DDS CALORIMETERS OPERATIONS MANUAL

Firmware Version 9.4

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DIGITAL DATA SYSTEMS PTY LTD

DDS CALORIMETERS

Scientific Analytical Calorimeter Solutions

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1 INTRODUCTION

Digital Data Systems (Pty) Ltd (DDS) specialises in the design and manufacture of scientific bomb calorimeter systems for various types of industries and applications. DDS bomb calorimeter systems are the most advanced combustion calorimeter systems available today with the inclusion of Artificial Intelligence (AI). The system is used to measure the calorific value of both solids and liquids.

DDS has a wide range of systems to suit different applications and sample requirements.

This manual applies to all systems Firmware V9 and higher:

CAL3K-AP	Automatic Oxygen Filling, 2-4 vessels, 4 modes
CAL3K-A	Manual Oxygen Filling, 2-4 vessels, 4 modes
CAL3K-F	Manual Oxygen Filling, 2-4 vessels
CAL3K-ST	Manual Oxygen Filling, Internal Cooling, 2 vessels
CAL3K-S	Manual Oxygen Filling, Internal cooling, 1 vessel

Please visit our website to find out more: www.ddscalorimeters.com

1.1 HISTORY OF DDS BOMB CALORIMETERS

In 1972, DDS manufactured its first Calorimeter product, the AMPC (Automatic Microprocessor 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. It had no surrounding water jacket. The determination time was significantly reduced, increasing the product's efficiency by four.

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 was the most advanced calorimeter system available at the time and an even bigger success than its predecessor, the CP500.

After the success of the CAL2K, DDS noted the need for a smaller, low sample volume system and in 2005, the ECO system was released. In 2007, our dual language E2K system was added.

All three of the CAL2K models were a great success. Then in 2014 our new calorimeter was launched, using the DDS Calorimeter brand name. The CAL3K range was introduced to our market.

The CAL3K-A system was released to replace the older CAL2K model and the CAL3K-A being the top of our range is our fastest model and designed for harsh production environments, the real work horse of the range. The CAL3K-AP system which is our fully automatic model, allowing for automatic oxygen filling and de-filling was the next to be added to our range answering the customer demand for a fully automatic model. The CAL3K-AP system is one of our most competitive systems. DDS Calorimeters then released our two most popular calorimeter models, the CAL3K-F and the CAL3K-S. The CAL3K-F system being the replacement to the old E2K, it is well suited to university applications. The system is flexible for low to high throughput without compromising on the accuracy and repeatability. The CAL3K-S system was introduced to replace the low throughput ECO model and has become one of our best sellers. The system is a powerful entry level system for low throughput but with incredible accuracy and repeatability. The system has low energy consumption and is very affordable for the features it offers. The CAL3K-ST system was the last to be released in our CAL3K range, the system is based on the same features and functionality as the CAL3K-S system, however the system can operate with two vessels, unlike the CAL3K-S systems one vessel. The CAL3K-ST model is also capable of operating with the older CAL2K thread vessels which makes it a great replacement system for existing CAL2K users.

2 PURPOSE OF THIS MANUAL

This manual applies to all CAL3K systems and provides safety instructions, an introduction to calorimetry and operating procedures and commands. It provides a reference for all keyboard and interface operations. It explains the very basics of operation and guides you to perform hardware tests. Some command sections apply only to a particular system (like the CAL3K-AP, which has internal oxygen filling). This will be clearly marked.

Do not read this manual all at once.

It is a lot to take in and appears to be complicated, but it isn't.
The manual follows the life of the calorimeter, from installation/setup to advance spiking.

Read the section you need and then perform the operation. This is an operational manual.

2.1 HOW TO USE THIS MANUAL

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

2.1.1 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.

2.1.2 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.

3 SAFETY

A 'BOMB CALORIMETER' uses a vessel (the bomb) which is filled with high pressure oxygen and the sample material, and then the sample is ignited. The sample burns and the resultant temperature increase of the vessel is measured and converted to a calorific value.

3.1 CALORIMETER

- Electrical Shock: There are NO user serviceable parts inside.
- Dangerous voltages will be present inside after the supply cable has been disconnected.

DO NOT TAMPER WITH THE EARTHING - CONSULT A QUALIFIED ELECTRICIAN SO THAT THE EARTHING CAN BE CHECKED.

3.2 COOLER (3K-2)

- Electrical Shock: There are NO user serviceable parts inside.
- Do not block the fan airflow
- Disconnect from supply before opening the Cooler.

DO NOT TAMPER WITH THE EARTHING - CONSULT A QUALIFIED ELECTRICIAN SO THAT THE EARTHING CAN BE CHECKED.

3.3 FILLING STATION (3K-3)

- Check the nylon pressure pipe for any mechanical damage.
- Install the flexible nylon pressure pipe without any sharp bends.
- Make sure the nylon pressure pipe has no 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 a dry, oil free pressure piping should be installed, as well as a shut off valve and pressure gauge within easy reach of the 3K-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.**
- **NEVER USE OIL OR OIL-BASED GREASE ON ANY PART OF THE OXYGEN SYSTEM, FOR SAFETY REASONS. USE ONLY THE DDS APPROVED HIGH-PRESSURE GREASE (3K-1-086).**
- **ALWAYS FILL THE VESSEL WITH OXYGEN TO A MAXIMUM PRESSURE OF 3000 KPA (30 BAR).**

NOTE:

With some applications you may need to fill the Vessel to less than 3000 KPA e.g. 1500 KPA (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 3000 KPA but NEVER more than 3000 KPA.

3.3.1 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 oil-based grease on any part of the gauge assembly or any part of the Filling Station and Vessel for SAFETY reasons. Use only the DDS approved high-pressure grease (3K-1-086).

- **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**.

3.4 VESSEL (4K-4)

- The Vessel has been pressure tested (certificate will be provided if required), at 3000 KPa according to international standards.
- The Vessel and its Cap's thread is subject to wear and tear, and it must be inspected, cleaned regularly and checked 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 detonation, 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 / decommissioning certificate will be issued.
- Vessels should be checked / inspected by your agent every 6 months or 2500 firings. However, the vessel thread may wear sooner depending on the type of samples analysed and the daily maintenance. Therefore, it is advisable to have your Vessel(s) checked regularly. If the vessel is deemed unsafe by the agent, it will need to be sent to DDS for reconditioning. A Vessel will require reconditioning after 5000 firings. 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 Calorimeter during the initial period.
- Consult your safety engineer or your mechanical engineer for guidelines when in doubt or contact DDS at calo@ddsystems.co.za for assistance.

- **NEVER OPERATE ANY UNSAFE VESSEL.**
- **NEVER IMMERSE THE VESSEL INTO WATER FOR COOLING. USE THE 3K-2 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 CALORIMETER SYSTEM REGULARLY AND CARRY OUT REGULAR MAINTENANCE.

During the combustion process, both the gas temperature and pressure increase.
The pressure increase depends on the speed of the burning process and to a certain extent on the sample volume. The rapid increase in gas pressure from the combustion process is a safety concern.

If the sample splatters or explodes during the determination, residue from the sample material may settle inside the vessel, this will affect the results of the determination and may affect the temperature rise of the vessel making it unsafe to operate.

Therefore:

1. **DO NOT** burn powdery substances by themselves, loose inside the crucible.
   They can explode on ignition or will blow out of the crucible during the oxygen filling process.
   It is preferable to use a gelatine capsule (3K-4-068) or press the sample material into a tablet or pellet form using the DDS Pellet Press Die Set (3K-7-041) and the Arbor Press (3K-7-042).

2. Choose a sample volume according to the Temperature Rise guidelines.

3. Examine and clean the vessel inner wall/floor after each sample burn for any sample residue. If residue is found, then either the sample has exploded inside the vessel, or the oxygen filling speed was to rapid. If residue is found, then examine the O-rings for cracks or deterioration and discard them. (Also refer to **MAINTENANCE**)

4. **DO NOT** use oil on any part of the calorimeter.
   It may ignite under pressure and exceed the design specifications and could cause harm depending on the severity of the reaction

3.5 SAFE ELECTRICAL INSTALLATION

- Connect the safety earth to the EARTH STUD on the back of the instrument.
  This is required when the external power supply fails.
- As an operator, do not remove any panel on the Calorimeter for any reason whatsoever. Only skilled service technicians or agents can service the calorimeter system.

DO NOT TAMPER WITH THE EARTHING - CONSULT A QUALIFIED ELECTRICIAN SO THAT THE EARTHING CAN BE CHECKED.

3.6 SAFE HIGH-PRESSURE OXYGEN

- The type of Oxygen to be used is the standard Industrial Oxygen used for welding (minimum oxygen purity of 99.2%).
- Conform to the industry standard of handling procedures for oxygen bottles.
- Secure the bottle against a wall.
- Should the Oxygen supply be in another room, make sure there is a high pressure shut off valve near the Calorimeter.
- Start the oxygen regulator at a very low/zero (Adjustor turned OUT) reading and then adjust it until 30 Bar = 3000 KPA as indicated on the gauge.

DO NOT USE ANY OTHER PIPE OTHER THAN THE HIGH-PRESSURE PIPE SUPPLIED FOR OXYGEN FILLING.

DO NOT USE THE HIGH-PRESSURE PIPE IF IT HAS A SHARP BEND, KINKS OR ANY MECHANICAL DAMAGE; DISCARD IT IMMEDIATELY IF DAMAGED!

FILL THE VESSEL WITH OXYGEN TO A MAXIMUM PRESSURE OF 3000 KPA (30 Bar=default).

NOTE:
With some applications you may need to fill the Vessel to less than 3000 KPA e.g., 1500 KPA (15 Bar), however this is only applicable when you have a sample which is highly combustible, for example powdery samples.

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

3.7 OVER-PRESSURE (CAL3K-AP CALORIMETER ONLY)

Over-pressure can exist in:

a) The oxygen feed line by incorrect oxygen regulator setting, or a faulty regulator. The max pressure is 35 Bar (3500KPa). The filling operation will fill to the "fill target setting" or when the vessel pressure is not increasing anymore.

The CAL3K-AP has a high pressure 'CUT-OUT':
It deflates the vessel pressure when it reaches 80-90 Bar. This cut-out is hard wired and is in addition to the settable pressure peak limit which can be turned off.

3.8 SAFE OXYGEN CONNECTIONS

Install the high-pressure oxygen pipe without any sharp bends, kinks or any mechanical damage. A 4mm pipe connection is provided (3K-3-27) The oxygen source connection depends on the installation (oxygen regulator or piped in oxygen). It is important that the oxygen hose is secured to the table to prevent 'flailing' in the event that it is cut/disconnected accidentally.

3.9 SAFE EXHAUST GAS CONNECTION

The exhaust gases should be routed to the outside.
The exhaust can smell and may contain corrosive gases depending on the sample material. A de-filler cap (3K-3-22), for manual deflation, and a suitable low pressure plastic hose is provided. A hose extension can be added onto the 3K-3-22 De-filler Cap if need be. The CAL3K-AP calorimeter has a special exhaust port, and the exhaust plumbing parts are provided as well.

Note:
There is no pressure in the exhaust pipe.

3.10 SAFE VESSEL HANDLING

- Handle the vessel over a table or solid surface.
- **DO NOT** drop a vessel.
- **DO NOT use any tools** to open or close the vessel.
  AP: If the vessel fails to deflate, use the pre-scribed 'emergency deflate' procedure as outlined later in this manual, which uses the 3K-3-18 EMERGENCY DEFLATE tool.
- **DO NOT** use any non-approved oil or grease on any of the oxygen fittings, pipes or O-rings.
  A very small amount of our DDS approved high-pressure oxygen grease (3K-1-086) is allowed on O-rings to make them pliable. Wipe them clean afterwards with lint-free cloth.

- Store the vessel with the lid open. Never store a vessel under pressure, always deflate using the de-filler cap/deflating cap.
- Clean the inside of the vessel with a paper towel after every use.
- Weigh the crucible every week and replace it when it has lost 10% of its original mass.
- Discard the crucible when the bottom is distorted and extremely discoloured.
- Remove the deflector plate every week and clean the top surface. It does accumulate residue and must be cleaned regularly.

NEVER OPERATE ANY UNSAFE VESSEL.

A SUITABLE INSPECTION WARNING PERIOD OF 4500 FIRINGS, AND A STOP OPERATING LIMIT OF 5000 FIRINGS ARE PRE-PROGRAMMED FROM THE FACTORY. THE EXACT WARNING LIMIT DEPENDS ON THE TYPE OF VESSEL.

VESSELS SHOULD BE CHECKED / INSPECTED BY YOUR AGENT EVERY 6 MONTHS OR 2500 FIRINGS. HOWEVER, THE VESSEL THREAD MAY WEAR SOONER DEPENDING ON THE TYPE OF SAMPLES ANALYSED AND THE DAILY MAINTENANCE. THEREFORE, IT IS ADVISABLE TO HAVE YOUR VESSEL(S) CHECKED REGULARLY.

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 CAL3K SYSTEM REGULARLY.

4 UNPACKING THE CALORIMETER 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 **Installation Guide** supplied with your order or a how to videos on our YouTube Channel (https://www.youtube.com/@ddscalorimeters/videos).

5 GETTING STARTED (SYSTEM COMPONENTS)

Congratulations on purchasing your new CAL3K Bomb Calorimeter System.

The CAL3K System 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 CAL3K 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.

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

1 x 3K-A Calorimeter 1 x 3K-A-KT Calorimeter Installation Kit
1 x 3K-AP Calorimeter 1 x 3K-AP-KT Calorimeter Installation Kit
1 x 3K-F Calorimeter 1 x 3K-MAN Calorimeter Installation Kit
1 x 3K-S Calorimeter 1 x 3K-S-KT Calorimeter Installation Kit
1 x 3K-ST Calorimeter 1 x 3K-S-KT Calorimeter Installation Kit

The complete CAL3K Calorimeter System comprises the following products dependent on the system option purchased: Calorimeter, Air Cooler, Filling Station and Vessels.

PRODUCT	PART NUMBERS	DESCRIPTION
	**CAL3K-AP / CAL3K-A**	**The Calorimeter** The unit conducts the calorific value determination.
	**CAL3K-F**	**The Calorimeter** The unit conducts the calorific value determination.
	**CAL3K-S**	**The Calorimeter** The unit conducts the calorific value determination.

PRODUCT	PART NUMBERS	DESCRIPTION
	**CAL3K-ST**	**The Calorimeter** The unit conducts the calorific value determination**.**
	**CAL3K-2**	**The Air Cooler** This cools the Vessel to the required temperature.
	**CAL3K-3**	**The Filling Station** This fills the Vessel with oxygen.
	**4K-4 / 4K-4AP**	**The Vessel** This holds the sample and gets fired in the Calorimeter while under pressure with oxygen.

5.1 THE DDS CALORIMETERS

Below is an external picture of the CAL3K Calorimeter 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.
All Calorimeter systems require an external keyboard for operation (this is not included in the below figures).

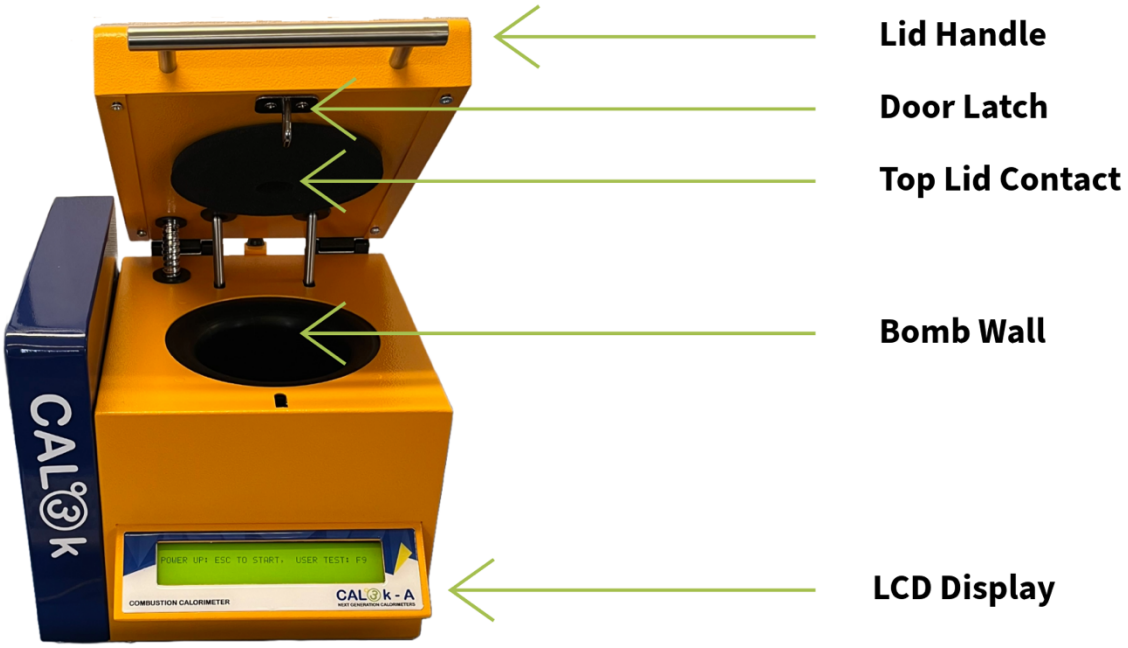

Figure 1 CAL3KA /AP CALORIMETER - EXTERNAL FRONT VIEW

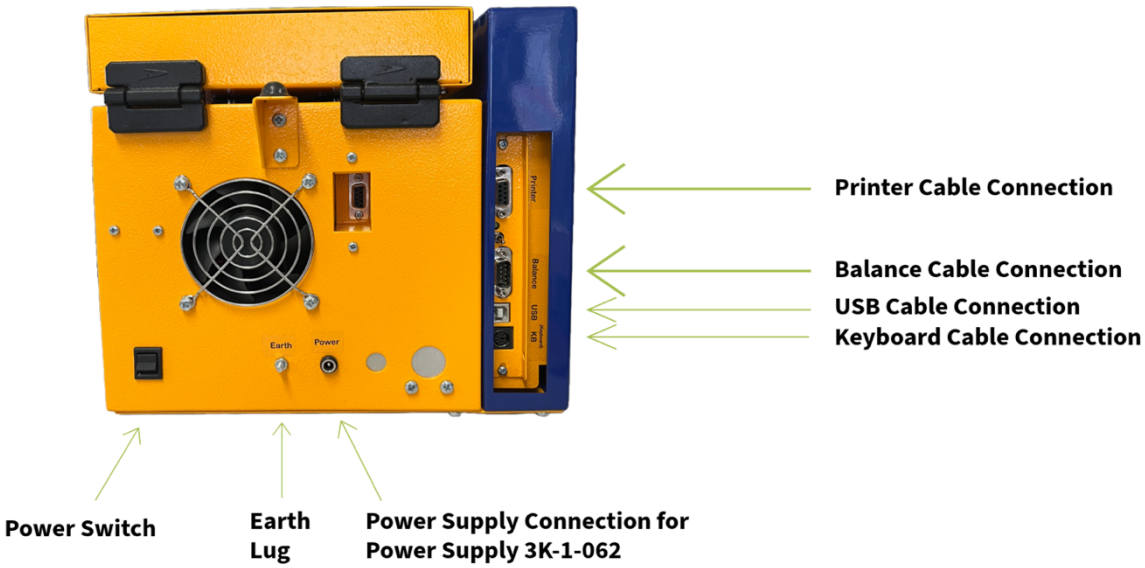

Figure 2 CAL3K-A CALORIMETER – EXTERNAL REAR VIEW

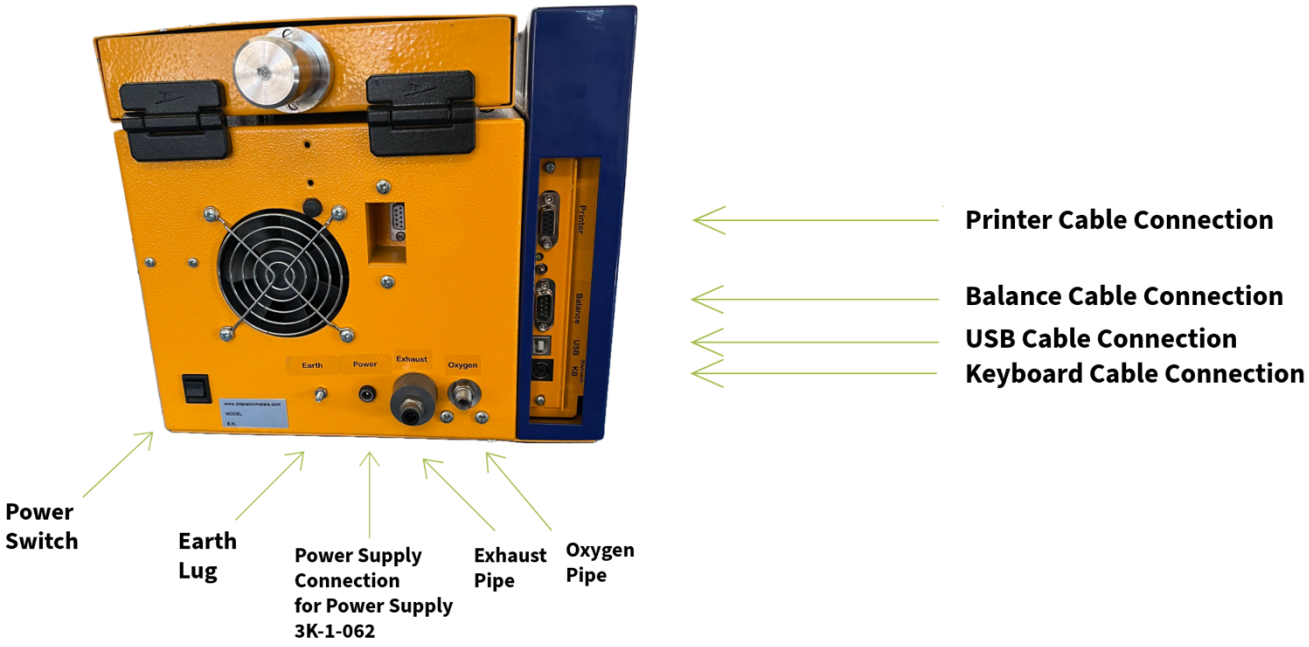

Figure 3 CAL3K-AP CALORIMETER – EXTERNAL REAR VIEW

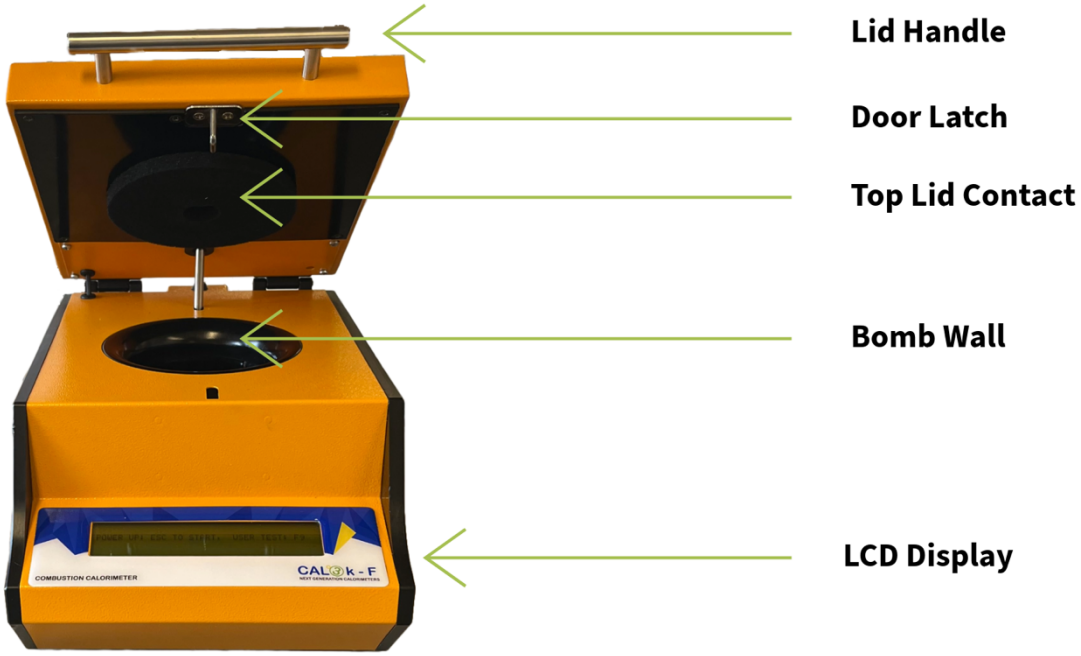

Figure 4 CAL3K-F CALORIMETER – EXTERNAL FRONT VIEW

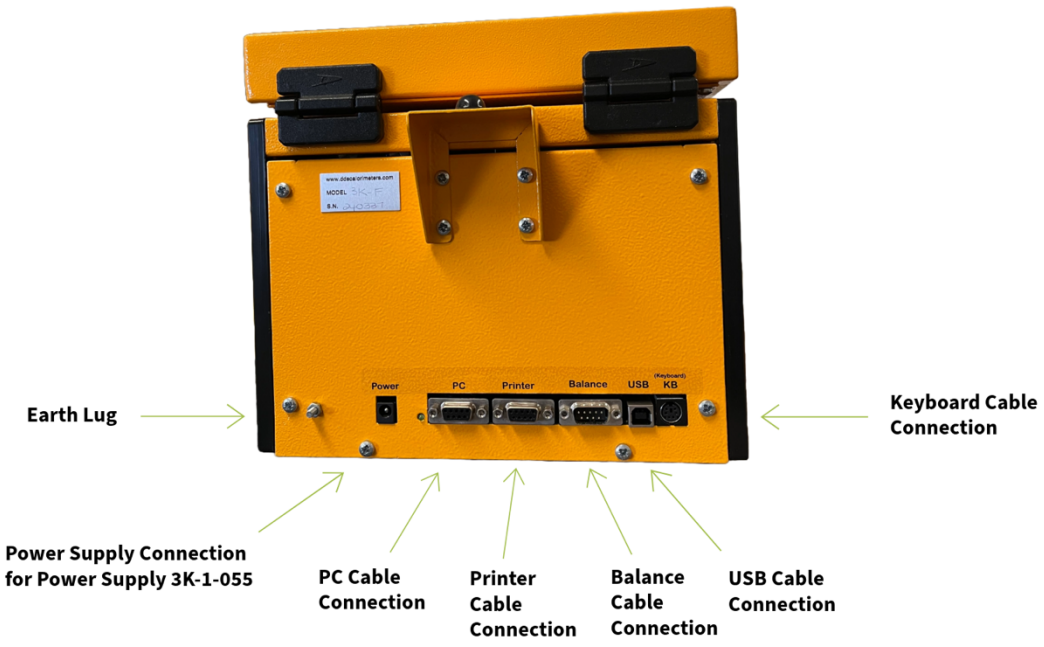

Figure 5 CAL3K-F CALORIMETER – EXTERNAL REAR VIEW

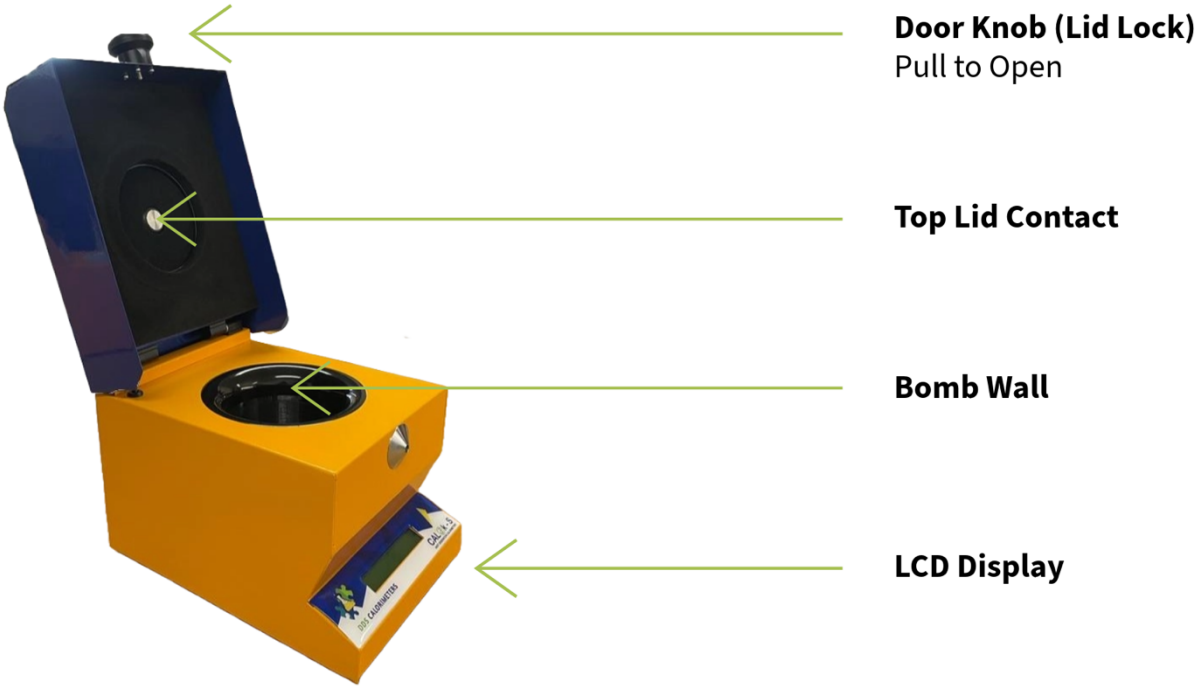

Figure 6 CAL3K-S / ST CALORIMETER – EXTERNAL FRONT VIEW

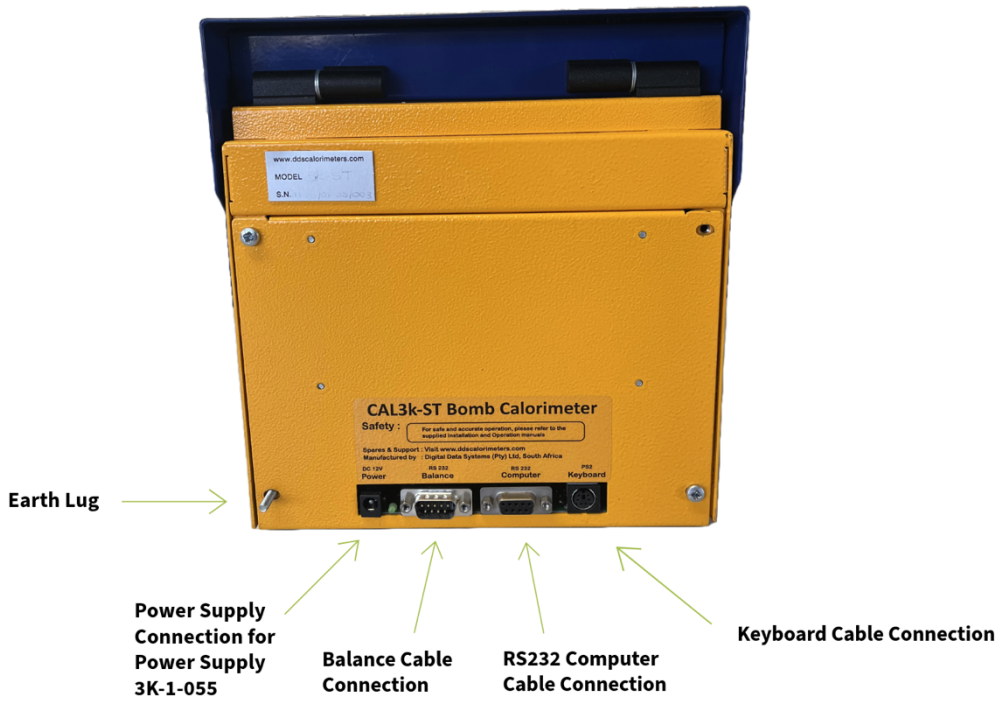

Figure 7 CAL3K-S / ST CALORIMETER – EXTERNAL REAR VIEW

5.1.1 LCD DISPLAY

This displays the relevant information to the user.

5.1.2 BEEPER

This is used as an audible indication that a cycle change has just happened. The beeper also indicates an error or warning during typing of commands. Basically, it draws your attention to the display where the details of the process or error / warning will be displayed on the screen.

5.1.3 DOOR LATCH AND LID SWITCH

The Lid closure switch is incorporated in the Door Latch, to ensure that the lid is securely closed before an operation is started. This is for safety and operational purposes.

5.2 THE AIR COOLER (3K-2)

Figure 8 COOLER – EXTERNAL FRONT VIEW

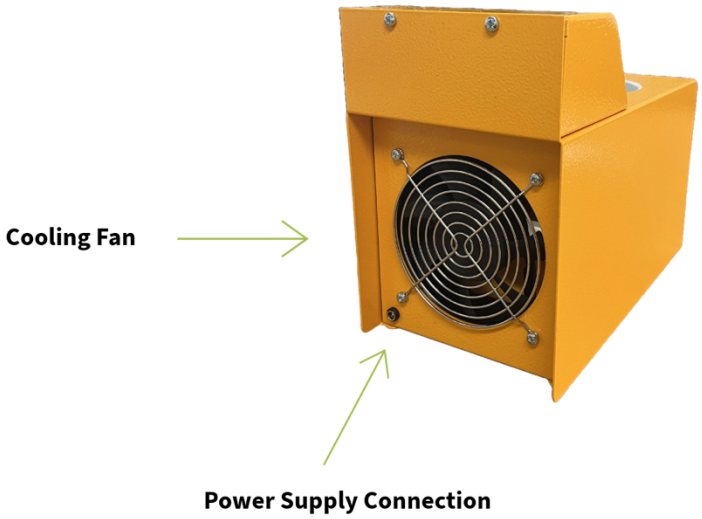

Figure 9 COOLER – EXTERNAL REAR VIEW

5.2.1 COOLER SYSTEM COMPONENTS

The Cooler should comprise of the following components:

1	x	3K-2 Air Cooler
1	x	3K-2 Air Cooler Installation Kit

Please see the **Section of 3K-2 Air Cooler Installation Kit** at the back of this manual, for a list of which items are included.

