thermoscientific

Operating Instructions   DB-117 E

RadEye PRD4

Personal Radiation Detector

RadEye PRD-ER4

Personal Radiation Detector
Extended Range

REVISIONS SHEET:

Rev.	Rev. state	Dept. resp.	Name	Rev. page	Cat. *)	Explanation
	2020-07-01	FSI-EH	Pijahn			First edition # P02/2020
A	2020-08-06	FSI-EH	Pijahn	8-1	A	Chapter 8. RadEye.exe ECN 83633
B	2020-09-22	FSI-E	Bu	0-11	C	FCC Compliance Statement added ECN 83689
C	2021-04-30	FSI-EH	Pijahn	Cpl.	A	ECN 83882

*) Category   C: editorial correction
                         I: clearing improvement
                         A: substantial amendment

Explanations must be given, at least with Category A.

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SAFETY INSTRUCTIONS

Do not use the unit if error messages appear on the screen.

The earphone connector at the bottom side of the instrument must be exclusively used by equipment that is specified for use with RadEye PRD and PRD-ER.

The instrument must not be used in explosive atmospheres.

The RadEye SPRD-ER is not intended to be used as a personal dosimeter. No neutron dose rate or dose calculation is performed. Due to the high detector sensitivity the gamma dose rate measuring range of the RadEye SPRD-ER is limited to 10 Sv/h (1000 rem/h). For higher dose rates (indicated by "Overload") an underestimation of the integrated gamma dose can be expected.

The RadEye SPRD-ER shall not be used for measurements in pulsed fields.

Nuclide ID and search and find are only available with the LDR detector.

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WEEE Compliance:

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2012/19/EU. It is marked with the following symbol:

Thermo Fisher Scientific has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on Thermo Fisher Scientific compliance with these Directives, the recyclers in your country, and information on Thermo Fisher Scientific products which may assist the detection of substances subject to the RoHS Directive are available at

https://www.thermofisher.com/us/en/home/industrial/environmental/environmental-learning-center/environmental-resource-library/epm-weee-compliance.html

FCC Compliance Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. this device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Canada

This device complies with Industry Canada license-exempt RSS standard(s).Operation is subject to the following two conditions:
(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :
(1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

1. Introduction

The RadEye PRD and PRD-ER personal radiation detector are highly sensitive and rugged measuring devices that detect and localizes gamma sources.

The patented Natural Background Rejection algorithm (NBR) allows RadEye PRD and PRD-ER to immediately separate man-made (non-NORM[1]) gamma radiation from natural background fluctuations during operation.

RadEye PRD and PRD-ER uses a distinct and unique dose rate algorithm to provide a fully energy compensated gamma dose rate. RadEye PRD and PRD-ER can be measured in terms of ambient equivalent dose rate H*(10) (Sv/h, rem/h), air kerma rate (Gy/h) or exposure rate (R/h).

The instrument is designed to meet the requirements in the standards N42.32-2016, N42.33A-2006, N42.42-2012, and IEC 60846-1.

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[1]   **N**atural **O**ccurring **R**adioactive **M**aterial (NORM).

The RadEye PRD-ER incorporates a CsI detector. To reduce size and power, the detectors are equipped with miniature silicon photo-multipliers (SiPM) allowing the detection of very low radiation levels.

In addition, the PRD-ER includes a High Dose-Rate Detector (HDRD) module for measuring the dose rate from 250µSv/h to 10Sv/h.

The RadEye PRD-ER pager distinguishes gamma and neutron alarms by different colored alarm LEDs, distinct audible tones, and by highlighting the alarming channels as appropriate. The RadEye PRD-ER also has different audible alarms and visual alarms to discriminate between elevated background/NORM and any artificial gamma radiation alarm. This gives the users the ability to quickly distinguish potential threats from benign sources.

At least 1600 measurement values of the gamma count rate, neutron count rate, gamma dose rate, alarms and errors are recorded internally and can be read out. A real time clock is provided to add a timestamp to all recorded data.

The RadEye PRD-ER enables measurement of detector count rates and energy compensated dose and dose rates.

All menu functions described in 3.2 can be configured to be hidden on the device to prevent unauthorized access.

The instrument can also be configured to provide as much or as little detail as possible, depending on user preference and training. From a simple 0-9 display to fully featured capability, RadEye PRD-ER allows users to add features and capability and training and experience improve.

Red LED: gamma alarm / blue LED: neutron alarm LEDs are showing radiation exceeding thresholds. Visible from top if worn in a holster and from display side

Key on top side to acknowledge alarms if worn in a holster

Powerful graphical display. Units in cps, Roentgen, Rem, Gray or Sievert.

Rugged plastic enclosure

Easy to use, four key menu driven user interface

Earphone connector

1.1   Cleaning the instrument

Remove the rubber boot and clean it separately. Clean the RadEye with a soft, dry cloth. For virus decontamination, dampen the cloth with a little water and detergent. Do not use harsh chemicals such as organic solvents.

1.2 Block diagram
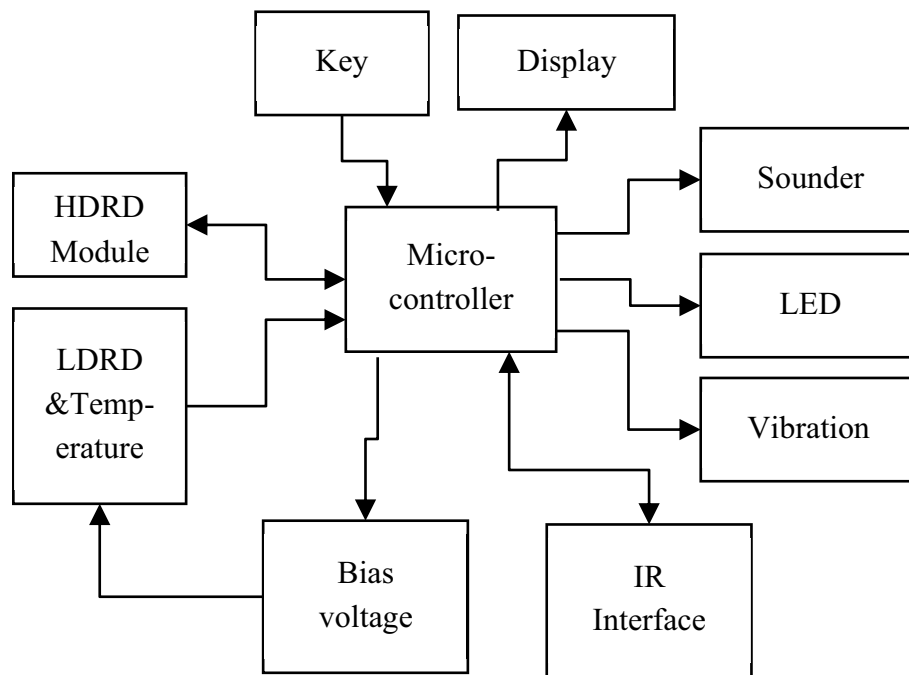
1.3   Used abbreviations

ADF	Advanced Digital Filter
BLE	Bluetooth Low Energy.
CsI	Caesium Iodide
HDR	High Dose-Rate (mode)
HDRD	High Dose-Rate Detector
ID	Identification
IR	Infra-red
LDRD	Low Dose-Rate Detector
NBR	Natural Background Rejection
NiMH	Nickel-metal hydride battery. Rechargeable battery
PC	Personal Computer
RTC	Real Time Clock
SiPM	Silicon Photomultiplier
USB	Universal Serial Bus
NORM	Natural Occurring Radioactive Material

2. Installation and start-up

2.1 Scope of delivery

The RadEye is delivered in a folding cardboard box together with two AAA cells, rubber protection sleeve, quick start guide and an operating manual.

For optional accessories see Chapter 12.

2.2 Inserting the battery

The two AAA alkaline cells as delivered with the instrument allow est. 170 h of normal operation.
AAA size NiMH rechargeable batteries can be used as well.

- Switch off the measuring instrument and wait about 5s for complete shutdown.

- Remove rubber boot.

- Open the cover of the battery compartment.
  Use of a coin is recommended to open the lid lock.

- Have fresh batteries ready. Exchange the batteries according to the shown polarity. Changing the batteries within 15 seconds preserves the date and time without having to re-synchronize it with a personal computer (PC).

- Close the compartment cover hooks first, taking care that the rubber seal is in its groove.

- Switch on the unit again. (see Chapter 2.4)

The instrument continues working in the operating mode set last (see Chapter 3).

The measured values in the history memory remain stored.
If Real Time Clock (RTC) is set, actual time and date is displayed for 3 s (see Chapter 2.4).

If correct timing information of logbook and history is required, the RTC should be set manually (see Chapter 4.10) or by means of the PC-program.

To keep RTC running during battery exchange, batteries must be exchanged without delays.

History data and measurement parameters are stored permanently, even if batteries are removed.

RTC information is required if the instrument is switched off and on during operation, and if correct timing information for history and logbook entries and stored is needed.
For the last power on interval, the relative time information of logbook and history is corrected to actual PC clock time during read out. In these cases the setting of the clock is not required.

2.3   Mounting of the protection sleeve

The rubber protection sleeve improves ruggedness to mechanical shocks and is required to maintain operability after 1.5m drops.

To mount the sleeve, first put the instrument into the top of the sleeve. Then pull lower edges of the sleeve, one after the other, into its right position.

First step   Second step

Front view   Rear view

2.4   Switching the unit on

To switch on the RadEye PRD-ER, keep the "ON" button pressed for at least one second. The RadEye may need a longer time for startup if it is started immediately after the batteries are inserted. The sound generator (beeper) and the LED test routine will remain on as long as the key is pressed.

```
RadEye
PRD-ER
Cal.:  2020-04-29
Lu:    2020-05-13
3.21V  E 4.00    34
```

Calibration date

Last Lutetium test

Checksum of the firmware

Battery voltage

Firmware version
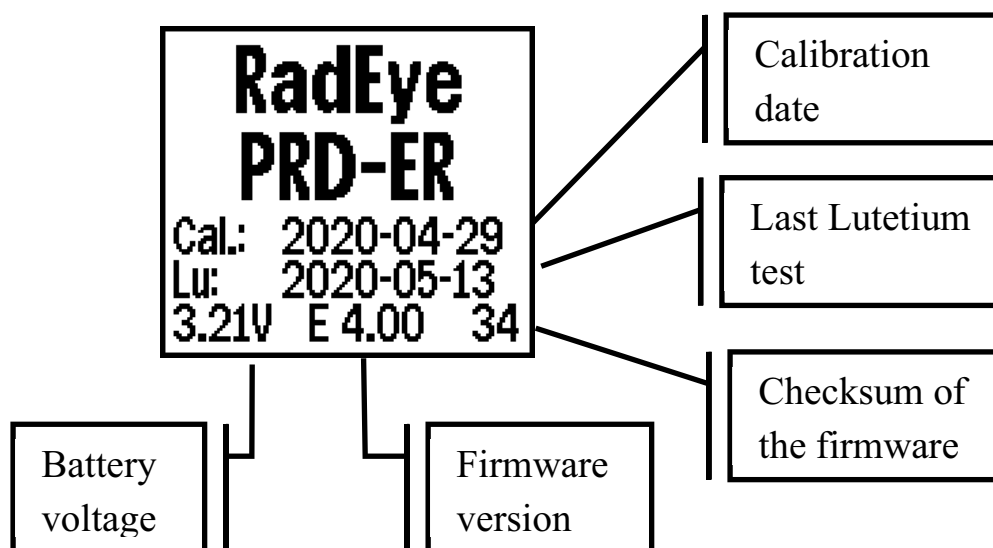
Display of the welcome screen.

The RadEye PRD-ER starts working with the parameters previously selected (operation mode, calibration factor, alarm threshold, measurement unit, etc.). The displayed measurement value is a **G**amma value, a **N**eutron value or both.

If the real time clock is set, actual time and date is displayed for 3s:
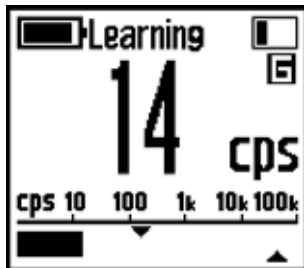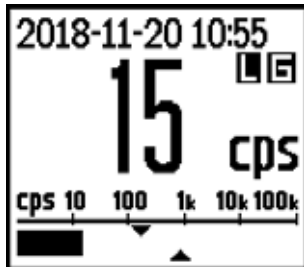
After startup, the message "Learning" is displayed together with a progress bar for the first 30 s. During this time the sigma-alarm levels of the gamma channel are adapted more quickly to the current radiation level. During the "Learning" period, the sigma alarms are active, but not with full sensitivity. The NBR-Alarm is immediately active.

This display after the Learning phase indicates that the RadEye is ready for operation:
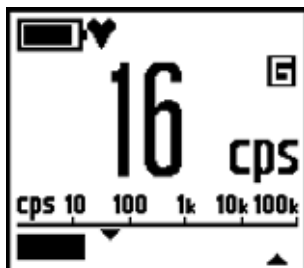
Unless a custom configuration is requested by the customer during the ordering process, the alarm values are preset based on field surroundings and the ANSI N42.48-2008 standard (see Chapter 14.1).

The factory preset alarm thresholds for dose rate and count rate are around 200 - 500 % above the typical normal backgrounds, and allow sensitive measurements without false alarms. The alarm thresholds for the dose are set to the maximum possible values, thus being deactivated. These values are typically set by customers according to their Concept of Operation (CONOP). The standard default partition of memory allows an interval of 600 s, meaning over a week of operation will be stored in the history memory.

These default values can be changed by the user with the menu functions or with the help of the optional PC-program and the cable 42540/26. Furthermore, additional monitoring modes can be activated.

The calibration parameters can only be changed in the factory using special software tools.

3. Configuration

3.1 Ratemeter

After switching on the RadEye PRD-ER, the configured basic display is activated. By a short press on the arrow up key (▲/Info) for one or more times four further display modes can be chosen which are shown for only some seconds.
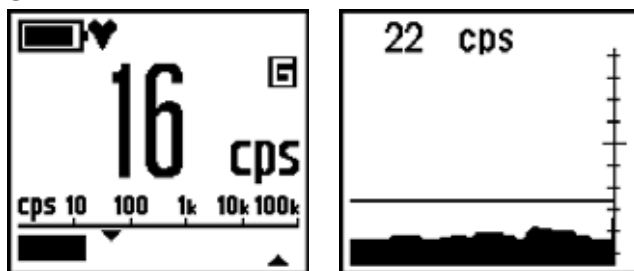The following Chapters describe the different modes of the basic display.
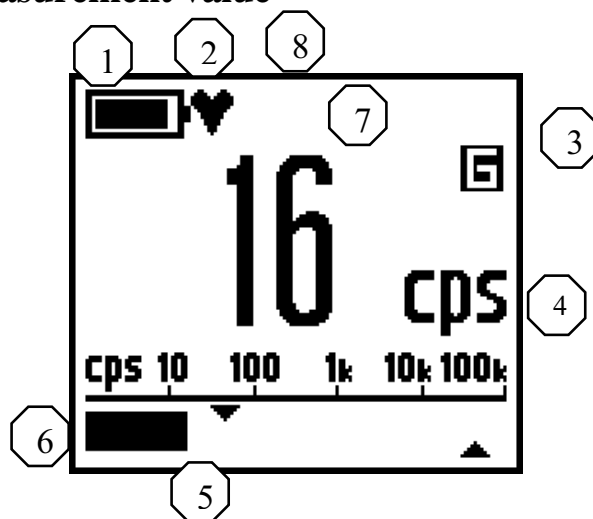
3.1.1 Basic display

Note: Some of the following display options may be disabled by the user specific configuration.

