E2K OPERATING MANUAL

VERSION 3.5

MANUFACTURED BY DIGITAL DATA SYSTEMS (PTY) LTD.
AND PART OF THE DDS CALORIMETERS BRAND
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INTRODUCTION

Digital Data Systems (Pty) Ltd (dds) specializes in the design and manufacture of scientific Bomb Calorimeter systems for various types of industries and applications from the coal mining industry to educational institutes. dds Bomb Calorimeter systems are the most advanced bomb calorimeter systems available today. The system is used to measure the calorific value of both solids and liquids. dds has three different Bomb Calorimeter models in their Scientific CAL2k range:

<table>
<thead>
<tr>
<th>CAL2K</th>
<th>ECO</th>
<th>E2K</th>
</tr>
</thead>
<tbody>
<tr>
<td>The CAL2k Calorimeter is aimed at the higher volume market; which requires higher quantities of CV samples per day.</td>
<td>The ECO Calorimeter is inexpensive and aimed at the lower volume market; which requires very small quantities of CV samples per day.</td>
<td>The e2k Calorimeter is a middle of the range product, suited to both the lower and higher volume markets. It also comes with a fantastic language compatible feature.</td>
</tr>
<tr>
<td>A determination will take approximately 7 minutes to run and depending on the number of Vessels used, 10 samples can be carried out every hour.</td>
<td>A determination will take approximately 40 minutes to run, and 1 (One) sample can be carried out every hour.</td>
<td>A determination can take approximately 10 minutes using the CAL2K-2 Cooler and one Vessel.</td>
</tr>
</tbody>
</table>

You have chosen the CAL2K-E2K Bomb Calorimeter System, which is best suited for your calorimetry requirements.

HOW TO USE THIS MANUAL

This Manual makes use of some informative symbols or icons, in order to bring your attention to the text.

WARNING SYMBOL

This yellow triangle with an exclamation mark inside it, indicates a WARNING message or a message that is instructing you NOT to do something. Please take note of this message, because if you ignore it you could damage the Calorimeter equipment.

INFORMATION (NOTE) SYMBOL

This white hand with a finger pointing, indicates a NOTE or INFORMATIVE message. It indicates something that you need to pay attention to. Please take note of this message, as it provides special or detailed information about a particular item.

HISTORY OF DDS BOMB CALORIMETERS

In 1972, dds manufactured its first Calorimeter product the AMPC (Automatic Micro Processor Calorimeter). It was a dual water isothermal unit controlled by a microprocessor. In 1980 a new revolutionary design of Vessel, namely the DRY Vessel or CP510 was produced as it had no surrounding water jacket. The determination time was significantly reduced, thus increasing the product’s efficiency by 4 times.
With the processing power of the microprocessors available at the time, the CP500 Calorimeter was born with its striking “buttercup yellow” colour. The CP500 proved to be a very fast and reliable system and was exported to the USA, Europe, Scandinavia, Australasia, Africa and India.

In early 2002 work began on the new CAL2k model. The tried and tested DRY system was retained and only the very latest electronic technology was used, including surface mount devices. The CAL2k is now in full production and is sure to be an even bigger success than its predecessor, the CP500. In 2005, dds realized the need for a smaller, low sample volume, and inexpensive calorimeter system with the same accuracy and reliability of the CAL2k. Based on these requirements, the ECO was then created as an alternative system to the CAL2k. By 2007, due to customer demands work began on the e2k model. The e2k was designed to be able to have two language options – one being English and the other an alternative language for example French. The e2k was also designed to work faster than the ECO but not as fast as the CAL2k with less features as the CAL2k to keep it cost-effective.

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**E2K CALORIMETER INTRODUCTION**

- Manages the temperature received from a Vessel, and presents it in the various forms
- Calculates CV(s)
- Provides access to the Vessel
- Restarts the temperature sampling in the Vessel every 6 seconds
- Provides large storage for results
- Provides interface to a Balance
- Provides RS232 interface to a PC
- Manages the SAMPLE ID and MASS
- Manages the 8 character Group Identification
- Provides firing control
- Manages calibration of the Vessel
- Has a Serial interface to the Vessel
- Interfaces to the display and keyboard
- Insulates the Vessel from the environment during a determination

---

**SAFETY**

**CALORIMETER (E2K)**

- Electrical Shock: There are NO user serviceable parts inside.
- Do not open the back panel unless the mains cable has been disconnected.
- Dangerous voltages will be present inside after the mains cable has been disconnected.
DO NOT TAMPER WITH THE EARTHING - CONSULT A QUALIFIED ELECTRICIAN SO THAT THE EARTHING CAN BE CHECKED.

COOLER (E2K-2)
- Electrical shock: There are NO user serviceable parts inside.
- Do not open with the water hoses connected.
- Disconnect from Mains before opening the Cooler (CAL2K-2).
- Dangerous voltages will be present inside after the mains cable has been disconnected.

AIR COOLER (E2K-FAN) – WITH MINIMUM SYSTEM ONLY
- If the fuse needs checking or replacing always disconnect the unit from Mains before removing the fuse cover.

FILLING STATION (E2K-3)
- Secure the Filling Station to the table.
- Install the flexible nylon pressure pipe without any sharp bends.
- Check the nylon pressure pipe for mechanical damage before putting it under pressure.
- Secure the pipe nuts to the pressure regulator side, then clamp the ferrule to the high pressure pipe on the gauge block side.
- If the oxygen bottle is not situated close to the Filling Station or if it is in another room or perhaps outside, then a solid, permanent installation of pressure piping should be installed, as well as a shut off valve and pressure gauge within easy reach of the E2K-3 Filling Station.
- If bottled oxygen is used, a suitable pressure regulator must be supplied by your agent, or sourced locally.
- The oxygen bottle should be secured according to regulations.

DO NOT USE ANY OTHER PIPE OTHER THAN THE HIGH PRESSURE PIPE SUPPLIED.
ALWAYS FILL THE VESSEL WITH OXYGEN TO A MAXIMUM PRESSURE OF 3000KPa (30 BAR).
NOTE: With some applications you may need to fill the Vessel to less than 3000KPa e.g. 1500KPa (15 BAR), however this is only applicable when you have a sample which is highly combustible, for example with wood related samples.

REMEMBER: You may fill the Vessel LESS than 3000KPa but NEVER more than 3000KPa.

HIGH PRESSURE OXYGEN

- The type of Oxygen to be used is the standard Industrial Oxygen used for welding. A purity of 99.5% will be suitable.
- Conform to the industry standard of handling procedures for oxygen bottles.
- Secure the bottle against a wall.

NEVER use oil or grease on any part of the gauge assembly or any part of the Filling Station and Vessel for SAFETY reasons!

DO NOT use a hammer to free a jammed valve.

- Use only an approved pressure reduction valve with a safety blow valve.
- Consult your safety engineer when in doubt.

VESSEL (CAL2K-4)

- The Vessel has been pressure tested (certificate will be provided if required), at 3000KPa according to international standards.
- The Vessel and its Cap’s thread is subject to wear and tear, and it must be inspected regularly. Check for excessive play.
- A Vessel with “loose” or worn threads is dangerous, and it must be repaired (reconditioned) by the dds Factory.
- A Vessel with worn threads may cause the lid to blow off during a determination, which is extremely dangerous and may cause injury to the operator. Vessels with worn threads which cannot be reconditioned will be deemed unsafe and a condemnation certificate will be issued.
- Vessels should be returned to dds every 6 months for reconditioning, checking and subsequent pressure tests. A Vessel will require reconditioning after 5000 firings; however it is this quantity could be significantly reduced depending on the type of samples analysed. Therefore it is advisable to have your Vessel(s) checked regularly. Vessels will need to be returned to dds for reconditioning, an agent is not authorised to recondition a Vessel and therefore it must be sent to dds for this procedure.
- Do not extend any part of your body over the e2k Calorimeter during the initial period.
- Consult your safety engineer or your mechanical engineer for guidelines, when in doubt.
NEVER OPERATE ANY UNSAFE VESSEL.

NEVER IMMERSE THE VESSEL INTO COLD WATER WHEN COOLING. USE THE E2K-2 COOLER, THE E2K-FAN AIR COOLER OR ALLOW THE VESSEL TO COOL DOWN NATURALLY.

NOTE: THE MANUFACTURER (DDS) AND ITS AGENTS CANNOT BE HELD RESPONSIBLE FOR ANY LOSS OR DAMAGE RESULTING FROM NEGLIGENCE OR INCORRECT USE OF THEIR EQUIPMENT. IT IS YOUR DUTY AND RESPONSIBILITY TO CHECK ALL SAFETY ASPECTS OF THE CAL2K SYSTEM REGULARLY.

UNPACKING THE E2K SYSTEM

Please retain all the packaging boxes and material once you have received the Bomb Calorimeter System for the first year (Warranty Period).

There are no special precautions to be taken during unpacking, other than retaining all the packaging material. Other information and instructions when unpacking the Bomb Calorimeter System, can be found in the printed e2k Handbook.

GETTING STARTED

SYSTEM COMPONENTS

Congratulations on purchasing your new e2k Combustion Calorimeter System!

The e2k is the most advanced Calorimeter system available today and if treated with the care and respect it deserves, it will give you years of service and satisfaction. No other calorimeter operates quite like the e2k and for this reason, we ask you to spend some time learning and discovering its qualities and idiosyncrasies. The time invested in studying this manual will provide you, the User, with the maximum usage of the machine.

NOTE: The e2k is available in a variety of system configurations and depending on which system you purchased the following will be included. Please note the E2K-2 Cooler is included with the Standard and Elite System configurations only. The E2K-FAN Air Cooler is included with the Minimum System configuration only.
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
</table>
| E2K      |             | The Calorimeter  
This conducts the calorific value  
determination.          |
| E2K-2    |             | The Cooler  
This cools the Vessel to the required  
temperature. Only supplied with  
Standard and Elite System  
Configurations          |
| E2K-3    |             | The Filling Station  
This fills the Vessel with oxygen. |
| E2K-FAN  |             | The Air Cooler  
This aids the cooling down of the  
Vessel, in approx. 30 to 40 minutes.  
Only supplied with the Minimum System. |
THE CALORIMETER (E2K)

Below is an external picture of the Calorimeter E2K showing the major components that make up the Calorimeter. Locate and identify each component to facilitate the understanding of reference to these parts in subsequent sections.

FIGURE 1. : CALORIMETER – EXTERNAL FRONT VIEW

- Door Knob (Lid Lock)
  Pull to Open

- LCD Display

- Standard PC Keyboard (PS2)
EXTERNAL CONNECTIONS (REAR PANEL)

FIGURE 2: CALORIMETER – EXTERNAL REAR PANEL

CALORIMETER COMPONENTS
The e2k Calorimeter comprises of the following components:
1 x e2k Complete Calorimeter (E2K)
1 x e2k Calorimeter Installation Kit (E2K-KT)

An Installation Kit is supplied with necessary accessories and spare parts. Please refer to the section on the e2k Calorimeter Installation Kit at the back of this manual, for a list of which items are included in this kit.

LCD DISPLAY
The LCD Display consists of Two (2) Lines/Rows. Each Line consists of a maximum of 16 characters:
- Line #1: Calorimeter Operations and Operator prompts
- Line #2: Keyboard and additional operations information

DOOR LATCH AND LID SWITCH
The Lid closure switch is incorporated in the Door Latch, so as to ensure that the lid is securely closed before a determination is started. This is for safety purposes.

VESSEL CONNECTIONS
These are situated inside the Vessel Well. There are four (4) connections between the Calorimeter and the Vessel. Three connections are in the Base of the Well and the fourth connection is at the top of the Vessel where the Vessel connects to the Lid Contact inside the Calorimeter’s Lid. The ground contact is incorporated in the 3 Vessel supports.
Communication with the Vessel is via the two spring-loaded contacts in the centre of the Base board. The firing contact is in the centre of the Lid and again is a spring contact, which only makes contact when the Lid is closed.

THE COOLER E2K-2

NOTE: The E2K-2 Cooler is only supplied with a Standard or Elite System configuration.

FIGURE 3. : COOLER E2K-2 – FRONT VIEW

FIGURE 4. : COOLER E2K-2 – REAR VIEW
COOLER SYSTEM COMPONENTS
The Cooler should comprise of the following components:
1  x  E2K-2 Complete Cooler
1  x  E2K-2-KT Cooler Installation Kit

An Installation Kit with Accessories and Spare Parts is supplied with the Cooler. Please see the Section on E2K-2 Cooler Installation Kit at the back of this manual, for a list of which items are included.

COOLER INSTALLATION
1. A stable, balanced workbench, near water and mains power supply is required.
2. The power requirements (Mains supply) need to be the following:
   a. Voltage: 90 – 260 VAC, 50/60Hz
   b. Consumption: 150 Watts Maximum
3. The CAL2K-2 needs to be positioned in a convenient place where it has access to both a mains supply and a main water supply (please note that only a TRICKLE of water flow is required).
4. Water may also be circulated through a tank system.
5. Connect the water supply to the CAL2K-2 pipe marked IN using the plastic water pipe and fittings supplied. The pipe marked OUT is to be taken to a draining point such as a sink or sump. Connect the ambient cable between the CAL2K-1 and the CAL2K-2 to the respective plugs marked AMBIENT SENSOR. This is for the remote temperature sensor for the Cooler. The Ambient Sensor cable is reversible.
6. Plug in the Mains cable.