5.2.2 COOLER INSTALLATION

1. The power requirements (Mains supply) need to be the following:

Voltage:	100-240 VAC, 50/60Hz
Consumption:	40 Watts Maximum
Output:	12 Volt DC, 1 Ampere

2. The 3K-2 Air Cooler needs to be positioned in a convenient place preferably next to the calorimeter and space behind for the fan to draw air.
3. Plug in the Mains cable into the external power supply.
4. Power to the cooler is provided by a 12V 1A external power supply.

5.2.3 COOLER NORMAL OPERATION

1. Connect the power supply cable and wait for the cooler to complete the test sequence.
2. Place the warm Vessel in the Cooler and wait for the fan to come on.
3. The cooler display will show the time remaining till the vessel is ready to use again.

This Cooler is designed to reduce the temperature of a recently fired Vessel to 9 Degrees C above ambient temperature. The cooling time will depend on the energy and mass of the sample, typically it will take 4 to 8 minutes for the cooling cycle.

5.3 FILLING STATION (3K-3)

Figure 10 FILLING STATION – MAIN PARTS (EXTERNAL)

5.3.1 FILLING STATION COMPONENTS INSTALLATION

The Filling Station should comprise of the following components:

1 x CAL3K-3 Complete Filling Station
1 x CAL3K-3-KT Filling Station Installation Kit

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

5.3.2 FILLING STATION 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 regulating to a pressure of 3000 Kpa.

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, please 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 (**Do not use any oils or grease!** other than DDS grease 3K-1-086). Slowly increase the pressure on the regulator and check all connections for any possible leaks. If a connection is leaking, turn the oxygen off immediately and disassemble the connection to inspect the leak.

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. The vessel can remain in the filling station unattended, provided the regulator has been correctly set up to 3000 Kpa.

There is one pressure gauge on the Filling Station. Without a vessel in the filling station, the pressure gauge will indicate the incoming oxygen pressure, and this should always be **3000Kpa**. Once a vessel is inserted under the filling station arm, the gauge will indicate the Vessel filling pressure.

Note that the pressure gauge will not drop down to ZERO when an empty vessel is being filled for the first time, expect the pressure gauge to read between 500 Kpa to 1000 Kpa.

The rate of the filling is clearly visible on the pressure gauge and should take longer than 30 seconds to fill the vessel. One can fill the Vessel to less than 3000 Kpa (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 1500 Kpa.

During normal operation, the Filling Station requires very little maintenance. However, it is suggested that the ex-centre and piston be lightly greased (NOT oiled) to minimise wear. (See the parts detail further on in this manual). Also, the O-ring in the nozzle (3K-3-29) should be smeared lightly with grease (3K-1-086) when needed, to avoid the Vessel from sticking to the nozzle when filling.

WARNING:
NEVER use any oil or oil-based lubricant on the Filling Station and Vessel. A light (small) amount of special oxygen grease (3K-1-086) can be used on the Filling Station Nozzle O-Ring (3K-3-29), Lever, Piston and Ex-Centre.

5.3.3 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) Loosen the screw, which holds the plastic base to the base of the Filling Station.
b) Place a Vessel in the disc and lower the arm of the Filling Station, ensuring that the nozzle fits directly onto the Vessel's valve, until the arm latches down all the way.
c) Now tighten the plastic base's screw from underneath.
d) Check the alignment and if correct.

The second adjustment is a height adjustment of the filling head. This again should be set by the factory and will only need to be changed if maintenance is required. Simply loosen the four cap screws holding the filling head in place to shift the filling head up or down to the required height. With the ideal height setting the filling arm should easily lock into place over the vessel and start the filling process.

WARNING:
Overtightening can cause the screw to strip out of the threads.
This can result in damage or cause injury to the Operator.

One more adjustment which could be required is that of the oxygen regulator pressure on the oxygen Bottle. This should always be set to **3000Kpa** to allow the Vessel to fill unattended. If the pressure is set correctly, then 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 about 1500 Kpa.

WARNING:
Any additional pressure can cause damage to the Filling Station or even injury to the Operator.

If a Vessel is filled to below 3000 Kpa, and the sample being analysed does not have a high combustion, there is a chance you will receive a miss fire 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.

5.4 THE VESSEL (4K-4)

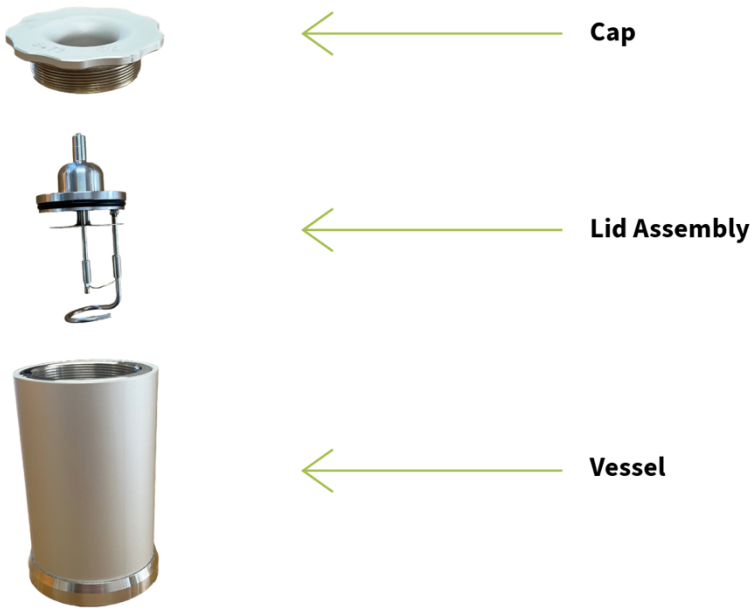

Figure 11 COMPLETE 4K-4 THREAD VESSEL

4K-4 VESSEL **4K-4 AP VESSEL**

Figure 12 VESSEL – BASE VIEW

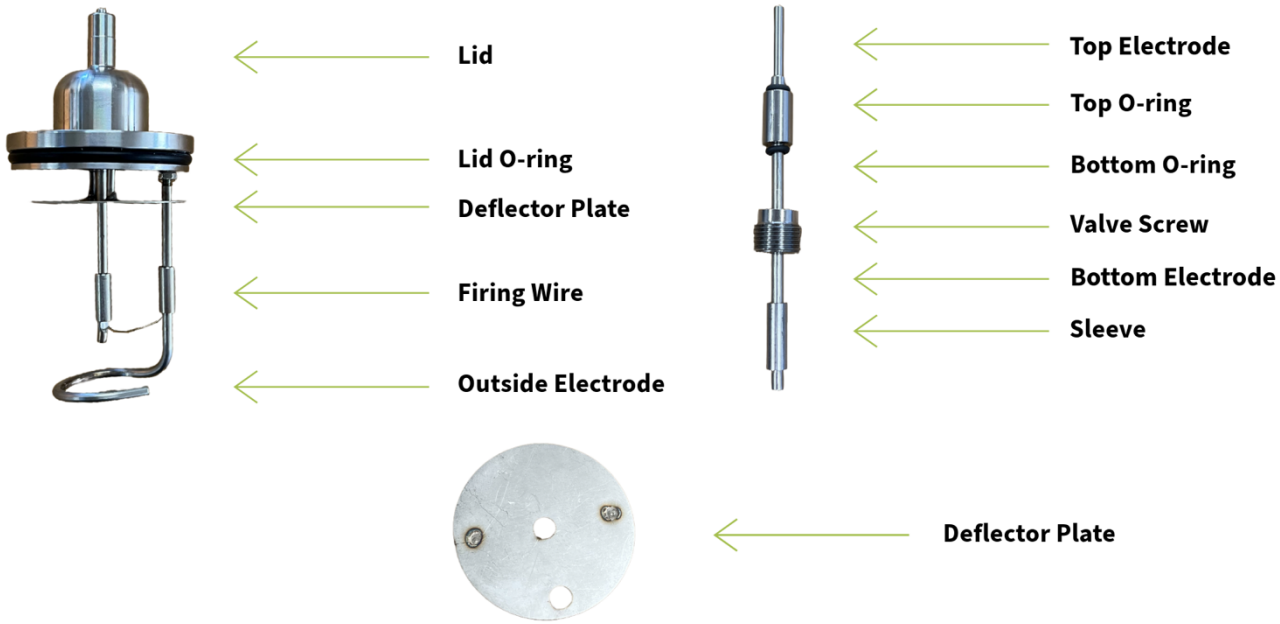

Figure 13 4K-4 VESSEL LID ASSEMBLY

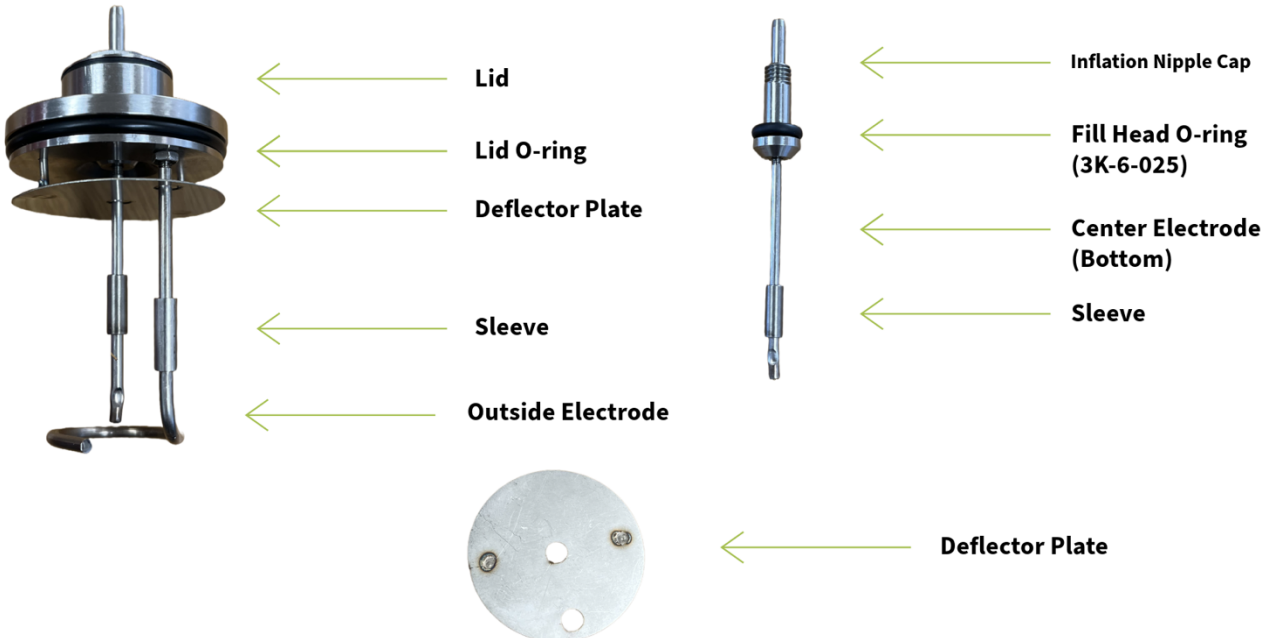

Figure 14 4K-4-AP VESSEL LID ASSEMBLY

5.4.1 VESSEL BACKGROUND

The 4K-4 Vessel is smaller than a conventional Vessel, which results in a smaller heat capacity and slightly higher temperature rise. Special attention was given to a thermally balanced Vessel design

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

The approximate temperature rise of the 4K-4 Vessel after the burning of 0.5g benzoic acid is 10 Degrees Celsius. Practical tests have shown that up to 0.8g of benzoic acid can be burnt without affecting the accuracy. Oxygen starvation will affect the results with higher energy and mass.

The Vessel must be cooled after a detonation. This can be achieved by inserting in 3K-2 cooler or conventional means such as simply leaving it on the table to cool down naturally. To speed up the cooling down process, a 3K-2 Air Cooler is recommended, and a necessity should more than 2 detonations be required in one hour. The Cooler reduces the temperature of the warm Vessel to the target temperature, which is typically 9 Degrees C above ambient (Room temperature). The absolute ambient temperature is not important.

5.4.2 MICROPROCESSOR

The Vessel is "smart" with its own processor built into its base. The high-resolution temperature sensors are attached directly onto the board. All the information pertinent to a Vessel is stored permanently in Vessel's memory i.e. Vessel number, number of firings, date of last reconditioning, etc.

The Vessel mainboard 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, however they would still need to be calibrated. The Vessel's memory can only be accessed through the Calorimeter Keyboard commands or the PC. All electronics and sensors are fully enclosed in epoxy to prevent physical damage as well as moisture from entering the electronics.

5.4.3 FIRING WIRE

The Firing Wire (3K-4-093) is semi-permanent and only needs to be replaced when it is damaged or burnt out. Only firing wire, which is pre-cut and supplied by DDS or its agents, must be used.

NOTE:
Using the incorrect firing wire influences results and the stability of the calibrations.

For firing, a length of pure cotton thread (3K-4-065) is tied to the firing wire with its "tail" touching/under 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.

6 BASIC KEYBOARD OPERATIONS

Before entering a command, always make sure that the calorimeter screen has returned to its home screen by using the '**ESC**' key.

For a list of Cal3k Commands, click here

The ***'ESC'*** key serves as a: CLEAR/TERMINATE/ESCAPE
The '***ESC'*** Key is safe to use at any time.

NOTE: Although all Commands are indicated in UPPER CASE, the calorimeter is not case sensitive.

The FUNCTION KEYS are assigned to recurring operations:

F1	Mass Entry
F2	Sample Identification (SID)
F3 (Not used)	*Not Used*
F4	Spike Mass
F5	Balance Mass
F6	Open the LID (Electronic locks only)
F7	Test Vessel Hardware
F8	Terminate user test, print displayed result
F9	Test CAL3k Hardware
F10	Function or Fault explanation
F11	Reserved

The '***ENTER'*** key is: ACCEPT/ENTER
All other keys function normally.

Once a shortcut operation is selected via a Function Key, the '***ENTER***' key is needed to Confirm / Accept/ Start the operation.

The CAL3K has many keyboard commands of which you need only a few.
The most popular and frequently used are readily accessible, the others require a password to get access to. Use the up and down arrow keys to scroll through all the commands or type the first few letters to auto complete the command.

Commands are explained in this manual as follows:

COMMAND	DESCRIPTION	Index
PASSWORD ENTRY	All commands in RED are password protected (not accessible). The password is 'DDS3K' to make RED commands visible. The password is active for 5 minutes.	006
SPIKE VALUE	The Spike Value is the CV of the spike material. If Benzoic Acid is used for spiking, then the Spike Value should be the certified combustion value of the Benzoic Acid. The default setting is 26.454KJ/g	015

Password Entry = Command text that is typed on the calorimeter keyboard
006 = Command Number Index
Colour (Black) = Accessible command from the menu or index
Colour (RED) = Restricted Command. Needs a Password to enable

All commands in RED are password protected (not accessible) without entering the password first. To enter the Password, type "PASSWORD" followed by '***ENTER'***. Type the password '**DDS3K'** to make all RED commands visible. The password activation is active for only 5 minutes. For more information, refer to Password Entry.

6.1 GENERAL KEYBOARD ACCESS

All keyboard commands are in alphabetic order and the '***UP'/ `DOWN'*** keys will scroll through the commands visible at this password level.

There are several ways to execute a command:

- If you know the command, then type it. After the first couple of letters the command will auto complete, if there are no duplicate commands with the same first few letters command is auto completed. Go to Command Execution.
- Type the first letter of the command and then use the '***UP'*** or '***Down'*** keys to show the full command list for the first few letters. Once you have the full command on the screen go to Command execution.
- Use a function key (when available). Then go to Command Execution
- Use the command index (if you know it). Type the three digit index number and the complete command will appear on the screen. Then go to Command execution

6.2 COMMAND EXECUTION

At this point the full command is shown on your screen. Press '***ENTER'*** to accept this command.
Most of the time the command is not executed except in special circumstances which have no consequence.

After acceptance one of the following happens:

- The command is executed if it is of no consequence (e.g. Display firing voltage)
- A ***YES*** or ***NO*** display indicating the present state (e.g. CALIBRATION ON or OFF)
- A number display indicating the PRESENT value

At this point after accepting the command you can either:

ESC	Terminate the command, start fresh again
or	
Type in a ***NO*** *or* ***YES*** *or* ***Number*** *or* ***Text***	This is the data that the command requires
ENTER	To accept your choice

6.3 COMMAND INDEX AND NUMBER EXECUTION

All the keyboard commands are indexed with a number, which is indicated in this manual with each key sequence. The Command text, Command Description and Command Index is indicated, below is an example:

COMMAND	DESCRIPTION	INDEX
D1 PORT SPEED	This command sets the D1 RS232 port speed. The default is 19200Kb.	054

D1 PORT SPEED = Command text that is typed on the calorimeter keyboard
054 = Command Number Index
Colour (Black) = Accessible command from the menu or index
Colour (RED) = Restricted Command. Needs a Password to enable

To execute a command by the index number, you need to know its Index number first. In the above example, now type "054" followed by '***ENTER'***. Now the 'D1 PORT SPEED' will show you 19200.

NOTE: Clear the last command entry with the '***ESC'*** key before typing the command index number.

The command list is universal to all DDS Calorimeter machines. Some commands may behave a little different to the explanations below, but the intentions are the same.

NOTE: A RED Command means the command has restricted access and a password is required to activate it. Refer to Password Entry.

For more information visit the All Cal3k Commands

6.4 INSTALLED COMMANDS

The different units share the same command structure (and numbering).
However, some commands are not installed in your unit.

To find out which commands are installed in your unit you have two choices:

A) Print them. This requires a printer.
B) If you have no printer, then type the letter 'A' and scroll up or down to see the commands.

Then type the password (**DDS3K,** see password section) and repeat the above process.
You will see many commands (for all possible operations).

7 TESTING

7.1 TEST CAL3K CALORIMETER HARDWARE

The test is activated by '**F9'** or by:

Command ***CAL3K-TEST*** **,** also refer to Basic Keyboard Operations

This command tests the CAL3K hardware.
Once started, the unit will cycle through all tests and will 'hang' on any fault. Individual tests can be executed (without cycling through all preceding tests) by replacing the 'YES' entry by the test number. The test number is shown on the screen in the 'M' number e.g. M905 is test 5.

This test should be repeated once a day.

NOTE: The vessel must not be in the well during this test.

7.2 TEST VESSEL HARDWARE

This test is activated by '**F7**' or:

Command ***VESSEL-TEST***, also refer to Basic Keyboard Operations

The vessel must be in the well. This command tests the CAL3K vessel in the well.
Once started, the unit will cycle through all tests and will 'hang' on any fault. Individual tests can be executed (without cycling through all preceding tests) by replacing the 'YES' entry by the test number. The test number is shown on the screen in the 'M' number e.g. M932 is test 2.

For the CAL3K-AP ONLY - The oxygen pressure must be connected.
All vessel functions are tested, including filling and a summary is displayed. The test must be repeated for each vessel.

7.3 TEST THE FAN

This test **does NOT** apply to the ***CAL3K-A/AP/F.*** This command puts the FAN on.

Command ***PUT FAN ON***, also refer to Basic Keyboard Operations

7.4 TESTING FOR OXYGEN LEAKS

Leaks are easily tested with soapy water, or dishwashing liquid (Bubble water) and a cotton bud.

The oxygen plumbing can be separated into 3 sections:

7.4.1 TEST OXYGEN SUPPLY

This CAL3K requires a regulated oxygen supply with approx. **3300 Kpa**/33 Bar max (30 Bar nominal) as indicated on the oxygen regulator. A leak on this line will deplete the oxygen in the oxygen bottle, but won't influence the unit's operation:

Check the following with soapy water:

- Oxygen bottle, regulator and pressure gauge.
- Optional shutoff valve.
- Flexible nylon pipe to CAL3K-AP bulkhead or filling station.
- CAL3K-AP Only: Flexible nylon pipe from bulkhead to lid or filling-head.
- CAL3K-AP Only: Filter and throttle jet (not visible).
- CAL3K-AP Only: exhaust filter housing.

Open the oxygen bottle and observe that the regulated pressure increases to the prescribed setting. Then close the bottle and observe that the pressure holds. If it decreases even slightly over an hour, then you need to find the leak by putting some 'soapy water' on each joint.

7.4.2 TEST OXYGEN INTERNAL PLUMBING (3K-AP ONLY)

Replace the filling head nut (grey plastic) (3K-6-018) with the domed like blocking device (3K-1-115). This blocks the oxygen feed to the vessel.
Insert the vessel WITHOUT the lid and cap into the machine and close the machine's lid. Then enter the command: ***SYSTEM LEAK TEST*****.** (Also refer to Basic Keyboard Operation**)**

This is a service command to check if the system is leaking. The oxygen must be connected and pressure set to 3000 kpa, and a vessel must be in the well, machines lid closed. Activate the test (YES) and the CAL3K will pressurise the system to the default or preset pressure value (***PRESS LEAK TEST***). Then it monitors the pressure and displays it. During the test one can try to find any leak if the pressure is declining. To end/exit the test press **ESC**.

NOTE: The filling is very fast because the filling volume (no Vessel) is very small.

Reinstall the filling head nut(3K-6-018) again. The filling nut is plastic and must be tightened by hand.

Do not use tools and do not 'cross thread' it.

7.4.3 TEST VESSEL LEAK (3K-AP)

This test INCLUDES the vessel and has the similar process as **TEST OXYGEN INTERNAL PLUMBING**.

Insert the vessel WITH the lid and cap installed correctly into the machine and close the calorimeter's lid. Then enter the command: ***SYSTEM LEAK TEST*****.** (Also refer to Basic Keyboard Operation**)**
This is a service command to check if the system is leaking. The oxygen must be connected and pressure set to 3000 kpa, and a vessel must be in the well, machines lid closed. Activate the test (YES) and the CAL3K will pressurise the system to the default or preset pressure value (***PRESS LEAK TEST***). Then it monitors the pressure and displays it. During the test one can try to find any leak if the pressure is declining. To end/exit the test press **ESC**.

Depending on the type of vessel used there are O-rings in the vessel lid which could leak and require replacement.

Note: The filling is much slower because the vessel is being filled. Once filled, monitor the pressure and if it is steadily declining then a leak is present. It is normal that the pressure declines rapidly in the beginning and then settles down. This is because a flow restriction is present in the vessel lid.

7.4.4 TEST VESSEL LEAK (MANUAL)

To test a vessel that is filled by an external filling station, you simply need some soapy water.

Test 1: Close the vessel properly and fill with oxygen. Now dispense 5 ml of water or soapy water into the top of the vessel LID depression. Should you see bubbles, then the main large O-ring (3K-4-094) needs to be replaced.

Test 2: As per test 1, also place a drop of water or soapy water onto the top of the vessel nipple. Should you see bubbles, then the small O-rings (3K-4-022) need to be replaced.

NOTE: Do not submerge the vessel in water!!
Avoid getting water on the bottom vessel base ring

8 OPERATING CYCLES

The CAL3K calorimeters go through the following cycles, sometimes referred to as periods / stages.
Each of the cycles is indicated in the upper left corner of the LCD display. During the operating cycles the unit checks on the conditions and reports.

During a complete determination, each Vessel must go through 6 distinct cycles as shown in the following sequence.

WHERE	CYCLE	OPERATION PERFORMED	TIME (MIN)
External	PREPARE	Prepare the Vessel	1.0 to 3.0
External or Internal	FILL WITH OXYGEN	Fill the vessel with 30 Bar Oxygen	0.5 to 1.0
Eternal to Internal	CLOSE LID	Place vessel into calorimeter and close the LID	0.5 to 1.0
Internal	INITIAL	Stabilisation of vessel	1.0 to 4.0
Internal	SAMPLE (FINAL)	Actual determination	2.0 to 4.5
Internal	END / DONE	The CV Result is displayed	0.5
Internal or External	COOL	Cooling the Vessel	3.0 – 8.0

The above cycle sequence must be adhered to for best results. Total throughput time is improved using more Vessels. The following describes the various operational cycles in detail.

8.1 PRIOR TO FIRING A VESSEL

Prior to using the calorimeter system for routine CV determinations (or bomb Vessel calibration), the following checklist must be verified:

1. All equipment is switched ON. Check Oxygen pressure and adjust the regulator if necessary.
2. System Tests carried out, '***F9***' and '***F7***'
3. Configuration parameters entered and/or checked.
4. **All Vessels cleaned and O-rings checked for any damage and if damaged, please change the O-rings.**
5. Check the vessel for **LEAKS, VESSEL (3K-AP AUTO FILL) or VESSEL MANUAL FILL**
6. All Vessels must be Calibrated.

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

8.2 CYCLE: PREPARING VESSELS

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

NOTE: Always store the vessel depressurised.
Always depressurise vessels when the calorimeter is not supervised.

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 and maintenance will ensure that unexpected breaks in routine operation will be kept to the absolute minimum.

- Place the Vessel in the Cooler if it has just been fired.
- Depressurise the Vessel after it comes out of the cooler. Use the De-filler Cap (3K-3-22) to depressurise the vessel.
- **Open the Vessel, clean the inside of the chamber using a 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 (3K-4-047) with a Wire Brush (3K-4-106). Old or damaged crucibles should be discarded as they can cause damage to the Vessel during firing.
- Clean the Vessel Cap threads with a damp paper towel. Once a day clean with a Wire Brush (3K-4-106).
- Inspect the Firing Wire (3K-4-093) and replace it if necessary. Only use the DDS supplied pre-cut Firing Wire.
- Insert the pre-cut length of Firing Cotton (3K-4-065) 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 Tared, 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. Don't spill any sample on to the balance weighing plate.
- Enter the mass into the calorimeter, either '**F1'**, '**F5'** or using the Mass command.
- Place crucible with sample into the outside electrode's (3K-4-124) 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. Tighten with two fingers quarter to half a turn. Do not over tighten!

8.3 CYCLE: EXTERNAL FILLING OF VESSELS

- Place the Vessel under the Filling Station, keeping it upright. Fill it with **3000 KPA** oxygen. The gauge will drop to about 5 to 10 Bar and then slowly start showing the vessel pressure as it being filled
- The filling time should be around 30 Seconds. It can take longer (Recommended) however should not exceed 1 minute.

8.4 CYCLE: EXTERNAL TO INTERNAL CLOSE THE LID

Once the vessel has been filled with oxygen, place the vessel into the calorimeter bomb well.
Be careful not to bump the vessel as this could dislodge the sample from the firing cotton.
Close the LID of the calorimeter when the message on the screen tells you to do so.

8.5 CYCLE: INTERNAL PREPARATION CHECK

The unit checks and reports messages as follows:

Power Start User	M102
Vessel Calibration and Prep	M101, M104, M505, M534, M538, M539
Mass and Vessel Data	M110, M106, M108, M111, M112, M109, M530
Vessel Inspection and Faults	M113, M116, M118, M180, M190, M192, M194, M197, M193, M508
Limits within Range Check	M146, M148, M150, M154, M155, M157, M159, M161, M162, M172
Lid Closed	M184
Firing Wire	M186

If everything is OK, it will go to the next cycle.

8.6 CYCLE: INTERNAL FILLING (CAL3K-AP ONLY)

The CAL3K-AP will operate the filling valve and monitor the filling progress.
It will try to fill the vessel up to the default target pressure, or preset target pressure (PRESS FILL TRGET) or until a plateau is reached above the default minimum fill pressure or preset minimum pressure (PRESS FILL MIN). It monitors the filling time in seconds (Duration can be changed with PRESS FILL SECND).

Manual Lid Open	M214
Filling in Progress	M230, M532, M536
Slow Filling, No Filling	M197, M206
Filling Fault	M204, M211
ATC Checks	M546, M547, M548, M549, M550

If all is in order it starts the initial cycle.

8.7 CYCLE: INITIAL

This is a very important cycle: it allows the vessel temperature to settle down and equalise. The un-equalized temperatures are the result of filling and handling of the vessel.

Vessel Communication	M210
Initial Cycle Interruption	M216, M240
CAL3K-AP Filling Leak	M304
Vessel Temperature	M258
Firing Voltage Low	M270
Firing	M280

If everything is OK, it ignites the sample and switches to the MAIN cycle.

8.8 CYCLE: MAIN

The main (measuring) cycle monitors the vessel temperature and calculates an interim result every 6 seconds starting 2.5 minutes before the end.

Start the cycle	M316
Termination, blocked	M374
Vessel and Ambient Fault	M300, M343, M344
Abort	M302
Miss Fire	M310
CAL3K-AP Pressure Abort	M382, M304, M374, M305
Vessel Warning	M318, M320, M324, M341, M342
Vessel Fault	M400, M401, M402, M403, M404, M405
Cal3k-AP Pressure	M512, M516, M518, M520
Wait	M330

At the end of the main cycle all variables are saved, and the end cycle is started.

8.9 CYCLE: END

At the END of the cycle, the calorimeter will display the calculated sample result. Depending on the calorimeter model, some will open the LID of the calorimeter automatically and others will give an audible sound letting you know that it has completed the cycle and can be opened.

CAL3K-AP Deflate the vessel	M360, M306, M307, M308, M305, M309
Remove vessel	M370
Calibration check	M380
Result Display	M340

8.10 CYCLE: COOL

All calorimeter models, except for the CAL3K-S, ST will require the fired vessels to be cooled down in an external air cooler (3K-2). The CAL3K-S, ST have an internal fan cooler.

- Wait for the cooling cycle to complete before deflating the vessel. De-fill the Vessel using the De-filler Cap (3K-3-22)

CAL3K-S, ST only:

The vessel is cooled down	M524, M525, M514

8.11 CYCLE: IDLE

These events are typically shown when working with the Calorimeter in between running samples. Most of these 'M' numbers are just messages or acknowledgements of actions.

Hardware Test Messages	M195, M196, M522, M900, M901, M902, M903, M905, M906, M907, M908, M909, M910, M911, M912, M913, M914, M915, M918, M919, M920, M921, M923, M924, M925, M926, M927, M929
Vessel Test Messages	M930, M931, M932, M933, M934, M935, M936, M937, M940, M941, M942, M950, M960, M961, M962, M963, M964, M965, M966
Read Data messages	M551, M553, M554, M558, M560, M561, M562, M565, M569, M570, M571, M572, M573, M574, M576, M582, M588, M544
Keyboard Command Messages	M601, M602, M603, M604, M605, M606, M607, M608, M609, M610, M611, M612, M613, M614, M615, M616, M617, M618, M619, M621, M622, M623, M624, M625, M626, M627, M628, M629, M630, M631, M632, M633, M634, M635, M636, M638, M639, M640, M642, M643, M644, M645, M646, M647, M648, M649, M650, M651, M652, M653, M654, M655, M656, M657, M658, M659, M660, M661, M662, M633, M664, M665, M667, M668, M669, M670, M671, M672, M673, M674, M675, M676, M678, M679, M680, M681, M682, M683, M684, M685, M686, M687, M688, M689, M690, M691, M692, M693, M694, M695, M696, M697, M699, M702, M703, M704, M705, M706, M707, M709, M710, M711, M712, M713, M714, M715, M716, M718, M720, M721, M722, M723, M724, M725, M740, M741, M743, M744, M745, M746, M747, M540, M545

8.12 UNDERSTANDING EVENTS

Our DDS Calorimeter range employs event logging. An event is defined as an occurrence that needs to be taken note of, typically a severe condition or fault. The Calorimeter will monitor all activity, including the user operations and should an event happen, it will display the event on the screen. In the table above are typical event messages of all faults. We refer to them as 'M' numbers. Each 'M' number is unique and points to a very particular place in the Calorimeter operational sequence. When an event or 'M' number is displayed on the screen, you can click on '**F10**' for extra help.

There are instances where an event fault causes multiple faults in quick succession, resulting in the calorimeter only showing the last event on the screen. Use the command ***READ EVENT RECRD*****.** (Also refer to Basic Keyboard Operation**)** to step through the last 32 events, starting with the event that happened last. Can also use the '**F11**' as a shortcut key to cycle through the event log.

Use Command ***PRT EVENT HISTORY*** to print out the last 32 events.
Use Command ***READ EVENT TEXT*** to give help on a particular 'M' number.
Use command ***Clear Results*** with 'Event' to clear all 32 Events.

9 CALORIMETER OPERATIONS

This section explains the MOST used commands during routine operation. There are many more for complex and special operations. See: **ALL CAL3K COMMANDS**

9.1 MASS ENTRY OF THE SAMPLE MASS

The sample mass is a weight in the range 0.2 to 1.5 grams (Default). Once the mass has been entered, the calorimeter will display the mass in the first row of the display. At this point the mass is CAPTURED and will only be deleted by the calorimeter once it has been ignited. Refer to Mass Erasing below should a mass need to be deleted.

There are three methods to enter mass into the calorimeter.

1. Manual Mass entry, using the '**F1'** shortcut key.
   Press the '**F1**' key followed by ***'ENTER'***. Then type your mass, e.g. 0.4969, followed by ***'ENTER'*** to CAPTURE the mass into the calorimeter.

2. Manual Mass entry by typing in command Mass.
   Command ***MASS***. (also refer to Basic Keyboard Operations)
   Type in ***MASS*** followed by ***'ENTER'***. Then type your mass, e.g. 0.4981, followed by ***'ENTER'*** to CAPTURE the mass into the calorimeter.

3. Automatic Mass entry when a balance is connected, using the **F5** shortcut key.
   Pressing the '**F5**' key reads the mass from the balance. When the mass weight is displayed and has stabilised, press ***'ENTER***' to CAPTURE the mass into the calorimeter.

The default mass range can be changed to suit your operations:

Command ***MIN MASS LIMIT***,also refer to Basic Keyboard Operations
Command ***MAX MASS LIMIT***,also refer to Basic Keyboard Operations

Also refer to the TEMPERATURE RISE section to better understand the ideal weight of your sample. Also refer to the SPIKING section for difficult to burn samples

9.2 MASS ERASING

Once the mass has been captured, it is 'LOCKED' into the present operation until it is ignited. There are two ways to 'ERASE' the mass or 'UNLOCK' it is as follows:

1. Type the word '***MASS***', '***Enter'***, a beep can be heard, and the entered mass is displayed.
   Then Press the '***DELETE***' button on the keyboard.
2. Command ***RESET*** or ***ABORT***

9.3 MASS CHECKING

On occasion it is required to check that your mass entered is correct. The first part is making sure your Precision Balance is serviced regularly.

