

Portable Contamination Analyser Gamma Eye - Bucket Monitor

User Manual



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1 VERSION HISTORY

Issue	Date	Author	Changes
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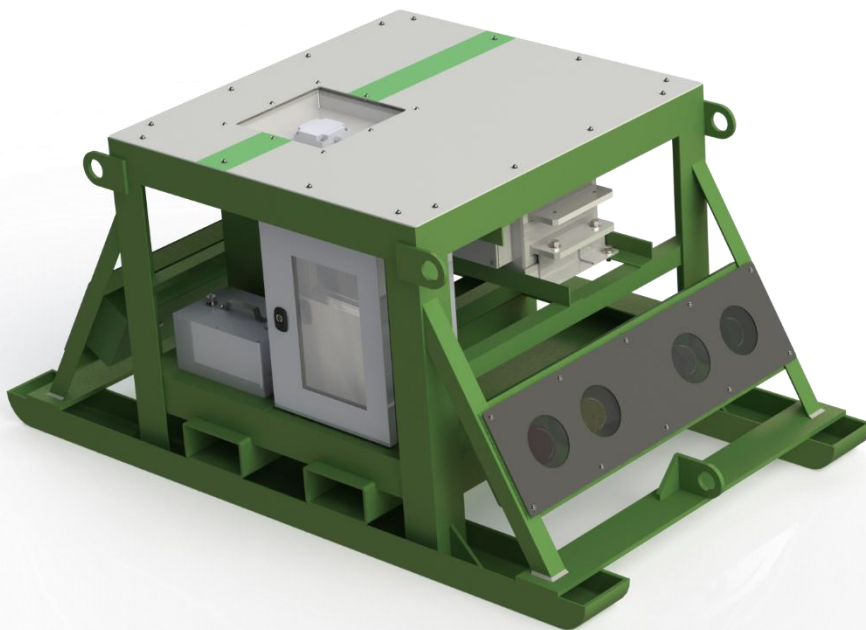
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The GammaEye Bucket Monitor provides a quick assessment of the bulk gamma contamination of excavated material within the bucket of a mechanical digger. This instrument contains a large scintillation crystal which is mounted within a substantial frame. The sensor is pre-calibrated for the contamination isotope of interest and can be set to alarm for discrete activity bands.

The driver of the mechanical digger rests the bucket containing the excavated material on the frame (or hovers the bucket just above it) and after a few seconds it provides him with a visual indication of the level of gamma contamination in the bucket by means of indicator lamps, which can be seen without needing to leave the cab of the digger. This indication is provided by a traffic light system – red, amber and green denoting the band within which the gamma contamination occurs.

On the basis of this information, the driver deposits the load in the appropriate place for subsequent disposal or processing. During operation no personnel are required to take meter readings, which is a key safety feature.

Once calibrated the “Bucket Monitor” is very simple and rapid to use. No specialist nucleonic knowledge is required by the operator. The driver simply observes and acts upon the traffic light indications. He does not even need to activate the counting process as the instrument automatically senses when the bucket is correctly positioned.



Features:

- Easily calibrated for a range of gamma contaminants
- User selectable alarm levels
- Automated initiation of counting
- Simple traffic light system to indicate alarm level reached
- Safe operation as no personnel need to be close to take meter readings
- Log of measurements maintained which can be downloaded to a PC

- No moving parts
- 24 hour battery operation, powered by rechargeable sealed lead acid battery units
- Easy to transport around site

Benefits:

- Quick & easy assessment of gamma contaminated material
- Fast throughput (one tonne per minute)
- Reduced measurement time leading to reduced time on site
- Reduced reclamation costs

This user guide explains the operation, maintenance and configuration of the system.

2.1 MANUAL FORMAT

The manual is broken into 4 sections that covers all aspects of operation of the system.

Part 1 is this introduction to the manual

Part 2 describes the GammaEye bucket monitor and describes the components that make up the systems