COOLER PERFORMANCE TESTING
1. Plug the Cooler into mains and observe that the POWER LED is ON. An auxiliary LED will flash every 6 seconds.
2. Press the LED test switch – all 11 other LEDs should be illuminated while the switch is held down.
3. Ensure that there is a flow of water in order not to overheat the pads. If there is no water flow, the LEFT or RIGHT OVER TEMP LEDs will switch on.
4. The LEFT and RIGHT ON LEDs should come on initially and then go off once the pads have cooled down. They will then come on and go off periodically.
5. Without a Vessel in the Cooler, no orange or red LEDs should be on. If there are any on, you should refer to the section on Troubleshooting.
6. After a few minutes, touch both the left and right pads. They should feel cold.
7. Place the warm Vessel in the Cooler’s well. The “VESSEL IN WELL” LED should be on as well as the “CLOSE DOORS” LED after 6 seconds.
8. Close the doors by holding both the Left and Right Doors in your hand and bringing them together until they lock into place. The Doors should stay closed and the “VESSEL COOLING” LED will come on.
9. Once the doors latch, test the “OPEN DOORS” function by pressing the “OPEN DOORS” button on the list of switches. The doors should open immediately. Close the doors again.
10. Once the Vessel has cooled to ambient temperature, the doors will open automatically and the “CLOSE DOORS” and “VESSEL COOLING” LEDs will switch off.
11. Remove the Vessel and the “VESSEL IN WELL” LED will switch off.
12. To test idle, press the “IDLE” button on the switch list. The “IDLE” LED should come on. Now press the “WAKE-UP” button and the “IDLE” LED should switch off.
13. Remove ambient cable and check that “AMBIENT FAULT” LED comes on. Re-insert ambient cable, and observe that the LED switches off again.
COOLER NORMAL OPERATION

1. Connect the water supply, ambient sensor cable and Mains power cable.
2. Wait for a few minutes for the Cooler to cool down.
3. Load hot Vessel in Cooler and close the doors. The indicators can be observed during this time.
4. When the doors open (release) the Vessel will be at the correct temperature, ready for further use.

This Cooler is designed to reduce the temperature of a recently fired Vessel to ambient temperature. The ambient temperature reference is plugged into the e2k Calorimeter ambient sensor. Solid state cooling is used and the hot junction of the Peltier elements is cooled by a continuous trickle from the mains water supply.

After installation and an initial warm-up or cool-down period, the unit is designed to operate continually and will reduce the average hot Vessel to ambient in approximately 2 minutes. This unit is suitable for high volume workload applications.

For a small volume workload the Cooler can be set in idle mode, when it is not required.

If 0.5 grams of average coal is burnt in the CAL2K-4 Vessel, the temperature will rise by approximately 9 Degrees C, however this is not fixed and may rise above or below 9 Degrees C. The energy released is approx. 220 Watt min. This heat has to be dissipated before a new determination can be started, otherwise the Vessel would get warmer with every determination.

**WARNING: NEVER immerse the Vessel in water to cool it down!**

The Cooler, with an effective cooling capacity of 200 Watt can cool the Vessel to its starting temperature within 2 minutes. The Vessel needs to be at ambient temperature prior to a determination.

This "cooling to ambient" is done to allow the Vessel enough time to stabilise (equalise) when it is being reloaded and handled.

COOLER DISPLAY PANEL

The display consists of 12 coloured LEDs and 4 push buttons. There are four (4) LEDs for the VESSEL, four (4) LEDs for the ELEMENTS and four (4) LEDs for the STATUS.

- Green LEDs indicate that the Cooler is functioning correctly
- Orange LEDs are informative and indicate the status of the Cooler
Red LEDs indicate fault conditions and require attention

VESSEL LED LIST
The far left column of Four (4) LEDs indicates the VESSEL status as follows:

Vessel in well
This LED will be green when the Cooler recognizes that a Vessel has been inserted into the well. The LED will go off once the Vessel has been removed.

Close doors
This LED will be orange if the Vessel is warm, indicating that the doors need to be closed.

Vessel cooling
This LED will be orange if the Vessel is cooling. Once the Vessel has reached ambient temperature, the LED will go off.

Vessel too cold
This LED will be red if the Vessel has significantly over cooled, indicating that the doors have stuck onto the Vessel.

The centre column of 4 LED’s indicates the status of the Peltier elements. The elements are referenced as left and right when the unit is viewed from the front.

ELEMENTS LED LIST
These four (4) LEDs are in the Middle Column of the Panel and indicate the ELEMENTS status as follows:

Left ON AND right ON
These are Green LEDs which indicate when the elements are actually switched ON. The elements work independently of each other and consequently both LEDs may not be on at the same time.

Left OVER TEMP and right over temp
These are Red LEDs and indicate that the hot side of the element has got too hot. This is usually caused by insufficient water flow or the incoming water is too hot.

STATUS LED LIST
The far Right Column of four (4) LEDs indicates the STATUS of the Cooler as follows:

Power
This is a green LED and will be ON continuously as long as mains power is applied to the unit.

Idle
This is an orange LED and will be ON if the unit has gone into IDLE mode.

Ambient Fault
This is a red LED and will be ON if the ambient sensor is not detected. This occurs if the ambient cable is faulty or not plugged into both the Cooler and the Calorimeter.

**AUXILIARY**
This LED has not been assigned to any function.

**PUSH BUTTON LIST**
The four (4) push button switches are momentary and need to be pressed in order for them to operate. When these buttons are pressed, their functions will be as follows:

**OPEN Doors**
This will open the doors before the ambient temperature has been reached.

**Idle**
This will force the Cooler to go into Idle mode. The idle LED will then be switched ON (green).

**Wake-up**
This will take the Cooler out of idle mode and return it to normal operation.

**LED Test**
This will illuminate all the 12 LEDs thus confirming that they are working. The test is only operative while the button is being held down.

**E2K AIR COOLER**

![E2K AIR COOLER – FRONT VIEW](image)

**FIGURE 6. : E2K AIR COOLER – FRONT VIEW**
FIGURE 7. : E2K AIR COOLER – rear VIEW

SYSTEM COMPONENTS
The e2k Air Cooler comprises of the following components:

1 x E2K-FAN e2k Air Cooler

There is no Installation Kit with the Air Cooler. A Mains Cable (CAL2K-MC) is supplied with the e2k Air Cooler.

INSTALLATION
The e2k Air Cooler requires a 220V 50/60 Hz mains power supply. power consumption is 2.2Watts. Ensure the unit is properly earthed through the mains cord. Position the unit so that it has a free flow of air. Ideally it should be positioned between the calorimeter and filling station.

TESTING
✓ Insert the mains plug
✓ Switch unit on
✓ Confirm that the fan is operating

NORMAL OPERATION
1. Place the vessel on the nylon holder, switch the unit on and leave for 10-15 minutes.
2. Switch the unit off and remove the vessel.
FIGURE 8: FILLING STATION – MAIN PARTS (EXTERNAL)

SYSTEM COMPONENTS
The Filling Station should comprise of the following components:
1 x E2K-3 Complete Filling Station
1 x E2K-3-KT Filling Station Installation Kit

A Filling Station Installation Kit is supplied. Please see the section on the E2K-3 Filling Station Installation Kit at the back of this manual for a list of the contents.

INSTALLATION
Prior to installation please make sure you have a suitable oxygen high pressure regulator. The regulator should be a high pressure regulator, capable of filling a Vessel to a pressure of 3000Kpa.

The Filling Station is packed in its own box along with the other components and Vessels, which are in their own plastic bag. Remove the foam, which holds the Filling Station in place. Before proceeding any further, inspect the Filling Station for any possible damages during transportation. If you find it to be damaged in any way, contact your Agent immediately. Also, check the packing list and confirm all the contents.

The type of oxygen to be used is normal Industrial Oxygen, used for welding. A purity of 99.5% is suitable. The oxygen bottle should be firmly secured to a wall or pillar. Using the pressure pipe and connectors supplied, connect the Filling Station to the oxygen bottle. Slowly increase the pressure and check all connections for any possible leaks. If a connection is leaking, turn the oxygen off and disassemble the connection to ensure that the ferrule is sealing.

Once the Filling Station is installed and ready to use, place the Vessel on the base and lower the arm, ensuring that the Filling Station nozzle fits directly and cleanly over the Vessel’s valve. Once the arm is fully down it will latch in this...
position and the Vessel will then fill, unattended. When the Vessel reaches the required pressure the arm can be lifted and the Vessel removed.

There are 2 pressure gauges on the Filling Station. The right hand gauge indicates the bottle or incoming pressure, and this should always be 3000Kpa. The gauge on the left indicates the Vessel or filling pressure. The rate of the filling is clearly visible on this gauge. One can fill the Vessel to less than 3000Kpa (never more), however this will only be applicable when one is analysing samples which are highly combustible (e.g. Wood samples) and need less oxygen to burn. For samples such as these we recommend filling the Vessel to 1500Kpa.

During normal operation the Filling Station requires very little maintenance. However it is suggested that the ex-centre and piston be oiled so as to minimize wear. (See the parts detail further on in this manual). Also, the O-ring in the nozzle should be lightly smeared with silicon grease daily, to avoid the Vessel from sticking to the nozzle when filling. Incorporated with the Filling Station are two holders on either side – one can be used for holding the handling hook and defiler cap, while the other is to hold the Vessel’s lid assembly.

ADJUSTMENTS

The Filling Station was designed to be as simple as possible to use by the Operator and to have as few adjustments as possible. Please refer to the diagrams on the Filling Station parts under the section on “Maintenance” further on in this Manual. There are only two adjustments which may be required on the Filling Station:

Firstly, the plastic base is adjusted so that the Vessel valve is directly under the Filling Station’s nozzle. This is adjusted in the Factory and should not require adjustment again. However, if an adjustment is necessary, the following procedure should be followed:

a) If the Filling Station is bolted to the table, remove the bolts.
b) Loosen the screw, which holds the plastic base to the base of the Filling Station.
c) Place a Vessel in the disc and lower the arm of the Filling Station, ensuring that the nozzle fits cleanly onto the Vessel’s valve, until the arm latches down all the way.
d) Now tighten the plastic base’s screw from underneath.
e) Check the alignment and if correct, bolt the Filling Station back to the table.

Secondly, adjustment to the rate of filling the Vessel may be needed. This is adjusted by the Flow Adjustor screw on the right hand side of the gauge block holder, next to the bottle pressure gauge. (See the parts detail further on in this Manual). This screw is already adjusted at the dds Factory so that a Vessel will fill up to 3000Kpa in about 20 seconds. Turning the screw inwards (clockwise) will reduce the flow and thus the Vessel will take longer to fill. Turning the screw outwards (counter clockwise) will increase the flow enabling the Vessel to fill faster. When turning the screw inwards, do not over tighten, as this will damage the plastic nipple inside.

When turning the screw outwards great care must be taken. The screw must NOT be turned more than 2 turns from its original position.

WARNING: Over turning can cause the screw to be blown out of the threads by the pressure. This can result in damage or cause injury to the Operator.
The filling time should be varied between 30 - 60 seconds only. The actual time being chosen should be in accordance with the operator’s experience and speed.

One more adjustment which could be required is that of the Bottle Pressure. This should always be set to 3000Kpa to allow the Vessel to fill unattended. If the pressure is set correctly the Vessel will not overfill. Please remember that with high combustible samples which require less oxygen to burn, it is advisable to fill the Vessel to 1500Kpa.

The absolute maximum pressure to which the incoming pressure can be set is 4000Kpa.

**WARNING:** Any additional pressure can cause damage to the Filling Station or even injury to the Operator. If a Vessel is filled to below 3000Kpa, and the sample being analysed does not have a high combustion, there is a chance you will receive a misfire error as there is not enough oxygen in the Vessel to burn the sample. However, as mentioned already this may not happen if the sample you are analysing is highly combustible and needs less oxygen to ignite.

**THE VESSEL CAL2K-4**

![Figure 9: Vessel Bottom View](image)

![Figure 10: Vessel - Main Components](image)
VESSEL BACKGROUND

The CAL2K-4 Vessel is smaller than a conventional Vessel, which results in a smaller heat capacity. Special attention was given to a thermally balanced Vessel design that was achieved with computer aided design (CAD) and computer simulation of heat transfer characteristics.

The Vessel has an oxygen volume of 0.2 Litre, which allows for a 0.5g sample of Coal with approx. 30MJ/Kg. The temperature sensors are located cylindrically within the Vessel’s walls at four places and terminate on the bottom of the Vessel PCB and subsequently onto the contact base rings.

The approx. temperature rise of the CAL2K-4 Vessel after the burning of 0.5g benzoic acid is 9 Degrees Celsius. Practical tests have shown that up to 0.8g of benzoic acid can be burnt without affecting the accuracy. Oxygen starvation affects the results with higher charges.

The Vessel must be cooled after a determination. This can be achieved by conventional means such as making use of a fan or simply leaving it on the table to cool down naturally. To speed up the cooling down process, a CAL2K-2 Solid-State Cooler is recommended, and a necessity should more than 6 determinations be required in one hour. The Cooler reduces the temperature of the warm Vessel to the starting temperature, which is also the room (or ambient) temperature. The absolute ambient temperature is not important.

Another design feature is the “firing through the valve” concept, which is of the utmost importance for the thermal balanced heat conductivity.

MICROPROCESSOR

The Vessel is “smart” with a microprocessor built into its base. The sensors plug directly into the microprocessor board. All the information pertinent to a Vessel is stored permanently inside the Vessel i.e. Vessel number, calibration curve, number of firings, date of last reconditioning, etc.
The Vessel PCB is only powered up when it is placed in the Calorimeter or the Cooler. The consequence of the Vessel memory is that any Vessel can run in any Calorimeter without a new calibration. The Vessel’s memory can only be accessed from the Calorimeter’s Keyboard or the PC. The electronics and sensors are fully vacuum epoxy impregnated to prevent physical damage as well as moisture from entering the electronics.

PERMANENT FIRING WIRE
The Firing Wire (CAL2K-4-FW) is semi-permanent and only needs to be replaced when it is damaged or burnt. Only firing wire, which is pre-cut and supplied by DDS or its agents must be used.

For firing, a length of pure cotton thread (CAL2K-4-FC) is tied to the firing wire with its “tail” touching the sample.

The Firing Cotton must be pure cotton, not any blend with synthetic fibres and must be of a standard length. It is recommended that only firing cotton supplied by DDS or its Agents should be used.

VESSEL BASE CONTACTS
There is digital communication between the Vessel and either the Calorimeter or Cooler.

Only three connections are required: positive, ground and signal. The connections are made via slip rings between the base of the Vessel and the base connection holders in the CAL2K-1 Calorimeter and the CAL2K-2 Cooler. Always ensure these slip rings are clean.

THE PRINCIPLE OF CALORIFIC MEASUREMENT
Studying this section is not essential to successfully operate the CAL2K-1 Calorimeter. It is intended for the laboratory technician or chemist who wants to know “how and why” things happen.

THEORY OF”DRY ISOTHERMAL” CV DETERMINATIONS : CONVENTIONAL WAY
The CV (Calorific Value) of a substance is measured by burning it in a controlled environment. The resulting heat released by this combustion i.e. the net temperature rise, is proportional to the calorific value.

