Manual

poCAMon

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Content

General information

Monitoring the air we breath for airborne radioactive substances is necessary to protect workers in all facilities in which dispersible radioactive substances are used. This is the case when handling liquid or powdery substances. Radioactive aerosols can also be produced by mechanical processing, such as cutting, grinding, welding, or cleaning processes, e.g. B. be released during the dismantling of nuclear power plants.

The aerosol monitor poCAMon, which can be fixed on the body, is used to determine the exposure of workers and emergency services to airborne radioactive aerosols and can also be monitored online. The poCAMon is equipped with a radio interface so that the current measurement data can be transmitted to an emergency control center.

The poCAMon aerosol monitor serves as personal protective equipment (PPE):

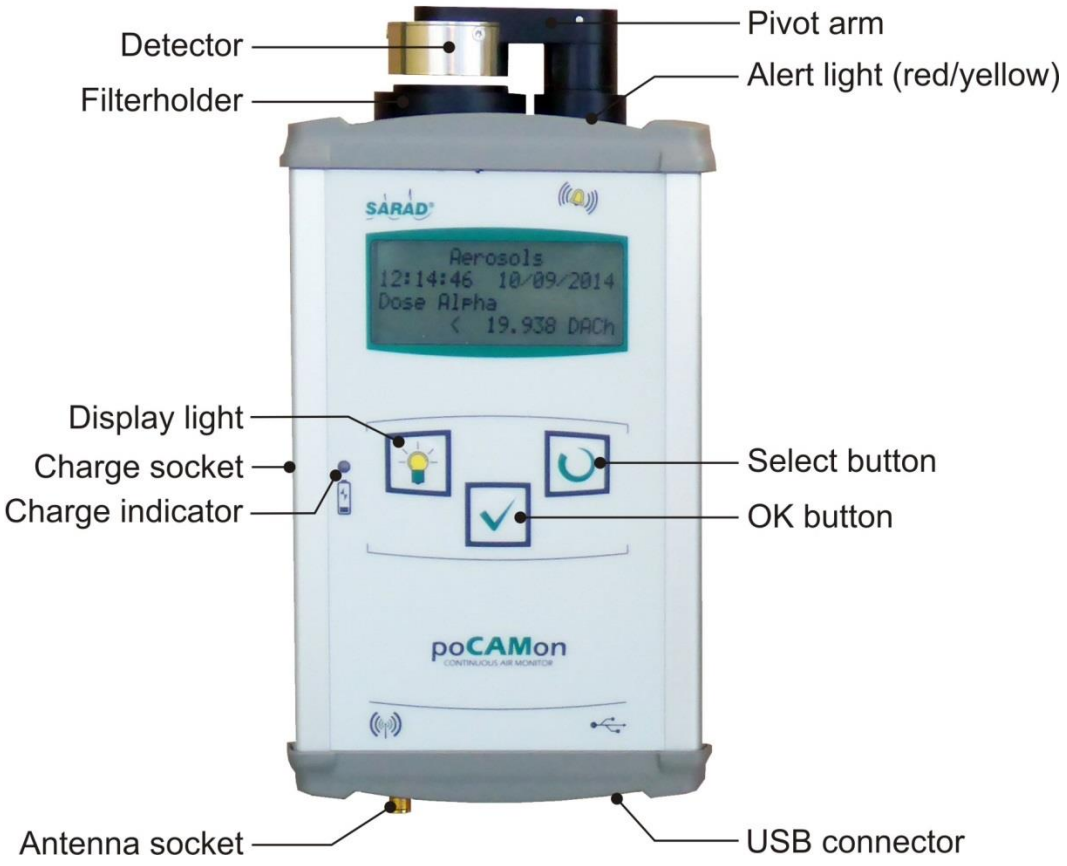
- **For fire brigade, police, THW, security personnel, etc.**
- **In nuclear facilities**
- **In mining operations**
- **In the NORM industry**
- **In nuclear medicine**

