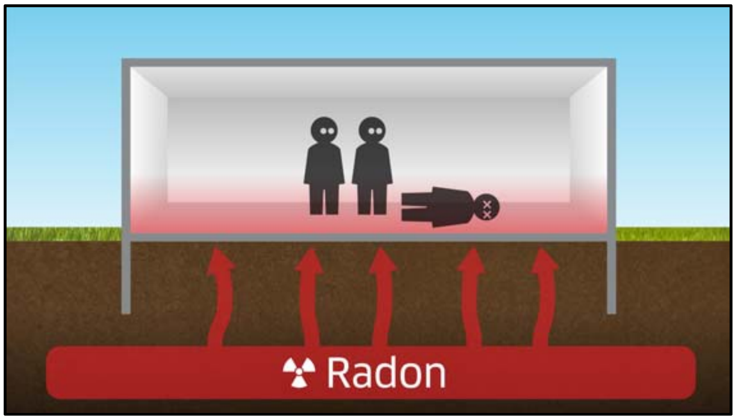
Small atmospheric air pressure differential pumps (exhalation) radon from the soil (emanation).



Radon enters the building through gaps between the foundation and the floor, utility penetrations and cracks in the concrete slab.

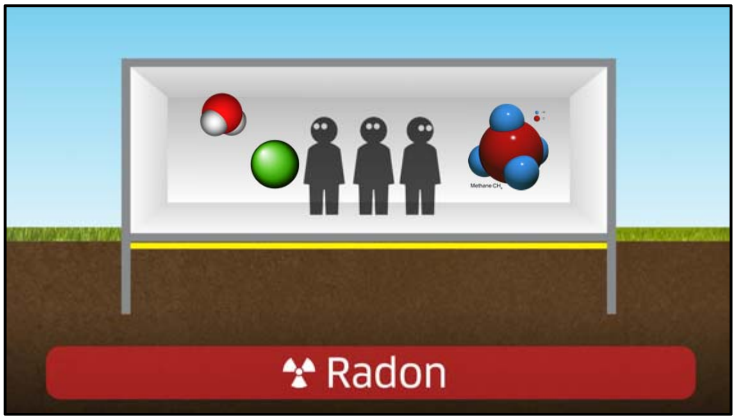
Any building that has a buried foundation, or that is constructed as a slab on grade or constructed over a crawl space is susceptible to radon accumulations.

Radon in open air is diluted quickly enough that it does not build up to concentrations of concern.



Radon was identified as a concern by Health Canada in 2009 in concentrations of 200 Bq/m^3 within occupied spaces. Higher concentrations have been shown as a leading cause of lung cancer. Higher concentrations of radon in occupied spaces is a result of improved building envelope performance and energy efficiency.

US-CDC compiled annualized actuarial data in 2016 showing deaths by radon (21,000) exceed deaths by drunk driving (17,400)… and that by implementing changes to the building makes radon deaths preventable in the same way that changes to alcohol limits lowered death rates associated with drunk driving.



Radon is a soil gas.

Soil gases are generally bad for people.

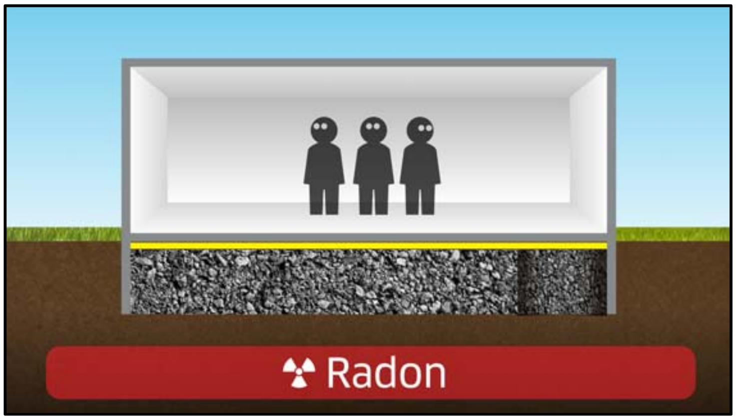
Soil gases can be prevented by the installation of an effective barrier.