A problem, however, occurs in that during the determination period (±10min) some energy may be gained from or lost to the environment.

In the adiabatic system, the environment is controlled so that no energy is lost or gained. To achieve this state, the calorimeter’s Vessel (bomb) and bucket are surrounded by a water jacket which is strictly temperature controlled by a system of circulators, heaters and Coolers, so that it has the same temperature as the inner bucket.

An Isothermal calorimeter measures the effect that the environment has on the bucket before and after the determination and corrects the result accordingly. This implies that the environment is stable during the determination. To achieve stability a large body of water surrounds the Vessel and bucket assembly, which is thermally stable.
MODIFIED CONVENTIONAL WAY

Prior to development of the CP500, over a 5-year period, it was demonstrated by "dds" that a polystyrene jacket, which has very little thermal mass and negligible heat conductivity, could replace the water jacket. This system was used in dds's first calorimeter product the AMPC.

DRY METHOD

In the conventional way a Vessel is placed in a water container and the water temperature is measured. Since the water quantity and container are part of the effective heat capacity, great care must be taken not to change the capacity. Equally important is that the water acts as a heat sink and a temperature transfer medium to the sensor.

In the dry way, the Vessel, water and container are replaced by a highly temperature conductive aluminium jacket which is shrunk over the stainless steel body at a very high pressure and forms an integral part of the Vessel. The temperature sensors are equally spaced around the Vessel body in between the aluminium jacket and the stainless steel body. This method eliminates all the problems with water and results in very fast temperature equilibrium, with a fixed heat capacity.

Since the Vessel became that much faster, the environment could affect the measurement 5 times less than with the conventional use of a water jacket.

Also, a warm Vessel is not placed in cold water to achieve equilibrium. The solid-state CAL2K-2 Cooler reduces the temperature from warm to ambient, after which the Vessel would be ready for firing once again.

The Vessel design was the result of a computer aided process and extensive computer simulations to predict its temperature behaviour. The Vessel is tested and certified to international material and test requirements.

From the operator’s point of view, the Vessel is lighter, easier to handle and plated on the exterior, for easy cleaning.

VESSEL IMPROVEMENTS

The CP500 had the sensors inside the Vessel, and the measuring electronics inside the CP500 Calorimeter. The CAL2k/e2k has the electronics and sensors inside the Vessel (bomb). Effectively the “whole” calorimeter is placed inside the Vessel, and the Vessel is “docked” in the e2k Calorimeter for supervision. The result is a faster and more stable temperature reading.

The Vessel’s temperature is measured with 8 sensors and a 25% redundancy (software). The Vessel’s electronics are vacuum epoxy sealed, and require no adjustment or maintenance.

The Vessel can be operated over a wide temperature range (+10 to +50 degrees C), but it is advised that the Vessel's starting temperature is the ambient (room) temperature. The “intelligent-SMART” Vessel brings other improvements such as: firing counts, identification, history of use and reconditioning data.
CONNECTION

OPTIONAL PC CONNECTION
The e2k Calorimeter operates without a PC, but a PC is required for electronic result retrieval and temperature graphing, and some “seldom” used set-up parameters.

The e2k Calorimeter has a serial RS232 output, which can be connected to a PC or PRINTER (with a serial RS232 interface). Once connected to a printer, the e2k can print EACH result after a determination or all results accumulated in its memory.

The PC connection is at a different (higher) baud rate, which is automatically set by the e2k.

The Windows PC Software and PC Cable are supplied with each e2k Calorimeter configuration.

OPTIONAL BALANCE CONNECTION
The following configurations are possible:

a) The MASS is manually entered (typed in) via the external Keyboard.

b) A Balance is connected to the e2k Calorimeter and the MASS is electronically entered. A Balance connecting cable is supplied in the Calorimeter Installation Kit.

See the Section: Technical Specifications for the Balance set-up.

OPTIONAL E2K-2 COOLER CONNECTION
E2K-2 Cooler is supplied with the Standard and Elite System configurations ONLY. The Cooler needs to be connected to:

- A clean water supply

  WARNING: Just a trickle of water is required for the Cooler. Too much pressure with a full open tap will cause leakages. The Cooler has been designed for LOW pressure!

- Mains power supply
- The ambient sensor to the e2k Calorimeter via the supplied cable – CAL2K-2-AS (round connectors)

EXTERNAL KEYBOARD CONNECTION
A standard PS2 PC Keyboard must be connected to the rear panel. The PS2 Keyboard is included in the Calorimeter Installation Kit.

PRINTER CONNECTIONS
The printer connects to the RS232 port, which is also used by the PC. If you connect to a Printer directly, you will not be able to connect to a PC. It will be one or the other. The Baud rate and set up for the Printer are different to that of the PC. Either the PC or the Printer can be used after a reset (power up) only. The Printer requires the following set up:
E2K FIRING CIRCUIT AND VOLTAGE

E2K FIRING VOLTAGE

- The external power supply has a constant output of 9 volts irrespective of the mains voltage. This power supply is rated for 96 to 260 volts and 50 or 60 Hz.
- The 9-volt supply is then increased internally to 40 volt DC.
- The 40 volts are then applied to the firing capacitors on the PCB.
- The voltage on the capacitors is controlled to a preset value by the microprocessor.
- The pre-set value is set by “FV” from the Keyboard
  - FV=xx.x then press Enter
  - Where xx.x is the required Firing Voltage (Usually this is 25)
- The Firing Voltage can be displayed at anytime by typing:
  - “FV/” then press Enter
  - The display will show: FV/xx.x-yy.y
  - Where xx.x is the pre-set value and yy.y is the actual capacitor voltage.

NOTE: yy.y does not continuously update – it only updates when FV/ is entered.

- TEST 4 = “T4” will display the Firing Voltage dynamically.
- The recommended Firing Voltage is 25 to 30 volts. If the voltage is set to less than this, the Firing Wire may not ignite the Firing Cotton. Any higher a voltage, will reduce the life of the Firing Wire.
- The Firing Voltage has very little to do with the burning of the sample. As long as the Firing Cotton ignites, the sample should burn successfully.

E2K FIRING CIRCUIT EXPLANATION

- At firing, the voltage on the firing capacitors is applied to the firing wire inside the Vessel.
- The Firing Wire will then heat up and glow, in turn igniting the Firing Cotton, which in turn will ignite the sample. The Firing Wire will not glow and the Firing Cotton will not burn except in an oxygen rich environment, so the Vessel must be pressurized with oxygen for the sample to ignite.
- The firing circuit relies on good contacts all the way through the circuit. Any bad contacts will reduce the firing voltage.
- These contacts are as follows:
  - Internal contacts of the e2k Calorimeter which are fixed
  - Lid contact in the e2k Calorimeter’s Lid to the Centre Electrode
  - Firing Wire to Centre Electrode
• Ensure that the Firing Wire is securely fitted to both electrodes.
• Ensure that the Firing Cotton is secure on the Firing Wire.
• Ensure that the Firing Cotton touches the sample.
• Ensure that the Firing Wire does NOT touch the Crucible or the Deflector Plate.
• Only use DDS manufactured Firing Wire (CAL2K-E-FW) and Firing Cotton (CAL2K-4-FC). Any other wire and cotton may cause ignition difficulties. The cotton must be 100% pure cotton.
• To check the firing circuit, always use Benzoic Acid tablets as a sample. If the BA (Benzoic Acid) ignites then the circuit is functioning correctly.
• If a sample is difficult to ignite and the circuit is functioning, consider using Benzoic Acid as a spiking material to help ignite the sample or alternatively place the sample in Gelatine Capsules as capsules also help to ignite the sample.

GENERAL OPERATION OF THE E2K
CALORIFIC VALUE MEASUREMENT
In essence, the e2k Calorimeter measures the temperature rise of a Vessel with constant mass, volume and pressure in an isothermal environment. The temperature rise is proportional to the energy released, which will yield the specific energy if the weight is known. The gross calorific value obtained is then related to the calibration and a gross sample CV is obtained. The corrections are applied and the corrected CV is displayed and stored in memory.

TEMPERATURE MEASUREMENT
8 Calibrated sensors are embedded within the Vessel’s wall. These are averaged to determine a single temperature. The temperature resolution on the display of the Calorimeter is limited (only shows a certain amount of characters), so on the display it will read as 0,0001°C. But the actual Temperature resolution of the Calorimeter is 0,000006°C. The temperature measuring range is from 0°C to 65°C. However, the actual temperature rise of a burned sample should be in the 4 – 12°C range, which can be anywhere in the total measuring range of 0 to 65°C.

SAMPLE IDENTIFICATION (SID)
A label identifies a particular sample. This label is called the SID (Sample Identification) and is entered via the keyboard. The SID is a 5-character number in the range from 0-65535.

GROUP IDENTIFICATION (GID)
This is an 8 character text message to attach better identification to the sample. The GID is NOT retained after a power loss. It is then replaced with “UNKNOWN?”.

VESSEL IDENTIFICATION
Each Vessel has a unique number so that the Calorimeter can identify which Vessel is being used. Vessel identification can be set from the Keyboard or by using the PC software and will be a number from 1 to 255.
NOTE: The number from 1 to 255 is NOT a serial number!

SAMPLE MASS ENTRY
The e2k Calorimeter utilises a sample mass of approximately 0.5g. The actual mass of the sample can be entered in the e2k Calorimeter in one of two ways:

AUTOMATIC MASS ENTRY
This method requires the connection of an electronic Balance directly to the e2k Calorimeter.

MANUAL MASS ENTRY
In the manual MASS entry method, the sample MASS is entered into the e2k Calorimeter via the external PC Keyboard prior to the determination.

The sample mass resolution in both cases is 0.0001 gram.

VESSEL CALIBRATION
The method of determining multiple (50) Vessel factors is utilised by the e2k Calorimeter. The calibration is not accessible from the Keyboard. The e2k Calorimeter keeps a “Vessel Factor” every 6 seconds for the full calibration run of 5 minutes.

CV DETERMINATION CYCLE
When a Vessel is inserted into the measuring chamber of the Calorimeter (Well) and the Lid is closed, the following checks are performed:

- There is communication to the Vessel
- A SID and MASS have been entered
- There is continuity between the Vessel’s electrodes (the Firing Wire is present)
- A calibration curve is available for the particular Vessel
- The firing voltage (in the Calorimeter) is present
- The Vessel is safe to operate (within the required firing count)

Assuming that the above checks are satisfactory, the determination cycle will automatically start and will proceed through the following four phases:

INITIAL
A temperature stabilisation phase will be carried out. The duration of this phase is dependant on two criteria:

- The drift the Vessel exhibits after inserting into the Well
- The initial time

Both criteria must be met in sequence. Once the Vessel temperature drift is less than the specified limit, then the initial time will start. The Initial drift and initial time can be set from the PC only.
FIRING
After the initial period, the Vessel is automatically fired. This means that the preset firing voltage is applied to the firing wire.

MAIN
This is initiated immediately after a successful FIRING phase. An unsuccessful Firing (i.e. sample not ignited or absent) will be reported as a “MISSFIRE” fault and the determination aborted. The Main phase takes from 2 to 5 minutes as indicated using the PC interface.

DONE
On completion of the MAIN phase, a CV result is displayed and stored. The Calorimeter will wait for the Lid to open.

END
This phase is short! It starts when the Lid has been opened. Then the Operator will be prompted to remove the Vessel from the Well.

COOL

WARNING – COOLING: DO NOT IMMERSE THE VESSEL INTO COLD WATER WHEN COOLING. Use the E2K-2 Cooler or E2K-FAN Air Cooler or allow the Vessel to cool naturally.

CORRECTION FACTORS

CORRECTION FACTOR #1
The Correction Factor #1 (Sample Correction) is used for corrections, which depend on the sample MASS. Such corrections are for SUPLPHURIC acid. The sum of all MASS related corrections is entered via the Keyboard (or PC). The entry is in: UNITS/MASS (MJ/Kg, Cal/g, Btu/lb)

CORRECTION FACTOR #2
The Correction Factor #2 (Wire Correction) is for non-MASS related energy, such as firing cotton and firing wire. The Correction Factor #2 can be entered via the Keyboard (or PC). The entry is in UNITS (MJ, Cal, Btu).

Burnt Energy – CORR 2

MASS

Correction Factor 2 (CORR2) is a constant for cotton, wire and nitric acid. This correction factor is not related to the MASS of the sample.

MANUAL MASS ENTRY
The MASS entry is as follows:

  Function Key (F1)
  Mass
  Enter
Alternatively, use the Up/Down arrow keys to scroll to the “MASS, ENTER” menu item, and then press:

= Mass
Enter

The MASS is “locked” after entry, and further MASS entries are prohibited. The MASS can be “un-locked” by pressing the DELETE key. The MASS entry is a compulsory requirement before closing the Lid. The Maximum MASS allowed is 1.999g, the Minimum MASS allowed is 0.2g.

**AUTOMATIC MASS ENTRY**

This requires a Balance to be connected to the e2k Calorimeter. Once the Balance is stable, the e2k will display the MASS followed by the letter “g” after pressing the “F1” key.

Press “Enter” to accept the Balance MASS. The MASS is locked thereafter. The MASS entry is compulsory before closing the Lid.

**SID ENTRY**

The SID entry needs to be up to a maximum of 5 numbers (0-65535) or less. A SID cannot include letters (text) or any special characters (e.g. punctuation). A SID must be entered BEFORE the Lid is closed. The SID can be entered in two ways:

1. Press the F2 key, type (=), SID (numbers only), followed by ENTER.
2. Use the UP/DOWN arrow keys to scroll through the menu until the SID Menu Item is found. Type (=), followed by the SID (numbers only), followed by ENTER.

Unlike the MASS (which is locked), the SID can be changed while the Lid is open. If the power has been removed the SID will start at zero. If no SID is entered then the e2k Calorimeter will automatically increment the SID by 1 for each determination.

**GID ENTRY (OPTIONAL)**

The group identification (GID) is an optional identifier, which can be used as a text description for the sample. Like the SID, the GID is retained during a power failure. The GID consists of 8 characters.

The GID can be entered in two ways:

1. Press the F3 key, type (=), GID followed by ENTER.
2. Use the UP/DOWN arrow keys to scroll through the Menu until the GID Menu Item is found. Then type (=), GID, followed by ENTER.