The unit measures long lived radioactive dust (LLRD) as well as natural occurring Radon daughter products. Both values are presented separately. The influence of Radon daughters is dynamically compensated for LLRD detection. Following results are achieved from the acquired energy spectrum

- Alpha exposure, dose and average concentration for LLRD
- Beta exposure, dose and average concentration for LLRD
- Equilibrium equivalent concentration for Radon (Rn-222) daughters
- Equilibrium equivalent concentration for Thoron (Rn-220) daughters

If any of the user-adjustable thresholds is exceeded, audible and optical alerts are generated. Special attention has been spent on quality assurance. Air flow and filter status are logged in parallel with the radiation results. A complete energy spectrum is saved for each single sampling interval. The instrument offers various measurement cycles to fit for several applications. The configuration and operation software package dCONFIG/dVISION will be delivered with the unit.

The picture below shows the main part and controls of the poCAMon



Power supply / Power On

The unit is powered by an internal 12V/3.8Ah rechargeable battery pack (standard cells). The battery allows more than 30 hours of autonomous operation. When the battery has been discharged (<10,8 V), the instrument switches automatically to standby mode resulting in very low power consumption. If the battery remains without recharging of longer periods, a deep discharge prevention circuit disconnects the whole electronics. Then, the display switches completely off.

After connecting the power supply, it takes a few minutes to reach the battery voltage threshold which is required to turn on the unit again.

For devices with the serial number > POC-00071:
The device is switched ON and OFF by pressing and holding the select button for some seconds.
If you turn on the device while charging, charging will stop.
To continue charging it must be briefly disconnected from the mains and then reconnected.

The charging process takes about two hours and is indicated by a red light left beside the buttons. If the charging has been completed, the light turns off. The instrument warms up during charging process therefore it should not be covered as long as the charger is connected. Only 18VDC power adapters with a minimum rate of 60VA can be connected.

The instrument can be permanently connected to the adapter. The integrated charge controller forces a cyclic charge/discharge process to maintain the battery.

Important hints for battery maintenance

The instrument contains high quality NiMH battery packs of leading manufacturers. This technology provides a high power density, long life time a high transportation safety. Some hints should be noticed to maximize the battery performance.

Do not store the instrument with discharged battery even for short periods. NiMH batteries undergo a certain self-discharge which discharges the battery even if no load is connected. This may result in deep discharge and can damage the battery pack. Charge the battery to 50…75% of the capacity before longer storage. Recharge the battery at least every six month.

Switch off the instrument if it is not in use. The instrument consumes power even in standby modus resulting in continued discharging. If the battery is exhausted, the deep discharge protection circuit will disconnect the electronics, but cannot avoid self-discharge (see previous item)

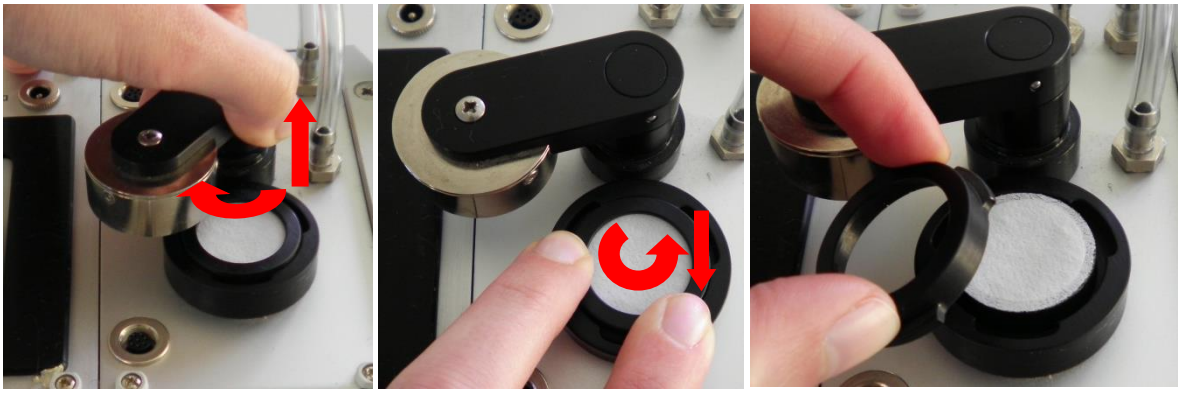
Charge the battery within the temperature range from 10°C to 30°C. In case of higher or lower temperatures, the battery cannot reach its full capacity. To protect the battery, the charge process will be interrupted if the temperature exceeds approximately 43°C.

