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1. PURPOSE

The purpose of the document should be to define the detailed operational requirements for a process (why) and who does what, where, when and how.

This SOP describes the systematic approach to measuring the radon-220 (Rn-220) (Thoron) emissions from ARTBIO's laboratories at Oslo Science Park (OSP). The limit according to the Radiation Protection Act (Strålevernforskriften) is 10 MBq of Rn-220 emission per year, while ARTBIO has applied for an increased limit of 70 GBq of Rn-220 emissions per year. It is therefore important to check the actual Rn-220 emissions from ARTBIO's laboratories to comply with Norwegian laws and regulations.

2. SCOPE

This SOP applies to all departments and employees at ARTBIO AS when reading out and analyzing the data from the RTMs (RTM 1688-2) to see what the actual Rn-220 emissions are to ensure ARTBIO is in compliance with Norwegian laws and regulations.

The Rn-220 emissions are measured using RTMs from SARAD, which measure the activity in Bq/m^3 of air. The air is taken from different points of interest in the ventilation system of ARTBIO's B-Lab. The B-Lab has a ventilation that is fully separated from the ventilation for the rest of OSP, ARTBIO's C-Lab and the ARTBIO's office.

3. ABBREVIATIONS & DEFINITIONS

3.1 Abbreviations & Definitions

Table 1: A list of abbreviations and terms with their respective definition or a short explanatory description.

Abbreviation / term	Definition
SOP	Standard Operating Procedure
RPO	Radiation Protection Officer
RPD	Radiation Protection Deputy
RTM	SARAD Radon Thoron Monitor, model RTM 1688-2
RPM	Reads per minute
Baud rate	Baud rate is a standard serial communication speed, that represents the number of bits per second (bps) that can be transferred using that connection
BPM	Bauds per minute or equivalent to bits per minute
SARAD	Company specializing in instruments for radon/thoron measurement
Vaisala	Digital logging system
Bq/m^3	Becquerel per cubic meter, a unit for measuring the radioactivity present in a volume
HSE	Health, Safety and Environment
OSP	Oslo Science Park
Rn-220	Radon-220 or thoron
MODBUS	An open-source serial communication protocol
poCAMon	Personal Continuous Air Monitor. It measures long-lived aerosols as well as short-lived radon daughters by alpha spectroscopy and beta counting.
B-Lab	Type B isotope laboratory
C-Lab	Type C isotope laboratory

4. RESPONSIBILITIES

Table 2: List of responsibilities connected to specific functions within the company

Job Title	Specific responsibilities required to complete the process
RPO	Responsible for performing or delegating the reading out of the different RTMs and analyzing the data and reporting to DSA if necessary.
RPD	Co-responsible for performing or delegating the reading out of the different RTMs and analyzing the data and reporting to DSA if necessary.
ARTSafe	Internal committee that handles safety and incidents, as well as considering and deciding on changes based on incidents.