Part 3 describes the standard operation of the GammaEye

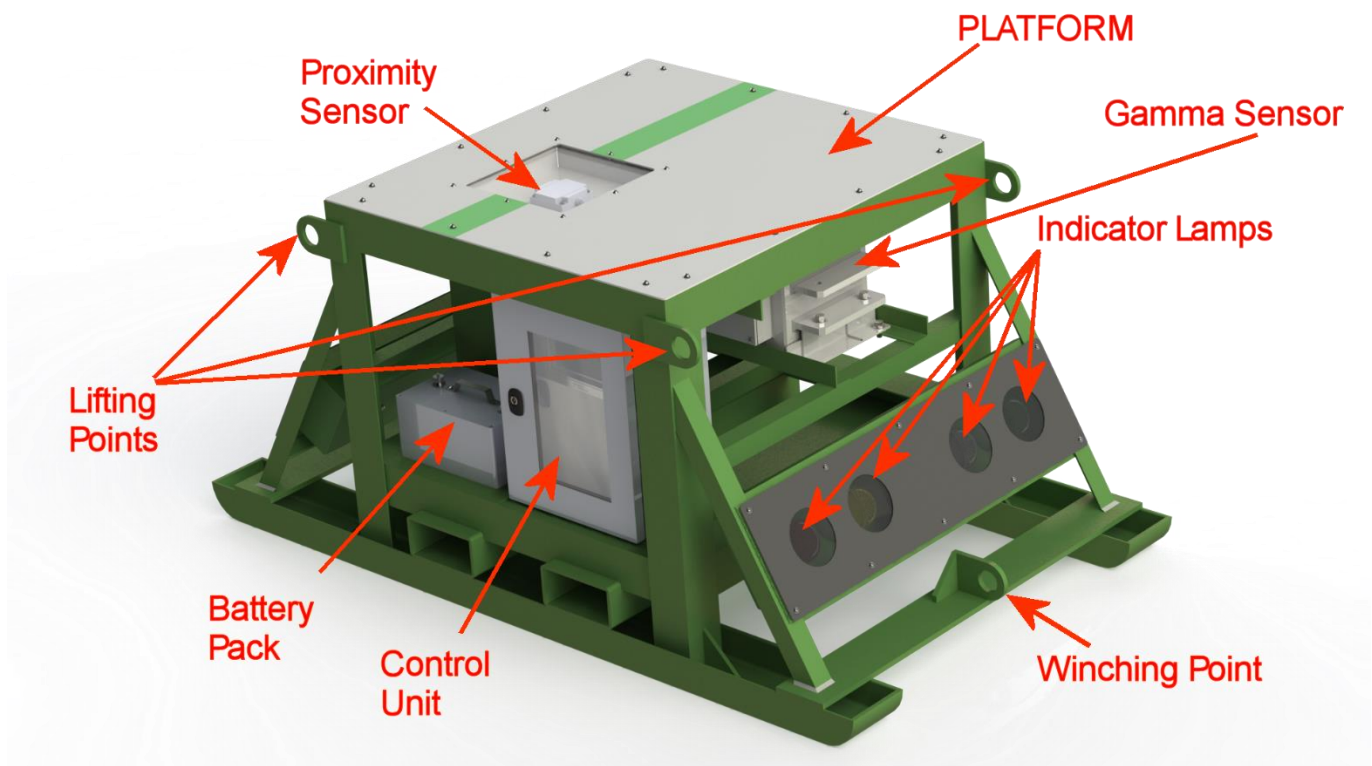
Part 4 describes the operation of the control unit display panel

3 SYSTEM DESCRIPTION

This section of the manual describes the individual components of the GammaEye.

3.1 OVERVIEW

The GammaEye system consists of a platform on which the bucket of a mechanical digger can be placed (or hovered just above). There is a scintillation crystal situated under the platform that will detect the gamma radiation being emitted from the material within the bucket. Although most things emit some amount of gamma radiation, the type of contaminated material to be detected emits significantly higher levels of this type of radiation, whereby the system can distinguish between the typical background radiation and that of sufficiently contaminated material.



A proximity sensor within the platform is used to detect when the bucket is in place and start the sampling operation.

The amount of radiation detected is proportional to the amount of contamination within the material. The system is calibrated to determine how much contamination is allowed before the user is alerted that the material is over level or optionally, is suspect but not quite over-level.

The bucket has to remain on the platform for a fixed period of time to give the system time to analyse the sample being presented.

A series of lamps are used to indicate the result of each tested sample and also any errors that may occur. Typically, a white/clear lamp is used to indicate that the unit is in the process of testing the sample and a green, amber or red lamp is used to indicate the result as either low, medium or high contamination respectively.

The system is powered by a 12Volt lead acid battery that can be removed from the frame and charged externally.

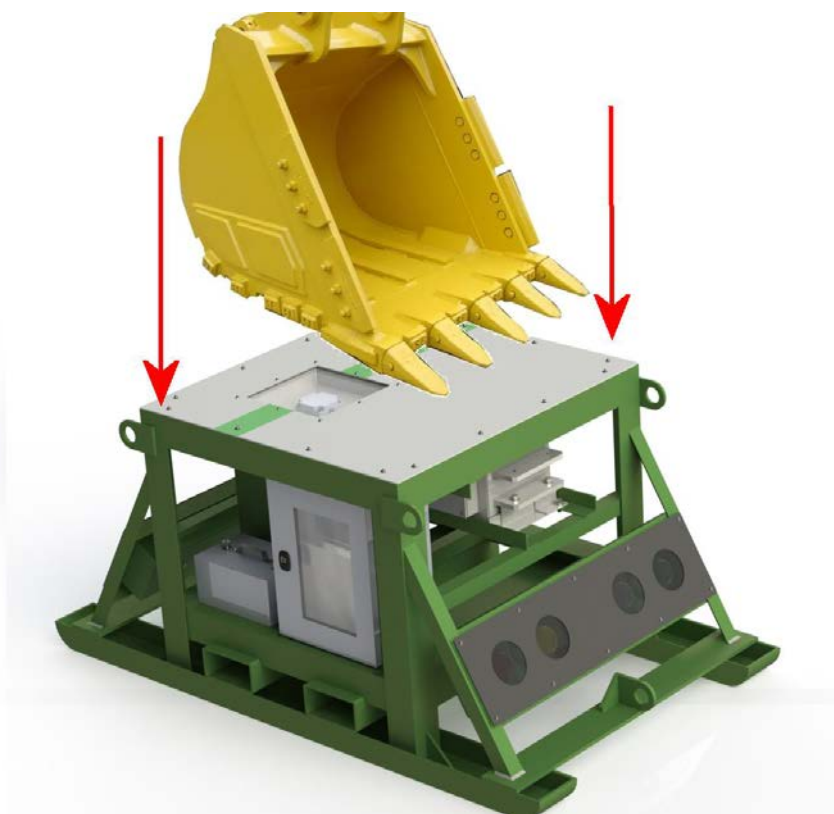
A Control Unit with a colour touch-screen display is situated within the framework which allows the unit to be configured and data to be displayed and downloaded to a memory stick.

