



# Conveyor Belt Ash & CV Instrument Analyser - Heat Eye

User Manual



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## Welcome

Welcome to the Bretby Gammatech Heat Eye Manual. You will find that the Heat Eye is very easy to use on a day-to-day basis and you will only need to refer to this Manual occasionally.

This manual introduces you to the Heat Eye and teaches you how to use several Heat Eye features. It is organised so that you can easily find what you need to know, as outlined in the following list, which gives a quick overview of the topics covered and where to find them.

The Manual is organised into three parts. The first part describes the system hardware, the second part describes the Local Processor operation and menu structure, and the third part describes the optional Remote Display.

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# Part 1: Heat Eye Description, Hardware and Maintenance

## 1. The Heat Eye Description

- 1.1 The basic theory of operation of the Heat Eye
- 1.2 The main features of the Heat Eye
- 1.3 System specifications

### 1.1 Basic Theory of Operation

The Heat Eye is a non-contacting instrument that provides an on-line measure of the ash content, moisture content and calorific value of a conveyed load. It is suitable for installation on belt conveyors (including steel cored).

The instrument is based on a model for coal that assumes that the coal is a (binary) mixture of carboniferous and sedimentary materials, the latter giving rise to the "ash" content of the coal. Both types of material contain trace amounts of radioactive elements (such as uranium, thorium and potassium) but the concentrations of these elements are very much higher in the sedimentary materials. Consequently, there is a strong correlation between the ash content of a sample of coal and the amount of gamma radiation that the sample emits. However, as the gamma activity of the sample is also dependent on the mass of the sample, the Heat Eye therefore estimates the ash content of conveyed material from a simultaneous measurement of *both* its gamma activity *and* its mass (weight).

The Heat Eye basically comprises two gamma sensors, one to detect the gamma radiation from the conveyed material and one to detect the 'background' gamma radiation, a moisture meter and a separate belt-weigher system to measure the belt speed and throughput of the conveyed material. The signals from all of these are connected to a **Local Processor Unit**.

The **Local Processor Unit** continuously monitors all of the signals and uses custom software to derive ash content. The **Local Processor Unit** can also send a serial message to a general-purpose computer, running custom software in the control room. This computer uses custom software to provide the comprehensive data management facilities that are required for improved quality control.

An **Over the Belt Shield** is mounted on the conveyor structure, to form a housing through which the conveyed load passes. This housing consists of several lead panels. These lead panels reduce effect of the naturally occurring background radiation.

## 1.2 Main Features

The main features provided by the Heat Eye are

- \* Simple, secure menu-driven operation, with automatic restart upon restoration of power.
- \* Real-time numerical displays of current ash content, the shift ash content, current moisture content, the shift moisture content, the current calorific value and the shift calorific value, the current tonnes per hour flow rate and the total shift tonnes.
- \* Up to four calibrations to handle different coal types.
- \* Up to eight different coal types can be accommodated.
- \* User-definable shift pattern with comprehensive end-of-shift reporting.
- \* Archival and retrieval of shift reports.
- \* Two 4 to 20mA Analogue outputs which can be set to the current ash content, the shift ash content, the current calorific value, the shift calorific value or the current tonnes per hour flow rate.
- \* Two Relay outputs (c/o contacts) which can be set to operate on a critical system fault, a non-critical system fault, when the current ash content, the current moisture content or the current calorific value is below, within or above a target band.
- \* User-definable quality parameters (target ash content and desired ash band, target moisture content and desired moisture band, target calorific value and desired calorific value band).
- \* Downloading of information to allow more comprehensive user analysis (usually in conjunction with other user-supplied data).
- \* Optional serial output (RS232) of ash, moisture, calorific value, tonnage and various other house keeping data for onward transmission to additional optional equipment, such as the Bretby Gammatech Heat Eye Remote Display Unit.

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## 1.3 System Specification

The **Heat Eye** has a basic cycle time of one second. Each cycle it reads the incoming signals, performs its calculations of ash content, tonnes per hour etc, updates the stored data and sends a serial message to the **Remote Display Unit**. The **Local Display** is also updated every cycle, if the ash content etc., is being displayed. However, the displayed information is hardly ever derived from just one second's measurement: it is more usual to average over a user selectable response time. Although it is possible to have a response time as low as 1 second or as high as 60 seconds, a value of about 30 seconds has been found to offer a reasonable compromise between speed of response and precision of measurement.

The **Heat Eye** maintains average data on ash and many other measured and calculated parameters over one of the following user-selectable trend periods: 15, 30, 60, 90, 120, 180 or 240 minutes. The system stores the last 1280 data records, giving 13 days 8 hours for the 15 minute trend period to 213 days 8 hours for the 240 minute trend period. This information can be downloaded to a Lap Top computer via the **Data Port** or a Multi-Media Card via the **MMC Slot**.

In addition to the trend facility, the system also maintains end-of-shift reports for the last 150 shifts. The end-of-shift reports can be downloaded to a Lap Top computer via the **Data Port** or a Multi-Media Card via the **MMC Slot**.

The **Heat Eye** provides two standard 4-20mA outputs. Both of these outputs can be used to represent the current ash content, the shift ash content, the current calorific value, the shift calorific value, and the flow rate in tonnes per hour, as displayed on the **Local Display**, with the response time applied. The user can select the output range of the ash content from 0 – 30%, 0 – 40%, 0 – 50%, 20 – 60%, 40 – 80% and 0 – 100%. The user can select the output range of the calorific value from 0 – 10MJ/Kg, 5 – 15MJ/Kg, 0 – 20MJ/Kg, 10 – 20MJ/Kg, 15 – 25MJ/Kg, 10 – 30MJ/Kg, 20 – 30MJ/Kg, 25 – 35MJ/Kg and 20 – 40MJ/Kg. If the outputs are used to represent the flow rate in tonnes per hour, the range is set from the **Belt Weigher** signal definitions. If a 4-20mA output is required for the moisture content, the input signal is used.

Two voltage-free change-over contacts are also provided by the **Heat Eye**. These may be selected by the user to represent one of a number of conditions (critical system fault, non-critical system fault, when the current ash content, the current moisture content or the current calorific value is below, within or above a target band).

A **Data Port** consisting of a serial output (RS232) at a user selectable baud rate from 1200 to 38400 is used to download the trend data file, the shift record file, the calibration coefficient file and the signal definition file to another computer.

A bi-directional serial interface (RS232) at user selectable baud rate from 1200 to 38400 is used for communication to the **Remote Display Unit**. The serial message, sent every second, consists of several parameters, dependant on the requirements of the installation. Long line drivers enable communications over distances of several kilometres.

A **Multi-Media Card Interface** is provided by the **MMC Slot** to give an alternative method of downloading the data files.

## 2. The Heat Eye Hardware

The Heat Eye system consists of several individual components, which, when mounted onto a conveyor belt, provide the means to calculate the ash content, moisture content and calorific value of the conveyed load in real time. The following is a brief description of the Heat Eye system components.

### 2.1 The Over the Belt Shield

The **Over the Belt Shield** is usually mounted on the conveyor structure, to form a housing through which the conveyed load passes, as shown in figure 2.1 below.



**Figure 2.1**  
**Over the Belt Shield**

The **Over the Belt Shield** is made up of three fabricated panels, two side panels and a top panel. Into each of these panels are mounted smaller lead panels, which are mounted in steel containers for protection against damage. These lead panels significantly reduce the amount of the naturally occurring background radiation detected by the **Main Sensor**. A fibreglass canopy is mounted on the top panel.

## 2.2 The Main Gamma Sensor

The **Main Sensor** is mounted underneath the top strand of the conveyor belt, as close as possible to the underside, without touching when the conveyor is fully loaded. See figure 2.2 below.

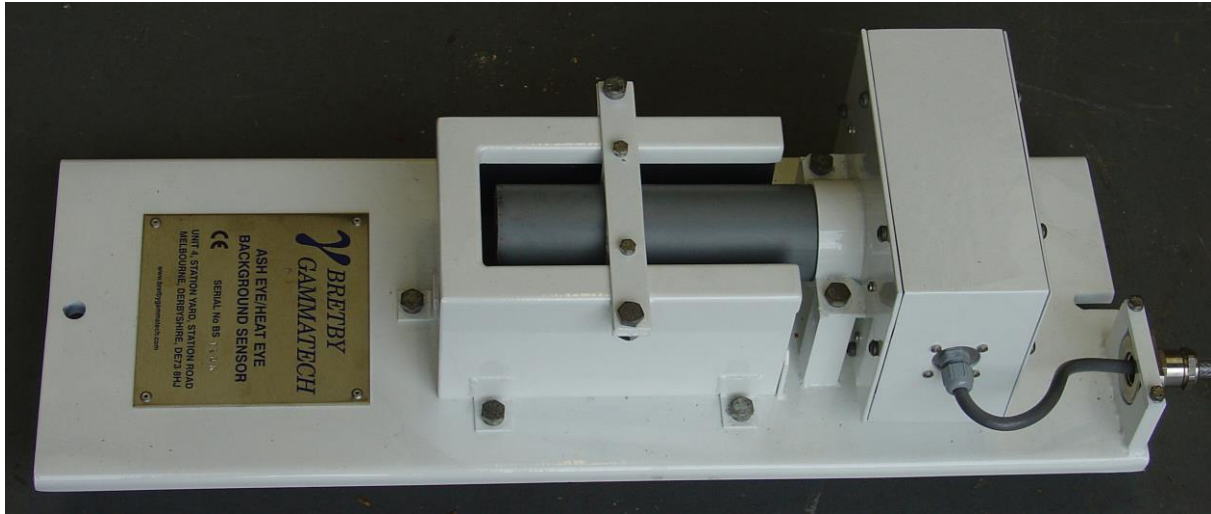


**Figure 2.2**  
**Main Gamma Sensor**

The **Main Sensor** is mounted on two cross beams, and aligned with the centre line of the conveyor. The two cross beams are attached to the main conveyor structure by mounting plates and long adjusting screws.

## 2.3 The Background Gamma Sensor

The **Background Sensor** is mounted centrally on the top of the **Over the Belt Shield**, underneath the fibreglass canopy. See figure 2.3 below.



**Figure 2.3**  
**Background Gamma Sensor**

The **Background Sensor** is a smaller version of the **Main Sensor**, and is used to monitor changes in the naturally occurring background radiation. It is shielded from the conveyed load by the top panel of the **Over the Belt Shield** and further lead panels around the sensor.

## 2.4 The Moisture Meter

The **Moisture Meter** is mounted on the conveyor as close as possible to the **Over the Belt Shield**.

**Bretby Gammatech Limited** does not manufacture a **Moisture Meter**. There are several different manufacturers of moisture meters, and the choice is left to the purchaser.

The **Heat Eye** requires information regarding the moisture content of the material on the conveyor. This is usually in the form of a 4 to 20 mA signal, proportional to the percentage moisture content.

## 2.5 The Local Processor Enclosure

This chapter describes the **Local Processor Enclosure**. The **Local Processor Enclosure** is mounted on, or near, the **Over the Belt Shield** at the sensor location on the conveyor belt.



**Figure 2.5**  
**Local Processor Enclosure**

The **Local Processor Enclosure** acts as a junction box, houses the local signal processor, keypad and local display. The various input signals to the **Heat Eye** system are connected to the **Local Processor Enclosure** via individual cables. Using these input signals the **Local Processor** calculates and displays information. Information can also be transmitted to a remote Display Unit via a serial data link.

The **Local Processor Enclosure** is an IP65 steel cabinet, which has a glass panel in the front door. Inside the front door, the 40 x 4 Liquid Crystal Display (LCD), 36-key keypad, on/off switch, Multi-Media Card Interface (MMC) and data port are mounted on a hinged inner door.

Opening the inner door gives access to the main field wiring connections, the main power switch and the electronic Printed Circuit Boards (PCB). Once the field wiring has been completed, access to the inside of the cabinet should not be required.

## 2.6 Optional Remote Display Unit

The **Heat Eye** can be connected to a **Remote Display Unit** via a serial link. A full description of the facilities and menu structure is given in the Remote Display Unit manual.



**Figure 2.6**  
**Remote Display Unit**

## 2.7 Other Hardware

The **Heat Eye** requires information regarding the flow rate of material on the conveyor. This is usually in the form of a 4 to 20 mA signal, proportional to the flow rate, in tonnes per hour. A separate belt weigher, preferably mounted close to the **Heat Eye** sensors on the same conveyor, is normally used to provide this signal.

The **Heat Eye** also requires information on when the conveyor is running and stopped. This information can be accepted in one of three forms, a volt-free contact, which is closed when the conveyor is running, a pulse stream from a wheel running on the conveyor, or an analogue signal proportional to the belt speed. The volt-free contact would normally be mounted in the main contactor panel controlling the conveyor, while the pulse stream or analogue signal could be supplied via the belt weigher.

## 2.8 General Maintenance

Once the system has been installed and calibrated, a little maintenance should ensure many years of good performance.

It is important to keep the top of the main sensor free from dust and debris. A check should be made regularly, as part of the conveyor belt maintenance/inspection routine, to ensure a clean sensor.

## Part 2: Local Processor Operation and Menu Structure

### 1. The Local Processor Unit

The **Local Processor Unit (LPU)** continuously monitors the incoming data signals from the **Main Sensor**, the **Background Sensor**, the **Belt Weigher** and the **Belt Speed Sensor** (or **Belt Running Contact**). From these signals the Ash Content of the conveyed load is calculated every second.



**Figure 1.1**  
**Local Processor Inner Door**

## 1.1 The Local Processor Hardware

The **Local Processor Unit** is mounted in the **Local Processor Enclosure** behind the inner door. The **Local Processor** consists of five printed circuit boards (PCBs), a 40 x 4 character liquid crystal display (LCD), a 36 key keypad and a field-wiring interface PCB.

There is a bi-directional serial interface (RS232) which is used for communication to the **Remote Display Unit** or other remote equipment capable of accepting RS232 communication. The serial message, sent every second, consists of several parameters, dependant on the requirements of the installation. Long line drivers enable communications over distances of several kilometres. Access to this interface is behind the inner door. Section 4.7 gives details on how to change the serial interface settings.

There are two 0.4 to 2.0 volt analogue outputs available, which can be set to the current ash content, the shift ash content, the current calorific value, the shift calorific value or the current tonnes per hour flow rate. Section 4.8 gives details on how to set the output ranges of the ash and calorific values, with the flow rate being fixed by the signal definitions for the **Belt Weigher**.

There are two voltage-free change-over contacts available. These may be selected by the user to represent one of a number of conditions (critical system fault, non-critical system fault, the current ash content, current moisture content or current calorific value below the target band, within the target band or above the target band). Section 4.9 gives details on how to change the relay settings.

There is a **Data Port** consisting of a serial output (RS232) which is used to download the trend data file, the shift record file, the calibration coefficient file and the signal definition file to another computer. Section 4.6 gives details on how to change the **Data Port** settings.

There is a **Multi-Media Card Interface** mounted on the inner door. This interface is used to give an alternative method of downloading the data files.

## 1.2 The Keypad

This section describes how to use the keypad to interact with the system.



**Figure 1.2**  
**Local processor Keypad**

The **Heat Eye** uses a 36-key keypad. 26 of these keys are used for each letter of the alphabet. The wide key on the bottom line of keys is the space bar.

The up and down arrow keys, [↑] & [↓] are used to navigate up or down the menu when on screen or changing from upper case letters to lower case letters when entering text. The left arrow key [←] is used to delete the last character typed.

To access the numeric keys when entering text, the [#] key is pressed. The numbers 1 through to 0 are displayed on the bottom line of the display, and pressing the required key will enter that number. For example, the number 4 is represented by the [R] key and 7 by the [U] key. Pressing the [#] key will toggle between numbers and letters for the top line of keys. When the user is required to enter a number, for example, when entering the belt weigher parameters, the numbers are automatically displayed. The [-] key is used as a minus sign when entering numbers. The full stop or period [.] is used in the text modes only. A decimal point is automatically inserted into any numbers that require one.

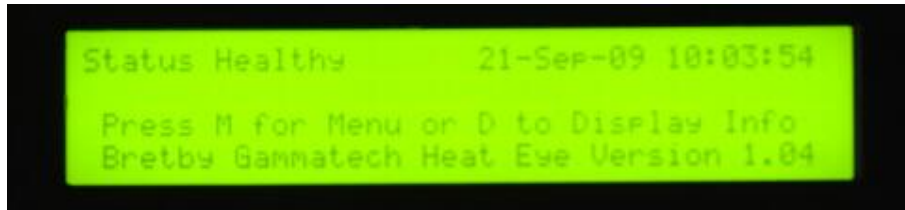
The [AC] key is an escape key, generally cancelling the currently-selected task and returning the user to the normal display screen.

The [C/CE] key is used mainly to skip any numeric input. If the [C/CE] key is pressed when the user is requested to enter a number, the original numeric value will be retained.

The [ENT] key is the ENTER key and is used to complete the entry of numerical data, the data not being accepted by the **Heat Eye** until the [ENT] key is pressed.

## 1.3 The Local Processor Display

The **Local Processor** display shown below in Figure 1.3 is as it normally appears on a working Heat Eye system.



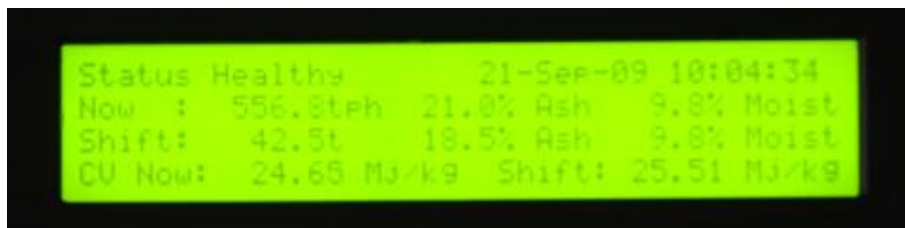
**Figure 1.3**  
**The Main Screen Display**

On the top line is displayed the system status and the current date and time. If there is a sensor fault then the word ‘Healthy’ is replaced with ‘Faulty’. The second line is used to indicate that a text message has been received, or there are one or more sensor faults. Under normal conditions, this line is blank. The third line has the message ‘Press M for Menu or D to Display Info’. The bottom line displays the message ‘Bretby Gammatech Heat Eye Version 1.00’.

Whenever the Main Screen Display is on the screen, only the F, M and D keys on the keypad are active.

Pressing the [F] key will display any faults on the second line of the display, while pressing the [M] key will access the menu system.

Pressing the [D] key will display the Calculated Information Display screen as shown in Figure 1.4.



**Figure 1.4**  
**The Calculated Information Display**

The Calculated Information Display screen is used to display the instantaneous (now:) tonnes per hour and %Ash, and the accumulated shift tonnage and %Ash. The display is updated every second. The instantaneous values which are displayed to the screen are smoothed by the ‘Response Time’, which can be set to any value between 1 and 60 seconds.

The display will revert back to the Main Screen Display one minute after the last key press or if the [AC] key is pressed.

## 2. Menu System

This chapter describes how to use the Menu System of the Local Processor, and how to enter and edit the various parameters and coefficients to enable the system to calculate the %Ash of the conveyed load.

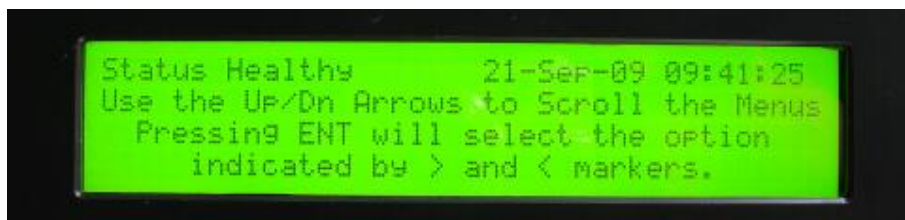
Refer to **Figure 10.1** at the end of this manual for the Heat Eye Menu Flow Diagram.

The [↓] and [↑] keys are used to scroll through all the menu options and the [ENT] key is used to select the option indicated. Individual menus will have a varying number of options which the user can select, indicated by the > and < markers on the third line of the screen. Pressing the [↓] key will move the menu text down one line on the screen, and pressing the [↑] key will move the text up one line, but the markers > and < will always be displayed on the third line of the screen. The menu options can be continually scrolled through in the same direction, i.e. lines 3, 4, 5, 1, 2 etc., or lines 2, 1, 5, 4, 3 etc. All the multi-option menus operate in this way.

The display will revert back to the Main Screen Display 15 minutes after the last key press or if the [AC] key is pressed, except where noted later in the manual.

### 2.1 Main Instruction Display

Pressing the [M] key when the Main Screen Display is on the screen will open the Menu Instruction Display as shown in Figure 2.1

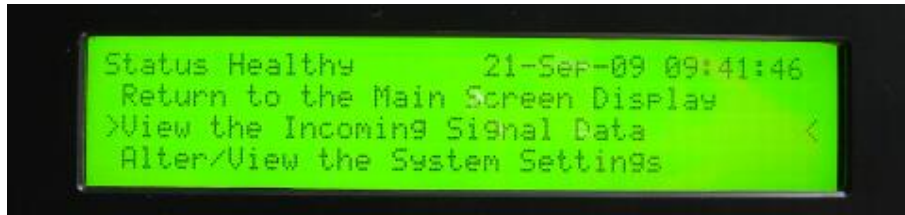


**Figure 2.1**  
**The Menu Instruction Display**

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## 2.2 Main Menu Display

Pressing the [↓], [↑] or [ENT] key when the Menu Instruction Display is on the screen will open the Main Menu Display as shown in Figure 2.2.