4.1 Practical information

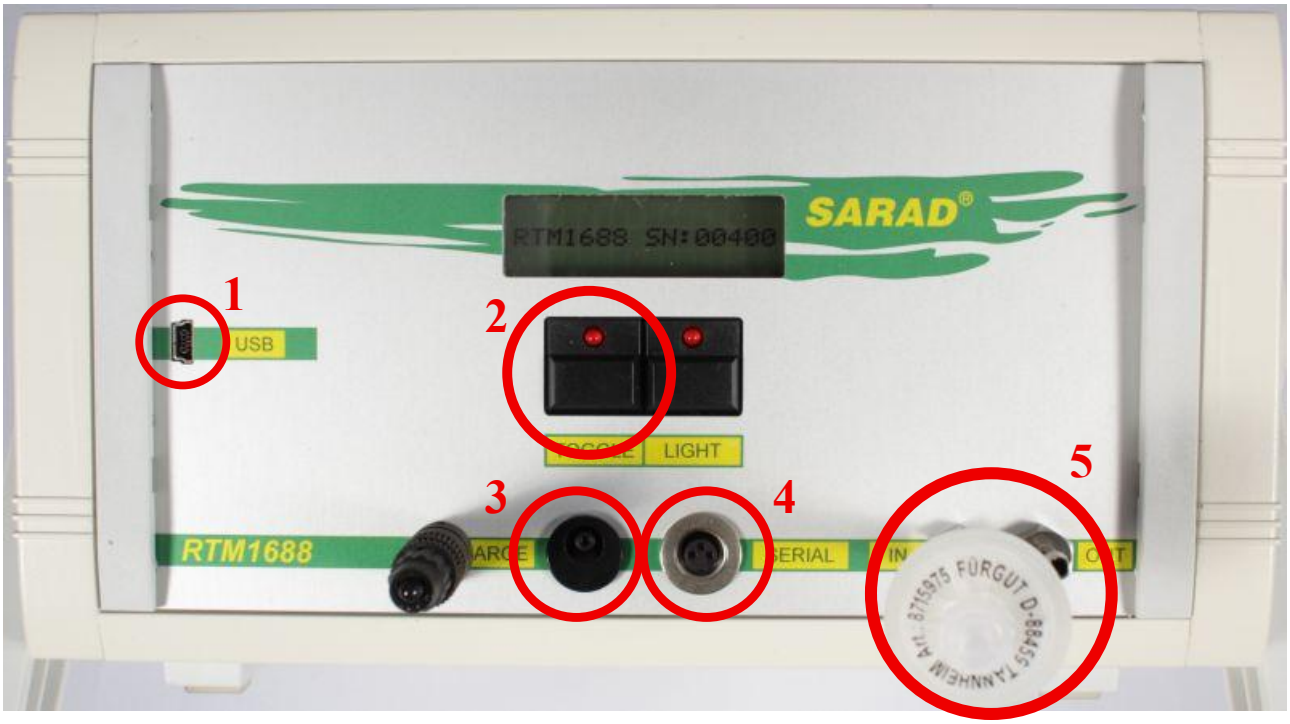

Figure 1: A photo of the front of an RTM. Highlighted are: 1) the USB type mini-B port, 2) The Toggle button, 3) The power input, 4) the serial port and 5) the ventilation connection point with filter attached.

4.2 Ventilation system and the Location of the RTM's

The ventilation system present in ARTBIO's B-lab is fully separated from the general ventilation system at OSP. This is to prevent any possible escape of Rn-220 into unwanted areas.

