RAE SYSTEMS
by Honeywell

NeutronRAE II

Personal Radiation Monitor

User's Guide

P/N 047-4204-100
Revision B, January 2013

www.raesystems.com

Read Before Operating

This manual must be carefully read by all individuals who have or will have the responsibility of using, maintaining, or servicing this product. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

CAUTION!

To reduce the risk of electric shock, turn off power and remove batteries before removing the monitor cover. Never operate this monitor while the cover is removed. Remove monitor cover and sensor modules only in an area known to be non-hazardous.

WARNING

To prevent ignition of flammable or combustible atmospheres, disconnect power before servicing.

WARNING

Do not mix old batteries with used batteries or mix batteries from different manufacturers.

WARNING

Substitution of components may impair performance.

This product 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 intereference that may cause undesired operation.

Warnings

For safety reasons, this equipment must be operated and serviced by qualified personnel only. Read and understand the user manual completely before operating or servicing.

Computer Interface

Do not transfer data by means of the Bluetooth® interface in hazardous atmospheres.

Static Hazard

Clean only with a damp cloth.

Long-Term Storage

Reliable performance of this radiation detector is based upon regular usage. For long-term storage, the battery should be disconnected. Preparation for use after long storage requires installation of the batteries and a warm-up period of at least 10 minutes for the sensors to equilibrate. The user should recognize that sensor life is based upon the purchase date.

Avertissements

Pour des raisons de sécurité, cet équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.

Câble de Computer

Ne transférez pas les données au moyen de l'interface de bluetooth en atmosphères dangereuses.

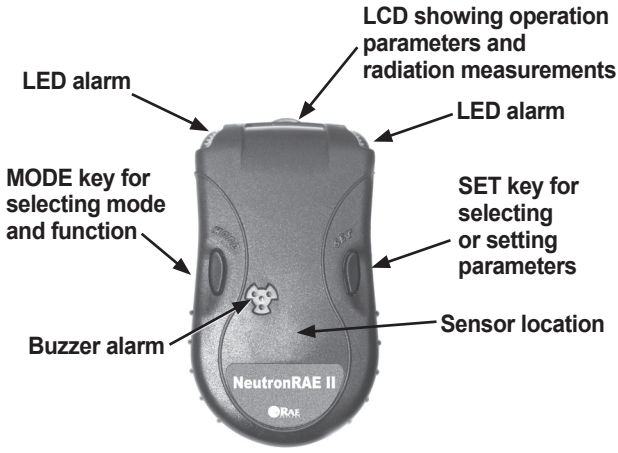
Danger Risque D'origine Electrostatique

Nettoyer uniquement avec un chiffon humide.

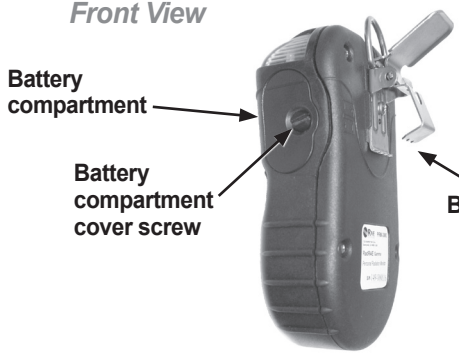
Stockage à Long Term

Le fonctionnement durable de ce détecteur de rayonnement est conditionné par une utilisation régulière de celui ci. Lors d'un stockage à long terme, la batterie doit être déconnectée. Le rédémarrage aprés une longue période d'arrêt, nécessite la réinstallation de la batterie, et une période de chauffage de 10 mn afin que les capteurs se mettent à l'équilibre. L'utilisateur doit être conscient que la durée de vie indiquée pour le capteur démarre à sa date d'achat.

Contents



Front View



Rear/Side View

General Information

The NeutronRAE II is a rapid detector of γ-ray (gamma) and neutron radiation sources. Because of its high sensitivity, it can alert first responders to the presence of a radiation threat well before they might be exposed to health-threatening levels. This personal radiation detector features a loud audible alarm, big, bright flashing LEDs, and a vibration alarm. For stealth operations, law enforcement personnel can disable each alarm separately.