The basic display shows the gamma channel.
Normally the On key toggles between standard display and gamma value on a time axis:

Gamma measurement value

Neutron measurement value
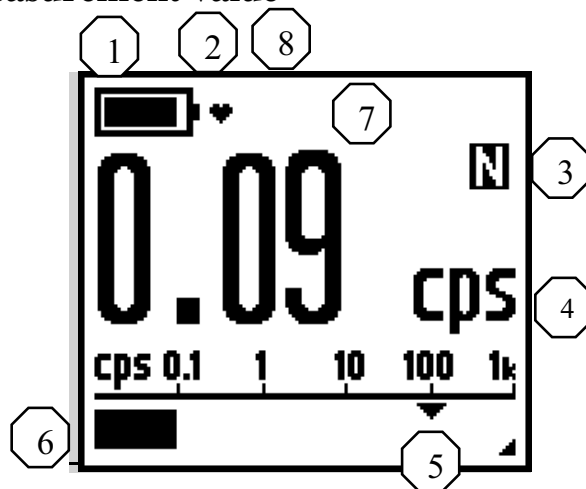
Gamma and neutron measurement values
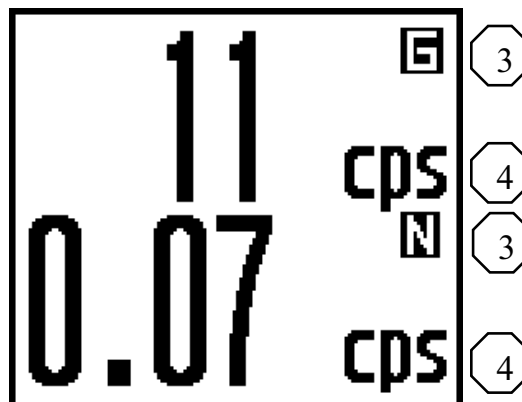
1: Battery indication	*5: Alarm thresholds*
2: Heart beat	*6: Bar graph overview*
*3: **G**amma or **N**eutron channel*	*7: Info line*
4: Measurement unit	*8: Auto adjust active*

Graphic display:
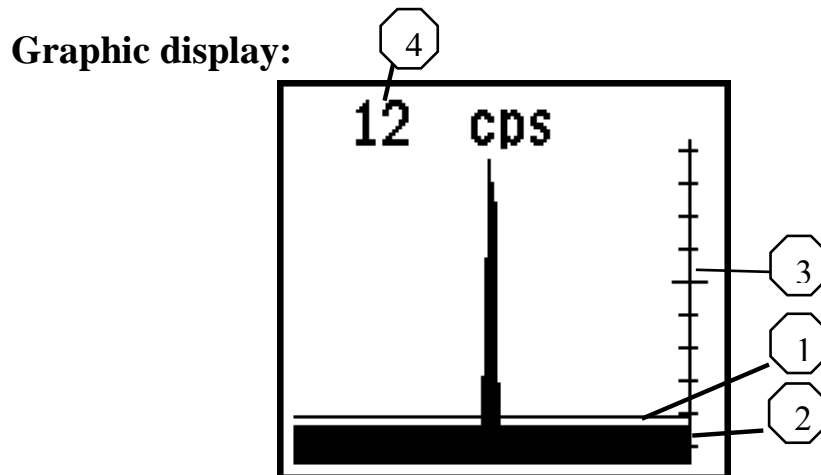
1: Threshold alarm 1
2: Gamma count rate
3: Linear scale (auto ranging)
4: Measurement value

The different display modes can be toggled by pressing the arrow down key.

Please note: *If the backlight of the display is not on, the first pressed key will lead only to an activated display backlight without any other action.*

The *battery indication* symbol shows the state of the battery. A pulsing *heart beat* and *auto adjust* symbol indicates that the RadEye PRD-ER is working properly. The *Gamma or the Neutron channel* is labeled with a **G** or a **N**. The *measurement unit* can be chosen by the main menu and may differ from the pictures above.

Please note that the time response of the gamma count rate (*measurement unit*: cps) is much quicker than the time response of the energy compensated dose rate (*measurement units*: rem/h, R/h, Sv/h, Gy/h). The RadEye PRD-ER does not show the Neutron dose or the dose rate.

During operation of the measuring device at least four *alarm thresholds* are checked. Two of them are shown in the basic displays with two triangles (upper triangle: alarm 1, lower triangle: alarm 2, for gamma and neutron), two of them refer to the dose and can only be seen in the `Edit Alarms` sub-menu. The *bar graph* graphically represents the intensity of the measurement value to simplify the meter-reading.
The *info line* at the top of the display is used to provide additional information, e.g. the ambient temperature, the NBR-Status, or any kind of malfunction.

3.1.2   Information mode display

Note: Some of the following display options may be disabled by the user specific configuration.
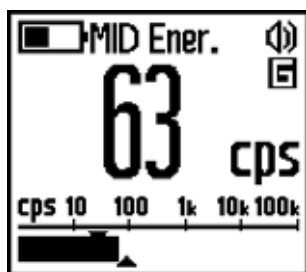
Pressing the up arrow key ▲ –
- 1ˢᵗ click: the current gamma dose rate (µR/h, µSv/h, µGy/h or rem/h)
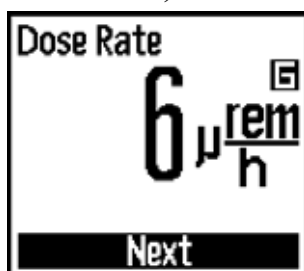
- 2ⁿᵈ click: the accumulated gamma dose (R, Sv, Gy or rem) additionally the remaining time until the dose alarm 1 is reached, assuming the current dose rate remains stable.
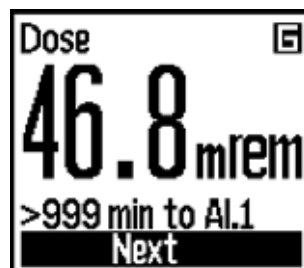
- 3ʳᵈ click: the mean value and peak value of the measured gamma count rate (cps), together with the time indicated since the last reset. Use the "Menu / ◄" button stop / restart the measurement.

Peak

Mean

Time

‚17.2 cps
ø14.5 cps
⊙00:04:21
Stop Next
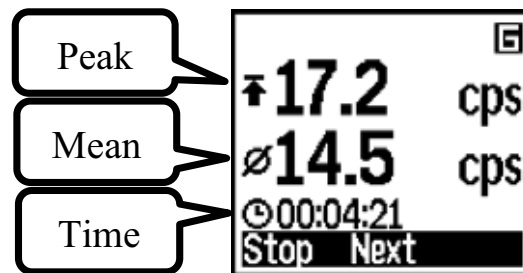
- 4th click: the mean value and peak value of the measured neutron count rate (cps), together with the time indicated since the last reset (if neutron measurement is enabled). Use the "Menu / ◄" button stop / restart the measurement.

‚0.15 cps
ø0.11 cps
⊙00:04:53
Stop Exit
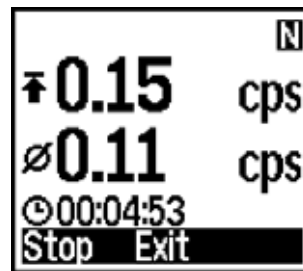
After 10 seconds or after 5th click the device returns to the basic display

3.1.3 Display/Screen Options

Depending on the configuration, RadEye can display up to 3 more live activity screens by pressing the down arrow ▼/On/Screen button.

- 1st click: the neutron levels in primary selected unit (cps)
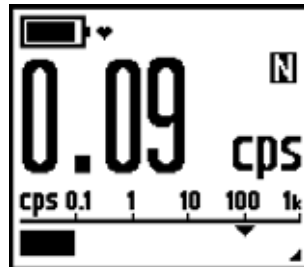
- 2nd click: dual channel display – actively updates and displays the current levels of gamma and neutron in the primary unit selected.
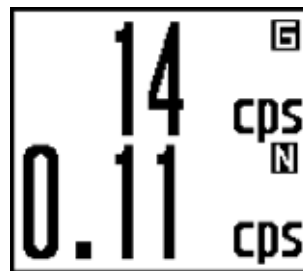
- 3rd click: graphical display of gamma count rate for use with pinpointing radiation source.
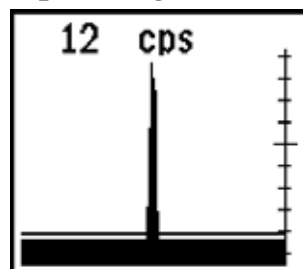
After 4th click the gamma channel is shown again.

3.1.4   Cross-mode display

In this mode the measurement value of the dose rate is displayed together with the bar graph alarm threshold using count rate. The count rate alarm thresholds are active, resulting in a quick alarm response, while the calculating of the dose rate for low count rates takes place over a longer time. This mode is useful for users who prefer to view their real time dose rate, but who also want to find hidden radioactivity without compromising alarm speed.
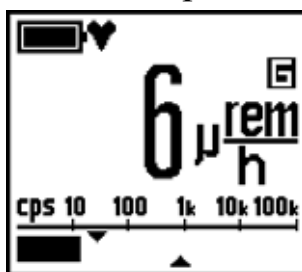
A press on the Info key (arrow up) results directly in the display of the accumulated dose respectively the mean- and max values.
This mode can be activated or deactivated via PC-Software

3.2   Menu functions

To enter the operating menu, press the "◄/Menu" key.
Scrolling through the single menu options is effected by the "▲/▼" arrow keys.
The display returns to its initial default setting in case no key has been activated for more than 10 seconds.
A ✓, when found behind some menu options, means that the respective function is active.

3.2.1 Main menu

The main menu offers the following displays:

The above illustration depicts all main menu options for the standard configuration.

Using the PC-program many functions can be hidden for more simplicity and to prevent unintentional changes.

To select a menu option or a submenu, highlight the desired action and press the left key.

The meaning of the Menu key may change with the selected menu. The meaning is shown on the bottom right side of the display:

Change: Edit Alarm values

Off, **On**: Switching a function on and off

Select: Select a default display mode

Yes: Confirmation of an action

Exit: Exit menu

In Change menu the Up-/Down arrow keys are used to change a digit of an alarm value.

MAIN MENU DISPLAY	DESCRIPTION OF THE FUNCTION OR SUB-MENU ACTIVATED BY THE LEFT KEY
Switch off	RadEye is switched off. Time and stored data are maintained.
Sound	The audible indication is enabled / disabled
LED	The Alarm LED is enabled / disabled for both gamma and neutron LED.
Vibrator	The vibration alarm is enabled / disabled
Count Rate	Select Count rate mode (cps)
Dose Rate	Select Dose rate mode (R/h, rem/h or Sv/h):
Level	Select level mode (1 – 9)
Alarm Dose Rate	Allows setting of Alarm1 and 2 (R/h, rem/h or Sv/h) for dose rate mode
Alarm Cnt. Rate	*SUBMENU Alarm Cnt. Rate* See 3.2.3
Alarm Dose	Allows setting of dose alarm 1 and 2 for all modes
Alarm NBR	Activation or deactivation of NBR-Alarm.
Autosend	If activated, the instrument sends a data string periodically to the infrared port. This is used for radio transmission units

Finder	Enabling and disabling of audible radiation intensity. Activation is done by audio keys (right button and top button).
Single Pulse	Enabling and disabling of single pulse indication. Activation is done by audio keys (right button and top button).
Backlight	Backlight always on/Backlight extinguished after 10 s.
Show Alarm	Display of alarms stored in log.
Settings	- Switching between battery type Alkaline and NiMh. It is used for the correct warning of low battery. - Set date and time of the real time clock. - Lu-Test: verification of detector amplification - Change menu language of RadEye PRD - Enable/disable rated alarm - Set display contrast
Text Info	Displays the text info stored in the RadEye

3.2.2   Submenu "Settings"
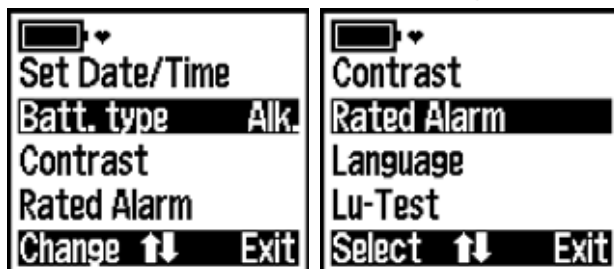
The above illustrations depict all main menu options for the submenu "Settings".

SUBMENU "SET-TINGS	DESCRIPTION OF THE FUNCTION
Battery type	Select between the battery type Alkaline ("Alk.") and NiMH. This determines the threshold for a low battery warning.
Set Date/Time	Sets date and time of the real time clock.
Language	Sets language to English, German or French
Lu-Adjust	Setting the detector amplification
Contrast	Adjusts the contrast of the LCD display
HDRD on	Force the RadEye PRD-ER to remain continuously in HDR mode

3.2.3 Submenu "Alarm Cnt. Rate"
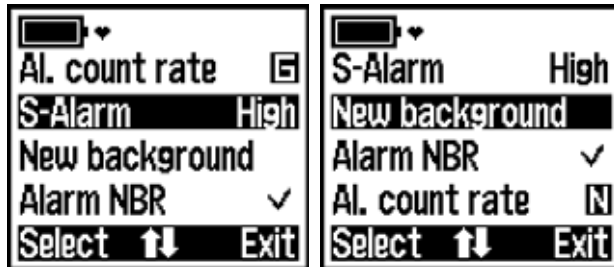
SUBMENU "EDIT ALARM"	DESCRIPTION OF THE FUNCTION
Al. count rate G	Edits the alarm threshold 1 and 2 of count rate gamma (measuring unit cps, cpm, and cross mode). If the measuring unit is set to R/h, rem/h or Sv/h the menu item will be renamed to "Al. dose rate G".
Al. count rate N	Edits the alarm threshold 1 and 2 of count rate neutron
Alarm NBR	If selected, the NBR function is active (see 5.2)
New background	Forces the RadEye to start a new background measurement (Ratemeter)
S-Alarm	Enables or disables the high sensitivity S-Alarm (see 5.3)

3.3   Alarm thresholds

There are two alarm thresholds each allocated to dose gamma, dose rate gamma, count rate gamma, Level and count rate neutron.

Two rate alarm thresholds corresponding to the chosen basic display mode are active. The two active rate alarm thresholds are marked at the bar graph (See 3.1.1 and 3.5).

Additionally the two gamma dose thresholds are active.
In order to avoid dose alarms while using the instrument exclusively as a rate meter, the dose alarms can be set to the maximum level.

It is possible to configure the alarm threshold 2 for dose rate as a safety alarm via the PC-program. In this case, the dose rate alarm threshold 2 is always active, regardless of the mode or units.

Configuration of the alarms is possible via infrared interface or via the menu. As to the alarm activation, please see Chapter 4.4.

3.4 Gamma alarm threshold based on the relative standard deviation (sigma threshold)

When the sigma value is set between 2 and 9, the first gamma alarm threshold is calculated four times a second based on the current background count rate, assuming a stable natural background. The actual alarm threshold adjusts itself automatically to the existing background radiation level. The actual setting of the alarm threshold 1 can be observed on the bar graph threshold mark (left most triangle ▼) if the standard Ratemeter display is currently active. When the instrument is first powered on, the background rate meter starts with its maximum value of 100 cps, reaching its final value after 30 seconds.

Using the menu option `Alarm Cnt. Rate G` in submenu `Alarm Cnt. Rate` the exact value of the alarm threshold currently valid at the respective background can be displayed.

After acknowledgement of a sigma-alarm, the background Ratemeter is set to the actual count rate. The alarm threshold is correspondingly increased.

Alarm 2 always refers to the total count rate without consideration of any learned background.

Recommended Sigma values:

Sigma = 6 enables almost false-alarm-free searching in areas with a fairly constant radiation background.

