RADIATION PAGER

USER'S MANUAL

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SENSOR TECHNOLOGY ENGINEERING
a HEICO Company

30 South Calle Cesar Chavez, Santa Barbara CA 93103
support@ste-sb.com
(805) 964-9507

1 OVERVIEW

The Radiation Pager is a compact Personal Radiation Detector (PRD) for use in the interdiction and location of nuclear materials. It was specifically designed to be used by Customs and Border Protection agents, Law Enforcement personnel, and First Responders. Employing a large cesium iodide crystal scintillator and a quality photomultiplier tube for gamma radiation sensing, coupled with electronics that have been tuned for performance and optimized for low power, the Radiation Pager is a very sensitive device with a fast response time. Designed to be worn in a belt holster or in a pocket, the Radiation Pager is the smallest PRD available on the market today.

When the Radiation Pager detects radiation at levels above the natural background, it quickly alerts the operator by flashing a daylight-viewable LED and by either sounding an alarm or vibrating. The operator can easily locate the radiation source using the single digit display, the flashing indicator, or the audible tone.

Designed from the ground up for connectivity, the Radiation Pager employs the latest Bluetooth standards for encryption and communication. This capability allows for real-time streaming of radiological data to mobile device applications and to centralized command and control networks.

The Radiation Pager is designed to withstand the rigors of daily operation, and can be worn in an available belt holster, or carried in a pocket. It will operate continuously for at least 3,500 hours on a single AA Lithium battery.

Figure 1: Radiation Pager Detector Location and Center

Table 1: Radiation Pager Specifications

Specification	Description
Radiation Type	Gamma
Detector Type	Cesium Iodide Scintillator
Detector Size	5 cc
Sensitivity	2.2 cps per µR/h at Cs-137 (662keV)
Low Energy Cutoff	45keV
Integration Time	Multiple (<1, 2 Seconds)
Size	9.3 cm x 5.6 cm x 2.3 cm
Weight	150g with battery
Battery	1x AA Lithium (Li-FeS2)
Battery Life	3,500 Hours
Environmental Protection	Per ANSI N42.32 2016
Ingress Protection	IP65
Temperature Range	-25º to 50ºC
Indicators	Visible, Audible, Vibration
Compliance	ANSI N42.32 2016
Communications	Bluetooth 5.0

2 OPERATION

The user interface of the Radiation Pager consists of a multicolor Indicator LED and a single digit numerical Level Display. Together, these two indicators show the status of the instrument and communicate the intensity of any detected gamma radiation (see Figure 2).

Figure 2: Radiation Pager User Interface

The Radiation Pager is activated by a three-position rotary Mode Switch. The middle position turns the instrument off. By rotating the knob right, the instrument is turned on and enables the audible alarm mode. Conversely, by rotating the knob left, the instrument is turned on and the silent (vibration) alarm mode is enabled.

> **NOTE:**
> It is important to not turn on the Radiation Pager in the vicinity of a radiation source. This will affect the alarm threshold calculation and will reduce the device's sensitivity.

When the Radiation Pager is turned on, the middle segment of the Level Display flashes while a self-test is conducted. At the successful conclusion of the self-test the outer segments of the Level Display will light in a clockwise rotation for 30 seconds while the instrument measures the ambient gamma radiation background. After the background radiation level has been measured, the Radiation Pager calculates and briefly displays the alarm threshold value. The instrument is now ready for use. The Radiation Pager is now measuring ambient gamma radiation and will alarm if the detected radiation exceeds the alarm threshold.

When the Radiation Pager alarms, it flashes the Indicator LED and either vibrates or sounds an audible tone, depending on the setting of the Mode Switch. The instrument will alarm for 14 seconds unless the Display Button is pressed to acknowledge the alert. Once the alarm has timed out or been acknowledged, the device enters a (silent) search mode, as described in the following paragraph. Future alarms will not occur until radiation levels fall below the preset alarm threshold level.