Recharge the battery even if it is not completely discharged. The capacity lost by the aging process can be minimized by operation between 20% and 80% of the capacity.

Remove the power adapter after charging. The integrated charge controller monitors the battery state continuously and provides a conservation charge. However, this cycle will accelerate the aging process of the battery.

Filter replacement and flow control

If the filter is heavily charged by particles and the pump cannot longer regulate the flow at the nominal rate, the yellow alarm light begins to blink. In this case the filter must be replaced. At first, the pivot mounted sampling head must be pulled out slightly and turned towards the display (pic. 1). After that, the filter cap (inner ring) must be pressed down and turned to lose the bayonet-catch (pic. 2). Now, the old filter can be removed and replaced by a new one. The smooth side of the filter must show in the direction of the sampling head. Only filters specified by SARAD should be used. This ensures a reliable sealing as well as the required spectroscopic performance.



The air flow rate determines mainly the calibration factor of any aerosol monitor. A constant flow rate ensures reliable results because not only the sampled volume but also the collection characteristics do not underlie variations. For this reason, the pump of the instrument is regulated to the nominal flow rate set-point even if the filter becomes loaded. As mentioned above, if the filter needs to be changed, the yellow signal starts to blink. This happens just before the contamination limit is reached. Thus, a running sampling can be finished before filter replacement. Flow rate as well as filter contamination are logged into the data file.

Important hint: The instrument must be switched off before filter replacement. Please see also chapter “Calculation of average activity concentration”.

Data storage

All acquired data is saved on an internal SD memory card (2GB). Data stored on the card can be read via PC either completely or for a selectable period (manual dVISION). If necessary, the SD card can be replaced by removing the bottom cap of the instrument’s enclosure (picture). After inserting a new card, the card needs to be initialized using the “RESET” button in the dVISIOn software.

Instrument operation by menus

If no measurement is in progress, the unit remains in a low power modus. 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)

Command „Show results“

After selection of this menu command by the OK button, a list of available measurements appears on the display:

- “Filter check” contamination status of the filter
- “Battery” current battery voltage
- “Counter” Detector gross count rate (all detected disintegrations)
- “Aerosols” Activity and dose values derived from the energy spectrum
- “Pump” Flow rate

To select one of these items, the select button must be pressed several times until the arrow points to the desired measure. After pushing the OK button, the results including the time stamp are shown on the display. Because the “Aerosols” menu contains more than one result, the select button must be used to toggle between them. Press the OK button to return to main menu.

Command „Select cycle“

The selected sampling cycle determines the duration of a sampling interval as well as the kind of measurement. Up to 15 various cycles can be defined by the user. After delivery, six pre-defined cycles are available:

„Hazard alert“: Sampling with one minute interval time to detect dangerous exposures quickly as needed for first responders.

„Hazard alert ZB“: Same as cycle one but with enabled wireless interface (Net Monitors).

„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.

„Staff monit. ZB“ Same as cycle one but with enabled wireless interface (Net Monitors).

„Dose assessment“: Spectroscopic analysis of the filter after exposure period (for example once per month). The sample interval is eight hours and the pump is not working (spectrometer mode). The filter analysis starts three hours after starting the cycle. Possibly remaining activity of Radon daughters decays during that period. 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.