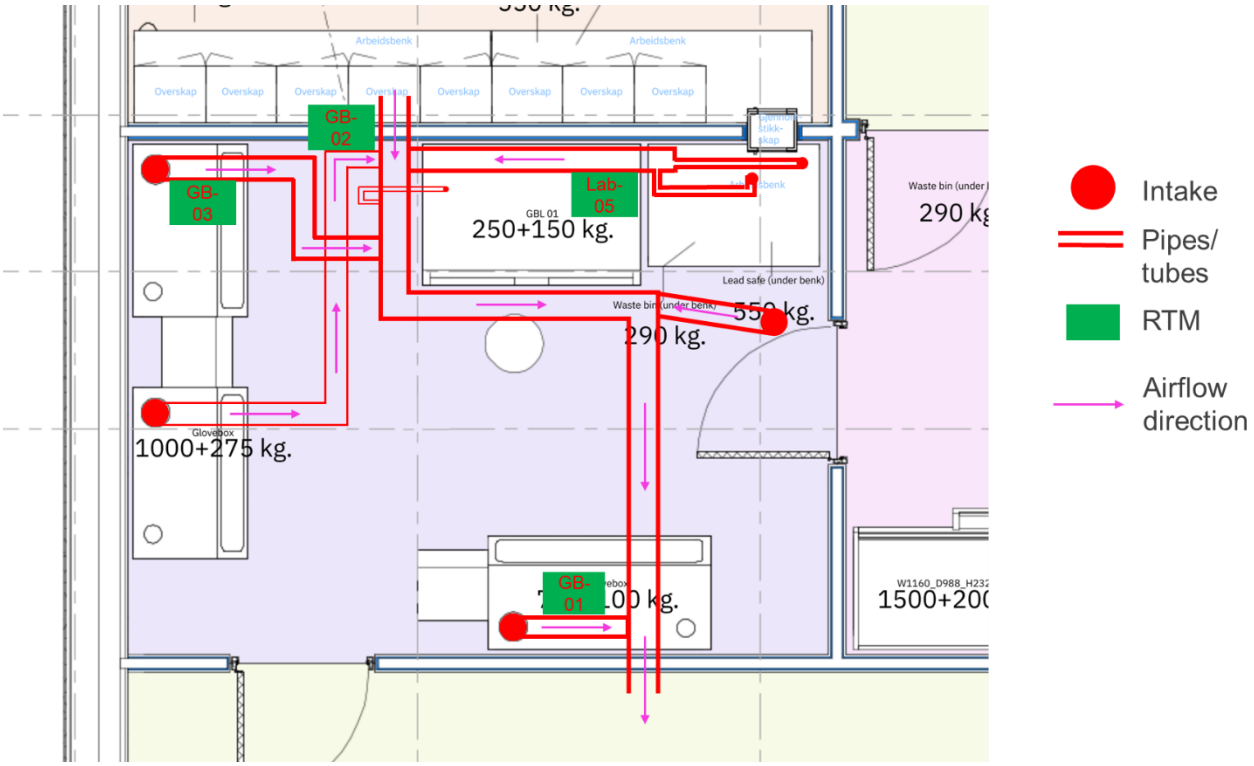

Figure 2: Schematic view of the ventilation located above the ceiling with the (possible) location of the RTM's. This is a schematic depiction of the part of the ventilation before the coal filters.

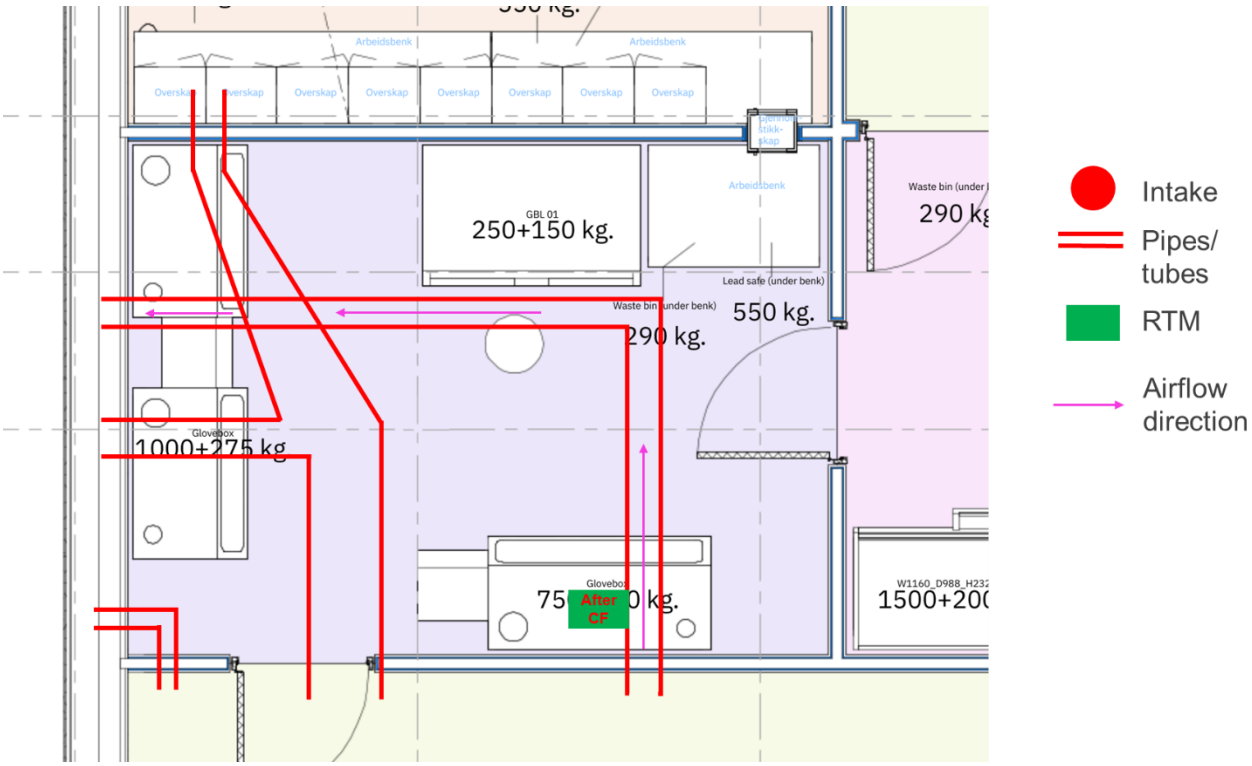

Figure 3: Schematic view of the ventilation located above the ceiling with the location of the RTM's. This is a schematic depiction of the part of the ventilation after the coal filters.

5. PROCEDURE

The RTMs can be read out using two different methods, a manual read-out using a direct connection from a PC to the RTMs, and a read-out through Vaisala. It is important to note that the RTMs don't have to be disconnected from the ventilation for them to be read out. It is also important that the ventilation valves need to be closed off if the RTMs do have to be disconnected from the ventilation.