The framework features a number of lifting and winching points to allow the unit to be moved using a crane, forklift truck, hoist or other suitable lifting equipment.

3.2 PLATFORM

The platform on which the bucket is placed (or is positioned just above), rests atop a framework designed to take the punishment of a mechanical digger's bucket being repeatedly placed upon it. A clear window is located within the platform area, under which is the proximity sensor. This detects the presence of the bucket and triggers the sampling operation. To one side of the platform frame is the gamma sensor, which detects the gamma radiation being emitted from the material within the bucket.

A green stripe runs across the platform. The bucket should be positioned in line with this stripe as far as possible as this constitutes the best position for the bucket with respect to both the proximity sensor and the gamma radiation detector/sensor.



Indication lamps are located at either end of the frame, four at each side, which are used to show the progress of the operation as well as the final test result or any errors. The next section describes the meaning of the indications depicted by the lamps.

3.3 INDICATION LAMPS

The table below shows the usual meaning of each individual lamp. The lamps can also be used together to indicate errors or fault conditions. Such indications are described in a later table.

As a general rule, indications made by a single lamp (flashing or permanently on) or by all lamps permanently on, indicate an operation starting or in progress or the result of an operation. Indications made by all lamps or pairs of lamps flashing indicates a fault or error condition. The exception to this is when the Test sequence is invoked when the unit is powered on or when it is invoked by the user from the Control Unit display. This test sequence involves a lamp test where the lamps are all lit in a particular sequence. This is described later in this section.

There are four lamps on each side of the platform so the indication can be seen from both directions. The individual coloured lamps are wired in pairs so one side will always mimic the other side. The description of the lamp meanings is based on one side of the frame, i.e. a single set of four colours (red, amber, green and white/clear).

When the bucket is detected by the platform at the start of a sampling operation, all lamps will be turned on for 5 seconds (this time period is configurable) to allow the operator time to position the bucket correctly. After this period, the analysis operation commences and the lights should follow the sequence below.

Lamp Colour	State	Standard Meaning
All lamps	All on	When all lamps are on, this indicates that a bucket has been detected being on or near the platform by the proximity sensor. The lamps will stay on for 5 seconds (user configurable) whilst the digger operator has chance to position the bucket, at which point all lamps will be extinguished and the sampling operation started (as shown by the white/clear lamp flashing as described below).
White/Clear	Flashing	When flashing at a rate of once a second, this indicates that the system is analysing the material within a bucket placed on the platform. This lamp will be turned off once the analysis has been completed.
Red	On	Indicates that the detected level of radiation is above the high level threshold indicating contaminated material (termed HIGH level in the data log).
Amber	On	Indicates that the detected level of radiation is below the high level threshold but above a lower threshold (if set) indicating possibly contaminated material (termed MEDIUM level in the data log).
Green	On	Indicates that the detected level of radiation is below all thresholds indicating material with an acceptable level of contamination (termed LOW level in the data log).

When indicating results, the red, amber or green lamps will remain lit until the bucket is removed or for 15 seconds if the bucket is removed before this time (the actual time period is user configurable).

Different sequences of combinations of lamps can indicate different error conditions or other situations. These are described in the table below:

Lamp Colour	State	Meaning
Red/Amber and Green/White	Flashing in alternate pairs for 5 seconds	This will occur when the bucket is first placed on the platform. It indicates that the battery is getting low and must be charged up as soon as possible. The sampling operation will continue afterwards as normal (as long as there is sufficient power remaining to complete the operation).
All lamps	Flashing for 5 seconds	The bucket has been removed from the platform during a sampling operation before the sampling period has completed. In this case a result cannot be indicated for the sample as the analysis will not have had time to complete. OR If the bucket is still in position, this indicates that the sensor is not reporting any readings and may be faulty or disconnected.

When the unit is first powered on, or when the **Test** button on the Control Unit front panel is pressed, the system will perform a self-test which light the lamps in the sequence below so the operator can see that all lamps are working correctly.

Step	Lamp States	Time (seconds)
1	All lamps turned on	2
2	All lamps off	2
3	White/Clear lamp on	1
4	Green lamp on	1
5	Amber lamp on	1
6	Red lamp on	1
7	All lamps off	1
8	All lamps on	2
9	All lights off	

3.4 CONTROL UNIT

The Control Unit is located in a cabinet within the frame under the platform. This is the heart of the system which controls the lanterns, monitors the radiation detected and determines the state of each analysed sample.

The Control Unit has an outer door which opens to reveal a touch-screen display panel user interface and a USB socket for transferring data to a memory stick. The inner door can be opened to access the circuit board of the Control Unit. This would normally only be accessed for repairs or to access the internal memory of the Control Unit via a type B USB jack (readings can be archived to internal memory and this can be used to retrieve such data).

The touch-screen display panel shows the status of the system and any samples currently being analysed and it can also show the results of previous tests.