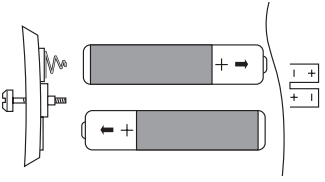
NeutronRAE II's water-resistant design makes for reliable operation in wet environments. Its sensitive Cesium Iodide (CsI) and Lithium Iodide (LiI) scintillators provide fast response to radiological threats.

The NeutronRAE II accumulates dosage. Stored dosage data can be cumulative or cleared and reset for each use period.

Inserting & Replacing Batteries

NeutronRAE II uses two AA alkaline batteries as its power source (use only Duracell MN1500 or Energizer E91). To change the batteries:

1. Use a coin or screwdriver to open the cover on the side of the unit. Turn the screw counterclockwise to loosen the screw, and then tilt the cover off.



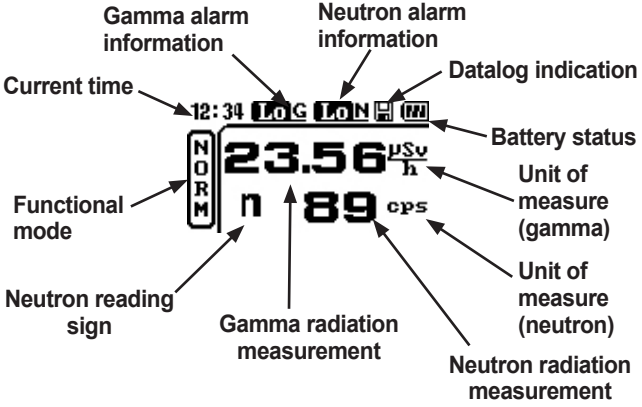
2. Insert batteries into the compartment according to the legend on the rear of the NeutronRAE II, making sure the batteries' polarity is correct.

3. Replace the cover and turn the screw clockwise to secure the cover.

User Interface

NeutronRAE II's user interface consists of the display, LEDs, alarm transducer and two buttons, labeled MODE and SET. The LCD display provides visual feedback that includes time, functional mode, battery condition, and gamma and neutron radiation measurements.

LCD display



MODE and SET switches

User Interface Icons

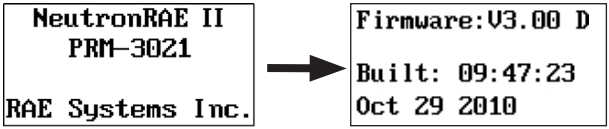
Icon	Indication
	Battery Voltage low Battery Low alarm triggered
	Battery fully charged
	Low Gamma alarm triggered
	High Gamma alarm triggered
	Gamma Over-Range (reading over 20 mR/h)
	Gamma Overload
	Low Neutron alarm triggered
	Neutron Over-Range (reading over 100 cps)
	Neutron Overload
	Bluetooth® communication active
	Datalogging active (flashing)

Turning NeutronRAE II On and Off

Turning NeutronRAE II On

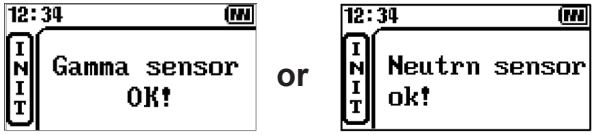
Press and hold the MODE button for 3 seconds. As NeutronRAE II starts up, the following occur:

1. A long beep sounds (if the buzzer is set to On), and unit information and the current firmware version are displayed. The LEDs and vibrator undergo a self-test.

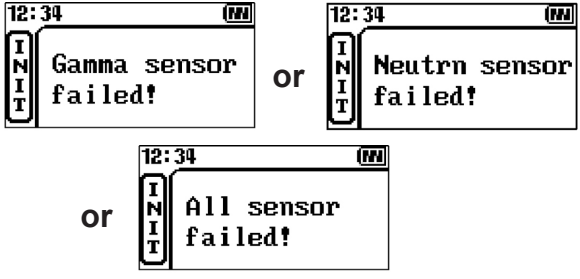


2. Unit self-check. The time and battery status are displayed:

During the 20-second self-check, the detector checks that the gamma and neutron sensors are functioning properly. If so, the messages "Gamma sensor OK!" and "Neutron sensor OK!" are displayed.



