Using the GammaRAE II Personal Radiation Detector

Training Agenda

- **GammaRAE II Features**

- **Normal Usage**
  - Turning Unit On
  - Operating Mode
  - User Screens

- **Advanced Features**
  - Programming Mode

GammaRAE II

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PROTECTION THROUGH DETECTION

GammaRAE II Features

- Detector: CsI (TI)/Photodiode

- Sensitivity: More than 1 cps per µR/hr (>100
  –   cps per µSv/hr)

- Dose Equivalent: 1–4000 µR/h (0.01–40 µSv/h)
- Rate (DER) range
- for 137Cs

- Accuracy of DER: ± 30%
- for 137Cs

- Dosage Range: 1 µR - 999 µR

- Energy Range: 0.06-3.0MeV

GammaRAE II Features

- LCD display flips for 2-way viewing
- Continuous digital display of dosage rate in µR/h or µSv/h (user programmable)
- Programmable audible, visible and/or vibration alarms
- Highly visible LED lights on both sides of LCD graphic display
- Loud alarm >85 dB @ 30cm for noisy environments
- 2 operation/program buttons
- Optional Windows™-compatible datalogging and set-up program

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PROTECTION THROUGH DETECTION

GammaRAE II Reliability

- Passes Drop Test from 59" (1.5m)
- Non-slip rubber housing with grippable ridges securely fits into hand or glove
- 0 -100% humidity, water resistant, IP-65 rated case
- Temperature range of -4°F to 122°F (-20°C to 50°C)
- 800 hours on alkaline battery (can be changed with a coin)
- Rugged metal belt clip, wrist strap

Physical Description

MODE *button for selecting mode and function*

Battery Compartment

Buzzer alarm

SET *button for setting or selecting parameters*

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Physical Description

LED alarm

*LCD flips 2 ways with **SET** button to easily show operation parameters and radiation measurements*

Battery compartment cover screw

GammaRAE II

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PROTECTION THROUGH DETECTION

Replacing Battery

- Using either a flat-head screwdriver or a coin, turn screw counterclockwise to loosen
- Tilt cover off to access AA batteries.
  – Initial use may require thin, flat object to assist in removal
- Screw is captured in battery cover
  – Note: Use only alkaline batteries; carbon batteries may leak causing damage.

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Replacing Battery

- Insert new batteries according to directions on back of GammaRAE II
- Replace cover and turn screw clockwise to tighten
- Unit will beep and LEDs will flash *once* indicating full battery charge
- If alarm beeps continuously, or makes a "zapping" noise, the batteries are almost dead and should not be used

Training Agenda

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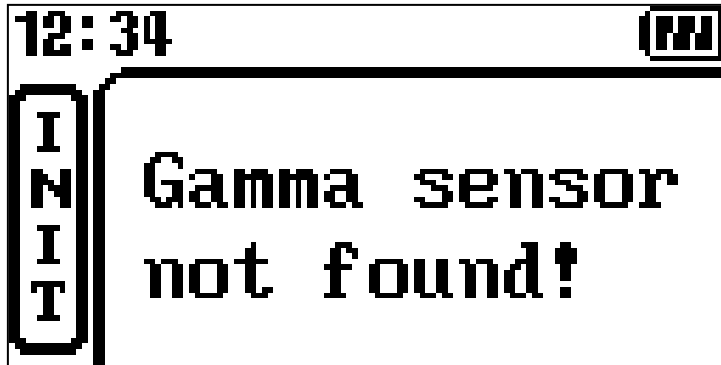- Advanced Features
  - Programming Mode

PROTECTION THROUGH DETECTION

Start-up: Turning Unit On

- Press and hold the **MODE** button for 3 seconds
- Alarm sounds (if buzzer is set to ON)
- LCD displays unit information
  - LEDs and vibrator self-test at this time
- Instrument performs self-check
  - Time and battery status are displayed
- GammaRAE II performs a 36-second background "calibration"