The other part is making sure your weighted sample remains in the crucible after filling. To Check the mass:

- Simply weigh your sample as before. Note the weight!
- **Don't put** the firing cotton on the firing wire.
- Filling the vessel with oxygen.
- **Don't put** the vessel into the calorimeter to fire.
- De-fill the vessel.
- Leave the balance set for the present sample (DO NOT TARE BALANCE)
- Remove the crucible carefully from the vessel.
- Place crucible back on the balance plate.

The weight of the sample before and after should be within 0.0010g of each other. Wipe the inside of the vessel walls with a white paper towel and check for raw sample matter. If there is a large weight discrepancy it could be:

- There is a problem with your oxygen filling, either the filling station or the LID assembly of the vessel (Centre Electrode, Valve Screw and Deflector plate).
- The sample is very fine, fluffy or powdery.
  - The Sample needs to be compressed into a tablet or pellet.
  - or SPIKING is required, not because the sample does not burn but because the sample is too light. Use a Gelatine Capsule.

9.4 SAMPLE IDENTIFICATION (SID)

The sample ID is a 16-character (or shorter) string of characters. The last character will be automatically incremented at each firing. That is to say that a 5 is incremented to 6, and 'C' increments to 'D'. If a short SID is used, followed by spaces, then the last non-space character is incremented. The SID is right orientated. The SID can be letters and numbers. The SID can be set by:

Command ***SAMPLE IDENTIFY***, also refer to Basic Keyboard Operations

or use the '**F2'** Shortcut Key

If the ***TIME IS SID*** is used by setting 'YES', then only 8 characters are used: HH:MM:SS

NOTE: Not all print formats print all SID characters.

9.5 GROUP IDENTIFICATION (GID)

The Group ID is a 16-character (or shorter) string of characters. It can be set by:

Command ***GROUP IDENTIFIER***,also refer to Basic Keyboard Operations

If the ***DATE IS GID*** is used by setting 'YES', then only 8 characters are used:
YY/MM/DD

A print command ***PRT RESULT GID*** is available to print all results stored with this group ID.

9.6 BALANCE MASS

The supplied balance cable (Part No: 3K-1-117) can be connected to a suitable balance so that the mass can be captured automatically to the CAL3K. The '**F5**' key reads the mass from the balance. When the mass is displayed and has stabilised, press '***ENTER***' to CAPTURE the mass into the calorimeter.

The default mass range can be changed to suit your operations:

Command ***MIN MASS LIMIT***, also refer to Basic Keyboard Operations
Command ***MAX MASS LIMIT***, also refer to Basic Keyboard Operations

9.7 OPEN LID

With the ***CAL3KS/ST*** calorimeters, the 'lid open' operation is a manual process. All other calorimeters will open the lid by a command '**F6**' or automatically.

Command LID, also refer to Basic Keyboard Operations

The lid can be open at any given time, although not recommended. The present operation cycle of the calorimeter is terminated.

Only With the ***CAL3K-AP,*** the vessel is first deflated and then the lid is opened.

NOTE: The Lid is opened automatically if no vessel is inserted, and the lid is closed.

9.8 LOADING DEFAULT PARAMETERS

The default parameters are loaded before shipment. It is strongly recommended that the default parameters are used and are regularly loaded. At power-up the vital parameters are checked during operation, and if they are out of specification then the DEFAULT PARAMETERS must be loaded. This is similar to a "Factory Reset".

Command ***PARA DEFAULT LOAD***, also refer to Basic Keyboard Operations

The above command loads the default parameters for the present mode. Each mode ***(CAL3k-A/AP)*** has its own default parameters.

Below is a list of the main default parameters:

DEFAULT PARAMETER	SETTING
Calibration ON/OFF	OFF
Firing volts	25V
Spike Value	26.454 (BA)
GID (Right orientated!)	DDS GID
SID (Right orientated!`)	DDS D001
Miss Fire Limit	0.22℃
FibreCV	16.736
Fibre percent	0
Moisture percent	0
Gelatine capsule rise	1.44
Cal3k-AP(Only) - Fill target	30 Bar
Cal3k-AP(Only) - Fill Minimum	20 Bar
Cal3k-AP(Only) - Fill leak (fill to fire)	0.2 Bar
Cal3k-AP(Only) - Press peak limit	70 Bar
Cal3k-AP(Only) - Fill Time	60 sec
Cal3k-AP(Only) - Deflate Time limit	40 sec
Cal3k-AP(Only) - Flush time seconds	3
Cal3k-AP(Only) - Leak test pressure	25 Bar
Min Mass	0.2 g
Max Mass	1.5 g
SulpCorr	0.0
Cotton + Wire Correction	0.022
Benzoic Acid	26.454

Balance speed	2400 baud
High Rise limit	16 ℃
Low Rise Limit	6 ℃
High Ambient Limit	36 ℃
Low Ambient Limit	8 ℃
D1 Speed (0=115200 Kb)	19200 baud
Minimum calibrations	4
Cali Max Numbers	8

9.9 ENTERING PASSWORD

The CAL3K has many keyboard commands of which you need only a few.
The most popular and frequently used are readily accessible, the others require a password to get access to. Use the up and down arrow keys to scroll through all the commands or type the first few letters to auto complete the command.

The Unit is delivered with a list of commands that are password protected. Unfortunately, this cannot be switched off.

The available commands can be checked by entering the letter '***A***' and then pressing the ***UP*** or ***DOWN*** arrow repeatedly. Also refer to Basic Keyboard Operations.

Enter the password:

Command ***PASSWORD ENTRY***, also refer to Basic Keyboard Operations

All commands in RED in the Command List are password protected (not accessible) without entering the password first. To enter the Password, type "PASSWORD" followed by '***ENTER'***. Type the password '**DDS3K'** to make all RED commands visible. The password activation is active for only 5 minutes.

If you hear a loud audible beep after pressing enter, you have entered the wrong password. Try again, only once the password has been correctly entered will the RED protected menu options become available.

9.10 ABORT

The abort (Reset) commands terminate the present operation. The exact sequence depends on the type of unit and safety measures.

It will deflate the vessel ***(CAL3K-AP ONLY)***.
It will write a terminated result into the memory and print it if enabled.
It will not save a calibration.
It will open the lid ***(CAL3K-AP/A/F)***.

The ABORT is the same as a RESET. It can be performed at any time.

Command ***ABORT/RESET*** , also refer to Basic Keyboard Operations

This command clears everything. It terminates any of the operational cycles such as INITIAL or MAIN. Data is lost. However, if a MAIN cycle was terminated then a record is stored with the appropriate status.

Command ***RESET*** , also refer to Basic Keyboard Operations

The same as ABORT. Any process is terminated. A Sample in progress is lost, Balance mass is lost.

9.11 UNITS OF MEASURE

The unit works in KJ/g and Celsius. However, the CV value can be expressed in other units of measure by:

Command ***UNIT: KJ, KCA, KBU***, also refer to Basic Keyboard Operations

This command sets the measuring units. Note that the internal working is in KJ/g, but any output is converted to the selected units. Enter the letters:

'**KJ**' for KJ/g
'**KCA**' for KCAL/g
'**KBU**' for KBTU/lb

The following conversion applies:

1KJ/g	=	429.9226	BTU/lb	=	0.4299226	KBTU/lb
1KJ/g	=	0.2388459	KCAL/g			

Therefore: The 26.454KJ/g = 11.373 KBTU/lb = 6.3184 KCAL/g

NOTE: The unit conversion is only used in communicating with the CAL3K and the display.

We know that the KBTU/lb and KCAL/g are not conventional, but they fit nicely into the display format.

10 MODE CHANGES (CAL3K-AP & CAL3K-A ONLY)

Mode changes only function with the CAL3K-AP and CAL3K-A calorimeter systems.

The operating mode influences the operating parameters of a model such as:

Initial timing:	Time spent to equalise the vessel before firing.
Main timing :	Time after firing to wait for the temperature to stabilise.
Compensations:	The accumulated temperature loss compensations.
Others:	Cooling time, filling times, parameters.

All models have a set of default parameters (settings).
Some of the parameters can be changed by the user, others are set by the Load Default Parameters and CANNOT be changed. In general, all parameters which affect the calibration CANNOT be adjusted.

The operating modes control the operating behaviour:

Mode 0 **DYNAMIC**

This mode is a mixture of ISOTHERMAL and ADIABATIC (or ISOPERIBOL). The jacket temperature follows the vessel temperature during the initial period (adiabatic) and remains constant during the main period (Isothermal). Best overall performance. By default, all our calorimeters are set up in this mode.

Mode 1 **ADIABATIC**

In this mode the jacket temperature follows the vessel temperature. Not popular, but traditional.

Mode 2 **ISOTHERMAL**

The jacket temperature is static (sort of). Not popular, too slow.

Mode 3 **FAST DYNAMIC**

Same as mode 0, but faster. Requires better environmental control.

Model	**Mode = 0**		**Mode = 1**		**Mode = 2**		**Mode = 3**	
	INITIAL	MAIN	INITIAL	MAIN	INITIAL	MAIN	INITIAL	MAIN
CAL3K-A	4	3	3	5	4	5	4.5	2.6
CAL3K-AP	4	3	3	5	4	5	4.5	2.6
CAL3K-F	4	3	-	-	-		-	
CAL3K-S	4	3	-	-	-		-	
CAL3K-ST	4	3	-	-	-		-	

A Vessel must be calibrated within each mode and does not have to be re-calibrated when reverting to its original mode.

There is a trade-off between operating speed and accuracy.
The decrease in accuracy is dependent on the laboratory conditions and in the number of vessels you use.

The operating mode can be set by The command ***SET OPS MODE*** , also refer to Basic Keyboard Operations**.**

11 CONNECTING

Different units have the following ports and default speeds:

UNIT	USB	PORT D1	PORT D2	BALANCE
CAL3K-AP	YES	19200	115200	2400
CAL3K-A	YES	19200	115200	2400
CAL3K-F	YES	19200	115200	2400
CAL3K-ST	-	19200	-	2400
CAL3K-S	-	19200	-	2400

11.1 USB PORT

It connects with a PC and the calorimeter system. The USB Port provides full functionality, just like a RS232 Port, just at a high communication speed. However, due to the high-speed communication, the USB is limited by the length of USB communication cable, typically 2m. The other limitation is that the USB port cannot be used for any printer.

- DDS Windows Software App https://ddscalorimeters.com/software/cal3k/
- DDS Windows REMOTE App. https://ddscalorimeters.com/software/Remote3K/

Install the correct USB Drivers and windows software from the website https://ddscalorimeters.com/software/cal3k/

NOTE:
A Software App is required on a PC! This PORT will not connect to a USB printer!

11.2 PORT D1 (PRINTER PORT)

This is a RS232 port and good for everything as seen later.
Of course, it can be connected to a PC and the DDS CAL3K and REMOTE Windows App. It is called the printer port because all keyboard print commands work on this port, and all units have this port.

The RS232 D1 port must be configured to the same setting as the connecting port.
The CAL3K D1 Port setting: Data=8-bit, Parity=none, Stop bit=1 (Standard).

The port speed can be set by the command ***D1 PORT SPEED***, refer to Basic Keyboard Operations**.**

This entry sets the D1 RS232 port speed in baud. The default is 19200 baud.
The speed can be set from: 1200 to 115200 baud.

This port can connect to:

- Printer RS232
- PC
- BLUETOOTH bridge (Wireless)
- RS232 to USB Convertor

That means that the user is restricted to a PC with a Software App such as:

- DDS CAL3K Windows App
- DDS REMOTE App
- TERA TERM

Refer to **Printing and Output**

11.3 PORT D2

This port is a RS232 port ***only available on the CAL3K-AP/A/F systems***. Its speed is fixed at 115.2KB baud.

NOTE: Printing is not possible.

The D2 port has a fixed baud rate of 115.2KB. It can be used for everything except keyboard printing. It connects to:

- PC
- BLUETOOTH bridge (Wireless)
- RS232 to USB Dongle
- Dongle

That means that the user is restricted to a PC with a Software App such as:

- DDS CAL3K Windows App
- DDS REMOTE App
- TERA TERM

11.4 BALANCE PORT

This is a RS232 port, and its purpose is to receive the sample mass from the balance for auto mass entry. Refer to Balance Mass.

The balance connection cable is included in the kit (3K-1-117). If the calorimeter is installed near the balance, then we recommend it be connected. The default balance speed is 2400 baud. Set your balance to this speed (**please refer to your balance manual**). To test the connection, press '**F5**' on the calorimeter keyboard. If the balance communication speed is correct, the weight should show on the calorimeter display.
With the weight showing on the display, if you now press ***'ENTER'*** then the mass is captured and ready for use. Once a mass is captured, it is locked to prevent accidental editing. Refer to Mass Entry to unlock it.

Command ***BALANCE SPEED*** , also refer to Basic Keyboard Operations

The balance must have the same setup as the CAL3K.

The setting is:

Parity	None
Stop bits	1
Data	8-bit
Default Speed	2400

The speed in the CAL3K can be adjusted from 1200 to 38400 baud to match the baud speed of the balance.

11.5 CONNECTING TO A PC WITH A RS232 PORT

The PC must have a RS232 port configured to the same speed and a receiving App such as TERA TERM or CAL3K Software or any virtual port emulator. If the PC has no RS232 port, then a RS232 to USB convertor can be used.
The data output is initiated from the CAL3K keyboard or internally. The calorimeter will only answer to a PC data request in a solicit manner.

11.6 CONNECTING TO A PC FOR DATA COLLECTION

This method initiates data transfer external to the unit via a Software App.
The DDS CAL3K Windows Software or the DDS REMOTE Windows software will upload data and save them to the PC hard drive-in a .CSV format.

The physical connection can be:

1. RS232 cable
2. USB Cable
3. BLUETOOTH BRIDGE (if no RS232 port, or if USB cable to short)
4. RS232 to USB convertor

Configure the DDS App to suit any of the above methods.

11.7 CONNECTING FOR REMOTE OPERATION

The CAL3K range of calorimeters can be operated remotely via the Internet. The purpose is to emulate the operational screen and keyboard of the CAL3K so that a user is remotely able to see / debug / fault find your calorimeter operation via a secure desktop application like Any Desk.

For this to work the following connections must be made:

A) The CAL3K must connect to a local PC. The connection can be:
   A1) USB cable
   A2) RS232 cable
   A3) BLUETOOTH BRIDGE: RS232 to USB
   A4) USB to RS232 converter (Cable)
B) The local PC must be connected to the internet.

C) The PC must run the supplied REMOTE software (https://ddscalorimeters.com/software/Remote3K/) .
D) The PC must use a desktop sharing APP such as: ANYDESK
E) The remote PC must use the same desktop sharing application.

If the CAL3K has only one RS232 port such as the CAL3K-S, CAL3K-ST then all print operations are re-routed and are displayed on the Remote PC Software. In normal instances, the single RS232 port on the CAL3K-S and CAL3K-ST is either a PC port or a printer port, not both.

The remote operation copies the CAL3K screen display to the Local PC and then via the internet and the remote desktop to the far PC.

Any keyboard entry on the far PC or the local PC or unit keyboard are visible on the CAL3K, and all other PC's commands will be executed as if operated from the CAL3K keyboard.

With the REMOTE connection the CAL3K can be operated from:
- CAL3K keyboard
- Local PC
- Far (Off Site) PC

The purpose of this remote operation is to teach, train, troubleshoot and operate the CAL3K from an offsite location. Large data dumps are not advisable.

12 CALIBRATION

NOTE: 1) Each Vessel is calibrated before delivery.
2) DO NOT Calibrate the vessel as the first sample of the day

Calibrations are needed to calculate the Calorific Value (CV) of an unknown sample. The calibration process is the same as with a sample, except that many more variables (conditions) are saved to a special calibration memory. All units keep up to 16 calibrations per vessel and operating mode.

A sample (Unknown CV) is compared to the calibration (Known CV) and the unknown CV is calculated.
That means that at least ONE calibration must be present before a sample can be determined. If the single calibration has an error, then the sample will have equally an error. To eliminate this type of error the CAL3K uses an AVERAGE of the available calibration for calculating the sample CV.

This implies that more than ONE calibration must be present to form an average. Ideally 4 or more calibrations should be used.

But what happens when one of the four calibrations is wrong (or has an error)? Then the error is quartered! This is where the calibration management sets it: The error is detected by a smart process in which all calibrations are compared with each other and if one is outside the set limit it is blocked from inclusion in the calibration averaging. The smart blocking process is learning from the calibration conditions: This is a little applied Artificial Intelligence (AI).

None of the above needs to be known while using the CAL3K. It is all automatic! The AI process is controlled by parameters, which can be changed by the user. The default parameters are good for initial operations.

NOTE: Do not use the first "firing" of the vessel as the calibration. Always "warm up" the Vessel and Machine with a "throw away" sample, then calibrate.

Also refer to: Preparing vessels, Prier to firing a vessel, Temperature Rise, Fire Manually, Basic Keyboard Operations

12.1 CALIBRATION MANAGEMENT

The process is automatic and operates within the set parameters. Changing a parameter only affects the blocking. After each calibration cycle all (including blocked) calibrations are analysed (compared with each other) and the bad ones are blocked. This is repeated until all unblocked calibrations are within limits or not enough calibrations are left.
A new calibration is inserted into the memory in:

a) An empty space
b) If non available into the most blocked space overriding it
c) If all unblocked into the oldest calibration overriding it

12.2 CALIBRATION CHECK SAMPLE

Traditionally a calibration check is performed to test the calibration. This can be done by entering **'CHK'** instead of the **'YES'** in the calibration command.
A normal calibration is entered in the calibration memory. A Check sample is not entered in the memory. During a calibration or a check sample the following items are not used:

Sulphur correction
Spiking
Moisture correction
Food fibre correction

A calibration check sample is identified in the result memory and in the unit display.

12.3 CALIBRATION COMMANDS

Command ***CALIBRATION*** , also refer to Basic Keyboard Operations

Enter '**YES**' to perform a calibration or '**CHK**' to perform a calibration check sample.
A 'YES' entry results in a calibration save to memory and 'CHK' entry does not perform a save.

Command ***BENZOIC ACID VALUE*** , also refer to Basic Keyboard Operations
This is the Benzoic Acid value in the specified units! To Set/Specify units, use the command UNIT. The default entry is 26.454KJ/g. This is the certification reference value that the calibration references against.

NOTE: Please check and update the Benzoic Acid Value every time you change to a new Benzoic Acid bottle or blister pack.

Command ***MIN CALIBRATIONS*** , also refer to Basic Keyboard Operations

This command allows the blocking when more than the minimum calibrations are saved. The calibration averaging only uses unblocked calibrations. The default is 4.

Command27 ***BLOCK ABOVE LIM*** , also refer to Basic Keyboard Operations

This command allows the AI module to BLOCK a calibration if it is outside the set Peak limit in KJ/g.
The default is 0.04KJ/g. A zero entry disables the blocking process. The blocking takes place after a NEW calibration was done and more than the minimum calibrations are stored.

Command ***MAX CALIBRATIONS*** , also refer to Basic Keyboard Operations

This command sets the calibration memory space. 8 is the default. The max space is 16 calibrations. The space assignment is valid for all bombs and modes. Once the assigned space is full a new calibration is entered in:

A) The highest blocked calibration
B) The oldest calibration

Command ***PRT CAL ANALYSIS*** , also refer to Basic Keyboard Operations

This command initiates a recalculation and a printout of all the data used and the compensation and blocking performed. The computations are performed after every calibration automatically without running this command.

12.4 CALIBRATION CONDITIONS

With each calibration all the variables such as:

Initial conditions
Main conditions

are saved. For optimum repeatability the ambient temperature should be constant. If this is not possible then calibrations should be performed at different ambient temperatures. It may be prudent to increase the MIN and MAX CALIBRATIONS to 6 and 10 respectively to have a better representation of the LAB conditions.

12.5 CALIBRATION IN DIFFERENT MODES

A calibration is saved for a particular vessel and a particular mode. Not all calorimeter products have a MODE parameter, but all calorimeters have a maximum of 16 calibrations per vessel.

The following table explains this:

PRODUCT	MODES	VESSEL	CALIBRATIONS	TOTAL CALIBRATIONS
CAL3K-AP	4	4	16	256
CAL3K-A	4	4	16	256
CAL3K-F	1	4	16	64
CAL3K-ST	1	2	16	32
CAL3K-S	1	1	16	16

Mode zero is **DYNAMIC** and is the default setup for all our calorimeters when they leave the factory. Refer to Mode Changes

12.6 CLEARING CALIBRATION (FACTORY)

All units leave the factory with 6-10 calibrations per vessel in mode ZERO. We use the data to monitor the performance, accuracy, and repeatability of the calorimeter system. You can use the factory calibrations and add yours to it (Recommended), or you can delete all and start fresh.

Before deleting the calibration set for a vessel, identify by vessel number where its calibration is stored in memory, 1 to 4.

Command ***READ BOMB CALI***, also refer to Basic Keyboard Operations

A calibration set is then deleted by using the command ***CLEAR B_CAL S/N***, also refer to Basic Keyboard Operations.

Specify the vessel number or the place in memory from 1-4 as applicable. Either use the vessel number e.g. 5412 or use the place in memory.

NOTE: The compensation values are not cleared for the deleted vessel.

12.7 CALIBRATION FREQUENCY

Starting with a CLEARED calibration memory, the calorimeter will force you to calibrate the system. If the compensations are destroyed, then it loads the default compensations automatically. The compensations are recalculated once the minimum number of calibrations are stored. Refer to ***Min*** and ***Max*** Calibration settings

Theoretical you can run a sample after one calibration, but it is advisable to perform more than ***MIN CALIBRATION*** to trigger the AI process. Refer to Calibration Management.

Never calibrate the vessel with the first sample of the day!

The unit is already shipped calibrated and is ready to run out the box. These calibrations should be valid for up to 2 weeks; But you should use this time to get familiar with the function and operation of the machine and sample preparation before attempting a calibration.

When should you calibrate? It is important to first establish a routine in running samples, to know how many samples you need to run per hour per shift. In basic terms your calibration needs to reflect your operation cycle.

It does not matter how you use your calorimeter, from either 1 sample per day to 8 samples per hour. We recommend that you find what works for your laboratory and production requirements and stick to it. By using the calorimeter system constantly, the same way each time will greatly increase repeatability and accuracy.

Once you have mastered the preparation then try a calibration at different times of the day and whenever the environment changes. Try calibrating the vessel as close to your normal operating process for optimal results.

The actual calibration frequency depends on the laboratory requirements. It can vary from every hour to once a week. Refer to ***CALIBRATION MANAGEMENT*** for details.

13 SPIKING

Spiking refers to a method where a known substance is used together with the unknown sample to improve the burning process to provide an accurate result of the unknown sample. On some occasions, the use of a Gelatine Capsule (3K-4-068) 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 spiking material in question. If Benzoic Acid is used as a spike, then the value is already set as a default value. The spike value can be adjusted with command ***SPIKE VALUE***, refer to *Basic Keyboard Operations*.
The spiking method is called for when a sample:

- Has a very low CV.
- Burns reluctantly.
- Fine powdery substances (rapid burning).
- Evaporates.
- Has a high moisture content.

A spike material is added to the sample to help the process. This material is the spike.

The 'Spike' must be of a known calorific value, usually benzoic acid of approx. 26.454MJ/Kg. On some occasions a Gelatine Capsule (3k-4-068) or Crucible Cover Disc (CAL2K-FLDS) needs to be used as a Spike.

A Gelatine Capsule as a Spike is used when burning:

- Fine powdery substances, which 'splatter' easily
- High moisture content
- Burns reluctantly

A crucible cover disk as a Spike is used when burning:

- Volatile samples (fuels)

A Benzoic Acid tablet as a Spike is used when burning:

- High moisture content
- Burns reluctantly
- Has a very low CV

When using these items, you will first need to determine the energy value of the Spike and adjust the value if necessary with the command ***SPIKE VALUE***, also refer to *Basic Keyboard Operations*

Since the vessel is calibrated with a BA tablet, there is an approximate 10℃ temperature rise in the vessel temperature. Be mindful that the addition of the spike material and the unknown sample could result in a high vessel temperature rise. Refer to Temperature Rise for more information in this regard.

13.1 SPIKE VALUE

The following method is the traditional method. Later a 'EASY CAPSULE' spiking method is explained.

If BA Tablet is used, then the calorific value is already known; but if another spike material is used (e.g. gelatine capsule, cover disc), You would need to determine the calorific value. This is done by running a CV of the spike material as a sample in the calorimeter to determine its calorific value. Once the value has been obtained the spike value is entered in the specified unit of measure.

Command ***SPIKE VALUE*** , also refer to Basic Keyboard Operations

The Spike Value is the CV of the spike material.

13.2 SPIKE MASS

This is the mass of the substance to be used for spiking. The procedure to follow is;

- 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. The shortcut key is '**F4**'.
- **Tare the balance again**.
- Add the sample mass.
- Capture the sample mass either via the balance cable '**F5**', or '**F1**' and enter manually. Refer to Mass Entry of Sample Mass for details.

The command ***SPIKE MASS*** is used to adjust the value for the spike material, also refer to Basic Keyboard Operations

This is the spike mass. If the spike mass value is >0 then spiking is assumed, and the result will be reduced by:
Spike mass x Spike value.

NOTE: The spike mass is cleared after a determination. A 'ZERO' spike mass disables the spiking process.

13.3 STEP BY STEP ENTERING THE SPIKE MASS (BA SPIKING)

- Place the crucible on the Balance.
- Press "Tare" to clear the weight of the crucible and to read 0.0000g
- Place one Benzoic Acid tablet (as a spike) and **note** the Mass = Spike Mass
- Enter the Spike mass by "Spike Mass" or '**F4**' enter.
- "Tare" the balance!
- Add the unknown sample to the crucible!
- Capture the sample mass electronically '**F5**' or manual '**F1**'
- Place the prepared crucible (benzoic acid tablet with sample) inside the Vessel with firing cotton and close the Vessel.
- If you have a ***CAL3K-AP***: Place the prepared vessel into the machines well. All other units: fill the vessel in the filling station with oxygen and then place it into the well of the machine.
- *Optional*: Enter the SID, e.g. 001
- Close the Lid of the Calorimeter when asked to do so.
- The CAL3K Calorimeter will now perform some standard checks and if all is good, it will begin with the "Initial", "Fire" and then the "Main" phase. Once completed the machine shall open the lid (**A**, **AP** and **F**,**FS**) or audibly indicate that it has finished (**S** and **ST**).
- The calorimeter will automatically take the result, minus the spike energy and present the calorific result of your sample.

13.4 EASY CAPSULE SPIKING

NOTE: The Spike Mass must be zero for Easy Spiking to work!

EASY SPIKING: It uses a gelatine capsule and assumes that all capsules have the same mass and consistency. The temperature rise of the capsule is deducted from the total temperature rise. This method is reasonably accurate and very convenient if used with samples of 12-degree Celsius rise or more. You need to know the temperature rise of a capsule or you can use the default:

Command ***CAPSULE RISE C***, also refer to Basic Keyboard Operations

The temperature rise caused by a gelatine capsule is entered here (Default=1.44C). This entry is associated with the DDS capsule (3K-4-068) where the Manufacturer, weight, size is constant. **IF** different capsules are used, please Refer to; **HOW TO MEASURE THE GELATIN CAPSULE RISE**.

Of course, you can determine the average CV of let say 10 capsules. The ***Temperature Rise*** of each determination must be read out via the calorimeter display ***READ RISE VESSEL*** and then averaged and entered via ***CAPSULE RISE***.

The **EASY SPIKING** is enabled via the command ***SET CAPSULE EN***, (also refer to Basic Keyboard Operations) A YES/NO entry enables/disables the use of gelatine capsule temperature deduction.

NOTE: The '***SET CAPSULE EN***' enable setting is retained after each sample. If a sample without a capsule is burned then the capsule compensation must be disabled (***SET CAPSULE EN*** = NO).

The capsule enable setting is ignored during a calibration.

In the '*EASY SPIKE*' method the ***CAPSULE RISE C*** value is deducted from the measured temperature rise (Sample + Capsule) before the result is calculated.

The operation is very easy:

1. Enable the easy spike process (***SET CAPSULE EN***, YES)
2. Tare the empty crucible with the empty capsule.
3. Put the sample into the capsule.
4. Weigh the filled capsule and capture the sample mass electronically '**F5**' or manual '**F1**'
5. Prepare the vessel, fill with oxygen
6. Run the sample in the calorimeter.

The EASY SPIKE method assumes that the capsule mass is constant. But in routine testing a deviation of ±0.0011g was measured. This deviation is significant at lower sample temperature rise but is acceptable when the sample temperature rise is 12 Degrees Celsius (12℃) or higher.

13.4.1 CAPSULE DETAILS

The gelatine capsules (DDS part number 3K-4-068) are not as consistent as assumed. Here are 10 weights of the capsules:

0.1177	
0.1175	
0.1162	1% low from average
0.1171	
0.1174	
0.1187	1.1% high from average
0.1168	

0.1174
0.1178
0.1178
Average: 0.1174g

The ~±1% in inconsistent weight relates to ±1% of temperature deviation. The temperature rise caused by the capsule was measured as an average ~1.44℃. Therefore, the temperature deviation caused by the inconsistent weight is ±1% of 1.44℃=±0.0144℃.

This deviation is influencing the total (capsule + sample) temperature rise. If the rise is 6℃ then the error

Is 0.24%, which may be too high. The error is 0.1% for a 14.4℃ total rise, which may be acceptable.

14 CORRECTIONS

The corrections are applied values that affect the result, or a combustion value was added during the combustion process, like firing cotton.

14.1 COTTON CORRECTION

Some energy is added to the burning process because of the following:

Firing energy
Wire oxidation
Electronic heating
Cotton thread

Command ***COTTON+WIRE CORR*** is used to adjust this value, also refer to Basic Keyboard Operations

This is the cotton and wire correction. The cotton has a definable energy and the electrical current which heats the firing wire has a constant energy content. Both these (and others which produce an offset) are combined in this entry. The default value is 0.0418℃. The entry is in Celsius.

NOTE: This correction is ALWAYS applied to samples and calibrations alike.

If the cotton length or firing wire size are changed then the value should be re-adjusted to suit.

The 'Cotton Correction' is constant. It is therefore treated as temperature rise compensation. The cotton correction is subtracted from the raw temperature rise to yield the NETT RISE. Use the ***READ RISE VESSEL*** to read the temperature rise of the firing wire and cotton thread.

14.2 SULPHUR CORRECTION

If the sample contains sulphur, then energy is released during the formation of SO2 from oxygen and sulphur. This energy is deducted from the net CV. The sulphur content of the sample must be measured before and the CV (KJ/g) of SO2 formation must be entered:

Command ***SULPHUR CORRECT*** is used to adjust this value, also refer to Basic Keyboard Operations

The sulphur correction deducts energy which is released by the formation of SO2. The entry is in KJ/g. The default setting is zero.

NOTE: The Sulphur correction is NOT applied during calibration.

14.3 MOISTURE CORRECTION

If a sample has a moisture content, then the NETT result can be compensated for. The moisture entry is in percent.

Command ***MOISTURE PERCENT*** is used to adjust this value, also refer to Basic Keyboard Operations

This entry is important when the moisture content of a sample is known, and the NETT calorific value must be calculated. The calorimeter calculates the nett mass and displays the nett calorific value.
The default setting is ZERO=Disabled.

The moisture content reduces the mass to a nett mass and increases the CV.

14.4 GELATINE CAPSULE CORRECTION

A gelatine capsule can be used in two different spiking methods:

1. Normal spiking: Requires capsule mass and capsule CV. Refer to **SPIKING**
2. Easy spiking: Requires capsule temperature rise. Refer to **EASY CAPSULE SPIKING**

14.5 FOOD COMPENSATION

Food is consumed by a body through quite a complex process, involving time, enzymes, and a lot more. The laboratory procedure is a 'wet' process, and nothing is burned. Because it is a complex process to repeat in a laboratory and it takes time (days) it is seldom used. Instead, a 'BOMB CALORIMETER' is used to determine the calorific value.

The calorimeter has a lot of advantages, **BUT** it requires some special considerations. This is best explained by analysing sawdust: It burns nicely and produces energy but consuming it yields no benefit and probably makes one sick.

However, a calorimeter is a nice, fast, and convenient tool to determine the digestible calories.

Food is measured in CALORIES or KJ. The **ATWATER** specification reads:

Protein	4Kcal	16.736KJ
Carbohydrates	4Kcal	16.736KJ
Fat	9Kcal	37.656KJ
Alcohol	7Kcal	29.288KJ
Fibre	4Kcal	16.736KJ

The last item (Fibre) is a factor in the calorimeter that we need to compensate for:

To compensate for fibres:

Use the command ***FIBRE CV VALUE*** to change the value to be compensated with, also refer to Basic Keyboard Operations

The fibre CV value is entered in the unit of measurement specified by the command ***UNIT: KJ, KCA,KBU*** to view and change the unit of measure;

The actual percentage of fibres is entered by:

The command ***FIBRE IN FOOD %*** is used to adjust a percentage value the machine uses in the compensation.

Entering a fibre percentage REDUCES the calorific value of the result.

NOTE: The 'FIBRE IN FOOD' entry is retained. But not used during calibration or BA checks.

15 FIRING

The CAL3K automatically fires the sample by sending a very high current through the firing wire, which glows yellow hot and ignites the cotton, which in turn ignites the sample. The amount of voltage to send through the wire can be programmed using the ***FIRING VOLTAGE*** command, also refer to Basic Keyboard Operations**.**

The firing voltage is default set at 25.0 volts. The setting depends on the sample and the oxygen pressure; however, the setting will suffice for 97% of all operations.

The firing voltage must be decreased if the "semi-permanent" firing wire melts too often. You should get 20 to 50 firings out of the wire depending on how corrosive the sample is.

The firing voltage should also decrease in instances where the burning process is extremely rapid. By reducing the firing voltage, the burning speed is also reduced.

The actual firing voltage is produced by a charged circuit, which takes about 2 to 3 minutes to charge. The charged voltage can be monitored by entering the command ***READ FIRING VOLT***, the voltage will then be displayed on the screen. (Also refer to Basic Keyboard Operations**.**) Press the ***ESC*** key to end the firing voltage display. The firing takes place automatically after the INITIAL cycle.
The sample can be fired manually:

15.1 FIRE MANUALLY

NOTE: This command (***FIRE MANUAL***) is for testing the calorimeter and triggers the firing circuit. This is password protected and is not recommended for normal operation!