**TIME AND DATE SETTINGS (OPTIONAL)**

The e2k Calorimeter has a real time feature, which retains accurate time and date for up to a week without power. If the real time is questionable after a prolonged power failure, a warning message will be displayed.
SETTING UP THE DATE

The DATE can be set up as follows:

1. Press the F4 key, type in the date in the format: Day, Month, Year, then press ENTER.
2. Use the UP/DOWN arrow keys until the date Menu item is found, and the date is displayed. Type (=), the DATE (format DD, MM, YY), followed by ENTER.

NOTE: The day, month, year entries must be separated by a comma, period or space.
For Example: 1.1.1 OR 02,02,07 OR 28 3 7

SETTING UP THE TIME

The e2k Calorimeter’s real time is entered in Hours, Minutes, and Seconds. The Seconds can be omitted. The TIME can be set up as follows:

1. Press F5, type the time in the form Hours, Minutes, Seconds, ENTER
2. Use the UP/DOWN arrow keys until the time menu displays the time. Type (=), the TIME, ENTER

NOTE: The Hours, Minutes, Seconds must be separated by either a comma, period or space!
For Example: 3.4.5 OR 03,23 OR 7 59 30

SUB-MENU

All operating parameters can be accessed via the Keyboard’s Menu function. The complete Menu is divided into two sections for convenience. The first section contains the most often used parameters, and the second section contains parameters, which are set up once only.

<table>
<thead>
<tr>
<th>FIRST MENU SECTION</th>
<th>FUNCTION KEY (ON KEYBOARD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter MASS</td>
<td>F1</td>
</tr>
<tr>
<td>Sample ID</td>
<td>F2</td>
</tr>
<tr>
<td>Set Calibration mode</td>
<td></td>
</tr>
<tr>
<td>Print Enable</td>
<td></td>
</tr>
<tr>
<td>Spike CV</td>
<td></td>
</tr>
<tr>
<td>Spike mass</td>
<td></td>
</tr>
<tr>
<td>Sub-Menu</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SECOND MENU SECTION</th>
<th>FUNCTION KEY (ON KEYBOARD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firing Voltage</td>
<td>F9</td>
</tr>
<tr>
<td>Test</td>
<td></td>
</tr>
<tr>
<td>Sample Correction</td>
<td>F7</td>
</tr>
</tbody>
</table>
### Wire Correction
- F8

### Load DEFAULT
- F10

### Calibration CV

### Initial Drift

### Initial Time

### Final Time

### Group Identification
- F3

### Ambient Offset

### Bomb Number

### Ambient Difference

### Clear Memory

### Date
- F4

### Time
- F5

### Unit of Measure

### Memory Records

---

**NOTE:** Some of the functions of the Second Menu section can be accessed via the indicated Function Keys. The Second Menu Section can be scrolled to by:

- Sub-Menu = 1 then press “Enter”

This switches the Sub-Menu ON until a power failure should occur. Once the power has been restored, the Sub-Menu will be switched OFF.

---

### DEFAULT PARAMETERS

The e2k Calorimeter has the following Default System Parameters, which are vital to its operation. These values can be set from the Keyboard or via the PC, and the DEFAULT setting is indicated.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>DEFAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setup</td>
<td>MJ/KG</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>CAL/g</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>BTU/lb</td>
<td>Yes</td>
</tr>
<tr>
<td>FireVolts</td>
<td>Firing Voltage</td>
<td>25V</td>
</tr>
<tr>
<td>CalVal</td>
<td>Calibration Value</td>
<td>26.454MJ/Kg</td>
</tr>
<tr>
<td>Corr#1</td>
<td>Sample Correction</td>
<td>0MJ/Kg</td>
</tr>
<tr>
<td>Corr#2</td>
<td>Wire, Cotton Correction</td>
<td>0MJ/Kg</td>
</tr>
<tr>
<td>SpikeVal</td>
<td>Spike C.V.</td>
<td>26.454MJ/Kg</td>
</tr>
<tr>
<td>IniDrift</td>
<td>Initial Drift</td>
<td>0.0020/6sec</td>
</tr>
<tr>
<td>AmbOff</td>
<td>Ambient Sensor Offset</td>
<td>0.0</td>
</tr>
<tr>
<td>AmbDiff</td>
<td>Max. Bomb/Ambient Diff.</td>
<td>3.0</td>
</tr>
<tr>
<td>Initial Time</td>
<td>Initial Wait Time</td>
<td>1.0 Minutes</td>
</tr>
<tr>
<td>Final Time</td>
<td>Final Determination Time</td>
<td>3.0 Minutes</td>
</tr>
<tr>
<td>GID</td>
<td>Group Identification</td>
<td>UNKNOWN?</td>
</tr>
</tbody>
</table>
CALIBRATION CV
This is the Calorific Value (CV) to which the unit calibrates, when the calibration cycle is switched ON.

INITIAL DRIFT
The e2k waits until the Vessel has equalised in temperature. This means that the bomb temperature changes, less that the entered value, every 6 seconds. Once the temperature change (Drift) criteria have been met the INITIAL TIME starts. Entering a high number can disable the Initial Drift check.

INITIAL TIME
The Initial Time starts after the INITIAL DRIFT criteria have been met and ends when the Vessel is fired. Normal entry is 0.5 to 1.0 minute. The actual time depends on the INITIAL DRIFT entry, and on the AMBIENT DIFFERENCE. The parameters, which influence the time before firing, include:
- Cooling method
- Time before Vessel is inserted
- Handling
- Initial Drift
- Initial Time

FINAL TIME
The Final Time is the time from firing to displaying the result. It should take between 1.5 and 3.0 minutes. The Final Time is influenced by:
- Burning speed of sample
- Sample preparation
- Lesser extent: Initial time

AMBIENT OFFSET
This is a value, which describes the offset between the Ambient Sensor and the Vessel Temperature measurement. The Vessel is factory calibrated, but the sensor is not. The Ambient Sensor calibration can be performed by leaving a Vessel in the Well for some time and then setting the ambient offset until both temperatures read the same. A 0.5 degree C difference is allowed.

AMBIENT DIFFERENCE
This is the difference between Vessel and Ambient Temperature before the Vessel is allowed inside the Well. This difference should not exceed 3 degrees C. If the Vessel exceeds the specified difference the following messages will appear:
- BOMB TOO COLD
- BOMB TOO WARM

PRIOR TO FIRING A VESSEL
Prior to using the e2k Calorimeter for routine CV determinations (or Vessel calibration) the following check list must be verified:
• All equipment is switched ON. Oxygen pressure (3000kPA) checked and regulator adjusted if necessary.
• System Tests carried out.
• All Vessels cleaned and O-rings checked for any damage, if damaged please change the o-rings.

Verification of the above checklist before starting a new batch of samples or after prolonged non-usage of machine will ensure trouble-free operation with minimum downtime.

PREPARING A VESSEL

NOTE: This section MUST be read as it provides valuable information for achieving accurate results.

The art of producing highly reproducible results revolves around establishing a constant work cycle with the minimum of interruptions. Adherence to the following Vessel preparation sequence will ensure that unexpected breaks in routine operation will be kept to the absolute minimum.

• Depressurise the Vessel if it has just been fired using the Defiller Cap (CAL2K-4-DC).
• Open the Vessel, clean the inside of the chamber using paper towel, and ensure no fibres are left inside the chamber. The Vessel should always be cleaned after every determination.
• Remove and clean the Crucible (CAL2K-4-CB) with a Wire Brush (CAL2K-4-WB). Old or damaged crucibles should be discarded as they can cause damage to the Vessel during firing.
• Clean the Vessel and Vessel Cap threads with a Wire Brush.
• Remove any old Firing Cotton (CAL2K-4-FC) from the firing wire (if the Vessel was not fired recently). If the Vessel has been fired the cotton would have burnt away with the sample so there should be no firing cotton left on the firing wire.
• Inspect the Firing Wire (CAL2K-4-FW) and replace if necessary. Only use the dds supplied pre-cut Firing Wire.
• Insert the pre-cut length of Firing Cotton (CAL2K-4-FC) by looping it over the firing wire and then twisting the ends together.
• Weigh the sample using a balance. Make sure you place the empty crucible on the balance weigh plate first, then press “Tare”. Once this has been done then you may place the sample inside the crucible and weigh the sample. By following this procedure you will cancel out the weight of the crucible and this will give you an accurate sample mass.
• Insert weighed crucible and sample into the outside electrode’s crucible holder, ensuring that the firing cotton touches the sample.
• Be careful as not to “flick” any sample out of the crucible with the cotton. Experience and technique practice helps.
• Insert the electrode assembly (Lid Assembly) into the Vessel body.
• Screw the cap down until it touches the top of the lid. Tighten with quarter to half a turn. Do not over tighten, as it will be difficult to open later. Also make sure the cap does not screw all the way down.
• Place the Vessel under the Filling Station, keeping it upright. Fill it with 3000KPA oxygen. The right hand gauge should read 3000KPA.
• Remove from the Filling Station with the Handling Hook (CAL2K-4-HH) and let the Vessel stabilize for approx. 1 minute before inserting it into the Calorimeter.
CALIBRATION OF VESSEL

Each Vessel is calibrated before delivery and the calibration is stored in the Vessel. Should it become necessary to perform a calibration, then follow the steps below:

- Weigh a tablet of Benzoic Acid (B.A.), and enter the MASS into the e2k Calorimeter using the Keyboard.
  - Place a Clean crucible on the Balance. Press Tare so that the weight with the crucible = 0.0000g.
  - Using tweezers: place a Benzoic Tablet into the Crucible and weight for the g to appear (measurement done)
  - Record this value and enter it into the E2K Calorimeter using the keyboard. \( F1 \) Mass:0.xxxx \( \text{Enter} \). If a balance cable is connected follow this: \( F1 \) wait for the balance weight to appear and then \( \text{Enter} \).
- Prepare a Vessel (as per below).

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- Place the Vessel under the Filling Station, keeping it upright. Fill it with 3000KPA oxygen. The right hand gauge should read 3000KPA.
- Remove from the Filling Station with the Handling Hook (CAL2K-4-HH) and let the Vessel stabilize for approx. 1 minute before inserting it into the Calorimeter.

- Place the Vessel in the e2k Calorimeter’s Well.
- Do not close the e2k Calorimeter’s Lid.
- Use the UP/DOWN arrow keys to find the “Calibration” Menu Item. Press (\( = \)) 1, then press \( \text{Enter} \).
- Close the Lid and observe that the e2k goes to the INITIAL, WAIT phase.
- Observe that the MAIN PERIOD, WAIT runs for 5 minutes.
- Note that the Display indicates “CALIBRATION DONE”. This means that the calibration has been stored in the Vessel with all other information.
Open the Lid and remove Vessel.
Now cool the Vessel and run a few Benzoic samples.
The better your process, the better your results.
When you are comfortable with the results, replace the benzoic with your sample.

**NOTE: The calibration mode is automatically terminated after firing of the charge.**

**DRIFT COMPENSATION**

The e2k Calorimeter has a temperature drift compensation method, which applies to the MAIN PERIOD only. This compensation is required when the temperature rise after firing is very different from the temperature rise of the calibration. In normal operating procedure the calibration mass is adjusted so that both the calibration rise and the sample rise are equal to within 1 Degree Celsius. If this is not possible, then the drift compensation can be used to compensate for different rise (Delta T). The drift compensation can also be used for different firing temperatures as compared to the ambient temperature. The default AMBIENT DIFFERENCE (parameter) is set to 2 Degrees Celsius. If this difference cannot be maintained (due to lack of cooling), and if the Ambient Difference is raised, then the drift compensation must be used.

Operating outside the 2 Degree Celsius default ambient to bomb temperature difference affects the accuracy negatively. The drift compensation will try to counteract and reduce the error (caused by the different MAIN period drift from the calibration). It cannot eliminate the error totally, because different factors contribute to this error:
- Bomb surface
- Humidity
- Conductivity of the polystyrene insulation in time
- Heat storage in the various components surrounding the Vessel

For high accuracy and repeatability, this parameter should be set to ZERO and the default bomb to ambient difference of 2 Degrees should be used. The following settings were established experimentally, and are a guideline ONLY!

<table>
<thead>
<tr>
<th>VESSEL/AMBIENT DIFFERENCE DEGREES CELSIUS</th>
<th>DRIFT COMPENSATION PER 6 SECONDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0.0002</td>
</tr>
<tr>
<td>4</td>
<td>0.0004</td>
</tr>
<tr>
<td>5</td>
<td>0.0007</td>
</tr>
<tr>
<td>6</td>
<td>0.0009</td>
</tr>
<tr>
<td>7</td>
<td>0.0012</td>
</tr>
<tr>
<td>8</td>
<td>0.0015</td>
</tr>
</tbody>
</table>

Once used, a new calibration must be performed. During calibration the actual ambient to end temperature gradient (source of temperature losses) will be saved in the Vessel. During a determination the same difference is calculated, and if different from the calibration conditions then the determination is compensated by the above factor every 6 seconds.
CV DETERMINATIONS

Before starting any CV determinations, ensure that the prerequisites have been carried out.

During a complete determination, each vessel has to go through 4 distinct cycles as shown in the following sequence. Note that the WAIT cycle does not require any work:

<table>
<thead>
<tr>
<th>CYCLE</th>
<th>OPERATION PERFORMED</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREPARE</td>
<td>Prepare the Vessel</td>
<td>1 to 3 Minutes</td>
</tr>
<tr>
<td>WAIT</td>
<td>Wait for Stabilization</td>
<td>0-1 Minute</td>
</tr>
<tr>
<td>INITIAL, FIRE, MAIN, DONE</td>
<td>Actual Determination</td>
<td>2-4 Minutes</td>
</tr>
<tr>
<td>COOL</td>
<td>Cool with the (E2K-2) Cooler</td>
<td>3-5 Minutes</td>
</tr>
<tr>
<td></td>
<td>Cool with the (E2K-FAN) Air Cooler</td>
<td>30 – 40 Minutes</td>
</tr>
<tr>
<td></td>
<td>Cool naturally. DO NOT immerse the Vessel in cold water to cool!</td>
<td>60 – 90 Minutes</td>
</tr>
<tr>
<td>TOTAL</td>
<td>Total Using E2K-2 Cooler</td>
<td>Approx. 10 Minutes</td>
</tr>
<tr>
<td></td>
<td>Total Using E2K-FAN Air Cooler</td>
<td>Approx. 30 Minutes</td>
</tr>
<tr>
<td></td>
<td>Total Using natural method</td>
<td>Approx. 1 hour 10 minutes</td>
</tr>
</tbody>
</table>

The above cycle sequence must be adhered to for best results. Total throughput time is improved by the use of more than one Vessel. The following describes the various operational cycles in detail:

PREPARE
Prepare a Vessel, as described earlier on in this Manual.