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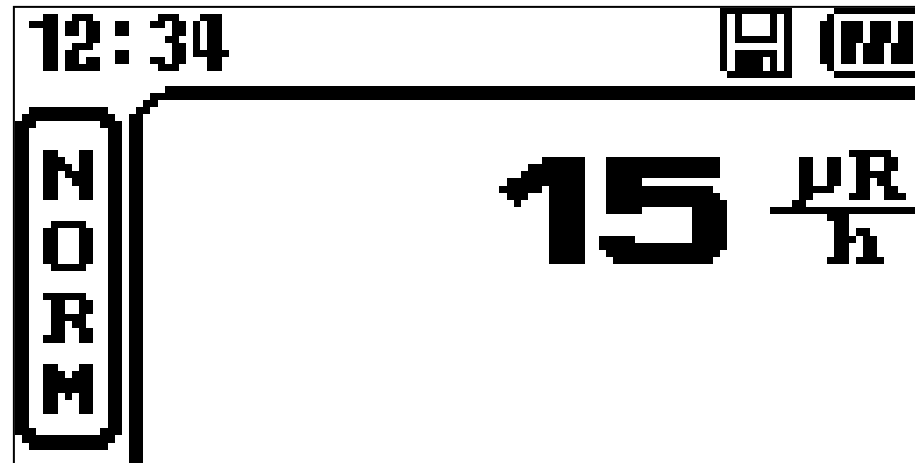# Start-Up Warnings

```
12:34                    (PN)
┌──────────────────────────┐
│I│                        │
│N│  Gamma sensor          │
│I│  not found!            │
│T│                        │
└──────────────────────────┘
```

```
12:34                    (PN)
┌──────────────────────────┐
│I│                        │
│N│  No sensor             │
│I│  installed!            │
│T│                        │
└──────────────────────────┘
```

Important! If your GammaRAE II displays "Gamma sensor not found" or "No sensor installed!" contact your distributor or RAE Systems service at ***408-752-0723***. Do not attempt to use or repair the unit. There are no user-serviceable parts in the GammaRAE II.

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Start-Up

Once calibration is complete and the unit is in Normal Operating Mode (NORM), you will see a screen like this.

Note: NORM does not mean "Naturally Occurring Radioactive Material"; It indicates that the unit is in Normal Operating Mode.

Turning Unit Off

- Press and hold the **MODE** button for 5 seconds

- The detector counts down 5 seconds on the screen, flashes the orange LEDs, and beeps, and then shuts off

- Do not release the **MODE** button until the unit has counted down to zero, flashed the *red* LEDs, and sounded a long beep.

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PROTECTION THROUGH DETECTION

Training Agenda

- GammaRAE II Features
- Normal Usage
  - Replacing battery
  - Turning Unit on
  - **Operating Mode**
  - User Screens
- Advanced Features
  - Programming Mode

GammaRAE II

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PROTECTION THROUGH DETECTION

GammaRAE II Operations

- The GammaRAE II has two modes of operation: Normal Operating Mode (NORM) and Programming Mode (PROG).

- In normal operating mode, the GammaRAE II detects Gamma radiation and accumulates radiation dosage data.

- In Programming Mode, operating parameters are specified.

Training Agenda

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PROTECTION THROUGH DETECTION

User Screens

- NORM - *Normal Operation Mode*
- CAL – *Background Calibration*
- PEAK – *Maximum radiation level detected since last cleared*
- MIN – *Minimum radiation level detected since last cleared*
- DOSE – *Accumulated radiation dosage since last cleared*
- STAT – *Detector status*
- TEST – *Self test*

  – Each function remains active for 60 seconds before automatically returning to the normal operating mode.
  – Pressing the **MODE** button moves the selection to the next one in the sequence.