FIRE MANUAL command is used to bypass the initial cycle, in which the wait time is bypassed, and the firing charge is ignited. It is useful in testing the firing/ignition procedure. It is not recommended for use during normal operation, as this will affect the accuracy of your sample! This can also be used to "warm up" the vessel and machine

before a calibration; Or a sample is run for the first time during the day or after a long rest period (Note: that this will not produce any accurate results).

Also refer to Preparing Vessels, Basic Keyboard Operations.

16 MISS FIRE

When the DDS Calorimeter machine runs a measurement, and the sample is not ignited/fired; This is classified as a "MISS FIRE".

The MISS FIRE may have accord for many reasons:

1. Technical: There is no or not enough current flowing through the firing wire
2. Bad preparation: No oxygen, no cotton, or the cotton thread does not touch the sample.
3. Bad Sample: It is difficult to ignite/combust! or there is no sample!

The CAL3K informs the operator of a miss fire condition and terminates the MAIN cycle if the temperature rise is not above the default 0.44℃ ***Miss Fire Limit***. The result is marked accordingly.

The ***MISS FIRE LIMIT*** command is used to adjust the temperature rise needed to be exceeded before registering a misfire. The '***MISS FIRE LIMIT***' can also be disabled by entering ZERO value. Also refer to Basic Keyboard Operations**.**

M310 MISS FIRE: TEMPERATURE RISE: xx.xxxx

This error comes up 30 seconds after firing when the temperature rise is below the set limit. The actual temperature rise of the vessel is indicated as xx.xxxx. The best way to determine what was the cause is to open the vessel and check the content.

A) The sample has burned, but the temperature rise is lower than the limit. The temperature rise is indicated as xx.xxxx. Two possible ways to solve this:

   A1) Increase the sample mass.
   A2) Decrease the '***LOW RISE LIMIT***'

B) The sample has not burned, and Cotton thread is visible but burned off the firing wire: No oxygen.

C) Cotton thread is burned (gone!), but sample is not: The cotton didn't ignite the sample.

   C1) It could be that the oxygen filling process is too fast, or during bomb handling a bump has moved the sample material away from the cotton thread.
   C2) The sample doesn't ignite easily. If the sample is moist then try drying it. Otherwise use the spiking method: The cotton ignites the spike material and this in turn ignites the sample.
   C3) the cotton thread/sample material has been blown away or off during the oxygen filling process.

Following is a list of other useful commands when one of the above errors was indicated:

Command	Action
F11	Display the last error message first. Press F11 for next, 'Enter' for full explanations
PRT EVENT HISTORY	Print on D1 Port the complete event errors, limited to the last 32 events
LOW RISE LIMIT	Set the low-rise limit
READ LAST N_RISE	Display the last NETT temperature rise
READ HELP TEXT	Enter 'M' number and display the explanations
READ FIRING VOLT	Display the firing voltage unit 'Esc'
CLEAR RESULTS	Enter "HELP" instead of 'YES' and the help event store is cleared
FIRE MANUAL	Needs vessel and lid closed. Useful for testing the firing circuit. **DO NOT USE DURING OPERATION.**
READ EVENT RECRD	Stepping through the event records, starting at the last one.

17 LIMITS

Limits can be applied to warn the operator of possible bad operations. If a limit is violated the result is flagged accordingly. By using one of these LIMIT commands you can adjust the values in which the warning shall appear.

Command ***HIGH AMBIENT LIM***, also refer to Basic Keyboard Operations

The unit measures the Ambient temperature, which has an influence on the result and the operation. The influence is mitigated by calibrating the unit at relatively high ambient temperatures. However, this limit can be set up to warn the operator. The default setting is 36C. A zero entry switches the limit off.

Command ***LOW AMBIENT LIM*** , also refer to Basic Keyboard Operations

The ambient temperature affects the unit's operation and result. However, this limit can be set up to warn the operator. The resulting influence can be eliminated by calibrating the unit at low ambient temperatures. The default setting is 8℃. The lowest possible temperature measurement is 2℃. A zero entry switches the limit off.

Command ***HIGH RISE LIMIT*** , also refer to Basic Keyboard Operations

The result is affected by the temperature rise after firing. This effect is minimised by calibrating the unit for high rise (e.g., 0.75g Benzoic Acid). However, the sample mass should be adjusted so that the temperature rise is near to the optimal 12℃ ±2℃ of a Benzoic Acid calibration. A limit can be set up to warn the operator that the temperature rise was too high. The default setting is 16℃. A zero entry switches the limit off.

Command ***LOW RISE LIMIT*** , also refer to Basic Keyboard Operations

The temperature rise after firing should be 12℃±2℃. This can be managed by adjusting the sample mass. A limit can be set up to warn the operator that the temperature rise was too low. The default setting is approx. 8℃. A lower rise can be achieved by calibrating the unit to an 8℃±2℃. A zero entry switches the limit checking off.

Command ***MAX MASS LIMIT*** , also refer to Basic Keyboard Operations

This limit applies to all sample mass entries. Exceeding this limit prevents a mass from entry. The default limit is 1.5g. Entries above 1.6g are prohibited.

Command ***MIN MASS LIMIT*** , also refer to Basic Keyboard Operations

This limit applies to all sample mass entries. An entry below this limit will be rejected, the default is 0.2g.
Entries below 0.05g are not allowed.

Command ***MISSFIRE LIMIT*** , also refer to Basic Keyboard Operations

If the sample is not igniting, then it is called a miss fire. The unit checks the temperature rise 30 seconds after firing, and if the rise is below the limit a miss fire is declared and the process is terminated. The default value is ~0.44℃. The MISS FIRE limit checking can be disabled by entering zero.

18 TIME AND DATE

The calorimeter units have a date and time circuit which keeps the time. The data and time are attached to every calibration, result, and event. The following command sets the time and date:

Command ***TIMESET HH:MM:SS*** , also refer to Basic Keyboard Operations

This command sets the time in HH:MM:SS. The internal clock runs for about 1 week without power and then the time (and date) must be set. The time can also be used as ***Sample Identification*** (SID).

Command ***DATESET YY:MM:DD*** , also refer to Basic Keyboard Operations

This sets the date of the CAL3K internal real time clock. Note that the clock remains active for up to a week without power. The entry is the form: YY/MM/DD

The date can be used as a ***Group Identification*** (GID).

Command ***DATE IS GID*** , also refer to Basic Keyboard Operations

This YES/NO entry allows for replacing the GID with the DATE in the form YY/MM/DD. The GID (***Group Identification***) is attached to every sample recording. Note that the first 8 characters of the GID are left blank.

The time can be used as a Sample Identification (SID). When this feature is enabled then the auto-increment of the SID is disabled.

Command ***TIME IS SID*** , also refer to Basic Keyboard Operations

The Sample Identification (SID) is normally a 16-character text string. Note that the first 8 characters of the SID are left blank. It can be replaced with the time in HH:MM:SS by entering 'YES'.

19 CAL3K-AP PRESSURE COMMANDS

This section applies to the ***CAL3K-AP ONLY*** which has automatic oxygen filling. It performs the following:

1. It fills the vessel from the connected oxygen supply.
2. It monitors the filling process to the specified pressure.
3. It monitors the pressure during the initial period.
4. It monitors the pressure during the main period.
5. It records all pressure variables.
6. It deflates the vessel.
7. It optionally flushes the vessel to remove harmful gases.

The vessel is filled to about 30 Bar (3000KPA) and this pressure is monitored. a pressure transducer device needs a 'zero' adjustment after prolonged use and storage. The adjustment must be done with the lid open.

Command ***PRESS ZERO ADJST*** , also refer to Basic Keyboard Operations

The pressure is measured with a transducer which has a zero offset of ±1 Bar. This error can be eliminated by using this command. The offset can be checked when the lid is open and the '***READ PRESSURE***', should read ZERO. ±0.2 Bar. If not, use the '***PRESS ZERO ADJ***' to set it to zero.

Command ***READ PRESSURE*** is used to display the pressure, also refer to Basic Keyboard Operations

READ PRESSURE is used to display the actual vessel pressure. You can clear the displayed values with '**ESC'**.

The filling is done up to the filling target pressure (***PRESS FILL TARGET***). During the filling, oxygen flows through a filter and restrictor to slow the filling down. The actual vessel pressure may be a little lower than the target pressure as a combination of the vessel lid flow restrictions and the fill restrictor creates a slight pressure differential.

Command ***PRESS FILL SECND*** , also refer to Basic Keyboard Operations

The filling time is monitored and when it exceeds the set limit, the operator is warned. The reason for slow filling could be: Empty oxygen bottle or blocked inlet filter. The filter (and filling restrictor) is a very unlikely cause for slow filling and the oxygen pressure should be investigated first.

Command ***PRESS FILL TRGET*** , also refer to Basic Keyboard Operations

The filling target is the nominal filling pressure when the filling valve is shut. The actual pressure may be 1 Bar down because of the pressure settling. The target should be 30 Bar. A lower filling pressure is suggested for powdery substances to reduce scattering of sample material.

NOTE: The default is 30 Bar. The entry range is from 0 to 35 Bar.

The filling is monitored and if the pressure slows down to 0.05 Bar per second and the pressure is above the Pressure Fill MIN, the filling process is then terminated. This eliminates any problem with the pressure regulator setting being a fraction lower than the target pressure. However, when the filling pressure doesn't reach the pressure filling minimum value, then the filling process is terminated. The minimum limit can be adjusted by:

Command ***PRESS FILL MIN*** , also refer to Basic Keyboard Operations

The minimum filling pressure specifies the lowest pressure limit at which the unit must fill above to function, this allows for slow filling and near empty oxygen bottles. The default is 20 Bar, which is sufficient for avoiding oxygen starvation at 26KJ/g Samples.

Once the filling operation is complete the unit goes to the INITIAL PERIOD and monitors the pressure. If the pressure drops by more than the '***PRESS FILL LEAK***' value then a warning is displayed. Note that the pressure will drop about 1 Bar depending on the restrictor and the flow constrictions in the lid.

Command ***PRESS FILL LEAK*** , also refer to Basic Keyboard Operations

After filling the vessel with oxygen, the pressure is monitored and if it declines (leaks) by more than the limit a warning is issued. Theoretically the pressure should be constant, but it requires approx. 1 Bar to equalise. The default setting is 2 Bar. The Fill Leak checking can be disabled by entering a zero value with the ***PRESS FILL LEAK*** command.

After the INITIAL CYCLE the sample is ignited, and the MAIN CYCLE starts. Burning the sample causes a very large gas temperature rise and the pressure rise is monitored. The pressure rise depends on the burning speed of the sample. A faster burning material has a higher peak pressure. The peak pressure and time in milliseconds are recorded with the sample. A very high pressure can also be the result of a large sample mass or high energy content. For safety concerns the unit has two pressure limits:

A) A fixed limit of 90 Bar. This limit is always in effect.
B) A variable user setting pressure peak limit: ***PRESS PEAK LIMIT*.**

Command ***PRESS PEAK LIMIT*** , also refer to Basic Keyboard Operations

The pressure peak limit (Default=70 Bar) is the max. pressure allowed shortly after firing when the pressure increases proportional to the burning speed. If the pressure exceeds this limit, the event is recorded, and the operator is warned. At this point the operation of the calorimeter is not affected. The pressure peak checking can be disabled by entering zero value with the ***PRESS PEAK LIMIT*** command.

If the 90-bar fixed limit is exceeded the vessel is deflated to a safe pressure and the MAIN CYCLE is terminated after a short time. The CAL3K-AP records:

- The absolute pressure
- The time from firing
- Peak Temperature

Command ***READ PRESSURE REC*** , also refer to Basic Keyboard Operations

The unit records any vessel pressure excess above the (PRESSURE PEAK LIMIT) and above the absolute maximum of 90 Bar. This command reads the recordings from the memory. Press '**ENTER**' for the next entry and '**ESC**' to terminate reading. The pressure recordings can be cleared by ***CLEAR PRESS RCRD*** and printed by ***PRT PRESS*** commands.

Command ***PRT PRESS RECRD*** , also refer to Basic Keyboard Operations

The pressure violations recorded on the Machine can be printed.

Command ***PRESS DEFLAT.SEC*** , also refer to Basic Keyboard Operations

After the MAIN PERIOD the vessel is deflated. This process is monitored in time.
The deflate time is monitored and if the limit is exceeded a warning is displayed. It could be that the filter or the exhaust valve is blocked. The default setting is 20 seconds. Again, this function can be disabled by entering zero.

Command ***PRESS FLUSH SEC*** , also refer to Basic Keyboard Operations
Once the vessel is deflated it can be (optionally) flushed with oxygen to remove any harmful gases, or at least dilute them.
The flush cycle is time based. A zero entry deactivates the flush cycle, otherwise the vessel is filled for the specified time in seconds and then deflated. Default value is 3 seconds.

SPECIAL: In the ***CAL3K-S/ST*** models this command is used to actuate the FAN for flush (Cooling) before a firing.

If a pressure leak is suspected, then the system can be tested. The complete pressure test is described in the TESTING section.

The test pressure can be set by:

Command ***PRESS LEAK TEST*** , also refer to Basic Keyboard Operations

This command sets the leak test pressure applied during ***SYSTEM LEAK TEST***. The leak test is useful when a leak is suspected. The default value is 25 Bar.

Command ***SYSTEM LEAK TEST*** , also refer to Basic Keyboard Operations

This command initiates the test so that You can inspect for any leaks. The oxygen must be connected, and a vessel must be in the well **without** the lid and cap and then the supplied domed like blocking device (3K-1-115) must be screwed in place of the grey filling head nut(3K-6-018) by hand. Then close the lid. The "mushroom" fits into the vessel.

Enter the command ***SYSTEM LEAK TEST***, then type the word '**YES**' and the CAL3K-AP will pressurise the system to the ***PRESS LEAK TEST*** value. It will then monitor the pressure and display it on the display. During the test one can try to find any leak if the pressure is declining. To end/exit the test press **ESC**.
Reinstall the filling head nut(3K-6-018) again. The filling nut is plastic and must be tightened by hand.
Do not use tools and do not 'cross thread' it.

NOTE: The filling is very fast because the filling volume (no Vessel) is very small.

20 PRINTING AND OUTPUT

The calorimeter has a D1 RS232 port which is its connection to a printer. Some units have a D2 RS232 port and a USB port. These ports are designated as follows:

D1 RS232	PRINTING
D2 RS232	BLUETOOTH, OTHER
USB	PC CAL3K APP

The D1 RS232 port must be set up to match the speed of the connecting port.

Refer to **Connection Setup** for assistance in setting up the Printer Port.

Outputs are designated as:

PRINT	{PRT….)	max 80 column output, readable
DUMP	(DUMP….)	More than 80 column output

20.1 OUTPUT PRINTING TO D1 PORT, KEYBOARD INITIATED

An output appears when one of the PRT… commands are executed. The following commands are suitable for an output to an 80-column printer.

Command ***READ RESULT MEM*** , also refer to Basic Keyboard Operations
This command displays the result in the display. By pressing `**F8'** the result is printed in the selected format A-H.

Command ***PRT RESULT DAY:*** , also refer to Basic Keyboard Operations
Enter the day number 1-31 and all results recorded on this day are printed. The results memory should be cleared every month, ***CLEAR RESULTS***.

Command ***PRT RTIME HEADER*** , also refer to Basic Keyboard Operations
The Real Time output header is printed when any of the real time output formats WXYZ are selected.

Command ***PRT A-H HEADER*** , also refer to Basic Keyboard Operations
This outputs a single text line describing (sort off) the data contents of the A-H output formats.

Here are the **PRT A-H HEADER OUTPUT FORMATS A-H**.

INDEX	FORMAT
A	Time , Smple ID, FAmb, FireTemp, SpikMas, Sulphur,Cotton, Mass ,Result DONE:23/11/01-11:31,Day= 1,Form=A
B	Date , Group ID,Smple ID,Bomb,SpikMas,Mois,Mass ,Result DONE:23/11/01-11:31,Day= 1,Form=B
C	Date ,Time ,Smple ID,Bomb,Result DONE:23/11/01-11:31,Day= 1,Form=C

D	Time ,Stat ,FireTem,FireDrf,FAmb,Slope ,T_Comp ,C_Dati,Cn,Result DONE:23/11/01-11:32,Day= 1,Form=D
E	Time ,Date ,Stat ,FireTem,FireDrf,FAmb,Slope ,Rise ,T_Comp ,Result DONE:23/11/01-11:32,Day= 1,Form=E
F	Time ,Smple ID,FireTem,FAmb,CTime,CFirTmp,CAmb,T_Comp ,CompMax,Result DONE:23/11/01-11:32,Day= 1,Form=F
G	Time ,Temp_C ,Drift_C,Amb_C ,Slope_C,Rise_C ,CompMax,TotComp,Date_C,Result DONE:23/11/01-11:32,Day= 1,Form=G
H	Time ,Mass ,Result ,FAmb,FireTemp,FireDrift ,EndSlope ,NRise ,FStabel DONE:23/11/01-11:32,Day= 1,Form=H

Command ***PRT TODAY FORM*** , also refer to Basic Keyboard Operations
Enter an output format A-H and all results for today are printed.

Command ***PRT CALORI INFO*** , also refer to Basic Keyboard Operations
The command prints the relevant CAL3K information, including parameters and customer settings. This printout is also included in the shipment.

Command ***PRT VESSEL INFO*** , also refer to Basic Keyboard Operations
This command prints the vessel information. The vessel must be in the well. The printout is also included in the shipment.

Command ***PRT MEM RSLT CR*** , also refer to Basic Keyboard Operations
Enter C/R/YES to print data from memory:

C Calibrations only
R Results only
YES Results and calibrations

Command ***SET OUTFORM A-H:*** , also refer to Basic Keyboard Operations
This command specifies one of the eight output formats A-H. The outputs can be disabled by specifying anything but letters A-H.

The formats are not set in stone, so it is best to print the HEADER of all formats. The text descriptions give you an idea of what the number columns(data) are.

Command ***PRT RESULT GID:*** , also refer to Basic Keyboard Operations
Each result in memory has a GID (Group Identification) of up to 16 characters. The GID can be an entered text(GROUP IDENTIFIER command) or the date(DATE IS GID command). Enter the GID (Up to 16 characters) and results stored with this GID are printed.

Command ***PRT CV'S VESSEL:*** , also refer to Basic Keyboard Operations
The entry is a 4-character vessel serial number, found on the vessel lid. The complete result memory is searched for this serial number and all the results pertained to the vessel are printed.

Command ***PRT RESLTS FORM:*** , also refer to Basic Keyboard Operations

Enter the output format A-H and all results in the memory are printed in the specified A-H format.

Command ***PRT MAX DATA*** , also refer to Basic Keyboard Operations
The accumulated maximum data are printed.

Command ***PRT KEY CMD LIST*** , also refer to Basic Keyboard Operations
The keyboard command list is printed for the present password priority. Enter the password to print the FULL list.

Command ***PRT EVENT HISTORY*** , also refer to Basic Keyboard Operations
The calorimeter records all major operational or setup faults. This command prints all recorded events. After 64 events the unit overwrites the oldest one. The printout consists of:

Message Number Mxxx (M Number)
Date and Time
Short display text

Command ***PRT COMPENS+MAX*** , also refer to Basic Keyboard Operations
During calibration the unit calculates the compensations applicable to the vessel and mode. This command prints the compensations and associated max limits.

Command ***SET FILTER C,F:*** , also refer to Basic Keyboard Operations
A filter can be applied to exclude items from the print output.

C Calibrations only
F Faults only
Blank All, no exclusions

The CAL3K_AP can supply the following information:

Command ***PRT PRESS. RECRD*** , also refer to Basic Keyboard Operations
An CAL3K-AP command. This command prints all (Max 16) pressure recordings which are caused by either:

Exceeding the PRESS PEAK LIMIT
Exceeding the internal max pressure setting 90 Bar

The pressure recordings can be reset by ***CLEAR PRESS RCRD***. The records can be read out on the display with the READ PRESS command.

The internal initiated (spontaneous) printing happens from two sources:

A) When a result is available and:

Command ***SET OUTFORM A-H*** , also refer to Basic Keyboard Operations
Command ***SET RESULT ENABL*** , also refer to Basic Keyboard Operations

B) When the REAL TIME output is specified.

Command ***SET RT FORM WXYZ*** , also refer to Basic Keyboard Operations
This command enables and sets the REAL TIME output format to WXYZ. Selecting anything but WXYZ disables the real time output. The WXYZ format can be tested by printing the header with the ***PRT RTIME HEADER*** command.

Command ***SET RTHEAD EN CP*** , also refer to Basic Keyboard Operations
The REAL TIME output (from 30 seconds before firing) can be preceded by Customer (C) and Parameters (P). If none is desired enter anything but CP.

The header can be printed with

Command ***PRT RTIME HEADER*** , also refer to Basic Keyboard Operations

The calorimeter has a REAL TIME (RT) printout facility. It must be enabled by selecting one of the 4 output formats WXYZ, by using the ***SET RT FORM*** command. Then the header (Data descriptor) is printed. If the ***SET RTHEAD EN*** CP, has a selection (C=Customer, P=Parameter) then this info is printed as well.

20.2 OUTPUT, NON-PRINTABLE (DUMPS)B

These commands cause a string of information, which requires a PC to capture. Use the DDS REMOTE or Tera Term software to capture the large print data.

Command ***DUMP ALL RESULTS*** , also refer to Basic Keyboard Operations

All results from memory are printed to the D1 port. The output is in the N format with about 300 characters per line.

Command ***DUMP RSLT VESSEL*** , also refer to Basic Keyboard Operations

Specify a vessel serial number and all results for this vessel are dumped to the selected port.

20.3 OUTPUT, EXTERNAL INITIATED

In principle the external PC must send a request for data to the calorimeter, and the unit replies with the requested data. This requires that a Software App runs on the PC; it could be:

A) The DDS CAL3K Windows Software App (Supplied)
B) The DDS REMOTE software App (Supplied)

A PC with the DDS Software App can be connected via:

1) RS232 cable
2) USB cable
3) BLUETOOTH BRIDGE
4) RS232 to USB bridge cable

20.4 PRINTING REAL TIME

It refers to a data print output while the determination is in progress. The data is gathered every 6 seconds and then output to the D1 Port. The real time (RT) printing is for customers who like to compute their own results like universities. It reveals the data the unit accumulates without any adjustments or compensations.

Select/enable a real time output by:

Command ***SET RT FORM WXYZ***, also refer to Basic Keyboard Operations

Enter one of the letters (WXYZ) to enable an output format or any other letter to disable real time printing.

Optional select a customer (C) and/or Parameter (P) header.

Command ***SET RTHEAD EN CP*** , also refer to Basic Keyboard Operations

The letter ‘C’ enables the printing of the customer header information and the letter ‘P’ the printing of the relevant parameters before the real time printing starts 30 seconds before firing.

Optional disable result printing:

Command ***SET RESULT ENABL*** , also refer to Basic Keyboard Operations

Enter 'NO'. This switches the result printing off.

To see a preliminary output, you can trigger this by:

Command ***PRINT RT HEADER*** , also refer to Basic Keyboard Operations

This prints the header; the data will appear during a determination. You may like to try the other Real Time output formats: WXYZ by using the ***SET RT FORM*** command

21 LIMS

Laboratory **I**nformation **M**anagement **S**ystems (**LIMS**) are used to organise and manage data flow from sample reception to tracking to obtaining a traceable result. It's as big as you make it and need it. The calorimeter is only a small data contributor in the overall **LIMS** database; But it is vital.

The CAL3K is ideally suited for **LIMS** implementation. There are two possible ways to implement **LIMS**:

21.1 AUTOMATIC DATA CAPTURE

This system requires optional hardware and software to operate. Contact your **LIMS** supplier for details. We, as the manufacturer of the calorimeter, can possibly help you with the software because we have done it already. The CAL3K calorimeter units all have one communication port (RS232, D1) for this purpose. The data capturing operation would be 'invisible' to the operator unless a message is sent from **LIMS** to the CAL3K to remind/request a sample determination or repeat.

The **LIMS** system would then capture the result data with proper identification, let's say every hour and insert the data into the **LIMS** database for further processing.

Very convenient! Rather expensive!
Contact the manufacturer for more details.

21.2 MANUAL DATA CAPTURE

This is the most implemented **LIMS** procedure.
A printer is attached to the CAL3K and the results together with proper identification are printed. Then the printed data is manually captured in the **LIMS** system.
The calorimeter printout can be done spontaneously when the result is available or on operator demand.
For details on printing:

Choose an output format A-H with:
Command ***SET OUTFORM A-H:*** , also refer to Basic Keyboard Operations

Then use any of the print commands from: **OUTPUT PRINTING TO D1 PORT**

21.3 LIMS BARCODE READING

A barcode reader can be connected to the keyboard. Up to 16 characters Sample Identification (SID) and 16 characters Group Identification (GID) can be read from barcode labels.

21.4 OUTPUT TO A SPREADSHEET

An output to a spreadsheet can be facilitated in a round-about fashion by an App running on the PC. The App facilitates the capture of the data and designating a place and file name for the data to go to. Suitable Apps are 'Terra-Term' or the Remote3K Software which capture the port data. Then the selected data can be transferred to the 'NOTEPAD' and a file name can be assigned to it. Note that the file extension should be '.CSV'.

21.4.1 TERMINAL EMULATOR (RS232)

This is an open-source App which is freely available from the NET such as TERA-TERM VT. Start the App and configure the baud rate to 19200 or the same as the D1 port.
Then type a print command on the CAL3K keyboard and the data appears on the PC App screen. Select all the data, open NOTEPAD and paste the data into Notepad. Then save the data to a file as NAME.CSV. A spreadsheet understands this format. Note that all calorimeter outputs are available, excluding PC triggered outputs.

21.4.2 DDS REMOTE APP

This App is included in the shipment and can be downloaded from https://ddscalorimeters.com/software/Remote3K/). Its prime function is the remote operation of a calorimeter unit. But it can be used to:

A) Capture the keyboard-initiated output.
B) Trigger the keyboard command which causes the output.
C) Capture Print data.
D) Remotely operate the calorimeter.

To use this App for data collection you need to connect a PC with the CAL3K. Refer to **Connecting for remote operation**. Then select a port and **START REMOTE SOFTWARE**. The connected calorimeter display should be visible on the PC.

A data output (printable 80 column or a dump) can be triggered from the calorimeter or the PC Keyboard.

For detail on output commands see:

OUTPUT PRINTING TO D1 PORT, KEYBOARD INITIATED
OUTPUT, NON-PRINTABLE (DUMPS)

Choose any of the commands (e.g. DUMP ALL RESULTS).

- This will cause a visible PC 'Printer Output' entry.
- Press the 'PRINT' button to send it to a local printer
- Press 'Copy All' to select the data for pasting to a spreadsheet.
- Press 'Open in Notepad' to save the data to a file. Open 'NOTEPAD' and you will see the data. Then 'File' and save the data to a destination and a NAME.CSV.

21.4.3 DDS CAL3K SOFTWARE APP

This App is included in the shipment. Configure it to the USB or RS232 port speed and it will connect to the CAL3K. It uses special commands to request outputs from the calorimeter. This allows you to upload:

Short version results (Format N, Normal)
Long Version results (Format U)

22 READING

This section contains all reading and display operations. Reading refers to retrieving information and displaying it on the LCD display.

Command ***READ CHA.FIRINGS*** , also refer to Basic Keyboard Operations
The number of firings in this chassis are displayed.

Command ***READ RISE VESSEL*** , also refer to Basic Keyboard Operations
The temperature rise of the vessel is displayed.

Command ***READ TEMP VESSEL*** , also refer to Basic Keyboard Operations
The vessel temperature is displayed until '**ESC**' is pressed.

Command ***READ DRIFT*** , also refer to Basic Keyboard Operations
The drift (Temperature difference per 6 seconds) is displayed until '**ESC**' is pressed.

Command ***READ CARD ID*** , also refer to Basic Keyboard Operations
The card identification is displayed. The Card ID is used by the factory.

Command ***READ MAX VESSEL*** , also refer to Basic Keyboard Operations
The vessel maximum data is displayed. The vessel must be in the well of the machine.

Command ***READ CAL3K MAX*** , also refer to Basic Keyboard Operations
The CAL3K maximum data is displayed (starts, temp, ambient) You will have to enter the password to view this information.

Command ***READ VESSEL INFO*** , also refer to Basic Keyboard Operations
The information of the inserted vessel is displayed (programmed date, serial number, firmware version, firings).

Command ***READ AMB TEMP.*** , also refer to Basic Keyboard Operations
This displays the present ambient temperature until '**ESC**' is pressed.

Command ***READ MEM RESULT*** , also refer to Basic Keyboard Operations
This command reads the CV results from the Machine's memory and displays them, starting with the last one first. Press '**ENTER**' to display the next result. The result in the display can be printed by pressing '**F8'**.

Command ***READ FIRING VOLT*** , also refer to Basic Keyboard Operations
The actual firing voltage is displayed until '**ESC'** is pressed.

Command ***READ RESULT DAY:*** , also refer to Basic Keyboard Operations
This command displays the number of results for an entered day number 1-31.

Command ***READ STABILITY*** , also refer to Basic Keyboard Operations
The vessel stability (2^{nd} derivative of temperature) can be displayed until '**ESC**' is pressed.

Command ***READ ATC TEMP.*** , also refer to Basic Keyboard Operations
Only applicable to ***CAL3K-A/AP***.
The ATC temperatures (Bottom and Top) are displayed until '**ESC**' is pressed.

Command ***READ LAST N_ RISE*** , also refer to Basic Keyboard Operations
The last Nett Temperature rise is displayed until '**ESC**' is pressed..

Command ***READ VESS.FIRING*** , also refer to Basic Keyboard Operations
The number of firings of the inserted vessel are displayed.

Command ***READ PRESSURE*** , also refer to Basic Keyboard Operations
The actual vessel pressure is displayed until '**ESC**' is pressed. This applies to the ***CAL3K_AP*** only.

Command ***READ BOMB CALI*** , also refer to Basic Keyboard Operations
The number of calibrations (Max=15) per vessel are displayed until '**ESC**' is pressed.

23 CLEARING

It is possible that the **CAL3K** memory becomes full because too many entries are filling up the effective storage. The units store from approx. 400 to 800 results. It is advisable to clear the result memory after a week or when more than 100-200 results are accumulated.

23.1 CLEAR RESULT MEMORY

Command ***CLEAR RESULTS*** , also refer to Basic Keyboard Operations
This command clears all results. Enter '**YES**' to clear the result memory or '**ESC**' to cancel.

23.2 CLEAR EVENT LOG

The unit keeps 32 events. These are recordings of severe operational faults. Recorded is the Date and time and the actual M number messages and errors 'Mxxx'.
Refer to ***Understanding events***

To view the events, use
Command ***PRT EVENT HISTORY*** , also refer to Basic Keyboard Operations

To clear the events, use
Command ***CLEAR RESULTS*** , also refer to Basic Keyboard Operations

The '**EVENT LOG**' recordings can be cleared by the '***CLEAR RESULTS***' command by entering the letters '**EVENT**' instead of the '**YES**'.

23.3 CLEAR VESSEL CAL HISTORY

Command ***CLEAR B_CAL S/N*** , also refer to Basic Keyboard Operations

This command CLEARS all calibrations for the specified vessel Serial Number (e.g. *CLEAR B_CAL 5401*) and the present mode. The vessel must be removed from the **CAL3K** Machine. The record deletion is permanent! This command should be used when memory space is needed for a new vessel. Command ***READ BOMB CALI*** displays all calibrations of calibrated vessel serial numbers on the Machine. Once a vessel calibration is cleared it must be re-calibrated, See ***CALIBRATION***.

23.4 CLEAR CAL3K MAXIMUM

Command ***CLEAR CAL3K MAX*** , also refer to Basic Keyboard Operations

This command clears the CAL3K maximum recordings. The recordings consist of:
Maximum Start Temperature and date and time it happened.
Maximum Vessel Temperature and date and time.
Maximum Ambient temperature and Date and Time.
Max Vessel pressure and date and time (***For CAL3K-AP only***)

Note that the CAL3K Maximums can be printed with the command ***PRT MAX DATA***, also refer to Basic Keyboard Operations

23.5 CLEAR VESSEL MAXIMUM

Command ***CLEAR VESSEL MAX*** , also refer to Basic Keyboard Operations

The maximum recordings in the vessel consist of:

- Maximum Temperature
- Firing count at max Temperature
- Date and time of max Temperature

The vessel must be inserted for the clearing.
This command only clears the data on the bomb present in the machine and should be repeated with each vessel.

23.6 CLEAR PRESSURE RECORD (CAL3K-AP)

Command ***CLEAR PRESS RCRD*** , also refer to Basic Keyboard Operations

This command clears the pressure recordings in the ***CAL3K-AP***. The unit keeps 16 records of:

- Date and Time
- Mass
- Temperature Rise
- Pressure
- Peak pressure time (Milliseconds)

The machine can only store 16 entries and when a new record is stored, the oldest entry will be overwritten.

NOTE: that the pressure recordings are triggered by exceeding the ***PRESSURE PEAK LIMIT***.

23.7 CLEAR MASS

Refer to ***MASS ERASING***

This is used when an entered mass for a sample is wrong, entered incorrectly or is just not needed anymore. Command Enter (**MASS** then '**ENTER**', '**DELETE**' button)

24 BLUETOOTH

The BLUETOOTH operation requires optional hardware. These BLUETOOTH devices are used to connect a PC to the CAL3K. A good reason to use the extra hardware is:

A) The USB cable is too short for a computer connection.
B) The PC has no RS232 port.
C) It is too difficult to run a RS232 cable from the CAL3K to the PC.

The BLUETOOTH uses wireless communication between the CAL3K (with a RS232 port) and the PC (with a USB port) and has a typical range of 20 metres (*device dependent*).

The BLUETOOTH communication speed is 115.2KB. If a BLUETOOTH device is used on the ***D1 port***, then the port speed must be set to 115200.

25 ALL CAL3K COMMANDS

To understand the how to access the installed commands, visit Basic Keyboard Operations

NOTE: Clear the last command entry with the '***ESC'*** key before typing the command index number.