WAIT
During this time (0.5 to 1.0 minute), the Vessel can equalize outside the e2k Calorimeter.

INITIAL, MAIN

- Insert a prepared Vessel, into the e2k Calorimeter’s Well.
- If the MASS and SID have not been entered, then do so now.
- Close the e2k Calorimeter’s Lid.
- The e2k Calorimeter checks various items, and displays any faults.
- If no fault has been detected, the INITIAL period will be displayed with the elapsed time.
- Once the INITIAL period has elapsed, the Vessel will be fired.
- Immediately after firing the MAIN period will be displayed with the wait time.
- After the MAIN period the result will be displayed and saved.
- Open the e2k Calorimeter’s Lid and remove the Vessel.
COOL

- De-fill the Vessel with Defiller Cap
- Let the Vessel stand for 30 to 45 minutes or cool it with a E2K-2 Cooler if ordered or the E2K-FAN Air Cooler if ordered.

**WARNING: DO NOT PLACE THE VESSEL IN COLD WATER TO COOL!** Allow the Vessel to cool down naturally.

- Then prepare the Vessel for the next determination

DISPLAY EXPLANATIONS
The top line of the Display is reserved for Operator prompts or status display and Keyboard entry. Keyboard entry is only possible when the Lid is OPEN.

**INSERT VESSEL**
Operator prompt.

**BOMB: NO CALIBRATION**
Shows after inserting a Vessel into the Well without a valid calibration. Follow the necessary procedures to prepare the Vessel for calibration.

**BOMB: NEAR RECOND.!**
The Vessel has been fired more than 4500 times and it is due for checking and reconditioning at 5000 firings.

**BOMB: EXPIRED!**
The Vessel has been fired 5000 times and needs to be sent back to dds for reconditioning.

**ENTER MASS +(SID)**
The e2k Calorimeter requires a MASS entry. The SID entry is optional.

**CLOCK FAULT: SET TIME**
The real time clock has lost power and the Date and Time may have been lost. Check both the Time and Date settings and re-enter either.

**REMOVE VESSEL**
The determination is complete, the e2k Calorimeter’s Lid was opened, and the Vessel must be removed.
CLOSE LID

The e2k Calorimeter has a MASS (OK) locked in, but the Lid is still open.

NO FIRING WIRE

After closing the Lid the e2k Calorimeter has detected that the firing connection (wire) is missing. Open the Lid and investigate the Contact in the Lid. If nothing is found, close the Lid and observe if the message is still there. If yes, open the Lid, remove the Vessel and proceed to open it to investigate. Don’t forget you’ll need to de-fill the Vessel first!

MISSFIRE -> OPEN

18 Seconds after firing, the Vessel’s temperature is checked. If the sample has not ignited, this message will be displayed. Open the Vessel (don’t forget to de-fill first) and start again. This could happen when the Firing Cotton is not touching the sample, or when the Vessel has not been filled with 3000Kpa oxygen. Remember, that in some cases (for high combustion samples), the Vessel needs to be filled to 1500Kpa and this will be acceptable. A misfire can also occur if there is a problem with the Lid Assembly, so check the o-rings and replace them where necessary.

CALIBRATION DONE

A calibration cycle was successful.

DETERMINATION DONE

The CV determination is finished and the result is displayed on the bottom line.

LID OPEN: ABORTED

The Lid was opened during the MAIN period, and the determination was aborted.

FIRING V. FAULT

The firing voltage is not on target and the e2k Calorimeter will not be able to fire the Vessel. Open the Lid and check the settings with the Test programs. You may also need to wait a minute or two to allow the Calorimeter to get to the required target.

BOMB TOO WARM

The Vessel is more than 12 degrees C warmer than the ambient temperature (higher than the setup limit). Please cool the Vessel by removing it from the e2k Calorimeter’s Well. DO NOT USE WATER TO COOL THE VESSEL! The result from firing at such an “elevated” temperature would be out of specification.
BOMB TOO COLD
The Vessel’s temperature is lower than the Ambient Temperature and therefore outside the setup limit. The Vessel will need to be warmed up.

MASS 0.2>MASS>1.999G
The MASS is outside the pre-set limits of 0.2g to 1.999g. The Vessel will not be allowed to fire.

INITIAL PERIOD, WAIT
The Initial period is in progress, in which the Vessel stabilises in preparation for firing. Once the initial drift criterion has been met, the initial time is counted down and the Vessel is fired.

MAIN PERIOD, WAIT XX.X
The MAIN determination time is in progress. The remaining time is displayed.

USING THE SPIKING TECHNIQUE

SPIKE VALUE
This is the known calorific value of the substance to be used for spiking, usually benzoic acid of approx. 26.454MJ/Kg. On some occasions, the use of a Gelatine Capsule (CAL2K-4-GC) or Crucible Cover Disc (CAL2K-FLDS) needs to be used with a solid sample or a volatile liquid sample respectively. When using these items, you will first need to determine the energy value of the item in question. You will need to use Benzoic Acid as the substance for spiking, as the Gelatine Capsule of Cover Disc becomes the “sample”. Once you have determined this value, you will then have the “Spike Value” for your determination.

SPIKE MASS
This is the mass of the substance to be used for spiking. The procedure to follow, is to place the crucible on the balance and press TARE. Then add the substance to be used for spiking to the crucible. This Mass value is the “Spike Mass” and must be entered manually into the Calorimeter. Then add the sample. This mass is the spike item’s mass plus the sample’s mass and must be entered in as the Mass. This can be read directly from the Balance if a Balance is connected.

STEP BY STEP ENTERING THE SPIKE VALUE
- Place the crucible on the Balance.
- Press “Tare” to clear the weight of the crucible and get to 0.000g.
• Place one Benzoic Acid tablet and note the Mass.
• Add the crucible cover disc and note the new total Mass.
• Remember to place the prepared crucible (benzoic acid tablet with cover disc) in the lid assembly, inside the Vessel, close the Vessel and fill with the required 3000Kpa of oxygen.
• Using the Down Arrow (Navigation Keys) on the Keyboard, go through the Menu options until you get to “Spike Mass”. Press “=” and then type in the Benzoic Acid mass e.g. 0.4787g.
• Using the Down Arrow (Navigation Keys) on the Keyboard, go to the next item “Spike Value CV”. Press “=” and enter the energy value of the Benzoic Acid tablet that you are using. This can be found on each bottle of dds Certified Benzoic Acid bottle of tablets, e.g. 26.454 (MJ/g). YOU MUST ENTER THIS VALUE EACH TIME YOU RUN A DETERMINATION WITH A COVER DISC OR GELATINE CAPSULE.
• Continue through the Menu items, until you get to “Enter MASS, SID”.
• Enter the Sample Mass, e.g. 0.5565g
• Enter the SID, e.g. 001
• Close the Lid of the Calorimeter
• The e2k Calorimeter will now perform some standard checks and if all is okay, it will begin with the “Initial Phase”, “Fire”, “Main” phase and then indicate that the determination has been completed.

Once the determination is complete, the result will display the calculated calorific value of the sample. The calorimeter will automatically take the end result, minus the spike energy and present your final result of your sample.

PRINTING RESULTS

The e2k Calorimeter (from Firmware V24), allows operations without a PC.

The printer connects to the existing RS232 port, which is alternatively used by the PC. The Baud Rate and Set Up, are different to the PC, and either the PC or the printer can be used after a reset (Power up) only. The printer requires the following to be set up:

It also includes two printing modes, which can be invoked from the external Keyboard:

PRINT ENABLE: = 0 {Enter}
   Switches all printing options off

PRINT ENABLE: = 1 {Enter}
   The results are printed as they arrive and stored in memory

PRINT ENABLE: = 2 {Enter}
   All the results in memory are printed

The memory can be cleared by:
CLEAR MEMORY: = 1 {Enter}

The amount of records in memory can be displayed:
MEMORY RECORDS:

A result record from Memory contains the following items:

- Date: dd,mm,yy,
- Time: hh,mm,
- Bomb Number: xxx,
- Status: AAA,
- GiD: aaaaaaaa,
- SID: xxxxx,
- Mass: xx.xxxx,
- Result in units: xx.xxxx,
- Unit: AAA,
- Sample Corr #1: xx.xxxx,
- Wire Corr #2: xx.xxxx,
- Fire – Amb Temp: xx.xxxx

Where:
- xxx = Numerical 0-9
- AAA = ASCII characters
- aaa = ASCII or numerical, as entered, e.g. ABC001D

Example of a Printout:

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Bomb Number</th>
<th>Results</th>
<th>Group ID</th>
<th>Sample ID</th>
<th>Mass</th>
<th>Result</th>
<th>Sample Correction</th>
<th>Wire Correction</th>
<th>Ambient Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>21,11,07,08,28</td>
<td>08,28,</td>
<td>001,</td>
<td>OK</td>
<td>12345678</td>
<td>0073</td>
<td>0.7999</td>
<td>16.254</td>
<td>0.0000</td>
<td>0.0000</td>
<td>2.8283</td>
</tr>
</tbody>
</table>

TESTING

The e2k Calorimeter has the following Operator test procedures built in, which can be used to assure the proper operation of the system. The tests are activated from the Keyboard only.

Activation procedure:
1. Use the **UP/DOWN** arrow keys on the Keyboard to locate the Test Menu item.
2. Type (=), followed by the Test Number 1-8, followed by **ENTER**.

Each test can be terminated with the DELETE key.

A new test can be started from a running a previous test by performing Step #2 above.

AMBIENT TEMPERATURE DISPLAY

The Ambient Temperature is displayed. If the e2k Calorimeter was just powered up, it may take several minutes for the temperature to stabilize. The reading should be within 1 Degree Celsius from the room temperature, provided that the unit is not standing in direct sunlight, or in a cold air stream.
**BOMB TEMPERATURE DISPLAY**
The Vessel must be inserted into the e2k Calorimeter’s Well. Every 6 seconds the Vessel’s temperature is updated. The readings should be within 0.3 Degree C to the real temperature of the Vessel when measured with a calibrated instrument. The readings should be consistent and not erratic.

**BOMB 6 SECOND DRIFT**
The difference to the previous (6 seconds) old reading is displayed. The Vessel should drift less than 0.001 Degree C per 6 seconds when the Vessel is at room temperature and the e2k Calorimeter’s Lid is closed.

**FIRING VOLTAGE AND FIRING**
The voltage on the firing capacitors is displayed. If a Vessel is in the Well, and the Lid is closed, and the Vessel has a Firing Wire (circuit completed), then the firing will be activated. This means the capacitors will be discharged.

**LID, WIRE AND LANGUAGE SENSE**
These three external inputs are displayed. Exercise each input and observe that the display changes. The Firing Wire is detected through the top Lid Contact, which connects to a Vessel.

**SUPPLY VOLTAGE DISPLAY**
It should be 9Volt. The e2k Calorimeter will stop working when the voltage is below 7 volts. In special circumstances the supply voltage can go to 12V (battery).

**DISPLAY BOMB FIRINGS**
The Vessel must be inserted into the Well, and the total amount of firings will be displayed. The Vessel leaves the dds Factory with approx. 10 to 20 firings.

**RESERVED, FACTORY SIMULATION**
This Test item is not for field use. It puts the unit into a very fast simulated determination cycle for assuring that all parts of the e2k are working satisfactorily.

---

**OPERATING WITH THE E2K MANAGEMENT SOFTWARE**

**PURPOSE**
The e2k Calorimeter needs not need a PC to operate. However, using the PC Windows Software that is supplied with the e2k System, on a PC connected to the e2k Calorimeter, can be very useful. For example, setting up the parameters (which are not accessible from the Keyboard), uploading results from the Calorimeter, etc.. The following services are provided in the Software:

- Allow storage of a temperature cycle for spreadsheet application
- Upload and save results in a spreadsheet form
- Clear the internal result memory
- Display and set the parameters
SOFTWARE INSTALLATION

MINIMUM SYSTEM REQUIREMENTS

The minimum system requirements for the e2k software are as follows:

- 100Mz Processor
- 128MB RAM
- Microsoft® Windows® 98/2000/XP/NT4.0
- 100MB Hard disk space

**NOTE:** Before you begin please make sure your screen layout settings on the PC are set correctly. The DPI setting must be set to 96dpi and NOT 120dpi.

STEP BY STEP INSTALLATION

- Insert the CD supplied with the e2k System.
- Using the Windows Operating System, in “My Computer” or “My Network Places” or “Windows Explorer”, browse your CD Drive and double click on the “Setup” Icon.

- The Windows Installer will appear:
- The “Welcome to the E2K Management Tool Setup Wizard” Screen will appear. Click on “Next>”.
• You can select whether you are loading the software for yourself or everyone who is using the computer by selecting the appropriate radio button, shown below. You can also change the folder where the software will be saved. It is recommended that you keep to the default settings and always save software programs under “Program Files” when using Microsoft Windows.

• Click on “Next” once you have made your selection or changes.

• The Installer will request that you confirm the installation, click “Next >” to continue.
- Wait until all the components have been installed:

![E2K Management Tool](image)

- Once the e2k Software has been completely installed, you can click on “Close”.

![E2K Management Tool](image)

- Exit from the CD Drive and remove the CD.
- Return to your Desktop screen.
- A shortcut icon “E2K Calorimeter” will be on your desktop:

![E2K Calorimeter](image)

The e2k Software has been successfully installed. Before you run the e2k Software make sure your display settings on your PC are set to the Windows Standard. To change the settings go to Windows “Control Panel”, and click on Display this will bring up your Display properties. Click on the “Appearance “Tab, under “Scheme”, and select “Windows Standard”, click “Apply”.
USING THE E2K MANAGEMENT TOOL SOFTWARE

FAMILIARISING WITH THE SOFTWARE FUNCTIONS

Double click on the “E2K Calorimeter” shortcut icon. The following dialog box will appear. You can either click on “Continue” or wait, as the software will automatically take you to the login screen.