Normal Operating Mode (NORM)
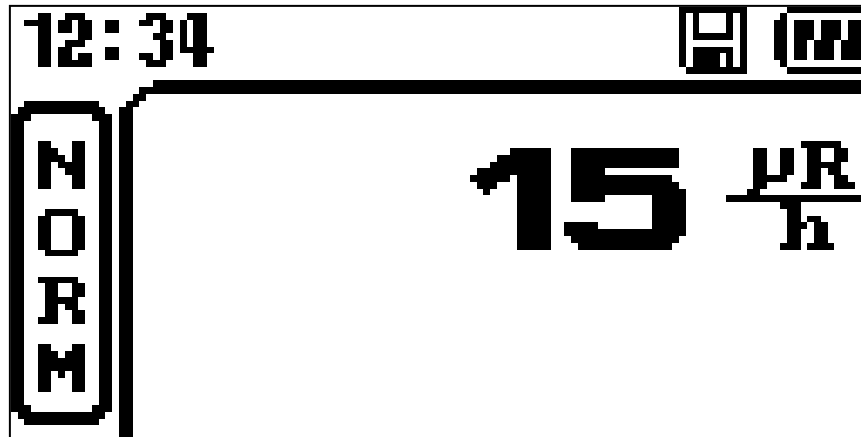
- Displays a measurement of the ambient radiation.

- Can operate in "search mode" (expressed in counts per second, cps) or "detection mode" (µR/h or µSv/h, depending on how the detector is set up in Programming Mode)

- Switch back and forth between search and detection modes by pressing the **SET** button.

- Press the **MODE** button to step to the next function.

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PROTECTION THROUGH DETECTION

Background "Calibration" (CAL)

```
12:34              [icons]
┌─┐┌──────────────┐
│C││ Update       │
│A││              │
│L││ background?  │
└─┘└──────────────┘
```

- Background "Calibration"
  - Low dosage background radiation can come from things like asphalt, higher elevations, fertilizers, and even recent hospital procedures
- Press the **SET** button to have the detector re-" "calibrate" to the background radiation
- Press the **MODE** button to step to the next function.

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Maximum Reading (PEAK)
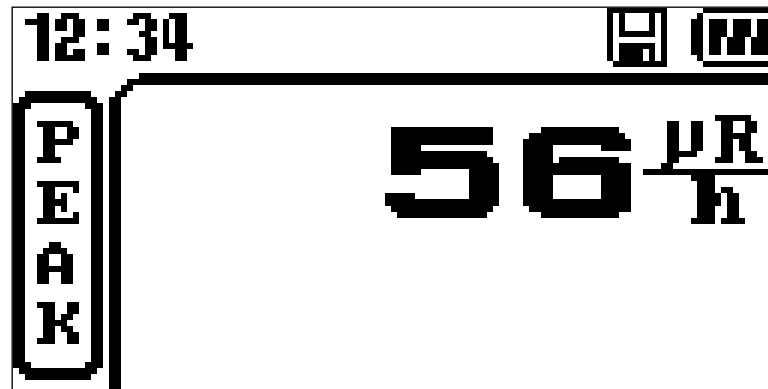
- The maximum radiation level detected since last cleared
- Press the **SET** button to clear the PEAK value
- The PEAK value is also cleared when the detector is turned off
- Press the **MODE** button to step to the next function

Minimum Reading (MIN)
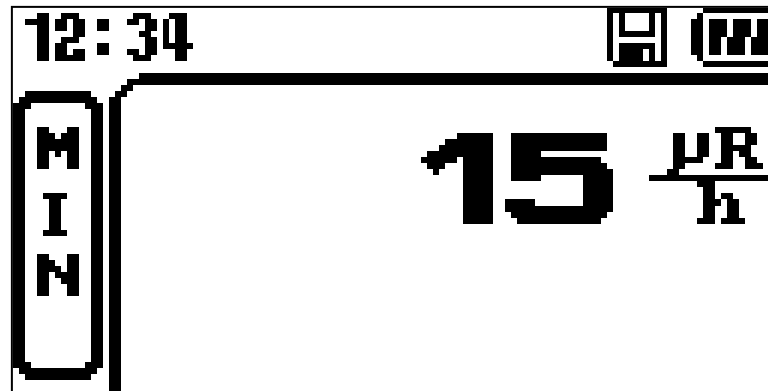
- The minimum radiation level detected since last cleared
- Press the **SET** button to clear the MIN value
- The MIN value is also cleared when the detector is turned off
- Press the **MODE** button to step to the next function