„Power off“: Switches off the instrument (for equipment with serial number < POC-00072)

Start of a measurement

A new measurement (using the previously selected cycle) can be started by the menu command "Start sampling". Then, the display shows the name of the cycle, interval time and the elapsed sampling time.

The bottom line shows various menu commands which can be toggled by the Select button. The output of the results is implemented in the same manner as in standby mode. In addition to the interval values, the display shows also the recent reading of the selected measure. A blinking bar indicates recent readings while the time stamp indicates the interval results (time stamp is related to the end of the interval).

One more display command („GPS position“) informs of the remaining data memory and, if the unit is equipped with GPS receiver, of the geographic position.

Alert functions

Several types of alerts can arise while the unit is in operation. In parallel to the radiometric measures, battery voltage, flow rate and filter contamination are monitored continuously. All alert thresholds are adjustable by the user. It is also possible to disable one or more alerts. These settings can be done with the PC configuration software dCONFIG.

The instrument offers two different alert signals, a yellow blinking light on the one hand and a red light combined with a buzzer on the other hand. In the upper display line appears an alert message and in the lower line the menu option “Show alerts” is offered. Pressing the OK button leads to a list containing all pending alerts. The alert list has to be confirmed by pressing the OK button again. The behaviour of the signal devices can be configured by the user for each alert source independently. Two options are available:

„Disable auto alert reset“	X	Signal devices will be switched off after the user confirms the alerts by the associated menu function.
	-	Signal devices will be switched off if the alert situation is not more present.
„Alert confirmation“ *)	X	The alerts appear in the menu list for confirmation.
	-	The alerts do not appear in the menu list for alert confirmation.

*) If “Disable auto alert reset” is activated, the alert always appears in the menu list independent on status of “Alert confirmation”.

After delivery, following alerts are pre-defined:

Alert source	**Signal/check period**	**Preset threshold**	**Displayed phrase**	**Reset**
Alpha dose	Red/Interval	> 10DACh	Aerosols	User
Beta dose	Red/Interval	> 10DACh	Aerosols	User
EEC Radon	Red/Interval	> 1000Bq/m³	Aerosols	User
EEC Thoron	Red/Interval	> 1000Bq/m³	Aerosols	User
Gros count ate	Red/Second	> 20 cpm	Count rate	Auto
Low battery	Yellow/Second	11,8 V	Battery	Auto
No filter inserted	Yellow/Second	< 0%	Filter check	Auto
Filter contaminated	Yellow/Second	> 90%	Filter check	Auto

The configuration procedure for alerts will be explained in the chapter “User specific settings“.

Gamma background

Increased background radiation results in an increased count rate for betas. The reason is the generation of conversion electrons by interaction of gamma quants with matter (e.g. detector housing). These conversion electrons cannot be separated from the electrons emitted by the collected aerosols. Thus, the instrument would show a beta exposure even if no air-born aerosols are present. This "virtual" exposure disappears as soon as the instrument leaves the gamma radiation field while the real collect filter activity cannot decrease.

The instrument offers the possibility of static background compensation if the gamma radiation field on site is known (work place). The best way is to measure the background count rate directly with the instrument (sampling without pump). Then, the achieved value can be set as one configuration parameter using the configuration software dCONFIG. The background count rate can also be estimated if the local dose on site is known. For a natural radiation field, the following formula may be used:

Background count rate = 55cpm/(µSv/h) * Dose rate (µSv/h)

The preset background count rate will be subtracted from the beta gross count rate, taking the statistical fluctuations in consideration. If the unit with preset background is operated in areas without gamma radiation, the configuration needs to be changed again. Otherwise, the detection limit would be increased.

To set the background count rate see chapter „user specific settings".

Natural Uranium separation

From radiation protection point of view, it makes sense to distinguish between the isotopes of the natural U-238 decay chain (U_{nat}) and others. The dose coefficient (respective DAC values) for U_{nat} is much lower than for Plutonium while the natural Thorium decay chain includes nuclides with dose coefficients similar to Plutonium. In many mines and Uranium facilities, U_{nat} is the single carrier of LLRD activity.