Concrete is not a good vapour barrier, pore structure of concrete is larger than water molecule; however, concrete is an excellent radon barrier (if it is not cracked or compromised) since the pore structure is smaller than radon:

- **Water molecule** has an atomic diameter of 220 picometers (pm)
- **Radon atom** has an atomic diameter of 240 pm
- **Methane molecule** – also a soil gas of concern has an atomic diameter of 400 pm. So in theory… a membrane that is a good vapour barrier is also a good radon and methane containment barrier.

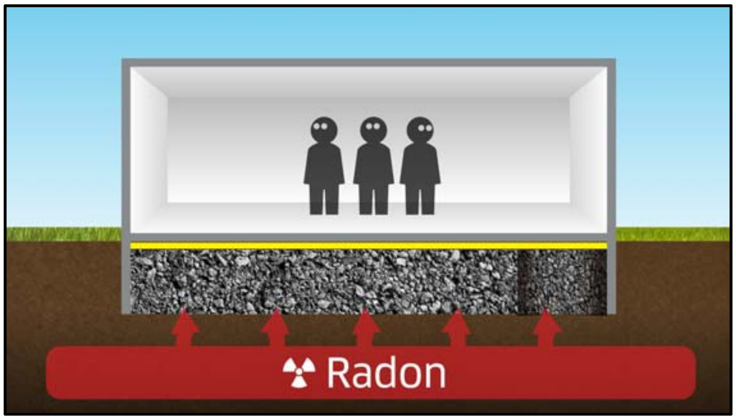
Approaching radon using the same solutions for methane soil gas control doesn't work… the concepts have to be separated as different work result solutions.

We will come back to the effective gas barrier shortly.

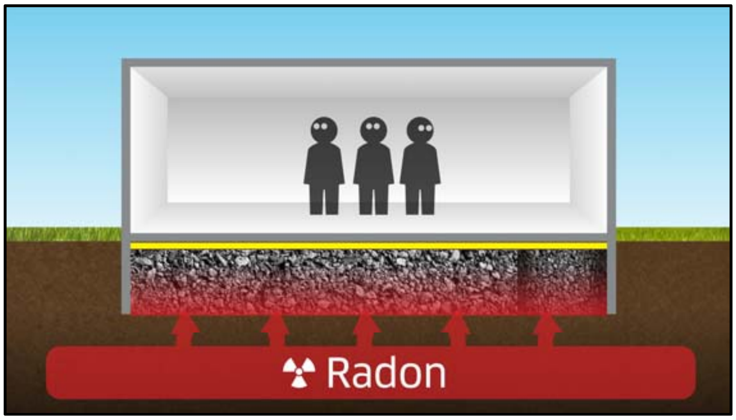


In addition to the gas barrier (environmental separation), the building code requires a granular depressurization layer. We used to call this the capillary layer, the purpose of which was to prevent liquid water coming into contact with the underside of the concrete slab.

This is the primary defense for radon mitigation strategies…

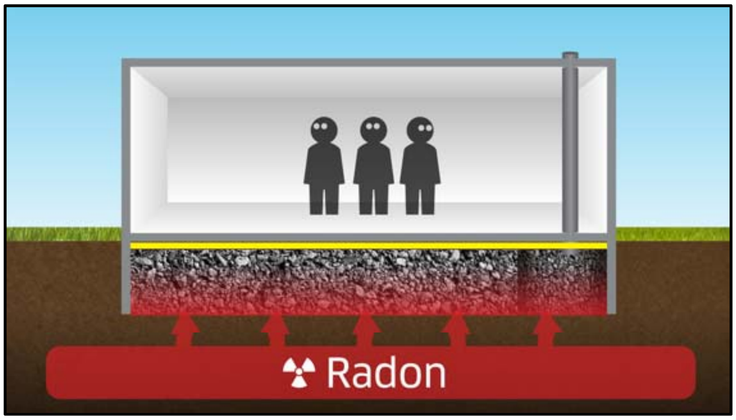


Radon accumulates below the effective gas barrier. Notice that the effective gas barrier has a colour. We will come back to this as a performance criteria for what constitutes an effective gas barrier.