During normal operation, the control panel does not need to be accessed as all the relevant analysis information is indicated to the operator through the external lamps, such that the operator does not need to leave the cab of their mechanical digger.

The Control Unit also provides the user interface for setting up the system in terms of threshold levels to determine high, low or medium contamination status of samples, the amount of time to analyse a sample before determining its state and various other parameters. Parameters can be password protected to prevent unauthorised or accidental setting.

Section 4 of this manual gives detailed information on the use of the Control Unit.

3.5 BATTERY

The system is powered by a deep cycle 12 Volt 12 Ah sealed lead acid battery. The battery is mounted in its own case by the side of the control panel and can be removed for charging. The pack connects to the control panel by means of a 2 pin LEMO connector.



The battery pack contains a power switch under a protective case. When the pack is connected to the GammaEye Control Unit, this switch acts as the On/Off switch for the system.

The battery pack also features an internal 2A fuse to protect the battery in the event of a cable fault.

A 3 stage charger is supplied to allow charging of the battery from any 50Hz/60Hz, 115V/230V AC mains supply.

PLEASE NOTE: When charging the battery, the power switch MUST be in the ON position.

3.6 SENSOR

The actual radiation detection sensor is situated under one side of the platform. It is surrounded by shielding to minimise the reading of natural background radiation so that it is principally detecting radiation from where the bucket should be located on top of the platform.

The sensor is a scintillation crystal tuned to be particularly sensitive to the typical isotopes likely to be found in contaminated material.

The gamma radiation emitted by the material causes photons of light to be generated. The photo-coupler circuitry connected to the crystal detects the photons and converts them to electrical pulses which vary in frequency according to the number of photons being generated and hence the level of radiation being detected. The system analyses a sample by counting the number of pulses each second and then taking the average of all the “counts per second” (CPS) over the entire sampling period (which is user configurable but is typically set to 60 seconds). The nature of radiation is such that the CPS each second will vary quite widely, but when averaged over time will yield a much more representative CPS. Taking an instantaneous CPS or one averaged over a short period of time is statistically unlikely to give an accurate reading. The longer the sampling time, the greater the level of accuracy.

The greater the resultant average CPS, the greater the level of gamma radiation and therefore contamination detected.

It should be borne in mind that all materials emit a certain amount of natural gamma radiation, but the system is designed to distinguish between the typical background radiation and the higher levels emitted by contaminated material.

3.7 OPERATOR'S MANUALS

This manual is provided on a CD and additionally a copy is included on a memory stick provided as part of the equipment. This is supplied specifically for transferring data from the Control Unit to another computer or device.

4 OPERATION

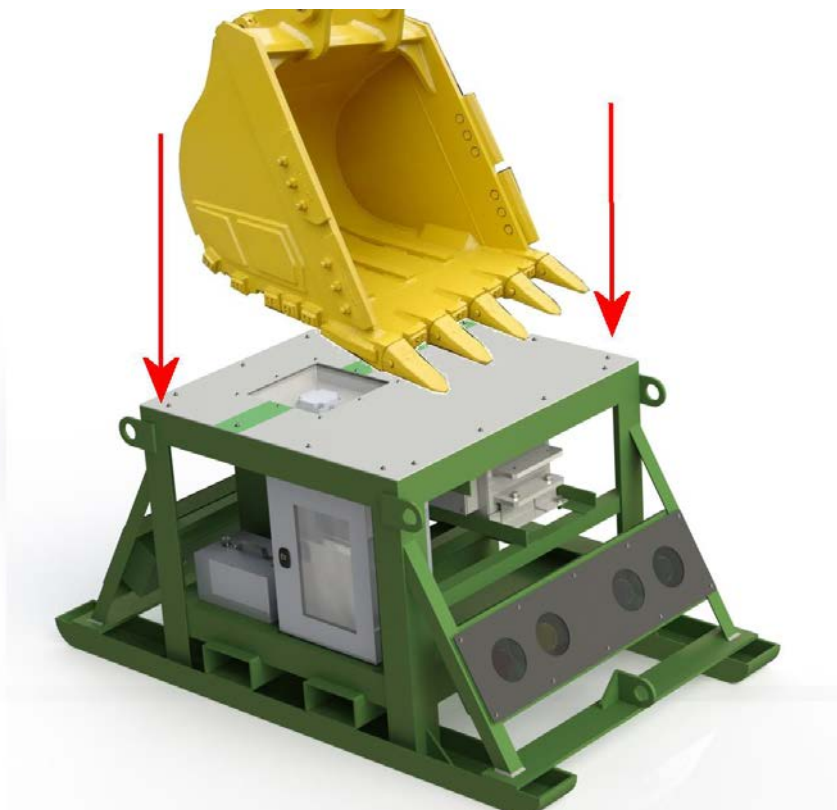
To start using the GammaEye, the unit should be moved to a suitable location where a mechanical digger can easily access the frame's platform with its bucket.

The battery pack should already be sited within the frame and connected to the main Control Unit. Turn the rocker switch on the battery pack to the ON position. This will power up the system and the indicator lamps should go through a test sequence to verify that they're operating correctly. Once the sequence has been completed and the lamps have been extinguished, the system is ready for use. The actual sequence of events is described in section 3.3 *Indication Lamps*.