3.5 Setting alarm thresholds

The menu options `Al.count rate G` , `Al.count rate N` in submenu `Alarm Cnt. Rate` and `Al. dose rate G` and `Alarm dose G` in main menu allow the alarm thresholds to be modified. Changing the value is effected by pressing the left (Change) button if the corresponding "Alarm" is selected:

To increment the number, press the ▲/▼ arrow keys. To go on to the next digit or to quit the edit mode, menu use ►/◄ arrow keys.
Once the last number has been set, quit the editing mode by pressing the "Exit"-key. Then, the value set is saved and the unit returns to the basic display.

Example: Changing the dose alarm threshold:

Press the ▲/▼ arrow keys until `Alarm dose` is selected.

Then enter the change screen pressing the "Change" key.

```
▭▾♥
Autosend
Alarm Dose
Alarm Dose Rate
Alarm Cnt. Rate
Change↑↓     Exit
```

Edit the value by pressing ▲/▼ keys select digit by ►/◄ keys.
The metrics prefix such as "μ", "m" may be chosen as well.

```
▭▾♥

Al.1: 0100   rem
Al.2: 1.00   rem

Exit     ↑↓      ➡
```

Leave the last digit with the ► arrow key:
Confirm storage of edited value pressing "Yes"

```
▭▾♥

Al.1: 0220 mrem
Al.2: 1.00   rem
      Save Value?
Yes            No
```

Example: Changing the sigma value for the gamma count rate alarm threshold:

Press "◄/Menu" key, and ▲/▼ arrow keys until `Alarm Cnt. Rate` is selected

Then enter the submenu by pressing the "Select" key.

```
▭▾♥
Alarm Dose Rate
Alarm Cnt. Rate
Dose Rate
Count Rate      ✓
Change↑↓     Exit
```

Press "◄/Menu" key, and ▲/▼ arrow keys until
`Al. Count rate G` is selected

Then enter change menu by pressing "Select" key.

```
▭▾♥
Al. count rate    N
Al. count rate    G
S-Alarm        Low
New background
Select  ↑↓     Exit
```
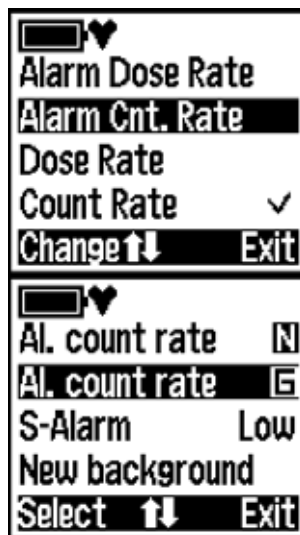
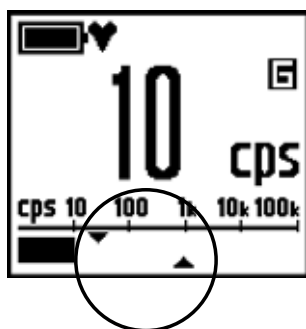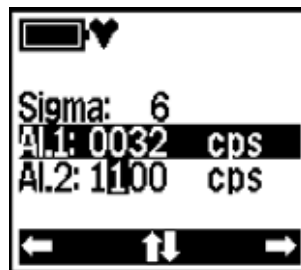Edit value by pressing ▲/▼ keys

Sigma-Alarm: 0: off: Al.1 can be set as a constant threshold.

Sigma-Alarm 2....9: Al.1 is calculated from the actual background. Actual value is displayed.

Save settings by leaving the menu.

The set points of the actual alarm thresholds are seen at the marks on the intensity bar scale. The upper mark shows alarm threshold 1, the lower mark shows alarm threshold 2.

4.   Operation

4.1   Ratemeter display options

RadEye PRD can be configured to have its primary screens shown in two distinct ways.

4.1.1   Standard Ratemeter

4.1.1.1   Low Dose Rate Mode

In this view, users choose the primary units for gamma measurements for fastest response to changes (shown below in CPS) or for dose rate (R/h, rem/h, Sv/h).
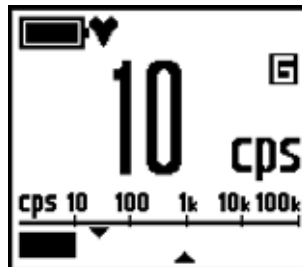
Alternatively, the unit can be configured in "Cross Mode" (Chapter 3.1.4) to display both dose rate but alarm using the faster CPS setting.

4.1.1.2 RadEye PRD-ER: High Dose Rate Mode

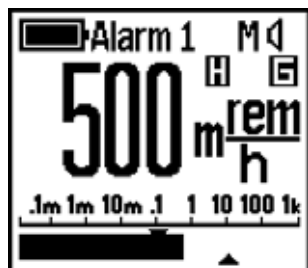Above 25 mrem/h (25 mR/h, 250µSv/h) the RadEye PRD-ER switches to High Dose Rate (HDR) Mode. Due to the fact that the HDR module is a stand-alone detector, the cps bargraph is hidden in the count rate and cross mode. The NBR and Neutron are not possible.

In dose rate mode, an H is displayed.

4.1.1.3 Over Range according to ANSI 42.32

The measuring range of the RadEye PRD and RadEye PRD-ER, as defined by ANSI 42.32, is limited to 250 µSv/h (25 mR/h). The corresponding over-range message is displayed as "HDRD active". Depending on the level and duration of the irradiated dose rate, the Low Dose Rate Detector (LDRD) may experience an afterglow effect. This time can take several hours. During this time the HDRD is active and the RadEye

PRD-ER can only be used as a dose rate meter. The detection functions, NBR and Neutron are not possible as long as the message "HDRD active" is displayed.

The warning message **"HDRD active"** informs the user, that the displayed dose rate is now derived from the less sensitive High Dose Rate Detector (HDRD) and that therefore no fast response at very low dose rates can be expected.

4.1.2 Simple Level Pager

Setting the unit into this mode sets the dose rate into levels.

The range appears in the below table:

Level	Range
0	0..0.1 mrem/h
1	0.1..0.6 mrem /h
2	0.6..3.6 mrem /h
3	3.6..21.6 mrem /h
4	21.6..129 mrem /h
5	129..777 mrem /h
6	777mrem/h..4.66 rem /h
7	4.66..28 rem /h
8	28..168 rem /h
9	168..1000 rem /h

Once enabled the Ratemeter screen displays only the level number. The alarm is based on the count rate (like in the cps or cross mode).

Alarms are displayed in the same way as the Simple mode defined in chapter 5.2.

Level Mode- non alarm state	Level mode- Alarm state with Natural Alarm

4.2　Audible single pulse indication and finder mode

With the single pulse indication active, every pulse of the detector generates a short audible signal emitted by the beeper, similar to a Geiger counter.

An audible alarm signal caused by exceeding the alarm threshold is not given while single pulse indication is active.

The single pulse indication must be enabled in the menu.
It is activated and deactivated by pressing the right button twice button:


Indicator single pulse
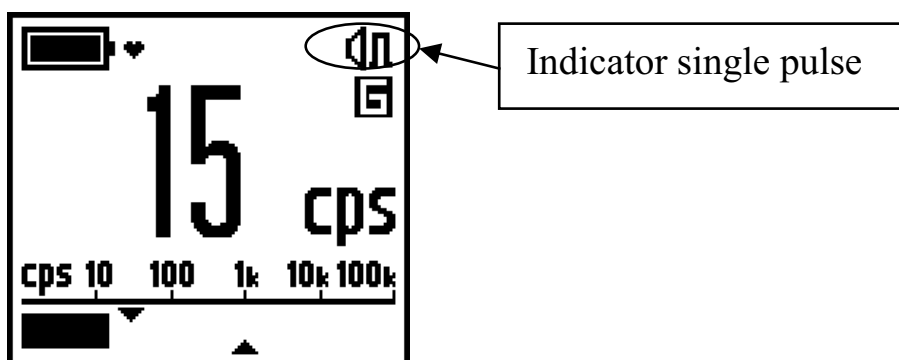
It is especially useful when used in conjunction with the Graphical screen to find hidden sources.

In the Finder mode, the sound frequency depends on the pulse rate of the detector. The Finder mode measures the count rate that is present at the moment the mode is activate. The greater the increase in the detector pulse rate above the captured rate, the higher the tone emitted by the PRD-ER.

The finder mode must be enabled in the menu.

It is activated and deactivated by pressing the right button twice:

Indicator finder mode
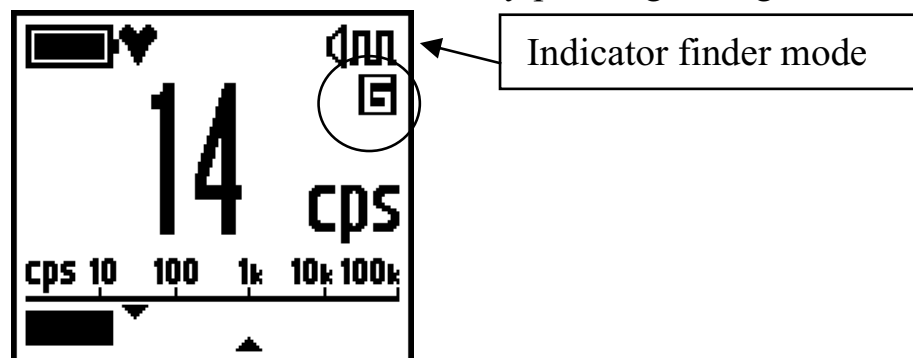
4.3 Rated alarm

A special audible sound "Rated Alarm" can be enabled in the submenu "Edit alarm". If active, the vibration, sound, and alarm LED are changing its intensity with the gamma count rate level (above learned background) once the first gamma alarm threshold has been exceeded.

4.4   Alarm indication

Each time the first alarm threshold is exceeded, all active alarm indicators (sounder, LED, vibe, display) are activated.

	Sounder	LED red	LED blue	Vibration
Count Rate and Dose Rate Alarm1, NBR: Balanced/ Natural or NBR disabled	1s high pitch tone 1s low pitch tone alternating	1s on 1s off	off	1s vibe within 2s
Count Rate and Dose Rate Alarm1, NBR: Artificial	NBR Sound	250ms on 250ms off	off	2 vibes within 1s
Count Rate and Dose Rate Alarm 2 Or Safety Alarm	4 short pulse in 1s followed by a 1s pulse high pitch tone	250ms on 250ms off	off	2 vibes within 1s
Neutron Alarm 1	Neutron Sound	off	1s on 1s off	1s vibe within 2s
Neutron Alarm 2	Neutron sound	off	250ms on 250ms off	2 vibes within 1s
Dose alarm 1 Dose alarm 2	High pitch tone	off	on	on

Except for the dual line display, additional text info is provided.

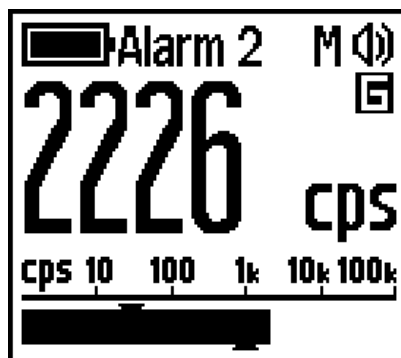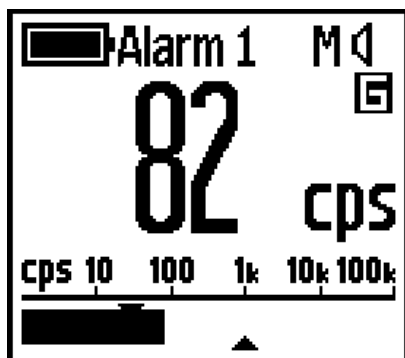Example (alarm by Ba-133):
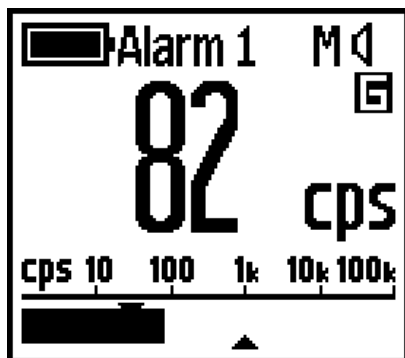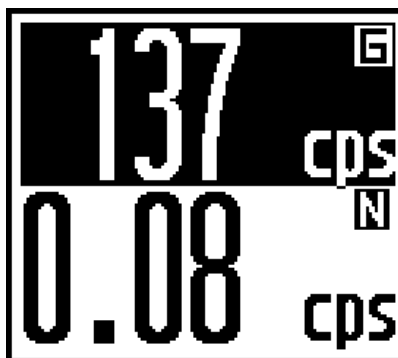
Ratemeter screen   Dual display screen

The sound and vibration alarm can be silenced by a short key depression of the ►/Mute or button on top of RadEye. However, the LED remains pulsing as long as the alarm threshold is exceeded. The alarm automatically clears once the radiation levels fall below the threshold.

With the PC-program the alarm threshold 2 of the dose rate can be configured as a safety alarm (see 3.3).

4.5 Alarm display indication

The status line alternates between Neutron, Gamma and NBR alarm messages according to the table below.

Neutron	Gamma count rate or dose rate		NBR Gamma
Neutron 2		Dose	LOW/MID/HIGH or ART
Neutron 1	Priority ⬆	Safety	
		Alarm 2	
		Alarm 1	BALANCED or NORM

4.6 Additional information

In addition, the menu options allow further setting of the operating mode and the activation and deactivation of the various alarm options.

Using the upper arrow key, additional measuring values are displayed (see Chapter 3.1.2).

4.7 Alarm latching

Using the PC-program it is possible to configure an alarm latching. Alarm latching means the alarm is stored for the configured time from 0 s (= off) to 9999 s.

This latching allows the user to get an alarm notification even in case of fast moving sources, in noisy environments or similar scenarios.

A latched alarm is indicated by an "M" near the alarm indicator. When the alarm is acknowledged the RadEye returns to normal operations.

Latching indicator
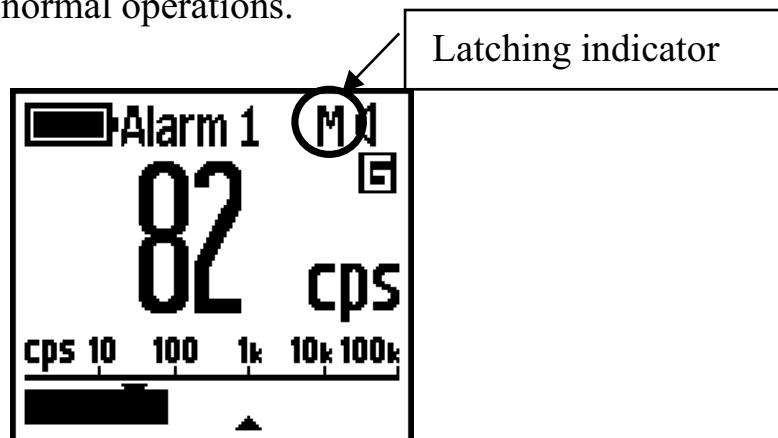
4.8 Show alarm
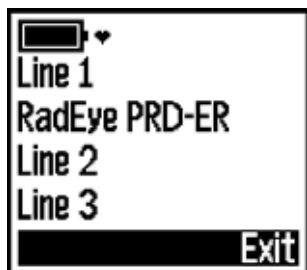
By selecting the menu item "Show alarm" the alarms stored in the alarm log are displayed together with the NBR information and time of alarm.