**Figure 2.2**  
**The Main Menu Display**

The Main Menu has five options, which are :-

- Return to the Main Screen Display
- View the Incoming Signal Data
- Alter/View the System Settings
- Access the Text Messages Menu
- Access the Data Files Menu

### 3. View the Incoming Signal Data Menu

Pressing the [ENT] key when the markers indicate 'View the Incoming Signal Data' will access the View the Incoming Signal Data Menu. This menu has four options, which are :-

- Return to the Previous Menu
- Display the Empty Belt Gamma Value
- Display the Signal Inputs
- Display the Digital Inputs

#### 3.1 Display the Empty Belt Gamma Value

Pressing the [ENT] key when the markers indicate 'Display the Empty Belt Gamma Value' will access the Empty Belt Gamma Display screens. The first screen displays the options available, as shown in figure 3.1.1 below.



**Figure 3.1.1**  
**Empty Belt Gamma Display Option Screen**

Pressing the [C] key will display the Empty Belt Gamma Display Screen, as shown in figure 3.1.2 below, while pressing the [B] key will return to the previous menu.



**Figure 3.1.2**  
**Empty Belt Gamma Display Screen**

The Empty Belt Gamma Display Screen allows the accuracy of the calculated Empty Belt Gamma value to be checked against the actual Empty Belt Gamma value of the Main Sensor.

The screen shows the current date and time on the top line, along with the number of readings that the Main Gamma Sensor counts per second (cps) has been averaged over. The second line is used to display the Main Gamma Sensor average cps along with the sigma of the cps. The third line is used to display the calculated Empty Belt Gamma cps along with the sigma of the cps. The bottom line of the display is used to report the belt status and the automatic empty belt compensation offset value.

Pressing the [P] key pauses the averaging. Pressing the [P] key again restarts the averaging from the same number of readings. Pressing the [R] key resets the readings and restarts averaging, while pressing the [ENT] key displays the previous menu.

The Empty Belt Gamma value is calculated to be the same as the count rate of the Main Sensor when there is no material on the belt. This value is then subtracted from the Main Gamma cps reading to give the net gamma cps, due to the material on the belt. The actual Main Sensor 'Empty Belt Gamma cps' varies continually, due to changes in atmospheric and weather conditions. The system uses either a keyboard entered Empty Belt Gamma count rate or a calculated Empty Belt Gamma count rate using the Background Sensor cps. The accuracy of the Empty Belt Gamma count rate value is checked for any slight variations whenever the belt is running or stopped with no loading, and the automatic empty belt compensation offset value calculated.

The automatic empty belt compensation offset value is only adjusted when the belt is either running empty or has been stopped after a short period of running empty. It is not adjusted if the belt is running loaded or has been stopped when loaded. The current belt status is displayed on the bottom line of the screen.

## 3.2 Display the Signal Inputs

Pressing the [ENT] key when the markers indicate 'Display the Signal Inputs' will access the Signal Input Display screen, as shown in Figure 3.2.1 below.



**Figure 3.2.1**  
**The Signal Input Display Screen**

The screen shows the current date and time on the top line, along with the number of readings that the Signal Inputs have been averaged over. Pressing the [P] key pauses the averaging. Pressing the [P] key again restarts the averaging from the same number of readings. Pressing the [R] key resets the readings and restarts averaging, while pressing the [ENT] key displays the previous menu. Each signal input is displayed in turn, using the [↓] and [↑] keys to scroll through the list, as shown below :-

Press P(ause), R(eset) or ENT to Clear  
Main Gamma Sensor  
Background Sensor  
Belt Speed Pulses  
Auxiliary Pulses  
Tonnes per Hour  
Belt Speed Analogue  
Moisture Analogue  
Temperature  
Analogue Output 0  
Analogue Output 1

It should be noted that some inputs may not be being used and will therefore show zero value. For example, the belt speed can be provided by a pulse input, analogue input (volts or mA) or a contact closure.

### 3.3 Display the Digital Inputs

Pressing the [ENT] key when the markers indicate 'Display the Digital Inputs' will access the Digital Input Display screen, as shown in Figure 3.3.1 below.



**Figure 3.3.1**  
**The Digital Input Display Screen**

The screen shows the current date and time on the top line, along with the Status of the system. The [↓] and [↑] keys are used to scroll through the list, while pressing the [ENT] key displays the previous menu. Each digital input is displayed in turn, along with the state of the input, as shown below :-

Press ENT to Return to Previous Menu  
Belt Running Contact  
Batch Control Contact  
Sampler Operate Contact  
Auxiliary Contact  
Coal Source Card  
Coal Source Number

## 4. Alter/View the System Settings Menu

For the system to calculate the ash content of the conveyed load, the main gamma sensor pulse rate signal, the distance between the main gamma sensor and the belt weigher, the belt weigher flow rate, the belt speed and the empty belt gamma value need to be known. Most of these parameters will vary from site to site, and so the signal definitions are used to set up the Heat Eye System for use at all sites. This section will show how to access and set up the various signal definitions. There are four main methods of altering or changing the signal definitions. These are described in **7. Methods of Altering Parameters**. To avoid repetition, the method used to alter the parameter will be referred to, without describing the actual method itself.

Pressing the [ENT] key when the markers indicate ‘Alter/View the System Settings’ will access the Alter/View the System Settings Menu.

Before the user is allowed access to the Alter/View the System Settings Menu, a password has to be entered.



**Figure 4.1**  
**The Password Entry Screen**

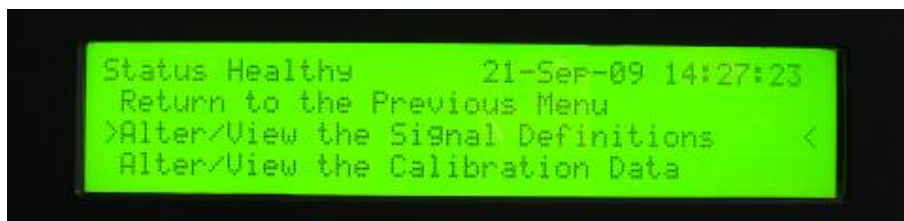
Figure 4.1 shows the password entry screen, with three characters already entered. As each letter or number is entered the ‘\_’ changes to ‘\*’. A combination of upper and lower case letters, numbers and the symbols ‘-’ and ‘.’ are allowed. The factory set default password is ‘BRETBY’, but the user can change this password if required. How to access the number keys and lower case letters is described in section 3.1. Once the correct password has been entered and the ‘ENT’ key pressed, the Alter/View the System Settings Menu is displayed.

If the password is entered incorrectly, the message ‘Password Incorrect!’ is displayed for 2 seconds before the Alter/View the System Settings Menu is displayed.

The user can skip entering the password by pressing the ‘C/CE’ key at any point before or during the password entry. If the ‘C/CE’ key is pressed, the message ‘Password Entry Skipped’ is displayed for 2 seconds before the Alter/View the System Settings Menu is displayed.

If the Alter/View the System Settings Menu has been accessed without a valid password being entered, then the user can only view the System Settings. The message ‘Press ‘C’ to Continue’ will be displayed on the bottom line of the screen, indicating that the user cannot change any of the System Settings.

Once the password entry section has been completed, the Alter/View the System Settings Menu will be displayed, as shown in Figure 4.1.1 below.



**Figure 4.2**  
**The Alter/View the System Settings Screen**

The Alter/View the System Settings Menu has twelve options, which are :-

- Return to the Previous Menu
- Alter/View the Signal Definitions
- Alter/View the Calibration Data
- Alter/View the Relay Settings
- Alter/View the Analogue O/put Settings
- Alter/View the Shift Definitions
- Alter/View the Remote Port Settings
- Alter/View the Data Port Settings
- Alter the System Date
- Alter the System Time
- Alter the User Password
- Alter the System for Heat Eye/Heat Eye

This menu system allows the user to view and/or alter the signal definitions, the calibration coefficients and other parameters.

The first three options access other menus, while the other six options access the parameter directly.

There are four different universal methods of altering the various parameters, dependant on the type of parameter being altered. Refer to section **7. Methods of Altering Parameters** for a full description of these methods.

## 4.1 Alter/View the Signal Definitions

Pressing the [ENT] key when the markers indicate 'Alter/View the Signal Definitions' will display the Alter/View the Signal Definitions Menu, as shown in Figure 4.1 below.



**Figure 4.1**  
**Alter/View the Signal Definitions Menu Screen**

The Alter/View the Signal Definitions Menu has ten options, which are :-

- Return to the Previous Menu
- Access the Bkground Sensor Definitions
- Access the Belt Weigher Definitions
- Access the Gamma Weigher Separation
- Access the Belt Speed Definitions
- Access the Moisture Definitions
- Access the Temperature Definitions
- Access the Response Time
- Access the Data Record Averaging Time
- Access the C.V. Definitions

This menu system allows the user to view and/or alter the signal definitions listed above.

### 4.1.1 Access the Background Sensor Definitions

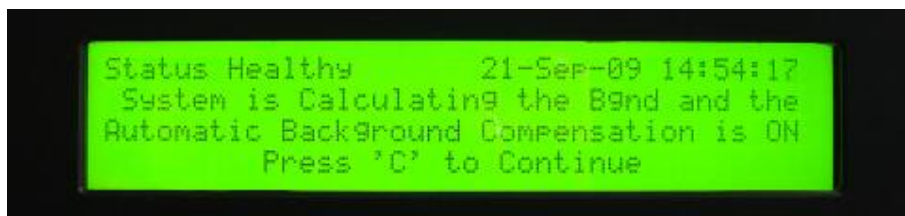
Pressing the [ENT] key when the markers indicate 'Access the Bkgnd Sensor Definitions' will display the Edit the Background Definitions screen, as shown in Figure 4.1.1.1 below.



**Figure 4.1.1.1 Edit the Background Definitions Screen**

To edit any, or all of the background compensation definitions the [Y] key is pressed. If the [N] key is pressed then the user will be taken back to the Alter/View the Signal Definitions Menu.

If the Alter/View the System Settings Menu has been accessed without a valid password being entered, then pressing the [ENT] key when the markers indicate 'Access the Bkgnd Sensor Definitions' will display the Background Definitions screen, as shown in Figure 4.1.1.2 below. The message 'Press 'C' to Continue' will be displayed, indicating that the user cannot change any of the background compensation definitions.



**Figure 4.1.1.2 View the Background Definitions Screen**

The Empty Belt Gamma value is calculated to be the same as the count rate of the Main Sensor when there is no material on the belt. This value is then subtracted from the Main Gamma cps reading to give the net gamma cps, due to the material on the belt. The actual Main Sensor 'Empty Belt Gamma cps' varies continually, due to changes in atmospheric and weather conditions. The system uses either a keyboard entered Empty Belt Gamma count rate or a calculated Empty Belt Gamma count rate using the Background Sensor cps. To calculate the Empty Belt Gamma from the Background Sensor cps, the following formula is used.

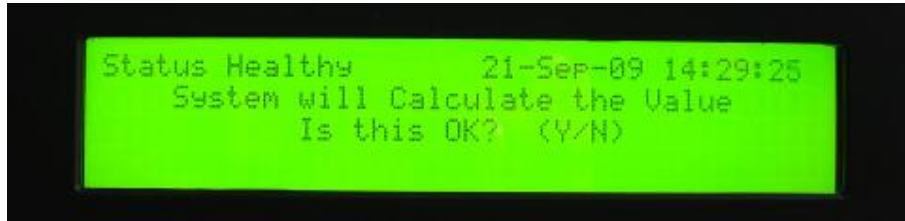
$$\text{Empty Belt Gamma} = \text{slope term} * \text{background sensor cps} + \text{intercept term}$$

The slope term and the intercept term being derived from a linear regression of the Main Gamma Sensor cps against the Background Sensor cps.

If the option for Automatic Background Compensation is turned ON, the accuracy of the Empty Belt Gamma count rate value is checked for any slight variations whenever the belt is running or stopped with no loading, and an automatic empty belt compensation offset value calculated.

If the option for Mass Absorption Compensation is turned ON, the Empty Belt Gamma count rate value is varied inversely proportionally to the mass loading on the belt.

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.1.3 below.



**Figure 4.1.1.3 Set the Background Calculation Method Screen**

Use 7.1 Method 1 to select from the option list shown below :-

System will Calculate the Value  
System will use Keyboard entered Value

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.1.4 below.



**Figure 4.1.1.4 Input the Slope Term Screen**

Use 7.3 Method 3 to enter the New Slope value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.1.5 below.



**Figure 4.1.1.5 Input the Intercept Term Screen**

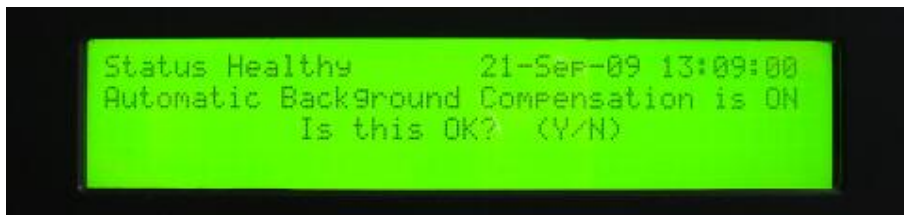
Use 7.3 Method 3 to enter the New Intercept value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.1.6 below.



**Figure 4.1.1.6 Accept the Background Definitions Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.1.3 Set the Background Calculation Method, while pressing the [Y] key will display the next screen, as shown in Figure 4.1.1.7 below.

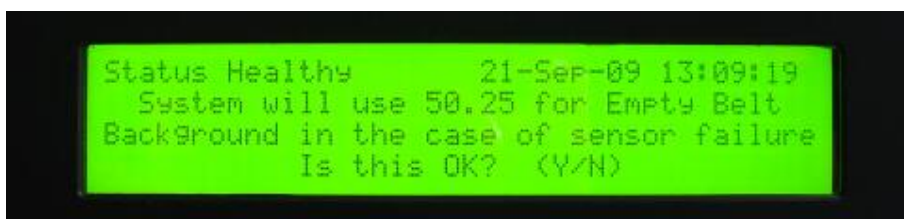


**Figure 4.1.1.7 Set the Automatic Background Compensation Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- Automatic Background Compensation is ON
- Automatic Background Compensation is OFF

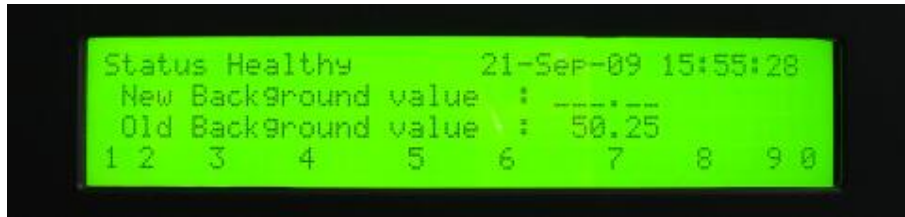
Pressing the [Y] key will display the next screen, as shown in Figure 4.1.1.8 below.



**Figure 4.1.1.8 Fixed Value for Empty Belt Background Screen**

If the option 'System will use Keyboard entered Value' had been selected above, the steps shown in Figures 4.1.1.4, 4.1.1.5 and 4.1.1.6 would have been skipped and Figure 4.1.1.8 displayed instead of Figure 4.1.1.3. It is necessary to enter a fixed value for the Empty Belt Gamma. The Heat Eye System will use this value in the event of the Background Sensor not working correctly.

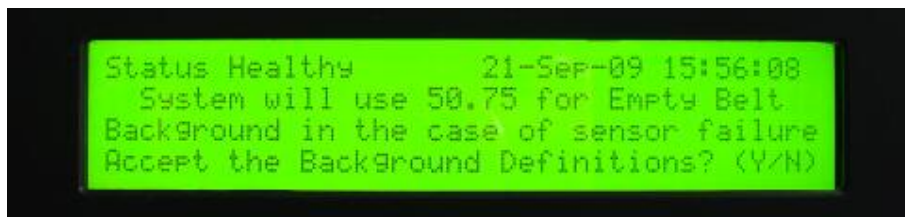
Pressing the [N] key will display the next screen, as shown in Figure 4.1.1.9 below, while pressing the [Y] key will skip the next two screens and display the screen as shown in Figure 4.1.1.11 below.



**Figure 4.1.1.9 Enter the Fixed Value for Empty Belt Background Screen**

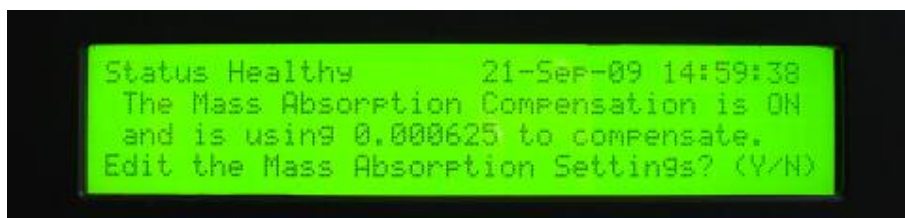
Use 7.3 Method 3 to enter the New Background value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.1.10 below.



**Figure 4.1.1.10 Accept the Fixed Empty Belt Background Screen**

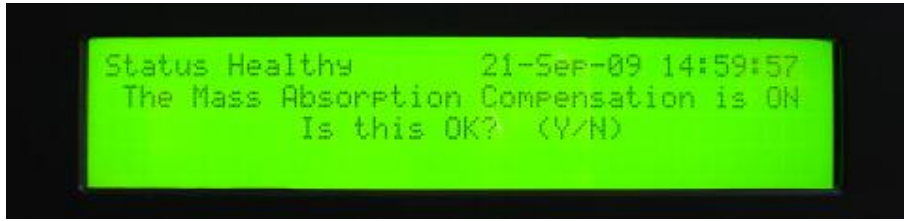
Pressing the [N] key will return the user to the start of the process, Figure 4.1.1.8 Enter the Fixed Value for Empty Belt Background, while pressing the [Y] key will display the next screen, as shown in Figure 4.1.1.11 below.



**Figure 4.1.1.11 Edit the Mass Absorption Compensation Screen**

To edit the Mass Absorption Compensation settings the [Y] key is pressed. If the [N] key is pressed then the user will be taken back to the Alter/View the Signal Definitions Menu.

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.12 below.



**Figure 4.1.1.12 Set the Mass Absorption Compensation Screen**

Use 7.1 Method 1 to select from the option list shown below :-

The Mass Absorption Compensation is ON  
The Mass Absorption Compensation is OFF

Pressing the [Y] key when the Mass Absorption Compensation is ON will display the next screen, as shown in Figure 4.1.1.13 below.



**Figure 4.1.1.13 Enter the Mass Absorption Value Screen**

Use 7.3 Method 3 to enter the New Mass Absorption value. The Mass Absorption value should be set within the range 0.000425 to 0.000625.

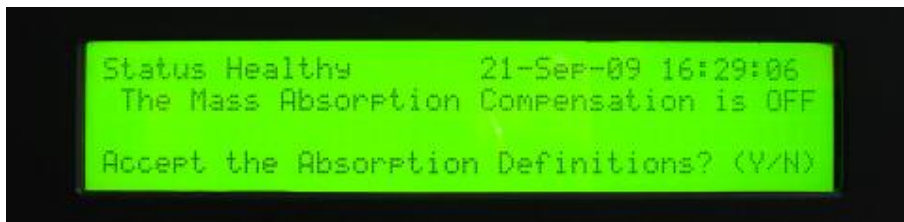
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.1.14 below.



**Figure 4.1.1.14 Accept the Mass Absorption Definitions Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.1.12 Set the Mass Absorption Compensation, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

Pressing the [Y] key when the Mass Absorption Compensation is OFF will display the next screen, as shown in Figure 4.1.1.15 below.

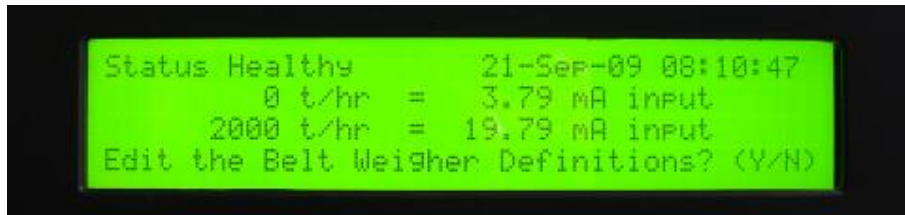


**Figure 4.1.1.15 Accept the Mass Absorption Definitions Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.1.12 Set the Mass Absorption Compensation, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

## 4.1.2 Access the Belt Weigher Definitions

Pressing the [ENT] key when the markers indicate ‘Access the Belt Weigher Definitions’ will display the Edit the Belt Weigher Definitions screen, as shown in Figure 4.1.2.1 below.

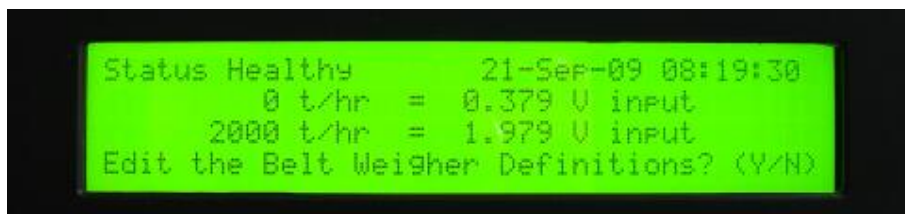


**Figure 4.1.2.1 Edit the Belt Weigher Definitions mA Input Screen**

The signal input from a belt weigher will normally be in the form of a 4 to 20mA analogue signal, with 4mA representing zero tonnes per hour (t/hr) and 20mA representing full-scale tonnes per hour. Small variations in belt weigher set up and analogue signal input electronics mean that the input signal is rarely exactly 4 to 20mA. To obtain the correct analogue signal value that represents the belt running empty, the belt should be run with no load for at least one revolution of the belting. The display signal inputs section 3.2 should be used to obtain this value. In the example in Figure 4.1.2.1 above 3.79mA was found to represent 0 t/hr. The full-scale mA should then be set to be 16mA above this value.

The Heat Eye System has been designed to accept an input signal of either 4 to 20mA or 0.4 to 2.0 volts for the tonnes per hour flow rate. There is a dual-in-line (DIL) switch on the BG1480 printed circuit board, which should be set to either Volts or mA, to suit the signal input.

