



ATF-LS-FRL Combustion Calorimeter Standard Operating Procedures	Published Online: March 2018
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1) Required Materials

a) UHP Methane Calibration gas

2) Initial Setup

a) *The combustion calorimeter is located on the south side of the mezzanine level in the 1MW shed. It is mounted on the east wall of the shed as shown in Figure 1.*



Figure 1. combustion calorimeter in 1 MW shed

b) *Connect the combustion calorimeter to the natural gas supply*

c) *Connect the combustion calorimeter to ultra high purity (UHP) methane calibration gas.*

3) Start-Up

- a)** Turn the red valve to the “ON” position where the gas sampling line meets the building main supply (Figure 2).

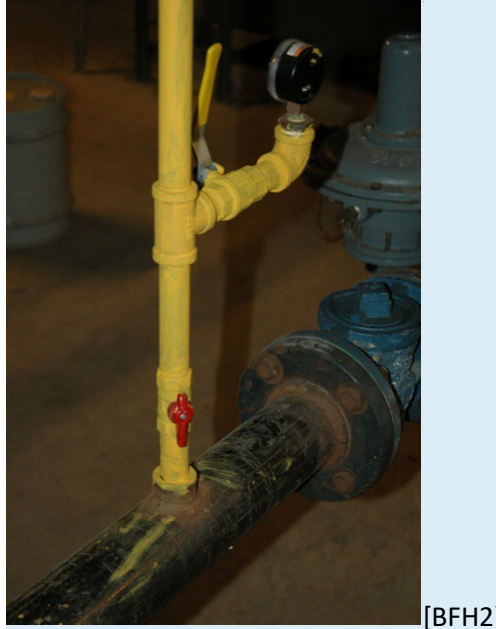


Figure 2: combustion calorimeter connection to natural gas supply line; Red valve shown in “ON” position

- b)** Turn the power switch on the combustion calorimeter to the “ON” position as shown in Figure 3. The power switch is located in the lower right hand corner of the unit.



Figure 3: Combustion calorimeter power switch, shown in “ON” position

c) *If proper gas flow is being provided to the combustion calorimeter, activating the power switch should fire a spark that lights the pilot flame.*

i) When the pilot is lit, the red “Flame” light should be active (Figure 4).

ii) The pilot flame can be viewed through the viewport next to the “Flame” light. The pilot should be approximately ¼” high.

(1) If the flame is not present or too short, it may indicate a lack of sample line pressure or a problem with the ignition system

(2) If the pilot is too high, it may indicate too much pressure in the sample line.

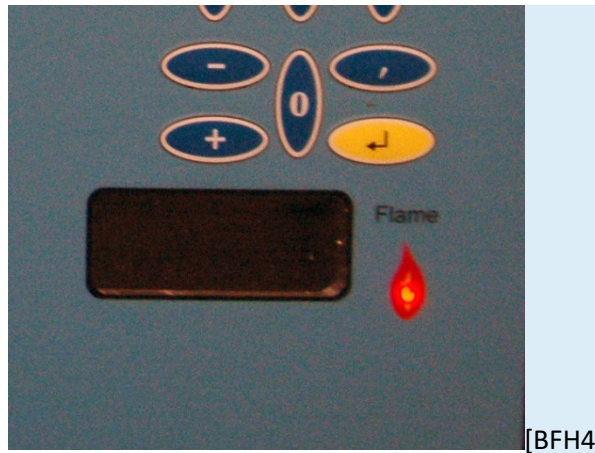


Figure 4: Pilot Flame Indicator Light and View Port

d) *After the pilot is ignited, check the pressure gauges on the right side of the panel (Figure 5). All of the gauges should read between 3.5 and 4.5 mbar. The top gauge shows differential pressure across the specific gravity cell, the middle gauge shows differential air pressure, and the bottom gauge shows gas pressure at the Wobbe jet.*

i) If the pressure is low for the top or bottom gauges, adjust the regulators for the sample or calibration gasses, as shown in Figure 6.

ii) Use very small adjustments to avoid adding too much pressure.