5.1 Manual read-out of RTM

Manual read-out of the RTM's is done by using a PC with RadonVision installed. RadonVision is a program distributed by SARAD.

- This PC is then connected to an RTM using a USB type A to USB type mini-B cable. The male USB type mini-B end of the cable is plugged into the RTM in the port highlighted with 1 in Figure 1.
- Set the RTM to read-out mode by holding the Toggle button (highlight 2 in Figure 1) for 3 ticks. This will turn off the measurement. The screen will now show the serial number of the RTM
- Hold the Toggle button again for 3 ticks. Now the screen will show the setting for baud-rate (bps). This should show 19200 bps; the RTM will be put back in this same setting after the read-out is finished. The Toggle button is then pressed once, such that the RTM shows the MODBUS settings. The Toggle button is then again held for 3 ticks. The RTM is now in read-out mode and the unit should now be a selectable option in RadonVision on the PC. If this is not the case, RadonVision should be refreshed by right clicking on the device selection drop-down-menu and clicking on "load new devices".

After the connection with RadonVision is made, the data can be read-out by pressing "Get Data", then going to the Calculations Tab and then pressing "Export/Save". After this the steps shown on the screen should be followed and 2 files need to be saved. One file is an Excel file, the other is a RadonVision Program file (.rvx) that can be opened using RadonVision. These files are saved in new folder with the date of the read-out as a name, which is saved in: ARTSafe Oslo channel > Shared > RP > Ventilation > RTM Readouts.

5.2 Read-out of RTM through Vaisala

Vaisala can be opened via the remote desktop manager for the server at ARTBIO. This can be done using the Remote Desktop Connection application and using the server's IP address and the required administrator password.

Vaisala can be accessed by logging in through ViewLinc. Within Vaisala, the Sites Manager-tab is selected and then the Dashboard tab is opened. This will show a map of the lab with the different detectors and sensors connected to the Vaisala system. This can also be seen in Figure 4. Double-clicking the desired parameter will open a real-time trend chart.

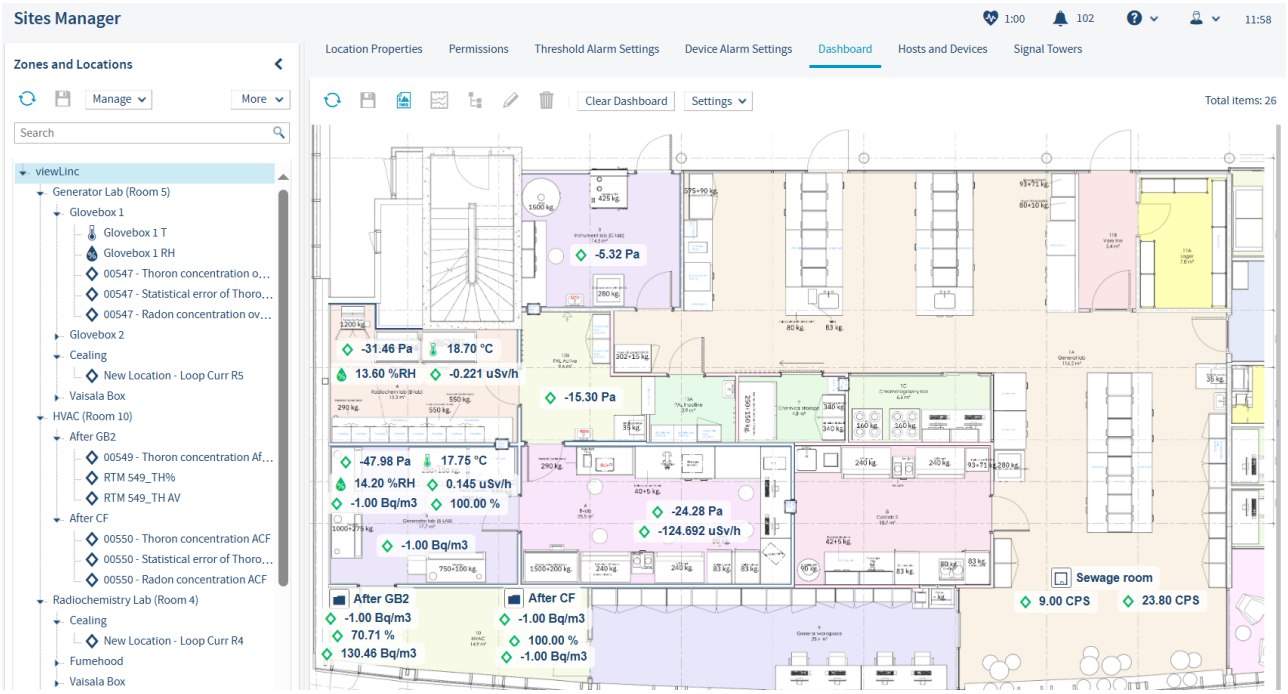

Figure 4: A screenshot of the Vaisala system showing the different detectors and sensors that are logged within Vaisala.