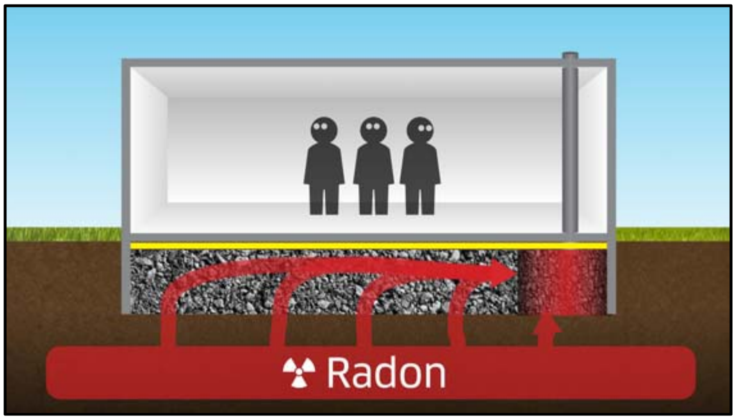


Radon would continue to accumulate in the granular layer and eventually seep out from around the foundation. But this raises the potential for the radon and other soil gases to find a way through imperfections in the gas barrier.

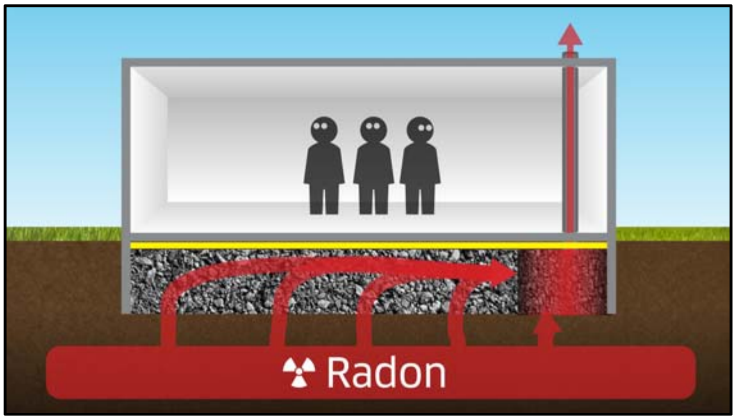
Gas barrier has to be effective – this is a move towards perfection; recognize that it cannot be perfect, but it must be durable.



As a part of the *DO SOMETHING* approach required by the Building Code – we prepare the granular material by roughing-in a gas extraction pit.

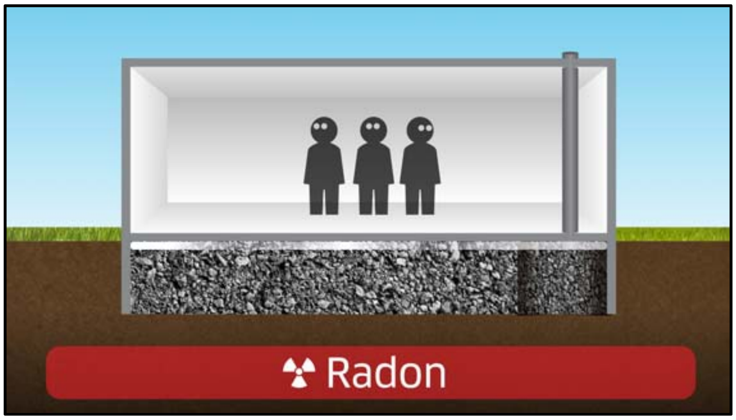


This is the potential escape route… the exhalation point.