The login screen will now appear. Presently, the security or access feature is not enabled, so you just need to click on “OK” without putting in a User Name and Password:

Once you have clicked on “OK” at the login screen and your PC is connected to your e2k Calorimeter, the status of the e2k Calorimeter connected to your PC will be displayed.
All “Menu Items”, “Displayed Information” and “Buttons” will now be described.

**MENU ITEMS**

The Menu Items can be located under the Main Screen under “Tools”.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>SOFTWARE IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tools</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set Time</td>
<td>Click on “Set Time” if you want the time of the Calorimeter to be the same</td>
<td></td>
</tr>
<tr>
<td></td>
<td>as that on your PC.</td>
<td></td>
</tr>
<tr>
<td>Display Data in</td>
<td>You can select the unit of measurement that you would like your results or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>parameters displayed in, by selecting the relevant radio button “Display Data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in”. You have the option of selecting the following units – BTU/MJ/CAL.</td>
<td></td>
</tr>
<tr>
<td>Clear Memory</td>
<td>Click on “Clear Memory” to clear the result memory of E2K.</td>
<td></td>
</tr>
<tr>
<td>Reset Default</td>
<td>Click on “Reset Default Settings” to re-set (clear) the settings on the</td>
<td></td>
</tr>
<tr>
<td>Settings</td>
<td>Calorimeter and return to the pre-selected default settings.</td>
<td></td>
</tr>
<tr>
<td>ITEM</td>
<td>DESCRIPTION</td>
<td>SOFTWARE IMAGE</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Setup Calorimeter</td>
<td>When you initially select this button, two options will be available: “Upload from CAL2K-e2K” and “Download to CAL2K-e2K”</td>
<td>![Setup Calorimeter]</td>
</tr>
<tr>
<td>Upload from CAL2K-e2K</td>
<td>In order to get all the information from the e2k Calorimeter, click on “Upload from CAL2K-E2K”</td>
<td></td>
</tr>
<tr>
<td>Download to CAL2K-e2K</td>
<td>If you make a change, for example changing the time, you can select “Download to CAL2K-E2K”, so that the e2k Calorimeter has the same time.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>SOFTWARE IMAGE</th>
</tr>
</thead>
</table>
| Help Handbook        | The Help Menu: Select either Handbook or Operating manual to gain access to the manuals. | ![Help Handbook]  
| Operating Manual     |                                                                             | ![Operating Manual] |

**DISPLAYED INFORMATION ITEMS**

The Main Screen has a number of displayed information items under the Menu Bar. These are described as follows:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>SOFTWARE IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Records</td>
<td>Indicates the number of results and parameter changes in the e2k Calorimeter’s memory.</td>
<td>![Number of Records]</td>
</tr>
<tr>
<td>Status of E2K</td>
<td>Indicates whether the lid of the e2k Calorimeter is OPEN or CLOSED, i.e. whether the unit is idle or busy with a determination.</td>
<td>![Status of E2K]</td>
</tr>
<tr>
<td>Firmware Version</td>
<td>Displays the software version of the Calorimeter’s firmware.</td>
<td>![Firmware Version]</td>
</tr>
</tbody>
</table>

**BUTTON ITEMS**

There are a few yellow buttons on the Main Screen. These are described as follows:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>SOFTWARE IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>Connects to the e2k Calorimeter.</td>
<td>![Status]</td>
</tr>
<tr>
<td>Setup Calorimeter</td>
<td>Brings up the screen where all your settings are entered.</td>
<td>![Setup Calorimeter]</td>
</tr>
<tr>
<td>Refresh</td>
<td>Re-loads the information from the connected e2k Calorimeter.</td>
<td>![Refresh]</td>
</tr>
<tr>
<td>View Vessel</td>
<td>Allows you to view the information from a Vessel that is inserted into the e2k Calorimeter.</td>
<td>![View Vessel]</td>
</tr>
<tr>
<td>Temperature Graph</td>
<td>Allows you to view the temperature graph during a determination.</td>
<td>![Temperature Graph]</td>
</tr>
</tbody>
</table>
Language

Allows you to upload TWO display languages. Upload Language 1 being English language. Upload Language 2 being a foreign language e.g., Chinese, German, French, etc.

Start Upload

Uploads the data on the system.

Display

Load data stored in memory and view in Excel spreadsheet format.

SETTING UP THE CALORIMETER

To set up the Calorimeter, click on the **Setup Calorimeter** button. The following screen will appear:

The screen will be blank with no parameters. Click on **Upload from CAL2K e2K**. The following screen will appear:
Should you wish to change the parameters, make the necessary changes and then select **Download to CAL2K e2K**.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Voltage</td>
<td>Firing voltage which is preset usually to 25 volts. Anything below 25 volts will cause a misfire.</td>
</tr>
<tr>
<td>Calibration value</td>
<td>Displays the entered value of Benzoic Acid which is usually 26.454Mj/Kg.</td>
</tr>
<tr>
<td>Correction #1</td>
<td>This is the correction for sulphur (mass related).</td>
</tr>
<tr>
<td>Correction #2</td>
<td>This is the correction for Firing Cotton and Firing Wire (not mass related).</td>
</tr>
<tr>
<td>Spike Value</td>
<td>This is the known calorific value of the substance used for spiking, usually benzoic acid of 26.454Mj/Kg.</td>
</tr>
<tr>
<td>Initial Drift</td>
<td>Initial drift is the rate in Degrees C at which the Vessel is drifting up or down.</td>
</tr>
<tr>
<td>Ambient Offset</td>
<td>This is used to calibrate the ambient sensor of the Calorimeter so that Vessel and the ambient sensor both read the same temperature.</td>
</tr>
<tr>
<td>6 second drift comp</td>
<td>Drift in Degrees C per 6 seconds.</td>
</tr>
<tr>
<td>Ambient difference</td>
<td>Always set to 2 Degrees C.</td>
</tr>
<tr>
<td>Initial Time</td>
<td>This displays the time of the initial phase. This continuously increments until firing when the counter stops and the total initial time is then displayed.</td>
</tr>
<tr>
<td>Final Time</td>
<td>This counter runs during the final phase and stops when the determination is “DONE”.</td>
</tr>
<tr>
<td>LCD On time</td>
<td>LCD is ON.</td>
</tr>
</tbody>
</table>

**UPLOADING AND RETRIEVING RESULTS**

To view the uploaded results click on “Upload from File”. The following dialog box will be displayed:
Click the “Start Upload” button to upload the data. Once the data has been uploaded from the Calorimeter, the data is automatically saved into a directory created on your PC called “E2K_Data”.

If you click on the “Display” button. The following screen will be displayed:

Once you have selected “Open”, your file will automatically open up into an Excel format and display the results.
VIEW VESSEL

Click on View Vessel, and a screen with non-relevant data will be displayed. Ensure that the Vessel is inserted into the e2k Calorimeter’s Well. The following screen will appear:

To load the data from the Vessel, click on Load Vessel. The data will now be displayed against a grey background indicating that the data can only be viewed and not changed.

Manufacture

This is the Serial Number which is stamped onto the Vessel and Vessel Cap.
Manufacture  This is the date of manufacture.

**Status and Firing**

<table>
<thead>
<tr>
<th>Status</th>
<th>Indicates the status of the Vessel. The messages include: “Calibrated”, “Near Recondition”, and “Recondition”. If it is “Recondition” it means it needs to be reconditioned, and must be sent back to dds.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firing Count</td>
<td>This is the number of firings performed by the Vessel since the last reconditioning.</td>
</tr>
</tbody>
</table>

**Reconditioning**

<table>
<thead>
<tr>
<th>Reconditioning #1</th>
<th>Displays the last 2 reconditioning dates.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconditioning #2</td>
<td></td>
</tr>
</tbody>
</table>

**Vessel**

<table>
<thead>
<tr>
<th>Vessel Number</th>
<th>The Vessel is pre-programmed with a number.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel Owner</td>
<td>The Vessel is pre-programmed with the owner’s name.</td>
</tr>
</tbody>
</table>

**TEMPERATURE GRAPH**

Click on the Temperature Graph to display this graph during a determination and a separate screen will be opened. “Temperature Curve” is the default screen.

The following information is displayed numerically:

<table>
<thead>
<tr>
<th>Ambient Temperature</th>
<th>Temperature inside the Vessel in Degrees Celsius.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elapsed Time</td>
<td>Time elapsed.</td>
</tr>
<tr>
<td>E2K Status</td>
<td>Status of the E2K (Closed or Open).</td>
</tr>
</tbody>
</table>
TEMPERATURE GRAPH DETAILS

- The temperature scale is auto ranging.
- The firing point is fixed.
- Only the last 2 minutes of the initial period are shown.
- The graph is refreshed automatically every 6 seconds.

LANGUAGE

Ensure that you have saved your required Language File (.lng) to the directory or folder called “E2K_Data”.

Then select the Language button to open up your Language Selection Screen.
Select two of the required Language Files – one must be English and the other can be your preferred alternative language file for example, German. With both lines selected, click on the button “Download Language”.

You will now be able to display both English and the alternative language selected, by using the switch on the back of the Calorimeter.

MAINTENANCE

E2K CALORIMETER

The e2k Calorimeter needs very little maintenance. The e2k Calorimeter should never be opened, as there are no serviceable parts inside.

- Always keep the Calorimeter clean.
- Ensure that the Vessel Well is clean – blow out any dirt with compressed air if necessary.
- Ensure that both connections to the Vessel (one in the lid and one in the base) are clean and that they do not stick down when depressed.
- If the Vessel Well or Lid Polystyrene is damaged, call a service technician or your local Agent to replace them.
- If the display fails, call a service technician or your local Agent.
- Always ensure that the Door Knob of the Lid latches correctly, as this incorporates the lid microswitch and is also a safety device to prevent the Lid from lifting in case of a Vessel failure.
E2K ELECTRONIC MAINTENANCE

The electronic parts of the e2k Calorimeter need NO maintenance. The Main PCB Card needs no adjustments, and it cannot be repaired. If the Main PCB Card fails within the warranty period, then it must be returned to the dds Factory for checking or replacement. The performance of the card can be checked from the Keyboard without opening the back panel. The User can do the checking. To invoke (activate) any of the following Tests use the up or down Arrow keys on the keyboard and find the item “TEST”. Then press “=” and the number of the Test and press “Enter”.

TEST #1: DISPLAY THE AMBIENT TEMPERATURE
The e2k has an ambient temperature sensor, which is used for stability calculations and temperature compensation. The displayed temperature in degree C should be stable (+-0.3 degrees) and should be within 1 degree C of the actual room temperature. The absolute reading can be adjusted with the [AO] ambient offset command. This is done prior to shipping the unit, and must be performed when the sensor is replaced.

TEST #2: DISPLAY THE VESSEL TEMPERATURE
This test requires that the Vessel be inside the e2k Calorimeter’s Well. It checks the e2k to VESSEL interface. The temperature readings should be STABLE to within 0.005C per 6 seconds. The first reading after the Vessel insertion is subject to large changes and must be ignored.

TEST #3: DISPLAY FIRING VOLTAGE AND FIRE
This test requires that a Vessel with a Firing Wire is inserted in the e2k Calorimeter’s Well, and that the Lid is closed. The e2k will charge up the firing circuit and fire the Vessel. A complete charge cycle can take up to 5 minutes.

Fault indications:
FIRING VOLTAGE STAYS HIGH:
  Firing wire connection is open (the wire has come undone).
FIRING VOLTAGE DOES NOT CHARGE UP:
  The firing capacitors have been shorted.
  The firing circuit on the Main PCB Card is faulty.

TEST #4: DISPLAY LID AND WIRE SENSING
The e2k Calorimeter displays the state of the Lid (open or closed) and the state of the Firing Wire. While the lid switch contact can be tested by opening or closing the Lid, connecting a “shorting wire” between the top lid switch contact and the three outer bomb base connections can test the Firing Wire connection.

NOTE: None of the contacts have any dangerous voltages!

TEST #5: DISPLAY REAL TIME
The real time in HH.MM.SS is displayed. Check the time increment to be correct. The time should be correct to within 20 seconds per day. A larger error indicates a malfunction on the Main PCB Card.

TEST #6: DISPLAY “BLACK” DISPLAY
The complete LCD goes BLACK (all the character blocks are filled). Missing display “characters” indicate a faulty LCD display. Complete lines or missing characters indicate a faulty LCD connection.
**TEST #7: DISPLAY SUPPLY VOLTAGE**
The supply voltage is displayed. The nominal supply voltage is 9 volts +- 0.5 volts. Any other indication requires replacement of the external power supply unit.

**TEST #8: DISPLAY VESSEL TEMPERATURE DRIFT**
Like Test #2 above, this Test requires that the Vessel is sitting the Well. It displays the Vessel’s temperature DRIFT every 6 seconds. The first readings may be too high and UNSTABLE. Leave the Vessel a few minutes to STABILISE. After this, the drift should be less than 0.001C. Larger drifts indicate an UNSTABLE Vessel, or recently changed conditions. Monitor the drift for some time with the LID CLOSED and confirm that the DRIFT is settling down.

**TEST #9: TESTING LANGUAGE DISPLAY**
The e2k has the capacity to display the Operator messages in a few languages. Each language has 25-display (messages) and this test command allows the operator to display (test) each one. The entry format is:

T9=nn  Where nn=00 to 24

The called message is displayed in the top line.

**E2K-2 COOLER**
Only supplied with the Standard and Elite System configurations.

**WEEKLY MAINTENANCE**
- Clean Vessel base to ensure that the Vessel sits neatly and central and that the contacts meet successfully with the base of the Vessel and its contact rings.
- Ensure the base contact operates freely.
- The contacts are spring loaded and when pressed down and released they should return to their original position.

**E2K FAN AIR COOLER**
Only supplied with the Minimum System configuration

**WEEKLY MAINTENANCE**
The Air Cooler needs very little maintenance.

If operated in a dusty environment, then the fan may need to be cleaned by blowing with compressed air. If the fuse needs checking or replacing always disconnect the unit from mains before removing the fuse cover. Always ensure the unit is earthed correctly through the mains cable. There are no electronics inside the unit.
FILLING STATION

O-RING REPLACEMENT

It is strongly suggested the following checks be made every 3 months or sooner depending on the number of firings you perform per day, as well as the type of sample you are analyzing (for the Vessel). A sample which ignites easily (highly combustible) will cause the Vessel o-rings to perish a lot faster than a substance which is less combustible.