The command list is universal to all DDS Calorimeter machines. Some commands may behave a little different to the explanations below, but the intentions are the same.

NOTE: A RED Command means the command has restricted access and a password is required to activate it. Refer to Password Entry.

Command List in Alphabetical order

COMMAND	DESCRIPTION	INDEX
ABORT/RESET	It terminates any of the operational cycles such as INITIAL or MAIN. Data is lost. However, if a MAIN cycle was terminated then a record is stored with the appropriate status. Refer to Mass Erasing Refer to Abort	012
BALANCE MASS	This is the same as the '**F5'** key. It displays the balance mass if connected. Press Enter to capture the mass in. To ***clear*** a locked mass type: **MASS**, '***ENTER'***, '***DELETE'***, '***ENTER'***	011
BALANCE SPEED	The balance must have the same setup as the CAL3K. The setting is: Parity None Stop bits 1 Data 8 bit Default Speed 2400 The speed in the CAL3K can be adjusted from 1200 to 38400 baud. Refer to Connecting Refer to Balance Port	024
BENZOIC ACID VAL	This is the Benzoic Acid value in the specified units! Refer to Units (KJ, KCA, KBA) for specifying the units. The default entry is 26.454KJ/g. This is the certification reference value that the calibration references against. Refer to Calibration Commands	018
BLOCK ABOVE LIM	This command allows the AI module to BLOCK a calibration if it is outside the set Peak limit in KJ/g. The default is 0.04KJ/g. A zero entry disables the blocking process. The blocking takes place after a NEW calibration was done and more than the minimum calibrations are stored. Refer to Calibration Commands	027
CAL3K-TEST:	This command tests the CAL3K hardware.	013

COMMAND	DESCRIPTION	INDEX
	Once started, the unit will cycle through all tests and will 'hang' on any fault. Individual tests can be executed (without cycling through all preceding tests) by replacing the '**YES**' entry by the test number. Refer to Testing	
CALIBRATION	Prepare the vessel with Benzoic Acid (BA) and set the calibration on '**YES**'. Make sure that the Benzoic Acid value reflects the BA certification. Then close the LID and wait. You will notice that the calibration operation is indicated in the top left corner. Once done, remove the vessel and repeat the procedure with the other vessels ***(Except CAL3K-S)*** which only has one vessel. Enter '**YES**' to perform a calibration or '**CHK**' to perform a calibration check sample. A '**YES**' entry results in a calibration save to memory and '**CHK**' entry does not perform a save. Refer to Calibration Commands	019
CAPSULE RISE C	The temperature rise caused by a gelatine capsule is entered here (Default=1.44). This entry is associated with the capsule (Manufacturer, weight, size) and is constant unless changed. The entry is in degrees Celsius. This capsule rise is used ONLY for EASY SPIKING Refer to Easy Capsule Spiking Refer to Measure Gelatine Capsule Rise	029
CLEAR B_CAL S/N	This command CLEARS all calibrations for the specified vessel Serial Number. The vessel must be removed from the CAL3K. The deletion is permanent. This command should be used when memory space is needed for a new vessel. Read Bomb Cali displays all used vessel serial numbers. Once a vessel calibration is cleared it must be calibrated, Refer to Calibration command Refer to Calibration Refer to Clear Vessel Cal History	042
CLEAR CAL3K MAX	This command clears the CAL3K maximum recordings. The recordings consist of: - Maximum Start Temperature and date and time it happened. - Maximum Vessel Temperature and date and time - Maximum Ambient temperature and date and time - Max Vessel pressure and date and time (***For CAL3K-AP only***) Refer to Clear Cal3k Maximum	040
CLEAR PRESS RCRD	This command clears the pressure recordings in the ***CAL3K-AP***. The unit keeps 16 recordings of:	038

COMMAND	DESCRIPTION	INDEX
	Date and Time Mass Temperature Rise Pressure Peak pressure time (Milliseconds) ***Note*** that the pressure recordings are triggered by exceeding the 'PRESSURE PEAK LIMIT' The recordings are in a circular fashion and the oldest one is over-written. Refer to Printer and Output Refer to Clear Pressure Record	
CLEAR RESULTS	This command clears all results. Enter '**YES**' to clear the result memory. The HELP memory is cleared if the text '**EVENT**' is entered instead of '**YES**'. Refer to Miss Fire Refer to Clearing	039
CLEAR VESSEL MAX	The maximum recordings in the vessel consist of: Maximum Temperature Firing count at max Temperature Date and time of max Temperature The vessel must be inserted for the clearing. The command should be repeated with each vessel. Refer to Clear Vessel Max	041
COMPENSATE BOMB	It requires an inserted vessel or the vessel number. It will analyse the calibrations and compute the compensations for this vessel.	113
COTTON+WIRE CORR	This is the cotton and wire correction. The cotton has a definable energy and the electrical current which heats the firing wire has a constant energy content. Both these (and others which produce an offset) are combined in this entry. The default value is 0.0418℃. The entry is in Celsius. This correction is ALWAYS applied: To samples and calibrations alike. If the cotton or firing wire are changed then the value should be re-adjusted to suit. The 'Cotton correction' is constant. It is therefore treated as temperature rise compensation. The cotton correction is subtracted from the raw temperature rise to yield the NETT RISE. Refer to Cotton Correction Refer to Measure the Wire and Cotton Rise	009
D1 PORT SPEED	This command sets the D1 RS232 port speed. The default is 19200Kb. Refer to D1 Port	054

COMMAND	DESCRIPTION	INDEX
DATE IS GID	This YES/NO entry allows for replacing the GID with the DATE in the form YY/MM/DD. The GID (Group Identification) is attached to every sample recording. Note that the first 8 characters of the GID are left blank. This is not available on the ***CAL3K-S***. Refer to Group Identification Refer to Time and Date	122
DATESET YY:MM:DD	This sets the date of the CAL3K internal real time clock. Note that the clock remains life up to a week without power. The entry is the form: YY/MM/DD The date can be used as a Group Identification (GID). This is not available on the ***CAL3K-S.*** Refer to Time and Date	005
DEFLATE SYSTEM	The pressure in the **CAL3K-AP** piping is deflated by opening all valves until '**ESC**'.	091
DUMP ALL RESULTS	This command dumps all results to the D1 port. The data are not printable but can be saved as a NAME.CSV file for a spreadsheet. The capturing of the data can be done by any terminal emulator like TERA TERM VT. Connect to the PC with an RS232 cable, then configure it for the RS232 printer port communication speed. Of course, you can capture the printable outputs as well as the non-printable. If the data should be usable in a spreadsheet see: OUTPUT TO A SPREADSHEET. Refer to Output, Non-Printable	079
DUMP RSLT VESSEL	The results of the specified vessel are dumped to the D1 port. Refer to Output, Non-Printable	147
FIBRE CV VALUE	The Fibre CV value is used during food analysis; the default is 16.736KJ/g. Unit conversion is active. Refer to Food Compensation	025
FIBRE IN FOOD %	This percent (of mass) entry is used to reduce the result by the percentage multiplied with the FIBRE CV VALUE. This fibre adjustment is NOT used during a calibration. Refer to Food Compensation	023
FIRE MANUAL	This can be used to shorten the initial period. The firing conditions are circumvented, and the Vessel charge is ignited. It is useful to test the firing/ignition procedure. It is not recommended for use during normal operation, as this will affect the accuracy of your sample being determined. Refer to Fire Manually Refer to Miss Fire	017

COMMAND	DESCRIPTION	INDEX
FIRING VOLTAGE	The firing voltage is default set at 25.0 volts. The setting depends on the sample and the oxygen pressure. The firing voltage must be decreased if the 'semi-permanent' firing wire melts too often. You should get 20 to 50 firings out of the permanent firing wire depending on how corrosive the sample is. Refer to Firing	016
FLUSH SECONDS	The vessel can be flushed with oxygen after deflating. The flushing removes harmful gases from the pipes and vessels. The flush cycle is time based. A zero entry eliminates the flush cycle, otherwise the vessel is filled for the specified time in seconds and then deflated. Default value is 3 seconds. In the ***CAL3K-S/ST*** models the flushing is applied to the fan in the vessel well before the calorimeter LID is closed. Refer to AP Pressure Commands	093
GROUP IDENTIFIER	The Group Identification (GID) is an 8–16-character text string. It can be replaced by the 'Date is DID' command. Refer to Group Identification	003
HIGH AMBIENT LIM	The unit measures the Ambient temperature, which has an influence on the result and the operation. The influence is mitigated by calibrating the unit at relatively high ambient temperatures. However, this limit can be set up to warn the operator. The default setting is 36℃. Refer to Limits	103
HIGH RISE LIMIT	The result is affected by the temperature rise after firing. This effect is minimised by calibrating the unit for high rise (e.g., 0.75g Benzoic Acid). However, the sample mass should be adjusted so that the temperature rise is near to the optimal 12℃ ±2℃. The default setting is 16℃. Refer to Limits Refer to Small Sample Mass	105
LOW AMBIENT LIMIT	The ambient temperature affects the unit's operation and result. The resulting influence can be eliminated by calibrating the unit at low ambient temperatures. The default setting is 8℃. The lowest possible temperature measurement is 2℃. Refer to Limits	102
LOW RISE LIMIT	The temperature rise after firing should be 12℃±2℃. This can be managed by adjusting the sample mass. A low-rise limit can be set up to warn the operator that the sample mass was too low. The default setting is 8℃. A lower rise can be achieved by calibrating the unit to an 8℃±2℃. It is just difficult to split a Benzoic Acid tablet to 2/3.	104

COMMAND	DESCRIPTION	INDEX
	Refer to Miss Fire Refer to Limits Refer to Small Sample Mass	
MASS	The sample mass is normally entered manually from the '**F1'** key or electronically via the '**F5**' (Balance mass) key or typing the command. Once a mass is entered it is LOCKED into the unit. To UNLOCK (delete an entered mass) the command must be typed followed by '**ENTER**', '**DELETE**'. Refer to Spike Mass	001
MAX CALIBRATIONS	This limit applies to the number of calibrations per vessel that the calorimeter will store. The physical limit is 16, the default is 8 calibrations. Refer to Calibration Commands Refer to Calibration Frequency	032
MAX MASS LIMIT	This limit applies to all possible mass entries. Exceeding this limit prevents a mass from entry. The default limit is 1.5g Refer to Mass Entry Refer to Balance Mass Refer to Limits Refer to Small Sample Mass	031
MIN CALIBRATION	These are the minimum calibrations in memory before the AI calibration management starts. Refer to Calibration Commands Refer to Calibration Frequency	026
MIN MASS LIMIT	This limit applies to all possible mass entries. An entry below this limit will be rejected, the default is 0.2g. Refer to Mass Entry Refer to Balance Mass Refer to Limits Refer to Small Sample Mass	030
MISFIRE LIMIT	If the sample is not igniting, then it is called a MISS FIRE. The unit checks the temperature rise 30 seconds after firing, and if the rise is below the limit a MISS FIRE is declared and the process is terminated. The default value is 0.44℃. The MISS FIRE limit checking can be disabled by entering zero. Refer to Misfire Refer to Limits Refer to Measure the Wire and Cotton Rise Refer to Measure Gelatine Capsule Rise	021
MOISTURE PERCENT	This entry is important when the moisture content of a sample is known, and the net calorific value must be calculated. The CAL3K calculates the nett mass and	033

COMMAND	DESCRIPTION	INDEX
	displays the nett calorific value. The default setting is ZERO. Refer to Moisture Correction	
OPEN LID	This command applies to the ***CAL3K-AP/A/F.*** Its command opens the lid. The present process is terminated, and the lid will open when it is safe to do so. The command is the same as the '**F6'** function key. Refer to Open Lid	073
PARA DEFAULTLOAD	This command loads ALL default values into the operating parameters. Any changes done to the parameters are over-written (lost). This command should be used whenever the parameters were changed, and the outcome is not desirable. We strongly suggest operating the unit on the default parameters unless a change is necessary. Different default parameters are available for each mode. Refer to Default Parameters	010
PASSWORD ENTRY	All commands with a priority = 1 are password protected (not accessible). The password is 'DDS3K' to make priority=1 commands visible. The password is active for 5 minutes. Refer to Password Entry Refer to Basic Keyboard Operations	006
PRESS DEFLAT.SEC	The command applies to the ***CAL3K-AP***. After the main period the vessel is deflated. The time is monitored and if the limit is exceeded a warning is displayed. It could be that the filter or the exhaust valve is blocked. The default setting is 20 seconds. Refer to AP Pressure Commands	092
PRESS FILL LEAK	This command applies to the ***CAL3K-AP***. After filling the vessel with oxygen, the pressure is monitored and if it declines (leaks) by more than the limit a warning is issued. Theoretically the pressure should be constant, but it requires approx. 1 Bar to equalise. The default setting is 1.5 Bar. Refer to AP Pressure Commands	095
PRESS FILL MIN	An ***CAL3K-AP*** command. The minimum filling pressure specifies the limit at which the unit stops working. It allows for slow filling and near empty oxygen bottles. The default is 20 Bar, which is sufficient for avoiding oxygen starvation at 26KJ/g Samples. Refer to AP Pressure Commands	096
PRESS FILL SECND	An ***CAL3K-AP*** command. The filling time is monitored and when it exceeds the limit the operator is warned. The reason for slow filling could be: Empty oxygen bottle	097

COMMAND	DESCRIPTION	INDEX
	or blocked inlet filter. The filter (and filling restrictor) is a very unlikely reason for slow filling and the oxygen pressure should be investigated first. Refer to AP Pressure Commands	
PRESS FILL TRGET	An ***CAL3K-AP*** command. The filling target is the nominal filling pressure when the filling valve is shut down. The actual pressure may be 1 Bar down because of pressure settling. The target should be 30 Bar. Lower filling pressures are indicated for powdery substances to reduce scattering of sample material. The default is 30 Bar. Refer to AP Pressure Commands	088
PRESS LEAK TEST	An ***CAL3K-AP*** command. This command sets the leak test pressure applied during SYSTEM LEAK TEST. The leak test is useful when a leak is suspected. The default value is 25 Bar. Refer to Test Oxygen internal plumbing Refer to AP Pressure Commands	099
PRESS PEAK LIMIT	An ***CAL3K-AP*** Command. The pressure peak limit (Default=70 Bar) is the max. pressure allowed shortly after firing when the pressure increases proportional to the burning speed. When the pressure exceeds this limit, the event is recorded, and the operator is warned. At this point the unit is NOT shutdown. The pressure peak checking can be disabled by entering zero. If the pressure increases to 90 Bar (Internal limit) then the vessel is partially deflated, and the process is terminated. This event is also recorded. Refer to AP Pressure Commands	087
PRESS ZERO ADJST	A ***CAL3K-AP*** command. The pressure is measured with a transducer which has a zero offset of ±1 Bar. This error can be eliminated by using this command. The offset can be checked when the lid is open and the 'READ PRESSURE' command should display ZERO. (±0.2 Bar). If not, use the 'PRESS ZERO ADJ' to set it to zero. Refer to AP Pressure Commands	090
PRT A-H HEADER	The unit has 8 print (Output formats) named A-H. The format can be set by SET OUTFORM A-H command. This command prints the header (a short text description of each format position) so you can see what the data consist of. Refer to Printer and Output	056
PRT CAL ANALYSIS	The calibration info per vessel is displayed. Refer to Calibration Commands	118

COMMAND	DESCRIPTION	INDEX
PRT CALORI INFO	The command prints the relevant CAL3K information, including parameters and customer settings. This printout is included in the shipment. Refer to Printer and Output	058
PRT COMPENS+MAX	The compensation for the serial number or inserted vessel is printed. Refer to Printer and Output	116
PRT CV'S VESSEL:	The Calorific Values (CV) of the specified vessel are printed to the D1 port. Refer to Printer and Output	067
PRT EVENT HISTORY	The calorimeter records all major operational or setup faults. This command prints all recorded events. After 32 events the unit overwrites the oldest one. The printout consists of: Date and Time Message Number Mxxx (M Number) Message Text Today : 24/07/07-00:02:44 211 24/07/07-00:02:36 M211: VESSEL COMMS LOST DURING FILLING 116 24/07/07-00:02:29 M116 WARNING: BOMB IS NEAR INSPECTION Refer to Miss Fire Refer to Printer and Output Refer to Clear Help Events Refer to Understanding Events	112
PRT KEY CMD LIST	The command prints all installed keyboard commands as follows: CMD NUMBER KEYBOARD ENTRY PRIORITY Refer to Printer and Output	107
PRT MAX DATA	The CAL3K (Chassis) accumulates maximum data. This command prints all maximums. The maximum readings can be reset by CLEAR CAL3K MAX command. Refer to Printer and Output	085
PRT MEM RSLTS CR	This command prints results from memory. A 'YES' entry prints calibration and results, a 'C' entry prints Calibrations only and a 'R' entry print result only. relates to Print Section	062

COMMAND	DESCRIPTION	INDEX
	Refer to Printer and Output	
PRT PRESS. RECRD	An ***CAL3K-AP*** command. This command prints all (Max 16) pressure recordings which are caused by either: Exceeding the PRESS PEAK LIMIT Exceeding the internal max pressure setting 90 Bar The pressure recordings can be reset by CLEAR PRESS RCRD command. The records can be read out on the display with command READ PRESS Refer to AP PRESSURE COMMANDS Refer to Printer and Output	101
PRT RESLTS FORM:	Enter the output format A-H and all results in the memory are printed. The selected/set output format remains as specified. Refer to Printer and Output	069
PRT RESULT DAY:	Enter the day number 1-31 and all results recorded on this day are printed. The resulting memory should be cleared every month, CLEAR RESULTS. Refer to Printer and Output	052
PRT RESULT GID:	Each result in memory has a GID (Group Identification) of 16 characters. The GID can be an entered text(GROUP IDENTIFIER command) or the date(DATE IS GID command). Enter the GID (Up to 16 characters) and results are printed. Refer to Group Identification Refer to Printer and Output	064
PRT RTIME HEADER	The CAL3K has a REAL TIME (RT) printout facility. It must be enabled by selecting one of the 4 output formats WXYZ,by using the SET RT FORM command. Then the header (Data descriptor) is printed. If the SET RTHEAD EN CP, has a selection (C=Customer, P=Parameter) then this info is printed as well. Refer to Printer and Output Refer to Printing real Time	053
PRT TODAY FORM:	Enter an output format A-H and all results for today are printed. Refer to Printer and Output	057
PRT VESSEL INFO	This command prints the vessel information. The vessel must be in the well. Refer to Printer and Output	059
PUT FAN ON	This test **does NOT** apply to the ***CAL3K-F***. This command puts the FAN on.	120

COMMAND	DESCRIPTION	INDEX
	Refer to Fan Test	
READ AMB TEMP.	This causes the display of the present ambient temperature until ESC is pressed. Refer to Reading	049
READ ATC TEMP.	Only applicable to ***CAL3K-AP***. The ATC temperatures (Bottom and Top) are displayed until ESC is pressed. Refer to Reading	078
READ BOMB CALI	The number of calibrations (Max=15) per vessel are displayed for each vessel. Refer to Calibration Refer to Reading	106
READ CAL3K MAX	The CAL3K maximum data is displayed. Refer to Reading	047
READ CARD ID	The card identification is displayed. The Card ID is used by the factory. Refer to Reading	045
READ CHA.FIRINGS	The number of firings in this chassis are displayed. Refer to Reading	034
READ DRIFT	The drift (Temperature difference per 6 seconds) is displayed until ESC. Refer to Reading	044
READ EVENT RECRD	Read the last Event Record. Starting at the most recent event, press '***ENTER'*** to see the next event in memory. The calorimeter keeps all major events that have happened in a 32-record revolving memory. Use PRT EVENT HISTORY to print all events. Use CLEAR RESULTS to delete all events. Refer to Understanding Events Refer to Miss Fire	108
READ FIRING VOLT	The firing takes place automatically when the calorimeter enters the Firing cycle. Type '***ESC'*** to end the firing voltage display Refer to Firing Refer to Miss Fire Refer to Reading	051
READ HELP TEXT	Each fault or operation has a message number attached, the number starting with a 'M' followed by 3 numerical digits. If it is required to read the help text type the command and number. Example: 114, ***'ENTER'***, 524 ***ENTER*** Refer to Miss Fire Refer to Understanding Events Refer to M Number messages and errors	114

COMMAND	DESCRIPTION	INDEX
READ LAST N_RISE	The last net temperature rise is displayed after the main period. This value is available till the next vessel firing. Refer to Miss Fire Refer to Reading Refer to Temperature Rise Refer to Measure the Wire and Cotton Rise Refer to Measure Gelatine Capsule Rise	081
READ MAX VESSEL	The vessel maximum data is displayed. The vessel must be in the well. Refer to Reading	046
READ MEM RECORDS	This command displays the: Total records Calibration records Fault records	110
READ PRESS. REC	This command reads the recordings from the memory. Press {enter} for the next and ESC to terminate reading. By using the CLEAR PRESSURE RECORDINGS command; The pressure recordings can be cleared and can be printed by using PRT PRESS command. Refer to AP PRESSURE COMMANDS	115
READ PRESSURE	**CAL3K-AP** command. The actual vessel pressure is displayed until '**ESC**' is pressed. Refer to AP PRESSURE COMMANDS Refer to Reading	089
READ RESULT DAY:	This command displays the number of results for the entered day number 1-31. Refer to Reading	065
READ RESULT MEM	The unit displays the Last result number and the result details in line #4. Press '***ENTER***' to display the result before the last The result can be printed with the '***F8***' function key! Refer to Printer and Output Refer to Reading	050
READ RISE VESSEL	The temperature rise of the vessel during the main period can be displayed until '**ESC**' is pressed. Refer to Easy Capsule Spiking Refer to Cotton Correction Refer to Reading	036
READ STABILITY	The entry is a 4-character vessel serial number, printed on the vessel lid. The complete result memory is searched for this serial number and all results are printed. Refer to Reading	068

COMMAND	DESCRIPTION	INDEX
READ TEMP VESSEL	The vessel temperature is displayed until '**ESC**' is pressed. Refer to Reading	043
READ VESS.FIRING	The number of firings of the inserted vessel are displayed. Refer to Reading	083
READ VESSEL INFO	The information of the inserted vessel is displayed. Including last calibration date and time as well as version number, number of firings as well serial number. Refer to Reading	043
RESET	The same as ABORT. Any process is terminated! A Sample in progress is lost, Balance mass is lost. Refer to Mass Erasing Refer to Abort	124
SAMPLE IDENTIFY	This command is the same as the '**F2**' key. The sample identifications are 8-16 characters. They are auto incremented if the 'Time is SID' command is not selected. Refer to Sample Identity Refer to Spike Value	002
SET CAPSULE EN.	A YES/NO entry enables/disables the use of gelatine capsule temperature deduction. Note that if '**GELATINE CAPSULE CORRECTION**' is enabled, the setting is retained after each sample. If a sample without a capsule is burned then the capsule compensation must be disabled (SET CAPSULE, '**NO**'). The capsule correction is automatically disabled during calibration. In the 'EASY SPIKE' method, the Capsule Rise value is deducted from the measured temperature rise (Sample + Capsule) before the result is calculated. Refer to Easy Capsule Spiking	028
SET FILTER C,F:	The print outs can be filtered to exclude Calibrations (C) and Faults (F). Refer to Printer and Output	055
SET HIGH RESOLUT	The unit can be switched to high display result resolution by a 'YES' entry. The resolution is: HIGH XX.XXXX LOW XX.XX Note that the resolution switch affects the DISPLAY only. All digital outputs depend on output format and destination. An output to a PC has a resolution of: XX.XXXXX	070

COMMAND	DESCRIPTION	INDEX
SET OPS MODE	The **CAL3K-A and AP** has four operational modes: 1. Dynamic 2. Adiabatic 3. Isothermal 4. FAST Dynamic Each of these modes has its own calibration, which means the vessel(s) must be calibrated in the new mode. Each of the modes has its own default parameters. The most preferred mode is 0=dynamic, followed by 4=Fast Dynamic. Refer to Mode Changes	082
SET OUTFORM A-H:	This command specifies one of the eight output formats A-H. The outputs can be disabled by specifying anything but A-H or by using the SET RESULT ENABL command, SET RESULT ENABLE=`**NO**'. Refer to Printer and Output Refer to Manual Data Capture	063
SET RESULT ENABLE	This command enables (YES) or disables (NO) the spontaneous printing of results after a determination. The results are entered in memory and can be printed later by any of the print commands. Refer to Printer and Output Refer to Printing real Time	086
SET RT FORM WXYZ	This command enables and sets the REAL TIME output format to WXYZ. Selecting anything but WXYZ disables the real time output. The WXYZ format can be tested by printing the header with the PRT RTIME HEADER command. Refer to Printer and Output Refer to Printing real Time	061
SET RTHEAD EN CP	The REAL TIME output (from 30 seconds before firing) can be preceded by Customer (C) and Parameters (P). If none is desired enter anything but CP. Refer to Printer and Output Refer to Printing real Time	060
SPIKE MASS	This is the spike mass. If the value is >0 then spiking is activated, and the result will be reduced by: Spike mass x Spike value. Refer to Spiking Refer to Spike Mass	007

COMMAND	DESCRIPTION	INDEX
SPIKE VALUE	The Spike Value is the CV of the spike material. If Benzoic Acid is used for spiking, then the CV=26.454KJ/g. The default setting is 26.454KJ/g Refer to Spiking Refer to Spike Value	015
SULPHUR CORRECT.	The sulphur correction deducts energy which is released by the formation of SO2. The entry is in KJ/g. The default setting is zero. This correction is switched off during calibration. Refer to Sulphur Correction	008
SYSTEM LEAK TEST	Note that the filling is much slower because the vessel is filled. Monitor the pressure and if it is steadily declining then a leak is present. It is normal that the pressure declines rapidly in the beginning and then settles down. This is because a flow restriction is present in the vessel lid. Refer to Test Oxygen internal plumbing Refer to AP PRESSURE COMMANDS	094
TIME IS SID	The Sample Identification (SID) is a 16-character text string. It can be replaced with the time in HH:MM:SS by entering '**YES**'. This is not available on the ***CAL3K-S***. Refer to Sample Identity Refer to Time and Date	121
TIMESET HH:MM:SS	This command sets the time in HH:MM:SS. The internal clock runs for about 1 week without power and then the time (and date) must be set. The time can be used as a SID (Time is SID), however this is not available on the ***CAL3K-S / ST.*** Refer to Time and Date	004

COMMAND	DESCRIPTION	INDEX
UNIT: KJ,KCA,KBU	This command sets the measuring units. Note that the internal working is in KJ/g, but any output is converted to the units. Enter the letters: KJ for KJ/g KCA for KCAL/g KBU for KBTU/lb The following conversion applies: 1 KJ/g = 429.9226 BTU/lb = 0.4299226 KBTU/lb 1 KJ/g = 0.2388459 KCAL/g Therefore: The 26.454KJ/g = 11.373 KBTU/lb = 6.3184 KCAL/g **Note: The unit conversion is only used in communicating with the CAL3K and the display.** We know that the KBTU/lb is not conventional, but it fits nicely into the display format. Refer to Units of Measure Refer to Food Compensation	022
VERSION	This command displays the CAL3K firmware version.	123
VESSEL-TEST:	This test is activated by **'F7'** or typing the command. The vessel must be in the well. ***CAL3K-AP only***: The oxygen pressure must be connected. All vessel functions are tested, and a summary is displayed. The test must be repeated for each vessel. Refer to Vessel Testing	014

26 TEMPERATURE RISE

The vessel is calibrated with 0.5g BA which raises the vessel temperature by approximately 10℃. This rise should be achieved when a sample is burned to best match the Calibration temperature rise. That it turns means that the sample mass should be adjusted so that it yields approximately the same rise. The CAL3K can 'tolerate' a range from 6℃ to 16℃ rise when calibrated with 0.5g of BA. By adjusting the sample mass to match the calibration temperature rise, then the calibration and sample repeatability would be accurate. As a guide, adjust the sample mass as follows:

Sample	Energy	Weight
Benzoic Acid	26.454 KJ/g	0.5g
Food	+/- 17 KJ/g	0.75g
Other	< 10 KJ/g	1.0g
Oil, Fat, Fuel	+/- 37 KJ/g	0.2g

The following commands are valuable:

Command ***READ LAST N RISE*** , also refer to Basic Keyboard Operations
This reads the Net Rise of the last sample. The display is valid until a new vessel is fired.

26.1 VERY SMALL SAMPLE MASS

Sometimes a sufficient sample mass is not available. Then a vessel should be calibrated with less than 0.5g BA. It is a bit messy to split a 0.5g tablet to ~0.2g or less, but it can be done.

BA Calibration Mass	Rise	Rise Range
~0.25g	6℃	3-9℃
~0.1g	2.5℃	2-4℃

Less than ~1℃ rise is not advised because the errors get out of hand.
If the calibration mass is changed then the calibration memory must be cleared, and new calibrations must be performed with the low mass. If more than one vessel is used, then all vessels' calibrations must be cleared and freshly calibrated.

The following parameters should be adjusted to conform with the reduced Benzoic Acid calibration weight:

Command ***LOW RISE LIMIT*** is set to a default value of 8°C. This should be adjusted to allow for a 2°C to 3°C lower temperature from the calibration temperature rise. As an example, if we are using half of the BA tablet 0.25g, then we expect about a 6°C temperature rise. We would therefore set the Low-Rise Limit to 4°C and the High Rise Limit to 8°C

Command ***HIGH RISE LIMIT*** This should be adjusted to allow for a 2°C to 3°C higher temperature from the calibration temperature rise.

Command ***MIN MASS LIMIT*** is set to a default value of 0.2g. This should be adjusted to allow for the lower mass settings. Do allow for the inputting of the mass to fluctuate per sample.

Command ***MAX MASS LIMIT*** is set to a default value of 1.5g. This should be adjusted to allow for the higher mass settings. Do allow for the inputting of the mass to fluctuate per sample.

The main purpose of the Min Mass Limit and the Max Mass Limit are to prevent accidental mass entries of the wrong weight.

26.2 HOW TO MEASURE THE WIRE+COTTON RISE

The default setting for cotton correction is ~0.0418℃. This is not very important because it is an offset to the raw temperature rise.
Disable the Miss-fire Limit with:

Command ***MISSFIRE LIMIT***, also refer to Basic Keyboard Operations
The default setting is 0.44℃. Enter '0', this disables the MISFIRE limit!
Then clear the Cotton correction.

Command ***COTTON+WIRE CORR***, also refer to Basic Keyboard Operations
Enter '0.0'.

Wait until the vessel temperature and the ambient temperature are equal (like waiting overnight).
Prepare the vessel (without a sample) but with wire and cotton thread only and run a determination. After the complete run command ***READ LAST N_RISE***.

Command ***READ LAST N_RISE***, also refer to Basic Keyboard Operations
This reads the Net Rise of the last sample. Since the cotton correction=0 it is the RAW TEMPERATURE RISE.
Enter the obtained cotton and wire correction reading with the command COTTON+WIRE CORR.

26.3 HOW TO MEASURE THE GELATIN CAPSULE RISE

The gelatine capsule rise is needed when EASY SPIKING is used. In this method the sample is packed inside the capsule and the capsule rise is deducted from the net-rise. Proceed as follows:
Disable the MISS FIRE limit:

Command ***MISSFIRE LIMIT***, also refer to Basic Keyboard Operations

Default setting is 0.44℃. Enter '0', this disables the MISS FIRE limit!

Prepare a vessel with a gelatine capsule but without a sample and run a determination.

After the run obtain the temperature rise:

Command ***READ LAST N_RISE***, also refer to Basic Keyboard Operations

This reads the Net Rise of the last sample. This is the temperature rise produced by the gelatine capsule.

1. Enter this value in: Command ***CAPSULE RISE C***, also refer to Basic Keyboard Operations

27 MAINTENANCE

The DDS Calorimeters are designed to work in a laboratory environment and require very little maintenance. However, all laboratories are different, and the maintenance depends largely on:

27.1 DAILY USE

This works out to samples per day. The maintenance of the system is fairly in line with the usage of the system.

27.2 MATERIALS TESTED

The different sample materials which are tested in the CAL3K are the biggest maintenance contributors. The sample materials differ from powdery substances (which may have violent combustion) to environmental hazardous samples. They all affect the O-rings, firing wire, deflector plate and the electrodes. The powdery substances are the worst: The material settles on the O-ring surface and 'cracks' the O-ring. Corrosive materials affect the crucible and the deflector plate. But the effects are highly visible and can be controlled through maintenance.

27.3 ENVIRONMENT

Dust, temperature, installation conditions also affect the system and maintenance. Dust being the main influence on the calorimeter. It blocks the fan (in the cooler and calorimeter) and can be electrically conductive if it is coal dust.

27.4 MAINTENANCE SCHEDULE (GUIDELINE)

The following maintenance schedule serves as a guideline only: Please adjust it to suit your conditions.