Accumulated Dose (DOSE)
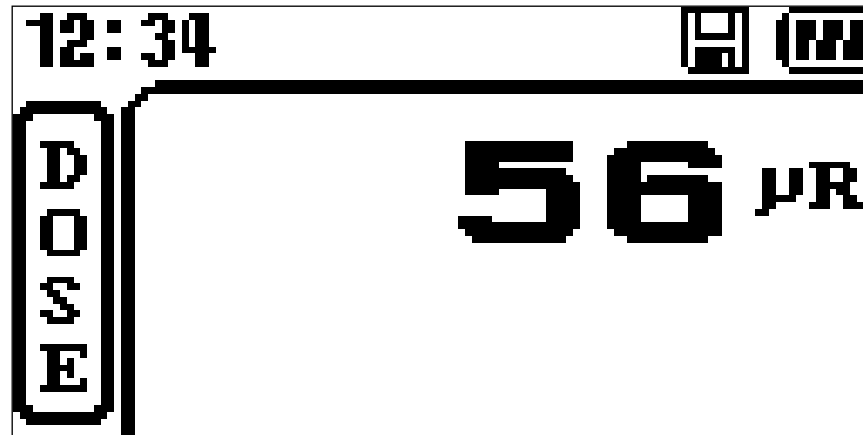
- The accumulated radiation dosage since last cleared
- Press the **SET** button to clear the DOSE value
- Press the **MODE** button to step to the next function

Dose Rate versus Dose

- The speedometer tells us how many miles per hour we are traveling
- A dose rate meter (detector) tells us how many mSv or mrem are received *per hour*

- The odometer shows how many miles the car has traveled
- A dosimeter show many mSv or mrem one has received altogether

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PROTECTION THROUGH DETECTION

Why measure Dose?

- It makes a difference whether the high dose is received all at one time or over a long period of time.

- "For example, a dose of 5,000 mSv is usually lethal if it is received in a short period and if the patient is left without special medical care. If a person receives the same dose slowly over several months, it would may or may not cause any signs of illness.

- "The same kind of effect could be illustrated by drinking a quart of whisky. If you drink the whole bottle at once, you will get drunk, and you may even die. If you consume it during one year, drinking one teaspoonful every day or two, it will have no effect at all."

- Bjorn Wahlstrom, Understanding Radiation

ICRP Standards: Important Dose Limits

Exposed Workers	Average: 20 mSv or 2000 mrem per year
	Maximum: 50 mSv or 5000 mrem per year
	During pregnancy: 2 mSv or 200 mrem per year
The public	Average: 1 mSv or 100 mrem per year
	Single event: 5 mSv or 500mrem