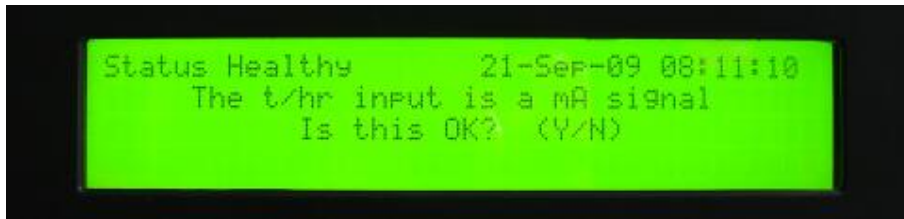
If the belt weigher analogue signal is in the form of 0.4 to 2.0 volts, then the Edit the Belt Weigher Definitions screen will be as shown in Figure 4.1.2.2 below. The method of entering the input values of a mA signal or voltage signal is the same in both cases. The only difference is that the units are displayed in the correct form, for example 3.79mA or 0.379 v.



**Figure 4.1.2.2 Edit the Belt Weigher Definitions Voltage Input Screen**

To edit any, or all of the belt weigher definitions the [Y] key is pressed. If the [N] key is pressed then the user will be taken back to the Alter/View the Signal Definitions Menu.

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.2.3 below.

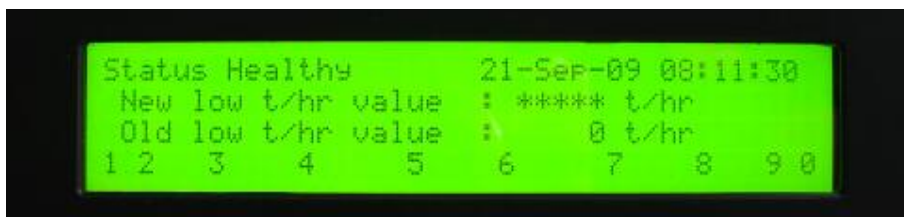


**Figure 4.1.2.3 Set the Belt Weigher Signal Input Type Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- The t/hr input is a mA signal
- The t/hr input is a voltage signal

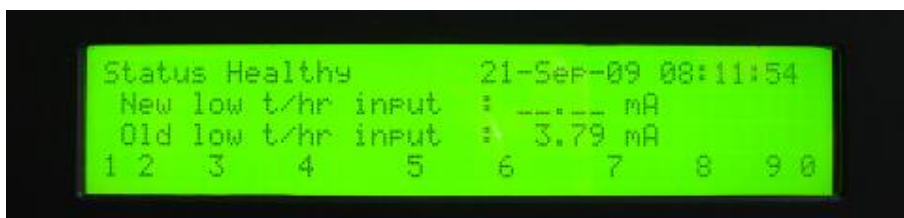
Pressing the [Y] key will display the next screen, as shown in Figure 4.1.2.4 below.



**Figure 4.1.2.4 Input the low t/hr value Screen**

Use 7.3 Method 2 to enter the New low t/hr value.

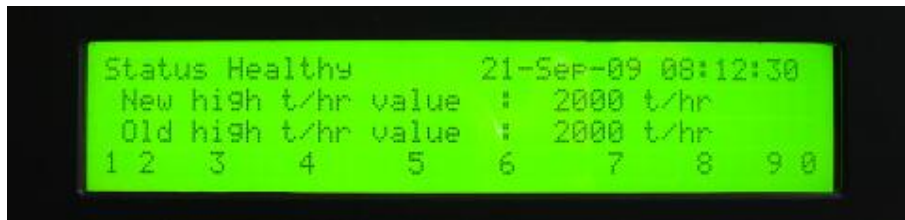
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.2.5 below.



**Figure 4.1.2.5 Input the low t/hr input value Screen**

Use 7.3 Method 3 to enter the New low t/hr input value.

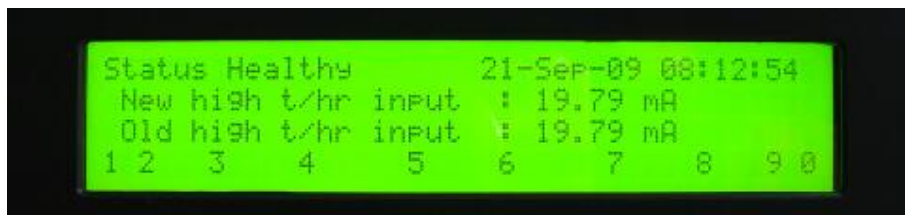
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.2.6 below.



**Figure 4.1.2.6 Input the high t/hr input value Screen**

Use 7.3 Method 2 to enter the New low t/hr input value.

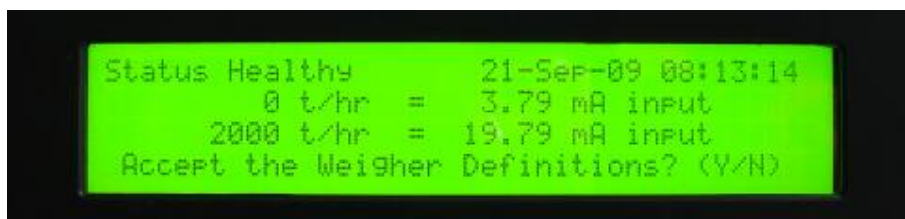
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.2.7 below.



**Figure 4.1.2.7 Input the high t/hr input value Screen**

Use 7.3 Method 3 to enter the New high t/hr input value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.2.8 below.

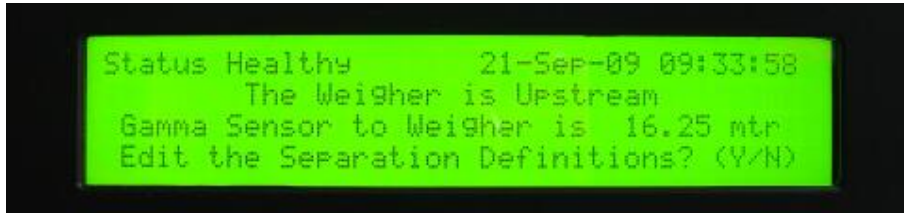


**Figure 4.1.2.8 Accept the Belt Weigher Definitions Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.2.3 Set the Belt Weigher Signal Input Type, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

### 4.1.3 Access the Gamma Weigher Separation

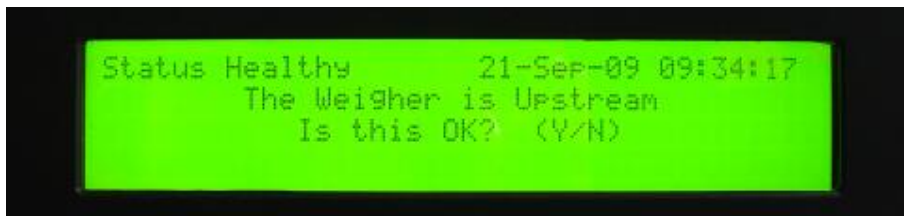
Pressing the [ENT] key when the markers indicate 'Access the Gamma Weigher Separation' will display the Edit the Edit the Gamma Weigher Separation screen, as shown in Figure 4.1.3.1 below.



**Figure 4.1.3.1 Edit the Gamma Weigher Separation Screen**

The belt weigher and the main gamma sensor are usually mounted on the same belt, but physically some distance apart. To ensure that the correct signal values are used each second, it is important that the belt weigher tonnes per hour signal and the main gamma pulse signal are synchronised. This is done by entering the distance between the two signal sources and also by entering whether the weigher is upstream or downstream of the gamma sensor. The Heat Eye software then synchronises the two signals, taking into account the distance, belt speed and relative position of the sensors.

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.3.2 below.

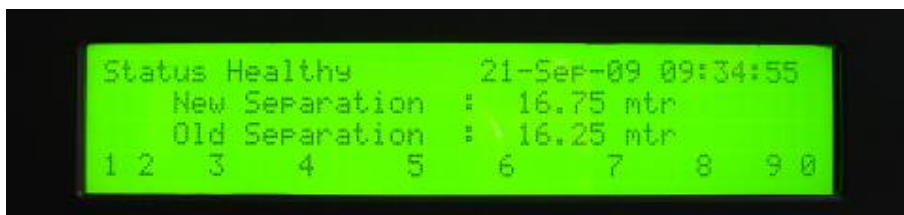


**Figure 4.1.3.2 Set the Weigher Position Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- The Weigher is Upstream
- The Weigher is Downstream

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.3.3 below.

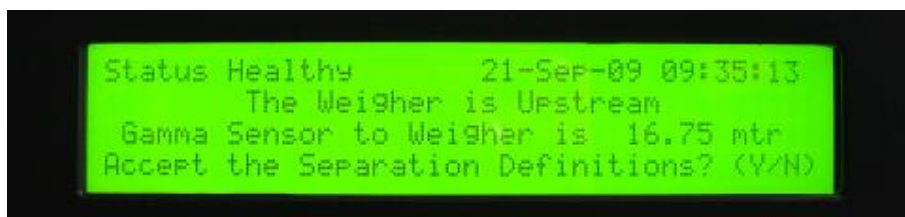


**Figure 4.1.3.3 Input the New Separation Screen**

Use 7.3 Method 3 to enter the New Separation value.

---

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.3.4 below.



**Figure 4.1.3.4 Accept the Gamma Weigher Separation Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.3.1 Edit the Gamma Weigher Separation, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

#### 4.1.4 Access the Belt Speed Definitions

The belt speed is determined by one of four methods, a contact closure using a fixed speed, a pulse signal, an analogue mA signal or an analogue voltage signal.

Whichever method is used, the actual belt speed under normal load conditions needs to be determined, in metres per second. It is recommended that a tachometer be used to measure the belt speed.

If the system is using a fixed belt speed then this figure is entered as the belt speed.

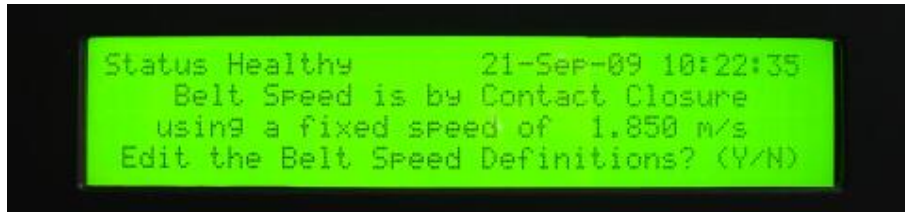
If the system is using a pulse signal, the distance the belt travels per pulse is used by the system to determine the belt speed. To obtain the number of pulses per second for belt speed, the display signal inputs section 3.2 should be used. The distance travelled per pulse can then be determined by dividing the belt speed, in mm per second, by the number of pulses per second.

If the system is using an analogue signal, analogue values should be obtained when the belt is stopped, and when the belt is running loaded. The signal input from a belt speed transducer will normally be in the form of a 4 to 20mA analogue signal, with 4mA representing zero metres per second (belt stopped), and the 20mA representing a theoretical full-speed. This theoretical full-speed will probably be higher than the actual belt speed and should be determined by calculation. Small variations in belt speed transducer and analogue signal input electronics mean that the input signal is rarely exactly 4 to 20mA. To obtain the correct analogue signal value that represents the belt stopped, the belt should be stopped for at least one minute and the display signal inputs section 3.2 used to obtain this value. This should be repeated with the belt running loaded, so that the analogue value representing the belt speed under loaded conditions can be determined.

The Heat Eye System has been designed to accept an input signal of either 4 to 20mA or 0.4 to 2.0 volts for the belt speed. There is a dual-in-line (DIL) switch on the BG1480 printed circuit board, which should be set to either Volts or mA, to suit the signal input.

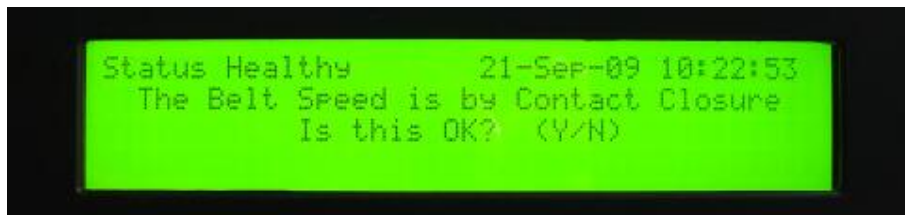
#### 4.1.4.1 Belt Speed Determined by Contact Closure

Pressing the [ENT] key when the markers indicate 'Access the Belt Speed Definitions' and the belt speed is being determined by a pulse signal, will display the Edit the Belt Speed Definitions screen, as shown in Figure 4.1.4.1.1 below.



**Figure 4.1.4.1.1 Edit the Belt Speed Definitions Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.1.2 below.



**Figure 4.1.4.1.2 Set the Belt Speed Signal Input Type Screen**

Use 7.1 Method 1 to select from the option list shown below :-

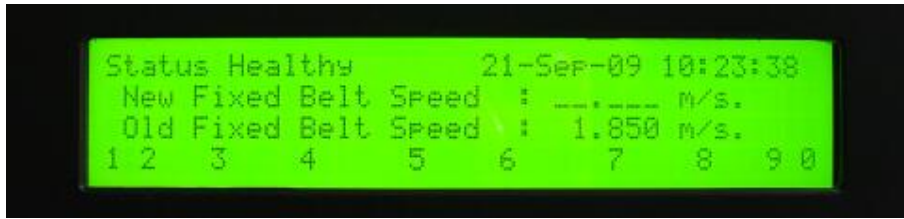
- The Belt Speed is by Contact Closure
- The Belt Speed is by a Pulse Signal
- The Belt Speed input is a mA signal
- The Belt Speed input is a voltage signal

Selecting the option 'The Belt Speed is by Contact Closure' by pressing the [Y] key will display the Edit the Belt Speed screen, as shown in Figure 4.1.4.1.3 below.



**Figure 4.1.4.1.3 Edit the Belt Speed Screen**

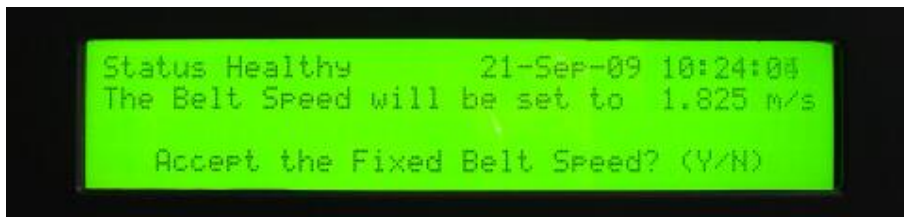
Pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.1.4 below.



**Figure 4.1.4.1.4 Input the New Fixed Belt Speed Screen**

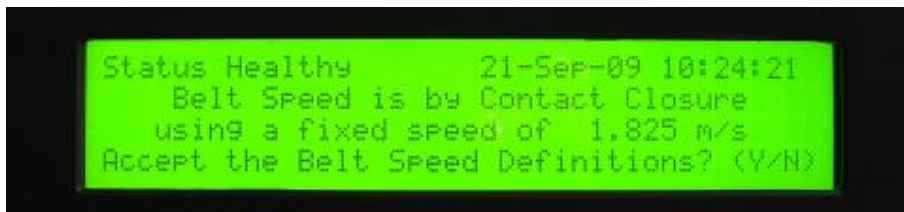
Use 7.3 Method 3 to enter the New Fixed Belt Speed value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.4.1.5 below.



**Figure 4.1.4.1.5 Accept the Fixed Belt Speed Screen**

Pressing the [N] key will return the user to the Input New Fixed Belt Speed screen, Figure 4.1.4.1.4, while pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.1.6 below.



**Figure 4.1.4.1.6 Accept the Belt Speed Definitions Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.4.1.2 Set the Belt Speed Signal Input Type, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

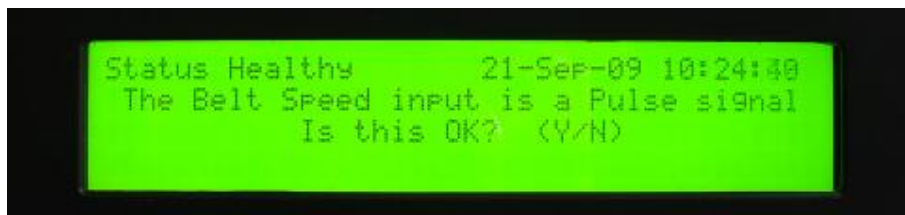
#### 4.1.4.2 Belt Speed Determined by Pulse Signal

Pressing the [ENT] key when the markers indicate 'Access the Belt Speed Definitions' and the belt speed is being determined by a pulse signal, will display the Edit the Belt Speed Definitions screen, as shown in Figure 4.1.4.2.1 below.



**Figure 4.1.4.2.1 Edit the Belt Speed Definitions Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.2.2 below.



**Figure 4.1.4.2.2 Set the Belt Speed Signal Input Type Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- The Belt Speed is by Contact Closure
- The Belt Speed is by a Pulse Signal
- The Belt Speed input is a mA signal
- The Belt Speed input is a voltage signal

Selecting the option 'The Belt Speed is by a Pulse Signal' by pressing the [Y] key will display the Edit the mm per pulse screen, as shown in Figure 4.1.4.2.3 below.



**Figure 4.1.4.2.3 Edit the mm per pulse Screen**

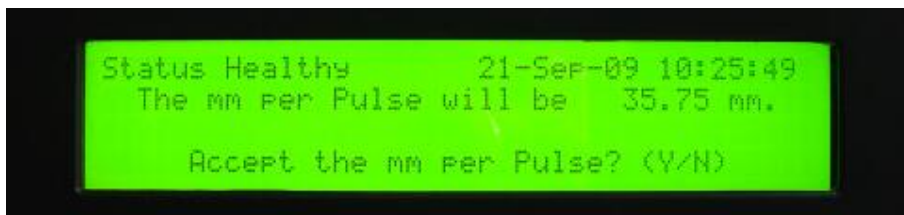
Pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.2.4 below.



**Figure 4.1.4.2.4 Input the New mm per Pulse Screen**

Use 7.3 Method 3 to enter the New mm per Pulse value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.4.2.5 below.



**Figure 4.1.4.2.5 Accept the mm per Pulse Screen**

Pressing the [N] key will return the user to the Input the New mm per Pulse screen, Figure 4.1.4.2.4, while pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.2.6 below.



**Figure 4.1.4.2.6 Accept the Belt Speed Definitions Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.4.2.2 Set the Belt Speed Signal Input Type, while pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.2.7 below.

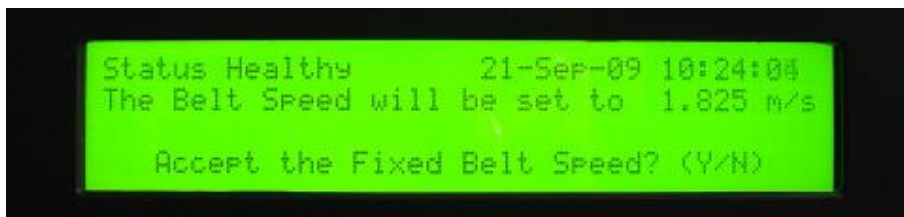
It is necessary to enter a fixed value for the Belt Speed. The Heat Eye System will use this value in the event of the Belt Speed transducer not working correctly.



**Figure 4.1.4.2.7 Input the New Fixed Belt Speed Screen**

Use 7.3 Method 3 to enter the New Fixed Belt Speed value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.4.2.8 below.

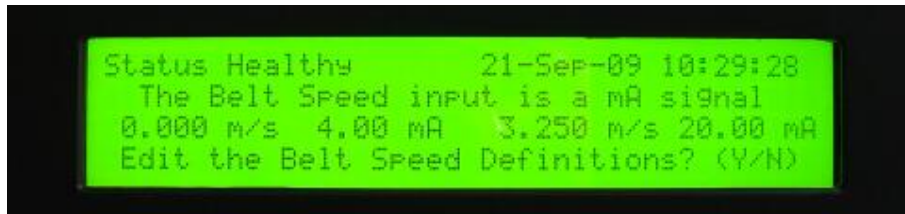


**Figure 4.1.4.2.8 Accept the Fixed Belt Speed Screen**

Pressing the [N] key will return the user to the Input New Fixed Belt Speed screen, Figure 4.1.4.2.7, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

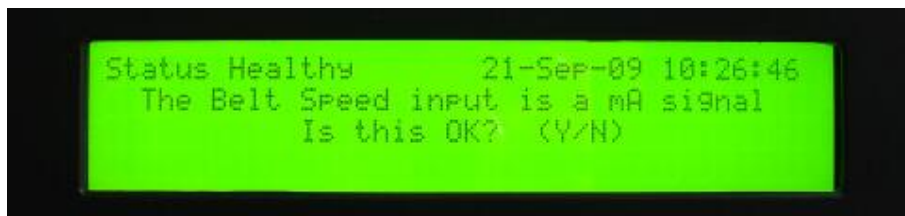
#### 4.1.4.3 Belt Speed Determined by Analogue Signal

Pressing the [ENT] key when the markers indicate ‘Access the Belt Speed Definitions’ and the belt speed is being determined by an analogue signal, will display the Edit the Belt Speed Definitions screen, as shown in Figure 4.1.4.3.1 below. The method of entering the input values of a mA signal or voltage signal is the same in both cases. The only difference is that the units are displayed in the correct form, for example 3.79mA or 0.379 v. An input signal of 4 to 20mA has been used in this section.