The separation algorithm uses the circumstance that the maximum emission energy of the whole U_{nat} decay chain is about 4.7MeV. All nuclides or decay chains with higher dose coefficients emit their alpha particles with energies above 4.7MeV. That means, if some LLRD activity appears in the energy region above 4.7MeV, we can assume that nuclides with high dose coefficients are present. In this case, the Plutonium dose coefficient will be applied to calculate the dose from the measured exposure - otherwise the instrument applies the one for U_{nat}. In both cases, the presented dose value covers the whole LLRD activity even if a mixture of U_{nat} and other nuclides has been collected. This implementation may result in a dose overestimation for such situations.

The configuration of the instrument allows the definition of two separate dose coefficients for U_{nat} and Plutonium. If a user knows that only U_{nat} or only Plutonium (or other) is present in the place of operation, both coefficients could be set either for U_{nat} or Plutonium.

If the instrument applies the U_{nat} dose coefficient, the phrase "*Unat*" appears on the display (if alpha dose value is shown). Please note: Due to statistical deviations and Radon background rejection, a misinterpretation of a single value (especially in the surrounding of the detection limit) is possible.

Therefore, the user should always take care for the frequency of "U_{nat}" appearances during sampling. Just one single "U_{nat}" reading within a number of LLRD results indicates definitely a statistical fluctuation.

Calculation of the average activity concentration

The LLRD activity collected on the filter is proportional to the exposure and finally to the dose. Therefore, the exposure is the primary result for the calculation of the average activity concentration by division by the exposure time. The accumulated exposure time remains in the memory even if the measurement will be interrupted. The recently calculated result of the average concentration is always related to the whole exposure period. The user needs to make sure that filter activity and exposure period are always consistent. The instrument must be switched off (use cycle "Power off") and on again to reset the exposure time in case of filter replacement. Now, a new averaging period starts. In the reverse conclusion, the instrument must not be switched off without filter replacement.

Please note that any presented result within the stored time distribution represents always the average concentration of the period from the last filter replacement to the related time stamp. The result does not represent the actual concentration in that moment.

Operation conditions

The instrument has been designed as a robust unit for portable use in nuclear facilities and mining facilities. Because of the sampling method, the detector head is directly exposed to the ambient conditions. Therefore, the user should mind a few limitations.

- The temperature range from 0°C to 50°C should not be exceeded. An extended range can be provided on request.
- Condensation of water must be avoided. After strong temperature changes (moving a cold unit in warm environment) the instrument should be tempered for a while before using.
- Avoid beats onto the enclosure or detector head. The microphonic (piezo-electric) effect generates electronic signals similar to decay events. The instrument is equipped with dynamic shock suppression (electronic pulse shape analyses). Frequently shocks or permanent vibration must still be avoided. The unit should be worn on the body using the holster. The holster and the position close to the breathing tract offer a perfect shock protection as well as a good sampling procedure.
- Do not use any strong source of electro-magnetic fields in the immediate surroundings of the instrument (e.g. mobile phones, Wi-Fi adapter/router).
- The internal battery warms up during charging process. Therefore, the instrument must not be covered or operated in a box while the power supply is connected.
- The instrument should never be operated without filter. Particles in the air loop resulting in an increased abrasion of the pump.

Communication via USB and Net Monitors (ZigBee)

The instrument is equipped with both, a standard USB and a wireless interface. The USB interface has always the highest priority. That means, if the unit is connected to PC by the USB cable, the wireless connection will be interrupted. The USB port appears in the PC software as a virtual COM port. A driver

must be installed before the communication can be established (see manual dVISION). After delivery, the wireless interface is only activated if one of the cycles “Hazard alert ZB” or “Staff monit. ZB” is in progress. If the wireless communication shall also be provided also in standby mode, the configuration needs to be changed (see chapter “user specific settings”). It should be taken in account that in this case the wireless interface draws still current from the battery, resulting in a faster discharge. It takes about 60 seconds after switching on the wireless interface (start of the cycle) until the connection has been established. Please mind the correct baud rate setting (9600) at the Net Monitors coordinator. If the connection will be interrupted, the instrument automatically re-connects as soon as it is back in the range of the coordinator.