If concentrations within the occupied space build to a level potentially harmful to building occupants, a simple vacuum is installed above the building (outside of the building enclosure), to create a small pressure differential – guiding radon to an atmospheric release point.

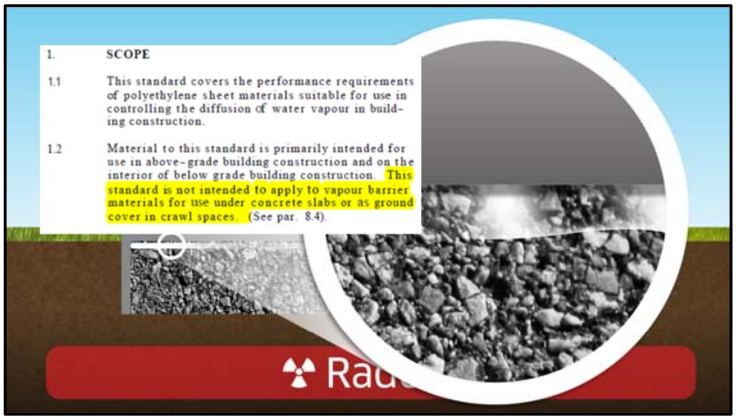
Radon depressurization does not operate the same way as soil gas extraction used to control methane for instance – radon relies on very low pressure differentials and low energy motors. Most soil gases rely on high air volume movement through the sub-slab environment. This is one key difference between radon mitigation and overall control of soil gases in general.



In the absence of performance criteria and a general lack of understanding within the design community of what constitutes an effective soil gas barrier in Parts 3, 5 and 6 of the Building Code → the trend is to rely on prescriptive direction described in Part 9 for polyethylene – a clear low density plastic material that has traditionally been used as a vapour barrier since the 1960's.

WRAP UP POINTS

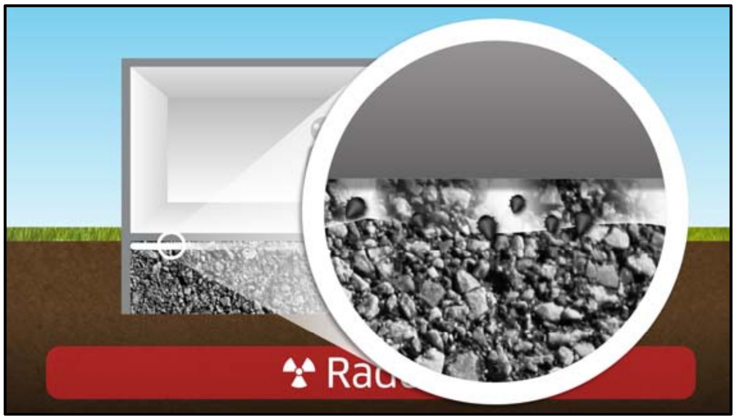
- Effective vapour barrier materials are also excellent radon, methane and other soil gas barriers.
- Exhalation of naturally occurring radon occurs with minimal pressure differentials.
- Radon accumulations in the granular layer are easily dealt with using low energy depressurization units mounted above the roof membrane.
- Methods used to extract methane and other soil gases require more extensive infrastructure and ventilation of the sub-slab granular layer.



<u>ROB WILL PRESENT SLIDES 22 TO 38</u>

Polyethylene is not an effective soil gas barrier… it has not been tested to withstand the environment into which it is placed.