**Figure 4.1.4.3.1 Edit the Belt Speed Definitions Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.3.2 below.

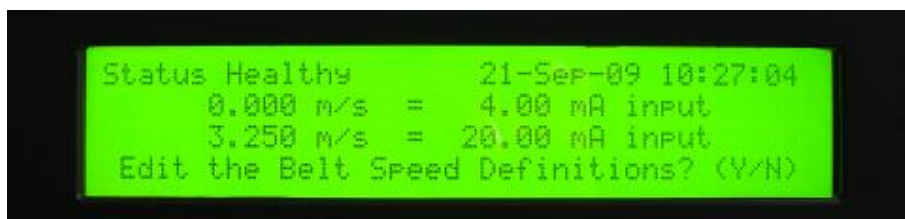


**Figure 4.1.4.3.2 Set the Belt Speed Signal Input Type Screen**

Use 7.1 Method 1 to select from the option list shown below :-

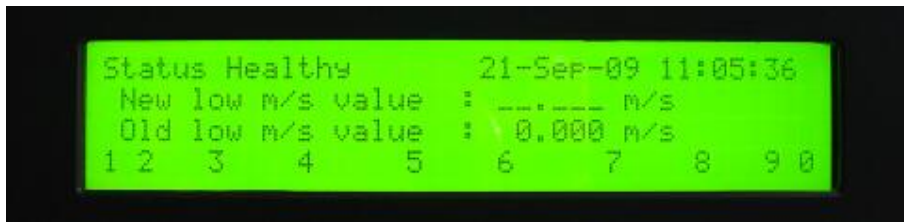
- The Belt Speed is by Contact Closure
- The Belt Speed is by a Pulse Signal
- The Belt Speed input is a mA signal
- The Belt Speed input is a voltage signal

Selecting the option ‘The Belt Speed is a mA Signal’ by pressing the [Y] key will display the Edit the Belt Speed Definitions screen, as shown in Figure 4.1.4.3.3 below.



**Figure 4.1.4.3.3 Edit the Belt Speed Definitions Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.3.4 below.



**Figure 4.1.4.3.4 Input the New low m/s value Screen**

Use 7.3 Method 3 to enter the New low m/s value.

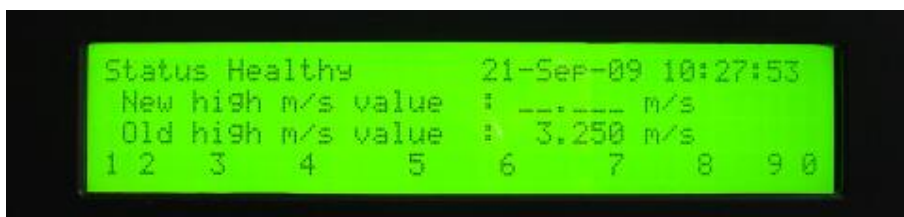
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.4.3.5 below.



**Figure 4.1.4.3.5 Input the New low m/s input Screen**

Use 7.3 Method 3 to enter the New low m/s input.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.4.3.6 below.



**Figure 4.1.4.3.6 Input the New high m/s value Screen**

Use 7.3 Method 3 to enter the New high m/s value.

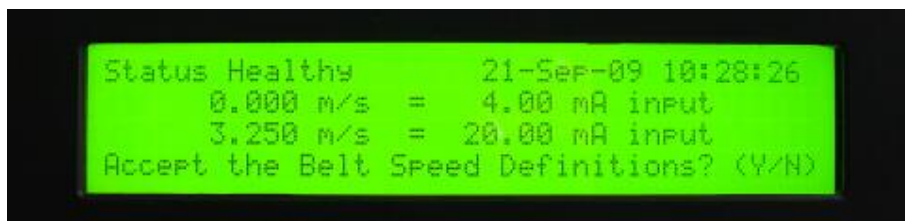
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.4.3.7 below.



**Figure 4.1.4.3.7 Input the New high m/s input Screen**

Use 7.3 Method 3 to enter the New high m/s input.

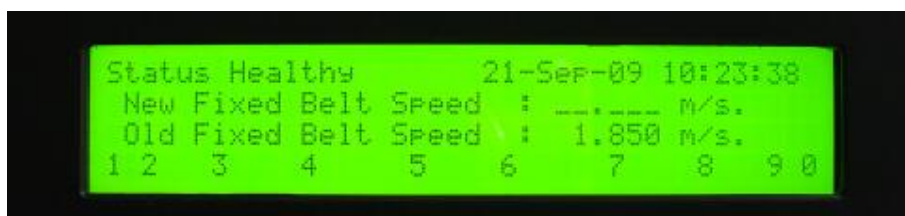
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.4.3.8 below.



**Figure 4.1.4.3.8 Input the New high m/s input Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.4.3.2 Set the Belt Speed Signal Input Type, while pressing the [Y] key will display the next screen, as shown in Figure 4.1.4.3.9 below.

It is necessary to enter a fixed value for the Belt Speed. The Heat Eye System will use this value in the event of the Belt Speed transducer not working correctly.

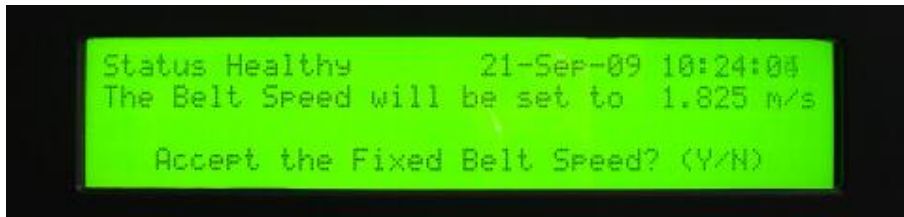


**Figure 4.1.4.3.9 Input the New Fixed Belt Speed Screen**

Use 7.3 Method 3 to enter the New Fixed Belt Speed value.

---

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.4.3.10 below.



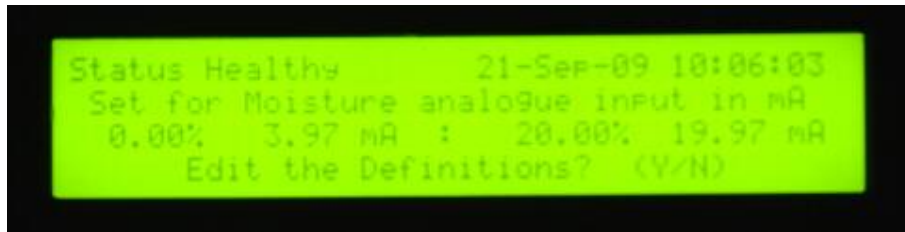
**Figure 4.1.4.3.10 Accept the Fixed Belt Speed Screen**

Pressing the [N] key will return the user to the Input New Fixed Belt Speed screen, Figure 4.1.4.3.9, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

## 4.1.5 Access the Moisture Definitions

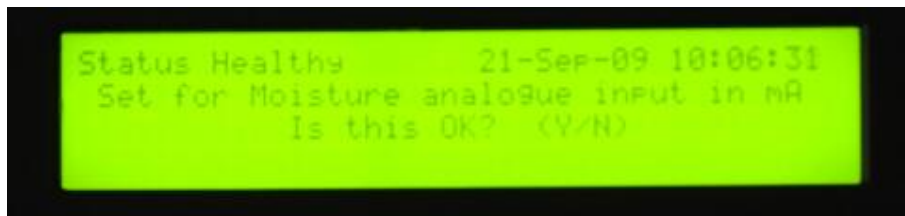
The Moisture input can be an analogue mA signal or an analogue voltage signal.

Pressing the [ENT] key when the markers indicate 'Access the Moisture Definitions' will display the Edit the Moisture Definitions screen, as shown in Figure 4.1.5.1 below. The method of entering the input values of a mA signal or voltage signal is the same in both cases. The only difference is that the units are displayed in the correct form, for example 3.79mA or 0.379 v. An input signal of 4 to 20mA has been used in this section.



**Figure 4.1.5.1 Edit the Moisture Definitions Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.5.2 below.



**Figure 4.1.5.2 Set the Moisture Signal Input Type Screen**

Use 7.1 Method 1 to select from the option list shown below :-

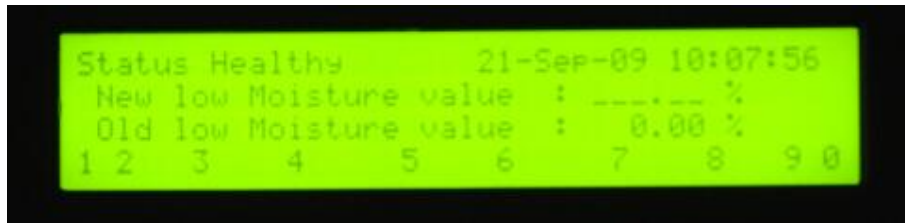
- The Moisture input is a mA signal
- The Moisture input is a voltage signal

Selecting the option 'The Moisture input is a mA Signal' by pressing the [Y] key will display the Edit the Moisture Definitions screen, as shown in Figure 4.1.5.3 below.



**Figure 4.1.5.3 Edit the Moisture Definitions Screen**

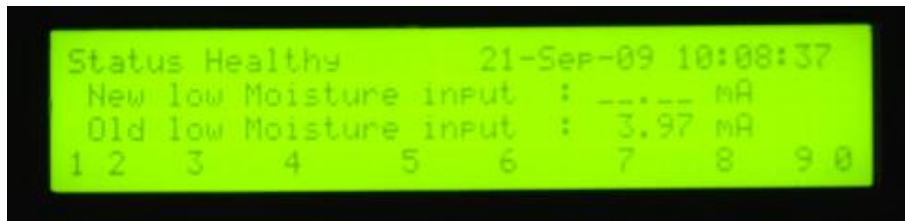
Pressing the [Y] key will display the next screen, as shown in Figure 4.1.5.4 below.



**Figure 4.1.5.4 Input the New low Moisture value Screen**

Use 7.3 Method 3 to enter the New low Moisture value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.5.5 below.



**Figure 4.1.5.5 Input the New low Moisture input Screen**

Use 7.3 Method 3 to enter the New low Moisture input.

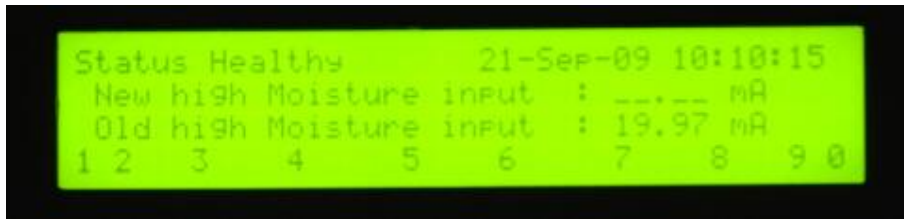
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.5.6 below.



**Figure 4.1.5.6 Input the New high Moisture value Screen**

Use 7.3 Method 3 to enter the New high Moisture value.

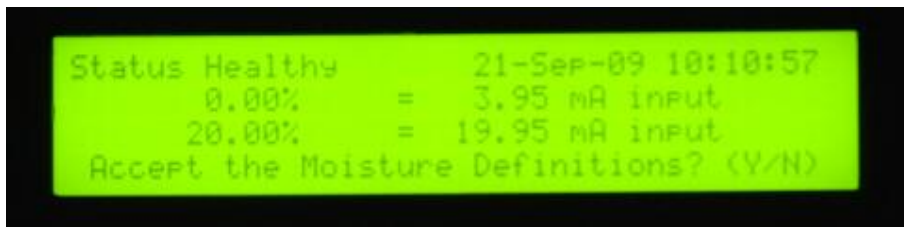
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.5.7 below.



**Figure 4.1.5.7 Input the New high Moisture input Screen**

Use 7.3 Method 3 to enter the New high Moisture input.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.5.8 below.



**Figure 4.1.5.8 Accept the New Moisture Definitions Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.5.2 Set the Moisture Input Type, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

### 4.1.6 Access the Temperature Definitions

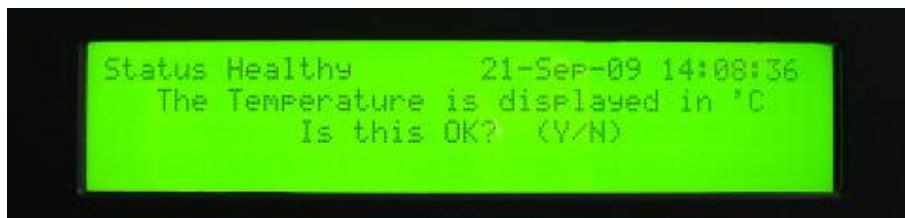
The Heat Eye system has a temperature transducer mounted inside the Local Processor Cabinet. The temperature can be displayed in Celsius or Fahrenheit.

Pressing the [ENT] key when the markers indicate 'Access the Temperature Definitions', will display the Edit the Temperature Display screen, as shown in Figure 4.1.6.1 below.



**Figure 4.1.6.1 Edit the Temperature Display Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.6.2 below.



**Figure 4.1.6.2 Set the Temperature Display Units Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- The Temperature is displayed in 'C
- The Temperature is displayed in 'F

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.6.3 below.



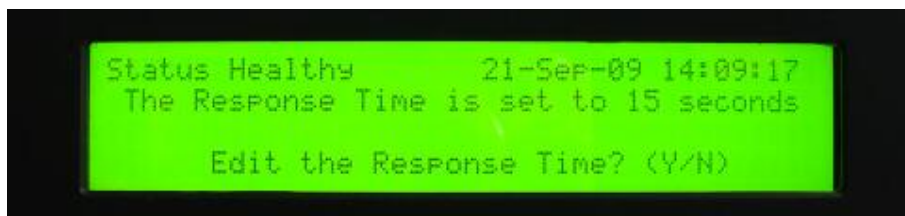
**Figure 4.1.6.3 Accept the Temperature Display Screen**

Pressing the [N] key will return the user to the Set the Temperature Display Units screen, Figure 4.1.6.2, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

### 4.1.7 Access the Response Time

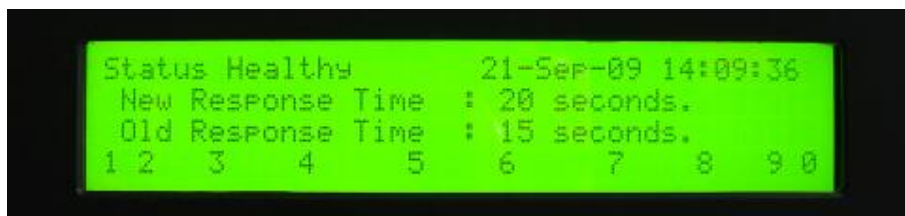
The Heat Eye system calculates the instantaneous ash content, instantaneous tonnes per hour, the shift ash content and the total tonnes for the shift every second. The instantaneous figures are very noisy and can be hard to read. In order to make the figures displayed on the screen are more readable, a response time can be applied. This response time is only used to smooth the figures displayed on the Calculated Information Display screen on the screen when the [D] key is pressed.

Pressing the [ENT] key when the markers indicate 'Access the Response Time', will display the Edit the Response Time screen, as shown in Figure 4.1.7.1 below.



**Figure 4.1.7.1 Edit the Response Time Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.7.2 below.



**Figure 4.1.7.2 Enter the New Response Time Screen**

Use 7.2 Method 2 to enter the New Response Time. The system will accept a response time between 1 and 60 seconds. A response time of between 15 to 30 seconds is normally used.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.7.3 below.



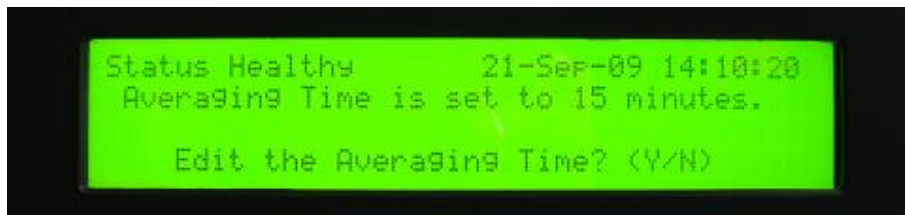
**Figure 4.1.7.3 Accept the Response Time Screen**

Pressing the [N] key will return the user to the Enter the New Response Time screen, Figure 4.1.7.2, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

#### 4.1.8 Access the Data Record Averaging Time

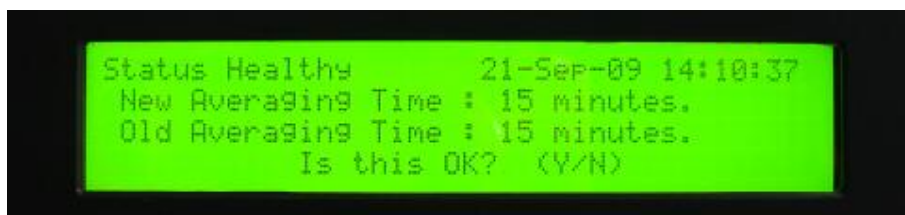
The Heat Eye system maintains a file, which holds information to allow the background slope term and intercept term to be calculated. The date, time, average main gamma count rate, average background gamma count rate, average calculated empty belt gamma count rate, average empty belt offset, average belt speed, average tonnes per hour, number of seconds in average and a belt empty flag are written to the file. The averages are built up every second, until the Averaging Time has been reached. The averages are then written to the file and the averages reset. The file holds 1280 records. The Averaging Time can be set from 15 minutes to 240 minutes, giving a file record of 13 days 8 hours to 213 days 8 hours. The Averaging Time is normally set to 45 minutes, to give a file record of 40 days, at a resolution suitable for the calculation of the background slope term and intercept term.

Pressing the [ENT] key when the markers indicate 'Access the Data Record Averaging Time', will display the Edit the Averaging Time screen, as shown in Figure 4.1.8.1 below.



**Figure 4.1.8.1 Edit the Averaging Time Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.8.2 below.



**Figure 4.1.8.2 Enter the New Averaging Time Screen**

Use 7.1 Method 4 to select from the option list shown below :-

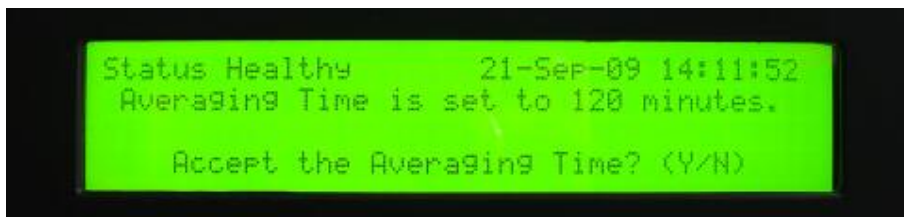
- 15
- 30
- 45
- 60
- 90
- 120
- 180
- 240

Pressing the [N] key five times will display the next screen, as shown in Figure 4.1.8.3 below.



**Figure 4.1.8.3 Enter the New Averaging Time Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.8.4 below.



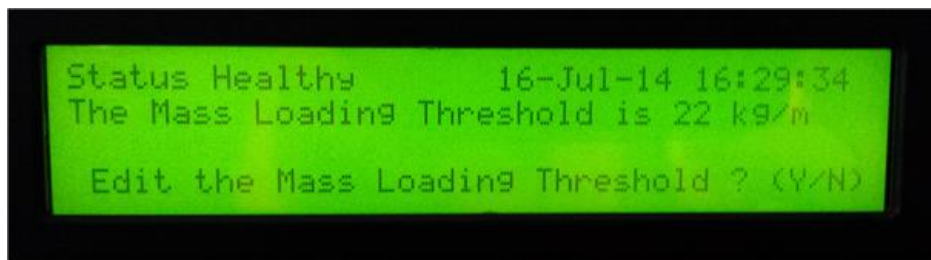
**Figure 4.1.8.4 Accept the Averaging Time Screen**

Pressing the [N] key will return the user to the Enter the New Averaging Time screen, Figure 4.1.8.2, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

### 4.1.9 Access the Mass Loading Threshold

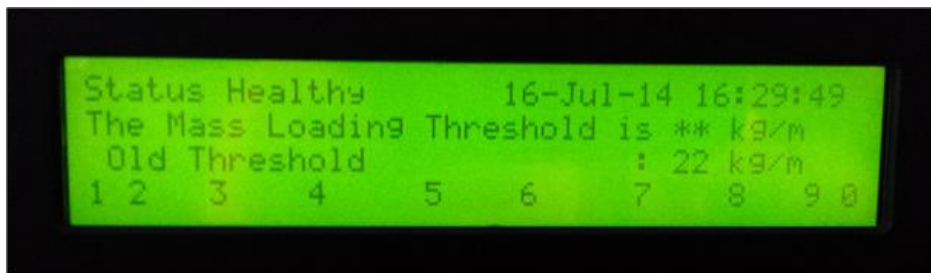
The mass loading is the amount of weight over each meter of the conveyor belt. It is determined by the tonnes per hour figure reported by the belt weigher and the determined belt speed. If the figure is too low, the calculated ash figure will be excessively high as there is not enough material to make an accurate calculation. The Mass Loading Threshold defines a lower limit for the mass loading. When the mass loading falls below this level, the reported ash figure will not be included in the averaging calculation for the shift as the figure is likely to be excessively, and falsely, high and therefore could skew the overall average.

Pressing the [ENT] key when the markers indicate 'Access the Mass Loading Threshold, will display the Edit the Response Time screen, as shown in Figure 4.1.9.1 below.



**Figure 4.1.9.1 Edit the Mass Loading Threshold Screen**

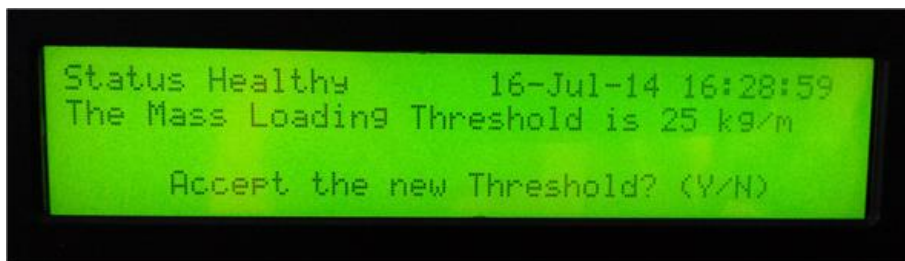
Pressing the [Y] key will display the next screen, as shown in Figure 4.1.9.2 below.