Typical Radiation Doses

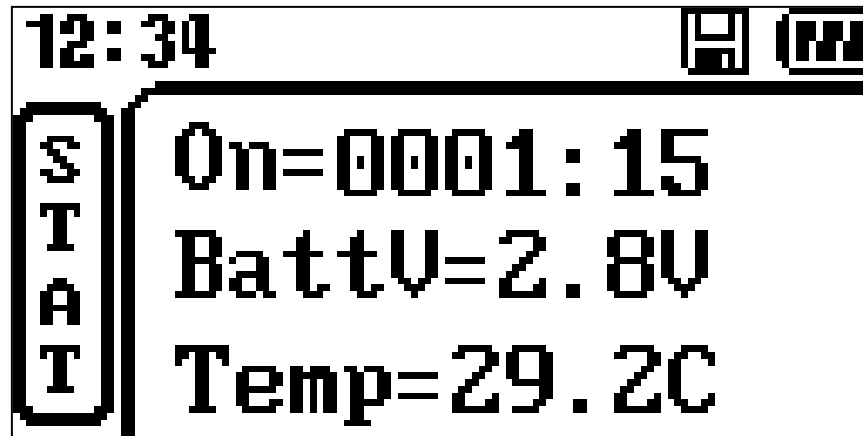|	
Exposed workers	Average 1 to 3 mSv per year/100 to 300 mrem Variation range 0 to 20 mSv/0 to 2000 mrem
Chest x-ray examination	About 0.1 mSv per examination/10 mrem Variation range 0.05 to 5 mSv/5 mrem to 500 mrem
Major x-ray examination	Up to 20 mSv per examination/up to 2,000 mrem
Radon gas in houses	Average 2 to 3 mSv per year/200 to 300 mrem Variation range 0.2 to 500 mSv/20 to 50,000 mrem
Background radiation	Mostly 1 to 3 mSv per year/100 to 300 mrem In extreme cases up to 20 mSv/up to 2,000 mrem
Construction materials in buildings	0.2 to 1 mSv per year/20 to 100 mrem
In the vicinity of nuclear power plants	Max. permissable 0.1 per year/10 mrem Actual 0.001 to 0.01 mSv/.1 to 10 mrem

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PROTECTION THROUGH DETECTION

Detector Status (STAT)

```
12:34                    💾 🔋

┌─┐┌─────────────────┐
│S││ On=0001:15       │
│T││                  │
│A││ BattV=2.8V       │
│T││                  │
│ ││ Temp=29.2C       │
└─┘└─────────────────┘
```
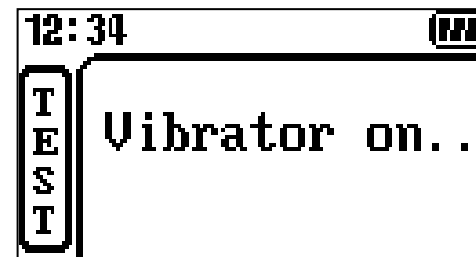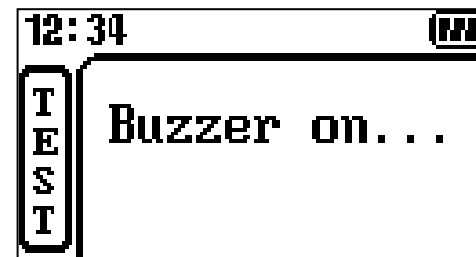
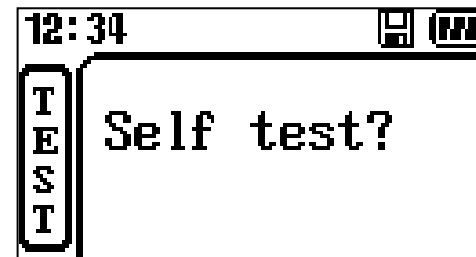- Detector status
- **On**: Run time from when the detector was turned on (shown in hours and minutes, 0000:00)
- **BattV**: Battery voltage
- **Temp**: Internal temperature (can be displayed in ° C or ° F – set in Programming Mode)
- Press the **MODE** button to step to the next function

Self Test (TEST)

Self test: This consists of tests to make sure all alert functions are working properly.
1. Press the **SET** button to accept and to initiate testing.
2. The buzzer is tested. Press the **SET** button to start the next test.
3. The vibrator is tested. Press the **SET** button to start the next test.

```
12:34              [] (M)
 ┌──────────────────┐
T│                  │
E│  Self test?      │
S│                  │
T│                  │
 └──────────────────┘
```

```
12:34                 (M)
 ┌──────────────────┐
T│                  │
E│  Buzzer on...    │
S│                  │
T│                  │
 └──────────────────┘
```

```
12:34                 (M)
 ┌──────────────────┐
T│                  │
E│  Vibrator on..   │
S│                  │
T│                  │
 └──────────────────┘
```
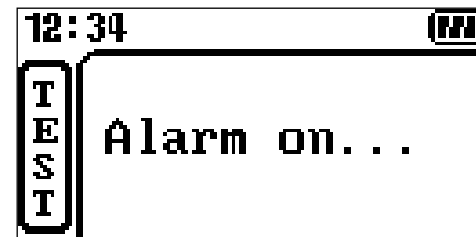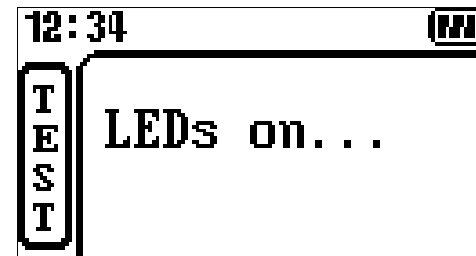
Self Test (TEST)