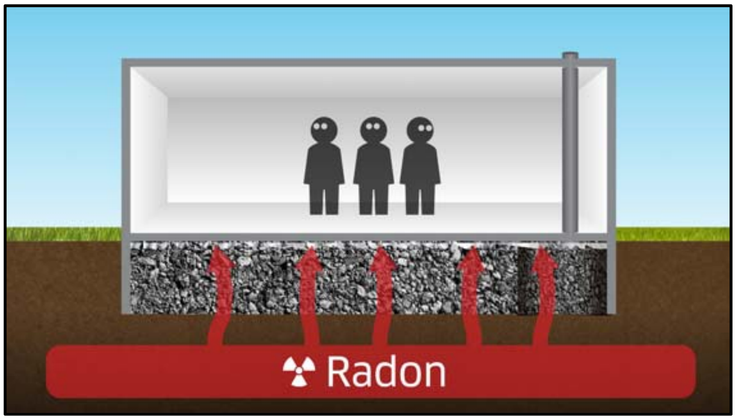
In fact the standard governing low-density polyethylene membranes used as vapour barriers contains a **specific statement indicating** that polyethylene is not suitable for installation… and making matters more dire – the restriction has been in place since 1986!



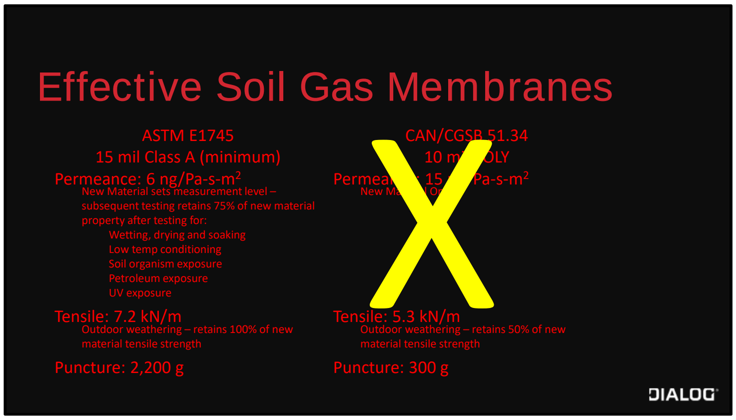
Effective membranes must have resistance to microbial attack, and degradation from the soil gases that the membrane is intended to resist.

CSA A23.1 Concrete Materials defines an effective vapour barrier as meeting the requirements of ASTM E1745 because materials meeting this standard resist damage from installation conditions, is unaffected by UV, soil organism exposure, petroleum distillates and does not change its properties as a result of heating, soaking in water or becoming brittle when the material get cold.

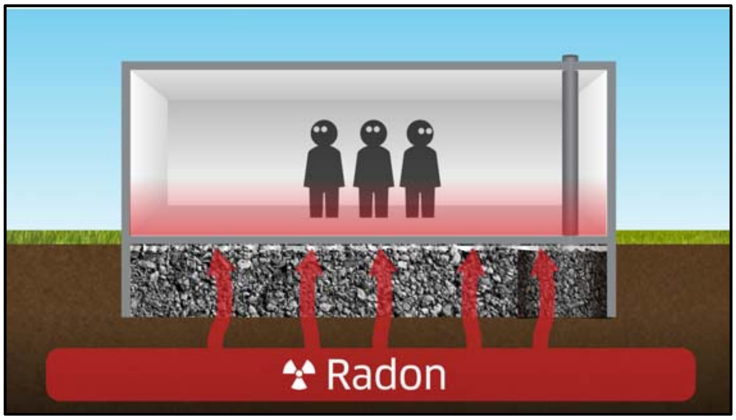
Standard polyethylene can degrade quickly if not concealed rapidly – the E1745 materials are resilient, durable and permanent… E1745 materials by their composition are typically translucent and have a colour to differentiate these materials from standard polyethylene.



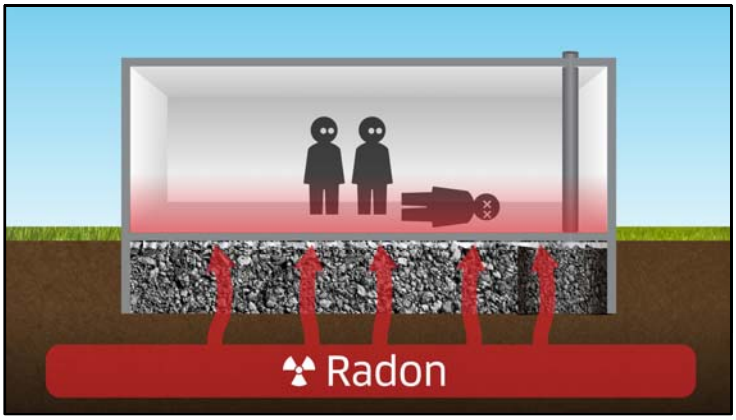
In this case – the quick and easy solution is to *DO SOMETHING* – because that is 'what we have always done' and the design community has been installing clear low-density polyethylene sheets that are ineffective and not durable.