The following Vessel parts require maintenance:

PART NUMBER	DESCRIPTION
3K-4-094	Large Lid O-Ring
3K-4-096 / 3K-4-036 / 3K-4-122	Centre Electrode
3K-4-037 / 3K-4-124	Outside Electrode
3K-4-093	Firing Wire
3K-4-022	Top & Bottom O-ring
3K-1-080	Nozzle O-Ring for CAL3K-AP Only (Black)
3K-4-107	Nozzle O-Ring for CAL3K-AP Only (High Quality) (Green)
3K-4-047	Crucible
3K-4-005 / 3K-4-092	Deflector Plate

The following Filling station parts require maintenance:

PART NUMBER	DESCRIPTION
3K-4-29	Nozzle O-Ring

The Following is a General Maintenance Schedule Guideline:

PART NUMBER / ITEM	CLEANING/REPLACEMENT FREQUENCY	METHOD
Vessel Body	**Clean every 5 to 50 firings. Dependent on Sample Type.**	**Scrub with water & detergent. Use Wire Brush on threads. Do Not immerse Vessel in water or wet Vessel PCB.**
Vessel Cap	**Clean every 5 to 50 firings. Dependent on Sample Type.**	**Use Wire Brush on threads.**
Vessel Lid (Electrode) Assembly	**Clean every 5 to 50 firings. Dependent on Sample Type.**	**Dismantle & scrub all parts with water & detergent. Use a wire brush to remove deposits. Dry & reassemble, change O-ring if necessary**
Top O-Ring 3K-4-022	**Worst conditions: 2-5 samples** **Average conditions: 40-50** **Samples Good Conditions: 100+ samples**	**Remove deflector plate from Lid. Unscrew centre electrode valve screw remove old top O-ring and replace.**
Bottom O-Ring 3K-4-022	**Worst conditions: 2-5 samples** **Average conditions: 40-50** **Samples Good Conditions: 100+ samples**	**Remove deflector plate from Lid. Unscrew centre electrode valve screw remove old bottom O-ring and replace.**
Lid O-Ring 3K-4-016 / 3K-4-094	**Worst conditions: 2-5 samples** **Average conditions: 40-50 samples** **Good conditions: 100+ samples**	**Unscrew cap and remove lid. Remove lid O-ring and replace. (***Should be checked regularly, as it gives a good idea of what other O-rings condition could be.***)**

PART NUMBER / ITEM	CLEANING/REPLACEMENT FREQUENCY	METHOD
Nozzle O-Ring (Black) – AP 3K-1-080	Worst conditions: 10-20 samples Average conditions: 20-50 samples	Remove and replace.
Nozzle O-Ring (Green) – AP 3K-4-107	Every 50 – 100 Samples	Remove and replace.
Deflector Plate 3K-4-005 3K-4-092	30-150 samples OR Replace when heavily corroded and cannot be cleaned.	Remove and replace.

PART NUMBER / ITEM	CLEANING/REPLACEMENT FREQUENCY	METHOD
Centre Electrode 3K-4-036 3K-4-096 3K-4-122	Worst conditions: 2-5 samples Average conditions: 40-50 Samples Good Conditions: 100+ samples	Remove deflector plate. Unscrew valve screw. Change Top & Bottom Electrode and O-Rings. Reassemble.
Outside Electrode 3K-4-037 3K-4-124	Replace every 30-120 samples	Remove Deflector Plate, change Electrode by unscrewing. Reassemble.
Crucible 3K-4-047	When weight loss >10% OR When bottom distorts and becomes completely discoloured	Remove, discard and replace.
Filling Station Nozzle O-Ring 3K-3-29	50 – 100 Samples	Remove plastic nut from end of filling head assembly and remove and replace O-ring.

28 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.

29 HINTS AND TIPS

29.1 GENERAL HINTS

- Use a solution of sodium carbonate (bicarbonate soda) in water (100g in 1 Liter) to clean the vessel. 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 refers to powder samples). This prevents clogging and oxygen starvation.
- Spiking. In certain cases, it is necessary to know the calorific value of a substance 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 CAL3K 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 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!**

29.2 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 "knocking" the sample out of the crucible.
- Discard sample after a MISS FIRE
- Do not leave the Vessel with a sample, filled with oxygen (pressurised) for more than 15 minutes before firing.
- Do not leave the Vessel pressurised (filled with oxygen) overnight.
- Do not leave the vessel pressurised and/or closed for a long period of time after firing, have the lid and cap off.
- Always store vessel with lid and cap off when not in use after cleaning.
- During long term storage, the vessel must be cleaned the lid and cap can be on the vessel.

- Check the Vessels once a day for leaks and replace, if necessary, the respective O-ring. The small electrode top O-ring can fail within a day, depending on use, (Refer to Maintenance Schedule Guideline).
- The 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 Celsius, but this can be approximate.
- Use only the recommended firing wire and firing cotton supplied.
- Re-calibrate the Vessel if the electrodes and/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 MISSFIRE. **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 CAL3K-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 ONLY USED SUPPLIED DDS O-RING LUBRICANT (3K-1-086).**
- 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 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.

30 TROUBLESHOOTING AND SOLUTIONS

30.1 ERROR – CALORIMETER DISPLAYS ######## INSTEAD OF THE RESULT

Remove the vessel from the calorimeter.
Enter command PARA DEFAULTLOAD and enter '**yes**' '**enter**'. This is to load the default factory values back into the calorimeter.
use the command 'CLEAR B_CAL S/N' (s/n referring to the bomb serial number), '**enter**' and '**yes**' '**enter**'. This will clear all the calibrations on the calorimeter.

Now prepare the vessel for calibration and enable calibration on the calorimeter by entering '**CALIBRATION**', '**enter**' and '**yes**'. (this is to "warm up the bomb and machine")

Let the vessel go through the entire cycle. Remove the vessel and prepare for another calibration.

Clear the calibration again with 'CLEAR B_CAL S/N' (s/n referring to the bomb serial number) and enter 'yes'. (refer to CAIBRATION).

Now proceed to calibrate the vessel again. At least 6 calibrations must be performed before a normal sample can be analysed. Please always calibrate with benzoic acid supplied.

30.2 FILLING STATION

a) **Bottle pressure gauge does not indicate** – Check that the oxygen bottle is open. Check the regulator on the oxygen bottle. Check the connection between regulator and Filling Station.
b) **Vessel does not fill** – Check oxygen regulator, Check filling head assembly on filling station, Check Lid Assembly of the Vessel.
c) **Nozzle leaks while Vessel is filling** – replace the Nozzle O-ring, check filling head plastic nut is finger tight.
d) **Nozzle leaks even with no Vessel inserted** – replace Valve O-ring on the grey plastic valve (Nipple) inside filling head assembly, check for any foreign debris where the valve O-ring sits and remove it.

30.3 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 underfilled 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 the 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.

31 CAL3K SYSTEM TECHNICAL SPECIFICATIONS

DESCRIPTION	UOM	CAL3K-AP	CAL3K-A	CAL3K-F	CAL3K-S/ST
Dimensions: (Width, Length (Depth), Height,)	**mm**	270 x 270 x 340	270 x 270 x 340	290 x 250 x 23	270 x 210 x 220
Weight:	**Kg**	12	9	8	5
Power		220-240 / 100-120V 50/60Hz	220-240 / 100-120V 50/60Hz	220-240 / 100-120V 50/60Hz	220-240 / 100-120V 50/60Hz
Operating Temperature:		5 – 50°C	5 – 50°C	5 – 50°C	5 – 50°C
Determinations		6	10	8	3

Repeatability:	0.1 (%RSD – Relative Standard Deviation)
Energy Resolution:	0.001 (MJ/Kg)
Temperature Resolution:	0.000001°C
Calibration:	Calibration Details per Calibration Curve Max 16 calibrations per vessel Automatic Standard Deviation Calculations (AI)

32 APPENDIX 1.

32.1 PRESSURE CONVERSIONS

3000KPa = 3 MPa
= 30 Bar
= 30 Atmospheres
= 435 PSI

33 APPENDIX 2.

33.1 MJ / CAL / BTU ENERGY CONVERSIONS

1 MJ/Kg = 429.9 BTU/Lb
1 MJ/Kg = 238.85 Calories/gm

34 APPENDIX 3.

INSTALLATION KITS (CONSUMABLES & ACCESSORIES)

34.1 3K-AP CALORIMETER INSTALLATION KIT (CAL3K-AP)

PART NUMBER	DESCRIPTION
3K-1-062	Power Supply 12V
3K-1-122	Mains Cable 15A
3K-1-117	Balance Cable
3K-1-084	PC Cable USB
3K-1-061	PC Keyboard (PS2)
3K-4-049	Preparation Stand
3K-1-098	Printer Cable (RS232)
3K-1-08	Stainless Steel Tweezers
3K-4-084	Certified Benzoic Acid Tablets (150 x 0.5gram Tablets per bottle)
3K-3-27	High Pressure Oxygen Pipe (4mm) (3.75m)
3K-6-012	Exhaust Pipe 6.4mm (4m)
3K-3-21	Oxygen Regulator Connection Quick fit

PART NUMBER	DESCRIPTION
3K-6-031	3K-AP Exhaust O-ring
3K-1-080	3K-AP Nozzle O-Ring (Black)
3K-4-107	3K-AP Nozzle O-Ring (Green)
3K-6-005	3K-AP Exhaust Filter O-Ring
3K-6-018	3K-AP Fill Nut
3K-6-025	3K-AP Fill Head O-Ring
3K-6-033	4mm Compression Pipe fitting with double ferrule
3K-1-115	3K-AP Pressure Leak Test Jig
3K-3-18	Emergency Deflate Cap
3K-1-086	O-Ring Lubrication Grease Tube
3K-4-106	Wire Brush
3K-1-134	Temperature Sensor Calibration Harness
3K-1-043	USB Memory Flash Drive (Manuals)
INSTALLATION_GUIDE	Printed Installation Guide

34.2 3K-A-KT CALORIMETER INSTALLATION KIT (CAL3K-A)

PART NUMBER	DESCRIPTION
3K-1-062	Power Supply 12V
3K-1-122	Mains Cable 15A
3K-1-117	Balance Cable
3K-1-084	PC Cable (USB)
3K-1-061	PC Keyboard (PS2)
3K-4-049	Preparation Stand
3K-1-081	Stainless Steel Tweezer
3K-4-084	Certified Benzoic Acid Tablets (150 x 0.5gram Tablets per bottle)

PART NUMBER	DESCRIPTION
3K-4-106	Wire Brush
3K-1-098	Printer Cable (RS232)
3K-3-18	Emergency Deflate Cap
3K-1-043	USB Memory Flash Drive (Manuals)
INSTALLATION_GUIDE	Printed Installation Guide

34.3 3K-MAN CALORIMETER INSTALLATION KIT (CAL3K-F)

PART NUMBER	DESCRIPTION
3K-1-055	Power supply 12V/1.5A
3K-1-117	Balance Cable
3K-1-084	PC Cable (USB)
3K-1-061	PC Keyboard (PS2)
3K-4-049	Preparation Stand
3K-1-081	Stainless Steel Tweezer
3K-4-084	Certified Benzoic Acid Tablets (150 x 0.5gram Tablets per bottle)
3K-4-106	Wire Brush
3K-3-18	Emergency Deflate Cap
3K-1-098	Printer Cable (RS232)
3K-1-043	USB Memory Flash Drive (Manuals)
INSTALLATION-GUIDE	Printed Installation Guide

34.4 3K-S/ST CALORIMETER INSTALLATION KIT (CAL3K-S/CAL3K-ST)

PART NUMBER	DESCRIPTION
3K-1-055	Power supply 12V/1.5A
3K-1-061	PC Keyboard (PS2)
3K-4-049	Preparation Stand
3K-1-081	Stainless Steel Tweezer
3K-4-084	Certified Benzoic Acid Tablets (150 x 0.5gram Tablets per bottle)
3K-4-106	Wire Brush
3K-3-18	Emergency Deflate Cap
3K-1-131	RS232 PC Cable
3K-1-043	USB Memory Flash Drive (Manuals)
INSTALLATION_GUIDE	Printed Installation Guide

34.5 3K-2/ AIR COOLER INSTALLATION KIT (CAL3K-2)

PART	DESCRIPTION
3K-1-055	Power supply 12V/1.5A

34.6 3K-3-KT FILLING STATION INSTALLATION KIT (CAL3K-3)

PART NUMBER	DESCRIPTION
3K-3-29	Nozzle O-Rings
3K-3-21	Oxygen Regulator Connection Kit (Quick fit)
3K-3-27	High Pressure Oxygen Pipe 4mm (3.75m)
3K-3-22	De-filler Cap
3K-1-080	Nozzle O-Rings
3K-3-32	Allen Key
3K-1-086	O-Ring Lubrication Grease Tube

34.7 4K-4 VESSEL INSTALLATION KIT (4K-4)

PART NUMBER	DESCRIPTION
3K-4-122	Centre Electrode
3K-4-124	Outside Electrode
3K-4-047	Crucible
3K-4-092	Deflector Plate
3K-4-065	Firing Cotton
3K-4-093	Firing Wire
3K-4-094	Large Lid O-ring
3K-4-022	Top & Bottom O-ring

34.8 4K-4-AP VESSEL INSTALLATION KIT (4K-4-AP)

PART NUMBER	DESCRIPTION
3K-4-036	Centre Electrode
3K-4-124	Outside Electrode
3K-4-047	Crucible
3K-4-092	Deflector Plate
3K-4-065	Firing Cotton
3K-4-093	Firing Wire
3K-4-094	Large Lid O-ring
3K-4-039	Inflation Nipple on vessel cap
3K-4-043	Nozzle Base O-Ring

35 APPENDIX 4

35.1 CERTIFICATIONS

Certificate of Compliance

EMC Bayswater Test Report: E2111-1479
Issue Date: March, 2022

Product(s):	Bomb Calorimeter
Model No:	CAL3k-S
Serial No:	0-05/ 10-21/026
Variant:	Cal 3k U, Cal 3K S & Cal 3kF
	The above listed variant (CAL3k-S) was tested by EMC Bayswater Pty Ltd as a representative model and the results and conclusions within this report do not necessarily reflect compliance for other models. Please refer to section 5 of this report for variant information and the customer variant declaration.
Manufacturer:	Digital Data Systems Pty Ltd, South Africa
Client Details:	Mr. Peter Barras A.L.P.E Pty Ltd t/a Scientific Solutions Australia Pty Ltd PO Box 3229 Bangor, NSW, 2234, Australia Phone No: 02 9543 7377 Fax No: 02 9543 7366 e-mail: peter@alpe.net.au
Test Specification(s):	EN 61326-1: 2013 (RCM Emissions Requirements Only) Electrical Equipment for Measurement, Control and Laboratory Use – EMC Requirements. Part 1: General requirements

Results Summary:			
	Electromagnetic Radiation Disturbance	(CISPR 11)	***Complied (Group 1, Class A)***
	Mains Terminal Disturbance Voltage	(CISPR 11)	***Complied (Group 1, Class A)***
	Electrostatic Discharge (ESD)	(EN 61000-4-2)	***Not tested****
	Electromagnetic Field	(EN 61000-4-3)	***Not tested****
	Burst	(EN 61000-4-4)	***Not tested****
	Surges	(EN 61000-4-5)	***Not tested****
	Conducted RF	(EN 61000-4-6)	***Not tested****
	Power Frequency Magnetic Field	(EN 61000-4-8)	***Not tested****
	Voltage Dips and Interruptions	(EN 61000-4-11)	***Not tested****
	Harmonic Current Emissions	(EN 61000-3-2)	***Not tested****
	Voltage Change, Fluctuation & Flicker	(EN 61000-3-3)	***Not tested****

**The customer requested EMC Emissions testing only for RCM. No EMC Immunity testing was performed.*

Test Date(s):	8th to the 25th of November, 2021
Test House (Issued By)	EMC Bayswater Pty Ltd 18/88 Merrindale Drive Croydon South, Victoria, 3136, Australia Phone No: +61 3 9761 5888 e-mail: sales@emcbayswater.com.au Fax No: +61 3 8761 6547 Web: www.emcbayswater.com.au

The A.L.P.E Pty Ltd t/a Scientific Solutions Australia Pty Ltd, CAL3k-S, Bomb Calorimeter, complied with the group 1, class A emissions requirements of EN 61326-1: 2013 (RCM Emissions Requirements Only).

Tested & prepared by:	Approved by:	
		03/03/2022 12:14
Fabio D'Amico (EMC Test Engineer)	Neville Liyanapatabendige (Manager)	Date

36 APPENDIX 4.

36.1 M NUMBER MESSAGES AND ERRORS

36.1.1 LID CLOSE 100-199

M101	**NO CALIBRATION ENTRIES -** *Refer to: INTERNAL PREP*
M101 THIS VESSEL MUST BE CALIBRATED ! M101: This vessel has no calibration history! Set '**CALIBRATE**', '**YES**' and prepare the vessel with a Benzoic Acid tablet for calibration.	
M102	**POWER START USER TEST -** *Refer to: INTERNAL PREP*
POWER UP: ESC TO START, USER TEST: F9; M102: The unit had a power up condition. It requires a HARDWARE test (F9) or '**ESC**' to proceed. The Hardware test can be performed at any time later with the '**F9**' key or 'CAL3K TEST' command.	
M104	**PREPARATION MODE -** *Refer to: INTERNAL PREP*
PREP: M=_____ SID=_____ ; M104: The Unit is in the PREPARATION mode. At this stage it requires a prepared vessel, a CALIBRATION and the sample MASS entered. Then the unit will proceed and check the rest.	
M106	**MASS IN, NO BOMB -** *Refer to: INTERNAL PREP*
M106: INSERT PREPARED BOMB, CHECK SID M106: The CAL3K does not communicate with the vessel or the vessel is missing. The vessel communication can be checked with the 'VESSEL-TEST'.	
M108	**ENTER MASS, CHECK SID -** *Refer to: INTERNAL PREP*
M108: ENTER MASS, CHECK SID M108: The CAL3K requires that a MASS is entered before proceeding. The MASS can be entered from the balance port, or from the keyboard, or from the Vessel (Docking). Once entered the unit will check more PREPARATION settings before switching to INITIAL CYCLE.	
M109	**ENTER MASS (used if TimeIsSid) -** *Refer to: INTERNAL PREP*
M109: ENTER MASS M109: The CAL3K requires that a MASS is entered before proceeding. The MASS can be entered from the balance port, or from the keyboard. Once entered the unit will check more PREPARATIONS settings before switching to INITIAL CYCLE.	

M110	**ENTER MASS, INSERT BOMB, CHECK SID -** *Refer to: INTERNAL PREP,ENTER MASS, SAMPLE IDENTIFICATION (SID)*
M110: ENTER MASS, INSERT BOMB, CHECK SID M110: The CAL3K needs a prepared vessel and the sample mass to proceed. PREPARE the vessel with approx. 0.5gr sample measured to 0.0001gr, fill the vessel with oxygen, and insert the prepared vessel in the well. Then enter the mass '**F1**' or via the balance interface.	
M111	**ENTER MASS, INSERT BOMB -** *Refer to: INTERNAL PREP, MASS ENTRY*
M111: ENTER MASS, INSERT VESSEL The CAL3K needs a prepared vessel and the sample mass to proceed. Prepare the vessel with a ~0.5gr sample measured to 0.0001gr, fill the vessel with oxygen, and insert the prepared vessel in the well. Then enter the mass '**F1**'.	
M112	**INSERT BOMB -** *Refer to: INTERNAL PREP, INITIAL CYCLE*
M112: INSERT VESSEL	

M112: The Mass is captured (entered) but the vessel is missing. Please insert a vessel!

M113	**BOMB TEMP TOO HOT -** *Refer to: INTERNAL PREP, COOING CYCLE*

M113: VESSEL TEMP __._ NEEDS EXT.COOLING
M113: The vessel temperature is above the max cooler temperature of 42C: Please remove the vessel and cool it!

M116	**BOMB NEAR FIRING INSPECTION -** *Refer to: INTERNAL PREP*

M116 WARNING: BOMB IS NEAR INSPECTION
M116: The firing count has exceeded the 'Fire warning' parameter, and the vessel needs to be inspected soon. The inspection is a safety precaution and must be performed by authorised personnel.

M118	**FIRING INSPECTION -** *Refer to: INTERNAL PREP*

M118 BOMB EXCEEDED FIRING LIMIT: INSPECT
M118: The Vessel has a **WARNING** and an INSPECTION limit, which is now exceeded. As a safety precaution all further operations are blocked. The Firing limit can be reset via the USB port after the inspection has been carried out by DDS or the agent!

M146	**FIRING VOLTAGE OUT OF SPEC -** *Refer to: INTERNAL PREP, FIRING VOLTAGE*

M146 FIRING VOLTAGE OUT OF SPEC: 5-35V "
The Firing voltage setting in the parameter section is out of the range from 5 to 35 Volts. Re-enter the parameter or load the 'DEFAULT PARAMETERS'.

M148	**BA RANGE -** *Refer to: INTERNAL PREP, CALIBRATION*

M148: BENZOIC ACID CALIBRATION VALUE BAD"
M148: The BENZOIC ACID (BA) CALIBRATION value is out of range 10 to 30MJ. The standard value is 26.454MJ/Kg. If other calibration material is used it must be in the range. Use the 'BENZOIC ACID VAL' command to set it!

M150	**SPIKE VALUE RANGE -** *Refer to: INTERNAL PREP, SPIKE MASS*

M150 SPIKE CALIBRATION VALUE PARA BAD "
The 'SPIKE VALUE' parameter is used when the 'SPIKE MASS' entry > zero. The Spike Value should read 26.454Kj/g if Benzoic Acid is used for spiking. The allowed range is 10 to 30MJ. Re-enter the value or load the 'DEFAULT PARAMETERS'.

M154	**AMBIENT TEMP READING BAD -** *Refer to: INTERNAL PREP*

M154 AMBIENT TEMP. READING BAD ___.__ C "
M154: The Ambient temperature reading is outside the 5-50C range. This can be caused by a faulty sensor or a faulty temperature calibration.

M155	**FILLING TARGET TOO HIGH -** *Refer to: INTERNAL PREP, OVER-PRESSURE, SAFE HIGH-PRESSURE OXYGEN*

M155 OXYGEN FILLING TARGET IS TOO HIGH! " (CAL3K-AP ONLY)
The Oxygen filling target is set higher than 35 Bar! This violates the safety conditions and the 3K_AP will not operate.

M157	**MIN MASS TOO LOW -** *Refer to: INTERNAL PREP, MASS, MIN MASS LIMIT, MAX MASS LIMIT*

M157 MIN MASS PARAMETER TOO LOW "
M157: The Minimum Mass parameter must be higher than 0.05g! The parameter can be changed from the keyboard or by loading the default parameters.

M159	**MAX MASS TOO HIGH -** *Refer to: INTERNAL PREP, MASS, MIN MASS LIMIT, MAX MASS LIMIT*
M159 MAX mass too high M159 MAX MASS PARAMETER TOO HIGH " The Maximum Mass parameter must be lower than 1.6g! The maximum mass parameter can be changed from the keyboard!	

M161	**MISFIRE LIMIT HIGH -** *Refer to: INTERNAL PREP, MISFIRE LIMIT*
M161 MISFIRE LIMIT TOO HIGH " M161: The Miss Fire limit must be lower than 0.5C. A Zero disables the misfire check. The parameter can be changed from the keyboard.	

M162	**BOMB FACTOR ADJUST -** *Refer to: INTERNAL PREP, LOAD DEFAULT PARAMETERS*
M162 BOMB FACTOR ADJUST: 0.99 - 1.01 " M162 The bomb factor range is 0.99 to 1.01 (±1%). The default value is 1.00.	

M172	**WAIT FOR ATC COOLING -** *Refer to: INTERNAL PREP, INITIAL CYCLE, READ ATC TEMP*
M172 WAIT ATC IS COOLING DOWN! " M172: The ATC is too warm from the last determination and needs to cool down. This should take about 30-60 seconds. After the cooling time the INITIAL CYCLE will start. Do not close the lid	

M180	**BOMB FAULT -** *Refer to: INTERNAL PREP, TESTING VESSEL HARDWARE*
M180 VESSEL SHOWS INTERNAL FLT: TEST IT!" M180: The Vessel displays an internal fault. The details can be confirmed with the vessel test. Type '**VESSEL-TES**T' or press '**F7**', Enter, '**YES**' and check for details.	

M184	**CLOSE THE LID -** *Refer to: INTERNAL PREP, OPERATING CYCLES*
M184: PLEASE CLOSE THE LID " Everything is OK, but the LID needs closing. The CAL3K has a bomb and a mass and has performed all system checks. It is ready to proceed after the LID is closed.	

M186	**FIRING WIRE OPEN CIRCUIT -** *Refer to: INTERNAL PREP, FILLING STATION INSTALLATION*
M186 FAULT: FIRING WIRE OPEN CIRCUIT! " M186: The Firing wire in the vessel is open circuit or makes no contact. Open the vessel and replace the wire or check the contacts to the outer and inner electrodes. Make sure oxygen is filled and that the regulator is set correctly.	

M190	**AMBIENT SENSOR OFFSET FAULT -** *Refer to: INTERNAL PREP*
M190 FAULT: AMBIEN SENSOR OFFSET ____.__" The Ambient sensor offset calibration is greater than ±10C. A temperature calibration is needed. If the fault persists after the calibration, then the sensor is faulty and the sensor must be replaced.	

M192	**ATC BOTTOM SENSOR OFFSET FAULT -** *Refer to: INTERNAL PREP*
M192 FAULT: ATC BOT SENSOR OFFSET____.__" M190: The bottom ATC sensor offset calibration is greater than ±10C. A temperature calibration is needed. If the fault persists after the calibration then the sensor is faulty and the sensor must be replaced.	

M193	**ATC TOP SENSOR OFFSET FAULT -** *Refer to: INTERNAL PREP*
M193 FAULT: ATC TOP SENSOR OFFSET____.__" M193: The top ATC sensor offset calibration is greater than ±10C. A temperature calibration is needed. If the fault persists after the calibration, then the sensor is faulty and the sensor must be replaced.	

M194	**PRESSURE SENSOR OFFSET FAULT -** *Refer to: INTERNAL PREP, CAL3K-AP PRESSURE COMMANDS , SAFE HIGH-PRESSURE OXYGEN*
M194 PRESSURE SENSOR OFFS FLT ____._ BAR" M194: The Pressure sensor has a high offset value. The reason can be a bad ZERO calibration or a faulty sensor. Recalibrate (Zero) the sensor with the lid open!	
M195	**SYSTEM CHECK FAULT -** *Refer to: CYCLE IDLE, LOAD DEFAULT PARAMETERS, HARDWARE TEST*
M195 SYSTEM FAULT IS DETECTED! IGNORE=F8" M195: A System fault is pending. The fault can be the result of bad calibration, a changed setup parameter, or a hardware failure. Load the default parameters, re-calibrate and test the CAL3K hardware '**F9**'.	
M196	**HARDWARE TEST ERROR -** *Refer to: CYCLE IDLE, LOAD DEFAULT PARAMETERS, HARDWARE TEST*
M196 HARDWARE TEST FAULT! IGNORE=F8 " M196: A hardware test fault is pending. Repeat the hardware test '**F9**' and judge the severity. You may carry on or call the maintenance/agent with the fault number.	
M197	**FILLING TIME EXCEEDED -** *Refer to: INTERNAL PREP, Internal Filling, CAL3K-AP PRESSURE COMMANDS , SAFE HIGH-PRESSURE OXYGEN*
M197 WARN: SLOW FILLING, TIME EXCEEDED " M197: The allocated filling time was exceeded. Check the oxygen supply pressure. If OK then the filter may be blocked. You can also lengthen the FILL TIME SEC from the default=45 sec to 60 seconds.	

36.2 INITIAL STAGE 200-299

M204	**FILLING PRESSURE BELOW MIN -** *Refer to: INITIAL FILLING, CAL3K-AP PRESSURE COMMANDS , SAFE HIGH-PRESSURE OXYGEN*
M204 WARNING: FILLING PRESSURE BELOW MIN" M204: WARNING: The Vessel filling pressure is below the set minimum setting. This could be intentional or the supply (Bottle) is low.	
M206	**NO FILLING, PRESSURE BELOW 0.5BAR -** *Refer to: INITIAL FILLING, CAL3K-AP PRESSURE COMMANDS , SAFE HIGH-PRESSURE OXYGEN, HARDWARE TEST*
M206 WARNING: NO OXYGEN PRESSURE! SLOW? " M206: WARNING: The absolute vessel pressure reading is too low (<0.5bar). The reason could be that the oxygen supply is shut down because the hardware is faulty. The hardware can be tested with the '**F9'** key.	
M210	**FAULT DURING INITIAL -** *Refer to: Cycle Initial, CALORIMETER HARDWARE TEST, VESSEL HARDWARE TEST*
M210: HARDWARE FAULT OR VESSEL COMMS FLT" M210: The communication to the vessel was lost or a hardware problem was found. Perform a hardware test on vessel and chassis.	
M211	**BOMB COMS LOST DURING FILLING -** *Refer to: CYCLE INITIAL, CALORIMETER HARDWARE TEST, VESSEL HARDWARE TEST*
M211: VESSEL COMMS LOST DURING FILLING " M211: The vessel communication was lost during the oxygen filling operation. The 3K_AP will deflate the vessel and start fresh.	
M214	**FILLING INTERRUPTED -** *Refer to: CYCLE INITIAL, PREPARING VESSEL*
M214: FILLING TERMINATED, START FRESH! "	

M214: The filling process was interrupted by an 'Open Lid' or an 'Abort'. The sample is lost and the vessel must be prepared with a fresh sample.

M216	**INITIAL CYCLE INTERRUPTED -** *Refer to: CYCLE INITIAL*

M216: INITIAL CYCLE (LID) TERMINATED "
M216: The initial period was terminated by the OPEN LID command.

M230	**FILL STAGE -** *Refer to: CYCLE INITIAL, CAL3K-AP PRESSURE COMMANDS , SAFE HIGH-PRESSURE OXYGEN, HARDWARE TEST, SYSTEM LEAK TEST, INTERNAL FILLING*

FILL PRESSURE= TARGET= s"
M230: The oxygen filling is in progress. The oxygen pressure should increase to the target pressure. If the pressure is stable and above the Minimum Pressure, then the Initial period starts.

M240	**INITIAL CYCLE DISPLAY -** *Refer to: CYCLE INITIAL*

INI "
M240: The initial stage is required to stabilise the vessel temperature before firing the charge.

M258	**INITIAL TEMPERATURE TOO HOT -** *Refer to: CYCLE INITIAL*, READ VESSEL TEMP

M258 INITIAL TEMP TOO WARM: COOL VESSEL!"
M258: WARNING: The INITIAL temperature is above the allowed limit. Once the vessel is fired the end temperature could be too warm to touch. Be careful! At high vessel temperatures the calibration should be repeated!

M270	**WAIT FOR FIRING CHARGER -** *Refer to: CYCLE INITIAL, CALORIMETER HARDWARE TEST, ABORT*

M270 WAIT FOR FIRING VOLTAGE: "
M270: The firing charger has not charged the firing battery to the stipulated voltage. Wait! If the charger gets "stuck" perform an '**ABORT**' followed by a calorimeter hardware test.

M280	**FIRING.... -** *Refer to: MAIN CYCLE*

M280 FIRING: THE CHARGE IS IGNITED "
M280: All the initial conditions are fulfilled, and the vessel is fired. When the sample ignites then the temperature will rise by approx. 12C.

36.2.1 MAIN (+END) STAGE 300-399

M300	**BOMB FAULT DURING MAIN, ABORTED -** *Refer to: MAIN CYCLE, CALORIMETER HARDWARE TEST, VESSEL HARDWARE TEST*

M300 BOMB FAULT DETECTED: ABORTED MAIN "
M300: The vessel failed to update! Any further operation is aborted! The bomb should be subjected to a '**VESSEL-TEST**'! If this happens repeatedly then the contact in the well must be checked or the CAL3K and vessel must be returned to the manufacturer.

M302	**KEYBOARD ABORT IN MAIN -** *Refer to: MAIN CYCLE*

M302: ABORT/LID OPEN IN PROGRESS, WAIT! "
M302: A manual abort or an open lid request was detected in the main period. As a safety precaution the vessel can't be removed in the first 60 seconds after firing. Please Wait!

M304	**FILLING LEAK -** *Refer to: INITIAL CYCLE, CAL3K-AP PRESSURE COMMANDS , SAFE HIGH-PRESSURE OXYGEN, HARDWARE TEST, SYSTEM LEAK TEST, MAINTENANCE*

M304: FILLING PRESSURE LEAKED: __._ BAR"

M304: The filling pressure has decreased before firing by more than the specified limit. Either the vessel is leaking or the 'FILL LEAK PRESS' limit is too small. A leak of 1.2 bar can be expected as part of 'settling in'!

M305	**DEFLATE OPERATION FAULT -** *Refer to: MAIN CYCLE, END CYCLE, CAL3K-AP PRESSURE COMMANDS , SAFE HIGH-PRESSURE OXYGEN, HARDWARE TEST, ABORT*

M305: DEFLATE FAULT! EMERGENCY DEFLATE! "
M305: The vessel could not be deflated. This can be a fault of the deflate solenoid, the driver, or a blocked filter. The **EMERGENCY DEFLATE** procedure must be followed. SEE: MANUAL.

M306	**OXYGEN FLUSH CYCLE -** *Refer to: END CYCLE*

M306 VESSEL FLUSH PRESSURE: ___.__ BAR"
M306: The vessel is flushed with oxygen to remove harmful gases from the pipes and from the vessel itself for the set time in seconds.

M307	**SLOW DEFLATE, CHECK FILTER -** *Refer to: END CYCLE, MAINTENANCE, CAL3K-AP PRESSURE COMMANDS*

M307: The deflation of the vessel was too slow compared to the time limit. Increase the 'DEFLATE TIME SEC' or investigate if the filter, exhaust valve or exhaust port are blocked.

M308	**FLUSH CYCLE IN PROGRESS -** *Refer to: END CYCLE, FLUSH SECONDS*

M308 WAIT, VESSEL IS FLUSHED WITH OXYGEN" (**CAL3K-AP/S/ST**)
M308: The vessel FLUSH option was enabled by entering a number (seconds) in the '**FLUSH TIME SEC**' parameter. The vessel is flushed out with oxygen by inflating and then deflated after the determination. The flush cycle can be aborted with `**ESC**'.

M309	**DEFLATE DONE** - *Refer to: END CYCLE*

M309 DEFLATE DONE! LID WILL OPEN! "
M309: The deflate cycle is done and the vessel can be removed after the lid opens.

M310	**MISFIRE** - *Refer to: MAIN CYCLE, MISFIRE LIMIT, MISS FIRE*

M310 MISSFIRE! TEMPERATURE RISE: _.____ "
M310: The CAL3K has detected a temperature rise of less than the miss fire parameter after firing and considers this a MISSFIRE. Please open the vessel and make sure that the cotton thread touches the sample. If a very small sample mass is burned, then the 'MISSFIRE LIMIT' should be lowered.

M316	**MAIN CYCLE DISPLAY -** *Refer to. MAIN CYCLE*

MAI "
M316: This is the MAIN operating cycle. It starts by firing the vessel and ends with the result display.

M318	**BOMB TEMP > 55C -** *Refer to. MAIN CYCLE, READ VESSEL TEMP*

M318 WARNING: VESSEL TEMPERATURE > 55C "
M318: The vessel temperature has exceeded 55℃. It may be too hot to handle when removing from the well! Depending on the calibration the accuracy may be affected!