User specific settings

The instrument is based on the DACM platform, which provides flexible tools for custom specific configurations. Each of the functional blocks, the so-called components, can be configured and controlled separately using the PC software dCONFIG. Changing the configuration requires caution and should be carried out by skilled persons only (administrator). Erroneous settings may result in a male function of the instrument. Before changing anything, the operator should read the recent configuration from the unit and save it on PC as configuration file. If necessary, this file can be written back to the unit in case of trouble. Each component offers a specific configuration window in dCONFIG for all available configuration parameter. The dCONFIG software manual informs of the procedures to access the various configuration windows.

Changing the alert settings for radiometric measures

Configuration window of component SPEC1

It is possible to define two independent alert levels. The threshold values must be entered into the edit fields “Alarm 1 threshold” and “Alarm 2 threshold”. Several measures can be assigned to each of the alert levels. These measures must be selected by marking the items within the list boxes “Alarm 1 source” and “Alarm 2 source”. The threshold level is always related to the physical unit of the selected measure. For example, one could use the first threshold for the dose value and the other one for Radon and Thoron concentration. The instrument offers two alert signals, which are controlled by the components DOUT3 (red light and buzzer) and DOUT4 (yellow light). After delivery, the component DOUT3 is chosen for radiometric alerts. To disable the alert function, select the item “inactive” from the list “Alarm output”.

Changing the threshold level for the count rate

Configuration window of components CMP1 and CNT1

Two components, a voltage comparator (CMP1) and a counter input (CNT1) are used for gross count rate measurements. The comparator output is internally connected to the counter input. A digital pulse appears at the counter input if the detector signal exceeds the threshold level of the comparator. Because the height of the detector signal is related to the emission energy of the decay event, the count rate contains only events above the energy corresponding with the threshold. This allows the configuration of the counter either as gross alpha or total event counter. The threshold level can be adjusted in the component window of CMP1, edit field “Threshold voltage”. To count alpha and beta decays, enter 100mV, for alphas only, enter 350mV.

The alert threshold for the count rate can be configured in the configuration window of component CNT1 (“Alarm if count rate becomes higher than”). The alert can be disabled in the same manner as described for the radiometric measures if the item “inactive” will be selected from the list box “Alarm index higher than”. After delivery, the red light and the buzzer (DOUT3) are activated in case of a pending alert. If only the yellow light shall signalize high count rates, select DOUT4 instead of DOUT3.

Adjusting the gamma background compensation

Configuration window of component SPEC1

To enter the background count rate, the parameter „Fixed Background Count Rate“ is available in the table “Calibration constants”. The unit is cpm (counts per minute).

Changing units (US/SI) and dose coefficients

Configuration window of component SPEC1

The activity and dose results can be presented either in traditional US units or in international SI units, depending on the selection in the list box “Unit scheme”. Changing the unit scheme requires always the changing of the dose coefficients. Dose coefficients must be stated in relation to the selected dose unit. That means for US unit scheme, the unit of dose coefficients is DACh/(Bqh/m³). The dose coefficient unit in case of SI unit scheme is µSv/(Bqh/m³). The values can be entered into the table “Calibration constants”. There, the parameters "Dose Coefficient Alpha", “Dose Coefficient Unat” and "Dose Coefficient Beta" are available.

The factory-set coefficients are adjusted with respect to the normative 10CRF20 of the US-DOE. Because there are specific laws for various applications and countries, the user must change these constants in accordance with the local regulations.