**Figure 4.1.9.2 Enter the Mass Loading Threshold Screen**

Use 7.2 Method 2 to enter the New Mass Loading Threshold value. The system will accept a value between 0 (which effectively disables the monitoring of the level) and 99 kg/m. The default values is 15kg. Bretby Gammatech suggest that mass loading needs to be above 25kg/m to give true readings of ash content.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.9.3 below.



**Figure 4.1.9.3 Accept the Mass Loading Threshold Screen**

Pressing the [N] key will return the user to the Enter the Mass Loading Threshold screen, Figure 4.1.9.2, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

#### 4.1.10 Access the C.V. Definitions

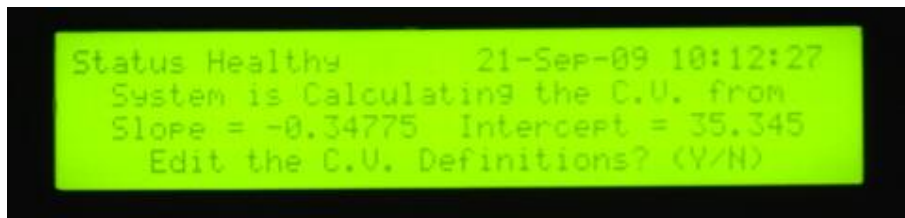
The Calorific Value is calculated from the sum of the %ash and % moisture. A linear relationship has been assumed between the total inerts (ash + moisture) and the calorific value. To calculate the Calorific Value from the total inerts, the following formula is used.

$$\text{Calorific Value} = \text{slope term} * \text{total inerts} + \text{intercept term}$$

The slope term and the intercept term being derived from a linear regression of the Calorific Value against the total inerts.

Pressing the [ENT] key when the markers indicate 'Access the C.V. Definitions' will display the Edit the C.V. Definitions screen, as shown in Figure 4.1.9.1 below.

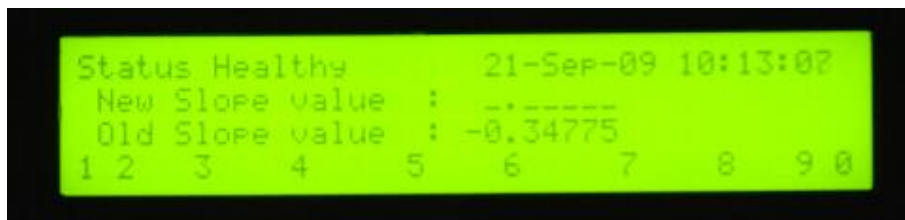
If the Alter/View the System Settings Menu has been accessed without a valid password being entered, then pressing the [ENT] key when the markers indicate 'Access the C.V. Definitions' will display the C.V. Definitions screen, as shown in Figure 4.1.10.1 below. The message 'Press 'C' to Continue' will be displayed, indicating that the user cannot change the C.V. definitions.



**Figure 4.1.10.1 Edit the C.V. Definitions Screen**

To edit the C.V. definitions the [Y] key is pressed. If the [N] key is pressed then the user will be taken back to the Alter/View the Signal Definitions Menu.

Pressing the [Y] key will display the next screen, as shown in Figure 4.1.10.2 below.



**Figure 4.1.10.2 Input the Slope Term Screen**

Use 7.3 Method 3 to enter the New Slope value.

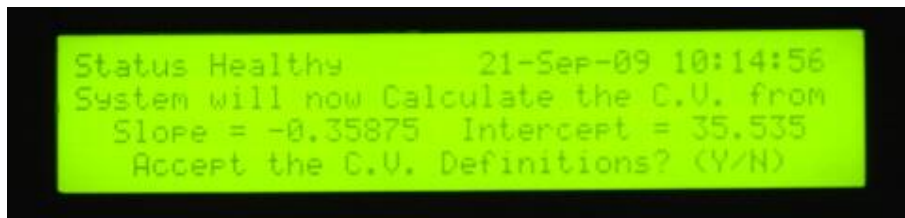
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.10.3 below.



**Figure 4.1.10.3 Input the Intercept Term Screen**

Use 7.3 Method 3 to enter the New Intercept value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.1.10.4 below.



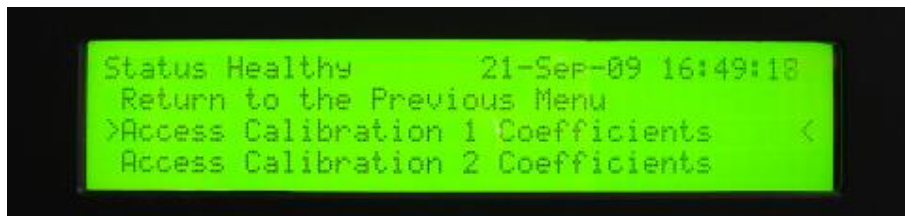
**Figure 4.1.10.4 Accept the C.V. Definitions Screen**

Pressing the [N] key will return the user to the start of the process, Figure 4.1.10.2 Input the Slope Term, while pressing the [Y] key will take the user back to the Alter/View the Signal Definitions Menu.

## 4.2 Alter/View the Calibration Data

The Heat Eye system uses the calibration coefficients to calculate the ash content of the load on the belt. Up to four separate sets of calibration coefficients can be stored and used. There are eight digital inputs to the Heat Eye system, each representing a different coal source. If two or more of these inputs are used, a different set of calibration coefficients can be automatically assigned to each coal source.

Pressing the [ENT] key when the markers indicate 'Alter/View the Calibration Data' will display the Alter/View the Calibration Data Menu, as shown in Figure 4.2.1 below.



**Figure 4.2.1 Alter/View the Calibration Data Menu Screen**

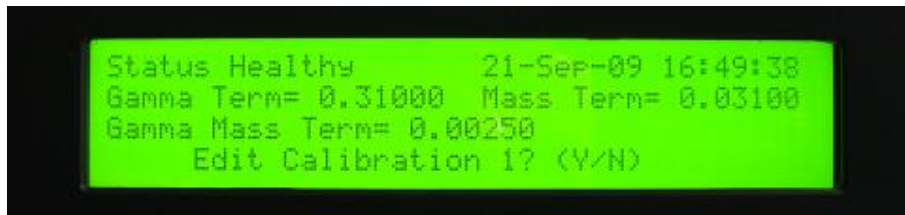
The Alter/View the Calibration Data Menu has six options, which are :-

- Return to the Previous Menu
- Access Calibration 1 Coefficients
- Access Calibration 2 Coefficients
- Access Calibration 3 Coefficients
- Access Calibration 4 Coefficients
- Assign Calibration Coefficients

This menu system allows the user to view and/or alter the calibration coefficients listed above. The method of altering the calibration coefficients is the same for all four sets of coefficients.

## 4.2.1 Access the Calibration Coefficients

Pressing the [ENT] key when the markers indicate 'Access Calibration 1 Coefficients' will display the Edit Calibration 1 screen, as shown in Figure 4.2.1.1 below.



**Figure 4.2.1.1 Edit Calibration 1 Screen**

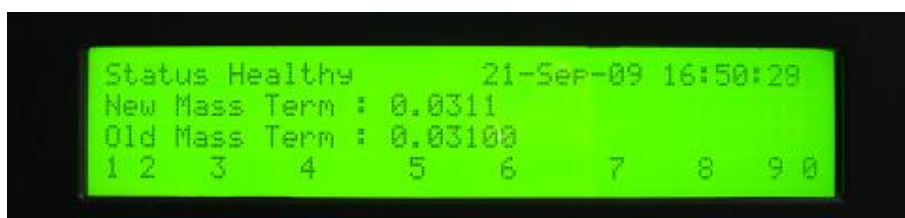
Pressing the [Y] key will display the next screen, as shown in Figure 4.2.1.2 below.



**Figure 4.2.1.2 Input the New Gamma Term Screen**

Use 7.3 Method 3 to enter the New Gamma Term value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.2.1.3 below.



**Figure 4.2.1.3 Input the New Mass Term Screen**

Use 7.3 Method 3 to enter the New Mass Term value.

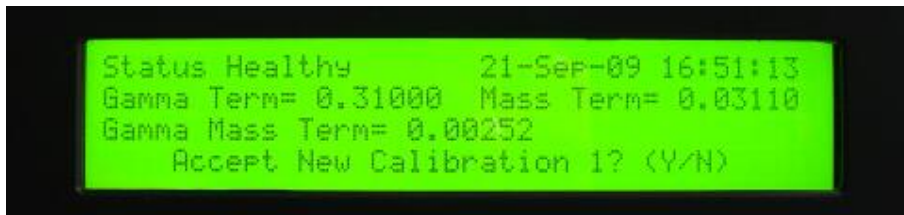
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.2.1.4 below.



**Figure 4.2.1.4 Input the New Gamma Mass Term Screen**

Use 7.3 Method 3 to enter the New Gamma Mass Term value.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.2.1.5 below.



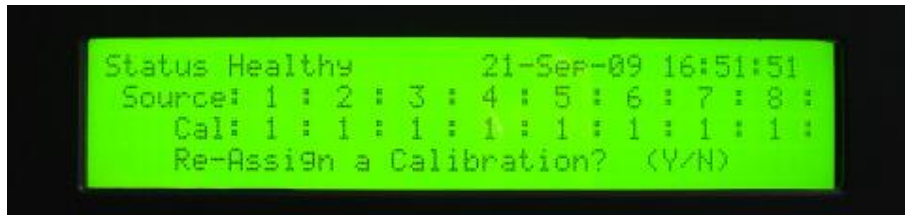
**Figure 4.2.1.5 Accept the New Calibration 1 Screen**

Pressing the [N] key will return the user to the Input the New Gamma Term screen, Figure 4.2.1.2, while pressing the [Y] key will take the user back to the Alter/View the Calibration Data Menu.

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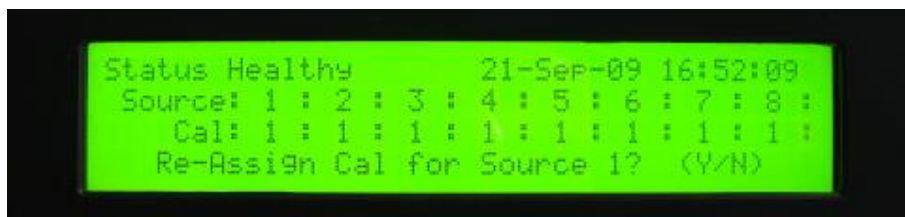
## 4.2.2 Assign Calibration Coefficients

Pressing the [ENT] key when the markers indicate 'Assign Calibration Coefficients' will display the Re-Assign a Calibration screen, as shown in Figure 4.2.2.1 below.



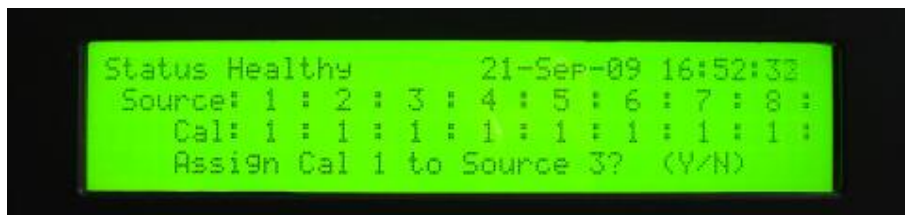
**Figure 4.2.2.1 Re-Assign a Calibration Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.2.2.2 below.



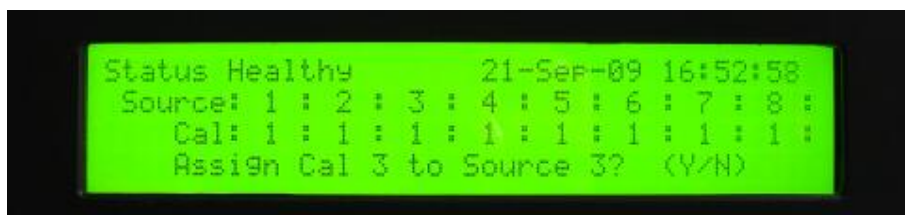
**Figure 4.2.2.2 Re-Assign Cal for Source Screen**

Press the [N] key until the required source is indicated. Pressing the [Y] key will display the next screen, as shown in Figure 4.2.2.3 below.



**Figure 4.2.2.3 Assign Cal to Source Screen**

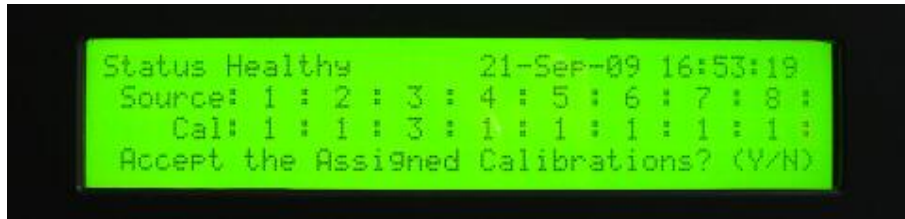
Press the [N] key until the required calibration is indicated. Pressing the [Y] key will display the next screen, as shown in Figure 4.2.2.4 below.



**Figure 4.2.2.4 Re-Assign Cal for Source Screen**

---

Pressing the [Y] key will display the next screen, as shown in Figure 4.2.2.2 above, but with 'Re-assign Cal for Source 4? (Y/N)' displayed on the bottom line. Once all the sources have been stepped through, Figure 4.2.2.5 will be displayed, as shown below.



**Figure 4.2.2.5 Accept the New Calibration 1 Screen**

Pressing the [N] key will return the user to the Re-Assign a Calibration screen, Figure 4.2.2.1, while pressing the [Y] key will take the user back to the Alter/View the Calibration Data Menu.

### 4.3 Alter/View the Relay Settings

The Heat Eye system has two sets of single pole changeover relay contacts. These are designated Relay 0 and Relay 1. The relays can be set to operate under various conditions as described below.

Pressing the [ENT] key when the markers indicate 'Alter/View the Relay Settings' will display the Alter/View the Relay Settings Menu, as shown in Figure 4.3.1 below.



**Figure 4.3.1 Alter/View the Relay Settings Menu Screen**

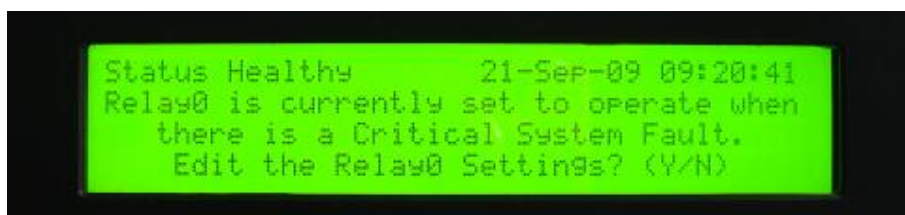
The Alter/View the Relay Settings Menu has four options, which are :-

- Return to the Previous Menu
- Alter/View Relay0 Settings
- Alter/View Relay1 Settings
- Alter/View %Ash Target and Range
- Alter/View %Moisture Target and Range
- Alter/View %C.V. Target and Range

This menu system allows the user to view and/or alter the settings of the relays listed above. The method of altering the relay settings is the same for both relays. Both relays use the same figures for the %Ash, %Moisture and C.V. Targets and Ranges. It is not possible to set a different %Ash, %Moisture and C.V. Target and Range for each relay.

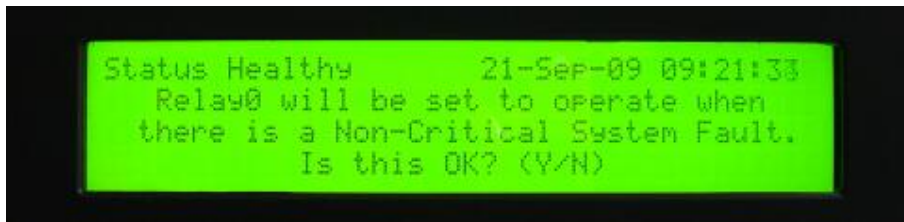
#### 4.3.1 Alter/View Relay0/1 Settings

Pressing the [ENT] key when the markers indicate 'Alter/View Relay0 Settings' will display the Edit the Relay0 Settings screen, as shown in Figure 4.3.1.1 below.



**Figure 4.3.1.1 Edit the Relay0 Settings Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.3.1.2 below.

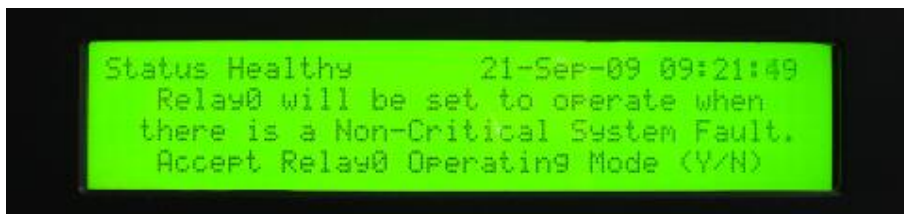


**Figure 4.3.1.2 Set the Relay Operating Mode Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- Relay0 will be set to operate when there is a Critical System Fault.
- Relay0 will be set to operate when there is a Non-Critical System Fault.
- Relay0 will be set to operate when the %Ash is < the Target Range.
- Relay0 will be set to operate when the %Ash is <math>\diamond</math> the Target Range.
- Relay0 will be set to operate when the %Ash is > the Target Range.
- Relay0 will be set to operate when the %Moisture is < the Target Range.
- Relay0 will be set to operate when the %Moisture is <math>\diamond</math> the Target Range.
- Relay0 will be set to operate when the %Moisture is > the Target Range.
- Relay0 will be set to operate when the C.V. is < the Target Range.
- Relay0 will be set to operate when the C.V. is <math>\diamond</math> the Target Range.
- Relay0 will be set to operate when the C.V. is > the Target Range.

Pressing the [Y] key will display the next screen, as shown in Figure 4.3.1.3 below.



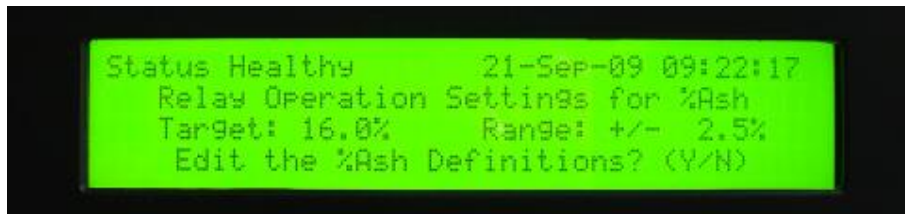
**Figure 4.3.1.3 Accept the Relay Operating Mode Screen**

Pressing the [N] key will return the user to the Set the Relay Operating Mode screen, Figure 4.3.1.2, while pressing the [Y] key will take the user back to the Alter/View the Relay Settings Menu.

### 4.3.2 Alter/View the %Ash Target and Range

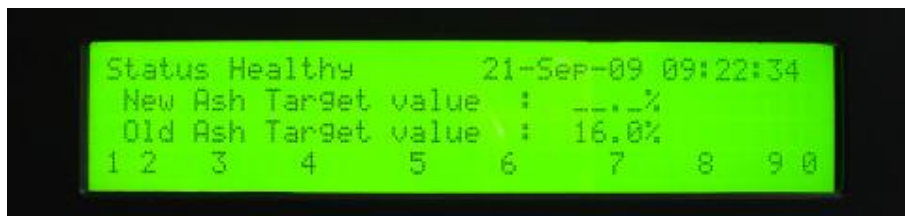
This facility allows the user to set a target % ash value and a %ash target range. For the example screen below, the %ash target is 16.0% with a range of 13.5% to 18.5%. The criteria for the relay operation in the above list is based on the 13.5 and 18.5 values, not the 16.0 value.

Pressing the [ENT] key when the markers indicate 'Alter/View %Ash Target and Range' will display the Edit the %Ash Definitions screen, as shown in Figure 4.3.2.1 below.



**Figure 4.3.2.1 Edit the %Ash Definitions Screen**

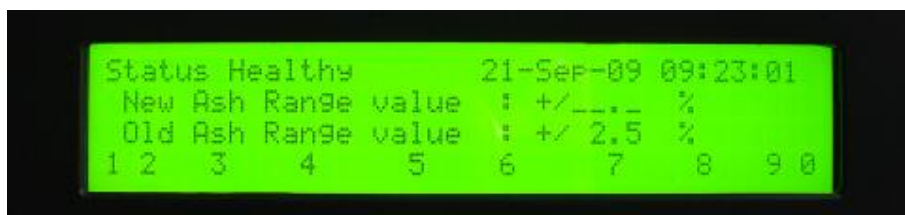
Pressing the [Y] key will display the next screen, as shown in Figure 4.3.2.2 below.



**Figure 4.3.2.2 Input the New Ash Target value Screen**

Use 7.3 Method 3 to enter the New Ash Target value. The target %Ash must be greater than 5.0% and less than 95%

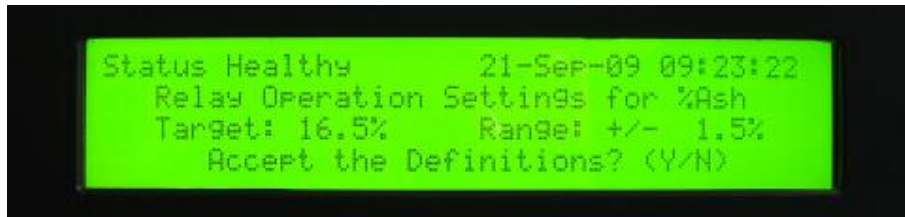
Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.3.2.3 below.



**Figure 4.3.2.3 Input the New Ash Range value Screen**

Use 7.3 Method 3 to enter the New Ash Range value. The %Ash range must be greater than 0.5%.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.3.2.4 below.



**Figure 4.3.2.4 Accept the Target and Range Settings Screen**

Pressing the [N] key will return the user to the Input the Ash Target value screen, Figure 4.3.2.2, while pressing the [Y] key will take the user back to the Alter/View the Relay Settings Menu.