A weekly emissions report will also be automatically generated and sent to system administrators, including RPO.

5.3 Warning systems

When the set limits for radon or thoron escape are exceeded, the Vaisala system will send out an e-mail warning to the RPO and RPD with the details. SMS messaging can be enabled for additional cost in the future.

If either the RPO or RPD observes that the values significantly exceed the set limit, or if a critical warning is received from the Vaisala system, the RPO and RPD will immediately ensure that Oslo Science Park, DSA, ARTSafe, and other relevant emergency contacts are notified without delay.

If significant radon or thoron escape occurs, partially closing the ventilation regulator in the gloveboxes can help limit emissions. Depending on the situation, OSP may need to clear the roof terrace to protect public safety. ARTSafe will review the incident and determine whether changes are needed to prevent future breaches of radon or thoron limits.

5.4 Other detectors

In case of failure of the ventilation system, when performing new activities with Th-228 or when performing work with Th-228 outside of a glovebox, a poCAMon (Figure 5) must be used as a working level monitor.



Figure 5: Main part and control of the poCAMon. Image is sourced from the user manual for the instrument.

PoCAMon is switched ON and OFF by pressing and holding the select button for some seconds.

The display shows the main menu containing the instrument name and configuration, the chosen sampling cycle and the selected menu command in the bottom line. The select button toggles between the following available commands:

- Start the chosen sampling cycle (Start cycle)
- Show the data of the last finished sampling interval after stopping the measurement (Show results
- Select a pre-defined sampling cycle (Select cycle)
    - The selected sampling cycle determines the duration of a sampling interval as well as the kind of measurement. By default, pre-defined cycles are available:

- „Hazard alert“: Sampling with one minute interval time to detect dangerous exposures quickly as needed for first responders.
- „Staff monitoring“: Sampling with 30 minutes interval time resulting in a low detection limit. This cycle is used to get the time dependent increase of exposure over the whole exposure period of a worker.
- „Dose assessment“: Spectroscopic analysis of the filter after exposure period (for example once per month). This procedure reduces the detection limit to a minimum which allows the exact determination of the exposure and related inhalation dose.
- „MARKOV PAEC“: Fast procedure (15min) for grab sampling of radon daughter products. Requires filter replacement before sampling.
- „Alert test“: Test of all available alert signals.

To select a command or cycle, use the OK button.

During high-risk work or when implementing new procedures, the "Hazard alert" mode should be used. Otherwise, "Staff monitoring" mode is generally sufficient.

Since radon and thoron gases are heavier than air, the instrument should be positioned at a lower level than the workstation. Ensure that the alert light is clearly visible from the workstation.

5.5 Maintenance

Maintenance of the RTMs is handled through Gammadata. Calibration of the RTMs should be done on a yearly basis. Recalibration should also be performed after service or repairs of the RTMs.

Maintenance of the gloveboxes and the ventilation system is performed by Bryn Byggklima and they should be contacted if any issues arise involving the ventilation system.

Service for the Vaisala system is provided by Vaisala. If there are technical problems with the system or major changes need to be made, they should be contacted.

Service and maintenance for the different air, temperature, and humidity sensors are provided by Axflow.

6. REFERENCES

6.1 Legislation and Guidelines

Reference	Document Title
FOR-2010-11-01-1394	Forskrift om forurensningslovens anvendelse på radioaktiv forurensning og radioaktivt avfall

FOR-2016-12-16-1659	Radiation Protection Act – Forskrift om strålevern og bruk av stråling (Strålevernsforskriften)
External Document	SARAD: RTM 1688-2 specifications and user manual
External Document	SARAD: poCAMon specifications and user manual
Emergency contact information signs.docx	Signs with emergency contact information

6.2 SOPs & Templates

SOP/Templates	Document Title
SOP-0011	Radiation Protection

7. REVISION HISTORY

Effective Date of SOP	Revision Number	Reason for update
Refer to header	01	New SOP first issue

8. APPENDICES

None.