M320	**TEMP RISE TOO HIGH -** *Refer to. MAIN CYCLE, READ VESSEL TEMP*

M320 Warning:Temp Rise high,Reduce Mass "
M320: The temperature Rise is higher than the set limit. Proceed with reduced accuracy or reduce the total mass by 30%.

M324	**TEMP RISE TOO LOW -** *Refer to. MAIN CYCLE, MASS CHECKING, READ VESSEL TEMP*
M324 Warning:Temp Rise low,Increase Mass" M324: The temperature Rise is lower than the set limit. Proceed with reduced accuracy or increase the total mass by 40%.	

M330	**MAIN TIME WAIT -** *Refer to: MAIN CYCLE*
M330 " M330: The unit has fired and waits for the 'Main time' before terminating this cycle. The Main time is fixed for a particular mode and unit.	

M340	**RESULT DISPLAY -** *Refer to: MAIN CYCLE, CALIBRATION, UNITS*
__-__:__ _____ _._____ _____" M340: The result is displayed in the selected units. The result is compensated and calculated according to the calibration.	

M341	**TEMPERATURE HIGH RISE SUSPECT -** *Refer to: MAIN CYCLE, CALIBRATION, HIGH RISE LIMIT, READ VESSEL TEMP*
M341: SUSPECT HIGH TEMPERATURE RISE " M341: The temperature rise of the last determination was above the High-Rise Limit of 16℃ (Default). You can change the limit with '**HIGH RISE LIMIT**' but the 16C℃ is optimal. Reduce the sample mass to stay within the limit. Higher temperature rise requires a calibration clear and subsequent calibrations with 1.0g BA!	

M342	**TEMPERATURE LOW RISE LIMIT SUSPECT -** *Refer to: MAIN CYCLE, VERY SMALL SAMPLE MASS, LOW RISE LIMIT*
M342: SUSPECT LOW TEMPERATURE RISE " M342: The Temperature rise of the last determination was below the Low-Rise Limit of 8℃ (Default). You can increase the sample mass or change the limit with 'LOW RISE LIMIT'. If a low rise is normal, then you should calibrate with 0.25g of Benzoic Acid.	

M343	**SUSPECT HIGH AMBIENT TEMPERATURE -** *Refer to: MAIN CYCLE, HI AMBIENT LIM, CALIBRATION, READ AMB TEMP*
M343: SUSPECT HIGH AMBIENT TEMPERATURE " M343: The Ambient temperature is above the High Ambient limit of default 36℃. If this is too low for your operation, then you can change the limit with 'HIGH AMBIENT LIM' and re-calibrate the unit.	

M344	**SUSPECT LOW AMBIENT TEMPERATURE -** *Refer to: MAIN CYCLE*
M344: SUSPECT LOW AMBIENT TEMPERATURE " M344: The Ambient temperature limit of 8℃ was reached. The unit should not be operated there unless it was calibrated. The cooling times are affected. It is best to keep the ambient temperature to a minimum of 16℃.	

M360	**WAIT, VESSEL IS DEFLATING -** *Refer to:* CYCLE END, *ABORT, OPEN LID*
360 WAIT, VESSEL DEFLATING:___._ BAR __s" M360: The determination is finished or was aborted. The CAL3K is deflating the vessel and will open the LID soon.	

M370	**REMOVE BOMB FOR COOLING AND PREPARATION -** *Refer to:* CYCLE END, *PREPARING VESSEL, COOLING CYCLE*
M370 REMOVE BOMB FOR COOLING AND PREP. "	

M374	**TERMINATION BLOCKED, WAIT -** *Refer to: MAIN CYCLE, CAL3K-AP PRESSURE COMMANDS*
M374: MAIN TERMINATION BLOCKED, WAIT! " M374: The determination can't be terminated for 60 seconds after firing. The termination can be the result of a manual or system request. The blocking is for 60 seconds after firing to allow the very high pressure in the vessel to subside.	
M380	**CALIBRATION AVERAGE CORRUPTION -** *Refer to: CYCLE END, CALIBRATION, CLEAR CALIBRATION, CALIBRATION COMMANDS*
M380: CALIBRATION CORRUPTION! CLEAR CALI" M380: During the average process a calibration was found to be corrupted. Clear the calibration (CLEAR B_CAL S/N). There is no recovery possible!	
M382	**PRESSURE EXPLOSION ABORT -** *Refer to: MAIN CYCLE, SAFE HIGH-PRESSURE OXYGEN, CAL3K-AP PRESSURE COMMANDS*
M382 VESSEL PRESS. SAFETY LIMIT EXCEEDED" M382 The vessel pressure exceeded 90 Bar after firing. The vessel must be inspected. This can happen when the sample mass is too high or with powdery substances.	

36.2.2 BOMB FAULTS 400-499

M400	**BOMB SUPPLY FAULT -** *Refer to: MAIN CYCLE, VESSEL HARDWARE TEST, CALORIMETER HARDWARE TEST*
M400: VESSEL SUPPLY FAULT " M400: The vessel has detected a supply fault. The nominal supply should be 5.4 to 5.7Volt with a vessel inserted. The fault could be in the control card, or the vessel. The fault may influence the temperature readings. Contact your agent!	
M401	**BOMB REFERENCE FAULT -** *Refer to: MAIN CYCLE, VESSEL HARDWARE TEST*
M401: VESSEL REFERENCE FAULT " M401: The vessel's reference voltage is out of specification. This vessel must be returned to the manufacturer.	
M402	**BOMB MEMORY FAULT -** *Refer to: MAIN CYCLE, VESSEL HARDWARE TEST*
M402: VESSEL MEMORY FAULT " M402: The Vessel memory shows a fault. No vital information is lost and the vessel may be used. However, it is recommended to return the vessel to the manufacturer!	

M403	**BOMB SENSOR #1 FAULT -** *Refer to: MAIN CYCLE, VESSEL HARDWARE TEST*
M403: VESSEL SENSOR #1 FAULT " M403: The vessel is not usable and must be returned to the factory!	
M404	**BOMB SENSOR #2 FAULT -** *Refer to: MAIN CYCLE, VESSEL HARDWARE TEST*
M404: VESSEL SENSOR #2 FAULT " M404: The vessel is not usable and must be returned to the factory!	
M405	**BOMB A/D FAULT -** *Refer to: MAIN CYCLE, VESSEL HARDWARE TEST*
M405: VESSEL A/D FAULT " M405: The Vessel shows an Analog to Digital (A/D) fault. The vessel must be returned to the factory.	

36.2.3 GENERAL 500-599

M502	**INTRODUCTION DISPLAY** *Refer to: GETTING STARTED, CONNECTING TO A PC*
M502: The unit detected a power up or Abort. It displays the Introduction for N Seconds, where N is a parameter. The parameter can be set via a PC connected to the USB port.	
M505	**CALIBRATION CLEAR NOT ALLOWED WITH BOMB INSERTED -** *Refer to: INTERNAL PREP, CALIBRATION, PREPARING VESSEL, CALIBRATION COMMANDS*
M505: REMOVE VESSEL TO CLEAR CALIBRATION" M505: The vessel must be removed while clearing the calibration field.	
M508	**BOMB FAILED -** *Refer to: INTERNAL PREP, VESSEL HARDWARE TEST*
M508 VESSEL FAILURE! DO NOT USE VESSEL " M508: The vessel can't be used unless the fault is rectified. For any vessel fault other than supply the vessel must be returned to the manufacturer! If the supply is faulty then this must be investigated by the agent first.	
M512	**POWERUP, DEFLATING -** *Refer to: MAIN CYCLE, CAL3K-AP PRESSURE COMMANDS, READ PRESSURE, PRESS ZERO ADJ*
POWERUP: DEFLATE VESSEL __._ FOR __ Sec" M512: The Power up procedure detected a high pressure in the vessel and has attempted to deflate the vessel for 30 seconds. The high pressure could be the result of: Real pressure or a misaligned pressure transducer.	
M516	**EMERGENCY DEFLATE -** *Refer to: MAIN CYCLE, CAL3K-AP PRESSURE COMMANDS, READ PRESSURE, PRESS ZERO ADJ, CALORIMETER HARDWARE TEST*
M516 EMERGENCY DEFLATE! HOLD LID, `**F6**' " M516: The unit is detecting pressure! The most likely reason is the pressure transducer zero offset, which can be set later via the '**PRESS ZERO ADJ**' command. Hold the lid down and press `**F6**' (Open Lid). Once open zero the pressure transducer offset. If the offset was not the reason, then: The deflate valve is not working. Contact your agent or the manufacturer.	
M518	**ABORT PRESSURE -** *Refer to: MAIN CYCLE, CALORIMETER HARDWARE TEST, CAL3K-AP PRESSURE COMMANDS, READ PRESSURE, PRESS ZERO ADJ*
M518 VESSEL PRESSURE INDICATED: __._ BAR" M518: The vessel pressure may not be real! It can be the result of a faulty pressure sensor or offset value.	
M519	**DISPLAY LAST NETT TEMPERATURE RISE -** *Refer to: CYCLE IDLE, EASY SPIKING, VESSEL PREPARATION*
M519 THE LAST TEMP. RISE WAS: __._____ C" M519: The last temperature Nett Rise is required for gelatine capsule compensation in the EASY SPIKE method. See Manual: EASY SPIKING!"	
M520	**DEFLATE TEMPERATURE TOO HIGH -** *Refer to: MAIN CYCLE, READ PRESSURE, READ TEMP VESSEL, CALIBRATION,*
M520 VESSEL DEFLATE TEMP= ___._ TOO HIGH" M520: The Vessel temperature is abnormally high and may damage the exhaust piping. The CAL3K will wait until the temperature is less than 60C before deflating the vessel.	
M522	**PERFORM HARDWARE TEST -** Refer to: CYCLE IDLE, *CALORIMETER HARDWARE TEST*
M522 PERFORM HARDWARE TEST AFTER 10 SEC "	

M522: The ABORT procedure detected some abnormality, and it is advisable to perform a hardware test.	
M530	**MASS LOCKED -** *Refer to: INTERNAL PREP, MASS ENTRY, VESSEL PREPARATION*
THE MASS: _._____ IS LOCKED or CAPTURED! Details: F10" The **MASS** for the NEXT determination has been captured. To unlock the mass: Type **MASS**, 'ENTER', **DELETE**.	
M532	**LEAK TEST ACTIVE -** *Refer to: INTERNAL FILLING(CAL3K-AP ONLY) CAL3K-AP PRESSURE COMMANDS, SYSTEM LEAK TEST, VESSEL LEAK TEST*
LEAK TEST: TARGET VESSEL BAR" M532: The leak test fills the vessel to the target pressure bless 5 bar and closes the inflate valve. Monitor the Vessel pressure! A declining vessel pressure indicates a leak.	
M534	**CLEAR ONE BOMB CALIBRATION -** *Refer to: INTERNAL PREP, CALIBRATION, CALIBRATION COMMANDS, CLEAR CALIBRATION*
M534: CLEAR ONE BOMB CALIBRATION " M534: The vessel just entered has a serial number which has no calibration. All calibration fields are full and ONE field must be cleared before proceeding with this vessel (S/N).	
M536	**LEAK TEST ERR -** *Refer to: INTERNAL FILLING(CAL3K-AP ONLY), CAL3K-AP PRESSURE COMMANDS, SYSTEM LEAK TEST, VESSEL LEAK TEST*
LEAK TEST REQUIRES BOMB AND LID CLOSED! " M536: The Leak Test requires that the vessel is inserted and that the LID is closed. Then the vessel is filled to the **LEAK TEST PRESSURE** and the pressure can be observed.	
M538	**NO CALIBRATION LOADED -** *Refer to: INTERNAL PREP, CALIBRATION, CALIBRATION COMMANDS, CLEAR CALIBRATION*
M538 SEVERE FAILURE! CLEAR CALIBRATION! " M538 No calibration was found when there should be at least one. Clear the calibrations with 'CLEAR B_CAL S/N' for the specific vessel and start again. If this problem persists, contact the manufacturer.	

M539	**NOT ENOUGH CALIBRATIONS FOR COMPENSATION -** *Refer to: INTERNAL PREP, CALIBRATION*
M539 NOT ENOUGH CALIBRATIONS FOR COMPEN." M539 A minimum of 4 calibrations are required for the compensation operation to start.	
M540	**ENTRY WAS BAD -** *Refer to: CYCLE IDLE, BASIC KEYBOARD OPERATIONS, ALL CAL3K COMMANDS*
540 ENTRY WAS UNSUCCESSFUL, NO CHANGE!" M540: The Keyboard entry was not understood by the unit and no action was taken, or no data was saved. The reason could be: Decimal point versus comma, too much or too little data, or alpha numeric entry in a numeric field.	
M544	**INSERT VESSEL TO READ DATA -** *Refer to: CYCLE IDLE, BASIC KEYBOARD OPERATIONS, ALL CAL3K COMMANDS, VESSEL HARDWARE TEST*
M544 INSERT VESSEL TO READ INFORMATION " M544: Insert the vessel in the well to read the Test Date and serial number and other information.	

M545	**AMB OFFSET SET TO ZERO -** *Refer to: CYCLE IDLE, READ AMB TEMP, CALORIMETER HARDWARE TEST*
M545 AMBIENT OFFSET FAULT, SET TO ZERO " M545: The Ambient offset could not be recovered and was set to zero. Perform the offset calibration.	

M546	**AMBIENT OFFSET WAS RECOVERED -** *Refer to: INTERNAL FILLING(CAL3K-AP ONLY), READ AMB TEMP, CALORIMETER HARDWARE TEST*
M546 AMBIENT OFFSET FAULT: RECOVERED " M546: An Ambient fault was detected and recovered.	

M547	**ATC TOP OFFSET SET TO ZERO -** *Refer to: INTERNAL FILLING(CAL3K-AP ONLY), READ ATC TEMP, READ AMB TEMP, CALORIMETER HARDWARE TEST*
M547 ATC TOP OFFSET FAULT, SET TO ZERO " M547: The ATC top offset has a fault and was set to zero. Temperature calibration is recommended.	

M548	**ATC TOP OFFSET WAS RECOVERED -** *Refer to: INTERNAL FILLING(CAL3K-AP ONLY), READ ATC TEMP, READ AMB TEMP, CALORIMETER HARDWARE TEST*
M548 ATC TOP OFFSET FAULT: RECOVERED " M548: The ATC top offset was corrected.	

M549	**ATC BOT OFFSET SET TO ZERO -** *Refer to: INTERNAL FILLING(CAL3K-AP ONLY), READ ATC TEMP, READ AMB TEMP, CALORIMETER HARDWARE TEST*
M549 ATC BOT OFFSET FAULT, SET TO ZERO " M549: The ATC bottom offset was set to zero.	

M550	**ATC BOT OFFSET WAS RECOVERED -** *Refer to: INTERNAL FILLING(CAL3K-AP ONLY), READ ATC TEMP, READ AMB TEMP, CALORIMETER HARDWARE TEST*
M550 ATC BOT OFFSET FAULT: RECOVERED " M550: The ATC bottom offset fault was corrected.	

M551	**MAX CAL3K DATA -** *Refer to: CYCLE IDLE, CLEAR CAL3K MAXIMUM, READ TEMP VESSEL, READ AMB TEMP*
MaxStrt=xx.x Temp=xx.x Amb=xx.x " ; 8 18 27 36 ;MaxStrt=xx.x Temp=xx.x Amb=xx.x Prs=xx.x" M551: The CAL3K shows the Max Firing Temperature, the Max VesselTemperature and the Max Ambient temperature. The maximums can be reset by 'CLEAR CAL3K MAX' keyboard command!	

M553	**PRESS OFFSET SET TO ZERO -** *Refer to: CYCLE IDLE, CAL3K-AP PRESSURE COMMANDS, PRESS ZERO ADJ*
M553 PRESSURE OFFSET FAULT: SET TO ZERO " M553: The pressure offset was set to zero.	

M554	**PRESS OFFSET WAS RECOVERED -** *Refer to: CYCLE IDLE, CAL3K-AP PRESSURE COMMANDS, PRESS ZERO ADJ, CALORIMETER HARDWARE TEST*
M554 PRESSURE OFFSET FAULT: RECOVERED " M554: The Pressure offset fault was recovered.	

M558	**FACTORY TEST IN PROGRESS -** *Refer to: CYCLE IDLE, CALORIMETER HARDWARE TEST*
M558 FACTORY TEST IN PROGRESS, WAIT! " M558: The CAL3K is in the factory test mode. Nothing will work until the test is done!	

M560	**TESTING NOT ALLOWED -** *Refer to: CYCLE IDLE, OPERATING CYCLES*
M560 TESTING NOT ALLOWED in MAIN CYCLE " M560: Testing is only allowed during the PREPARATION CYCLE, because the testing operates on the same hardware. Wait until the INITIAL or MAIN CYCLE is finished.	

M561	**DISPLAY CHASSIS FIRINGS -** *Refer to: CYCLE IDLE, READ CAL3K MAX, PRINT AND OUTPUT*
M561 TOTAL FIRINGS IN CHASSIS: _____ " All firings in this chassis (Control card) are counted and displayed!	
M562	**MASS NOT IN RANGE -** *Refer to: CYCLE IDLE, MIN MASS LIMIT, MAX MASS LIMIT, PREPARING VESSEL*
MASS OUTSIDE LIMITS __._____ to __._____ " M562: The Mass is outside the set limits of MinMass and MaxMass parameters. The limits can be changed via 'MIN MASS LIMIT' and MAX MASS LIMIT'.	

M565	**READ RESULTS PER DAY NN -** *Refer to: CYCLE IDLE, PRINTING AND OUTPUT*
M565: DAY __ FOUND RESULTS __ " M565: The results for the specified day in the range 1-31 are counted as 'found'. Results with a different month but the same day are counted as well. Clear the results regularly!	
M569	**BOMB MAX DISPLAY -** *Refer to: CYCLE IDLE, READ MAX VESSEL*
Tm=__._ @yy/mm/dd-HH:mm Fc=_____ T=_____" M569: The vessel records the date/time, the max temperature and the firing count.	
M570	**BOMB TOTAL FIRINGS CLEAR -** *Refer to: CYCLE IDLE, READ MAX VESSEL*
M570: VESSEL TOTAL FIRINGS ARE CLEARED " M570: The vessel TOTAL firing count is reset.	
M571	**BOMB FIRING COUNT RESET -** *Refer to: CYCLE IDLE, CLEAR VESSEL MAX*
M571: VESSEL FIRING COUNT IS CLEARED " M571: The vessel FIRING count was cleared.	
M572	**LIMS PORT NOT ENABLED -** *Refer to: CYCLE IDLE, PRINTING AND OUTPUT, OUTPUT FORMAT A-H*
M572 PRINT PORT D1 NOT ENABLED " M572: To send a message to the printer port D1 a output format A-H must be specified with the 'OUT FORM A-H' command.	
M573	**NOT ALLOWED, REMOVE BOMB -** *Refer to: CYCLE IDLE*
M573 OPS NOT ALLOWED WITH VESSEL, REMOVE" M573 This operation is not allowed with the vessel inserted. Please remove the vessel!	
M574	**REALTIME PORT NOT ENABLED -** *Refer to: CYCLE IDLE, PRINT AND OUTPUT, SET RT FORM WXYZ, SET RTHEAD CP*
M574 REALTIME (RT) NOT ENABLED WITH WXYZ" M574: To send the Real Time header information to the D1 port an output format W,X,Y,Z must be specified with the 'SET RT FORM WXYZ' command. The customer(C) and parameter(P) can be specified with the 'SET RTHEAD CP' command.	

M576	**PRINTER PORT #1 NOT ENABLED -** *Refer to: CYCLE IDLE, PRINT AND OUTPUT*
M576 WARNING: THE PRINTER PORT D1 UNUSED" M576: The Printer port D1 is not used at all and the port speed was NOT set! Enable it for printing and then set the Baud rate (Speed).	

M582	**CALIBRATION NOT ALLOWED -** *Refer to: CYCLE IDLE, CALIBRATION, PREPARATION CYCLE*
M582 SET CALIBRATION IN PREP MODE ONLY " M582: Setting the unit to perform a calibration is only allowed in 'PREPARATION' mode. That is to say BEFORE a determination!	
M588	**READ VESSEL FIRINGS -** *Refer to: CYCLE IDLE, READ VESSEL INFO*
M583 VESSEL: _____ FIRING:_____ TOT:_____" M583: The Firing and the Total firings count are displayed. The Total is never reset during inspection. When the firing count exceeds the limit then the vessel must be inspected and the count must be reset.	

36.2.4 KEY COMMAND HELP (600+)

M601	**F1/MASS -** *Refer to: CYCLE IDLE, MASS ENTRY*
SAMPLE MASS, NORMALLY 0.5g " The Mass can be entered in three ways: '**F1'**, or Type **'MASS**' or via the balance port. A new mass can be entered after firing. Once a mass is entered it is locked. To 'unlock' it type: **MASS**, enter, DELETE.	
M602	**SID -** *Refer to: CYCLE IDLE, SAMPLE IDENTIFICATION*
SAMPLE IDENTIFICATION, 16 CHARACTERS " The SAMPLE IDENTIFICATION 'SID' is self-incrementing. It increments the last character in the max. 16-character alphanumeric string. Numerals or letters are incremented!	
M603	**GID -** *Refer to: CYCLE IDLE, GROUP IDENTIFICATION*
SAMPLE GROUP IDENTIFICATION, 16 CHARACTER." The GROUP IDENTIFICATION 'GID' is a up to 16 character string. It is used to identify a 'GROUP' of determination (if needed). It can be left blank!	
M604	**TIME SET -** *Refer to: CYCLE IDLE, TIME AND DATE*
SET THE TIME! IT IS USED IN DATA STORAGE" The CAL3K has a timing circuit which operates approx. 1 week without power. The time is needed when the result and calibrations are saved.	

M605	**DATE SET -** *Refer to: CYCLE IDLE, TIME AND DATE*
SET THE DATE! USED TOGETHER WITH TIME " The date comes from a timing circuit which operates approx. 1 week without power. It is normal to set the time after prolonged no power.	
M606	**PASSWORD -** *Refer to: CYCLE IDLE, PASSWORD ENTRY*
ENTER PASSWORD! BEEP INDICATES WRONG PSW" The factory password is 'DDS3K'. The password can be changed via the USB port. If the CAL3K beeps after the password entry, then it is rejected. The password is active for the Password time (parameter).	

M607	**SPIKE MASS -** *Refer to: CYCLE IDLE, EASY SPIKING*
SPIKE MASS. >0 ENTRY ACTIVATES SPIKING " The spike mass must be ZERO, which disables the spike calculation if a spike is not used. Otherwise enter the mass of the spiking material. The spike mass is cleared after a determination.	
M608	**SULPHUR CORRECTION -** *Refer to: CYCLE IDLE, SULPHUR CORRECTION*
SULPHUR CORRECTION. ENTRY in UNITS " The sulphur correction is entered as an absolute value in Kj/g. The entry is not used during 'Calibration' or 'BA Check Sample'.	
M609	**COTTON + WIRE CORRECTION -** *Refer to: CYCLE IDLE, COTTON CORRECTION*
COTTON & WIRE CORRECTION, ENTRY in UNITS" The cotton and wire correction is entered in degree C. It compensates for the electrical firing energy, the cotton energy, and the wire oxidation. A standard entry is 0.0593C.	
M610	**PARA DEFAULT LOAD -** *Refer to: CYCLE IDLE, LOAD DEFAULT PARAMETERS*
LOAD FACTORY DEFAULT PARAMETERS " Operating this command invokes a set of DEFAULT parameters, which the manufacturer deemed sufficient.	
M611	**BALANCE MASS -** *Refer to: CYCLE IDLE, MASS ENTRY OF THE SAMPLE MASS*
USE F5 FUNCTION KEY: BALANCE MASS (PORT)" This feature requires that a balance is connected to the CAL3K balance port (pin 2 or 3)and that the balance operates on the same baud rate.	

M612	**ABORT / RESET -** *Refer to: CYCLE IDLE, RESET, ABORT*
RESET CAL3K! SAME AS POWER UP " Abort is the same as a power-up. Any mass value is cleared. If the lid is closed, it will be opened after deflating the vessel. Any determination is aborted.	

M613	**CAL3K TEST -** *Refer to: CYCLE IDLE,* CALORIMETER HARDWARE TEST
CAL3K FIELD HARDWARE TEST! " This test checks all system components. The progress can be observed by the changing 'T' number. The test stops when a fault is found. An individual test can be run by entering the test number instead of 'YES'.	
M614	**VESSEL TEST -** *Refer to: CYCLE IDLE, VESSEL HARDWARE TEST*
VESSEL FIELD TEST! INSERTED VESSEL " The vessel test requires that oxygen pressure is connected. It tests the filling/deflating of the vessel and all electrical components.	
M615	**SPIKE VALUE -** *Refer to: CYCLE IDLE, EASY SPIKING*
SPIKE VALUE IN MJ,CAL or BTU UNITS " The spike value must be in the specified units of measure. If Benzoic Acid is used then the entry should be 26.454KJ/g.	
M616	**FIRING VOLTAGE -** *Refer to: CYCLE IDLE, MAIN CYCLE, FIRING VOLTAGE, READ FIRING VOLTAGE*
FIRING VOLTAGE, NORMALLY AROUND 25V " The firing voltage can be set to suit the operation. It is normally around 25.0 volts. If the wire burns too often then reduce the voltage.	
M617	**FIRING MANUAL -** *Refer to: CYCLE IDLE, FIRE MANUALLY*

CAUTION: THE VESSEL IS FIRED MANUALLY "
This fires the vessel. It should not be used during operation, but it is a great tool to speed up the diagnostics.

M618	**ENTER BA VAL MJ -** *Refer to: CYCLE IDLE, MASS ENTRY, CALIBRATION*

ENTER BA STANDARD VALUE (KJ=26.454) "
The Benzoic Acid (BA) display and entry is in the respective unit of measure as indicated: 26.454Kj/g = 11.3731Kbu/lb = 6.3148KCal/g.

M619	**CALIBRATION -** *Refer to: CYCLE IDLE, CALIBRATION*

SET THE CAL3K TO PERFORM A CALIBRATION "
This initiates a calibration entry in the history. The New calibration is entered in a up to 16 deep calibration history. If full then the least used and oldest is replaced.

M621	**MISSFIRE LIMIT -** *Refer to: CYCLE IDLE, MISS FIRE, TEMPERATURE RISE*

MISSFIRE TEMPERATURE LIMIT "
The miss fire limit is normally set to 0.2C. A sample which raises the vessel temperature by less than the limit is declared a 'MISS FIRE' and the determination is aborted.

M622	**SET UNITS MJ, CAL, BTU -** *Refer to: CYCLE IDLE, UNIT OF MEASURE*

SET CALORIFIC MEASURE UNIT: KJ,KCA,KBU "
The CAL3K works in KJ/g. However, the output and display unit of measure can be set to: KCa (Kilo Calories/g), KBU (Kilo BTu/lb), or the default KJ (Kilo Joul/g). Note that MJ/Kg = KJ/g.

M623	**FIBRE IN FOOD PERCENT -** *Refer to: CYCLE IDLE, CORRECTIONS, FOOD COMPETITIONS*

SET THE FIBRE PERCENT FOR FOOD SAMPLES "
The CV fibre compensation must be with an entry >0. Then the sulphur correction is disabled and the CV is adjusted down by the entered percentage.

M624	**BALANCE SPEED -** *Refer to: CYCLE IDLE, FOOD COMPETITIONS BALANCE PORT, BALANCE SPEED, MASS ENTRY*

BALANCE BAUD SPEED 1200 - 38400 BAUD "
This is the BAUD rate of the balance interface. The default is 2400, but it can be set to 1200,4800,9600,19200,38400 baud.

M625	**FIBRE CV VALUE -** *Refer to: CYCLE IDLE, FOOD COMPETITIONS*

SET THE FIBRE CV VALUE: 4KCal=16.7472KJ "
This CV value for fibres is used together with the 'Fibre Percent' enmple CV. The entry depends on the Unit of measure: 4KCal , *CALIBRATION*= 16.7472KJ

M626	**MIN CALIBRATION -** *Refer to: CYCLE IDLE, CALIBRATION*
M627	**BLOCK CALIBRATION ABOVE LIMIT -** *Refer to: CYCLE IDLE, CALIBRATION*

ALLOW BLOCKING ABOVE DEVIATION LIMIT KJ "
Aed when the peak deviation (to the average) is higher than, *EASY SPIKING*, *SET CAPSULE EN* the limit in KJ.

M628	**GELATINE CAPSULE EN -** *Refer to: CYCLE IDLE, EASY SPIKING, SET CAPSULE EN*
GELATINE CAPSULE COMPENSATION ON/OFF " The gelatine capsules are used for command can enable (YES) or disable (NO) the compensation.	
M629	**GELATINE CAPSULE RISE C -** *Refer to: CYCLE IDLE, EASY SPIKING, HOW TO MEASURE GELATINE CAPSULE RISE, CAPSULE RISE*
ENTER THE GELATINE CAPSULE RISE IN C " If a gelatine capsule is used for the sample then the temperature rise of the capsule alone can be entered CAPSULE=YES' command.	
M630	**MIN MASS LIMIT -** *RRefer to: CYCLE IDLE, ENTERING MASS, MIN MASS LIMIT*
MINIMUM MASS LIMIT " The Minimum Mass limit guards against bad mass entry. Normal setting is 0.2gr.	
M631	**MAX MASS LIMIT -** *Refer to: CYCLE IDLE, ENTERING MASS, MAX MASS LIMIT*
MAXIMUM MASS LIMIT " The Maximum Mass limit guards against bad mass entry. The normal setting is 1.5gr.	
M632	**MAX CALIBRATIONS -** *Refer to: CYCLE IDLE, CALIBRATION, CALIBRATION MANAGEMENT*
CALIBRATIONS MAX BUFFER LENGTH " This command restricts the calibration storage space. The max are 16 calibrations. Practical entry is from 6 to 12.	

M633	**MOISTURE PERCENT ENTRY -** *Refer to: CYCLE IDLE, CORRECTIONS, MOISTURE CORRECTION*
SET THE MOISTURE PERCENT ENTRY " The moisture compensation is enabled with an entry >0 to be active. Then the sample MASS will be reduced by the moisture percent entry.	
M634	**READ CHASSIS FIRINGS -** *Refer to: CYCLE IDLE, READ CAL3K MAX*
READ CHASSIS FIRINGS " The total fining's of the chassis (control card) are displayed.	
M635	**AMB TEMP SENS CALIBRATION -** *Refer to: CYCLE IDLE, READ AMB TEMP, LOADING DEFAULT PARAMETERS*
AMBIENT TEMPERATURE SENSOR CALIBRATION " The sensor offset is set in the factory.	
M636	**READ RISE OF VESSEL -** *Refer to: CYCLE IDLE, TEMPERATURE RISE, READ LAST N RISE*
READ THE TEMPERATURE RISE AFTER FIRING " The Temperature rise after firing is displayed in real time until the RESC key is pressed. This is the gross temperature rise!	
M638	**CLEAR PRESSURE RECORDINGS -** *Refer to: CYCLE IDLE, CLEAR PRESSURE RECORDS, CLEAR PRESS RECD*
CLEAR PRESSURE RECORDINGS " The 3K_AP keeps the last 16 pressure recordings when the Pressure Peak Limit is exceeded. The limit can be set by the 'PRESS PEAK LIMIT' command !	
M639	**CLEAR RESULT MEMORY -** *Refer to: CYCLE IDLE, CLEAR RESULT MEMORY*

WARNING: THE RESULT MEMORY IS CLEARED! " The COMPLETE result memory is cleared. All stored results are lost.	
M640	**CLEAR CAL3K MAX DATA -** *Refer to: CYCLE IDLE, CLEAR RESULT MEMORY*
CLEAR MAXIMUM CAL3K DATA FIELD " The maximum data accumulated during the operation are cleared.	
M641	**CLEAR VESSEL MAX DATA -** *Refer to: CYCLE IDLE, CLEAR RESULT MEMORY*
CLEAR MAXIMUM VESSEL DATA FIELD " The maximum data field in the vessel is cleared. The vessel must be in the well.	

M642	**CLEAR CALIBRATION HISTORY -** *Refer to: CYCLE IDLE, CLEAR CALIBRATIONS, CALIBRATION MANAGEMENT, CALIBRATION*
CLEAR A VESSEL CALIBRATION: ENTER S/N " All calibrations are cleared for the specified vessel. The entry is the vessel Serial Number or the field (1-4) Number.	
M643	**READ VESSEL TEMP -** *Refer to: CYCLE IDLE, READ TEMP VESSEL*
THE VESSEL TEMPERATURE IS DISPLAYED " This command displays the vessel temperature until the `**ESC**' key is pressed.	
M644	**READ DRIFT AND STABILITY -** *Refer to: CYCLE IDLE, READ DRIFT, READ STABILITY*
DISPLAY VESSEL TEMP DRIFT AND STABILITY " It displays the vessel temperature drift and stability every 6 seconds.	
M645	**READ CARD ID -** *RRefer to: CYCLE IDLE, READ CARD ID*
READ CARD IDENTIFICATION " The Card Identification is set by the factory. It is the Serial Number!	
M646	**READ VESSEL MAX DATA -** *Refer to: CYCLE IDLE, READ MAX VESSEL, PRINTING AND OUTPUT*
READ THE MAXIMUM DATA FROM THE VESSEL " The maximum temperature of the vessel, the date, and the firing count are displayed.	
M647	**READ CAL3K MAX DATA -** *Refer to: CYCLE IDLE, READ CAL3K MAX, PRINTING AND OUTPUT*
READ THE MAXIMUM ACCUMULATED CAL3K DATA " The CAL3K accumulates: Maximum Start Temperature, Maximum Vessel temperature, Maximum Ambient temperature, Maximum Pressure. The dates of the maximum recordings are available on a PC.	
M648	**READ VESSEL INFO -** *Refer to: CYCLE IDLE, READ VESSEL INFO, PRINTING AND OUTPUT*
VESSEL TEST DATE AND SERIAL NUMBER " The Factory test data are displayed followed by the firmware version, serial number and firings.	
M649	**READ AMB TEMPERATURE -** *Refer to: CYCLE IDLE, READ AMB TEMP*
THE AMBIENT TEMPERATURE IS DISPLAYED " This command displays the Ambient temperature in real time. Press ESC to stop the display.	