### **4.3.3 Alter/View the %Moisture Target and Range**

This facility allows the user to set a target % moisture value and a %moisture target range. The method of entering the %moisture target and range is identical to that described in section 4.3.2 Alter/View the %Ash Target and Range above.

The target %Moisture must be greater than 5.0% and less than 95%

The %Moisture range must be greater than 0.5%.

### **4.3.4 Alter/View the C.V. Target and Range**

This facility allows the user to set a target C.V. value and a C.V. target range. The method of entering the C.V. target and range is identical to that described in section 4.3.2 Alter/View the %Ash Target and Range above.

The target C.V. must be greater than 5MJ/kg and less than 30MJ/kg.

The C.V. range must be greater than 0.5MJ/kg.

## 4.4 Alter/View the Analogue Output Settings

The Heat Eye system has two 4 to 20mA analogue outputs. These are designated Vout0 and Vout1. The analogue outputs can be set to represent the values as displayed on the Calculated Information Display screen, Figure 1.4. The instantaneous (now:) tonnes per hour, %Ash and C.V., and the accumulated shift %Ash and C.V. can be assigned to either of the analogue outputs. The analogue outputs are updated every second. The instantaneous values are smoothed by the 'Response Time', which can be set to any value between 1 and 60 seconds.

Pressing the [ENT] key when the markers indicate 'Alter/View the Analogue O/put Settings' will display the Alter/View the Analogue O/put Settings Menu, as shown in Figure 4.4.1 below.



**Figure 4.4.1 Alter/View the Analogue O/put Settings Menu Screen**

The Alter/View the Analogue O/put Settings Menu has eight options, which are :-

- Return to the Previous Menu
- Alter/View Analogue Vout0 Settings
- Alter/View Analogue Vout1 Settings
- Alter/View the %Ash now Output Range
- Alter/View the %Ash shift Output Range
- Set the Analogue Outputs to 12mA
- Alter/View the C.V. now Output Range
- Alter/View the C.V. shift Output Range

This menu system allows the user to view and/or alter the settings of the analogue outputs listed above. The method of altering the analogue settings is the same for both analogue outputs. Both analogue outputs use the same figures for the %Ash now Output Range, the %Ash shift Output Range, the C.V. now Output Range, the C.V. shift Output Range and the tonnes per hour Output Range. It is not possible to set a different Output Range for the same parameter, if the same parameter is sent to both analogue outputs.

#### 4.4.1 Alter/View Analogue Vout0/1 Settings

Pressing the [ENT] key when the markers indicate 'Alter/View Analogue Vout0 Settings' will display the Edit the Analogue Vout0 Settings screen, as shown in Figure 4.4.1.1 below.



**Figure 4.4.1.1 Edit the Analogue Vout0 Settings Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.4.1.2 below.

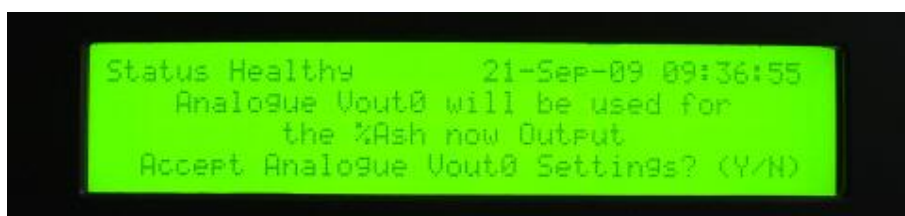


**Figure 4.4.1.2 Set the Analogue Vout0 Output Mode Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- Analogue Vout0 will be used for the %Ash now Output
- Analogue Vout0 will be used for the %Ash shift Output
- Analogue Vout0 will be used for the T/hr Output
- Analogue Vout0 will be used for the C.V. now Output
- Analogue Vout0 will be used for the C.V. shift Output

Pressing the [Y] key will display the next screen, as shown in Figure 4.4.1.3 below.



**Figure 4.4.1.3 Accept the Analogue Vout0 Output Mode Screen**

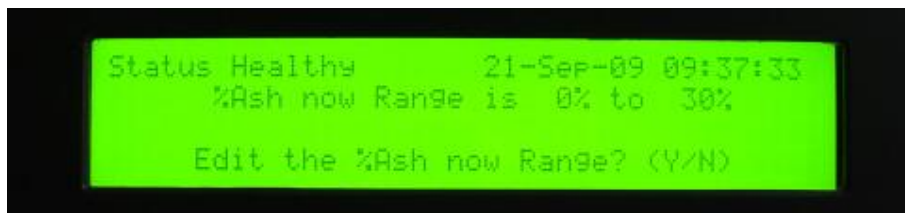
Pressing the [N] key will return the user to the Set the Analogue Vout0 Output Mode screen, Figure 4.4.1.2, while pressing the [Y] key will take the user back to the Alter/View the Analogue O/put Settings Menu.

#### 4.4.2 Alter/View the %Ash now Output Range Settings

The Heat Eye system has two 4 to 20mA analogue outputs. These are designated Vout0 and Vout1. The parameters %Ash now, %Ash shift, C.V. now, C.V. shift and tonnes per hour can be output to either analogue output. Both outputs are smoothed by the Response Time.

The %Ash now, %Ash shift, C.V. now and C.V. shift output ranges can be varied to suit the ash content and the C.V. normally displayed, but the tonnes per hour range is set by the full-scale value of the Belt Weigher Definitions. The method of altering the analogue output range is the same for %Ash now, %Ash shift, C.V. now and C.V. shift.

Pressing the [ENT] key when the markers indicate 'Alter/View the %Ash now Output Range', will display the Edit the %Ash now Output Range screen, as shown in Figure 4.4.2.1 below.



**Figure 4.4.2.1 Edit the %Ash now Output Range Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.4.2.2 below.

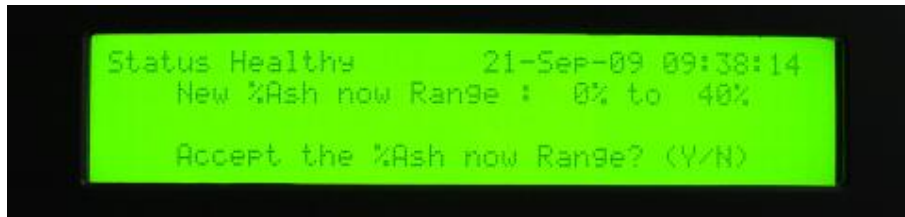


**Figure 4.4.2.2 Enter the New %Ash now Output Range Screen**

Use 7.1 Method 4 to select from the option list shown below:-

- 0 to 30%
- 0 to 40%
- 0 to 50%
- 20 to 60%
- 40 to 80%
- 0 to 100%

Pressing the [Y] key will display the next screen, as shown in Figure 4.4.2.3 below.



**Figure 4.4.2.3 Accept the New %Ash now Output Range Screen**

Pressing the [N] key will return the user to the Enter the New %Ash now Output Range screen, Figure 4.4.2.2, while pressing the [Y] key will take the user back to the Alter/View the Analogue O/put Settings Menu.

#### **4.4.3 Alter/View the %Ash shift Output Range Settings**

The method of altering the %Ash shift Output Range Settings is identical to that described in section 4.4.2 Alter/View the %Ash now Output Range Settings above.

#### **4.4.4 Set Analogue Outputs to 12mA**

Selecting this option will set both analogue outputs to 12mA. This facility allows the outputs to be checked with a known, steady value. If this facility has already been selected then the option to Set analogue Outputs to Normal will be in the Settings Menu. The analogue outputs will revert to normal after 15 minutes.

#### **4.4.5 Alter/View the C.V. now Output Range Settings**

The method of altering the C.V. now Output Range Settings is identical to that described in section 4.4.2 Alter/View the %Ash now Output Range Settings above. Use 7.1 Method 4 to select from the C.V. ranges option list shown below:-

- 0 to 10MJ/kg
- 5 to 15MJ/kg
- 0 to 20MJ/kg
- 10 to 20MJ/kg
- 15 to 25MJ/kg
- 10 to 30MJ/kg
- 20 to 30MJ/kg
- 25 to 35MJ/kg
- 20 to 40MJ/kg

#### **4.4.6 Alter/View the C.V. shift Output Range Settings**

The method of altering the C.V. shift Output Range Settings is identical to that described in section 4.4.2 Alter/View the %Ash now Output Range Settings above.

## 4.5 Alter/View the Shift Definitions

The Heat Eye system maintains a shift file, which holds information to allow the performance of the system to be checked. The shift start date and time, shift % ash and shift tonnes are written to the file at the end of every shift. The file holds 150 records. The user can specify the length of the shift in hours (from a list) and the number of minutes after midnight the shift starts. In the example below the shift length is 8 hours starting at 06:00, giving a daily shift pattern of 6:00 to 14:00, 14:00 to 22:00 and 22:00 to 06:00. The shift starting time after midnight can be any number of minutes, from 1 minute to 1 minute less than the length of shift in minutes.

Pressing the [ENT] key when the markers indicate 'Alter/View the Shift Definitions', will display the Edit the Shift Definitions screen, as shown in Figure 4.5.1 below.



**Figure 4.5.1 Edit the Shift Definitions Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.5.2 below.

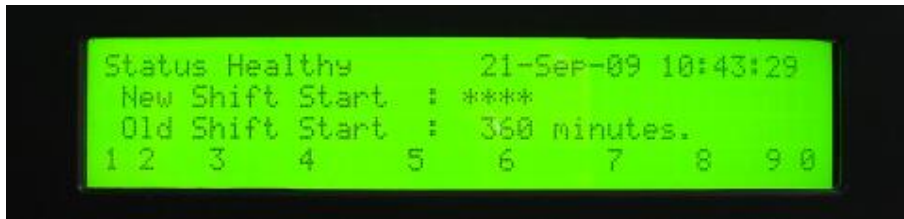


**Figure 4.5.2 Enter the New Shift Length Screen**

Use 7.1 Method 4 to select from the option list shown below :-

- 1
- 2
- 3
- 4
- 6
- 8
- 12
- 24

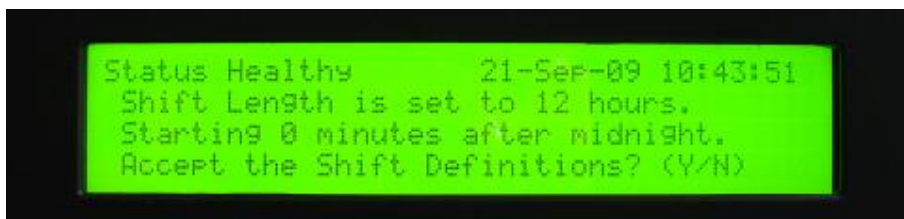
Pressing the [Y] key will display the next screen, as shown in Figure 4.5.3 below.



**Figure 4.5.3 Enter the New Shift Start Screen**

Use 7.3 Method 2 to enter the New Shift Start time. The shift start time must be 1 minute less than the length of the shift. If a time greater than the length of a shift is entered, a warning is given and the time for the shift start after midnight set to 0 minutes.

Pressing the [ENT] key or the [C/CE] key will display the next screen, as shown in Figure 4.5.4 below.



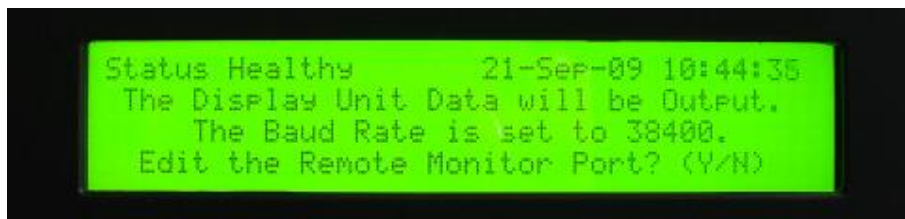
**Figure 4.5.4 Accept the Shift Definitions Screen**

Pressing the [N] key will return the user to the Enter the New Shift Length screen, Figure 4.5.2, while pressing the [Y] key will take the user back to the Alter/View the System Settings Menu.

## 4.6 Alter/View the Remote Port Settings

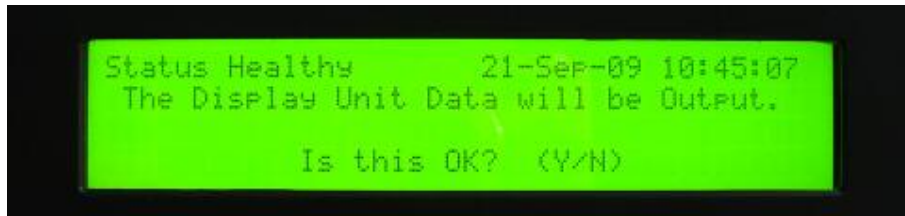
The RS232 serial port designated as the Remote Port is normally used to communicate with an Heat Eye Remote Display via long-line drivers and twisted pair cable. Distances of up to 10km are possible, dependent on local conditions. The baud rate of the port can be set, along with the type of data transmitted to the remote computer.

Pressing the [ENT] key when the markers indicate 'Alter/View the Remote Port Settings', will display the Edit the Remote Monitor Port screen, as shown in Figure 4.6.1 below.



**Figure 4.6.1 Edit the Remote Monitor Port Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.6.2 below.

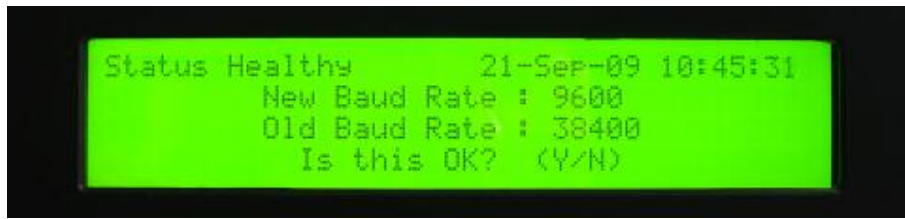


**Figure 4.6.2 Set the Output Data Type Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- The Display Unit Data will be Output.
- The Ash Data will be Output.
- The Original NGCQM Data will be Output.
- The NGCQM & D/Unit Data will be Output.
- All Data will be Output.
- No Data will be Output.

Pressing the [Y] key will display the next screen, as shown in Figure 4.6.3 below.



**Figure 4.6.3 Set the New Baud Rate Screen**

Use 7.1 Method 4 to select from the option list shown below :-

1200  
2400  
4800  
9600  
19200  
38400

Pressing the [Y] key will display the next screen, as shown in Figure 4.6.4 below.



**Figure 4.6.4 Accept Remote Monitor Port Settings Screen**

Pressing the [N] key will return the user to the Set the Output Data Type screen, Figure 4.6.2, while pressing the [Y] key will take the user back to the Alter/View the System Settings Menu.

## 4.7 Alter/View the Data Port Settings

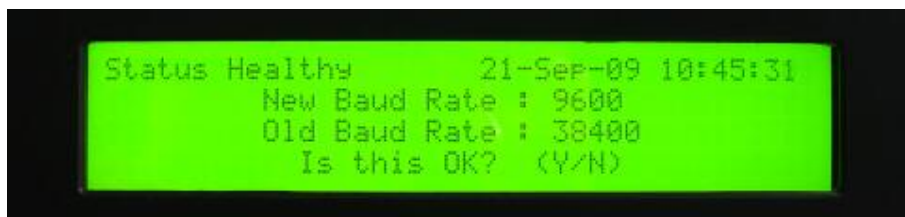
The RS232 serial port designated as the Data Port is normally used to download the data files to a local computer. The baud rate of the port can be set.

Pressing the [ENT] key when the markers indicate 'Alter/View the Data Port Settings', will display the Edit the Remote Monitor Port screen, as shown in Figure 4.7.1 below.



**Figure 4.7.1 Edit the Data Port Settings Screen**

Pressing the [Y] key will display the next screen, as shown in Figure 4.7.2 below.



**Figure 4.7.2 Set the New Baud Rate Screen**

Use 7.1 Method 4 to select from the option list shown below :-

1200  
2400  
4800  
9600  
19200  
38400

Pressing the [Y] key will display the next screen, as shown in Figure 4.7.3 below.

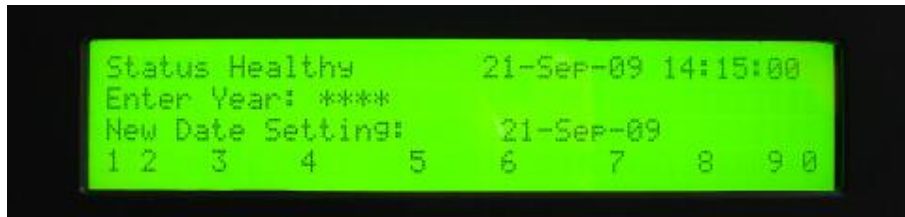


**Figure 4.7.3 Accept the Data Port Settings Screen**

Pressing the [N] key will return the user to the Set the New Baud Rate screen, Figure 4.7.2, while pressing the [Y] key will take the user back to the Alter/View the System Settings Menu.

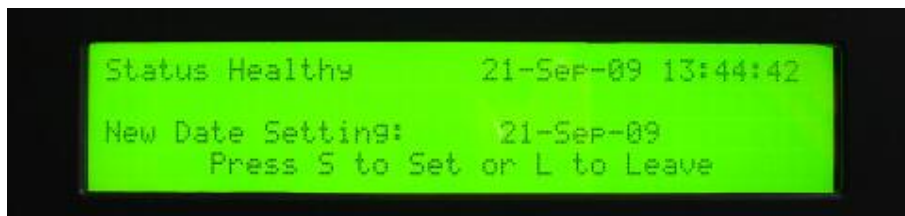
## 4.8 Alter the System Date

Pressing the [ENT] key when the markers indicate 'Alter the System Date', will display the Edit the System Date screen, as shown in Figure 4.8.1 below.



**Figure 4.8.1 Edit the System Date Screen**

The user will be prompted to enter each element of the date in turn, starting with the year. The year has to be entered as a 4-digit number, for example 2009. Pressing the [ENT] key will update the New Date Setting: and display the next date element screen. The month and the day have to be entered as a 2-digit number, for example 05. Once all three elements have been entered, or skipped by pressing the [C/CE] key, the Set the System Date screen will be displayed, as shown in Figure 4.8.2 below.

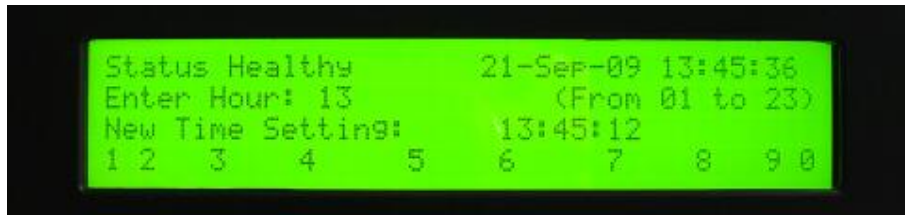


**Figure 4.8.2 Set the System Date Screen**

Pressing the [S] key will set the system date to the new setting, while pressing the [L] key will leave the date unchanged, and will also take the user back to the Alter/View the System Settings Menu.

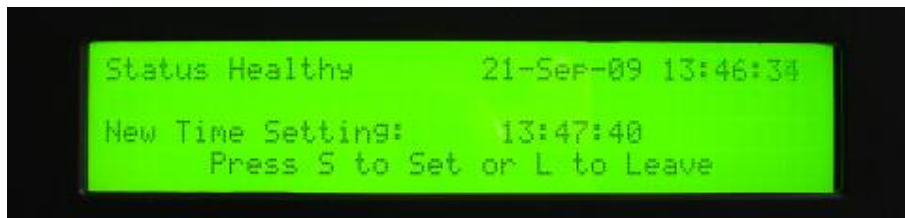
## 4.9 Alter the System Time

Pressing the [ENT] key when the markers indicate 'Alter the System Time', will display the Edit the System Time screen, as shown in Figure 4.9.1 below.



**Figure 4.9.1 Edit the System Time Screen**

The user will be prompted to enter each element of the time in turn, starting with the hours. Pressing the [ENT] key will update the New Time Setting: and display the next time element screen. The hours, minutes and seconds have to be entered as a 2-digit number, for example 05. Once all three elements have been entered, or skipped by pressing the [C/CE] key, the Set the System Time screen will be displayed, as shown in Figure 4.9.2 below.

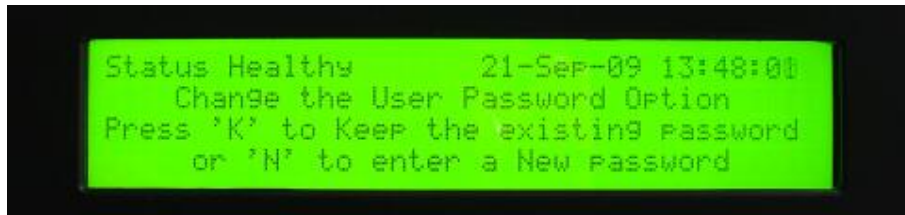


**Figure 4.9.2 Set the System Time Screen**

Pressing the [S] key will set the system time to the new setting, while pressing the [L] key will leave the time unchanged, and will also take the user back to the Alter/View the System Settings Menu.

## 4.10 Alter the User Password

Pressing the [ENT] key when the markers indicate 'Alter the User Password', will display the Change the User Password Option screen, as shown in Figure 4.10.1 below.

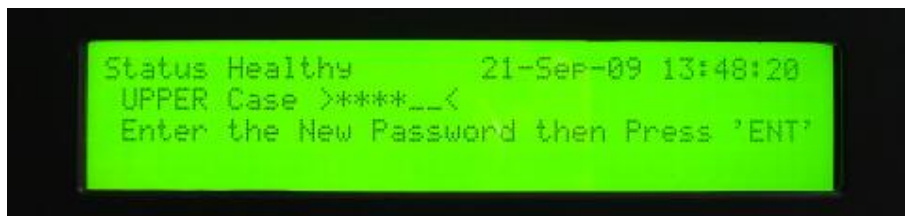


**Figure 4.10.1 Change the User Password Option Screen**

The user is prompted to press the [K] key to keep the existing password or the [N] key to enter a new password.

