

# Furnace Demonstrators

Educational Training Equipment for the 21st Century

Bulletin 236-111B

## H-CLT-1

### Combustion Laboratory Trainer

#### Purpose

The Hampden **Model H-CLT-1** Combustion Laboratory Trainer gives accurate control of fuel to air ratios of various weak to rich fuel mixtures. This unit will burn both gaseous and light boiler distillate fuels, excluding gasoline.

#### Description

Combustion occurs in a special water cooled chamber with observation port for observation of the flame envelope. Samples of the combustion can be removed for analysis.

This unit consists of a metal frame with control panel, dual fueled burner, water-cooled combustion chamber and instrumentation.



#### Experiment Capabilities

- Burner Assessment
- Firing rate
- Flame stability
- Flame shape
- Flame radiation
- Turndown range
- Smoke emission
- Light boiler distillate fuels
- Domestic fuel gases
- Effect of air to fuel ratio on combustion efficiency as measured by flue gas composition, heat transfer and energy balance
- Flue gas analysis in comparison with theoretical prediction
- Effect of flame and quarl radiation on heat transfer and observed temperature
- Gas sampling within the combustion chamber
- Fuel additive analysis on the combustion process

#### Specifications

##### Control Panel:

11-gauge furniture stock steel finished in instrument white

##### Control Enclosure:

14-gauge furniture stock steel finished in instrument tan

##### Support frame:

1½" square mechanical tube finished in black heat resistant enamel

##### Combustion Burner:

Dual fuel approximately 512,000 BTU/Hr, 150Kw complete with fan

##### Combustion Chamber:

Refractory type enclosed in a water cooled stainless steel enclosure. Observation ports are fitted in the enclosure along with a water cooled sampling probe.

##### Controls:

Manual controls for cooling water, oil, gas, and air. Burner is provided with safety features with associated fuel line emergency shut-offs and emergency pushbutton

##### Instruments:

- Flowmeters:
  - Cooling water 50 to 500 g/s
  - Gas 0.5 to 5.0 g/s
  - Oil 0.5 to 5.0 g/s

- Air-differential pressure manometer with orifice
- Air dial thermometer -30 to 60°C
- Flue Gas Analog Indicator and Temperature Probe, 0-1000°C
- Cooling water
  - Inlet temperatures: Dial thermometer - 30 to 60°C
  - Outlet temperature: analog indicator with high temperature cutout and probe 0-100°C
- Gas water manometer

##### Safety features:

- All electric circuits to be circuit breaker protected

#### Equipment not supplied

- External flue pipe
- Oil tank & piping up to the safety fuel shut-off
- Gas & gas lines up to the gas line shut-off
- Electrics from source to main circuit breaker
- Water source and drain up to shut-off valves

All Hampden units are available for operation at any voltage or frequency

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# Furnace Demonstrators

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Bulletin 236-111-1B

## H-CLT-CA

### Combustion Efficiency Analyzer

#### Purpose

The Hampden **Model H-CLT-CA** Combustion Efficiency Analyzer is an easy-to-use industrial-grade combustion efficiency and environmental analyzer that calculates the combustion efficiency of furnaces, boilers and other industrial combustion equipment.

Its user-friendly interface makes it simple to operate – while it generates reliable measurements and calculations that help improve overall combustion efficiency, reduce fuel costs and determine emissions compliance.

#### Description

- Large, easy-to-read fluorescent display that is visible from wide angles.
- Battery life of over eight hours.
- Modular design lets you add sensors as your needs change.
- Built-in printer and complete data downloading to a PC capability.
- EPA-ETV test verified performance.
- Measures and displays O<sub>2</sub> and CO in the flue gas, pressure (draft), primary air temperature, and stack temperature.
- Calculates and displays combustion efficiency, excess air, and CO<sub>2</sub>.
- Optionally measures and displays NO, NO<sub>2</sub>, SO<sub>2</sub>, HC (methane equivalent combustibles), and CO in the high range of 4,000 to 8,000 ppm).
- Optionally calculates NO<sub>x</sub> (the combination of NO and NO<sub>2</sub>), and calculates CO, SO<sub>2</sub>, and NO<sub>x</sub> individually referenced to a user defined Oxygen level of between 0 and 15%.
- Optionally displays pollution conversions for CO, NO, NO<sub>2</sub>, and SO<sub>2</sub>. Pollution conversions include parts per million, pounds of pollutant per million BTU, milligrams of pollutant per cubic meter of gas, and grams of pollutant per gigajoule.
- Stores over 1000 individual combustion and/or pressure test records, which can later be recalled for viewing or printing.
- Stored test records can be downloaded to a personal computer and stored as a text file, which can then be opened in a spreadsheet program for analysis.
- Performs datalogging