4.1 PLACING THE BUCKET

The bucket of the mechanical digger should be filled with the material to be tested and the bucket positioned in line with the green stripe across the top of the GammaEye platform, such that it rests or hovers just above on the platform.

This green line indicates the position best suited to the bucket being detected by the proximity sensor (which is located under the clear panel) and for the contamination in the material within the bucket to be measured by the gamma radiation detector (situated to the side of the proximity sensor). The bucket needs to be less than 6cm above the proximity sensor in order to be detected.



Once the bucket is near to the platform, the system will detect its presence automatically and all the lamps will be turned on for 5 seconds (this period is user configurable) to indicate that the bucket has been detected. The 5 seconds gives the operator time to manoeuvre the bucket precisely before the sampling and analysis starts. Once

the lights are extinguished, the actual analysis starts. The bucket should be left in position until a result is indicated after the analysis has completed.

4.2 SAMPLING/ANALYSIS

Once the system has given enough time for the bucket to be positioned correctly, the system starts to analyse the sample in the bucket. During this process the clear/white lamp will be flashed once a second to indicate analysis in operation.

The analysis will take place over a fixed period of time (which can be set from the Control Unit), typically 60 seconds. The bucket must remain in place during this period or the analysis will be aborted and no result displayed.

When the analysis period is complete the result is shown to the operator by means of the Green, Amber or Red lamps. Only one lamp will be displayed to indicate the result.

Lamp Colour	Meaning
Green	The sample is deemed to be LOW , meaning that the detected contamination was below the lowest threshold
Amber	The sample is deemed to be MEDIUM , meaning that the detected contamination was above the lowest threshold, but below the highest threshold.
Red	The sample is deemed to be HIGH , meaning that the detected contamination was above the highest threshold.

4.3 ERROR AND FAULT INDICATIONS

If the analysis failed to complete, the operator will be notified by indications made by the lamps. Errors and faults are always indicated by means of all four lamps.

Error indications from the lamps will only be shown when the bucket has been placed on the platform or has just been removed. The errors/faults that can be detected are:

Lamp Colour	State	Meaning
Red/Amber and Green/White	Flashing in alternate pairs for 5 seconds	This will occur when the bucket is first placed on the platform. It indicates that the battery is getting low and must be charged up as soon as possible. The sampling operation will continue afterwards as normal (as long as there is sufficient power remaining to complete the operation).
All lamps	Flashing for 5 seconds	The bucket has been removed from the platform during a sampling operation before the sampling period has completed. In this case a result cannot be indicated for the sample as the analysis will not have had time to complete.

		<p>OR</p> <p>If the bucket is still in position, this indicates that the sensor is not reporting any readings and may be faulty or disconnected.</p>
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5 CONTROL UNIT OPERATION

5.1 OVERVIEW

The Control Unit lies at the heart of the system. It processes the readings from the sensor and provides the analysis of the data. It also controls the indicator lamps and monitors for the presence of a bucket.

It includes a touch panel colour screen (800 x 480 pixels) which is used to show system status, allow configuration of various system parameters and to view and extract analysed data.

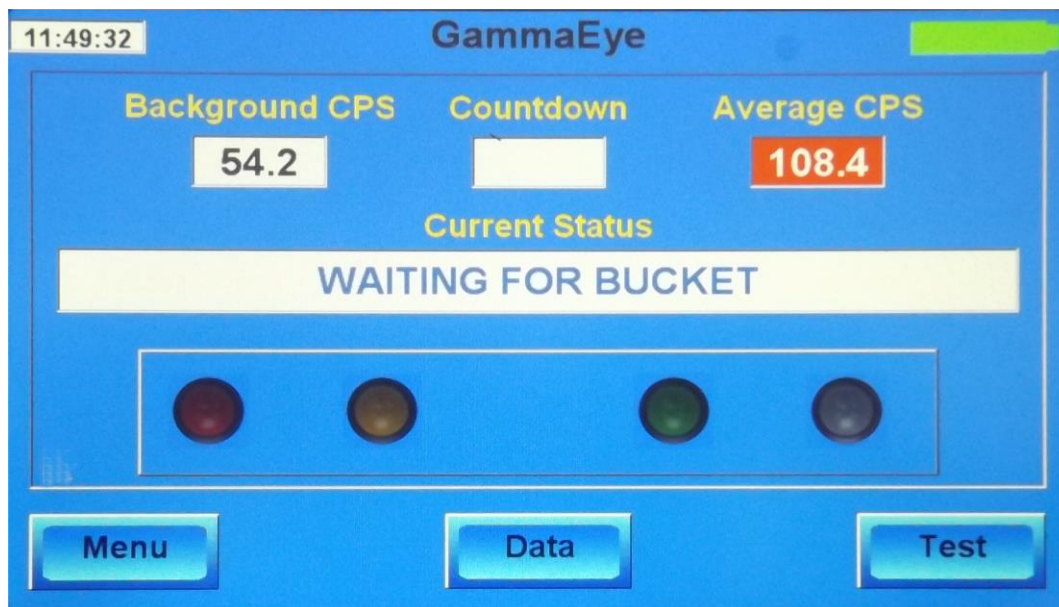
The touch-screen user interface is located behind an outer door, which requires a removable handle to open. This handle should always be removed when the control panel is not being used in order to prevent unauthorised access (although a password can be set to prevent unauthorised personnel from changing any parameters) and also because the handle is likely to be shaken off during operation or when being transported.