If the [K] key is pressed, the message 'The existing password will be kept' is printed on the third line of the screen for a short period and then the user is taken back to the Alter/View the System Settings Menu.

If the [N] key is pressed, the Enter the New Password screen will be displayed, as shown in Figure 4.10.2 below.



**Figure 4.10.2 Enter the New Password Screen**

Figure 4.10.2 shows the new password entry screen, with four characters already entered. As each letter or number is entered the '\_' changes to '\*'. A combination of upper and lower case letters, numbers and the symbols '-' and '.' are allowed. The factory set default password is 'BRETBY', but the user can change this password if required. How to access the number keys and lower case letters is described in section 3.1.

Once the new password has been entered and the [ENT] key pressed, the Re-enter the Password screen will be displayed, as shown in Figure 4.10.3 below.



**Figure 4.10.3 Re-enter the Password Screen**

The user is prompted to re-enter the password, exactly as entered in the previous step, and then press the [ENT] key. If the re-entered password matches the new password then the New Password Confirmed screen will be displayed, as shown in Figure 4.10.4 below.



**Figure 4.10.4 New Password Confirmed Screen**

The New Password Confirmed message is displayed for a short period and then the user is taken back to the Alter/View the System Settings Menu.

If the password entry is skipped by pressing the [C/CE] key at any time, the message 'Password Entry Skipped' is displayed on the third line of the screen for a short period and then the user is taken back to the Alter/View the System Settings Menu.

If the new password and the re-entered password are not the same then the message 'New Password NOT Confirmed' is displayed on the third line of the screen for a short period and then the user is taken back to the Alter/View the System Settings Menu.

## 5. Access the Text Messages Menu

The Heat Eye System has the facility to send text messages to, and to receive text messages from, the Heat Eye Remote Display Unit. These messages can be in the form of fixed messages, or text messages written via the keypad. The received text messages are stored in a file when they are received, along with the date and time of the message and a 'new message' tag. As each message is read (displayed on the screen), the 'new message' tag is removed, so it is possible to determine whether or not a message has been read. The file can hold the last ten messages, with the oldest one being removed when a new message is received.

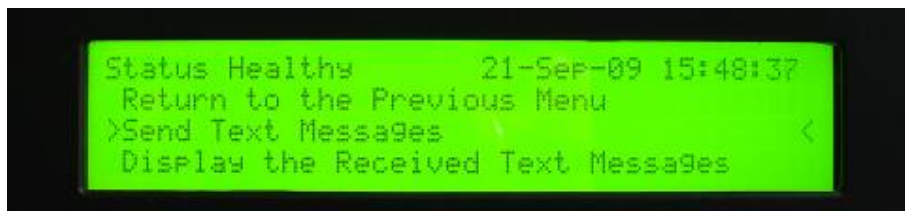
The facility has been designed to help during the calibration process, in the unlikely event that communication by telephone, tannoy system or radio is difficult.

When a text message is been received, the message 'New Text Message' as well as the date and time of the message, is displayed on the second line of the screen, as shown in Figure 5 below.



**Figure 5 New Text Message Received Screen**

Pressing the [M] key and selecting the 'Access the Text Messages Menu' option from the Main Menu will display the Text Messages Menu, as shown in Figure 5.1 below.



**Figure 5.1 Text Messages Menu Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- Return to the Previous Menu
- Send Text Messages
- Display the Received Text Messages

## 5.1 Display the Received Text Messages

Pressing the [ENT] key when the markers indicate ‘Display the Received Text Messages’ will display the Received Text Messages screen, as shown in Figure 5.1.1 below.



**Figure 5.1.1 Received Text Messages Screen**

When first selected, this screen will show the last message received. On the second line information is given on the number of messages in the message file and the number of the current message being displayed, in this case message 1 of 4. The actual message is displayed on the third line of the display. The date and time of the message time is displayed on the bottom line of the display. The word ‘New’ will also be displayed if this is the first time the message has been displayed. If the [ENT] key is pressed then the user will be taken back to the Text Messages Menu.

Pressing the [↓] and [↑] keys will scroll through the received messages. Pressing the [↓] will display the message in the file, as shown in Figure 5.1.2 below.

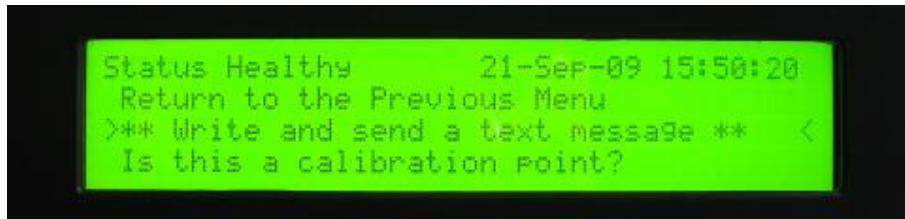


**Figure 5.1.2 Received Text Message 2 Screen**

Note that this message has already been displayed at least once, and the word ‘New’ is not displayed on the bottom line of the screen.

## 5.2 Send Text Messages

Pressing the [ENT] key when the markers indicate ‘Send Text Messages’ will display the Send Text Messages Menu screen, as shown in Figure 5.2.1 below.

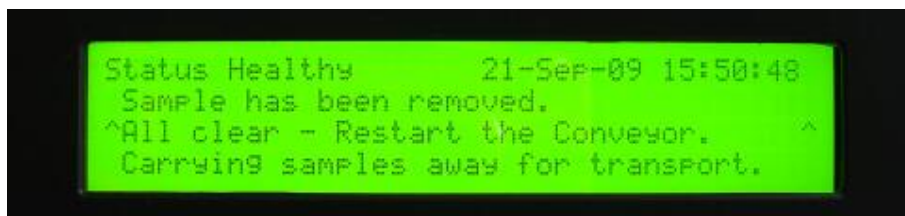


**Figure 5.2.1 Send Text Messages Menu Screen**

Use 7.1 Method 1 to select from the option list shown below :-

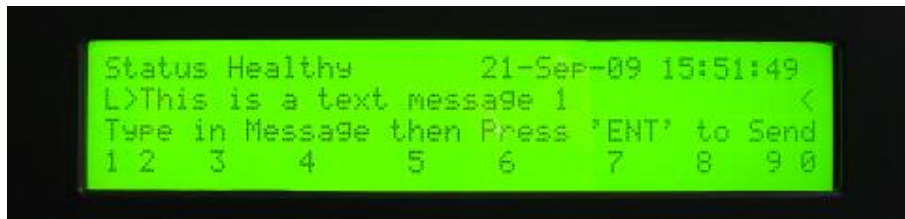
Return to the Previous Menu  
 \*\* Write and send a text message \*\*  
 Is this a calibration point?  
 Sample has been removed.  
 All clear – Restart the Conveyor.  
 Carrying samples away for transport.  
 Digging off sample now, DO NOT START.  
 All clear – move up conveyor.  
 What was the last sample number?  
 How many more samples are we doing?  
 Is it time to go home yet?  
 Gone away – back in ten minutes.

If the fixed message ‘All clear – Restart the Conveyor’ is highlighted by the ‘>’ and ‘<’ indicators, and the [ENT] key pressed, the selected message is sent to the Remote Display Unit via the serial port. The two indicators change to ‘^’ to show that the message has been sent, as shown in Figure 5.2.2 below.



**Figure 5.2.2 Text Message Sent Screen**

If the message ‘\*\* Write and send a text message \*\*’ is highlighted by the ‘>’ and ‘<’ indicators, and the [ENT] key pressed, the Write a Text Message screen is displayed, as shown in Figure 5.2.3 below.



**Figure 5.2.3 Write a Text Message Screen**

Any text message can be typed in, using upper case letters, lower case letters and numbers, as well as the symbols ‘-’ and ‘.’. When set to use upper case letters a ‘U’ will be displayed at the start of the text message, and if set to use lower case letters a ‘L’ will be displayed (as shown above). Messages are restricted to 37 characters. Pressing the [ENT] key will send the message and the Message Sent screen displayed, as shown in Figure 5.2.4 below.



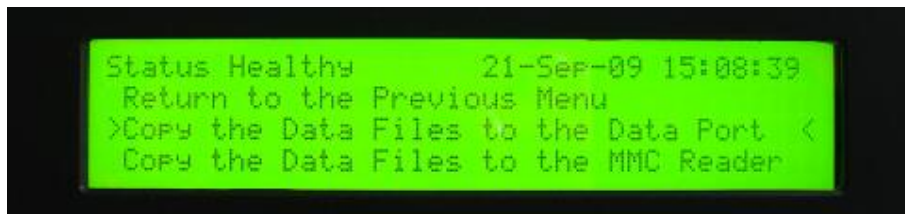
**Figure 5.2.3 Message Sent Screen**

If the [Y] key is pressed, the sent message is cleared and another message can be typed and sent. If the [N] key is pressed then the user will be taken back to the Send Text Messages Menu.

## 6. Access the Data Files Menu

The Heat Eye System has the facility to send data files to the Data Port and the MMC reader. The Data Port and the MMC reader are located on the inner door of the Local Processor. The Data Port is an RS232 serial data port labelled Data Output. The MMC writer is a multi-media card read/writer and is labelled MMC Slot. The shift data file, the background data file, the calibration coefficients file and the signal definitions file can all be sent to these ports, in a format suitable for opening with a spreadsheet, such as MSExcel

Pressing the [M] key and selecting the 'Access the Data Files Menu' option from the Main Menu will display the Data Files Menu, as shown in Figure 6.1 below.



**Figure 6.1 Data Files Menu Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- Return to the Previous Menu
- Copy the Data Files to the Data Port
- Copy the Data Files to the MMC Reader
- Delete the Data Files

### 6.1 Copy the Data Files to the Data Port

Pressing the [ENT] key when the markers indicate 'Copy the Data Files to the Data Port' will display the Copy Files Menu, as shown in Figure 6.1.1 below.



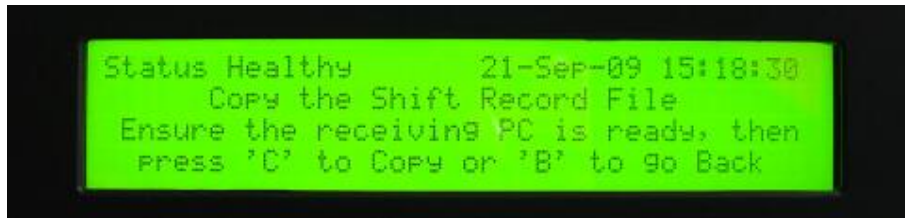
**Figure 6.1.1 Copy Files Menu Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- Return to the Previous Menu
- Copy the Background Data File
- Copy the Shift Record File
- Copy the Calibration Coefficients
- Copy the Signal Definitions

This menu system allows the user to carry out the copy options listed above. The method of copying the files is the same for all four copy options. The Background Data File can take up to 5 minutes to download via the serial port, due to the size of the file.

Pressing the [ENT] key when the markers indicate 'Copy the Shift Record File' will display the Copy the Shift Record screen, as shown in Figure 6.1.2 below.



**Figure 6.1.2 Copy the Shift Record Screen**

Pressing the [C] key will start the file copy process as shown in Figure 6.1.3 below. If the [B] key is pressed then the user will be taken back to the Copy Files Menu.



**Figure 6.1.2 Copying the Shift Record Screen**

Once the file has been downloaded, a file download completed message is displayed on the bottom line of the screen for a short time and then the user is returned to the Copy Files Menu, as shown in Figure 6.1.1 above.

## 6.2 Copy the Data Files to the MMC Reader

Pressing the [ENT] key when the markers indicate 'Copy the Data Files to the MMC Reader' will display the Copy Files Menu, as shown in Figure 6.2.1 below.



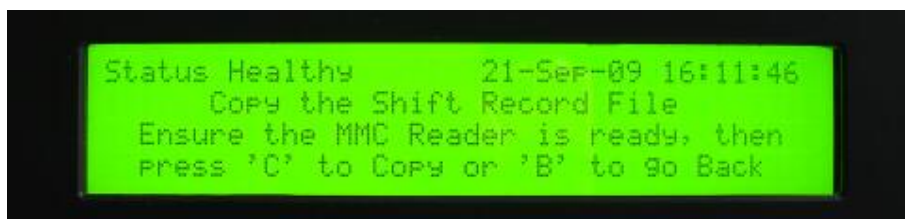
**Figure 6.2.1 Copy Files Menu Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- Return to the Previous Menu
- Copy the Background Data File
- Copy the Shift Record File
- Copy the Calibration Coefficients
- Copy the Signal Definitions

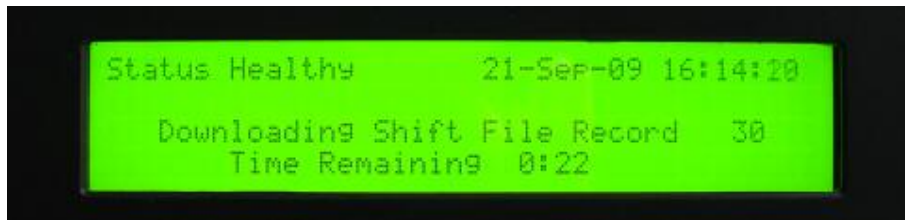
This menu system allows the user to carry out the copy options listed above. The method of copying the files is the same for all four copy options. The Background Data File can take up to 10 minutes to download to the MMC Reader, due to the size of the file.

Pressing the [ENT] key when the markers indicate 'Copy the Shift Record File' will display the Copy the Shift Record screen, as shown in Figure 6.2.2 below.



**Figure 6.2.2 Copy the Shift Record Screen**

Pressing the [C] key will start the file copy process as shown in Figure 6.2.2 below. If the [B] key is pressed then the user will be taken back to the Copy Files Menu.



**Figure 6.2.2 Copying the Shift Record Screen**

Once the file has been downloaded, a file download completed message is displayed on the bottom line of the screen for a short time and then the user is returned to the Copy Files Menu, as shown in Figure 6.2.1 above.

If there is no card in the card reader, then the copy will be abandoned and the screen shown in Figure 6.2.3 below will be displayed for a short time. The user will be taken back to the Copy Files Menu.



**Figure 6.2.3 Copy Abandoned Screen**

### 6.3 Delete the Data Files

Pressing the [ENT] key when the markers indicate 'Delete the Data Files' will access the Delete the Data Files Menu.

Before the user is allowed access to the Delete the Data Files Menu, a password has to be entered.



**Figure 6.3.1**  
**The Password Entry Screen**

Figure 4.1 shows the password entry screen, with three characters already entered. As each letter or number is entered the ' \_ ' changes to '\*'. A combination of upper and lower case letters, numbers and the symbols '-' and '.' are allowed. The factory set default password is 'BRETBY', but the user can change this password if required. How to access the number keys and lower case letters is described in section 3.1. Once the correct password has been entered and the 'ENT' key pressed, the Alter/View the System Settings Menu is displayed.

If the password is entered incorrectly, the message 'Password Incorrect!' is displayed for 2 seconds before the Alter/View the System Settings Menu is displayed.

The user can skip entering the password by pressing the 'C/CE' key at any point before or during the password entry. If the 'C/CE' key is pressed, the message ' Password Entry Skipped' is displayed for 2 seconds before the Alter/View the System Settings Menu is displayed.

If the Alter/View the System Settings Menu has been accessed without a valid password being entered, then the user can only view the System Settings. The message 'Press 'C' to Continue' will be displayed on the bottom line of the screen, indicating that the user cannot change any of the System Settings.

Once the password entry section has been completed, the Delete the Data Files Menu will be displayed, as shown in Figure 6.3.2 below.



**Figure 6.3.2**  
**Delete the Data Files Menu Screen**

Use 7.1 Method 1 to select from the option list shown below :-

- Return to the Previous Menu
- Delete ALL the RAM Files
- Delete the Background Data File
- Delete the Shift Record File
- Delete the Text Record File

This menu system allows the user to delete the data record files stored in the battery backed RAM area of the VM-1 processor. The method of deleting the files is the same for all four of the delete file options above.

Pressing the [ENT] key when the markers indicate 'Delete the Text Record File' will display the DELETE the Text Record File screen, as shown in Figure 6.3.3 below.



**Figure 6.3.3 Delete the Text File Screen**

Pressing the [D] key will display the confirm delete screen as shown in Figure 6.3.4 below. If the [L] key is pressed then the user will be taken back to the Delete the Data Files Menu.



**Figure 6.3.4 Confirm File Delete Screen**

Pressing the [C] key start the file delete process as shown in Figure 6.3.5 below. If the [L] key is pressed then the user will be taken back to the Delete the Data Files Menu.



**Figure 6.3.5 Deleting Text Record File Screen**

**ONCE THIS PROCESS HAS BEEN STARTED IT CANNOT BE STOPPED**

Once the file or files, have been deleted, a file deleted message is displayed on the bottom line of the screen for a short time and then the user is returned to the Delete the Data Files Menu, as shown in Figure 6.3.2 above.

## 7. Methods of Altering Parameters

There are four different universal methods of altering the various parameters, dependant on the type of parameter being altered.

Method 1 is used to alter the type of input, for example pulse, voltage or current.

Method 2 is used to enter an integer number, for example 2000.

Method 3 is used to enter a floating-point number, for example 19.25.

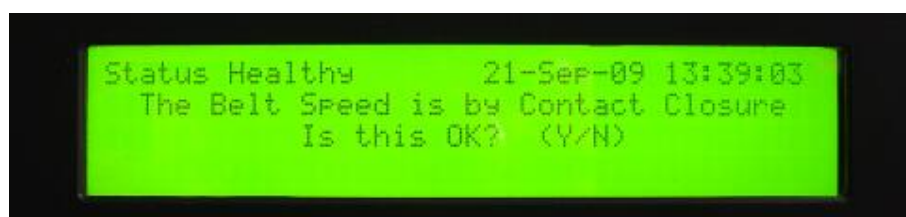
Method 4 is used to select a fixed number from a list, for example the baud rate of the serial ports.

How to use each method will be described with examples. Where these methods are used to alter the parameters, as described in Chapter 4 Alter/View the System Settings, reference will be made to this section.

In the following examples, the belt speed has been used to show the first method, the belt weigher has been used to show the next two methods, while altering the Data Port baud rate has been used to show the last method.

### 7.1 Method 1 – Text List

This method is used to select from a text list. The list of text will vary in length, dependant on the number of options available. In the following example the type of signal input is set.



**Figure 7.1.1 Set Type of Signal Input Screen**

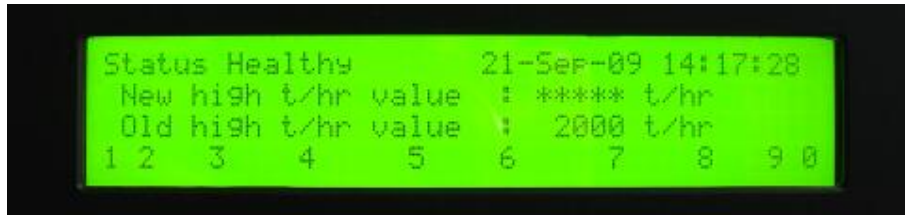
When the user is requested to select from a text list, the option offered is displayed on the second line of the screen, with the question ‘Is this OK? (Y/N)’ displayed on the third line. If the ‘N’ key is pressed, the next option is displayed on the second line of the screen, again with the question ‘Is this OK? (Y/N)’ displayed on the third line. Repeated pressing of the ‘N’ key will scroll through the options available. In the case of the example above, the belt speed input type, the following options are available :-

- The Belt Speed is by Contact Closure
- The Belt Speed input is a Pulse signal
- The Belt Speed input is a mA signal
- The Belt Speed input is a Voltage signal

Pressing the ‘Y’ key will accept the input signal type. Pressing the ‘AC’ key twice will return the user to the Main Screen Display (Figure 3.1), without altering the input signal type.

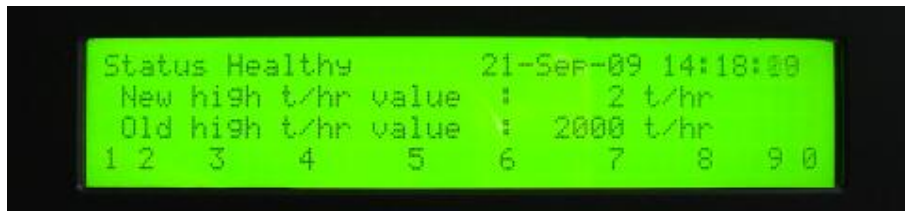
## 7.2 Method 2 – Integer Numbers

This method is used to input an integer number. The number of digits can vary, and in some cases a negative number can be entered if required. In the following example the belt weigher full-scale tonnes per hour value is set.



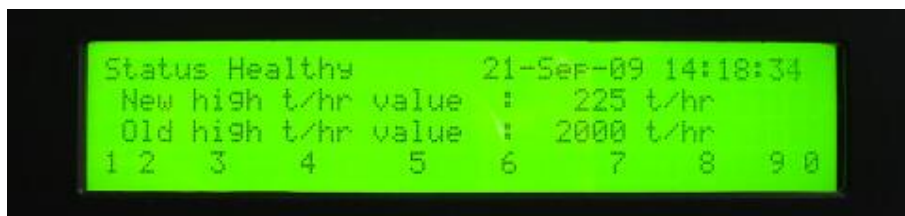
**Figure 7.2.1 Input Integer Number Screen 1**

When the user is requested to enter an integer number, the number of digits allowed are shown by a number of '\*', in this case five, on the second line of the screen. The units and old value may also be shown on the screen. The numbers 1 through to 0 are displayed on the bottom line of the display, and pressing the required key will enter that number. For example, the number 4 is represented by the [R] key and 7 by the [U] key.