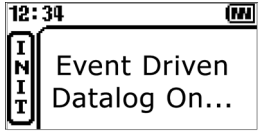
If the sensor is damaged or not functioning properly, the message "Gamma sensor failed" or "All sensors failed" is displayed, turn the unit off and contact your distributor or the RAE Systems service department.



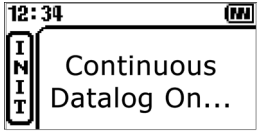
Important! If your NeutronRAE II displays "Gamma sensor failed," "Neutron sensor failed," or "All sensors failed!" contact your distributor or RAE Systems service at 408-952-8200. Do not attempt to use or repair the unit. There are no user-serviceable parts in the NeutronRAE II.

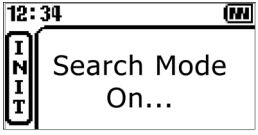
3. The datalog type is displayed, followed by the gamma alarm mode. These parameters can be changed in

Programming Mode, described later in this guide.



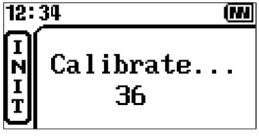
or



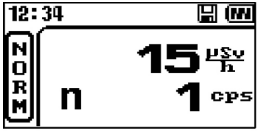


or

4. Gamma background calibration reading (only if the NeutronRAE II is in Search Mode). The NeutronRAE II performs a 36-second background reading countdown.

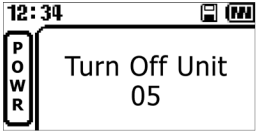


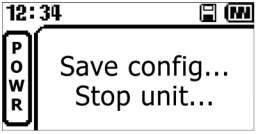
When background calibration reading is complete, datalogging starts (if Continuous Datalogging is enabled) and the unit is in Normal Operating Mode. The display looks like this:



Turning NeutronRAE II Off

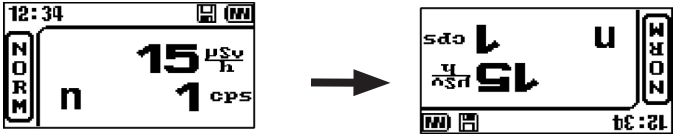
Press the MODE button and hold for 5 seconds. The detector counts down 5 seconds and then turns itself off. Do not release the MODE button until the unit counts down to zero and the display reads “Save config...” and “Stop unit...”





Flipping the Screen

The NeutronRAE II is easy to read, whether held in the hand or clipped to a belt. To flip the screen, press the SET button and hold it down for 3 seconds. When the image inverts, release the button.



To flip the display again, press and hold SET for 3 seconds.

Operation

The NeutronRAE II has two modes: Normal Operating Mode and Programming Mode. Normal Operating Mode is the default; see Programming Mode, on page 20, for details on entering and using Programming Mode.

Normal Operating Mode

In Normal Operating Mode, the NeutronRAE II detects gamma and neutron radiation and accumulates gamma radiation dosage data. In Normal Operating Mode, pressing the MODE button sequentially steps the unit through the following functions:

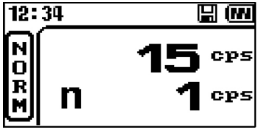
NORM	Normal Operating Mode
CAL	Gamma background calibration (only in Search Mode)
PEAK	Maximum radiation levels detected since last cleared
MIN	Minimum radiation levels detected since last cleared
DOSE	Accumulated gamma radiation dosage since last cleared
TIME	Time, date, and time unit has been on
STAT	Detector status (battery voltage and internal temp.)
COMM	Open BlueTooth communication with computer
TEST	Self test (if Diagnostic Flag is set during start-up)

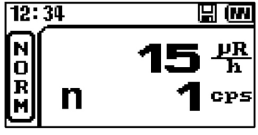
Each function remains active for 60 seconds before automatically returning to the Normal Operating Mode. Pressing the MODE button changes the selection from one function to the next one in the sequence.