4. The LED is tested. Press the **SET** button to start the next test.
5. The backlight is tested. Press the **SET** button to start the next test.
6. The alarm buzzer is tested.

Press the **SET** button to finish the TEST functions. This returns GammaRAE II to Normal Operating Mode.

Training Agenda

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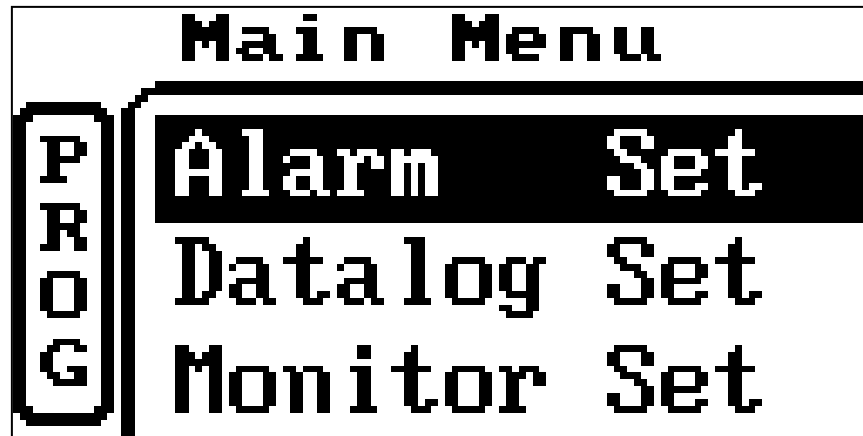- **Advanced Features**
  - Programming Mode

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Programming Mode (PROG)

Programming Mode is used to change alarm settings and detector settings

- Hold the **MODE** and **SET** buttons for 3 seconds to enter into Programming Mode
- Press the **MODE** button to step through the menu
- Press the **SET** button to select
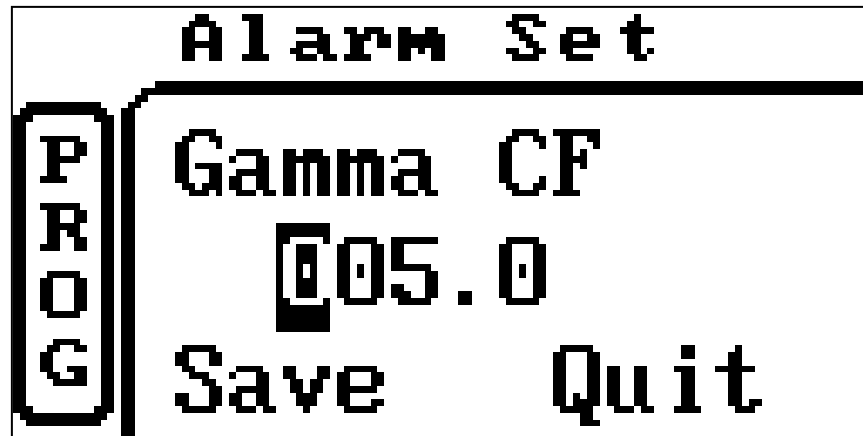
Programming Mode (PROG)

- **Alarm Set** allows you to reset the alarm setpoints (CF)
- **Datalog Set**
- **Monitor Set** allows you to reconfigure the parameters of the GammaRAE II