Stored alarm with NBR information

Time of the stored alarm
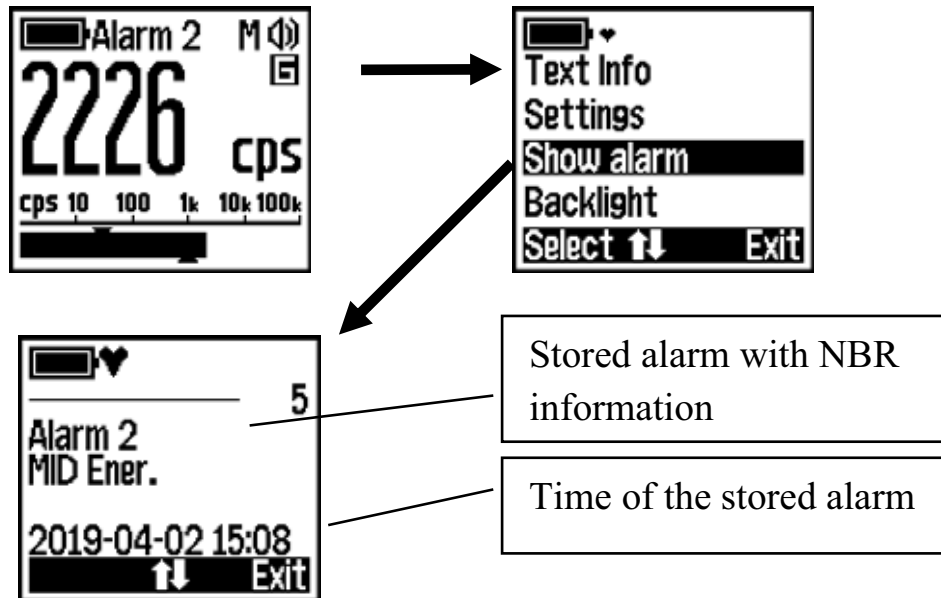
By pressing the up and down arrow keys you can scroll through the alarm log. By pressing the right button the display returns to the menu.
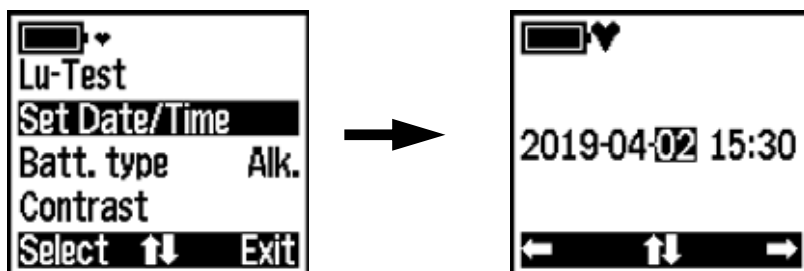
4.9   Text Info

Using the PC program it is possible to place text information in the RadEye PRD-ER. This text information can be displayed with the menu function "Text Info".

```
┌─────────────────────┐
│ ▇▇▇▇▇ ·♥             │
│ Line 1              │
│ RadEye PRD-ER       │
│ Line 2              │
│ Line 3              │
│                Exit │
└─────────────────────┘
```

4.10   Set date and time

In addition to setting the date and time by the PC-program, these changes can also be performed via the menu function Settings → Set Date/Time.

```
┌─────────────────────┐        ┌─────────────────────┐
│ ▇▇▇▇▇ ·♥            │        │ ▇▇▇▇▇·♥            │
│ Lu-Test             │        │                     │
│ Set Date/Time       │   →    │                     │
│ Batt. type    Alk.  │        │ 2019-04-02 15:30    │
│ Contrast            │        │                     │
│ Select  ⇅    Exit   │        │ ⇐      ⇅      ⇒     │
└─────────────────────┘        └─────────────────────┘
```

The format YYYY-MM-DD hh:mm is used, with the hour's field in 24-hour format. The fields are selected with the keys right/left. With the keys up/down the Year, month, day, hour or minute can be changed. After setting the date and time the real time clock is set and is used for alarm logbook and history.

4.11 Battery type

Select the battery type: Rechargeable NiMH or non-rechargeable alkaline (Alk.) batteries. This is necessary for a correct low battery warning.
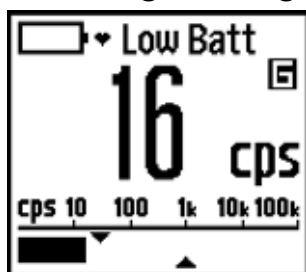

Battery type "Alkaline"

Battery type "NiMH"

If the battery voltage is below the configured threshold the following warning appears:

In addition, the sounder generates a chirp sequence every 30s. This acoustic warning can be suppressed by pressing the alarm acknowledge key. The chirp will begin again after 8hrs if the battery level is still below the threshold. Even under a Low Batt warning, RadEye can still be operated for several hours.

Once the battery voltage falls below 2.1 V, the battery symbol starts flashing. The acoustic warning (chirp) is generated every

8s and cannot be acknowledged. The battery must be changed as soon as possible.

4.12 Lu-Adjust

RadEye PRD family leverages Thermo Fisher's patented Lutetium test adapters (Chapter 12.3) to perform optimization and performance verification tests. The base material, a Lu-176 ceramic, is a stable (36 Billion years half-life), natural isotope, with very low activity, it is not classified as a radioactive source, nor does it require a license to possess. Since the primordial natural isotope Lu-176 is not part of the normal background radiation, it is identified by RadEye's NBR-circuitry as non-NORM (ART or MID energy) isotope.

For immediate verification of the alarms, simply fit the adapter on the back of RadEye as shown below. The adapter in the left hand is fitted to the back of RadEye in the right hand.

Immediately, RadEye will alarm and the NBR will classify it as Artificial or mid Energy. Perform an ID to verify the identi-
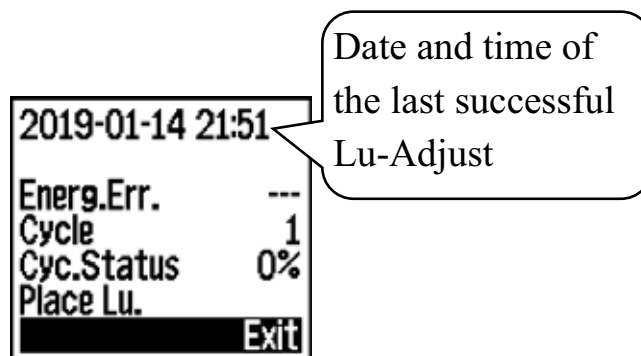
fication performance is also working properly, which typically takes 60 sec to finish.

To optimize, RadEye PRD-ER is equipped with an onboard diagnostic tool that leverages the Lu Test Adapter to optimize the internal detector high voltage and bias.
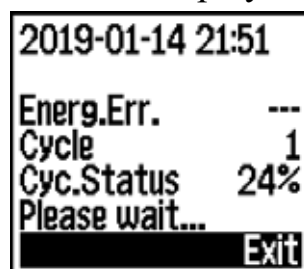
To begin, remove all sources including the Lu test adapter from the immediate area - RadEye should read below 50 cps for best results. The optimize feature can be found by tapping ◄/Menu. Cycle using ▼/▲ and select "Settings" and then cycle to and select "Lu-Adjust".

During the first seconds the RadEye checks the background and displays the date and time of the last time the routine was performed.

When the background measurement is complete, the display instructs the user to place the test adapter:

```
2019-01-14 21:51

Energ.Err.        ---
Cycle               1
Cyc.Status         0%
Place Lu.
                 Exit
```

Date and time of the last successful Lu-Adjust

The RadEye will recognize the test adapter automatically and starts the routine. No further action is required. The status of the adjustment is shown in the display.

```
2019-01-14 21:51

Energ.Err.        ---
Cycle               1
Cyc.Status        24%
Please wait...
                 Exit
```

During the process, the RadEye may stop and require acknowledgement if it determines significant changes are needed to optimize.

```
2019-04-03 10:41

Energ.Err.      +1.5%

     Bias adjust
    recommended
      OK     Exit
```

Simply acknowledge by pressing the ▲/Info button and the process continues. After setting the correct bias voltage and completing the process successfully (energy error ±1%), RadEye displays "---Ready --" at the bottom of the screen along with an acoustic chirp.

```
2019-04-03 11:14

Energ.Err.    +0.3%
Cycle            3
Cyc.Status    100%
-- READY --
          OK
```
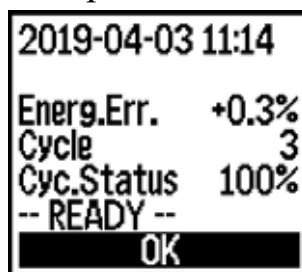
If the high voltage is outside of adjustment range the message "Inspection required" is displayed. In this case or if the Lu-Source is not recognized automatically the instrument should be sent to Thermo Fisher Scientific Messtechnik GmbH, Service Center or to Columbia U.S. Depot Service for inspection.

```
2019-04-03 10:41

Energ.Err.       ---



-- INSPECTION --
               Exit
```
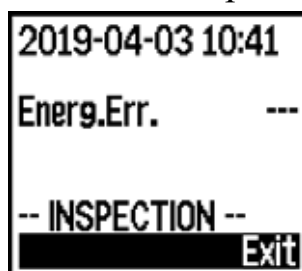
Leave Lu-Check by pressing the OK or Exit button.

4.12.1 Lu-Check reminder

The RadEye PRD has a Lu-Check reminder. The interval is settable via the PC-program.

A reminder screen comes up if Date and Time is set after the RadEye is started:

Acknowledge this screen by pressing the right button or start the Lu-Adjust with the left button (follow instructions in Chapter 4.12).
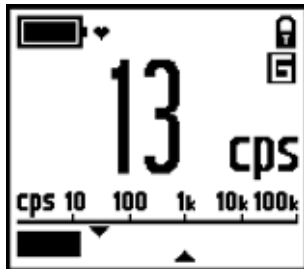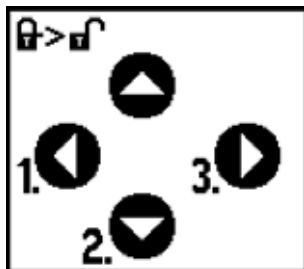
4.13 Key Lock

If enabled in the configuration, pressing the "▼/On" key for at least one second a notification screen is displayed:

Keep the button pressed to lock the key pad:

Unlocking is performed according to the LCD instructions upon pressing any key:

Press left key first, then lower key and then right key.
This feature can be disabled using the PC-Program.

5. Detection of gamma sources

To detect hidden gamma sources, the use of the count rate mode or the cross-mode is recommended. In these modes the instrument reacts much more quickly to an increase in the radiation intensity.

The value set for the alarm threshold is either a fixed alarm threshold set slightly higher than the occurring display values observed over a longer period of time, or alternately a sigma threshold, amounting to 4 to 6 sigma according to the false alarm frequency desired. Next, the operator moves past the object while keeping the distance between the object and the RadEye as small as possible.

With an alarm occurring, the operator should move the instrument while observing the display in order to localize the position of the source. Please note that the alarm can occur up to two seconds after passing the nearest distance to the source. Please refer to Chapter 6 for the detection of neutron sources.

In order to avoid frequent nuisance alarms due to a varying natural gamma background level, a minimum count rate threshold "sigma min Rate (cps)" can be set via PC-configuration in the tab "Alarm". Setting this level to typically 35 to 50 cps will avoid NORM related nuisance alarms even in areas with elevated natural radioactivity.

5.1 Gamma Background

During operation in count rate mode with sigma ≥ 2 the background radiation is always monitored and a smoothed, low pass filtered value is computed. This value, limited to 150 cps, is used for the calculation of Alarm 1 if the sigma alarm is activated. This Alarm 1 replaces any value set in Alarm 1 (Chapter 8.4.6). In addition, while the sigma alarm is triggered, the monitoring of background is suspended.
On acknowledgement of an Alarm 1, provided that no artificial radioactivity has been detected (NBR-alarm, see Chapter 5.2), the background Ratemeter is readjusted automatically and set to the new count rate and background learning continues. This provides users with the most sensitive detection in all levels of natural background.

5.2 NBR (Natural Background Rejection)

NBR uses the ratio between the detected gamma energies to indicate unusual radiation conditions. Three energy channels for low-, mid- and high range energy are monitored and compared with three thresholds. If the channels exceed the adjustable (via PC-program) thresholds, an alarm is generated. The alarm tone and vibration can be acknowledged by a short key depression. The NBR-indicator can be activated by the menu function or the PC-program.
The purpose of this additional alarming algorithm is to allow the setting of a significantly lower detection level (compared to the gross count rate alarm) for a vast number of artificial gamma isotopes: Especially in an urban environment the background count rate varies from a few cps up to 50 cps or

even more. Thus, when using an Alarm 1 level of less than 20 cps, natural background variations can cause a lot of nuisance alarms. Using the NBR feature, however, radiation fields with an energy distribution that is sufficiently different from the natural environment can trigger an alarm at 20 cps or even below.

A typical detection limit for a background of 0.05 µSv/h (5 µrem/h) is about 0.004 µSv/h (0.4 µRem/h) for Am-241 and 0.008 µSv/h (0.8 µrem/h) for Co-57.

Fast initial alarm indication is achieved by the automatic adjustment of the Alarm 1 gross counting level according to the 5 – 6 sigma setting (if the set minimum value is exceeded).

Depending on the selected NBR-message configuration, artificial radioactivity is displayed and summarized as "artificial", where "LOW ener.", "MID ener." and "HIGH ener." are grouped together.

A count rate or dose rate alarm without any detected energetic anomaly is indicated as "Balanced" or "NORM" or "NATURAL" depending on the selected NBR-message configuration.

Alarm displays with standard NBR alarm configuration:
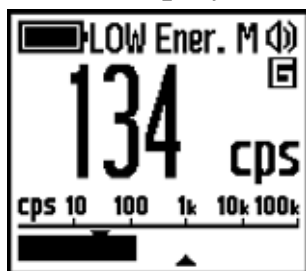
Man-made radioactivity with main energies up to approximately 150 keV.
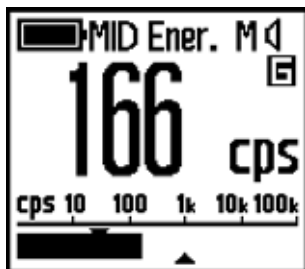
Man-made radioactivity with main energies up to approximately 600 keV.
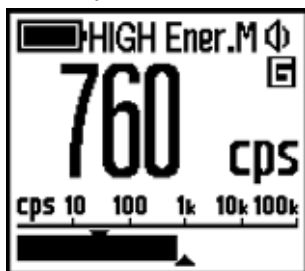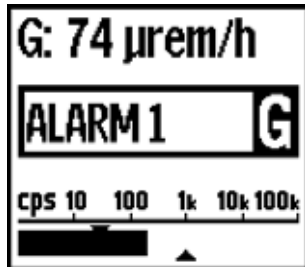

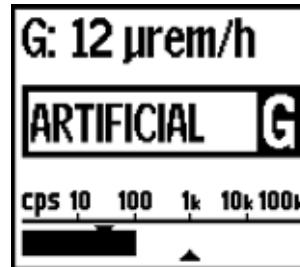Man-made radioactivity with main energies above 600 keV.
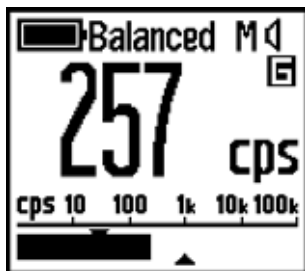
Natural radioactivity (NORM-Material)

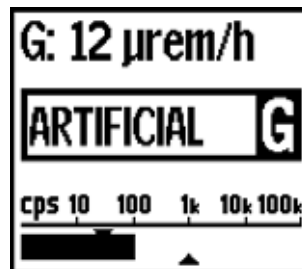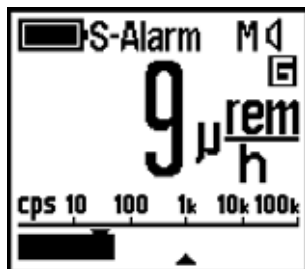If configured in simplified display mode, the following screens appear after an alarm is triggered:

NORM / Natural radiation detected or NBR is disabled

Artificial radiation detected

5.3 Highly sensitive alarm for artificial gamma emitters in the range 90 - 450 keV (S-Alarm)

If enabled a special algorithm will provide an extremely sensitive alarm. The audible indication is the same as for NBR-alarms. If configured in simplified display mode, the alarm is displayed as Artificial.