Figure 5: combustion calorimeter Flow Gauges

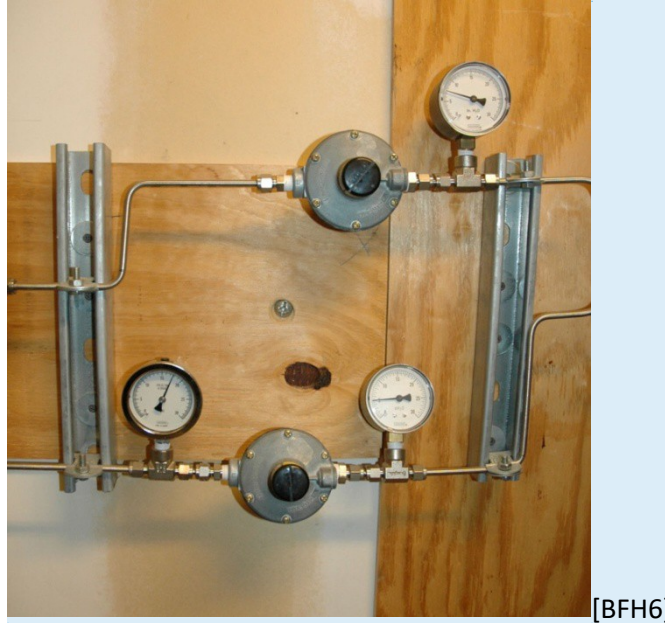


Figure 6: combustion calorimeter sample gas (bottom) and calibration gas (top) pressure regulators

- e)** *Check the UHP methane tank to ensure that the valves are open and that there is sufficient gas in the tank to perform calibrations.*
- f)** *Verify that the data cables are correctly plugged into the National Instruments Field Point Module. The dry (superior) specific heat (CVs), the saturated (inferior) specific heat (CVi) and the specific gravity (SG) are currently recorded by the Historian via National Instruments Field Point Modules under the channels "FP38_AI02_05", "FP38_AI02_07" and "FP38_AI02_06", respectively.*

NOTE: The combustion calorimeter is left in the "ON" position at all times in order to provide a continuous measurement of the natural gas entering the building. Only turn the combustion calorimeter "OFF" when performing maintenance.

4) During Use

- a)** *The specific gravity cell within the combustion calorimeter is highly sensitive to vibrations. When entering and leaving the 1 Megawatt shed the door should be opened and closed gently. When*

opening and closing the combustion calorimeter front panel care should be taken to move the panel slowly and minimize vibration and air flows reaching the specific gravity panel.

- b)** *The combustion calorimeter's signal stability is indicated by the "Stab." label in the upper right corner of the main display screen. When the value is > 0.15 the unit will not provide accurate readings or complete a calibration.*
- c)** *The output from the combustion calorimeter has been programmed to send a "hold" signal at times when the specific gravity is unstable (due to the door being opened and closed for example) or when a calibration cycle is underway. During this "hold" cycle the outputs will continue to send the last good data point to FireTOSS.*
- d)** *The combustion calorimeter should be maintained in an environment in which the temperature does not vary by more than 7°C from the temperature at which calibration was performed. It should not be subjected to temperature gradients exceeding $2^{\circ}\text{C} / \text{hour}$. If using the combustion calorimeter with a calibration burner, the warning light on the burner control iFix screen will alert that the temperature variation is outside of tolerance.*

5) Shut-Down

- a)** *Turn off the power switch located on the bottom right hand corner of the unit.*
- b)** *Close the red valve on the natural gas sampling line.*
- c)** *Close the UHP Methane calibration gas tank.*
- d)** *Make a note on the white board in the control room describing why the combustion calorimeter has been brought offline.*

6) Calibration

- a)** *The combustion calorimeter is calibrated with UHP Methane.*
- b)** *The combustion calorimeter automatically performs calibration Monday-Friday at 05:00.*
- c)** *Additional calibration can be initiated at any time using the combustion calorimeter on-screen menu.*

Options

↳ Calibration

↳ Calibrate

- d)** *Calibration takes approximately 10 minutes. During this time, the "Operation" light will stop blinking green. Also during calibration, two messages will display in the upper right corner of the*

display: Hold Signal, and then Blend Signals. After both of these messages have stopped, and the "Operation" light has begun blinking again, the calibration has finished.

e) Calibration records are recorded and stored within the calorimeter.

f) Calibration constants specific to the individual calibration gas are entered into the combustion calorimeter. These constants are calculated using a software program from the manufacturer.

i) For UHP Methane (assuming 100% methane and negligible traces of other gasses) the calibration values are as follows:

COMPRESSIBILITY (Z)	0.9981		
SPECIFIC GRAVITY	<u>0.5547</u> *		
CALORIFIC VALUE	BTU/SCF	KCAL/NM3	KJ/NM3
Net, Dry	913.2	8570	35865
Gross, Dry	1014.3	9519	39834
Net, Saturated	897.3	8421	35241
Gross, Saturated	996.6	9353	39141
WOBBE INDEX			
Net, Dry	1226.1	11507	48154
Gross, Dry	<u>1361.8</u> *	12780	53483
Net, Saturated	1204.8	11307	47317
Gross, Saturated	<u>1338.1</u> *	12558	52554
OFFSET FROM CV NET TO VE GROSS	1.1107		

ii) If a calibration gas other than UHP Methane is used the calibration values will need to be recalculated. In this case, contact Delta Instruments to have one of their representatives perform the calculations. (www.deltainstrument.com)

7) Maintenance

a) Turn off the combustion calorimeter and close ALL gas lines before performing any maintenance. This system involves natural gas under pressure and should only be operated by those with proper training.