The screen display also has a timeout facility which turns the screen off when not in use. This helps conserve battery life. Simply pressing any area of the screen will cause the display to turn back on.

When the battery pack power switch is connected to the control panel and the power switch first turned on, the control panel screen will display the initialisation screen, where the unit serial number and software version are displayed (this can also be determined from the About screen display – see later in this chapter).

5.1.1 HOME SCREEN DISPLAY

The main screen of the unit shows the current status of the system, including the state of the external lamp indicators, the operational status (e.g. Waiting For Bucket, Analysing Bucket Load, Analysis Complete, etc.), the ambient background CPS (Counts Per Second), the average CPS of the last sampling operation and, during an analysis operation, the current and average CPS (for the sample being analysed) from the sensor.





This screen also provides access to the other functions within the software.

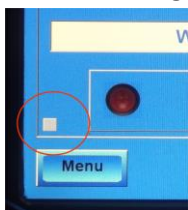
The components of the main screen are:

- **Current Status** – This text display field shows the current status of the system, i.e. the state of an analysis operation of the fact that the system is waiting for an operation to take place.
Messages that can be displayed are:
 - **WAITING FOR BUCKET** – Indicates that the system is awaiting a bucket to be analysed
 - **BUCKET DETECTED- WAITING TO SETTLE** – A bucket has been placed on the GammaEye platform and the system is waiting for a period of 5 seconds (user configurable) to give the operator time to position the bucket correctly
 - **ANALYSING BUCKET LOAD** – Indicates that the sampling operation is in progress and the material in the bucket is being analysed
 - **ANALYSIS COMPLETE** – Indicates that the analysis of the bucket has completed and a result is being displayed by means of the external lamps and also the lamp mimic panel below the status display. This message remains on screen until the bucket is removed (or for a user configurable period of time if the bucket is removed too quickly)
 - **ANALYSIS INCOMPLETE - BUCKET MOVED** – This indicates that the bucket was removed from the platform before the analysis was complete. This message will be displayed for 5 seconds
 - **ANALYSIS INCOMPLETE - SENSOR FAULTY** – This is shown if the Control Unit is not able to detect the presence of the sensor. This may be because the sensor is faulty or has been disconnected. This message will be displayed for 5 seconds

- **Background CPS/ Current CPS** – The contents of this field change depending upon whether an analysis is in progress or not.
When no analysis operation is in progress, it shows the average background radiation as a **Counts Per Second (CPS)** figure. The value is actually averaged out over each minute and updated at the end of each averaging period.
When an analysis operation in progress (or the test sequence has been invoked), it shows the current CPS figure from the sensor and is updated each second.

In the event of an error, e.g. the sensor is faulty or disconnected, the figure will be shown with a red background to denote this.

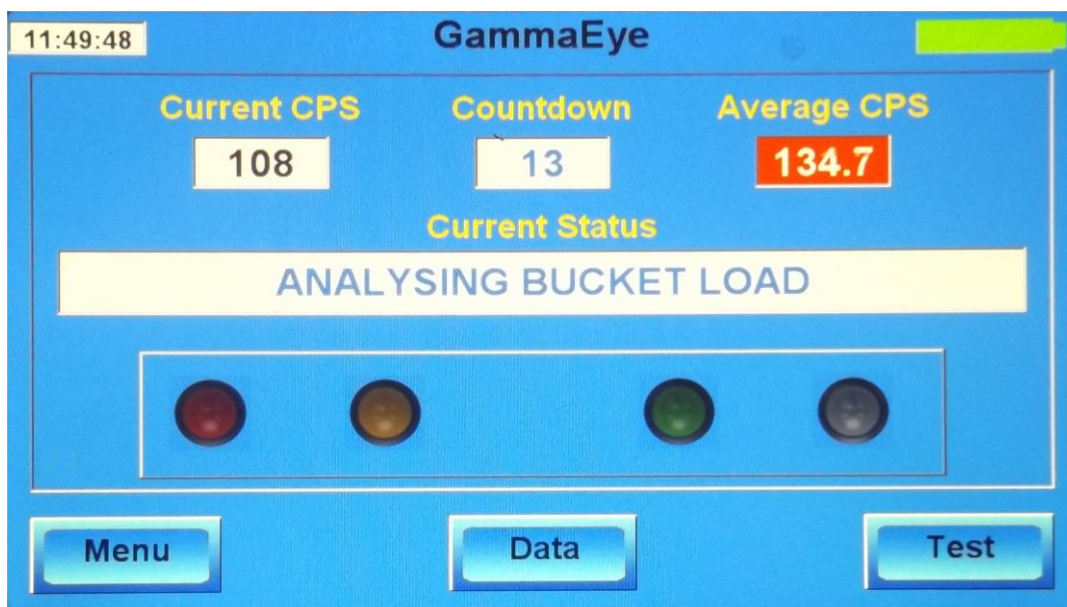
- **Countdown** – During an analysis operation, this display shows the number of seconds remaining until the analysis is complete and a result is displayed.
- **Average CPS** – This shows the average **Counts Per Second (CPS)** of the current analysis operation if one is taking place, or the final average CPS of the last analysis to be carried out if the system is idle. The average is based upon all of the second by second CPS readings taking during the analysis/sampling period.
NOTE: This is a gross CPS figure, i.e. the average total number of counts per second produced by the sensor, which will include the background CPS count at the time of reading
The background colour of this display indicator indicates whether the average calculated so far is HIGH (red background), MEDIUM (amber background) or LOW (green background).
When analysis is complete, the last recorded result remains displayed until a new operation is carried out (or the unit is reset).
- **Lamp Mimic Panel** – This panel shows a mimic of the red, amber, green and clear/white indicator lamps on the sides of the frame.
- **Menu Button** – The menu button gives access to the program’s configuration facilities, including the setting of the various timers (sampling/analysis period, bucket settling period, etc.), CPS thresholds, password protection and power saving parameters.
- **Data Button** – This function displays the list of all the stored results of analysis operations and allows exporting of this data in a spreadsheet format to an external memory stick (or to internal memory).
- **Test Button** – This function invokes the system’s self-test mechanism, which is used to ensure that the sensor and external lamps are all operating correctly
- **Battery Status Indicator** – The battery status indicator shows when the battery is low and needs recharging. It is depicted as a green battery shaped indicator in the top right corner of the screen normally 
If the battery voltage drops below 9Volts, then the indicator will be shown in red with the text **LOW** displayed within the icon to indicate that the battery should be charged as soon as possible 
- **Time Display** – The current time is shown in a small panel in the top left corner of the screen.
- **Test Checkbox** (optional) – For test and demonstration purposes, a tiny “check-box” can be displayed at the bottom left corner of the main status panel. This is selected as an option in the Settings menu. If displayed, then the user can use it to simulate the presence of a bucket and thereby initiate analysis operations to test the functionality without requiring a mechanical digger to be present. The state of the check-box (solid green or grey colour) indicates whether a simulated bucket is present or not, with solid green indicating a virtual bucket is being simulated. The state of the check-box is toggled by pressing it.