#### Specifications

##### Measurements & Ranges

Oxygen	0.1 to 20.9%
Carbon Monoxide (hydrogen compensated)	0 to 4000 ppm
Carbon Monoxide (high)	(hydrogen compensated) 4001 to 8000 ppm
Nitric Oxide	0 to 3500 ppm
Nitrogen Dioxide	0 to 500 ppm
Sulfur Dioxide	0 to 4000 ppm
Combustibles	0 to 5.00% (oxygen dependent)
Stack Temperature	-4 to 2400 degrees F (-20 to 1215° C)
Primary/Ambient Temperature	-4 to 999 degrees F (-20 to 999° C)
Pressure/Draft	-27.7 to 27.7 inches of H <sub>2</sub> O

##### Calculations & Ranges

Combustion Efficiency	0.1 to 100.0%
Excess Air	1.0 to 250%
Carbon Dioxide (dry basis)	0 to fuel dependent maximum
NO <sub>x</sub> (NO <sub>x</sub> =NO+NO <sub>2</sub> )	0 to 4000 ppm
NO <sub>x</sub> referenced to % O <sub>2</sub>	0 to 17000 ppm
CO referenced to % O <sub>2</sub>	0 to 99999 ppm
NO referenced to % O <sub>2</sub>	0 to 14900 ppm
NO <sub>2</sub> referenced to % O <sub>2</sub>	0 to 2100 ppm
SO <sub>x</sub> referenced to % O <sub>2</sub>	0 to 17000 ppm

##### Accuracy

Oxygen	±0.3% O <sub>2</sub> on practical concentration of flue gas
Stack or Flue Gas Temp.	±4°F between 32 and 255°F (±2°C between 0 and 124°C) ±6°F between 256 and 480°F (±3°C between 125 and 249°C) ±8°F between 481 and 752°F (±4°C between 250 and 400°C)
Primary-air/ambient Temp.	±2°F between 32 and 212°F (±1°C between 0 and 100°C)
Pressure Draft	±2% of reading or ±.02 in wc whichever is greater
CO	±5% of reading or ±10 ppm whichever is greater between 0-2000 ppm CO ±10% of reading between 2001 to 40000 ppm CO
NO	±5% of reading or ±5 ppm whichever is greater between 0-2000 ppm NO
NO <sub>2</sub>	±5% of reading or ±5 ppm whichever is greater between 0-500 ppm NO <sub>2</sub>
SO <sub>2</sub>	±5% of reading or ±10 ppm whichever is greater between 0-2000 ppm SO <sub>2</sub>
HC	±5% of full scale
Selectable Fuels	Natural Gas, Oil #2, Oil #4, Oil #5, Oil #6, Propane, Coal, Wood, Kerosene, Bagasse
Power	Universal AC adapter and an internal battery pack. Adapter will accept input voltages from 100 to 240V. Fully charged battery pack provides a minimum of 8 hours of operation
Pumps & Probe	Two pumps are included. The first pump supplies gas sample to the sensors. The second pump supplies fresh air to purge the low range CO sensor when CO levels exceed 4000 ppm. Probe includes a standard probe and hose assembly equipped with a water trap, particulate filter, probe stop, 15 feet of hose, and 12-inch probe tube.
Size	13.5"H x 18.5"W x 9"D
Weight	25 lbs. (11.34 kg.)

All Hampden units are available for operation at any voltage or frequency

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