armfield

FTT SERIES

FIRE TESTING TECHNOLOGY – FTT1-FTT7

Life safety and means of escape dominate fire safety in buildings and are associated with the behaviour of materials under fire conditions. This means fire protection must be considered at the architectural and construction stages of a building project, which involves an understanding of the reaction to fire behaviour of a material, or combination of materials.

The Armfield FTT series is designed to introduce students to the fundamental principles of measuring reaction to fire, exploring the concepts of ignition, flame spread, smoke production, heat release and toxicity.

APPLICATIONS

enviro™ PRODUCTS

BM TRADA CERTIFICATION ISO 9001:2008 UKAS QUALITY MANAGEMENT 012

EXTENDED WARRANTY 2 years

This data sheet is available online at:
www.armfield.co.uk/ftt

PROVISIONAL

IGNITABILITY APPARATUS – FTT1

The FTT1 Ignitability Apparatus measures the minimum percentage of oxygen in a test atmosphere required to marginally support ignition/combustion. This percentage is referred to as the oxygen index. A higher oxygen index suggests a more fire-resistant material.

FEATURES

- Digital readout for oxygen concentration ± 0.1%
- Oxygen cell for assessing accurate oxygen levels (<0.1%)
- Compact unit for efficient use inside a laboratory hood, with ventilation
- Automatic flow control gives oxygen level adjustment by turning one single valve
- Quick loading of test specimen into test chimney measuring 450 × 75mm
- Digital display of oxygen percentage in atmosphere during test (no calculations needed)
- Digital display of temperature of gas mixture entering the test chimney
- Sample holders for both rigid and flexible samples supplied
- Shortened gas path for rapid response
- Compact design

BENEFITS

The FTT1 is an economical and precise quality control test for measuring the ignitability of materials. Ignitability is defined as the capability of a material of being ignited. Its ease of use together with high levels of precision has made this technique a primary characterising and quality-control tool to the plastic and electric cable industries and it has been specified by several military and transport groups.

DESCRIPTION

This apparatus consists of a control unit with a separate glass chimney, specimen holders (two types) and a hand-held propane igniter.

The whole assembly, including the chimney, has a total height of 750mm, a width of 365mm and a depth of 364mm, although a bench depth of at least 630mm will be required to allow for gas and mains connections. The mass of the assembly is approximately 15kg.

The FTT1 – Ignitability Apparatus

DEMONSTRATION CAPABILITIES

The oxygen index, *OI*, is calculated from the following equation:

$$OI = c_F + k \bullet d$$

where:

c_F = Final value of oxygen concentration (in per cent volume to one decimal place) used in the NT series (ie that of the last test)

d = Step size between oxygen concentration levels used in the evaluation part of the procedure

k = Factor to be obtained from a table based on the pattern of response of the specimen in test (refer to instruction manual for details)

TECHNICAL SPECIFICATION

Digital readout for oxygen concentration:	± 0.1%
Dimensions:	Width: 350mm Depth: 370mm Height: 280mm
Column size:	75 or 100mm diameter × 450mm high
Weight:	17kg (approx)

REQUIREMENTS

Single-phase electrical supply

FTT1: **110-240V / 1ph / 50-60Hz**

Nitrogen (oxygen-free), oxygen (minimum 99.5% purity), propane

Extraction hood: Extraction rate of at least 50 l/s

OVERALL DIMENSIONS

Length:	0.35m
Height:	0.73m
Depth:	0.37m

SHIPPING SPECIFICATION

Volume:	0.36m^3
Gross weight:	45kg

ORDERING CODES

FTT1: **110-240V / 1ph / 50-60Hz**

ORDERING SPECIFICATION

- Digital readout for oxygen concentration ± 0.1%
- Oxygen cell for assessing accurate oxygen (< 0.1%) levels
- Compact unit for efficient use inside a laboratory hood, with ventilation
- Automatic flow control gives oxygen-level adjustment by turning one single valve
- Quick loading of test specimen into test chimney measuring 450 × 75mm
- Digital display of oxygen percentage in atmosphere during test (no calculations needed)
- Digital display of temperature of gas mixture entering the test chimney
- Sample holders for both rigid and flexible samples supplied
- Shortened gas path for rapid response

FLAME SPREAD APPARATUS – FTT2

The FTT2 Flame Spread Apparatus is designed to study flammability of materials typically used in occupant compartments of motor vehicles, such as passenger cars, multipurpose passenger vehicles, trucks and buses.

This test enables the user to measure the distance a flame spreads along a material against time to determine the burning rate. A lower burning rate suggests a more fire-resistant material.

The FTT2 – Flame Spread Apparatus

FEATURES

- Stainless steel combustion chamber
- Gas controls and safety flashback device
- Ignition source with fine-adjustment valve
- Specimen holder
- Timer

BENEFITS

- Complete and ready-to-use system
- Low maintenance requirement

DESCRIPTION

Combustion chamber:

The combustion chamber is an enclosure constructed from stainless steel, with a heat-resistant window at the front for observation.

The interior of the cabinet is 381mm long, 203mm deep and 356mm high. It has a high-temperature-resistant glass observation window, an opening to permit insertion of the specimen holder from the right-hand side of the unit, Bunsen burner, needle valve to control the gas flow, safety flashback arrestor, and specimen support rails.

Gas controls:

Gas flow is controlled by a needle valve outside the chamber to produce flame stability. Connection is made at the top of the flashback arrestor, which is a standard 6mm hose barb.