- Verify the oxygen flow rate and re-adjust the Flow Adjustor if necessary. The rate of flow should be adjusted to fill a Vessel in approx. 45 seconds. Replace the O-ring if necessary.

WARNING: DO NOT over tighten the Flow Adjustor – it should be tightened by hand and as soon as any resistance is felt stop tightening!
• Check all pressure pipe connections for leaks.
• Check the Nozzle O-ring and replace if worn. Apply a light film of Silicon grease, to ensure it does not stick to the Vessel.
• The Piston O-Ring is the same part as that for the Nozzle O-Ring, but it does not get worn down as frequently as the Nozzle O-Ring. Check the Piston O-Ring at least once a year and replace if worn.

**WARNING**: Please **DO NOT** apply silicon grease to any o-rings on the Vessel. You may apply a light film of silicon grease on the nozzle o-ring of the Filling Station ONLY, however it is advised not to apply grease to any other o-rings.

Before an O-ring is replaced, turn the oxygen supply OFF at the bottle and release the pressure in the pipes by filling a Vessel until both gauges on the Filling Station read zero.

**HIGH PRESSURE PIPE**

A brass Ferrule is supplied inside the nut where the High Pressure Pipe (CAL2K-3-OP) needs to be attached to the Gauge Block. Place this Ferrule inside the High Pressure Pipe and tighten it to the nut on the Gauge Block. The other end of the High Pressure Pipe will need to be attached to the High Pressure Oxygen Regulator. **dds** provides an Oxygen Regulator Connection with the Filling Station Installation Kit, but this is not a universal connection and may not work for some oxygen regulators. If the oxygen regulator is purchased from **dds**, the oxygen regulator gets a special fitting on it in order for it to be attached to our Filling Station.

**NOZZLE**

The O-ring in the Nozzle, which seals onto the Vessel’s lid valve, is replaced by unscrewing the cover (knurled nut) at the end of the Nozzle. (A pair of round jaw pliers may be required to grip the nut, but generally it should be hand tight and can be opened by hand). Once the knurled nut has been removed the o-ring can be replaced. Lubricate the new o-ring with a very SMALL amount of silicon grease before use. The knurled nut can now be replaced onto the nozzle.

**PISTON**

There is an O-ring between the Nozzle and the Piston. To replace this O-ring the two pressure pipe connections to the Nozzle must be removed FIRST. The Nozzle can now be unscrewed from the Piston. To stop the Piston from turning when the Nozzle is unscrewed, we suggest that the arm be put down in the latched position. The O-ring can now be changed. The O-ring on the Piston is the same as the Nozzle O-ring. Before re-assembly, ensure that the nipple inside the Nozzle is in place. Screw the Nozzle back onto the Piston and then re-attach the two pressure pipe connections.

**NIPPLE (INSIDE THE NOZZLE)**

To replace the O-ring on the nipple proceed as in the “Piston” O-ring above until the Nozzle and Piston are separated. Now remove the Nipple from the Nozzle, replace the O-ring on the Nipple and re-assemble as above. Use the same Viton O-ring which is used on the Vessel’s Centre Electrode for the Nipple’s O-ring.

**FLOW ADJUSTOR**

To replace the O-ring on the screw Flow Adjustor, unscrew the adjustor completely and remove it. The O-ring must now be cut off the Adjustor and a new one put on. The Adjustor can now be screwed back in completely using your hand to tighten.
WARNING: DO NOT over tighten as this can damage the plastic seal (Nipple).

Now un-screw the Adjustor about 1/4 to 1/2 a turn outwards. The filling flow must now be adjusted by trial error as explained in the section about Adjustments for the Filling Station above.

FLOW ADJUSTOR NIPPLE
To replace the plastic seal (Nipple) inside the Flow Adjustor, proceed as in the Flow Adjustor procedure above BUT with exception. When the Adjustor is removed, apply high pressure oxygen to the oxygen pipe in order to “blow out” the nipple from the Flow Adjustor hole. Take the new Nipple and place a small amount of glue on it and place it onto the end of the Adjustor. The glue is required to hold the Nipple in place so that you can replace the Adjustor into its hole for tightening.

FIGURE 13. : FILLING STATION - GAUGE BLOCK PARTS
**VESSEL RECONDITIONING**

Every 6 months a service engineer or your Agent, must inspect the threads of the Vessel for excessive wear and tear. If the wear is excessive the Vessel must be returned to dds for reconditioning. Irrespective of time, the Vessel must be returned to dds for inspection and possible reconditioning after 5000 firings. The built in counter will prevent the Vessel from operating after 5000 firings.

**MAINTENANCE SCHEDULE**

The Vessel design incorporates several O-rings and other consumable items and parts, which require checking, cleaning and/or replacing on a regular basis. Please remember that the frequency of replacement of consumables is a function of usage, quality and type of sample and Vessel cleaning techniques. The following Vessel maintenance schedule provides a guideline.
NOTE: This is A GENERAL GUIDELINE and depending on the quality of the sample, the maintenance schedule may need to be followed more regularly. i.e. With a substance which ignites easily (highly flammable) the o-rings may only last 5-10 firings (sometimes less) and therefore it may be necessary to change the o-rings more often. Please do take note of this and use this maintenance schedule as a GUIDELINE only.

<table>
<thead>
<tr>
<th>ITEM &amp; PART NUMBER</th>
<th>CLEANING &amp; REPLACEMENT FREQUENCY</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>VESSEL BODY CAL2K-4-BD</td>
<td>Clean every 10 to 50 firings</td>
<td>Scrub with water and detergent. Use wire brush on threads. <strong>DO NOT</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>immerse the Vessel in water. <strong>DO NOT</strong> wet the Vessel contact PCB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>when cleaning or cooling.</td>
</tr>
<tr>
<td>VESSEL CAP CAL2K-4-CP</td>
<td>Clean every 10 to 50 firings</td>
<td>Scrub with water and detergent. Use the supplied wire brush on threads.</td>
</tr>
<tr>
<td>LID ASSEMBLY (ELECTRODE ASSEMBLY) CAL2K-4-CL</td>
<td>Clean residue after each CV. Clean fully every 10 to 50 firings.</td>
<td>Dismantle and scrub all parts with water and detergent. Use wire brush to remove deposits. Dry and reassemble, change o-rings if necessary.</td>
</tr>
<tr>
<td>TOP ELECTRODE O-RING CAL2K-4-CR</td>
<td>Replace every 5 to 50 firings. Check after every 5 firings to confirm.</td>
<td>Remove deflector plate from lid. Unscrew centre electrode remove old o-ring and replace.</td>
</tr>
<tr>
<td>BOTTOM ELECTRODE O-RING CAL2K-4-CR</td>
<td>Replace every 5 to 50 firings. Check after every 5 firings to confirm.</td>
<td>Follow the steps as above and remove old o-ring and replace.</td>
</tr>
<tr>
<td>LID O-RING CAL2K-4-LR</td>
<td>Replace every 20 to 50 firings. Check after every 20 firings to confirm.</td>
<td>Remove deflector plate from lid. Remove old o-ring and replace with a new one. Ensure the new o-ring fits snug in the o-ring cavity.</td>
</tr>
<tr>
<td>DEFLECTOR PLATE CAL2K-4-DP</td>
<td>Replace when heavily corroded and cannot be cleaned.</td>
<td>Remove and replace.</td>
</tr>
<tr>
<td>OUTSIDE ELECTRODE CAL2K-4-OE</td>
<td>Replace whenever necessary.</td>
<td>Remove deflector plate. Unscrew the electrode and change with a new one. Reassemble.</td>
</tr>
</tbody>
</table>

After every determination clean the inside of the Vessel with a paper towel to remove any residue or moisture. Clean the threads on both the Vessel body and Vessel Cap using the Wire Brush.
HINTS AND TIPS

GENERAL HINTS

- The use of 10ml sodium carbonate solution (1 litre water and 100g sodium carbonate) is recommended if Vessel washings are not examined. It neutralises the sulphuric acid and prolongs the life of the Vessel parts.
- **REMEMBER – DO NOT immerse the Vessel in water!**
- For additional accuracy, place the sample on the bottom of the crucible in a spread out form. This prevents clogging and oxygen starvation.
- Spiking. In certain cases it is necessary to know the calorific value of a substances whose combustibility is too low for self-ignition. In such cases the technique of “spiking” is used. A known amount of a more combustible substance of known calorific value is mixed with the sample, thus allowing the composite material to ignite. Provided the total calorific value of the “spike” is entered in the CAL2K-1 Calorimeter, automatic compensation is made, and the true Calorific value of the sample is displayed.
- Sample preparation: a 200-mesh sample size is sufficient. Please note this refers to coal samples only.
- An easy way to check for leaking Vessel lid o-rings, is to fill the top of the Vessel cap with water (lid assembly must be inside the Vessel, the Vessel cap screwed down and the Vessel filled with oxygen (under pressure)). If bubbles are seen in the water then it is clear that one or more of the o-rings are leaking and should be replaced. Remember only to fill the lid cap (lid assembly inside Vessel) with a little water – **DO NOT immerse the entire Vessel in water!**

OPERATING HINTS

- Benzoic acid fires easily with wire and cotton.
- Do not change the method between calibration and samples.
- Develop a technique for inserting the crucible into the holder without “Flicking” the sample out of the crucible.
- Discard sample after a misfire
- Do not leave the Vessel with sample, filled with oxygen (pressurized) for more than 15 minutes before firing.
- Do not leave the Vessel pressurized (filled with oxygen) over night.
- Check the Vessels once a day for leaks and replace, if necessary, the respective O-ring. The lifetime of the large Lid O-ring is estimated to be one month. The small electrode top O-ring can fail within a day, depending on use, delta temperatures achieved and bad-luck. (Refer to Vessel maintenance schedule). Remember the easy way of checking for leaking o-rings refer to General Hints above.
- The CAL2K-1 Calorimeter is the most accurate if the temperature rise is the same as that of the calibration e.g. Approximately 9 degrees Celsius. Please note the temperature rise is not fixed, the ideal rise is 9 degrees C but this can be more or less.
- Use only the recommended firing wire and firing cotton supplied.
- Re-calibrate the Vessel if the electrodes or deflector plate have been damaged and replaced.

**NEVER OPERATE THE VESSEL WITHOUT THE DEFLECTOR PLATE.**

- Remember to use the correct firing wire and firing cotton when running a normal determination with oxygen. **DO NOT** use the demo firing wire when running a normal determination with oxygen.
• Fill the Vessel with oxygen to 3000Kpa to avoid a misfire. **Please note** it is important to fill the Vessel to this pressure, however with some samples (highly combustible, easily ignitable samples) the pressure can be less. **Please note** the Vessel pressure must **NEVER** be more than 3000Kpa.

**DO NOT COOL VESSEL IN WATER, RATHER USE CAL2K-2 COOLER TO COOL THE VESSEL.**
**DO NOT SUBMERGE THE VESSEL IN WATER FOR CLEANING OR COOLING.**
**DO NOT APPLY GREASE OR ANY OTHER FORM OF LUBRICANT TO THE O-RINGS ON THE LID ASSEMBLY OR VESSEL.**

• Store the Vessels cleaned and open over night.
• Use only the crucibles supplied. Burn in new crucibles in a furnace at 800 degrees C for 10 minutes to burn any excess oil away.
• Keep crucibles clean with a wire brush. Heavy deposits can be burnt off in a furnace.
• Do not touch the Vessel unnecessarily during preparation. Wipe the outside if it is wet from the Cooler.
• Clean Cooler brackets if excessive condensation collects.
• Switch the Cooler OFF over night, but leave the e2k running. The Cooler E2K-2 consumes up to 150 watts, the CAL2K-1 only 15 watts of power.
• Do not place the Vessel on a surface or area where the surface can touch the contact base rings.
• The electrodes must be replaced if they are damaged. Always keep spares of the electrodes, crucibles, o-rings, deflector plates, firing wire and firing cotton.

**TROUBLE SHOOTING AND SOLUTIONS**

**CALORIMETER**

a) **“No Wire”** – clean base and lid connections and then check Vessel. Make sure you are using the correct firing wire and not demo firing wire.
b) **“No Bomb”** – clean base connections and check Vessel. Make sure the PCB contact is not wet.
c) **Polystyrene deteriorates** – call a Service Technician or your local Agent to replace all polystyrene inserts.
d) **MASS does not transfer from the Balance** – check interconnection cable, balance cable and balance set-up.

**COOLER**

Only supplied with the Standard and Elite System configurations.

This section is intended to coincide with the section “Cooler : Performance Testing”. If any problems are encountered, please return to the section “Getting Started” and see the sub-section **“Cooler Performance Testing”**, to refer to the following diagnoses:

a) **If no POWER LED** – check that mains is connected to the unit.
b) **If all or some of the LED’s do not work** – refer to the Maintenance Manual.
c) With no water flow, the LEFT and RIGHT OVER TEMPERATURE LED’S will come on after a while. **DO NOT run the Cooler in this condition continuously.** Once water is flowing, they should switch off.
d) **If the LEFT and RIGHT ON LED never come ON** – refer to the Maintenance Manual.
e) If any orange or red LEDs are ON, then refer to that specific condition.

f) If either pad is NOT cold – refer to the Maintenance Manual.

g) If the “VESSEL IN WELL” LED does not come ON - check the seating of the Vessel and the Vessel contacts. If the “CLOSE DOOR” or “VESSEL LOADING” LEDs come ON, check that the Vessel is warmer than ambient temperature. The “VESSEL TOO COLD” LED will come ON if the Vessel is colder then the ambient temperature.

h) If the “CLOSE DOOR” LED is ON and the doors will not stay latched – refer to the Maintenance Manual.

i) If the doors do not open when the “DOORS OPEN” switch is pressed - ensure that the doors are not mechanically jamming on the Vessel. If the doors are free and this still occurs, refer to the Maintenance Manual.

j) If the doors do not automatically open - refer to i) above.

k) If the VESSEL LED doesn’t go OFF – refer to the Maintenance Manual.

l) If the IDLE LED on and then OFF – refer to the Maintenance Manual.

AIR COOLER

a) Ensure that you supply the correct Main power voltage. Get a converter if you need to convert to 220V.