NORM

Normal Operating Mode of the NeutronRAE II.

Displays a measurement of the ambient gamma and neutron radiation. It can display gamma in counts per second (cps) or µR/h or µSv/h, depending on how the detector is set up (see Programming Mode) and neutron in counts per second. Switch back and forth between gamma units by pressing the SET button.



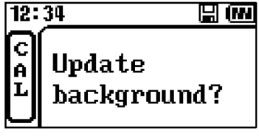


Press the MODE button to step to the next function.

CAL

Background calibration. This option is only active if the NeutronRAE II in Search Mode. This option is skipped if the detector is in Safety Mode.

Press the SET button to have the detector update the background radiation reading.

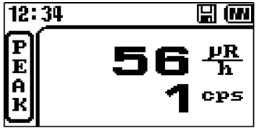


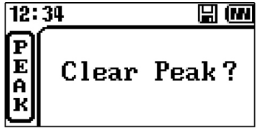
Press the MODE button to step to the next function.

PEAK

The maximum radiation levels detected since last cleared.

Press the SET button twice to clear the PEAK values. If you press SET once but do not want to clear the readings, press MODE to return to the PEAK readings. The PEAK values are also cleared when the detector is turned off.



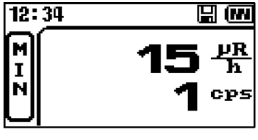


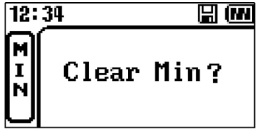
Press the MODE button to step to the next function.

MIN

The minimum radiation levels detected since last cleared.

Press the SET button twice to clear the MIN values. If you press SET once but do not want to clear the readings, press MODE to return to the MIN readings. The MIN values are also cleared when the detector is turned off.



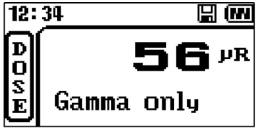


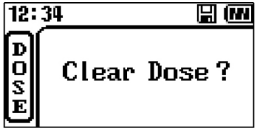
Press the MODE button to step to the next function.

DOSE

The accumulated gamma radiation dosage since last cleared.

Press the SET button twice to clear the DOSE value. If you press SET once but do not want to clear the DOSE reading, press MODE to return to the DOSE reading.



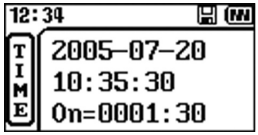


Press the MODE button to step to the next function.

TIME

Time, date, and run time. Date is displayed in YYYY-MM-DD format (can be set in Programming Mode). Time is displayed in HH:MM:SS format (can be set in Programming Mode).

On Run time from when the detector was turned on (shown in hours and minutes, 0000:00)

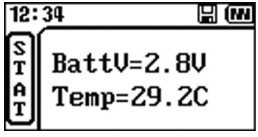


Press the MODE button to step to the next function.

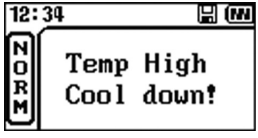
STAT

Detector status.

BattV Battery voltage
Temp Internal temperature (can be displayed in °C or °F – see Programming Mode)



If the internal temperature exceeds the maximum operating temperature, the unit will alarm and display:



Cool the unit down to resume normal operation.

Press the MODE button to step to the next function.

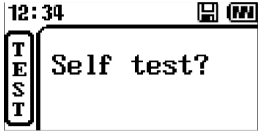
COMM

Communicate with a computer using Bluetooth® radio. Press SET to open the connection on the NeutronRAE II unit end. Use the ProRAE Studio II Software on your computer to download datalogs.

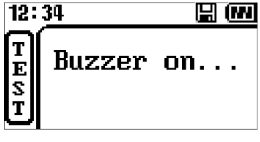
TEST

Self test. This consists of tests to make sure all alert functions are working properly. This function is only enabled if the Diagnostic Flag was set at start-up. To set the Diagnostic Flag, press and hold SET and MODE simultaneously when turning the unit on, instead of pressing MODE only.

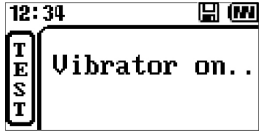
Press the SET button to accept and to initiate testing.