Alarm Set

```
Alarm Set
┌─────────────────────────┐
│ P │ Gamma CF            │
│ R │                     │
│ O │     ▮05.0           │
│ G │ Save      Quit      │
└─────────────────────────┘
```

- Select Alarm Set to set the low detection limit for the alarm
- The Gamma CF is used to set

$$\text{Low Alarm} = CF * \sigma \, bk$$

  - $\sigma \, bk$ = (*standard deviation of background*)
  - this is the same as the 'n' in the GammaRAE pager
- Press the **MODE** button to step through the digits from left to right
  - **Note:** The default value is 5.0
- Use the **SET** button to increment each digit (from 0 through 9)

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PROTECTION THROUGH DETECTION

Alarm Set

- The alarm is not a fixed value, but a % above background
- Smaller "**CF**" increases the alarm sensitivity
  - Small "**CF**" is like no squelch and large "**CF**" is like full squelch
- Alarm threshold value (alarm point):

$$\textbf{Alarm = B + CF x D}$$

  - **B** = background radiation reading (from "CAL"). It is the average reading of every 0.25 second in 36 seconds
  - **CF** = number of the deviations to trigger the alarm. Can be set from 1.0 to 9.9
  - **D** = mean square deviation of background radiation (from "CAL"). The statistical difference of all of the 0.25 second readings for 36 seconds

Alarm Set

- Example: At a background reading of 15 μR/h

CF	Alarm % Above Background	Alarm Threshold Value	Probability of False Alarm
1	15%	17 μR/h	16.6%
2	30%	20 μR/h	2.6%
3	45%	22 μR/h	0.2%
4	60%	24 μR/h	0.01%
5	75%	26 μR/h	<0.01%
6	90%	29 μR/h	<0.01%
7	105%	31 μR/h	<0.01%

Alarm Set

- To exit Alarm Set, step through the options using the **MODE** button until you see "Quit"

- Press the **SET** button to exit Alarm Set

- Then step through the Main Menu until you see "Quit"

- Press **SET** to exit Program mode and return to Normal Operating Mode

Monitor Set

- Select Monitor Set to change any of the following parameters:
  - Back Lite
    - Default setting: Manual
  - Buzz & Lite
    - Default setting: Both On
  - Vibrate
    - Default setting: On
  - Temp Unit
    - Default setting: Celsius
  - Gamma Unit
    - Default setting: µR/h
  - Change Date
  - Change Time
- Press the **MODE** button to scroll down these menu options
- Select an option using the **SET** button