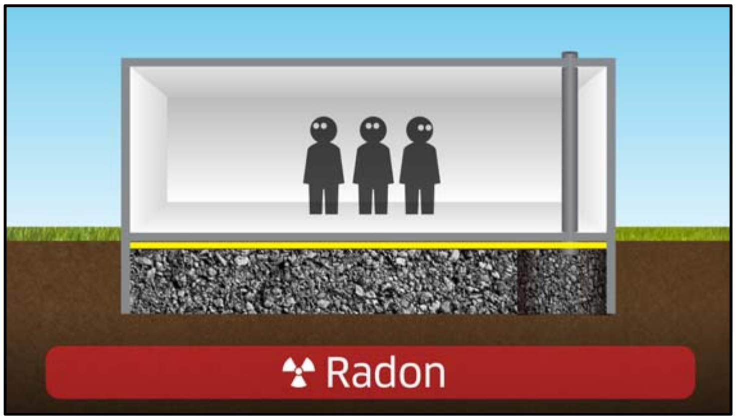
Quick comparison ---- **actually** there is no comparison → Low Density Poly is not suitable for ground contact exposures… not to be too pointed, but there are at least 6 product families that perform in this condition better than poly.



Meaning that slabs protected by low-density polyethylene sheets are essentially the same as *DOING NOTHING* except that there is the added expense of installing a material that is ineffective in an effort to *DO SOMETHING*.



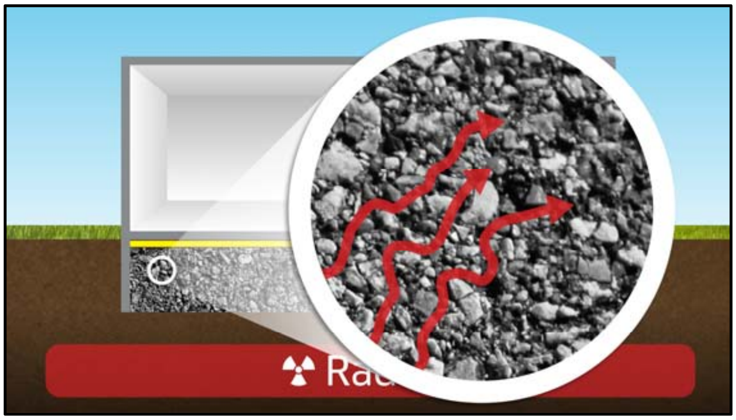
Net effect being the same as doing nothing (what we did before the last set of changes to the Building Code).



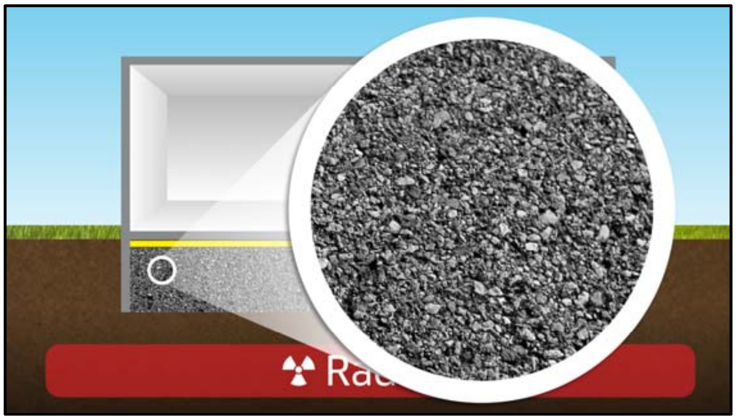
Effective Gas Barrier is also dependent on an Effective Depressurization Layer as previously discussed.