At any time, the Radiation Pager may be used to search for radioactive material by pressing and holding the Display Button. Depressing the Display Button causes the Indicator LED to flash at a duty-cycle proportional to the level of gamma radiation detected. At low radiation levels the Indicator LED will flash green after every 16 radiation counts. If the detected radiation increases to the point that the alarm threshold is exceeded, the Indicator LED will flash yellow. If the Mode Switch is set to enable audio, a short tone will also be emitted each time the Indicator LED flashes. At higher radiation levels the Indicator LED will appear to stay on continuously. While the Display Button is depressed, the Level Display will also be activated, and the detected radiation will be represented here numerically.

The Level Display provides an indication of the relative intensity of the detected radiation on a scale of zero through nine. Each number indicates a radiation intensity of roughly twice the previous value (i.e. a level 4 is about twice the radiation intensity of a level 3).

Table 2 shows the Level Display values and their corresponding exposure rates in microroentgen per hour (µR/h). Above the exposure rates shown here, the unit will continue to display a 9.

Table 2: Exposure Rate Table

Level	Exposure Rate[1] µR/h at Cs-137 (662keV)
1	10
2	25
3	60
4	140
5	300
6	600
7	1,400
8	3,000
9	6,000 +

At approximately 6,000 µR/hr the Indicator LED will be illuminated red, which indicates that the device is reading gamma radiation above it's normal operating range and that radiation levels may have reached a level hazardous to the operator.

3 BLUETOOTH

The Radiation Pager is equipped with a Bluetooth communications capability which enables it to stream sensor data to a mobile device in real time. This capability is primarily intended for use with the DHS Securing the Cities mobility platform[2], however a mobile application for Android devices is also available directly from Sensor Technology Engineering. The 'STE' application can be downloaded for free from the Google Play store (https://tinyurl.com/y6y65olh).

Each time that the Radiation Pager is turned on, Bluetooth communications are enabled and the device is available for pairing for two minutes. This state is accompanied by the Indicator LED flashing blue. If a mobile device is successfully paired to the Radiation Pager during this period, Bluetooth will remain active and the instrument will begin to stream sensor data. While this connection is active, the Indicator LED will periodically double-flash blue.

If the Bluetooth link is disrupted, the Indicator LED will cease double-flashing blue, and will resume single-flashing blue. The user will have two minutes to re-establish the Bluetooth connection from the mobile device. After two minutes the Radiation Pager's Bluetooth communications will be disabled for security purposes, and even though the Indicator LED will continue to single-flash blue, the PRD will need to be reset in order to re-enable Bluetooth pairing.

[1] Exposure rates listed here are indicative of the average rate represented by level reading shown.
[2] Available only directly from the Department of Homeland Security

In order to pair the Radiation Pager to the STE or DHS mobile applications, follow these steps:

1) Start with the Radiation Pager off, and the mobile device's Bluetooth on;
2) Open the 'STE' application on the Android mobile device;
3) Turn on the Radiation Pager;
4) In the application, select 'STE Radiation Pager' from the list of devices; and
5) In the application, select the device to pair with.