- b)** *Periodic maintenance checks should be performed to identify any potential problems with the equipment. Delta Instruments recommends that these checks be performed every six months.*
- i) All hose connections to the gauges, pressure sensors, specific gravity cell and the primary air connection to the burner should be checked and changed if necessary.*
 - ii) The gas pressure regulator diaphragm should be checked; if this has become hardened or brittle it should be replaced.*
 - iii) The rubber connections on the Wobbe jets and air jets should be checked for any leakage.*
 - iv) The calibration gas should be checked to ensure an adequate supply and for expiration date of the gas calibration certification. The combustion calorimeter requires 5-10 liters of calibration gas per calibration cycle, which occurs approximately twice per week.*
- c)** *If any problems are noted when performing maintenance, the following troubleshooting steps can be taken.*
- i) Specific gravity or gas pressure cannot be adjusted to within 3.5 – 4.5 mbar:*

If the gas or specific gravity cell pressures are outside the 3.5-4.5 mbar range and slight changes to the external pressure regulators (see Startup procedure) do not solve the problem, an engineer may adjust the weight on the internal gas sample regulator.

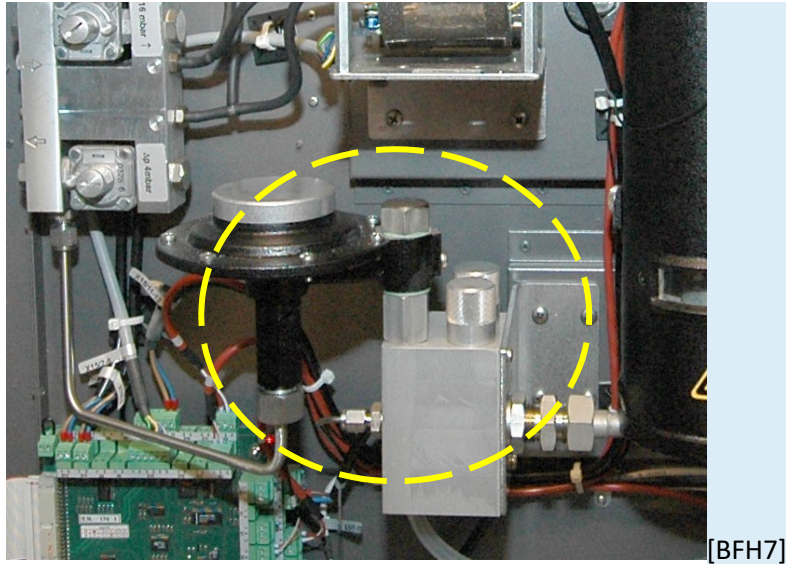


Figure 7: combustion calorimeter Internal Gas Sample Regulator

To adjust the gas sample regulator, unscrew the silver metal cap and add/remove weights as necessary to achieve the required pressure. Note that this will adjust both the specific gravity and gas sample pressures, and it is best to avoid changes to this regulator if possible

ii) Air flow pressure reading is less than 3.5 mbar

Either the air filter needs to be cleaned/replaced, or the fan unit needs to be replaced.

iii) Unstable readings

Unstable readings may result from rapid temperature fluctuations. If this becomes a problem it may be necessary to provide a more stable temperature control system in the 1 Megawatt Shed.

iv) Drift in readings

If readings drift upwards in one direction and are not corrected by calibration the air filter must be replaced.

If readings drift downwards it is likely that the heat exchanger is worn out. Remove and wash the heat exchanger with warm water and remove any deposits with a brush. The heat exchanger should be dried with compressed air before reinstallation.

v) Incomplete/no ignition

The pilot flame will not ignite if the door to the unit is open. Close and lock the door in place before attempting to turn on the combustion calorimeter.

It is possible that the ignition electrode is corroded and needs to be replaced.

Insufficient gas pressure can lead to lack of ignition. Check that the gas line is intact, all valves are open, and pressure regulators are set correctly.

vi) Software problems

The combustion calorimeter is currently running version 1.66 of the required software. Updates can be made using factory software installed via a floppy drive on the inside of the door of the combustion calorimeter (underneath the monitor). Updates can be applied by selecting "System" then "... " then inserting the floppy disk with the software and pressing "Update".

All other software problems should be directed to Delta Instruments.

d) Check calibration gases and records regularly.