High Void Content Aggregate is essential for effective exhalation of radon from the granular layer.

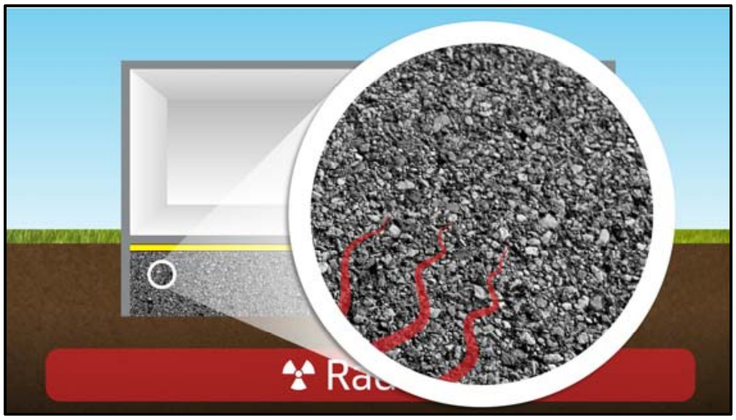
Guideline EPA 625 referenced in the building code as a *guide document* describes ASTM C33, #5 Sieve granular material, which represents 50% Void Content.



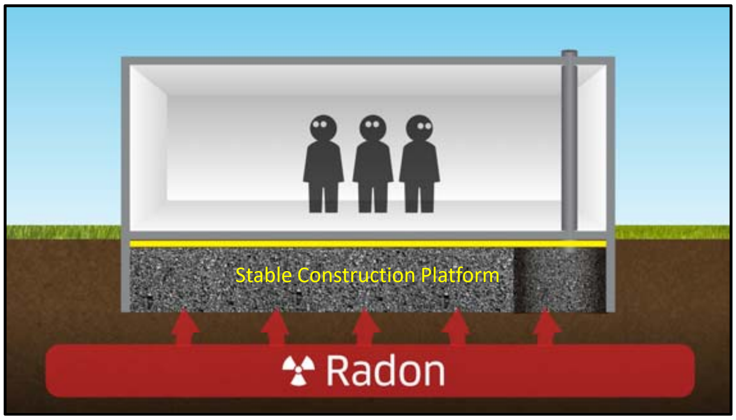
This 50% Void Content granular forms a part of the story of effective radon management, and is colloquially called “Radon Rock” by the industry.



Typical aggregate used in the prairie provinces is called “road crush” and is comprised of the left over screenings resulting from gravel mining.

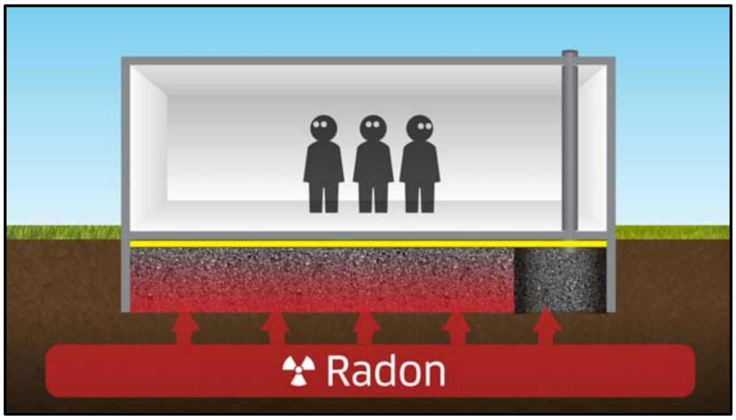


This material has a Void Content of less than 10% - meaning that friction within the granular layer reduces its effectiveness.