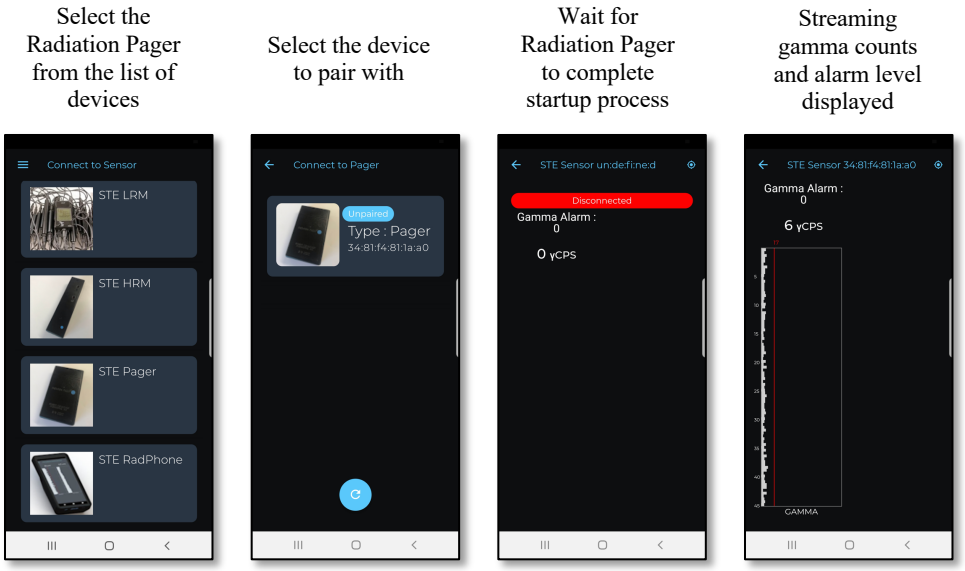

Figure 3: Pairing with the STE Mobile App

If the pairing is successful, a new window will open with an orange header which reads 'Connecting. Once the Radiation Pager completes its startup process, this header will turn blue and will read 'Connected'. At this point you should see live streaming gamma data displayed on the screen.

4 BATTERIES

The Radiation Pager uses one AA Lithium (Li-FeS2) battery. In routine operation with few alarms and low Bluetooth usage, one such battery will power the unit continuously for 3,500 hours.

A low battery condition is indicated when the Level Display briefly flashes an 'L' every 20 seconds. This indication will be accompanied by a brief 'chirp' when the instrument is in audible alarm mode.

To change the battery on the Radiation Pager, remove the battery cover using a coin as a tool. The old battery can then be removed, and a new AA Lithium battery can be installed. Care should be taken to ensure that the new battery is installed in the correct orientation (positive terminal first – see Figure 4). Ensure that the battery cover O-ring and the mating surface on the Radiation Pager enclosure are clean, insert the battery cover, and use a coin as a tool to screw it in place – do not overtighten.

NOTE:

Alkaline batteries should not be used in the Radiation Pager due to the risk of leakage over long periods of time. Alkaline battery leakage has historically been a leading cause of Radiation Pager failure, and damage from the use of Alkaline batteries is not covered by the Radiation Pager limited warranty.

Figure 4: Unscrewing (left) and Removing the Battery Cover (center), and Replacing the Battery (right)

5 MAINTENANCE AND CALIBRATION

The Radiation Pager does not require periodic maintenance or factory calibration. It is good practice, however, to occasionally verify the functionality of the instrument against a small, low energy gamma check source. The preferred source is one µCi of Americium (Am-241). This source will be detectable at about three inches from the sensor. The alarm level will be in the range of 3-6 when the instrument is placed in contact with the check source.

If the Radiation Pager doesn't power up, shows a solid middle element on the Level Display, or false alarms frequently, then it needs to be sent back to Sensor Technology Engineering for service.

WARNING - HIGH VOLTAGE:

Do not open the Radiation Pager enclosure - there are no user serviceable parts inside.

6 REFERENCE

Tables 3 and 4, below provide a quick guide as to the various Radiation Pager states and indications.

Table 3: Radiation Pager Indicator LED States

Indication	Color	Description	Explanation
	Blue	Flashing (Single)	Bluetooth communications ready to pair
		Flashing (Double)	Bluetooth is paired
	Green	Flashing (With Display Button Pressed)	Relative indication of gamma radiation level, below alarm threshold
	Yellow	Flashing (With Display Button Pressed)	Relative indication of gamma radiation level, above alarm threshold
		Flashing with Audible or Vibration Alarm	Alarm. Indicates that a gamma radiation source is present.
	Red	Solid, Accompanied by a '9' on the Level Display	Over-range indication. Indicates a gamma radiation exposure rate of 6,000 µR/hr or greater. Follow departmental procedures for operating in elevated gamma radiation environments.

Table 4: Radiation Pager Level Display States

Indication	Description	Explanation	Action
	Rotating	Measuring radiation and calculating background level	None
	Flashing	Power up system tests being performed	None
	Solid[3]	System tests failed	Try replacing the battery; if that fails, return the unit for factory service
	Flashing (Every 20 Seconds)	Low battery	Replace the battery
	Solid	Indication of the relative gamma radiation level	Locate the radiation source

[3] The middle element of the Level Display will be briefly illuminated solid at the completion of a successful self-test. This should not be cause for concern. If the unit fails self-test, the middle element will be displayed solid indefinitely.