FILLING STATION

a) Bottle pressure gauge does not indicate – check the regulator on the oxygen bottle. Check the connection between regulator and Filling Station.

b) Vessel does not fill – check the setting of the Flow Adjustor, check Lid Assembly of the Vessel.

c) Nozzle leaks while Vessel is filling – replace the Nozzle O-ring.

d) Nozzle leaks even with no Vessel inserted – replace Valve O-ring (Nipple) inside Nozzle assembly.

VESSEL

a) “No Wire” – check that the Firing Wire is present and securely clamped by the sleeves. Make sure you are using the correct Firing Wire and not “Demo” Firing Wire.

b) Oxygen leaks – replace all Lid Assembly O-rings. Make sure the Vessel is filled to 3000Kpa. If under filled it could cause leaking. Remember however, that high combustion samples require less oxygen.

c) Cap is difficult to turn – clean threads on both the Vessel Cap and Vessel Body with a wire brush.

d) Display shows “No Bomb” when Vessel is in the Well – clean the base of the Vessel and contacts in the Well. Give the Vessel a twist to ensure a better contact. Make sure that the Vessel’s base is NOT wet!

e) Centre electrode does not move freely – strip and clean the Lid Assembly.

E2K SYSTEM TECHNICAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>UM</th>
<th>E2K CALORIMETER</th>
<th>E2K-2 COOLER</th>
<th>E2K-3 FILLING STATION</th>
<th>CAL2K-4 VESSEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions: (Width, Height, Depth) mm</td>
<td>280 x 290 x 400</td>
<td>280 x 250 x 320</td>
<td>220 x 450 x 300</td>
<td>82mm Diameter 150mm Height</td>
<td></td>
</tr>
</tbody>
</table>

E2K OPERATING MANUAL V3.5  | www.ddscalorimeters.com  | calo@ddsystems.co.za
### Weight

<table>
<thead>
<tr>
<th>Kg</th>
<th>9</th>
<th>10</th>
<th>4.5</th>
<th>2.5</th>
</tr>
</thead>
</table>

### Power

- 90 – 260 VAC
- 50/60Hz

### Operating Temperature

- 0 – 60°C

### Repeatability

0.1 (%RSD – Relative Standard Deviation)

### Resolution

0.001 (MJ/kg)

### Temperature Resolution

0.000001°C

### Calibration

- Calibration Details per Calibration Curve

### Determinations

- 6 per Calorimeter per Hour, using ONE Vessel and E2K-2 Cooler

### Results in Memory

1024

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### PARTS AND INSTALLATION KITS

#### PARTS LIST – E2K CALORIMETER

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DISCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAL2K-1-AS</td>
<td>Ambient Sensor</td>
</tr>
<tr>
<td>CAL2K-1-BC</td>
<td>Base Contact PCB with Supports and Contact</td>
</tr>
<tr>
<td>CAL2K-1-DK</td>
<td>Door Knob</td>
</tr>
<tr>
<td>CAL2K-1-DL</td>
<td>Door Latch and Switch</td>
</tr>
<tr>
<td>CAL2K-1-LC</td>
<td>Lid Contact</td>
</tr>
<tr>
<td>CAL2K-1-PC</td>
<td>Protective Cover</td>
</tr>
<tr>
<td>CAL2K-E-FV</td>
<td>Firing Capacitors PCB</td>
</tr>
<tr>
<td>E2K-AB</td>
<td>Aluminium box</td>
</tr>
<tr>
<td>E2K-DC</td>
<td>Perspex bezel</td>
</tr>
<tr>
<td>E2K-DS</td>
<td>Display</td>
</tr>
<tr>
<td>E2K-MC</td>
<td>Cover for Main PCB</td>
</tr>
<tr>
<td>E2K-MN</td>
<td>Main PCB</td>
</tr>
<tr>
<td>E2K-PY</td>
<td>Polystyrene set</td>
</tr>
<tr>
<td>E2K-WR</td>
<td>Wiring and connectors</td>
</tr>
</tbody>
</table>

#### E2K-KT CALORIMETER INSTALLATION KIT

<table>
<thead>
<tr>
<th>QTY</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CAL2K-1-SM</td>
<td>Power Supply</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-KB</td>
<td>Keyboard</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-MC</td>
<td>Mains Cable 220V</td>
</tr>
</tbody>
</table>
PARTS LIST – E2K-2 COOLER (IF PURCHASED)

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2K-2</td>
<td>Cooler</td>
</tr>
<tr>
<td>CAL2K-2-AC</td>
<td>Ambient Cable</td>
</tr>
<tr>
<td>CAL2K-2-BC</td>
<td>Base Connection</td>
</tr>
<tr>
<td>CAL2K-2-CB</td>
<td>Cast Cold Block</td>
</tr>
<tr>
<td>CAL2K-2-CN</td>
<td>Hot Block Connections – Straight</td>
</tr>
<tr>
<td>CAL2K-2-CR</td>
<td>Hot Block Connections - 90°</td>
</tr>
<tr>
<td>CAL2K-2-CS</td>
<td>Case Set</td>
</tr>
<tr>
<td>CAL2K-2-DL</td>
<td>Door Lock Mechanism</td>
</tr>
<tr>
<td>CAL2K-2-DS</td>
<td>Door Support</td>
</tr>
<tr>
<td>CAL2K-2-FR</td>
<td>Ferrule</td>
</tr>
<tr>
<td>CAL2K-2-HB</td>
<td>Hot Block</td>
</tr>
<tr>
<td>CAL2K-2-HC</td>
<td>Hose Clamp</td>
</tr>
<tr>
<td>CAL2K-2-NC</td>
<td>M3 Nut Cover</td>
</tr>
<tr>
<td>CAL2K-2-PN</td>
<td>Pipe Nut</td>
</tr>
<tr>
<td>CAL2K-2-SD</td>
<td>Studs for Hot Block</td>
</tr>
<tr>
<td>CAL2K-2-SM</td>
<td>Switch Mode Power Supply</td>
</tr>
<tr>
<td>CAL2K-2-SO</td>
<td>Power Supply Stand Offs</td>
</tr>
<tr>
<td>CAL2K-2-TS</td>
<td>Temperature Sensor</td>
</tr>
<tr>
<td>CAL2K-2-VH</td>
<td>Vessel Holder</td>
</tr>
<tr>
<td>CAL2K-2-WC</td>
<td>Water In/Outlet Connection</td>
</tr>
<tr>
<td>CAL2K-2-WN</td>
<td>Water In/Outlet Nut</td>
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<tr>
<td>CAL2K-2-WP</td>
<td>1m Water Piping</td>
</tr>
<tr>
<td>CAL2K-2-WR</td>
<td>Wiring and Connectors</td>
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</tbody>
</table>

E2K-2-KT COOLER INSTALLATION KIT

<table>
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<th>PART NUMBER</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>3</td>
<td>CAL2K-2-HC</td>
<td>Water Pipe Hose Clamp</td>
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<tr>
<td>1</td>
<td>CAL2K-2-AC</td>
<td>Ambient Cable</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-2-WP</td>
<td>10m Water Pipe</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-MC</td>
<td>Mains Cable 220V</td>
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</table>

PARTS LIST – E2K-3 FILLING STATION

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2K-3</td>
<td>Filling Station</td>
</tr>
<tr>
<td>CAL2K-3-AM</td>
<td>Arm and Knob</td>
</tr>
<tr>
<td>PART NUMBER</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>CAL2K-3-BN</td>
<td>Gauge Block Nipples</td>
</tr>
<tr>
<td>CAL2K-3-EC</td>
<td>Ex Centre</td>
</tr>
<tr>
<td>CAL2K-3-FA</td>
<td>Flow Adjustor</td>
</tr>
<tr>
<td>CAL2K-3-FN</td>
<td>Flow Adjustor Nipple</td>
</tr>
<tr>
<td>CAL2K-3-FR</td>
<td>Flow Adjustor O-Ring 4, 42x2, 62</td>
</tr>
<tr>
<td>CAL2K-3-FS</td>
<td>Frame plus 2 Plates</td>
</tr>
<tr>
<td>CAL2K-3-HR</td>
<td>Gauge Holder</td>
</tr>
<tr>
<td>CAL2K-3-HR</td>
<td>Holder</td>
</tr>
<tr>
<td>CAL2K-3-KN</td>
<td>Knurled Nut</td>
</tr>
<tr>
<td>CAL2K-3-NP</td>
<td>Nipple</td>
</tr>
<tr>
<td>CAL2K-3-NR</td>
<td>Nozzle O-Ring 8x2, 62</td>
</tr>
<tr>
<td>CAL2K-3-NZ</td>
<td>Nozzle Body</td>
</tr>
<tr>
<td>CAL2K-3-OP</td>
<td>1m 1/8 Inch Oxygen Piping</td>
</tr>
<tr>
<td>CAL2K-3-OR</td>
<td>Oxygen Pipe Nipple O-Ring 3, 1x1, 6</td>
</tr>
<tr>
<td>CAL2K-3-PG</td>
<td>Pressure Gauges</td>
</tr>
<tr>
<td>CAL2K-3-PH</td>
<td>Pipe Holder</td>
</tr>
<tr>
<td>CAL2K-3-PN</td>
<td>Pipe Nuts</td>
</tr>
<tr>
<td>CAL2K-3-PR</td>
<td>Piston O-Ring 8x2.62</td>
</tr>
<tr>
<td>CAL2K-3-PN</td>
<td>Piston</td>
</tr>
<tr>
<td>CAL2K-3-SG</td>
<td>Spring</td>
</tr>
<tr>
<td>CAL2K-3-ST</td>
<td>Shaft</td>
</tr>
<tr>
<td>CAL2K-3-VH</td>
<td>Vessel Holder</td>
</tr>
<tr>
<td>CAL2K-3-WR</td>
<td>Washer</td>
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**E2K-3 FILLING STATION INSTALLATION KIT**

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<tr>
<th>QTY</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CAL2K-3-FR</td>
<td>Flow Adjustor O-Rings</td>
</tr>
<tr>
<td>5</td>
<td>CAL2K-3-NR</td>
<td>Nozzle O-Rings</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-3-OP</td>
<td>High Pressure Pipe 2m</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-3-RC</td>
<td>Oxygen Regulator Connection</td>
</tr>
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</table>

**PARTS LIST – CAL2K-4 VESSEL**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
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</thead>
<tbody>
<tr>
<td>CAL2K-4</td>
<td>Vessel Complete</td>
</tr>
<tr>
<td>CAL2K-4-BD</td>
<td>Body with Sleeve</td>
</tr>
<tr>
<td>CAL2K-4-BR</td>
<td>Body Ring</td>
</tr>
<tr>
<td>CAL2K-4-CE</td>
<td>Centre Electrode and Sleeve</td>
</tr>
<tr>
<td>CAL2K-4-CP</td>
<td>Cap – with Thread Cut</td>
</tr>
<tr>
<td>CAL2K-4-CR</td>
<td>Top and Bottom O-Ring 3, 1x1, 1.6 Viton</td>
</tr>
<tr>
<td>CAL2K-4-DP</td>
<td>Deflector Plate</td>
</tr>
<tr>
<td>CAL2K-4-LD</td>
<td>Lid – Without Electrodes</td>
</tr>
<tr>
<td>CAL2K-4-LR</td>
<td>Lid O-Ring 46.0x3.53</td>
</tr>
<tr>
<td>CAL2K-4-OE</td>
<td>Outside Electrode - with Sleeve</td>
</tr>
</tbody>
</table>
## CAL2K-4-PT  Pressure Test

## CAL2K-4-SN  Temperature Sensor

## CAL2K-4-SV  Valve Screw

## CAL2K-4-VS  Vessel PCB

### CAL2K-4-KT  VESSEL INSTALLATION KIT

<table>
<thead>
<tr>
<th>QTY</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CAL2K-4-CE</td>
<td>Centre Electrode</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-4-OE</td>
<td>Outside Electrode</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-4-DP</td>
<td>Deflector Plate</td>
</tr>
<tr>
<td>10</td>
<td>CAL2K-4-CR</td>
<td>Electrode O-Rings</td>
</tr>
<tr>
<td>5</td>
<td>CAL2K-4-LR</td>
<td>Lid O-Rings</td>
</tr>
<tr>
<td>5</td>
<td>CAL2K-4-FW</td>
<td>Firing Wire</td>
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### E2K-ACC-KT  E2K ACCESSORIES KIT

<table>
<thead>
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<th>QTY</th>
<th>PART NUMBER</th>
<th>DESCRIPTION</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>CAL2K-BC</td>
<td>Balance Cable</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-4-PS</td>
<td>Preparation Stand</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-4-DC</td>
<td>Defiller Cap</td>
</tr>
<tr>
<td>2</td>
<td>CAL2K-BA</td>
<td>Benzoic Acid Tablets</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-4-FC</td>
<td>Firing Cotton</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-4-WB</td>
<td>Wire Brush</td>
</tr>
<tr>
<td>1</td>
<td>CAL2K-4-HH</td>
<td>Handling Hook</td>
</tr>
<tr>
<td>5</td>
<td>CAL2K-4-CB</td>
<td>Crucibles</td>
</tr>
</tbody>
</table>
APPENDIX 1
PRESSURE CONVERSIONS
3000KPa = 3 MPa
= 30 Bar
= 30 Atmospheres
= 435 PSI

APPENDIX 2
MJ / CAL / BTU CONVERSIONS
1MJ/Kg = 429.9 BTU/Lb
1MJ/Kg = 238.85 Calories/gm

APPENDIX 3
BALANCE SETTINGS FOR E2K BOMB CALORIMETER
Data Output: Automatic output synchronous readout at stability
Characters: 7 Bit
Baud Rate: 2400
Synchronisation: 1 start bit, 1 stop bit
Parity Bit: Odd

DB25 CONNECTOR
Pin 1 Ground
Pin 2 Balance transmit (output)/input to CAL2k or E2K

APPENDIX 4
PRINTER SETUP
Word Length: 8bits
Parity: Disable
Parity: Odd
Baud Rate: 9600

CONNECTION CABLE
<table>
<thead>
<tr>
<th>E2K</th>
<th>Signal</th>
<th>Printer</th>
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</thead>
<tbody>
<tr>
<td>D9 connector</td>
<td>Communication</td>
<td>D25 connector</td>
</tr>
<tr>
<td>pin 4</td>
<td>ground</td>
<td>pin 3</td>
</tr>
<tr>
<td>pin 1</td>
<td>link pin 6 to 20 (DSR to DTR)</td>
<td>pin 7</td>
</tr>
</tbody>
</table>

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