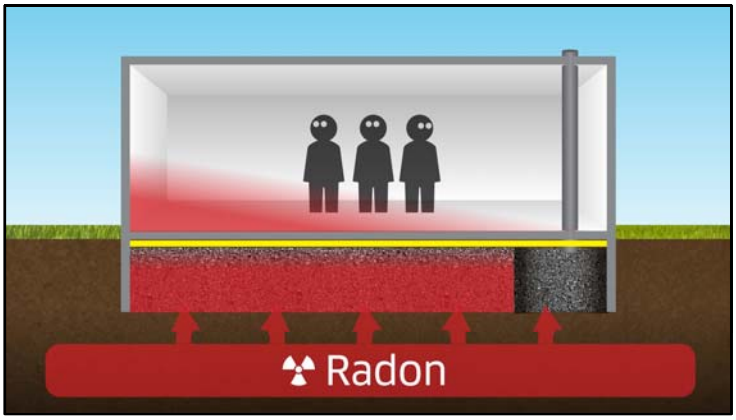


The granular material needs to form a Stable Construction Platform.

Whether using “Road Crush” or “Radon Rock”, the key performance requirement to be an effective construction platform **is that the material has crushed faces** that provide mechanical stability so that the soil gas membrane and subsequent concrete placement can be done without displacing the granular materials.



50% Void Content granular allows for exhalation of radon through the aggregate with little interference from friction within the materials and allows for large extraction fields ~ 8,400 m^2 per extraction pit.



Void Content in granular materials less than 30% makes exhalation of radon through the aggregate less effective, meaning that the numbers of extraction pits increases to reduce the potential for build-up or radon at the fringe areas of the extraction fields.

Efficiency of the granular layer is logarithmic, small changes in Void Content leads to large increases in air friction within the granular layer – leading to increased numbers of extraction pits.

Most crushed, clean aggregate in Alberta has Void Content in the range of 35 to 40%. We design our buildings using a design assumption of 40% Void Content. The EPA 625 guide document referenced in the Building Code is an engineered granular material and can achieve 50% void content → and which is not generally available in the non-engineered granular material used for under slab fill.

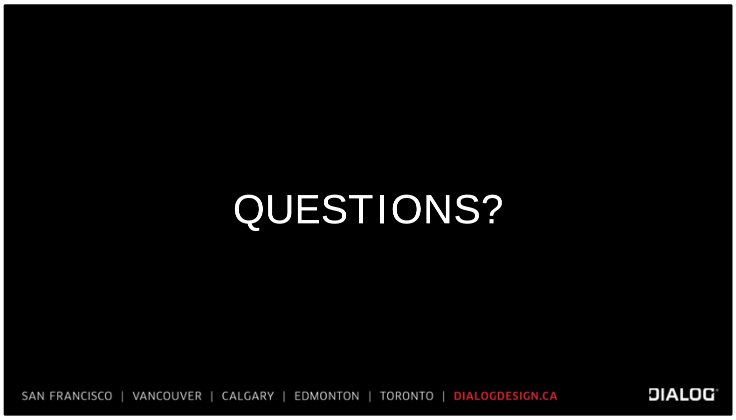
Aggregate Installed in a 10,000 m² Warehouse:

50% Void Content = 2 Pits
40% Void Content = 6 Pits
30% Void Content = 27 Pits
20% Void Content = 123 Pits

Spreadsheet was developed by DIALOG to aid our teams in communicating with accurately with the contractor project requirements and allowing cost assurance to the owner during the bid period.

WRAP-UP COMMENTS

- Soil gas containment membranes must be effective barriers and durable to soil exposure conditions
- Granular materials must be available in the market area of the building.
- Granular materials must have an efficient void content and provide a stable construction platform.
- The number of radon exhalation pits needs to be adjusted based on the void content of the granular materials actually used for the project to account for differences between local market availability and design standards.



WILLEM TO MEDIATE QUESTIONS AND SPUR CONVERSATION

THANK YOU!

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