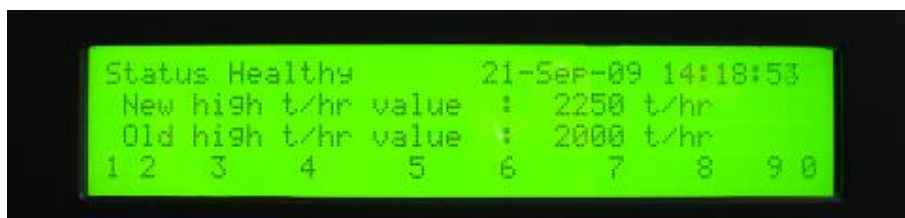
**Figure 7.2.2 Input Integer Number Screen 2**

After the first digit has been entered, the '\*'s are deleted and the number starts to build from the right most digit.



**Figure 7.2.3 Input Integer Number Screen 3**

As more of the digits are entered, the previously entered digits move one place to the left.



**Figure 7.2.4 Input Integer Number Screen 4**

Once the new value has been entered, pressing the 'ENT' key will store the new value, overwriting the old value. Pressing the 'C/CE' key at any time will skip entering the new value, and go on to the next step, with the original value left unchanged. Pressing the 'AC' key twice will return the user to the Main Screen Display (Figure 3.1), without altering any of the previously entered or changed parameters in the section, in this case the belt weigher signal definitions.

### 7.3 Method 3 – Floating-point Numbers

This method is used to input a floating-point number. The number of digits can vary, and in some cases a negative number can be entered if required. In the following example the belt weigher low tonnes per hour mA value is set.



**Figure 7.3.1 Input Floating-point Number Screen 1**

When the user is requested to enter a floating-point number, the number of digits allowed is shown by a number of ‘-’, in this case four, on the second line of the screen. The number of decimal places of the expected number is known and so it is not necessary to enter a decimal point. The units and old value may also be shown on the screen.



**Figure 7.3.2 Input Floating-point Number Screen 2**

In the case of floating-point numbers, if there are more digits indicated in front of the decimal point than are required to be entered, then a leading ‘space’ or ‘0’ must be entered. In the example above, a space has been entered.



**Figure 7.3.3 Input Floating-point Number Screen 3**

Once all the digits in front of the decimal point have been entered, only the first decimal place ‘-’ is displayed.

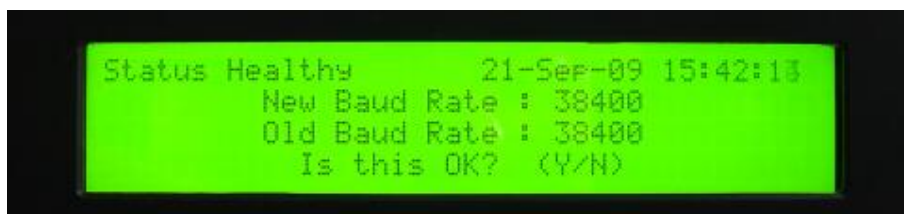


**Figure 7.3.4 Input Floating-point Number Screen 4**

Once the new value has been entered, pressing the 'ENT' key will store the new value, overwriting the old value. Pressing the 'C/CE' key at any time will skip entering the new value, and go on to the next step, with the original value left unchanged. Pressing the 'AC' key twice will return the user to the Main Screen Display (Figure 3.1), without altering any of the previously entered or changed parameters in the section, in this case the belt weigher signal definitions.

## 7.4 Method 4 – Number List

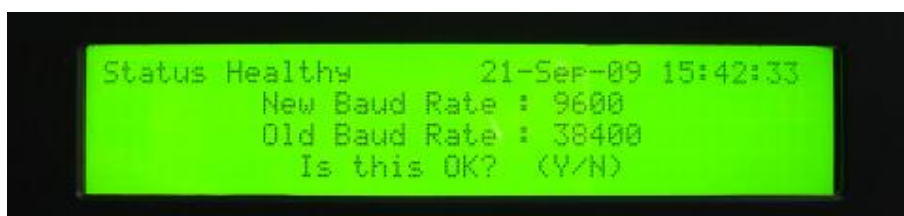
This method is used to select a number from a number list. The list of numbers will vary in length, dependant on the number of options available. In the following example the baud rate of the Data Port is set.



**Figure 7.4.1 Select a Fixed Number Screen 1**

When the user is requested to select from a number list, the new number offered is displayed on the second line of the screen, the old number is displayed on the third line, with the question ‘Is this OK? (Y/N)’ displayed on the bottom line. If the ‘N’ key is pressed, the next number in the list is displayed on the second line of the screen, again with the old number displayed on the third line and the question ‘Is this OK? (Y/N)’ displayed on the bottom line. Repeated pressing of the ‘N’ key will scroll through the numbers available. In the case of the example above, the Data Port Baud Rate, the following numbers are available :-

1200  
2400  
4800  
9600  
19200  
38400



**Figure 7.4.2 Select a Fixed Number Screen 2**

Pressing the ‘Y’ key will accept the number. Pressing the ‘AC’ key twice will return the user to the Main Screen Display (Figure 3.1), without altering the existing number.

## 8. System Faults

There are two types of faults, which may occur in the Heat Eye System. The first type is described as a critical fault, and the second type a non-critical fault.

All sensors and inputs are checked every second, and if one or more are out of range, for example if the background sensor count rate per second is lower than 10 or greater than 500, the sensor is out of range, and therefore faulty. If the background sensor is faulty, the system will automatically use the keyboard entered **Empty Belt Gamma** value, instead of the Empty Belt Gamma value calculated from the background sensor count rate. This is classed as a non-critical fault because the Heat Eye System can still calculate Ash. However, if the main sensor count rate is out of range, this is classed as a critical fault, because the system needs to know the main gamma counts to calculate Ash.

If there are no faults then the words 'System Healthy' are displayed on the top line of the screen. If there are one or more faults then 'System Faulty' will be displayed. If one or more of the faults are critical faults, then the system stops calculating Ash and the faults are continuously displayed in turn on the second line of the display, for five seconds each. If the faults are all non-critical then the faults are only displayed on the second line of the display when the 'F' key is pressed when the Main Screen Display, as shown in Figure 3.1 is on the screen. Each fault is displayed in turn for five seconds. After the last fault has been displayed, the display reverts to the Main Screen Display. The faults are displayed in the following format:

Fault x of y: Fault description

where x is the number of the fault being displayed and y is the number of faults.

The message 'There are no system faults to display.' will be displayed on the second line of the screen if the 'F' key is pressed when there are no system faults to display.

### 8.1 Critical Faults

There are two sensor failures that are considered critical faults. The first is the Main Gamma Sensor and the second is the Belt Weigher flow rate signal. If either of these sensors fail, the system cannot work.

#### 8.1.1 Main Gamma Sensor Fault

If the Main Gamma Sensor count rate in any second is less than 10 or greater than 500, the sensor is giving a count rate which is out of the expected count range. This is considered to be a fault and the message 'Fault x of y: Main Sensor Failed' is displayed on the second line of the screen.

#### 8.1.2 Belt Weigher Sensor Fault

The Belt Weigher gives an analogue 4 to 20mA signal proportional to the material flow rate, in tonnes per hour. If the analogue signal is less than 2mA or greater than 22mA, the signal is out of the expected range. This is considered to be a fault and the message 'Fault x of y: T/hr Sensor Failed' is displayed on the second line of the screen.

## 8.2 Non-Critical Faults

There are three failures that are considered non-critical faults. The first is the Background Sensor, the second is the Belt Speed Sensor and the third is a high loop time. If any of these fail, the system can continue to work.

### 8.2.1 Background Sensor Fault

If the Background Sensor count rate in any second is less than 10 or greater than 500, the sensor is giving a count rate which is out of the expected count range. This is considered to be a fault and the message 'Fault x of y: Background Sensor Failed' is displayed on the second line of the screen if the 'F' key is pressed. The system will continue to work, using the keyboard entered Empty Belt Gamma value.

### 8.2.2 Belt Speed Sensor Fault

The Belt Speed is determined by one of three methods. The first one is by contact closure to indicate that the belt is running, when the system uses a fixed keyboard entered belt speed. The second is by a pulse stream, each pulse representing a fixed distance travelled, and the third is by an analogue 4 to 20mA signal proportional to the belt speed, in metres per second.

In the case of using contact closure to indicate belt speed, no fault can be detected.

If the belt speed is derived from a pulse stream, the sensor is considered faulty if the derived speed from the sensor is greater than 1.25 times the fixed keyboard entered speed. This is considered to be a fault and the message 'Fault x of y: Speed Sensor Failed' is displayed on the second line of the screen. The system will continue to work, using the keyboard entered Belt Speed value.

If the analogue signal is less than 2mA or greater than 22mA, the signal is out of the expected range. This is considered to be a fault and the message 'Fault x of y: Speed Sensor Failed' is displayed on the second line of the screen. The system will continue to work, using the keyboard entered Belt Speed value.

### 8.2.3 Loop Time Fault

The Loop Time is the time the system takes from the start of the start of the process (reading the signal inputs) to the end of the process (calculating the ash). The system must complete the process within one second. When the system is running normally, when the Main Screen Display is on the screen, the process takes about 180 msec. As each different menu is displayed on the screen, the process time increases, due to the time taken to print characters to the screen. When the 'Display the Signal Inputs' menu is being shown, as Figure 3.2.1, several characters have to be displayed each second and the process takes about 550 msec to complete.

The Loop Time is checked every second and smoothed using a response time of 5 seconds. If the smoothed Loop Time exceeds 800 msec it is considered to be a fault and the message 'Fault x of y: Loop Time High' is displayed on the second line of the screen.

## 9. Calibrating the Heat Eye

It is necessary to calibrate the Heat Eye by taking calibration samples and having the samples analysed for Ash content. This has to be carried out before the system is ready for use. There are two procedures. The first is the Calibration Data Gathering Procedure, and the second is the Calibration Data Analysis Procedure.

### 9.1 Calibration Data Gathering Procedure

Before undertaking the calibration the Main Sensor and surroundings must be cleaned of all dust. Ensure that all personnel are at least 3m from the main sensor at all times other than when digging out the samples from the conveyor belt.

Run the belt empty and when completely free of material take an empty-belt reading following the procedure outlined below:

Press the [M] key to display the Main Menu. Select the 'View the Incoming Signal Data' option from the Main Menu and then the 'Display the Signal Inputs' option. The signal input display screen as shown in Figure 9.1 below should be displayed.



**Figure 9.1**  
**The Signal Input Display Screen**

Observe the Main Gamma Sensor cps reading, and when the value to the right of the → symbol becomes less than 1% of the cps reading, press the [P] key to pause the counting. This generally takes 3 to 4 minutes. Make a note of the Main Gamma Sensor cps reading, the number to the right of the → symbol and the number of readings from the top line of the screen. Once the readings have been noted press the [R] key to reset the values and start the counting process again to obtain another set of empty belt values. If the two sets of Main Gamma Sensor cps readings are within 1.5 counts, proceed to the next stage, otherwise repeat the above procedure.

Press the [AC] key and then the [D] key to display the Calculated Information Display screen as shown in Figure 1.4. Run the conveyor belt and then stop the belt when it is laden with material suitable for the calibration. Note the ash and tonnage readings from the just before the belt stops (this can be difficult – don't worry if it is missed). Once the belt is stationary go to the Signal Input Display Screen as shown in Figure 9.1 above. Observe the Main Gamma Sensor cps reading, and when the value to the right of the → symbol becomes less than 1% of the cps reading, press the [P] key to pause the counting. This generally takes 3 to 4 minutes. Make a note of the Main Gamma Sensor cps reading, the number to the right of the → symbol and the number of readings from the top line of the screen. Once the readings have been noted press the [R] key to reset the values and start the counting process again to obtain another set of values. If the two

sets of Main Gamma Sensor cps readings are within 2 counts of each other, proceed to the next stage, otherwise repeat the above procedure.

Place the calibration frame over the material on the conveyor belt such that it is positioned centrally over the Main Sensor. Then push it into the material and dig off all the material that falls within the calibration frame. Place all this material into bags for subsequent weighing and ash analysis. Each bag should be labelled with the appropriate Sample Number. Ensure that the total weight of all the bags of each sample is obtained along with the combined ash content. Without this data it is not possible calculate the calibration coefficients. Once all the material and the calibration frame have been removed from the conveyor belt the conveyor can be started again. Repeat this process until a complete suite of calibration samples covering all the likely combinations of ash and mass loading has been obtained. This is likely to require at least 16 samples. Once the calibration data gathering is completed carry out a final empty-belt check by running the belt empty and following the procedure outlined above.

## 9.2 Calibration Data Analysis Procedure

Once all the data for the calibration has been gathered the analysis needs to be carried out in order to generate the appropriate calibration coefficients.

The calibration equation is of the form:

$$\text{Ash Mass} = A * M + B * G + C * M * G \quad (1)$$

$$\text{Or Ash \%} = (A + (B * G) / M + C * G) * 100 \quad (2)$$

Where A (the mass term), B (the gamma term) and C (the gamma\*mass term) are the calibration coefficients.

M is the Mass Loading in kg/m.

G is the Nett Gamma Counts in counts per second (i.e. The Gross Gamma Counts (Mean Gamma) – Empty Belt Gamma Counts)

In many calibrations the Mass term can be equal to zero.

### 9.2.1 Calibration Data Entry Procedure

In order to derive the coefficients the regression facility within a spreadsheet is used. Bretby Gammatech use Microsoft Excel but any spreadsheet offering multiple regression will suffice. In the following description it is assumed that the reader will be familiar with spreadsheets.

The data first needs to be entered into the spreadsheet. It is recommended that the data be entered in the following manner:

Rows 1 & 2 Title information

Rows 6 & 7 Data column titles with the actual data starting in row 8

Column A The overall sample number

Column B The calibration set number and the sample number within that calibration set (or the source name)

Column C The date the sample was taken

Column D The weight of the sample taken from the calibration frame (kg/frame length<sup>1</sup>)

Column E The Gross Gamma Counts (cps)

Column F The Empty Belt Gamma Counts (cps)

Column G The Analysed Ash %

Column H The Ash Mass (kg/m) (i.e. (Column G \* Column I)/100)

Column I Mass Loading in kg/m (i.e. Column D/frame length (m)<sup>1</sup>)

Column J Nett Gamma Counts (i.e. Column E – Column F)

Column K Nett Gamma \* Mass Loading (i.e. Column J \* Column I)

<sup>1</sup>The frame length (often 0.6m) can either be entered into the equation directly or inserted into a field near the top of the data worksheet.

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### 9.2.2 Regressing the Data & Plotting Calibration Graphs

Once this data has been entered the regression can be undertaken.

Column H data is used as the Dependant variable (Y) and columns I, J and K as the Independent variables (X). The regression should be carried out so that the **Constant term is set to Zero**. The regression output should be set to a new worksheet within the workbook. This will generate calibration coefficients with a Mass term (a three-term calibration). The above regression should be repeated but using only Columns J & K as the independent variables. This will generate a calibration without a Mass term (a two-term calibration).

The two sets of calibration coefficients should be copied across to the data worksheet into Rows 1 – 3 in Columns N and P. Calculated ashes can then be generated in Columns M and O using formula (2) above. The differences between the calculated ashes in Columns M and P and the Analysed ashes in Column G should be generated in Columns N and P respectively.

The Bias and the standard deviation of the errors should be calculated and displayed in rows below the error data columns.

Graphs (XY scatter) showing Calculated Ash against Analysed Ash for the two Calibrations should be generated. The scales of both axes should be made the same. A diagonal line should be plotted from the origin to the top right hand corner of the graph to show the Calculated ash v Analysed ash. A trend line through the data should also be inserted.

A graph (XY scatter) showing Ash Error against Analysed ash for the two Calibrations should be generated. This graph will also show if there is any ash dependency in the calibration.

A graph (XY scatter) showing Ash Error against Mass Loading for the two Calibrations should be generated. This graph will show if there is any mass dependency in the calibration.

### 9.2.3 Analysing the Calibrations

Once the above procedures have been completed the quality of the calibrations can be assessed. There are several criteria to optimise:

The two lines plotted on the calibration graphs should lie close and parallel to each other. Significant differences in slope indicate an ash dependency in the calibration. Significant offset indicates a bias in the calibration.

The points should lie evenly scattered about the calibration line. There may be outliers and these can be dealt with in due course. The wider the spread the greater the standard deviation of the errors. The analysed ash range should exceed the standard deviation of the errors by at least a factor two and preferably rather more.

The Ash Error against Analysed ash and the Ash Error against Mass Loading graphs should show evenly scattered points with no obvious trends (i.e. no ash or mass dependency).

If there are no obvious outliers and the calibrations appear to have no ash or mass dependency then choose the calibration with the smaller standard deviation of errors. If one of the calibration

shows an ash dependency then choose the other even if the standard deviation of the errors is higher.

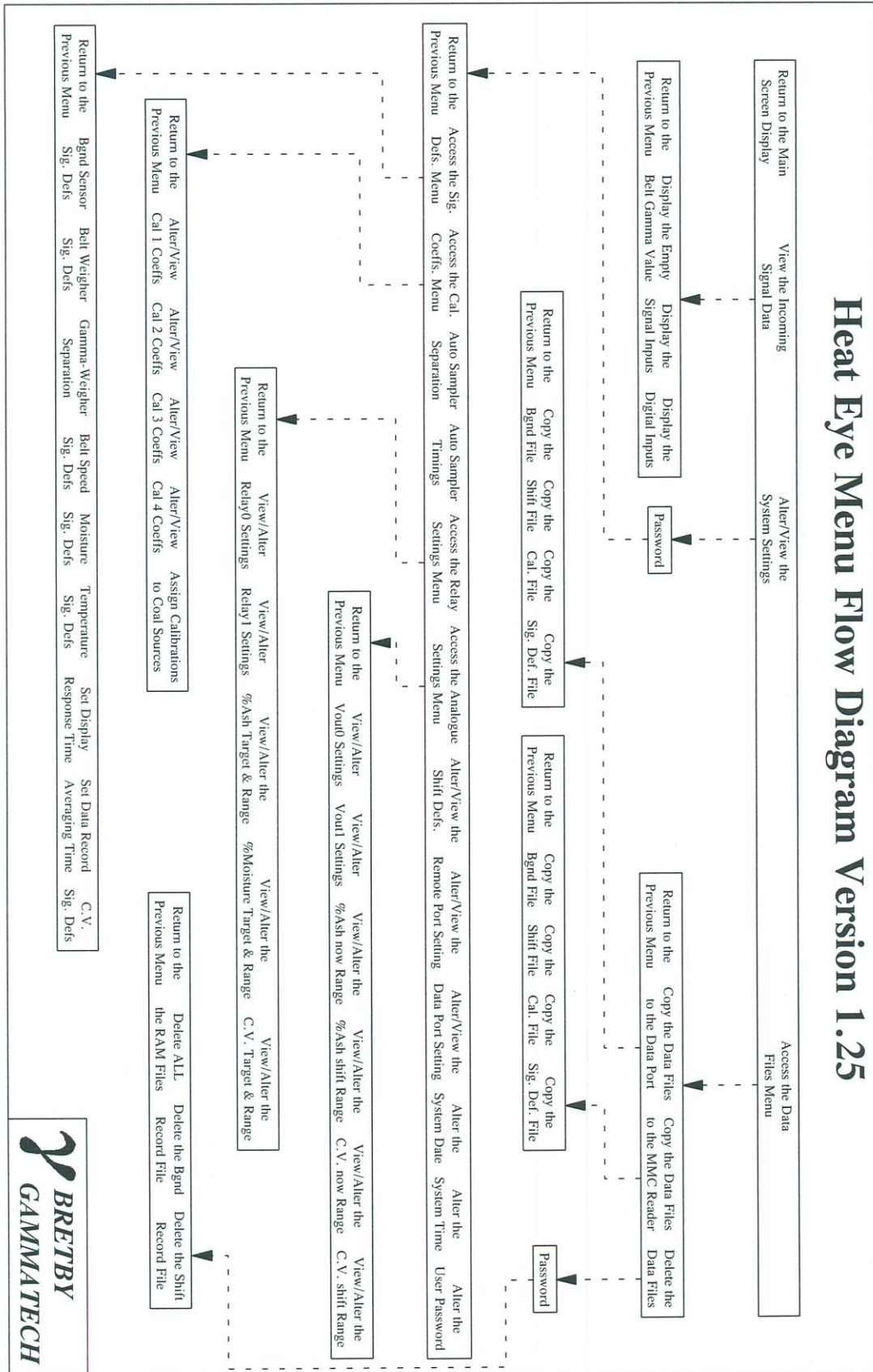
With run of mine calibrations the standard deviation of the errors often looks quite poor with values reaching 5% ash or more. This is not usually cause for alarm. The reason is because the material gathered during the calibration is likely not to be very homogeneous. The main sensor does not sense the whole of the load with equal weighting. It tends to sense the material at the bottom of the belt and at the centre of the calibration frame with greater sensitivity than the top or edges of the frame. Whereas the ash analysis is carried out on the whole sample (i.e. even weighting is given to all parts of the calibration sample). With sufficient calibration points (assuming a random distribution of ash in the calibration samples) the calibration should converge to close to the true mean even if the standard deviation is quite high. This is shown as the Standard Error of the fit, expressed as % ash, in the regression worksheet.

With final product systems the calibrations will produce much lower standard deviations of the errors – typically around 2% ash or better.

#### **9.2.4 Removing Outlying Calibration Points**

There are statistical methods for determining outliers but usually they can be spotted by eye on the calibration graphs. Each outlier should be removed from the calibration data set in turn and the data re-regressed and analysed. The easiest way to do this is to make a second copy of the data worksheet within the calibration workbook and then delete the row containing the outlier. The data can then be regressed from this worksheet. The new regression coefficients can then be copied into the worksheet and the new calculated ashes and ash errors generated and the above graphs produced. This process should be repeated until a satisfactory calibration is achieved. It is often an iterative process.

Figure 10.1 Heat Eye Menu Flow Diagram



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