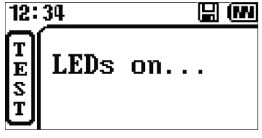
The Buzzer is tested. Press the SET button to start the next test.



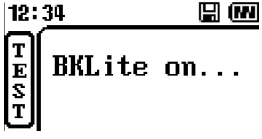
The Vibrator is tested. Press the SET button to start the next test.



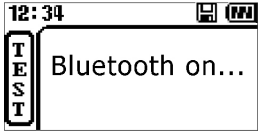
The LEDs are tested. Press the SET button to start the next test.



The back light is tested. Press the SET button to start the next test.



The Bluetooth® radio is tested.



Press the SET button to start the next test.

The Buzzer in Alarm is tested.

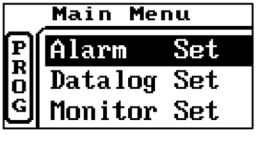
Press the SET button to finish the TEST functions. This returns NeutronRAE II to Normal Operating Mode. During any test, if the SET button is not pressed within 60 seconds, the unit will automatically move on to the next test.

Programming Mode

Programming Mode is used to change alarm settings and detector settings (units of measure, time, etc.).

Note: Changes to some parameters cause the detector to automatically restart or recalibrate.

From Normal Operating Mode, simultaneously press the MODE button and SET button, and hold them down for 3 seconds. NeutronRAE II enters the Programming Mode and displays the Main Menu:



Press the MODE button to step through the menu of parameters.

Press the SET button to select a parameter.

Alarm Set

Select Alarm Set to set the alarm mode or type and the detection limits for the alarm:

Parameter	Used In
Alarm Type	Select Search or Safety Mode
Gamma CF	Search Mode
Gamma Hi	Safety Mode
Gamma Low	Safety Mode
Quit	

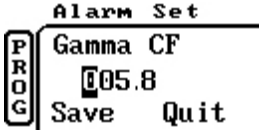
The Gamma CF (Correction Factor) is used to set the Search Mode alarms at a calculated threshold above background. The alarms are set according to:

$$\text{Search Mode Alarm} = CF * \sigma_{bk}$$

where σ_{bk} is the standard deviation of the stored background reading.

Note: The default value is 005.8 for the Gamma CF. In Safety Mode, there are two absolute Gamma alarms: Gamma Low and Gamma Hi. These are set in µR/h, where 1µR/h is equal to 0.01µSv/h. The Neutron alarm remains in Search Mode at all times.

Press the MODE button to step through the digits from left to right. Use the SET button to increment each digit (from 0 through 9).
Select Save to save changes or Quit to discard changes.



To exit Alarm Set, step through the options using the MODE button until you see Quit. Press the SET button to exit Alarm Set, and then step through the Main Menu until you see Quit. Press SET to exit Program mode and return to Normal Operating Mode.

Datalog Set

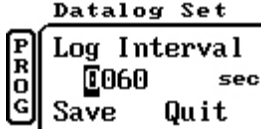
Select Datalog Set to change any of the following datalog parameters:

Clear Data	Log interval
Datalog Type	Quit

Clear Data: Press the SET button to clear the datalog. Press the MODE button to return to the Datalog Set Menu.

Datalog Type: Set the type of datalogging. Choices are Continuous or Event-driven. Choose Continuous to log data at a set interval at all times (except when the unit is Programming Mode). Choose Event-driven to log data only when the dose rate readings increase or the unit goes into alarm.

Log Interval: Set the time interval between datalog points. You may set any time interval between 1 and 3600 seconds. Press the MODE button to step through the digits from left to right. Use the SET button to increment each digit (from 0 to 9). Select Save to save changes or Quit to discard changes.



Quit: To exit Datalog Set, step through the options using the MODE button until Quit is selected. Then press the SET button.

Monitor Set

Select Monitor Set to change any of the following parameters:

Back Lite
Buzz & Lite
Vibrate Mode
Temp Unit
Gamma Unit
Change Date
Change Time
Quit

Press the MODE button to step through these options.