6. Indication of neutron sources

The RadEye PRD-ER does not contain a specific thermal neutron detector, but uses specific characteristic features of the measured gamma radiation to indicate the presence of a neutron source. Thus the RadEye PRD-ER does not meet the alarm sensitivity requirements for neutron radiation according to ANSI 42.48, but indicates the presence of neutron radiation once a source had been detected via the emitted gamma radiation.

This feature is particularly important to quickly indicate and distinguish neutron sources from other less relevant radioisotopes, i.e. small shielded AmBe or large shielded Am-241 industrial sources, as well as industrial Cf-252 sources that may not be properly identified by conventional gamma only pagers.

Please note, that unlike neutron pagers containing a detector for thermal neutrons, the capability of the RadEye PRD-ER to indicate neutrons is not significantly reduced, once the pager is taken out of the holster. The RadEye PRD-ER should be placed as close as possible to the source (but not exceeding the recommended count rate of 5000 cps for nuclide identification).

Factory default and recommended setting for the dual (gamma neutron) display is "disabled". Via PC-program, this setting can be changed to "enabled". The neutron count rate alarm and message at the end of a nuclide ID are both set to "enabled".

For operation in altitudes exceeding 1000 m above sea level, the Neutron alarm level in the ratemeter mode and the neutron alert level for the ID may need to be adapted.
E.g. in 2500 m above sea level values of 1.5 cps for the ratemeter and 0.4 cps for the ID are recommended.
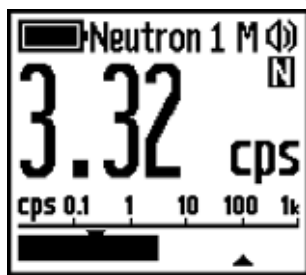
Neutron alert in Ratemeter mode

Neutron alert as ID-Result

Neutron display and alarming is disabled while the RadEye PRD-ER operates in HDRD mode.

7. Functional test

The radiation meter performs continuous self-check routines. A complete failure of the detector will be detected in 30 s and will be indicated on the LCD and be announced by the beeper. The same applies to the battery voltage.

7.1 Functional test

To carry out a simple test, briefly press any key twice. The first key press turns the backlight illumination on without any other action. With the second key stroke a short audible pulse (key click) should be generated, unless this has been disabled via PC configuration.

The heart symbol next to the battery indicator must be "beating". This indicates that the cyclic tasks are active, such as calculating measurement values and checking the alarm thresholds.

7.2 Failure indication

In case of a failure, or if the battery voltage is low, the beeper generates a tone sequence every 30 s.
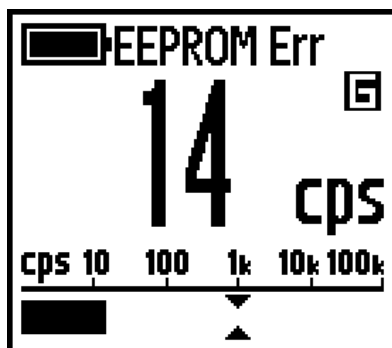
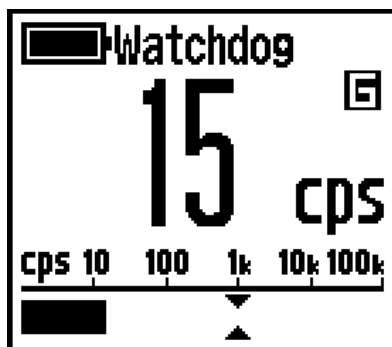The corresponding failure message is displayed in the LCD:
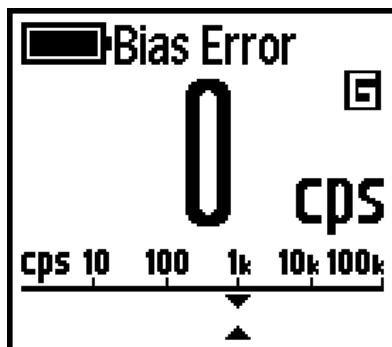
Error bias voltage generation
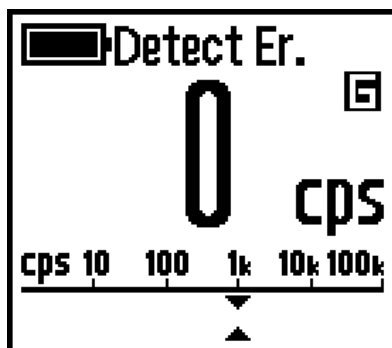
No gamma detector pulse within 30 seconds,

EEPROM with calibration data shows EEPROM Read or EEPROM Write error.

A Watchdog Error indicates that the micro controller was unable to complete its tasks in a given timeframe. Reasons are strong electromagnetic pulses, firmware errors, or hardware issues.

7.3   Overload indication

For dose rates of more than 1000 R/h (10 Sv/h) an overload indication is given:

The dose value is marked with an overload indication, if a dose rate overload occurred since the last dose reset.
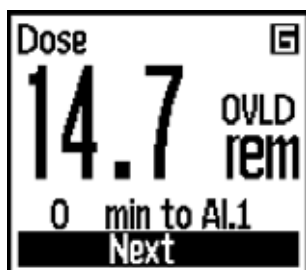
Neutron count rates of more than 10000 cps lead to a neutron overload. Both overload messages of the neutron and the gamma channel can be displayed by the RadEye PRD-ER.

8. PC configuration

The configuration of the RadEye PRD via Windows software requires optional Thermo Scientific hardware and software. Please refer also to chapter 12 for details.

8.1 PC connection

It is recommended to use the optional RadEye desktop holder to align the RadEye's IR window with the IR window of a connection cable.

The optional USB connection cable is used to connect to a USB port.
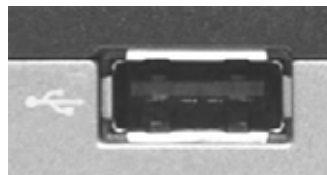
Installation of a connection cable

Attach the adapter cable to the desktop holder and PC without exerting too much force

8.2 Installation of the optional PC software

During installation the following Security alert is shown
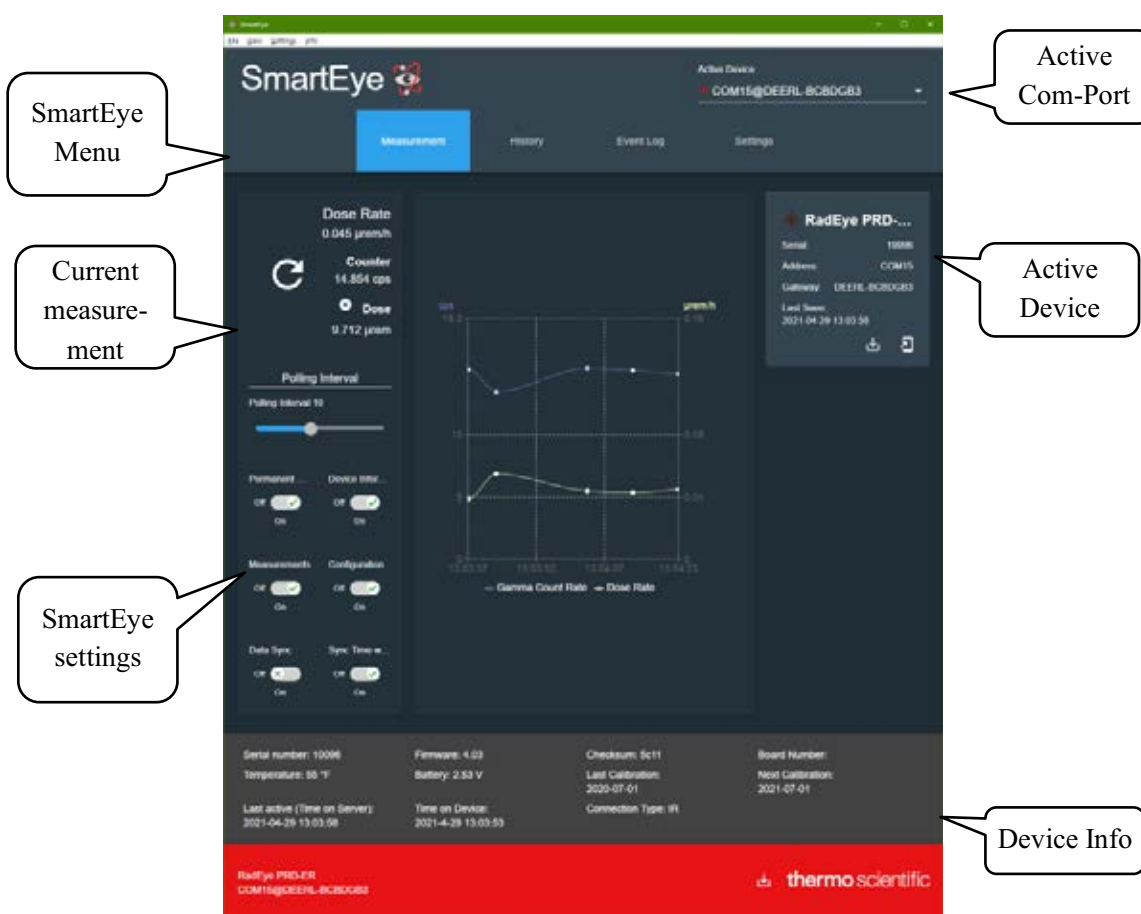

It is necessary to allow this feature.

8.3   SmartEye

After start up the program scans all Com-Ports. During the
scan a spinning circle is displayed. Once a RadEye is detected,
the basic parameters are shown:

8.3.1   SmartEye measurement view

8.3.3 History view

8.3.3.1   History Table

Use the history table to download history data, to clear the history or to export the history to a csv-file. Note: clearing the history will also clear the event log.

8.3.3.2   *History graph*
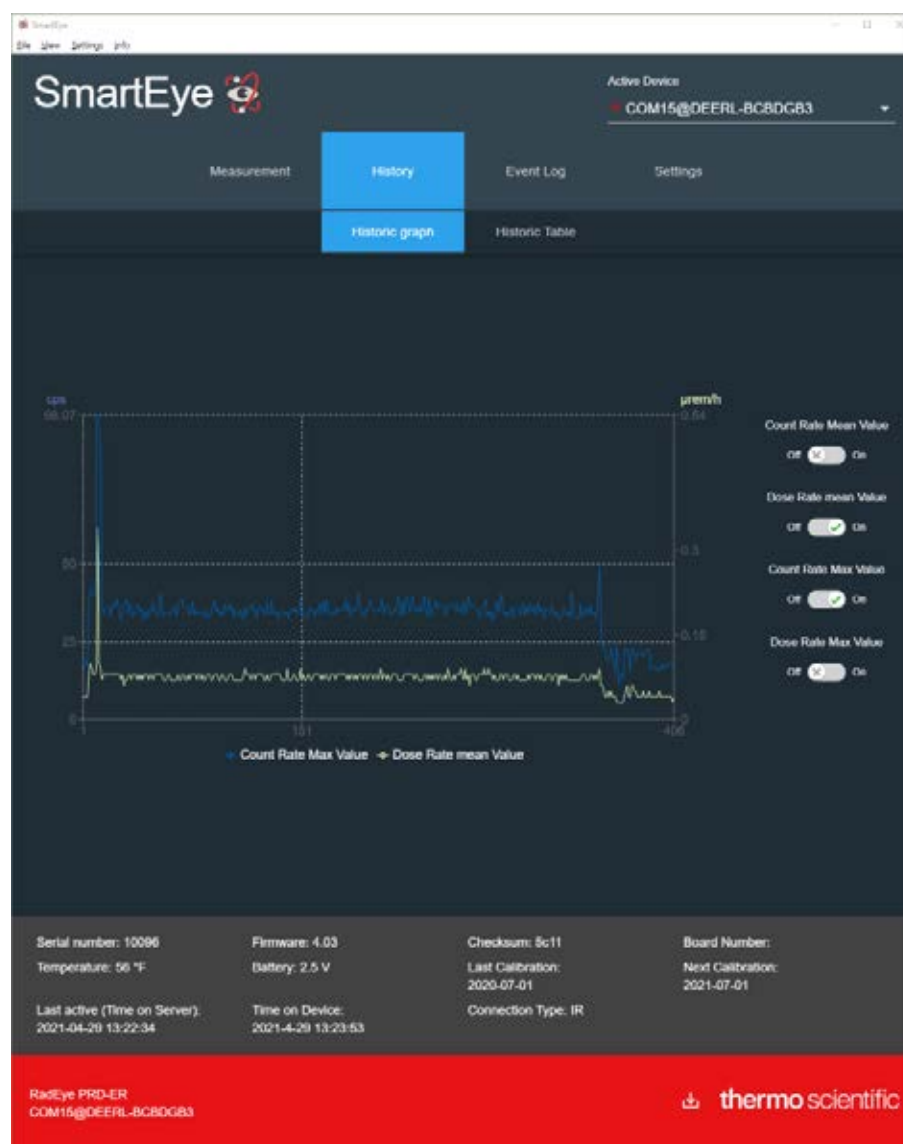
Historic graph offers a graphical view of the history. The mean and maximum values of gamma count rate, gamma dose rate and neutron count rate if available can be selected individually.

The RadEye unit loses its date and time settings if the power supply is interrupted (battery exchange). Therefore, the date and time stamps of the history data can be affected, if the date and time information is not updated immediately.

8.3.4 Event Log

Use this view to download event log data or to clear the event log or to export the data to a csv-file. Note: clearing the event log will also clear the history.

The RadEye unit loses its date and time settings if the power supply is interrupted (battery exchange). Therefore, the date and time stamps of the history data can be affected, if the date and time information is not updated immediately.