Coefficient for	in DACh/(Bqh/m³)		in µSv/(Bqh/m³)
	10CRF20	10CRF835	German StrlSchV §§63 u. 63a Anlage 3
Plutonium	9,01	5,4	192
Natural Uranium	1,35	0,34	76,8
Strontium	0,014	0,0039	0,84

Enabling of the wireless interface in standby mode

Configuration window of component SPEC1

The power supply for the wireless interface can be switched on/off with the status of the switch output DOUT2. The output can be controlled during the measurement by the cycle definition chart (see dCONFIG). The configuration window offers the possibility to define the status of the output during standby. Use the list box “Reset status” either to turn on („active“) or turn off (“inactive”) the interface. After delivery, the reset status is set to „inactive“.

Appendix

Assignment of components in dCONFIG

Name	Function	Component type
DOUT1	Power supply for flow regulator	Switch outputs
DOUT2	Power supply for wireless interface (Net Monitors)	Switch outputs
DOUT3	Red Alert signal/buzzer	Switch outputs
DOUT4	Yellow alert signal	Switch outputs
CNT1	Gross count rate	16 bit counters
AIN8	Filter check (Pump voltage)	12 bit configurable analogous inputs
BATT	Battery voltage measurement	Internal sensors
SPEC1	Spectrometer for filter activity	Spectrometer
REG2	Flow rate regulator (set-point)	P-Regulator/analogous output
CMP1	Threshold for detector pulse signal	Voltage comparator input

Technical Data

Detector

- 400mm² ion-implanted silicon detector
- Energy range 0.15..3MeV (Beta); 3…10MeV (Alpha)
- Counting efficiency (4π) approx. 20%
- Open face sampling for minimum collection losses

Filter

- Membrane filter (PTFE); 3µm pore size; 25mm dia. with Neoprene sealing
- Deposition rate >99,9%
- Active filter test with respect to perforation and exhaustion
- Tool-less replacement of the filter
- More than 1 month operation in “normal” environment

Pump

- Low noise quality rotary van pump
- Nominal air flow 3l/min (adjustable range 1.5 to 3l/min)
- Processor controlled air flow for constant deposition conditions
- Pressure drop across the filter 5…20mbar (at 3l/min)
- Noise emission approx. 48/51dBA (in 1m/30cm distance)

Results

- Equilibrium Equivalent Concentration (EEC) for Radon and Thoron daughter products in Bq/m³
- Exposure for Alpha and Beta emitters (LLRD) in Bqh/m³
- Dose for Alpha and Beta emitters in µSv or DAC-hrs (dose coefficients adjustable by user)
- Detection of Natural Uranium with automatic selection of the U_{nat} dose coefficient
- Average activity concentration for Alpha and Beta emitters in Bq/m³
- Separate channel for Alpha gross counting in cps or Bq or Markov Algorithm for Radon daughter product grab sampling
- Flow rate, filter exhaustion, battery voltage

Standards

- IEC 60761-1
- IEC 60761-2
- IEC 61578
- IEC 61577-3
- IEC 1263
- CE

Compensation

- Compensation of natural Radon background by Alpha spectroscopy with dynamic fitting of peak shape with respect to progressive filter exhaustion
- Upper Alpha energy threshold for LLRD = 5,6MeV
- Static compensation of Gamma background
- Dynamic shock rejection (mechanical shock) by pulse signal shape analysis

LLRD Sensitivity	• approx. 2cpm/(Bqh/m³)
Measurement range	• 0…125000Bqh/m³ (0…625000 DACh(Pu)) • 7.5MBq/m³ over 1 minute or 16kBq/m³ over 8 hours
Measurement	• Up to 16 user definable sampling cycles (1s to 1year) • Predefined sampling cycles 1 and 30 minutes as well as 12 hours filter analysis (without pump)
Detection limits	• See tables below
Alert indication	• Configurable alert thresholds for all measured results • Bright alert LED with yellow and red light • 85dB signal buzzer • Alert indication at display • Alert reset is configurable (either with confirmation by the user or automatic reset if the alert condition is no longer present) • Pre-defined alerts for LLRD activity, low/high count rate, filter perforation
Data storage	• 2GB SD card (> 1,200,000 data records) • Storage of all measured raw data incl. spectra
Handling	• Large alphanumerical display 4 x 20 characters • High contrast even in direct sunlight • Backlight • Three buttons, operation with gloves possible • Intuitive, straight forward menu structure
Interface	• USB, Net Monitors wireless (ZigBee)
Power supply	• Standard NiMH battery pack 12V/3.8Ah • Power adapter 18V/3A
Housing	• Ergonomic and smart design • Ease of decontamination • 106mm x 56mm x 200mm • 1.3kg
Ambient conditions	• 0…50°C • 5…95%rH, noncondensing

