Radon Analytical Laboratory

The Radon Analytical Laboratory, within the Institute for Environmental Research, operates a comprehensive suite of instrumentation for the monitoring and analysis of natural radioactivity resulting from radon ($^{222}\text{Rn}$), thoron ($^{220}\text{Rn}$) and their progeny.

The facility’s capabilities include: (a) measuring an extended range of radon and radon progeny concentrations in indoor or outdoor air; (b) in situ radon and thoron emanation from rocks and soils; and (c) radon exhalation rates from gaseous, liquid, solid and mixed phase samples. Our radon analytical and monitoring facilities include:

Radon Concentration Measurements

The “Radon Rig”

Built at ANSTO, the radon rig is designed to measure very low radon concentrations in, and radon exhalation from, either solid, liquid or gaseous samples under normal pressures.

The rig employs a de-emanation technique, whereby radon released from a sample is first collected by adsorption onto activated charcoal trap, then transferred to zinc sulphide lined Lucas Cells for alpha-decay counting using a sensitive photomultiplier tube.

The fully-automated counting system is capable of analysing 28 samples simultaneously, and its ability to quantify low radon concentrations is greatly assisted by its low instrumental background (0.3-0.5 counts per minute), and freedom from interference.

Counting time for a batch of standard samples is 9 hours (longer for extremely low concentrations). The lower limit of detection for this method is a function of ambient concentration and sample volume.

Liquid Scintillation Counter

A Tri-Carb 3100TR liquid scintillation counter is available to quantify a broad range of radon concentrations in air and clear water samples for environmental or industrial purposes.

Samples are analysed in 20 mL vials (with a maximum of 300 samples per run), and each sample is counted for half an hour.

Due to its high sensitivity and low instrumental background, this counter has a lower detection limit of 200 Bq m$^{-3}$. 
Single-trap radon sampler

Built at ANSTO, the single-trap sampler is designed to be taken to a remote site for radon to be captured on activated charcoal. Each stainless steel trap contains approximately 115g of charcoal, sufficient to capture radon from several hundred litres of sampled air. Air can be sampled either using the in-built 240V pump, or from a pressurised processing line. At the default 1 L/min flow rate, and 30 minute sampling period, the lower limit of detection is approximately 0.2 Bq m⁻³.

While presently designed to operate from mains power, the unit can easily be modified for battery operation. Traps are prepared in batches of 5 or 10, and a total of 60 traps are available. Each trap is purged of radon and then sealed prior to shipment to the measurement location. Once collected, traps need to be returned directly to ANSTO, for analysis on the radon rig, since the half-life of the captured radon is 3.8 days. Traps are shipped separately.

AlphaGUARD

Five Saphymo GmbH Alpha Guard radon monitors are available for the continuous, hourly measurement of radon concentrations in air between 2–2,000,000 Bq m⁻³. These detectors can be operated in diffusion mode, for which no additional pump is necessary, or flow-through mode.

Although designed for indoor use (buildings, tunnels, caves etc), they may also be placed inside ventilated enclosures for outdoor monitoring.

Each AlphaGUARD simultaneously records ambient temperature, relative humidity and atmospheric pressure.

The alphaguards use a pulse-counting ionization chamber (alpha spectroscopy) for their measurements, and offer a high detection efficiency, wide measurement range, fast response and permanent maintenance-free operation with a long-term stable calibration. They are also insensitive to high humidity, and vibrations. For continuous measurements the instrument can operate on 240V mains power, but it can also run for several days from the internal battery.

Dual flow loop, two-filter radon detector

Two models (700 L and 1500 L) of semi-portable detectors are available for outdoor, continuous, hourly monitoring of ambient radon in air. These detectors, which can be manoeuvred by 2-4 persons (<3m long; <100kg), can be deployed to most field sites for either short-term (several weeks), or semi-permanent, monitoring.

The lower limit of detection of these instruments is 20-40 mBq m⁻³ (ie suitable for monitoring quite pristine air), and their power requirements are minimal (100W @ 240V).

Once deployed, these detectors can operate for long periods with minimal maintenance.
Radon Emanations

Radon emanometer (flux chamber)

Built at ANSTO, the radon emanometer is designed to be taken into the field to simultaneously measure the radon and thoron flux densities from soil or rock surfaces. Radon and thoron flux estimates are made based on the flow-through accumulator method, with each sample taking approximately 24 minutes.

The current model emanometer operates on 240V (from a 12V inverter in a nearby vehicle), and the operating data logger (a CR1000) can store several months of sampling data prior to being downloaded.

Gamma spectrometer

A high purity germanium crystal gamma detector is available to determine rates of radon emanation from solid samples. Samples need to be at least 0.5 kg, with a grainsize not exceeding 1-5mm.

A 30-day counting time is required for radon, and radon progeny, in the sample pore space to reach equilibrium with the radium (226Ra) in the sample. The emanation estimate is based on the difference in gamma activity of radon progeny in the sample pore space between the beginning and end of the 30-day count.

The gamma detector, coupled to an Ortec DSpec Pro multi-channel analyser, is monitored by a PC running the Ortec spectrum analysis program Maestro 32.

Contact Details

For general enquiries, or more detailed information regarding radon / thoron measurement capabilities, or research and commercial applications, please contact:

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Summary of the Radon Analytical Laboratory Facilities

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<th>Measurement</th>
<th>Medium</th>
<th>Analysis rate</th>
<th>Comments</th>
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<tr>
<td>Liquid Scintillation</td>
<td>Concentration</td>
<td>Liquid/gas</td>
<td>30 min per run</td>
<td>20 ml; samples; LLD 200 Bq m⁻²; up to 300 samples per run.</td>
</tr>
<tr>
<td>Single-trap sampler</td>
<td>Concentration</td>
<td>Gas</td>
<td>20 per day</td>
<td>1 L min⁻¹ sampling; 60 traps available; analysis performed on radon rig.</td>
</tr>
<tr>
<td>AlphaGuard</td>
<td>Concentration</td>
<td>Gas</td>
<td>10-60 min per measurement</td>
<td>LLD 2 Bq m⁻³</td>
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<tr>
<td>700/1500L Rn detectors</td>
<td>Concentration</td>
<td>Gas</td>
<td>Hourly measurements</td>
<td>LLD 0.03-0.04 Bq m⁻³</td>
</tr>
<tr>
<td>Radon Rig</td>
<td>Concentration</td>
<td>Solid / liquid / gas</td>
<td>20 per day</td>
<td>Instrumental BG &lt;0.5 cpm; LLD depends on volume sampled.</td>
</tr>
<tr>
<td>α spectrometer</td>
<td>Emanation</td>
<td>Solid</td>
<td>30 days per analysis</td>
<td>0.5 kg sample, grainsize &lt;5mm.</td>
</tr>
<tr>
<td>Rn Emanometer</td>
<td>Emanation</td>
<td>Solid</td>
<td>30 min per measurement</td>
<td>LLD = 4 mBq m⁻³ s⁻¹; typically 10% measurement error.</td>
</tr>
</tbody>
</table>

* Numerous samples can be counted sequentially and then left for their 30-day equilibration time.