Select an option using the SET button. Once you have selected a menu option, step through the options using the MODE button, and select using the SET button.

Back Lite

Set the behavior of the display backlight. Choices are Automatic (a photosensor turns on the light in dark locations), Manual (light stays on for 15 seconds when you tap any button in any operating mode), or Off.

Buzz & Lite

Set the behavior of the audible and visible alarms. Choices are Both on (LEDs and audible alarm), Light only (LEDs only), or Both off.

Note: You cannot turn off all of the alarm alerts at the same time. If you select Both Off when the Vibration alarm is Off, "Invalid Setting" is displayed and the previous Buzz & Lite setting is restored.

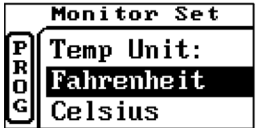
Vibrate Mode

Set the vibration alarm. Choices are On or Off.

Note: You cannot turn off all of the alarm alerts at the same time. If you select Off when the Buzz & Lite is set to Both Off, "Invalid Setting" will be displayed and the previous Vibrate setting will be restored.

Temp Unit

Set the temperature unit. Choices are Fahrenheit and Celsius. Press MODE to select Fahrenheit or Celsius. Then press SET to save your choice and exit.

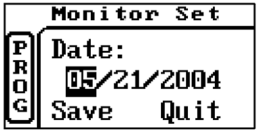


Gamma Unit

Set the unit of measure (of gamma radiation). Choices are µR/h or µSv/h. Press MODE to select your choice, and then SET to save your choice and exit.

Change Date

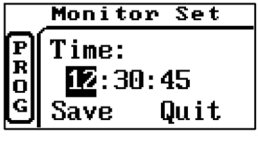
Set the date (mm/dd/yyyy). Press MODE to step through month, date, and year, and press SET to increment through the digits (holding the SET button continuously speeds through the numbers).



Press MODE to select Save, and press SET to save your date changes. Otherwise, press MODE again to select Quit and press SET to exit.

Change Time

Set the time (hh/mm/ss). Press MODE to step through hours, minutes, and seconds, and press SET to increment through the digits (holding the SET



button continuously speeds through the numbers).
Note: The clock operates in 24-hour mode only.

Press MODE to select Save, and press SET to save your time changes. Otherwise, press MODE again and select Quit. Press SET to exit.

Quit

To exit Monitor Set, step through the options of Monitor Set until you see Quit. Press the SET button to exit Monitor Set. Then step through Main Menu selections using the MODE button until you see Quit. Press SET to exit Program Mode and return to Normal Operating Mode.

NeutronRAE II Default Settings & Parameter Ranges

Main Menu	Sub Menu	Default Settings	Data Range
Alarm Set	Alarm Type	Search	Search/Safety
	Gamma CF*	5.8	1.0-9.9
	Gamma Hi	200µR/h	0 to 20mR/h
	Gamma Low	50µR/h	0 to 20mR/h
Datalog Set	Clear Data	N/A	N/A
	Change Type	Continuous	Continuous or Event-driven
	Log Interval	60 sec	1-3600 sec

* Correction Factor

Monitor Set	Back Lite	Manual	Automatic
			Manual
			Off
	Buzz & Lite	Both On	Both On
			Light Only
			Both Off
	Vibrate	On	On
			Off
	Temp Unit	Celsius	Fahrenheit
			Celsius
	Gamma Unit	µR/h	µR/h
			µSv/h
	Change Date		MM/DD/ YYYY
	Change Time		HH/MM/SS

NeutronRAE II Specifications*

Size	4.92" x 2.68" x 1.38" (125 x 68 x 35 mm)
Weight	10 oz. (283g)
Detectors	**Gamma:** 1cc CsI(TI)/Photodiode **Neutron:** 1cc LiI(Eu)/Photodiode
Battery	2 AA alkaline batteries easily accessible with a coin
Operating Period	500 hours
Display	Graphic LCD display with 1.2" x 0.75" (30.5 mm x 19 mm) viewable area can be flipped for view by wearer or by others
Key Pad	2 operation/program buttons
Direct Readout	Gamma dose rate (cps, µR/h, µSv/h) Neutron radiation intensity (cps) Gamma/Neutron peak Gamma/Neutron minimum Gamma dose Battery status Current time and date Current time since startup Internal temperature

*Specifications are subject to change.