M650	**READ RESULT -** *Refer to: CYCLE IDLE, READ RESULT DAY, READ RESULTS MEM, READ MEM RECORDS*

THE RESULTS ARE DISPLAYED, LAST FIRST " The results from the memory are displayed first. The result on display can be printed via the '**F8'** key.	
M651	**READ FIRING VOLTAGE -** *Refer to: CYCLE IDLE, READ FIRING VOLT*
THIS IS THE FIRING VOLTAGE AT PRESENT " This is the actual firing voltage. The firing circuit charges up to the standard 25 Volts in approx. 2 minutes.	
M652	**PRINT RESULTS DAY N -** *Refer to: CYCLE IDLE, PRINT AND OUTPUT, PRINT RESULTS DAY*
PRINT RESULTS FROM DAY N (1-31) " Enter a day number (1-31) and all results for this day are printed on the D1 port in the form A-F.	
M653	**PRINT REAL TIME HEADER -** *Refer to: CYCLE IDLE, PRINT AND OUTPUT, PRINTING REAL TIME, SET RT FORM WXYZ*
PRINT REAL TIME DATA HEADER ON PORT D1 " An additional real time data output Header in the format W,X,Y,Z as enabled is printed.	
M654	**SET D1 PORT SPEED -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, PORT D1 (PRINTER PORT), D1 PORT SPEED*
SET DATA#1 PORT SPEED " The D1 port operates at 19.2Kb unless set differently by this command. The other settings are: 8 Bits, Parity=none, Stop=1.	
M655	**FILTER LIMS CALI, FLT -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT*
FILTER LIMS CALIBRATION(C), FAULTS(F) " The output to the LIMS port D1 can be filtered to EXCLUDE Calibration (C) and or Faults (F) results. Faulty results are Misfires, Aborts, Simulations and Manually fired samples.	
M656	**PRINT LIMS HEADER -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, PORT D1 (PRINTER PORT), OUTPUT FORMAT, LIMS*
OUTPUT LIMS HEADER IN SELECTED FORMAT " The data header for one of eight (A-H) LIMS data formats selected by the 'OUT FORM A-H' command is output on the D1 port. Check Port speed!	
M657	**PRINT TODAY FORM -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, PORT D1 (PRINTER PORT), OUTPUT FORMAT*
PRINT TODAY'S DATA IN THE FORM A-F " This prints today's results in the output form A-H on the D1 port.	
M657	**PRINT TODAY FORM -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, PORT D1 (PRINTER PORT), PRT TODAY FORM*
PRINT TODAYS DATA IN THE FORM A-F " This prints today's results in the output form A-H on the D1 port.	
M658	**PRINT CALORIMETER INFO -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, PORT D1 (PRINTER PORT),LOAD DEFAULT PARAMETERS*
CAL3K STATIC INFO PRINTOUT ON D1 PORT " .ascii "The delivery configuration of the CAL3K together with the customer info is printed.	
M659	**PRINT BOMB INFO -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, PRINT VESSEL INFO, PORT D1 (PRINTER PORT)*
STATIC VESSEL PRINT D1: INSERT VESSEL! "	

The delivery info of the vessel is printed together with customer info. The vessel must be inserted in the well.	
M660	**ENABLE REAL TIME HEADER CP -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, PRT RTIME HEADER, LIMS*
ENABLE RT HEADER FOR C=CUSTOMER, P=PARAM" Each real time printout can be preceded by a customer header (C) and a parameter header (P).	
M661	**SET RT DATA FORM W, X, Y, Z -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, PRT RTIME HEADER*
SET THE REAL TIME DATA PRINT FORM WXYZ " The real time (RT) printout format can be set to W,X,Y,Z which are all printer friendly.	
M662	**PRINT MEMORY RESULTS CR -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, PRT RESULTS FROM*
PRINT RESULTS FROM MEMORY: C/R/YES " Enter C for Calibrations only, enter R for results only, Enter YES for all Results.	
M663	**LIMS OUT FORM A-H -** *Refer to: CYCLE IDLE, CONNECTING, PRINT AND OUTPUT, LIMS, OUTPUT FORMAT*
SET THE LIMS OUTPUT FORMAT A-H " The unit has 8 different output formats A-H. Print the format with 'LIMS HEADER PRT' to check if it has what you need and if it fits on to your printer. The formats A-H can be printed with an 80 column printer.	
M664	**PRINT RESULT GID -** *Refer to: CYCLE IDLE, GROUP IDENTIFIER, PRINT AND OUTPUT*
PRINT ALL RESULTS WITH THE SPECIFIED GID" All results with the entered GID are printed on the D1 port. If the GID alignment has changed then the GID results before the change are not printed.	
M665	**READ RESULTS DAY NN -** *Refer to: CYCLE IDLE, READ RESULT DAY, PRINT AND OUTPUT*
READ AMOUNT OF RESULTS FROM DAY NN " This command displays the amount of results per specified day 1-31. If no entry (or zero) then TODAY is assumed.	
M667	**PRINT VESSEL CV'S -** *Refer to: CYCLE IDLE, PRT VESSEL CV, PRINT AND OUTPUT*
PRINT RESULTS (CV) FOR THE VESSEL NUMBER" This command prints all results for the specified vessel number in the form A-H.	
M668	**READ STABILITY -** *Refer to: CYCLE IDLE, READ STABILITY*
READ VESSEL TEMPERATURE STABILITY " The Temperature stability of the inserted vessel is displayed until ESC.	
M669	**PRINT RESULT FORM -** *Refer to: CYCLE IDLE, OUTPUT FORMAT*
PRINT RESULTS IN THE FORM A-H " The results in the output form A-H are printed on the D1 port.	

M670	**HIGH RESOLUTION -** *Refer to: CYCLE IDLE, SET HIGH RESOLUT*
SET HIGH RESOLUTION DISPLAY " The Display resolution can be changed from 2 decimals to 4 decimals.	
M671	**CONTRAST ADJUST -** *Refer to: CYCLE IDLE*
DISPLAY CONTRAST ADJUST: DARK=0, FAINT=15" The LCD display is temperature sensitive. For optimal viewing the contrast can be set to suit.	
M672	**BOMB FACTOR ADJUST -** *Refer to: CYCLE IDLE*
BOMB FACTOR ADJUST: 1.000 ± 0.009 " Field setting! Vessels must be inserted! Bomb factor range is 0.990 to 1.01! Default (Do nothing!) value is 1.000000	

M673	**OPEN LID -** *Refer to: CYCLE IDLE, OPEN LID*
SAME AS F6 FUNCTION KEY: OPENS LID " This command is the same as '**F6'**. It opens the LID! If the LID is opened in the 'MAIN' period, then the determination is aborted.	
M674	**COOL READY TEMP -** *Refer to: CYCLE IDLE*
MODE SETTING: COOLER READY TEMPERATURE " It controls the cooler ready temperature in the ABSOLUTE cooling operation. The absolute cooling requires a stable room temperature!	
M675	**COOL AMB ADD -** *Refer to: CYCLE IDLE*
MODE SETTING: COOLER AMBIENT ADDITION " The ambient addition is added to the ambient temperature to form the RELATIVE ready temperature. This RELATIVE cooling operation yields constant cooling times regardless of the room temperature.	
M676	**COOL MAX TEMP -** *Refer to: CYCLE IDLE*
MODE SETTING: COOLER MAXIMUM TEMPERATURE" It controls the maximum Cooler Ready temperature. Note that the vessel handling temperature is approx. 12C higher than the max setting and should not exceed 55C!	
M678	**READ ATC TEMPERATURE -** *Refer to: CYCLE IDLE, RAD ATC TEMP*
READ ATC BOTTOM AND TOP TEMPERATURE " The unit displays the Top and bottom ATC temperatures until the '**ESC**' key is pressed!	
M679	**PRINT RESULT DATA -** *Refer to: CYCLE IDLE, D1 PRINTER PORT, PRINTING AND OUTPUT, SET OUTPUT FORMAT (A-H)*
PRINT ALL RESULTS TO THE D1 PRINTER PORT" All results in the memory are dumped to the D1 printer port in a .CSV format.	
M680	**INITIAL TIME -** *Refer to: INITIAL CYCLE*
Enter the initial time in Minutes " This is the time in minutes which is needed to stabilise the vessel after filling.	
M681	**READ NETT RISE -** *Refer to: CYCLE IDLE, TEMPERATURE RISE, COTTON CORRECTION*
Display the last Nett Temperature Rise " The last nett temperature rise is displayed. The nett rise is cotton + wire corrected.	

M682	**OPERATING MODE SETTING -** *Refer to: CYCLE IDLE*, SET OPS MODE, CALIBRATION, MODE CHANGES(CAL3K A/AP)
ATTENTION! CHANGING THE OPERATING MODE? " The unit has 3 modes: 0=Dynamic, 1=Adiabatic, 2=Isothermal, 3=Fast Dynamic. Every mode must be calibrated. The calibration is retained with mode changes.	
M683	**READ TOTAL BOMB FIRINGS -** *Refer to: CYCLE IDLE*, READ VESSEL INFO, READ VESSEL MAX
READ TOTAL VESSEL FIRINGS " The vessel records the firings and the total firings. The Vessel firings are reset during inspection. The warning limit is 4500 firings, and at 5000 the vessel must be inspected.	
M684	**DUMP CALIBRATION S/N -** *Refer to: CYCLE IDLE*, D1 PRINTER PORT, PRINTING AND OUTPUT, DUMP RSLT VESSEL
DUMP CALIBRATION FOR SPECIFIED S/N " The calibrations for the specified vessel Serial Number (S/N) are dumped to the printer port D1 in a .CSV format.	
M685	**PRINT MAX DATA -** *Refer to: CYCLE IDLE*, D1 PRINTER PORT, PRINTING AND OUTPUT, PRT MAX DATA
PRINT RECORDED MAXIMUM DATA " The unit records max data, which can be printed!	
M686	**SET RESULT ENABLE -** *Refer to: CYCLE IDLE*, D1 PRINTER PORT, PRINTING AND OUTPUT, SET RESULT ENABLE
ENABLE UNSOLICITED RESULT PRINTING ON D1" The D1 port is shared with the Real Time (RT) printing and a possible computer connection. Disable the 'unsolicited' printing if it interferes with other D1 port activities.	
M687	**PRESSURE PEAK LIMIT** (CAL3K-AP ONLY) **-** *Refer to: CYCLE IDLE*, CAL3K-AP PRESSURE COMMANDS, PRESS PEAK LIM
SET THE ABSOLUTE MAX PRESSURE AFTER FIRE" This setting specifies the absolute max pressure allowed, which can be disabled by a zero entry. Normal setting is 70 Bar. An additional safety limit is at 90 Bar which will deflate the vessel!	
M688	**SET FILLING PRESSURE -** *Refer to: CYCLE IDLE*, CAL3K-AP PRESSURE COMMANDS, PRESS FILL TRGET
SET OXYGEN FILLING TARGET PRESSURE " This is the Target Filling pressure. The default setting is 30bar. It can be lowered for special conditions. If set to zero then the filling time is implemented.	

M689	**READ PRESSURE -** *Refer to: CYCLE IDLE* CAL3K-AP PRESSURE COMMANDS, READ PRESSURE
DISPLAY THE PRESENT VESSEL PRESSURE " The vessel pressure is displayed. If the lid is open or the vessel is out of the well then the reading should be zero.	
M690	**ZERO PRESSURE READING -** *Refer to: CYCLE IDLE* CAL3K-AP PRESSURE COMMANDS, PRESS ZERO ADJST, READ PRESSURE
ZERO PRESSURE SENSOR READING " The pressure sensor reading can be set to zero by this command. Make sure that the lid is open!	

M691	**DEFLATE SYSTEM -** *Refer to:END CYCLE*, CAL3K-AP PRESSURE COMMANDS, DEFLATE SYSTEM, ABORT, FLUSH SECONDS,
DEFLATE: OPEN FILLING and EXHAUST VALVE " This command deflates the pressure line from the bottle to the CAL3K_AP by opening both valves. Close the cylinder valve. This operation is required when disconnecting the pressure pipes.	
M692	**DEFLATE TIME SECONDS -** *Refer to: END CYCLE*, CAL3K-AP PRESSURE COMMANDS, DEFLATE SYSTEM, FLUSH SECONDS, PRESS DEFLATE.SEC, *PRESS FLUSH SEC*
ENTER THE MAX ALLOWED DEFLATE TIME SEC " If the deflate time is exceeded a warning is issued. The exhaust filter may be blocked. Investigate!	
M693	**FLUSH TIME SECONDS -** *Refer to: END CYCLE*, CAL3K-AP PRESSURE COMMANDS, DEFLATE SYSTEM, FLUSH SECONDS
ENTER THE FLUSH TIME IN SECONDS, 0=OFF " The flush time option allows the flushing (ventilation) of the vessel after a determination. The vessel is inflated for the stipulated time followed by a deflating. This is required when harmful substances are burned!	
M694	**SYSTEM LEAK TEST -** *Refer to: CYCLE IDLE*, CAL3K-AP PRESSURE COMMANDS, SYSTEM LEAK TEST, SAFE HIGH-PRESSURE OXYGEN
LEAK TEST: FILLS TO TEST PRESSURE, WAIT " This test requires that a vessel is inserted. Upon command activation the vessel is filled to the 'PRESS LEAK TEST' value and then the valve is closed. Then the pressure can be observed: If it declines then a leak exists.	

M695	**FILL LEAK PRESSURE -** *Refer to: CYCLE IDLE*, CAL3K-AP PRESSURE COMMANDS, SYSTEM LEAK TEST, SAFE HIGH-PRESSURE OXYGEN, PRESS FILL LEAK
FILLING LEAK PRESSURE LIMIT " This is the allowed pressure drop from filling to firing before a warning is issued. A zero entry disables this check. The default is 2bar	
M696	**MIN FILL PRESSURE -** *Refer to: CYCLE IDLE*, CAL3K-AP PRESSURE COMMANDS, PRESS MIN FILL
MINIMUM ACCEPTABLE FILLING PRESSURE " This is the lowest acceptable filling pressure before a warning is issued. It can be disabled by entering zero.	
M697	**FILLING TIME SECONDS -** *Refer to: CYCLE IDLE*, CAL3K-AP PRESSURE COMMANDS, PRESS FILL SECND
SET THE FILLING TIME IF OTHER DISABLED " If all filling parameters are disabled (set to zero) then a pure time-based filling can be achieved with this time setting in seconds.	
M699	**LEAK TEST PRESSURE -** *Refer to: CYCLE IDLE*, CAL3K-AP PRESSURE COMMANDS, PRESS LEAK TEST, SYSTEM LEAK TEST
SET LEAK TEST PRESSURE " This sets the leak test pressure. The leak test is activated by: SYSTEM LEAK TEST command. It fills the vessel to the set pressure and allows the checking of possible leaks.	
M702	**LOW AMBIENT LIMIT -** *Refer to: CYCLE IDLE*, READ AMB TEMP
Low Ambient temperature limit " The CAL3K checks the ambient temperature to be in the range from LOW to HIGH settings. If the temperature is outside these limits, then the result is marked as SUSPECT.	

M703	**HIGH AMBIENT LIMIT -** *Refer to: CYCLE IDLE*, READ AMB TEMP
High Ambient temperature limit " The CAL3K checks the ambient temperature to be in the range from LOW to HIGH settings. If the temperature is outside these limits, then the result is marked as SUSPECT.	

M704	**LOW RISE LIMIT -** *Refer to: MAIN CYCLE*, LOW RISE LIMIT
LOW temperature rise after firing limit " The temperature rise after firing should be 12C ± 4C. If it is lower or higher than the sample mass should be adjusted accordingly. A violation results in a SUSPECT result.	

M705	**HIGH RISE LIMIT -** *Refer to: MAIN CYCLE*, HIGH RISE LIMIT
HIGH temperature rise after firing limit" The temperature rise after firing should be 12C ± 4C. If it is lower or higher than the sample mass should be adjusted accordingly. A violation results in a SUSPECT result.	

M706	**READ VESSEL CALIBRATIONS -** *Refer to: CYCLE IDLE*, READ BOMB CALI
DISPLAY THE 4 VESSEL CALIBRATION S/N " The 4 vessel fields and the calibrations performed for each vessel are displayed.	

M707	**PRINT KEY COMMAND LIST -** *Refer to: CYCLE IDLE*, PRT KEY CMD LIST, PRINTING AND OUTPUT
Print Keyboard command list " The command list is printed on the D1 port. The list contains all keyboard commands.	

M709	**PRINT SPECIAL DDS VESSEL DATA -** *Refer to: CYCLE IDLE*, PRINTING AND OUTPUT,
Print Vessel data " Print short vessel results.	

M710	**READ MEMORY RECORDS -** *Refer to: CYCLE IDLE*, READ MEM RECORDS, PRINTING AND OUTPUT
DISPLAY THE AMOUNT OF MEMORY RECORDS " The total memory records and the included calibrations and faults are displayed.	

M711	**PRINT E_CAL FOR SERIAL NUMBER -** *Refer to: CYCLE IDLE*, CALIBRATION COMMANDS, PRINT CAL ANALISIS
Print the calibration for the vessel S/N" The calibration for the entered vessel serial number (and the present mode) is printed on the D1 port.	

M713	**COMPENSATION BOMB -** *Refer to: CYCLE IDLE*, COMPENSATE BOMB
PERFORM COMPLETE COMPENSATION CALC. " This command loads the bomb data and calculates ALL compensation factors!	

M714	**READ HELP TEXT -** *Refer to: CYCLE IDLE*, READ HELP TEXT
READ THE SPECIFIED HELP TEXT! ESC=EXIT " Enter the M Code number and retrieve the associated explanations. Press 'Enter' to see the full text. Press ESC to exit!	

M715	**READ PRESSURE RECORDS -** *Refer to: CYCLE IDLE*, READ PRESS REC
READ PRESSURE PEAK VIOLATIONS! ESC=Stop "	

The CAL3K_AP saves all pressure limit violations above Peak pressure or MAX_PRESS(90bar). This command reads the pressure records. Press {enter} for next or ESC to end.	
M716	**PRINT COMPENSATION + MAX LIMITS -** *Refer to: CYCLE IDLE*, PRINT COMPENS+MAX, PRINTING AND OUTPUT
PRINT COMPENSATION FACTORS + MAX LIMITS " The present compensation factors and maximum limits are printed.	
M718	**PRINT CAL ANALYSE -** *Refer to: CYCLE IDLE*, PRINT CAL ANALYSIS, PRINTING AND OUTPUT
PRINT CALIBRATION ANALYSIS OF VESSEL " The vessel calibrations are analysed, and the results are printed.	
M720	**TEST PUT FAN ON -** *Refer to: CYCLE IDLE*
TEST: PUT THE INTERNAL FAN ON " In-House command.	
M721	**TIME IS SID -** *Refer to: CYCLE IDLE*, TIME IS SID, SAMPLE ID
The Sample Identification (SID) is Time " The Sample Identification (SID) is replaced with the time. This makes the result unique within 24 hours.	

M722	**DATE IS GID -** *Refer to: CYCLE IDLE*, DATE IS GID, SAMPLE ID
The Group Identification (GID) is Date " The Group Identification (GID) is replaced with the date. This makes the result searchable by date.	
M723	**VERSION -** *Refer to: CYCLE IDLE*, VERSION
Display CAL3K software version " The CAL3K software version is important when a fault (bug) is reported.	
M724	**RESET/ABORT -** *Refer to: CYCLE IDLE*, ABORT, RESET
RESET is the same as POWER CYCLE or ABORT " Any determination is aborted. On automatic units the LID is opened! (Do not power cycle CAL3K-AP during a CV/pressurised. Always use commands to abort)	
M725	**LOAD DEFAULT COMPENSATIONS -** *Refer to: CYCLE IDLE*, LOAD DEFAULT PARAMETERS
LOAD DEFAULT COMPENSATION! " The default compensation settings are loaded for the present mode. The computed compensations are destroyed! The default compensations are set by the factory!	

M740	**DUMP U_CAL -** *Refer to: CYCLE IDLE*
DUMP U_CAL (AVERAGE CALIBRATION) " Dumps the calibration buffer	
M741	**DUMP E_CAL -** *Refer to: CYCLE IDLE*
DUMP THE CALIBRATION BUFFER " Dumps all calibration records.	
M743	**SET ATC OFFSET -** *Refer to: CYCLE IDLE*

SET AMBIENT SENSOR OFFSET VALUE " This forces the ambient sensor offset value. Not for field use!	
M744	**SET ATC TOP OFFSET -** *Refer to: CYCLE IDLE*
SET ATC TOP SENSOR OFFSET VALUE " This forces the ATC top sensor offset value. Not for field use!	
M745	**SET ATC BOTTOM OFFSET -** *Refer to: CYCLE IDLE*
SET ATC BOTTOM SENSOR OFFSET VALUE " This forces the ATC bottom sensor offset value. Not for field use!	
M746	**SET PRESSURE OFFSET -** *Refer to: CYCLE IDLE, CAL3K-AP PRESSURE COMMANDS*
SET PRESSURE SENSOR OFFSET VALUE " This forces the pressure sensor offset value. Not for field use	
M747	**DUMP RESULTS FOR VESSEL -** *Refer to: CYCLE IDLE, DUMP RSLT VESSEL*
DUMP RESULT OF SPECIFIED VESSEL " All results for the specified vessel are dumped to the printer port.	

36.2.5 TESTING (900+)

M900	**HARDWARE FIELD TEST (F8) -** *Refer to: CYCLE IDLE, TEST CAL3K HARDWARE*
CAL3K HARDWARE TEST:__ WAIT AND OBSERVE " M900: The hardware test requires some intervention from the operator. Wait and observe!	
M901	**REMOVE BOMB -** *Refer to: CYCLE IDLE*
M901: REMOVE VESSEL FOR CHASSIS H/W TEST" The Vessel must be removed for this test! The vessel can be tested with the vessel test '**F7'**.	
M902	**MEMORY #1 U6 -** *Refer to: CYCLE IDLE*
M902: MEMORY #1 OK " M902/T02: The memory #1 is located on the control card and is vital for the operation of the unit. If faulty it can't be replaced in the field and the control card must be returned to the agent or the manufacturer.	
M903	**MEMORY #2 U7 -** *Refer to: CYCLE IDLE*
M903: MEMORY #2 OK " M903/T03: The memory #2 is located on the control card and is vital for the operation of the unit. If faulty it can't be replaced in the field and the control card must be returned to the agent or the manufacturer.	
M905	**AMBIENT SENSOR BAD -** *Refer to: CYCLE IDLE, READ AMB TEMP*
M905: AMBIENT TEMP SENSOR READS __._ OK " M905/T05: The ambient sensor is located on the outside of the ambient box (cage) or near the fan. The test assumes that the temperature is between 5C and 32C. If the room temperature is outside these limits, then ignore the fault. Otherwise replace the sensor and/or the control card!	

M906	**ATC SENSORS BAD -** *Refer to: CYCLE IDLE, READ ATC TEMP, TEST CAL3K HARDWARE*
M906: ATC TEMP. Top=__._ Bot=__._ OK "	

M906/T06: The Automatic Temperature Control (ATC) sensors are located on the heating mantel. If the sensor outputs are between 5C and 42C then the sensors are OK. Otherwise, the instrument must be returned. The ATC temperatures are vital to the calibrations and the operating modes.

M907	**LCD BACKLIGHT VOLTS BAD -** *Refer to: CYCLE IDLE*, TEST CAL3K HARDWARE

M907: LCD BACKLIGHT SUPPLY OK "
M907/T07: The LCD backlight voltage should be between 4.5 and 5.2Volts. It improves the display contrast. It is generated on the control card. Apart from the visibility of the display it is of no consequence.

M908	**REAL TIME -** *Refer to: CYCLE IDLE*, TIMESET, DATESET, TEST CAL3K HARDWARE

M908: REAL TIME __/__/__-__:__:__ OK "
M908/T08: The unit has a real time clock calendar, which provides timing. The real time clock has a one-week battery for power outages. If it fails, then the control card must be returned. The clock can be set by the 'DATESET' and the 'TIMESET' keyboard commands

M909	**LID LOCK DRIVE FAULT -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST

M909: LID LOCK DRIVE OK "
M909/T09: The lid lock release activation is tested. This test will not operate the loch mechanism! If the Lock is faulty then the lock must be replaced or the CAL3K returned to the manufacturer.

M910	**LID SWITCH OPERATION -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST

M910: LID SWITCH OPERATION OK "
M910/T10: The LID open/close recognition is tested. If it fails, then the lid switch is faulty, or the wires are disconnected. Your service agent can help!

M911	**BOMB SUPPLY BAD -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST (F7), CAL3K HARDWARE TEST

M911: VESSEL SUPPLY IS OK "
M911/T11: The Supply to the VESSEL should be between 5.2 and 5.8Volts. This can be measured on the INNER contact in the well. The voltage is generated on the control card, and if not, then the control card must be returned.

M912	**CHARGING WAIT -** *Refer to: CYCLE IDLE*, FIRING VOLTAGE, READ FIRING VOLT, CAL3K HARDWARE TEST

M912: WAIT, CHARGING __._ to __._ V BAD"
M912: Wait: The unit charges the Firing battery. The voltage should increase slowly to 25V. The charging process can take a minute.

M913	**ATC TOP DRIVE (CAL3K-A/AP) -** *RRefer to: CYCLE IDLE*, CAL3K HARDWARE TEST

M913: ATC TOP DRIVE OK "
M913/T13: The Vessel is surrounded by a heater (ATC) which consists of a top and a bottom heater. The top heater is disconnected. If the heater is at fault, then the unit must be returned.

M914	**ATC BOTTOM DRIVE (CAL3K-A/AP) -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST

M914: ATC BOTTOM DRIVE OK "
M914/T14: The Vessel is surrounded by a heater (ATC) which consists of a top and a bottom heater. The bottom heater is disconnected. If the heater is at fault, then the unit must be returned.

M915	**FAN DRIVE -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M915: FAN DRIVE CIRCUIT OK " M915/T15: The FAN circuit has a fault. The connection from the controller to the FAN is missing or the control card has a fault. The agent can help before sending the unit to the manufacturer.	
M918	**POWER SUPPLY NO LOAD -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M918: POWER SUPPLY NO LOAD OK " M918/T18: The power supply to the CAL3K should be 11 to 13 Volts without load.	
M919	**POWER SUPPLY MAX LOAD -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M919: POWER SUPPLY MAX LOAD OK " M919/T19: The power supply should be a 12V 3A unit. It must support this current for short times only. Check the power supply rating. Note that the cooler power supply has a lower current (1A) rating and can't be used for the CAL3K!	
M920	**ATC TOP HEATER SWOP (CAL3K-A/AP)-** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M920: ATC TOP HEATING TEST OK " M920/T20: The ATC TOP heater is switched on and the temperature increase is monitored. This can be confirmed by putting your hand into the well. The test may take a couple of seconds!	
M921	**ATC BOTTOM HEATER SWOP (CAL3K-A/AP)-** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M921: ATC BOTTOM HEATING TEST OK " M921/T21: The ATC BOTTOM heater is switched on and the temperature increase is monitored. This can be confirmed by putting your hand into the well. The test may take a couple of seconds!	
M923	**5V RAIL SUPPLY -** *RRefer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M923: 5 VOLT RAIL SUPPLY OK " M923/T23: The 5V rail voltage should be between 4.8 and 5.2Volts. This voltage feeds to the LCD backlight and various other devices. It is generated on the control card from the 12V supply.	
M924	**LCD BACKLIGHT SWITCH -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M924: LCD BACKLIGHT SWITCHING OK " M924/T24: The LCD backlight is switched OFF to preserve power and ON when a keyboard or other operation demands it. If the test fails, then it should be fixed at the next maintenance opportunity.	
M925	**INFLATE VALVE CONNECTION (CAL3K-AP ONLY) -** *Refer to: CYCLE IDLE* CAL3K HARDWARE TEST
M925: INFLATE VALVE CONNECTION OK " M925/T25: The inflation valve is disconnected or not operating. The valve is located in the LID and fills the Vessel with oxygen.	
M926	**EXHAUST VALVE CONNECTION (CAL3K-AP ONLY) -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M926: EXHAUST VALVE CONNECTION OK " M926/T26: The EXHAUST valve is disconnected or not operating. This valve is located in the LID and DEFLATES the Vessel after the determination. The fault could be a faulty control card, wiring or an open circuit valve.	
M927	**PRESSURE SENSOR READING (CAL3K-AP ONLY) -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST, READ VESSEL PRESSURE, PRESSURE COMMANDS

M927/T27: The pressure sensor reading is bad. This is irrelevant for the 3K_A but needs to work in the 3K_AP. Note that the pressure sensor must be 'ZERO CALIBRATED' before this test with the keyboard command 'ZERO PRESSURE'!

M929	**CAL3K HARDWARE TEST SUMMARY -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST

M929: CAL3K HARDWARE TEST SUMMARY OK "
M929/T29: The outcome of ALL hardware tests are summarised.

36.2.6 BOMB TESTS START HERE

M930	**BOMB COMMUNICATION BAD -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST, VESSEL HARDWARE TEST

M930 VESSEL COMMUNICATION OK "
M930/T30: If the bomb communication is bad then the Vessel is not in the well or there is no communication with the vessel. The centre contact pin should have approx. 5.5V on them. If not then the connections are faulty.

M931	**BOMB SUPPLY CHECK -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST, CAL3K HARDWARE TEST

M931 VESSEL SUPPLY IS _____ V OK "
M931/T31: The CAL3K supplies approx. 5.6V to the vessel. If it goes below 5.2V when the vessel is inserted then the vessel is at fault (Try a different Vessel!) or the control card is faulty.

M932	**FIRING WIRE OK -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST, CAL3K HARDWARE TEST

M932 VESSEL FIRING WIRE OK "
M932/T32: After the Lid is closed the CAL3K checks the firing wire. The firing wire detection is handled by the FIRING PCB and the control card.

M933	**FIRING OK -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST, CAL3K HARDWARE TEST

M933: VESSEL FIRING __._ VOLT @ __._ OK "
M933/T33: The CAL3K has fired the Vessel but has failed to observe the discharge of the firing battery. This is a fault in the firing PCB and the unit must be returned.

M934	**BOMB INTERNAL TEST -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST

M934: VESSEL INTERNAL TEST OK "
M934/T34: In this step all the vessel report bits are checked and combined. If a fault persists then the vessel must be returned to the factory.

M935	**BOMB INFLATION TEST (CAL3K-AP ONLY) -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST, CAL3K HARDWARE TEST, CAL3K-AP PRESSURE COMMANDS

M935: VESSEL INFLATION TEST OK "
M935/T35: This test requires oxygen pressure! The vessel is inflated in a short burst of the inflate valve (Clicking sound). The pressure must increase up to 3 Bar. If not, the oxygen is missing, the vessel is leaking, the valve is not operating or the non-return valve is stuck.

M936	**BOMB EXHAUST TEST (CAL3K-AP ONLY) -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST, CAL3K HARDWARE TEST

M936: VESSEL EXHAUST TEST OK "
M936/T36: The pressure (3bar) of the previous test is deflated. If the pressure stays up then the deflate valve is not operating, the filter is blocked, or the exhaust is blocked.

M937	**BOMB TEST SUMMATION -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST
M937: BOMB TEST SUMMATION OK " M937/T37: The bomb test was completed! If the test has failed, then the vessel must be returned to the manufacturer.	

M940	**LID SWITCH INDICATION: Closed -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M940: LID IS CLOSED, DOES NOT OPEN: BAD" M940/T10: The LID switch indicates that the lid is permanently closed. This is a fault and must be rectified before proceeding.	

M941	**LID NEEDS CLOSING -** *Refer to: CYCLE INITIAL*
M941: LID IS OPEN, PLEASE CLOSE IT " M941: The indication is that the LID is open and needs closing.	

M942	**FIRING WIRE CHECK, CLOSE LID -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST
M942 VESSEL FIRING WIRE CHECK, CLOSE LID" M942/T32: The unit tests the connection from the firing circuit to the firing wire INSIDE the vessel. Please insert a vessel with an attached firing wire and close the lid. The vessel requires no oxygen.	

M950	**TEST NOT USED -** *Refer to: CYCLE IDLE*
M950: TEST __ NOT USED! ESC TO EXIT " M950: The test is not used! The test may be active in other units!	

M960	**BOMB INTERNAL SUPPLY FAULT -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST, VESSEL HARDWARE TEST
M960 VESSEL INTERNAL SUPPLY FAULT " M960 The vessel reported an internal supply fault. The value of the internal supply is displayed via the vessel test #31.	

M961	**BOMB INTERNAL REFERENCE FAULT -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST, VESSEL HARDWARE TEST
M961 VESSEL INTERNAL REFERENCE FAULT " M961 The vessel reported an internal reference fault. The vessel must be returned to the manufacturer for repair.	

M962	**BOMB INTERNAL MEMORY FAULT -** *Refer to: CYCLE IDLE*, CAL3K HARDWARE TEST, VESSEL HARDWARE TEST
M962 VESSEL INTERNAL MEMORY FAULT " M962 The vessel has reported an internal memory fault. If the vessel works otherwise, it can be used without affecting the operation.	

M963	**BOMB INTERNAL SENSOR #1 FAULT -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST
M963 VESSEL INTERNAL SENSOR #1 FAULT " M963 The vessel reported a sensor #1 fault. The vessel can't be used anymore and must be returned to the manufacturer for repair.	

M964	**BOMB INTERNAL SENSOR #2 FAULT -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST
M964 VESSEL INTERNAL SENSOR #2 FAULT " M964 The vessel reported a sensor #2 faults. The vessel can't be used anymore and must be returned to the manufacturer for repair.	
M965	**BOMB INTERNAL A/D FAULT -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST
M965 VESSEL INTERNAL A/D FAULT " M965 The vessel reported an A/D fault. The vessel must be returned to the manufacturer for repair.	
M966	**BOMB INTERNAL INSPECTION FAULT -** *Refer to: CYCLE IDLE*, VESSEL HARDWARE TEST
M966 VESSEL INTERNAL FIRE INSPECTION FLT" M966 The vessel reported a Fire Inspection fault. The vessel must be inspected by qualified personnel or by the manufacturer.	