8.3.5 Settings

8.3.5.1 General
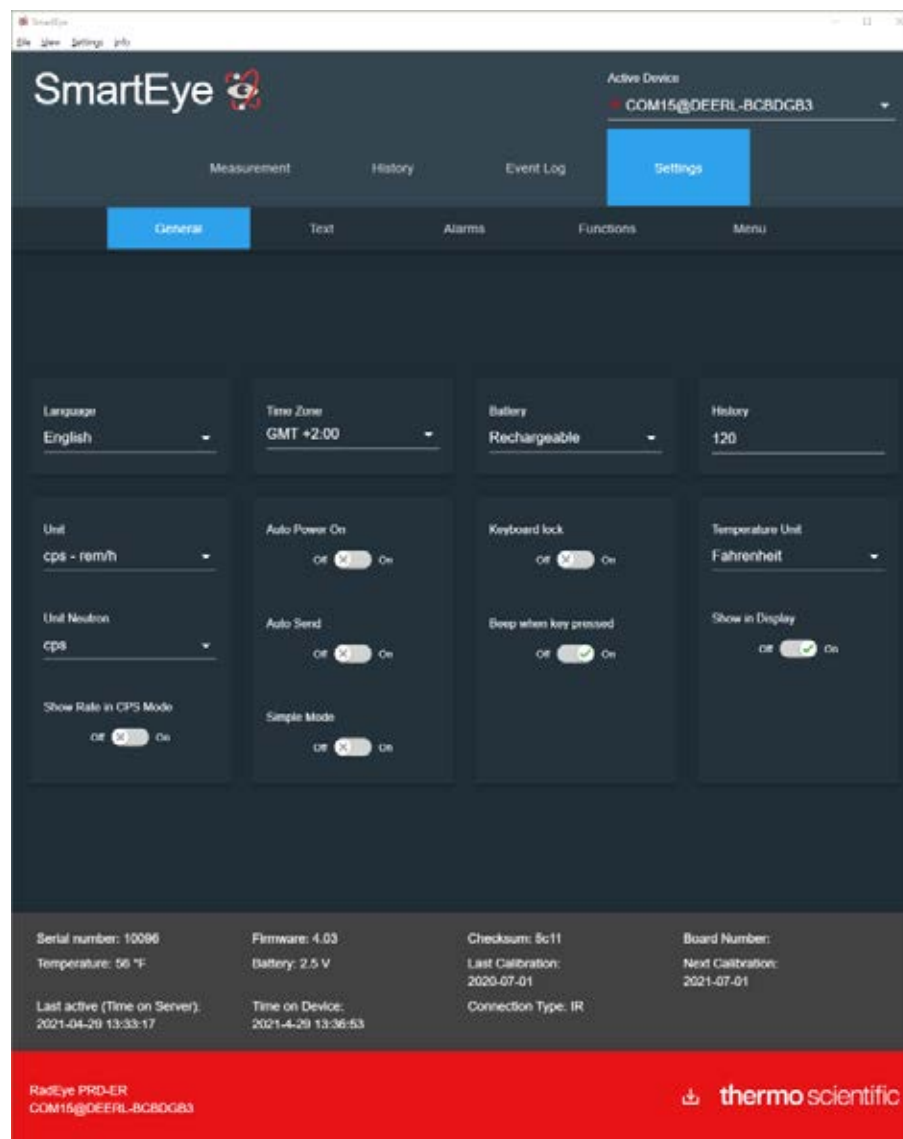
The setting of the unit consists of two parts. The first part indicates what is displayed in the basic ratemeter mode. The second part determines the correct display of the dose rate unit in the count rate display. The switch "Show dose rate in cps mode" activates the cross-mode (chapter 3.1.4)

If the batteries in use are changed from the delivered non rechargeable (Alkaline) to rechargeable batteries or backwards, then the correct type can be selected in the section "Type of battery".

The time interval for the history memory can be set between 1s and 43200s.

The time zone is used to set the correct time of the RadEye.

8.3.5.2　　　　*Text*
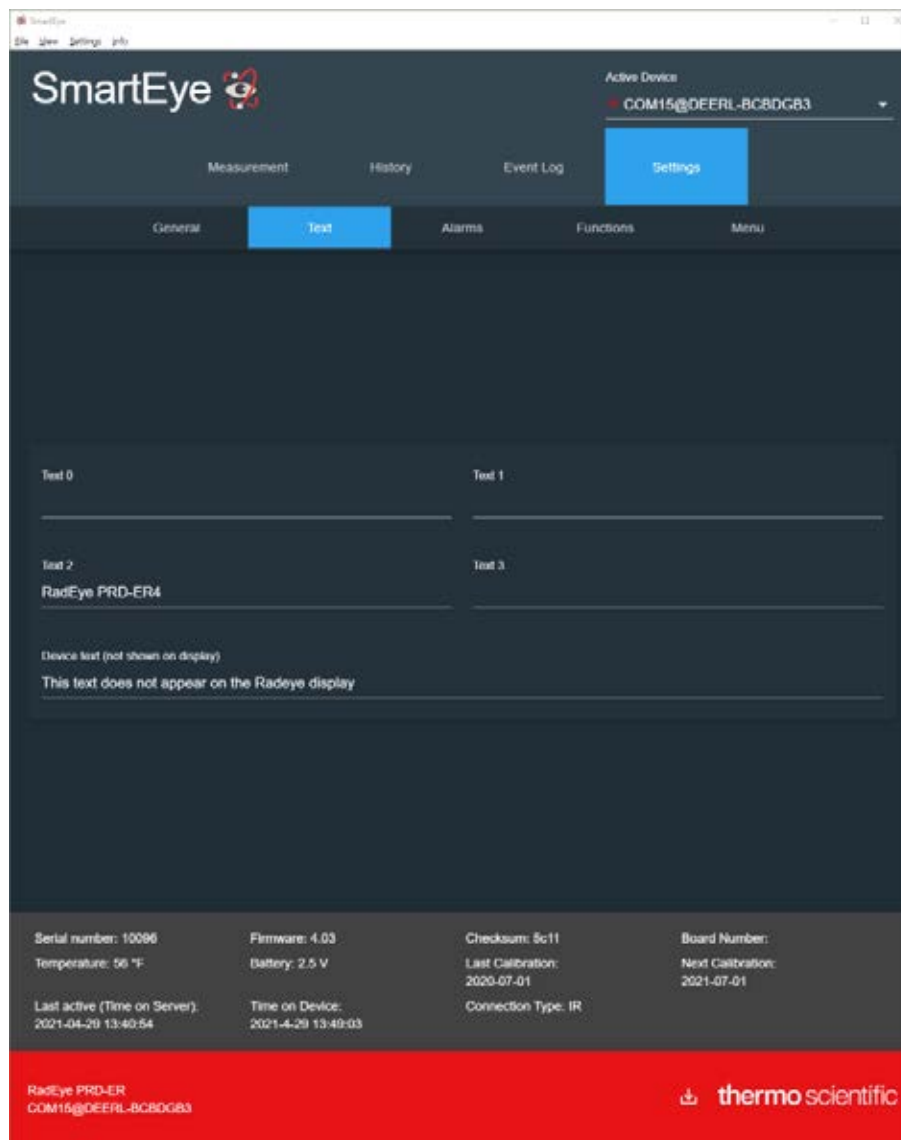
The user can enter 4 lines of text (Display Line 1-4), which can be read on the RadEye's LCD (see chapter 4.9).
The text in the "Text Field" cannot be displayed by the RadEye directly but can be read in this view.

8.3.5.3 Alarms

The Alarm view offers the user the possibility of making the alarm settings for the single basic displays (Count rate & Dose Rate). The sigma alarm settings "Sigma" and "Sigma min Rate [cps]" are explained in chapter 5.

If the switch **Safety Alarm** is active alarm level 2 of Dose Rate will be checked additionally to alarm level 1 and 2 of Count Rate.

Rated alarm will activate to an alarm mode in which the intensity of the alarm signaling increases with the radiation.

If **Simplified NBR alarm** is On the NBR alarm messages "High energy", "Mid energy" and "Low energy" in the top line of the Ratemeter display are replaced with "ART".

Neutron ADF selects the filter of the Count rate Neutron between ADF and a sliding window.

Neutron Alarm from Background is not active for RadEye PRD4.

If **Alarm read only** is On the alarm thresholds can't be changed in the RadEye menu.

After a natural alarm is acknowledged, the active background learning will activate an improved learning mode.

Alarm signaling

Furthermore, the options on this tab allow beeper and additional alarm monitoring processes to be configured.

If the RadEye PRD is mainly used as an alarm device wearing at the belt, it is recommended to set an alarm latching time of 10s. This is useful to notice short exposure events.

Energy Rate

The software control of the energy ratio sensitivity allows a fine tuning of the NBR-alarm (see chapter 5.2).

8.3.5.4   Functions
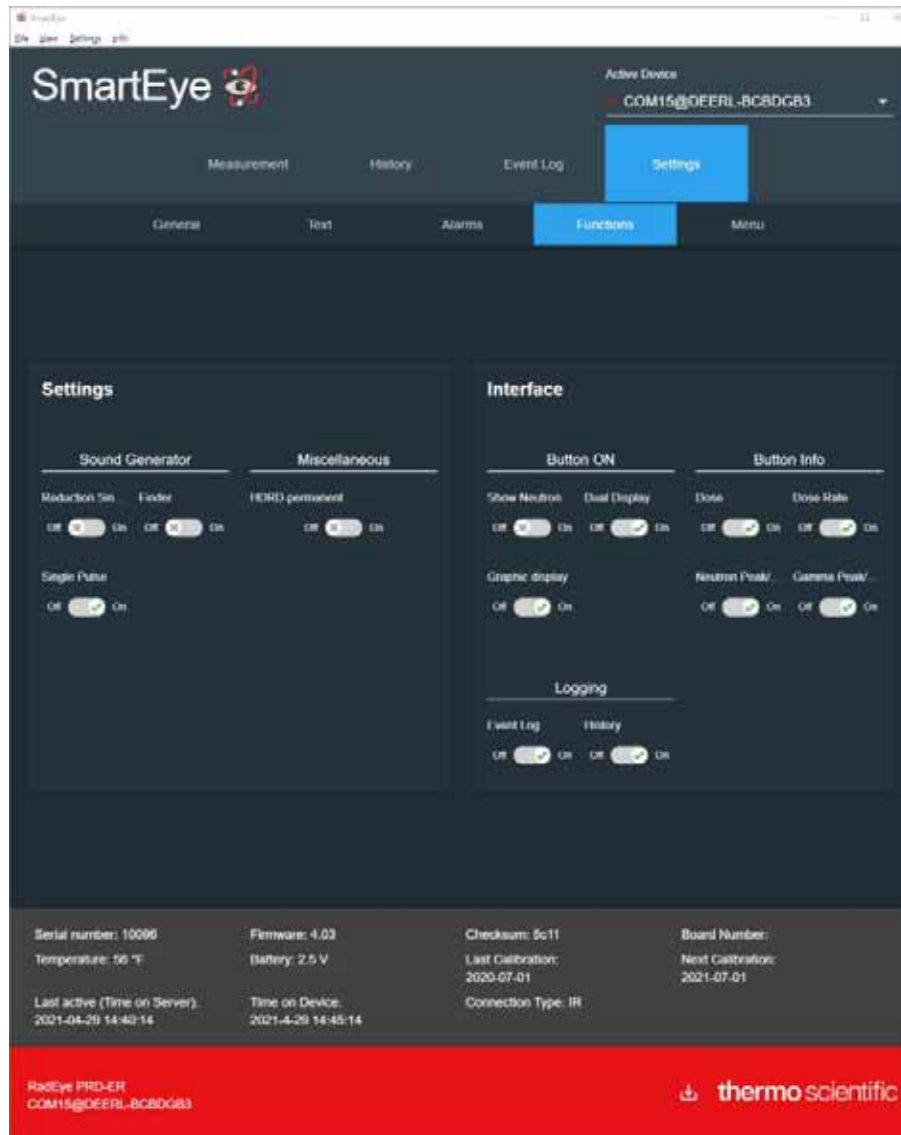
Sound Generator

Finder and Single Pulse can be enabled/disabled.

HDRD-Permanent enables the HDRD Module permanently.

This option only affects the RadEye PRD-ER4.

Button ON

Here are several options for Button ON / ▼ in basic ratemeter mode that can be enabled or disabled:

- Neutron
- Dual Display
- Graphic Display

Button Info

Here are several options for Button Info / ▲ in basic ratemeter mode that can be enabled or disabled:

- Dose
- Dose Rate
- Neutron Peak/Mean
- Gamma Peak/Mean

Logging:

Event Log and History can be enabled or disabled.

8.3.5.5 *Menu*

The menu items available to the user can be selected. For example, if LED alarm shall be always active and rate level indication shall not be used, these functions can be hidden for the user.

8.3.6 Writing the configuration to the RadEye

Once the setting of a parameter has changed, a symbol is displayed in the bottom line.

Clicking on ☑ will send the parameters to the RadEye. 🗑
Discards the changes.

8.3.7 Export and Import a configuration

The current configuration can be saved and imported on the Measurement page:
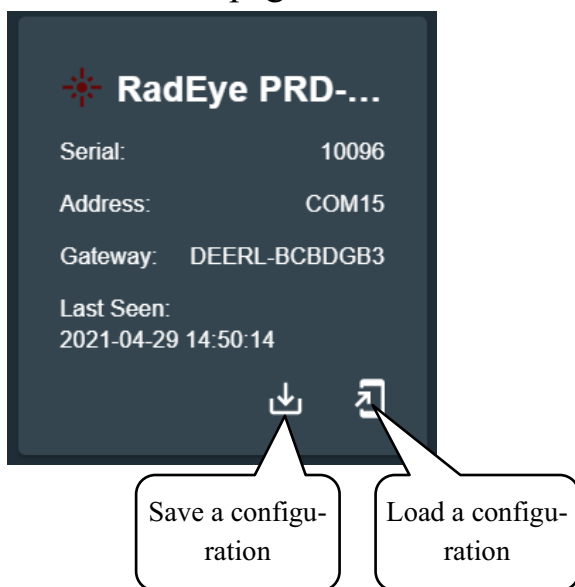
9. Troubleshooting

9.1 RadEye PRD-ER doesn't power on

9.1.1 Press "On" for at least one second

Keep the button "▼" pressed until the LED and the sound is active. The RadEye may need a longer time for startup if it is started immediately after the batteries are inserted. If the button is pressed too briefly, then the startup routine is not activated. The LED may flash then only very shortly.

9.1.2 Check battery

If the RadEye PRD-ER does not respond to a long press (> 1s) of the "▼" button, then please use the following step by step procedure:

A) Remove the current batteries

B) Clean the battery contacts

C) Check the required orientation of the batteries according to the printed "+" symbols in the battery compartment.

D) Insert two AAA cells with sufficient capacity: Rechargeable AAA batteries should be completely loaded, non-rechargeable batteries should supply at least 2.5V (total) under load.

E) Press the "▼" button for more than one second (see also 9.1.1).

9.2 Reading data from the start up screen

The startup screen shows important data like the last calibration, the current battery voltage, and the firmware version.
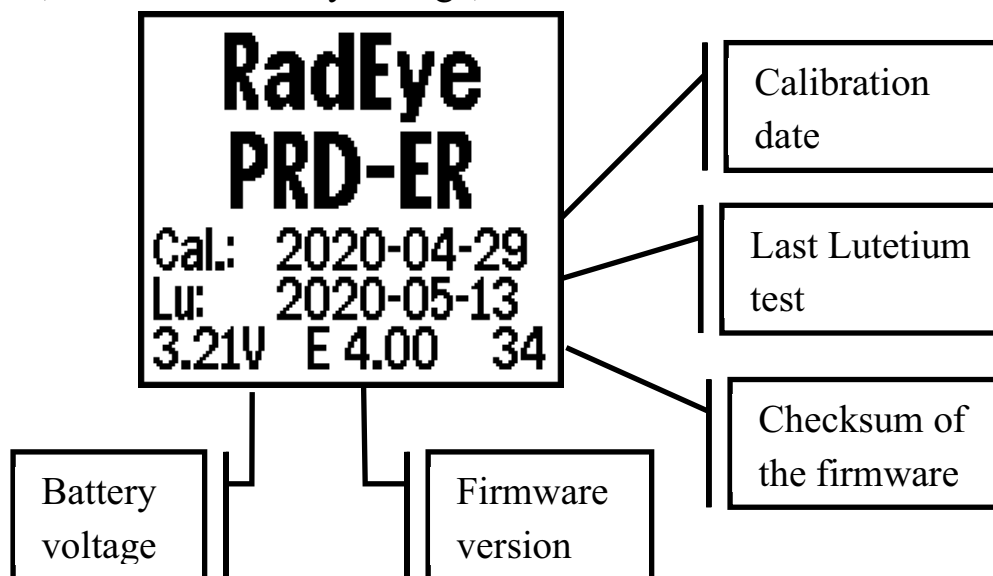
This screen stays active as long as the "▼" button is kept pressed during the power-on of the RadEye device.