Monitor Set

- Back Lite
  - Set the behavior of the display backlight
    - Automatic – A photosensor turns on the light in dim lighting
    - Manual – Turn on by pressing **MODE**
    - Off
- Buzz & Lite
  - Set the behavior of the audible and visible alarms
    - Both on – LEDs light and buzzer sounds when in alarm
    - Light only – Only LEDs light when in alarm
    - Both off
- Vibrate Mode
  - Set the vibration alarm
    - On
    - Off
- **WARNING**: You **can** turn all three of the alarm alerts (Buzzer, LEDs & Vibrator) **OFF** at the same time!!!!
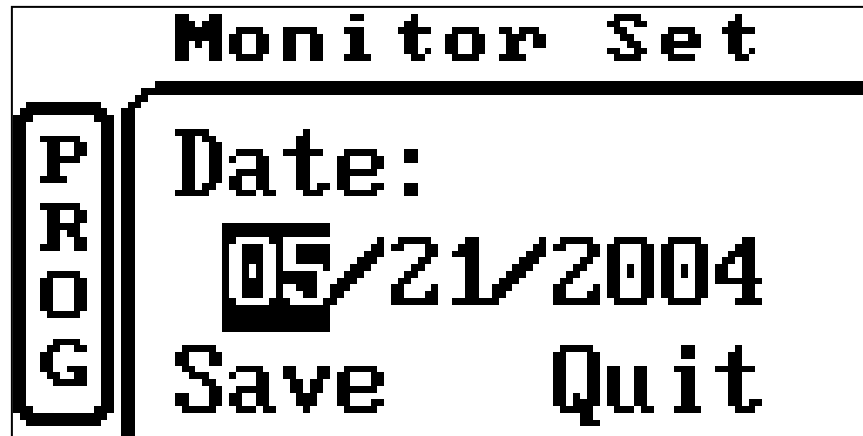
Temp Unit
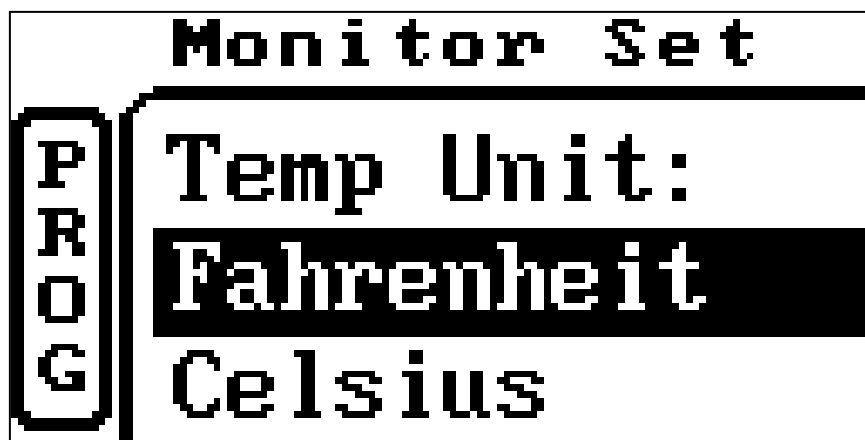
- Set the unit of measure
- Choices are Fahrenheit and Celsius
- Press **MODE** to select Fahrenheit or Celsius
- Then press **SET** to save your choice and exit

PROTECTION THROUGH DETECTION

Gamma Unit

- Set the unit of measure (of radiation).
- Choices are µR/h (US) or µSv/h (SI Unit)
  - 100 μR/h = 1 μSv/h
- Press **MODE** to select unit
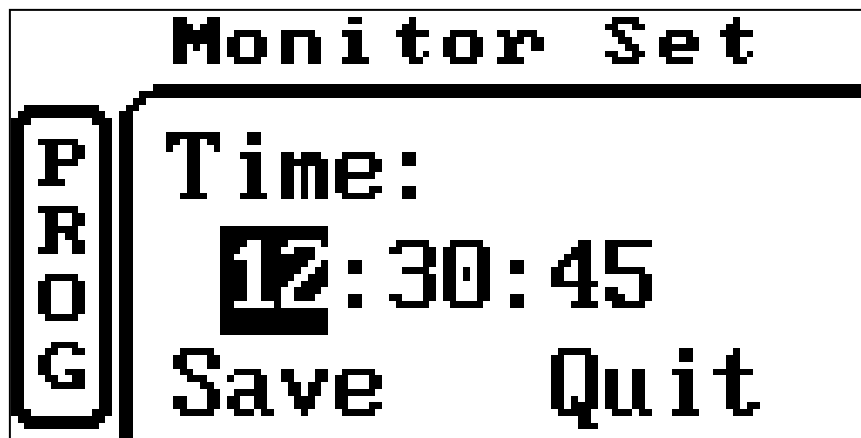- Press **SET** to save your choice and exit

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 speeds through the numbers)
- Press **MODE** to select "Save" and press **SET** to save your date changes and exit
- Otherwise, press **MODE** again to select "Quit" and press **SET** to exit.

Change Time

```
┌─────────────────────────────┐
│  Monitor Set                │
│ ┌─┐┌──────────────────────  │
│ │P││Time:                    │
│ │R││                         │
│ │O││ 12:30:45                │
│ │G││Save      Quit           │
│ └─┘└──────────────────────  │
└─────────────────────────────┘
```

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

Questions?

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PROTECTION THROUGH DETECTION