Note: During analysis, much of the processing power is dedicated to the sampling operation and display of indicators, so this checkbox may not always be monitored and the user may need to press the check-box several times to toggle its state.

5.1.1.1 Home Screen During a Sampling Operation

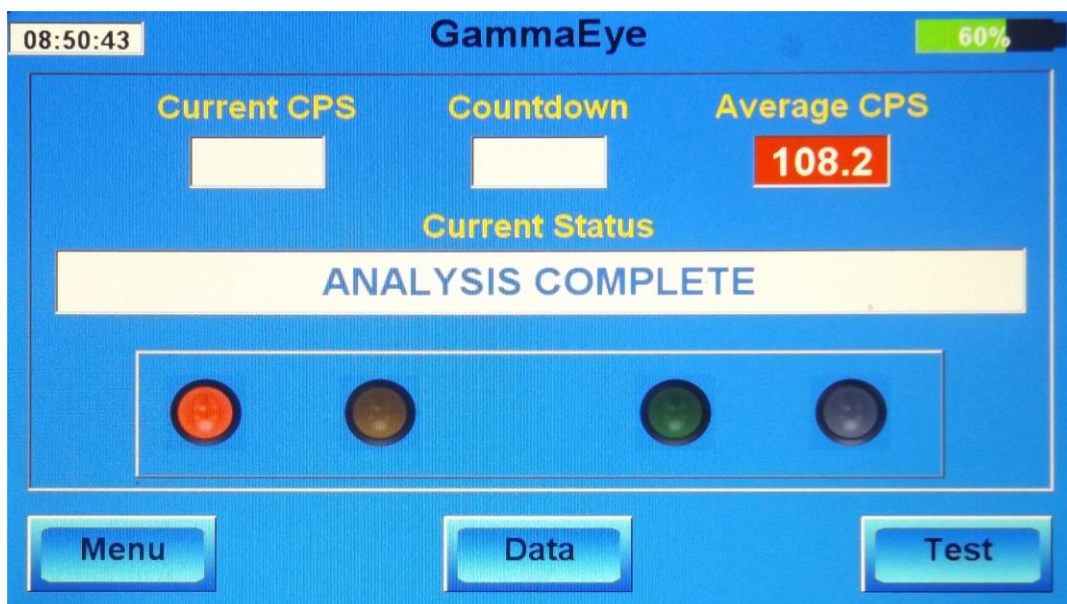
When a sampling/analysis operations in in progress, the screen shows the status of the operation by means of the lamp mimic panel as well as the status text display and the current and average counts-per-second (CPS) figures.



The **Average CPS** field will show the current calculated average with a colour background to indicate whether the average is deemed HIGH (red), MEDIUM (amber) or LOW (green).