9.3 The RadEye doesn't show the menu items as described in the manual

The items available in the RadEye PRD-ER's menu can be disabled or enabled via the RadEye_PRD.EXE software. The factory setting has all menu functions enabled. Next, please check the firmware version of your RadEye PRD-ER (see Chapter 2.4) and compare your version number with the revision table of this manual at the beginning of the document. The revision table shows the introduction of new functions together with the corresponding firmware version.

9.4 The RadEye shows an error message in the display's top line

Please refer also to Chapter 7.2. If one of the following failures is indicated, then the instrument must be repaired by the Thermo Scientific bench repair team:

```
Bias-Error
Detect Err
EEPROM Err
Watchdog*
```

Please contact our Customer Service for more details.

*) Please see the failure description in the above referenced Chapter. If the failure was related to a strong electromagnetic pulse scenario and the failure went away afterwards, then a repair may not be necessary. A diligent observation of the RadEye PRD-ER proper operation after the failure is strongly recommended.

9.5 The RadEye is not found in the software

Please check whether:
- The RadEye has been positioned correctly in the desktop holder (with rubber boot) and the RadEye is turned on.
- The infrared transmission windows are clean.
- The correct serial interface has been selected.

9.6 RadEye lost date and time settings

The date and time information is lost each time the batteries are removed or below the required voltage for operation. The simplest way to program the date and time is to use the "synchronize" function of the optional SmartEye software. Also the current date and time can be set also through the RadEye's menu "Settings" / "Set Date / Time".

9.7 RadEye's battery status is lower than expected

Please check if the correct battery type is selected under "settings" / "Batt. type" and change the type if necessary. Rechargeable batteries supply a voltage of 1.2V each, while Alkaline batteries provide 1.5V.

Rechargeable batteries offer also a steeper drop from acceptable battery voltage to "battery low" than alkaline types.

9.8 History data shows the wrong time and date

See Chapter 9.6.

10. Maintenance

10.1 Recommended maintenance

The RadEye PRD-ER is basically maintenance free. However, there are a few steps that should be performed to verify and insure proper functionality for years after delivery.

10.1.1 Lu-Adjust and Neutron Alignment

It is recommended to perform a Lutetium test routine (Lu-Adjust) with the optional Lutetium test adapter on a regular basis. The Lutetium test routine and neutron alignment is described in Chapter 4.12.

Level of usage	Period between Lu-Adjusts
Intensive, changing climate	3 month
Normal, daily usage	6 month
Low	12 month

10.1.2 Cleaning the instrument

The rubber boot should be removed and cleaned separately. The RadEye unit should be cleaned with a moist tissue, using only water as a cleaner. The rubber boot may be washed in water. Do not use aggressive chemicals like organic solvents.

10.1.3   Remove batteries for storage

It is highly recommended to remove both AAA batteries from the battery compartment if the RadEye unit is stored for a longer period (> 1 week), to avoid damage through battery leakage.

11. Spare Parts

11.1 Available spare parts

Item	Part Number
Battery cover	425067033
Rubber shock protection (rubber boot)	42506703018
Battery IEC-LR03 Micro 1,5V ENERGIZER E92 (1 pack = 2 batteries)	SM164600012

11.2 Recommended spare parts

Battery IEC-LR03 Micro 1,5V ENERGIZER E92 (1 pack = 2 batteries)	SM164600012

12. Optional Accessories

12.1 RadEye Holster (42506/7046)

The clip at the backside of the holster allows convenient carrying of the RadEye at the belt.

RadEye not included

There are several other holster styles available in the catalog. Please ask your sales representative for more options. In addition, if you have special requests, a custom holster can be designed to specifically fit your mission.
For best performance, the RadEye PRD-ER must be worn with the display facing the body.

12.2   Earphone for RadEye series (42506/7037)

The usage of the earphone is recommended if the RadEye is being used in FINDER mode and must be audible in a noisy environment.

The earphone is plugged into the RadEye's socket at the bottom of the unit. The cable length is 1.2 m.

12.3 Lutetium Test-Adapter for RadEye (42506/7071)

The 36g of encapsulated Lutetium-oxide provides a net count rate of approx. 140 cps when the adapter is attached to the backside of the RadEye. The shape of the adapter ensures that the Lutetium material is placed close to the reference point of the RadEye unit. A very cost effective 7g Lu-Test adapter is also available (42508/1044), but adjustment and test takes more time. This adapter provides a net count rate of approx. 55 cps.

Please see Chapter 4.12 and Chapter 10.1.1 about the usage of the test adapter.

12.4 Desktop holder (42506/7060)

Alignment between the RadEye's IR data interface window and the IR interface of a PC connection cable is ensured by the usage of the desktop holder. Please see Chapter 8.1 for details.

12.5 IR connection cable USB (42540/26)

The IR plug of the connection cable can be fixed easily by screws at the desktop holder. The PC connection plug is a USB port.
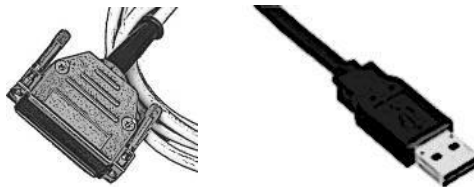
Please see Chapter 8.1 for details. Cable length = 1.2 m

12.6 Bluetooth® battery cover (42506/7095)

The standard battery lid is replaced with the Bluetooth® battery cover. The Bluetooth® cover uses BLE (BT4) and is designed

to pair with modern mobile devices with lower power consumption. Read manual DB-106 E for details on using the adapters.

12.7 IR Battery Cover (42506/9150)

The IR Battery Cover supports both functions of charging and communication with RadEye instrument.

Replace current Battery back with this IR Battery Cover.

12.8 RadEye charger

The Thermo Scientific Charger is an optional charging kit for the RadEye handheld instruments. When charging the unit, a Bluetooth battery cover or IR battery cover is required.

There are three versions of the RadEye charger:

- RadEye charger SD (p/n 42506/9110)
  Single desktop charger. Charge a single RadEye on a desktop. One IR battery cover is included.

- RadEye charger SC (p/n 42506/9120)
  Single car charger. Charge a single RadEye in a car. One IR battery cover is included.

- RadEye charger MD (p/n 42506/9130)
  Eight IR battery covers are included.

For more information see DB-109 E.

12.9   Gamma Laboratory Kit (42506/9015)

The Gamma Laboratory Kit is designed to quickly verify contamination caused by a nuclear accident.

Using the extremely compact and portable sample changer assembly, the typical background is reduced by up to 90 % and thus samples of up to 180 ml can be measured for low activity contamination. Further information can be found in the manual DK-017 E.

13. Technical data

13.1 RadEye PRD-ER LDRD

Radiation type: RadEye PRD-ER: Gamma radiation, neutron radiation

Measured variables: Gross count rate [cps], [cpm]
Ambient equivalent dose rate and dose:
$\dot{H}$*(10) [Sv/h], [rem/h],
H*(10) [Sv], [rem]
Air kerma dose rate and dose:
[Gy], [Gy/h]
Exposure and exposure rate
Hx [R], $\dot{H}$x [R/h]

Within the RadEye PRD-ER the relation 1 rem =10 mSv and 1R=8.77mGy is used.

Gamma Sensitivity:

Energy (Nuclide)	(cps/mR/h)	(cps/μS/h)
60 keV(Am-241)	43000	3000
662 keV(Cs-137)	2000	200
1250 keV(Co-60)	950	95

Energy range: 58 keV – 6.0 MeV:
for dose and dose rate measurement
20 keV – 3.0 MeV
For search and find and nuclide ID

Energy dependence: see Figure 13-1 to Figure 13-4

Detector: Ø16 x 31mm CsI

FWHM   typically 7.5%, maximum 8%

Direction of maximum response: perpendicular to the device's longitudinal axis, to the reference mark on the back side of the unit. See Figure 13-3.

Linearity error: max. ± 10 % in the measuring range

Averaging filters: ADF (Advanced Digital Filter) for count rate and dose rate. Digital RC-Filter with time constant 0.5s.....100s, depending on count rate and dose rate changing.
Cycle time: 0.25s
Background filter type: digital RC filter.
Limited to 100 cps: 64s
cycle time: 1s

For determination of sigma thresholds
NBR-ratio filter type: RC: 10s
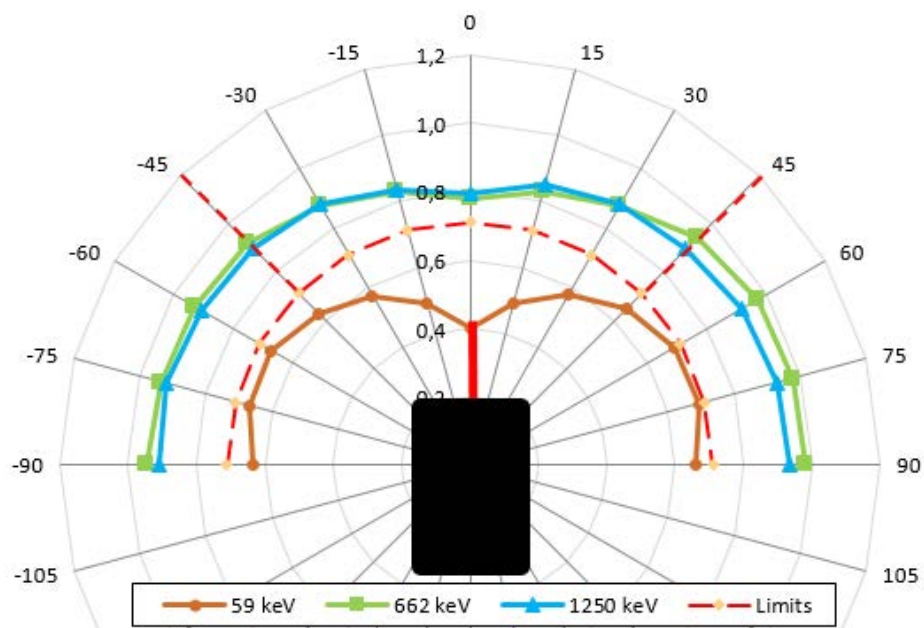cycle time: 1s

Reference point: on the axis of the direction of max. response, 14 mm behind reference mark. See Figure 13-9
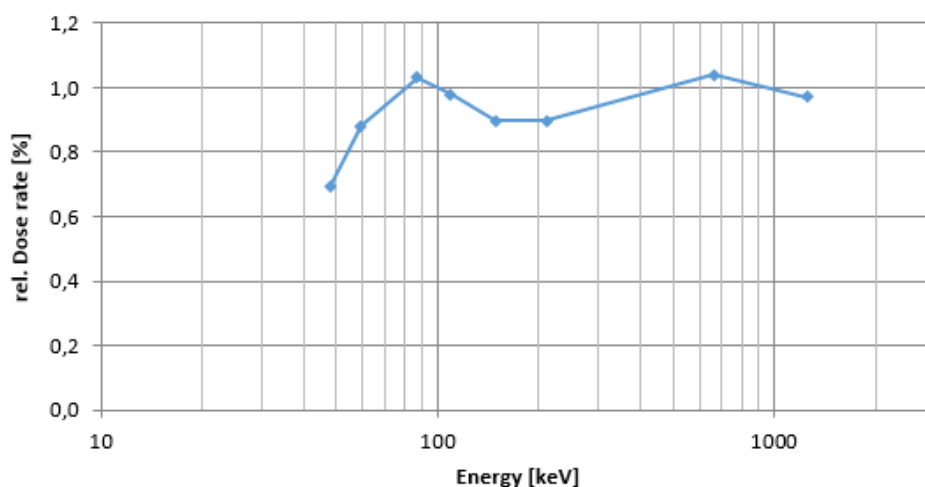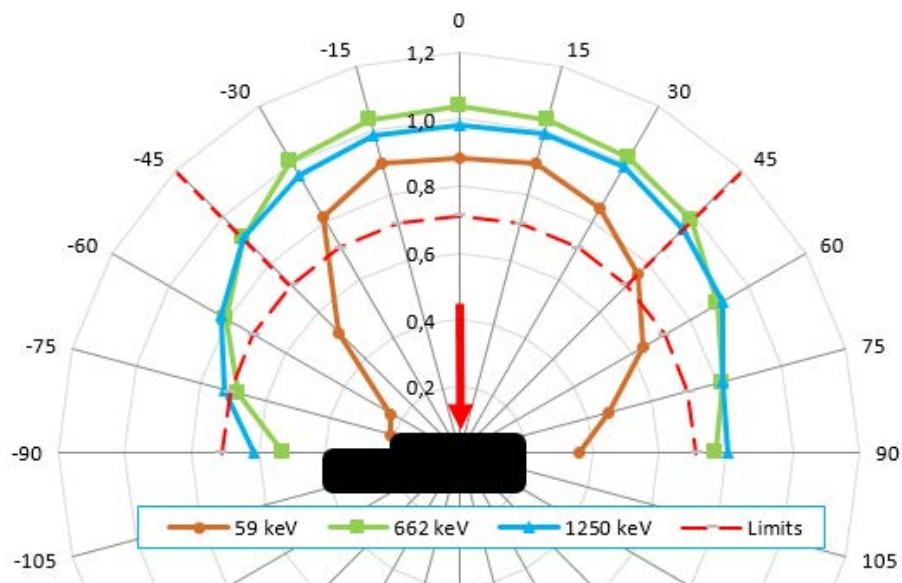

Figure 13-1 Energy response LDRD module
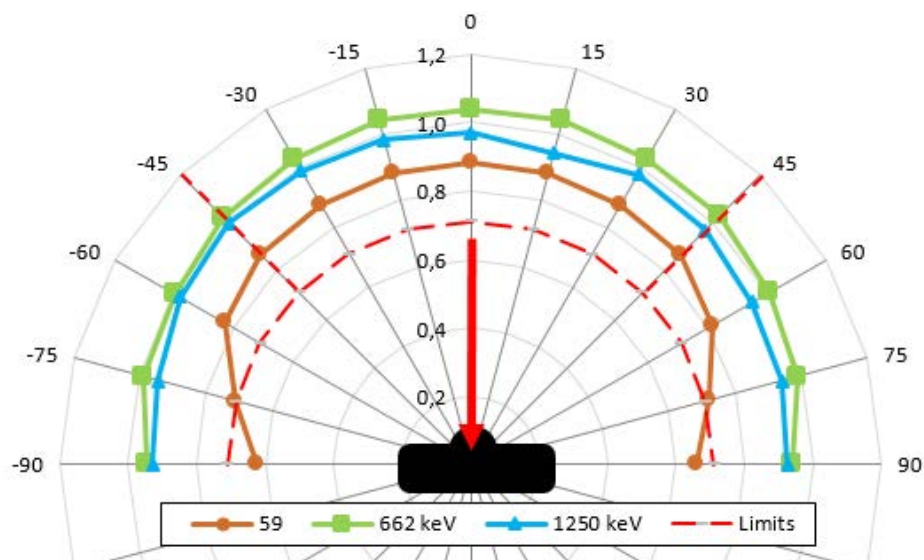
Figure 13-2: Angle response LDRD module frontal
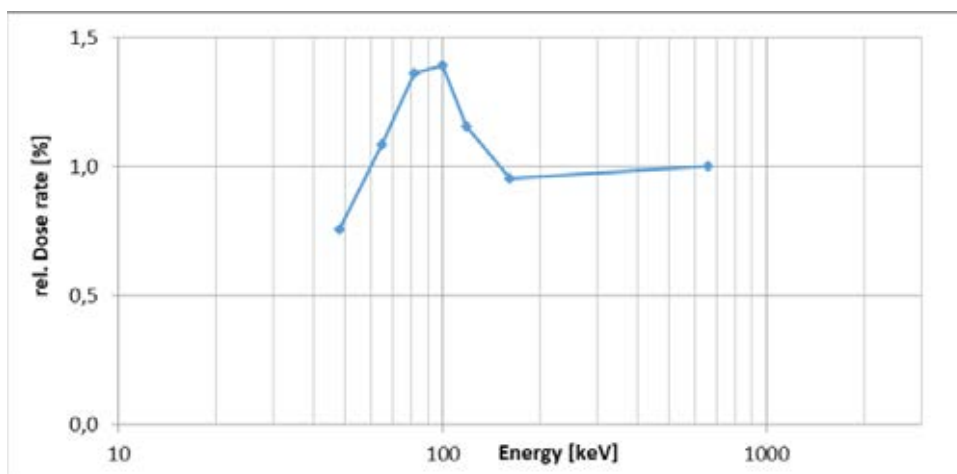
Figure 13-3: Angle response LDRD module top

Figure 13-4: Angle response LDRD module side

DB-117 E   RadEye PRD4 / -ER4

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13.2 RadEye PRD-ER HDRD

Radiation type: Gamma radiation

Measured variables: Ambient equivalent dose rate and
                           dose: H*(10)
                           Within the RadEye PRD-ER the rela-
                           tion 1 rem=10 mSv and 1R=8.77mGy
                           is used.