Software dVISION	• Remote control • Data transfer, visualization • Data management, export to text files • System configuration • Creating/Editing of measurement cycles • Network management
Additional options	• GPS receiver
Calibration/Test	• Factory calibration in a Radon daughter product atmosphere with aerosol generator • Test sources Am-241 (Alpha), Cs-137 (Beta), Co-60 (Beta); recommended are area sources with 25mm diameter and 185Bq nominal activity such as Eckert & Ziegler AMRB25499, CDRB25498, CKRB25500 or similar • Flow rate check on top of the filter using adapter dome and low differential pressure air flow meter ($\Delta p < 10mbar$ @3l/min)
Accessories	• USB cable • charger/power supply adapter • user manual both instrument and SW (on CD as .pdf-file) • calibration certificate • aerosols filter (1+10 pcs.) • transport suitcase • harness for comfortable wearing (optional)

Detection Limits

The detection limits stated in the tables below are valid for following operational conditions:

- Flow rate = 3l/min
- $k_{1-\alpha}$ =3 (99.8%)
- $k_{1-\beta}$ = 1.65 (95%)
- 1DAC(Pu) = 0.2Bq/m³ (10CRF835)
- 1DAC(Sr90) = 200Bq/m³ (10CRF835)

Additionally for Beta measurement:

- F = 0.6
- Gamma background = 0.1µSv/h

The assumption for the detection limit of the concentration is a momentarily step-like increase of air activity concentration up to the detection limit at the beginning of a sampling interval. Furthermore it is presumed that there was no LLRD activity deposited on the filter.

Alpha LLRD									
Po-218 *)	Detection limit T = 1min			Detection limit T = 10min			Detection limit T = 30min		
Bq/m³	Bqh/m³	DACh	Bq/m³	Bqh/m³	DACh	Bq/m³	Bqh/m³	DACh	Bq/m³
10	8,14	40,7	488	0,95	4,73	5,7	0,51	2,6	1,0
20	8,14	40,7	488	1,28	6,38	7,7	0,71	3,5	1,42
50	8,14	40,7	488	1,95	9,74	11,7	1,13	5,6	2,3
100	9,46	47,3	567	2,74	13,7	16,5	1,66	8,3	3,3

Beta LLRD									
Po-218 *)	Detection limit T = 1min			Detection limit T = 10min			Detection limit T = 30min		
Bq/m³	Bqh/m³	DACh	Bq/m³	Bqh/m³	DACh	Bq/m³	Bqh/m³	DACh	Bq/m³
10	10,5	0,053	632	3,12	0,016	18,7	1,77	0,009	3,6
20	13,2	0,066	794	3,98	0,020	23,9	2,28	0,011	4,6
50	19,1	0,096	1150	5,84	0,029	35,0	3,35	0,017	6,7
100	26,0	0,130	1560	8,02	0,040	48,1	4,61	0,023	9,2

*) The activity concentration of Po-218 is always less than the one of Rn-222

The detection limits for a 12 hours measurement using filter analysis mode (without pump) after complete decay of Radon daughters are 0.01Bqh/m³ (0.06DACh; 0,001Bq/m³) for Alpha and 0.2Bqh/m³ (0.001DACh; 0.017Bq/m³) for Beta emitters.