Backlight	Automatic, manual, or off
Calibration	Periodic functional test recommended using a ^{137}Cs check source. Factory calibration recommended every two years
Alarm Setting	Programmable alarm sensitivity with background compensation to minimize false alarms, absolute safety alarms for gamma
Alarm Modes	**Search Mode:** Alarm thresholds set at a calculated value above background reference reading **Safety Mode:** User-set high and low absolute alarm levels (gamma only)
Alarm Alerts	Loud 85dB @ 12" (30 cm) for noisy environments
	Built-in vibration alarm
	Highly visible LED lights on both sides of LCD graphic display
Datalog	10,000 datapoints (20 days @ 180-sec. intervals), wraparound log

Specifications continue on next page

Specifications (continued)

Datalog Modes	**Continuous:** Logs data continuously **Event Driven:** Begins logging on alarm
Log Interval	User-programmable (1 to 3600 sec.)
Communications	Built-in Bluetooth® radio
Ergonomics	Nonslip rubber housing with grippable ridges securely fits hand or glove
Energy Range	**Gamma:** 0.06 to 3.0 MeV **Neutron:** thermal to 14 MeV
Sensitivity	**Gamma:** More than 0.3 cps per µR/hr (>30 cps per µSv/hr) **Neutron:** 1 to 2 cps per 2.5 neutrons/second/cm^2
Dose Equivalent Rate (DER) range for ^{137}Cs	**Gamma:** 1 µR to 20 mR/h (0.01 to 200 µSv/h) **Neutron:** 1 to 100 cps
Accuracy of DER for ^{137}Cs	±20%
Dosage Range	1 µR to 999 R (gamma only)
Temperature	-20° C to 50° C (-4° F to 122° F)
Humidity	0% to 95% (non-condensing)

Shock Resistance	Passes drop test from 1.5m (59")
IP Rating	IP67
Attachments	Rugged metal belt clip and wrist strap

Proper Battery Disposal

The Waste Electrical and Electronic Equipment (WEEE) directive (2002/96/EC) is intended to promote recycling of electrical and electronic equipment and their components at end of life. This symbol (crossed-out wheeled bin) indicates separate collection of waste electrical and electronic equipment in the EU countries. This product may contain one or more Nickel-metal hydride (NiMH), Lithium-ion, or Alkaline batteries. Specific battery information is given in this user guide. Batteries must be recycled or disposed of properly.

At the end of its life, this product must undergo separate collection and recycling from general or household waste. Please use the return and collection system available in your country for the disposal of this product.

Limited Warranty

RAE Systems Inc. warrants NeutronRAE II to be free from defects in materials and workmanship for a period of 1 year. This warranty is expressly limited to the original owner who purchases the equipment directly from RAE Systems or from an authorized RAE Systems reseller. To validate this warranty the original Warranty & Registration Card supplied with the product must be completed and returned to RAE Systems, or the product registered online via the RAE Systems, Inc. online registration system, within 30 days of purchase.

To maintain this limited warranty, the product must be operated, calibrated and maintained in accordance with the Operation and Maintenance Manual supplied with the product. Abuse, mechanical damage, alteration, and/or repair procedures not made in accordance with the Operation and Maintenance Manual voids the RAE Systems Standard Limited Warranty.

The obligation of RAE Systems under this limited warranty is limited to the repair or replacement of components deemed by the RAE Systems Instrument Service Department to have been defective under the scope of this Standard Limited Warranty. To receive consideration for warranty repair or replacement procedures, products must be returned to RAE Systems at its manufacturing location in San Jose, California, USA, with transportation and shipping charges prepaid. It is

necessary to obtain a return authorization number from RAE Systems prior to shipment.

This limited warranty is expressly in lieu of any and all representations, express or implied, including but not limited to, the warranty of fitness for a particular purpose. RAE Systems will not be liable for loss or damage of any kind connected to the use of its products or failure of its products to function or operate properly.

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