Gamma Sensitivity: 25 cps/(mSv/h), 2.5cps/(rem/h)

Energy range: 58 keV – 3.0 MeV

Energy dependence: see Figure 13-5 to Figure 13-8

Detector: Plastic scintillator (PVT)

Direction of   perpendicular to top side of the housing
max. response: see Figure 13-9

Reference point: on the axis of the direction of max.
                           response, See Figure 13-9

Linearity error: max. 10 % in the measuring range

Averaging filters: ADF (Advanced Digital Filter) for
                           dose rate. Digital RC-Filter with time
                           constant 2s…100s, depending on dose
                           rate of change. Cycle time: 1s

Figure 13-5: Energy response HDRD module

Figure 13-6: Angle response HDRD module frontal

Figure 13-7: Angle response HDRD module top
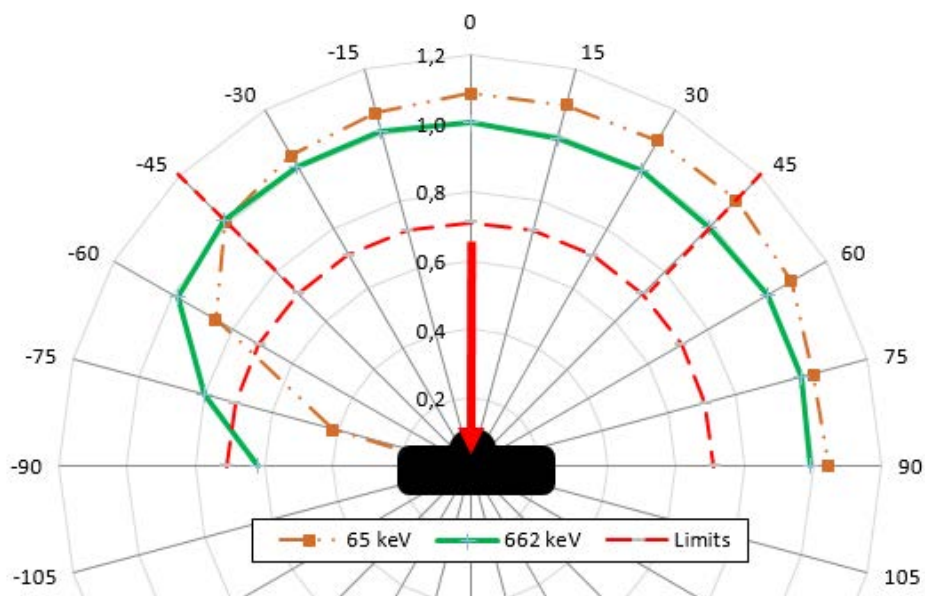

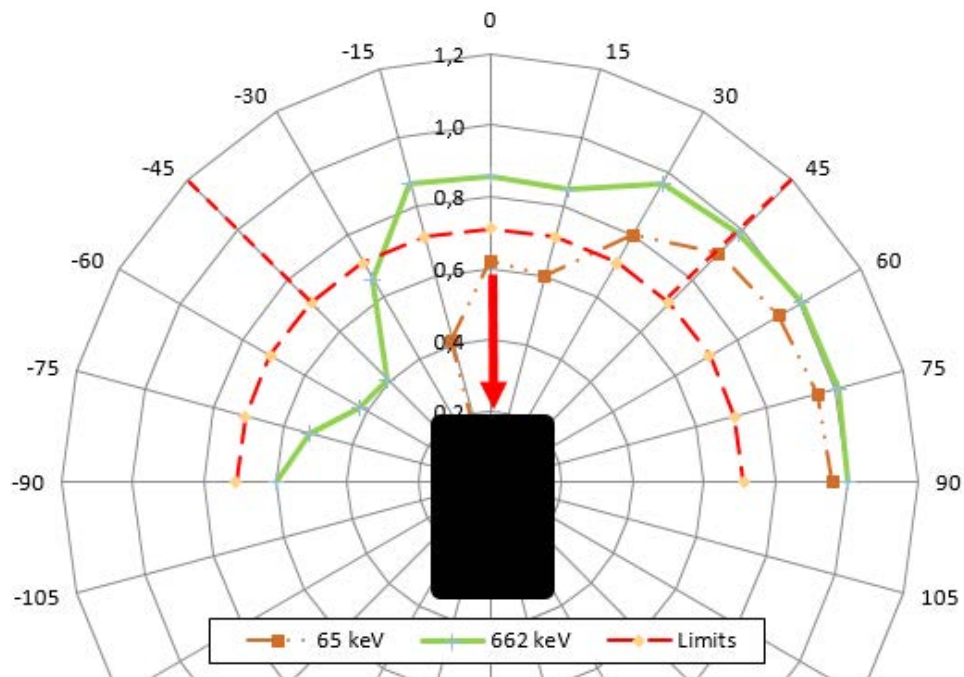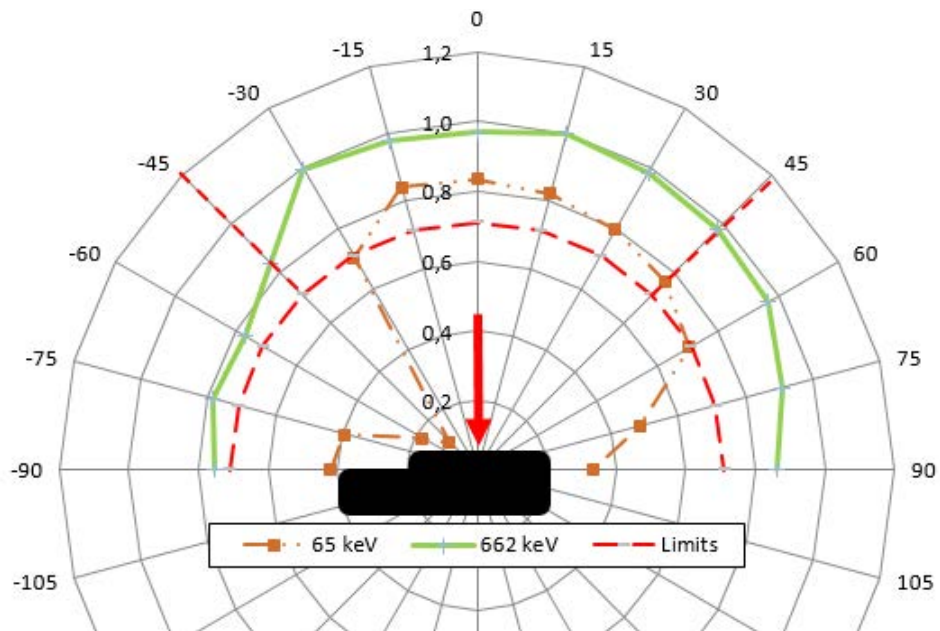**Figure 13-8: Angle response HDRD module side**

13.3 RadEye PRD-ER

Measuring range: Gamma:
10 Sv/h [1000 rem/h] depending on calibra-
tion and photon energy
Gamma count rate display up to 999 kcps
Neutron count rate display up to 10 kcps

Overload display: more than 10 Sv/h [1000 rem/h]

13.4 RadEye PRD

Measuring range: Gamma:
250μ Sv/h [25 mrem/h] depending on calibra-
tion and photon energy
Gamma count rate display up to 999 kcps
Neutron count rate display up to 10 kcps

Overload display: more than 250 μSv/h [25 mrem/h]

13.5 RadEye PRD and PRD-ER

Alarm threshold: Independent alarm thresholds for all
operating modes.

Audible alarm   at least 85 dB(A)
intensity: at a distance of 30 cm

Temperature

Operating: -20°C ... +50°C

Storage: -30°C…. +70°C

Relative humidity: 10 ... 95 % @35°C, non-condensing

Operating voltage: 1.9... 4.0 V,
         Battery low voltage starting from 2.2V

Degree of protection: IP 65 according to EN 60529

EMC: Disturbance emission: EN 61000-6-3
         Immunity: EN 61000-6-2

Mechanical shock: Drop onto a concrete surface
         0.5m without protection sleeve
         1.5m with protection sleeve

Size: 96 mm x 61 mm x 31 mm,
         without rubber protection

Weight: around 210 g including two Alkali
         Manganese AAA cells LR 3 and rub-
         ber protection.

Internal memory: The last 1600 measured values,
         alarms, errors, and configuration
         changes are saved and can be read out
         via PC program. Max- and mean value
         of count rate and dose rate. The time
         interval is factory preset to 120 s by
         default.

Power consumption: $\approx$ 17mW: normal operation without alarm signals and LCD illumination

$\approx$ 45mW with illuminated LC display

$\approx$ 60mW LED alarm

$\approx$ 185mW acoustic alarm

$\approx$ 80mW vibration alarm

Battery service life: $\approx$ 170 h using two alkaline AAA cells

$\approx$ 85 h using 800mAh NiMH battery
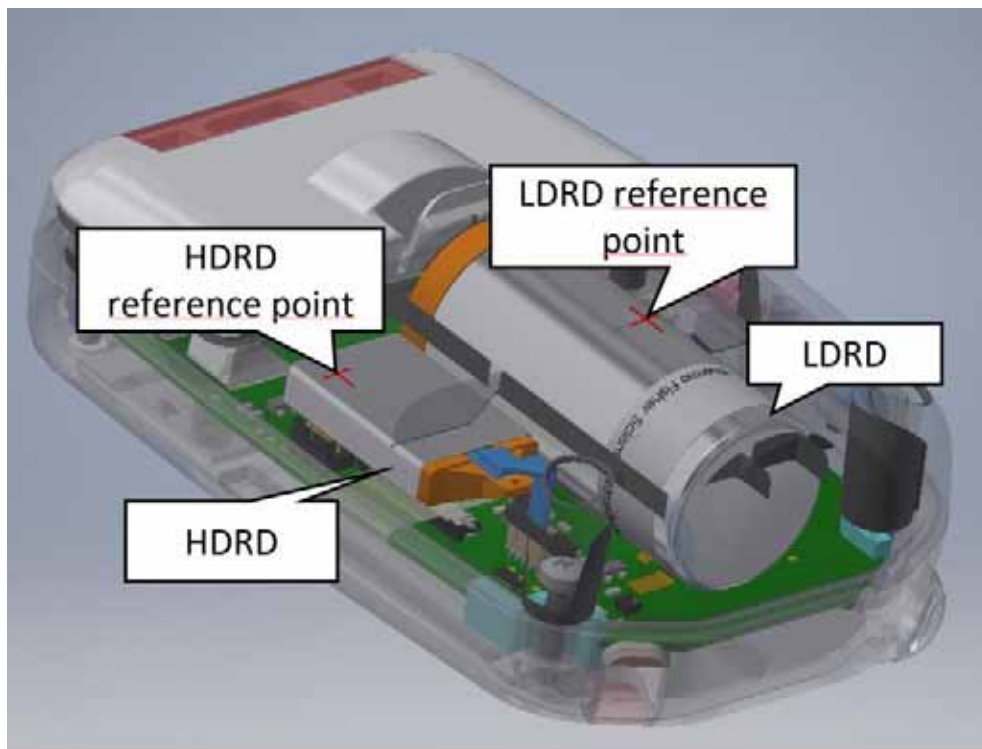
Figure 13-9: Location and reference of LDRD and HDRD

13.6 Firmware version

V 4.00

First edition

V 4.03

The following bugs have been fixed:

- After a lutetium adjustment, the RadEye gave an alarm. From version 4.03, a background learning phase is started after the adjust.
- In HDRD mode the dose rate in the unit Gy/h was displayed 14% too high
- In HDRD mode, NBR information was shown in the simplified display
- The change in battery type was not saved in the EEPROM when it was changed in the RadEye menu
- For the RadEye PRD4 type, the dose rate scale of the RadEye PRD-ER4 was displayed

The following improvements have been introduced:

- Reduced influence of the neutron count rate by a high-energy gamma rate (e.g. thorium)
- The gamma count rate is filtered 4x per second instead of 2x per second
- New type RadEye PRD-ER4J and RadEye PRD4J:
  - No timeout of the mean value and maximum value display
  - The background lighting is not switched off during the mean value and maximum value display

- The mean value and maximum value measurement can be stopped and restarted in the mean value and maximum value display.
- The dose rate of the mean and maximum value display is displayed in nSv/h (or nGy/h) for dose rates less than 1μSv / h (or μGy/h)
- Improvement of the NBR

14. Annex

14.1 Factory Settings RadEye PRD-ER

Item	Factory default
Language	English
Unit	cps – R/h
Unit neutron	cps
Crossmode	Disabled
Type of battery	Battery (Alkaline)
Auto Power On	Off
Autosend	Off
Simple Mode	On
Keyboard Beep when key pressed	Enabled
Keyboard lock	Enabled
Temperature unit	°F
Show in display	On
History time	120
Acoustic indication	Single pulse indication
Single Pulse Click Divider	1
Lu-Check Interval	52 weeks
Lu-Check Password	0 (disabled)
Auto power on	Disabled
Text display line 1	Line 1
Text display line 2	RadEye PRD-ER
Text display line 3	Line 3
Text display line 4	Line 4
Text field	This text is not shown in the LCD.
Alarm 1, Count rate Gamma	50 cps
Alarm 2, Count rate Gamma	500
Sigma value	6
Sigma min. Rate [cps]	30
Safety Alarm	Disabled
Alarm 1, Count rate Neutron	0.3 cps
Alarm 2, Count rate Neutron	30 cps

Sigma Neutron	Disabled
Alarm 1, Dose rate Gamma	50 µR/h
Alarm 2, Dose rate Gamma	1000 µR/h
Alarm 1, Dose	999.9 R
Alarm 2, Dose	999.9 R
Alarm thresholds read only	Disabled
Alarm indicator, Sound	Enabled
Alarm indicator, LED	Enabled
Alarm indicator, Vibration	Enabled
Alarm indicator, Backlight	Enabled
Alarm latching time	0s
Energy Rate	Enabled
Minimal rate for energy ratio [cps]	30
NBR-Alarm Threshold	100
S-Alarm	On, normal sensitivity
Info Button: Dose Rate Gamma	Enabled
Info Button: Dose Gamma	Enabled
Info Button: Peak/Mean Gamma	Enabled
Info Button: Peak/Mean Neutron	Enabled
On Button: Display Neutron	Enabled
On Button: Dual Display γ/n	Enabled
On Button: Graphic Display	Enabled
Enable History	Enabled
Enable Eventlog	Enabled
Finder	Off
Single Pulse	On
Functions	All menu items active

15. Service contact

To request repair or calibration services, please use the online RGA (Return Goods Authorization)
process at:

http://www.thermofisher.com/servicerepair