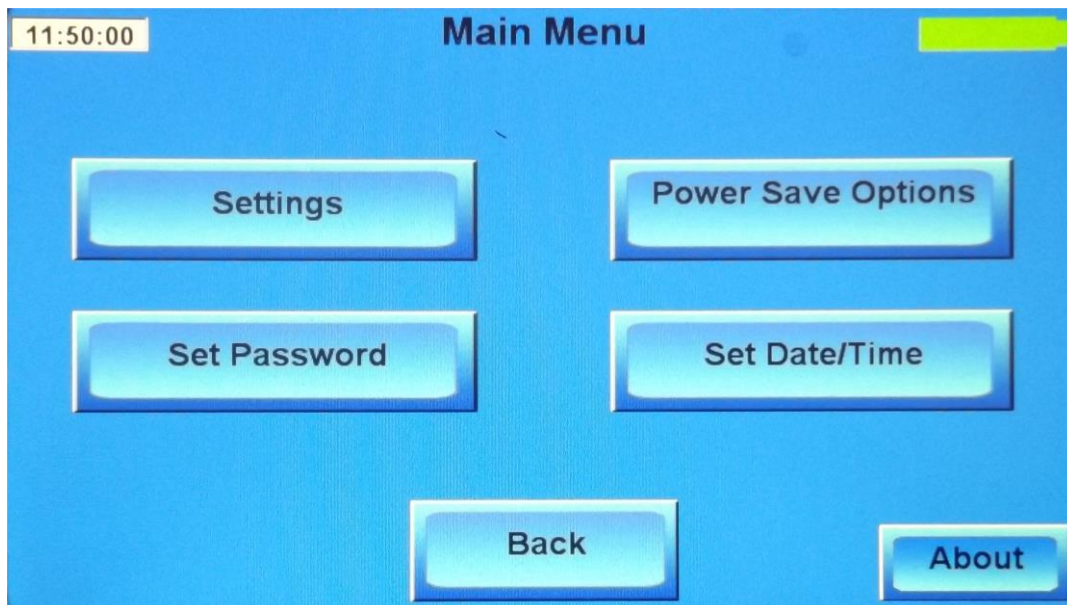
When the operation is complete, the display will indicate the result by lighting the red, amber or green lamp mimic according to the result.

The display remains in this state until the bucket is moved away, at which point the lamps will be extinguished, but the **Average CPS** field will continue to show the result of the last operation until a new analysis is started.



5.1.2 MENU

This button is used to access the program and system configuration facilities. It displays a page with more buttons to access the individual functions (**Settings**, **Set Password**, **Power Save Settings**, **Set Date/Time** and **About**).



Pressing the **Back** button returns to the main screen display

Many functions can be optionally protected by a password to prevent unauthorised changes. If such as password has been set, then when the user presses one of the protected parameter function buttons, the password access screen is first displayed and they must enter the correct password and press the **OK** button to gain access to the desired function.

5.1.3 DATA

The **Data** function allows the log of previously analysed samples to be viewed and optionally, exported or cleared.

For every sample analysed, a log is created which contains the date/time on which the sample was analysed (time stamped at the point the result was reported to the operator), the average counts-per-second recorded for the sample (gross CPS), the overall test result; HIGH, MEDIUM or LOW and also the last background CPS figure recorded prior to the sample being taken (subtracting the background CPS from the average CPS for the sample gives the net CPS for that sample). In addition, each log is assigned a unique ID to identify it.

ID	Date/Time	Average CPS	Result	Background CPS
6	11-Feb-15 11:03	61.5	Medium	51.7
7	11-Feb-15 11:04	59.3	Low	51.7
8	11-Feb-15 11:11	97.9	Medium	54.6
9	11-Feb-15 11:12	113.4	High	54.6
10	11-Feb-15 11:22	125.0	High	108.5
11	12-Feb-15 09:14	109.9	High	53.7
12	12-Feb-15 10:18	108.3	High	0.0
13	12-Feb-15 14:20	108.3	High	51.0
14	12-Feb-15 14:20	108.4	High	51.0
15	18-Feb-15 11:37	131.4	High	77.8

The display shows the list of all logs recorded by the system. The scroll bar Up and Down buttons at side of the display panel are used to move to the previous or next page of logs should there be too many to fit on one screen.

5.1.3.1 Export

The **Export** function is used to take a copy of the logs and store them to a memory stick for offline viewing or to internal memory for archiving purposes.

The format of the output file is **CSV** (comma separated values) format, which is a basic spreadsheet/database format file that can be read by almost all spreadsheet or database packages, including Microsoft Excel and Microsoft Access.

The user should selected a file name in the appropriate field. It is highly recommend that the file name is given an extension of **.CSV** (e.g. LOGS.CSV) so that when the file is read by offline applications, they can automatically detect and load the file correctly.

The user then needs to choose whether to save the file to a Memory Stick or to Internal Memory. Pressing the box next to each choice selects that choice, indicated by the box being coloured green.

When **Memory Stick** is selected, the user needs to insert a suitable device into the USB port on the front panel before pressing the **Save** button.

When selecting **Internal Disk**, the file will be stored on the internal flash memory of the control panel. This can be useful to archive samples before clearing the data from the system.

Pressing **Save** will write the data to the desired location.

APPENDIX A: SPECIFICATIONS

Weight	<500 kg
Dimensions	71 cm (h) x 84 cm (w) x 156 cm (d)
Operating Temperature	-20°C to +55°C
Battery	12Volt, 12 Ah sealed lead acid
Battery Charger	3 Stage Lead Acid Battery Charger
Output voltage & Charge Current	12v @ 2A
Input Voltage	Input Voltage: 100 → 240Vac, 50Hz-60HZ
Control Unit	
Processor	32 bit 72MHz ARM Cortex-M3
Memory	8MB Flash, 2MB SRAM
Touch Screen Display	7" TFT, 800 x 480 pixels, 65K colours
Gamma Radiation Detection Sensor	76mm x 152mm Sodium Iodide Crystal
Proximity Sensor Type	Induction
Detection Distance	50mm above platform (60mm from sensor surface)

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