Ignition source:

The tube of the Bunsen burner has a 10mm inside diameter. A needle valve (located externally) is used to adjust the flame height to 38mm. The gas supplied to the burner should have a calorific value of approximately 38 MJ/m^3. The suggested gas supply is natural gas or a flame temperature equivalent.

Specimen holder:

The test specimen is inserted between a U-shaped frame of 50mm wide by 330mm long. A specimen that softens and bends at the flaming end so as to cause erratic burning is kept horizontal by supports consisting of thin, heat-resistant wires 0.25mm in diameter, spanning the width of the U-shaped frame under the specimen at 25mm intervals.

DEMONSTRATION CAPABILITIES

Results for burn rate can be calculated from the following formula:

$$B = 60 \times (D/T)$$

where:

B = Burn rate (mm/min)
D = Length the flame travels (mm)
T = Time for the flame to travel D millimetres (s)

Material shall not burn, or transmit a flame front across its surface, at a rate of more than four inches per minute. However, the requirement concerning transmission of a flame front shall not apply to a surface created by the cutting of a test specimen for purposes of testing. If a material stops burning before it has burned for one minute from the start of timing, and has not burned more than two inches from the point where timing was started, it shall be considered to meet the burn-rate requirement.

TECHNICAL SPECIFICATION

Measuring principle: Horizontal flammability test

Operating temperature: 23 ± 5°C, non-condensing environment

Bunsen burner tubes diameter: 9.5mm & 10mm supplied

Cabinet dimensions (interior):

Width: 381mm
Depth: 203mm
Height: 356mm

Sample holder: U-shaped frame
50mm wide x 330mm long

REQUIREMENTS

The FTT2 should be situated in a draught-free environment at 23 ± 5°C and a relative humidity of 50 ± 20%.

A supply of natural gas. In order to obtain flame stability the gas pressure shall be between 10kPa and 50kPa.

The combustion chamber should be situated under a suitably ventilated hood.

OVERALL DIMENSIONS

Length: 0.45m
Height: 0.39m
Depth: 0.20m

SHIPPING SPECIFICATION

Volume: 0.19m^3
Gross weight: 38kg

ORDERING CODES

FTT2

ORDERING SPECIFICATION

- Stainless steel combustion chamber
- Gas controls and safety flashback device
- Ignition source with fine-adjustment valve
- Diameter 9.5mm & 10mm Bunsen burner tubes supplied
- Interior cabinet dimensions
  381mm (w) × 203mm (d) × 356mm (h)
- U-shaped sample holder frame
  50mm wide by 330mm long
- Bunsen burner tube has a 10mm inside diameter
- Flame height adjustment to maximum 38mm
- Integrated timer

SMOKE RELEASE APPARATUS – FTT3

The FTT3 Smoke Release Apparatus is designed to measure and observe the amount of smoke produced when a material combusts.

The measurements are made in terms of the loss of light transmission through a collected volume as a result of smoke produced under controlled, standardised conditions. Two indexes, the maximum smoke produced and the smoke-density rating, are used to rate the material.

BENEFITS

- Complete and ready-to-use system
- Low maintenance requirement

FEATURES

- Combustion chamber
- Specimen holder
- Ignition system
- Photometric system
- Control unit, including smoke meter
- PLC – integrated safety and control system, 24V DC powered
- Independent burner control
- Thermocouple type K interlock for main and auxiliary burners
- Fan and exhaust damper control
- Light-source control 5V DC switch mode power supply
- Convection cooling
- Various built-in safety measures including over-voltage and over-current protection
- ExitSign software

DESCRIPTION

The FTT3 test is designed for the measurement and observation of the smoke-producing characteristics of plastics under controlled conditions of combustion or decomposition.

The unit has a bench mounted draught-free aluminium chamber with a large lift-off door and a window made from toughened heat-resistant glass giving a generous view of the specimen during a test.

The FTT3 – Smoke Release Apparatus

DEMONSTRATION CAPABILITIES

The test specimen is exposed to flame for the duration of the test, and the smoke is collected in the chamber in which combustion occurs. A 25 × 25 × 6mm specimen is placed on a supporting metal screen and burned in the test chamber under active flame conditions using a propane burner. The chamber is closed during the four-minute test period. A heat-resistant glass door is fitted to allow observation of the test while it is in progress.

Measurement is by means of transmitting a beam of light through the smoke generated by the sample under test to a light-measuring receiver. Results obtained are in units of light absorption (%). The light-absorption data are acquired by a user-friendly software tool called ExitSign and plotted versus time. Two indexes, the maximum smoke produced and the smoke-density rating, are used to rate the material.

TECHNICAL SPECIFICATION

Chamber:	Draught-free aluminium chamber mounted on a 360 × 400 × 57mm base
Internal dimensions:	Width: 300mm Depth: 300mm Height: 790mm
Voltage:	96-264V / 50-60Hz at 1 amp
Outer diameter of exhaust fan:	104mm
Exhaust flow rate:	1700 l/min
Interior light:	2 × 6W fluorescent lights, 240V / 50-60Hz, 3400 K
Burners:	A burner with a 0.13mm diameter orifice Auxiliary burner with a 1100g weight constructed from stainless steel
Gas type and pressure:	Commercial-grade 85.0% minimum propane pressure regulated at 40psi for the main burner and 20psi for the auxiliary burner
PLC:	Integrated safety and control system, 24V DC powered: • Independent burner control • Fan and exhaust damper control • Light-source control 5V DC switch mode power supply
Flashback arrestor:	Safety precaution fitted on both burners
Photometric system:	The light source houses a 1493 compact filament microscope lamp running between 5.3V DC and 6.3V DC. The signal is monitored and processed via a smoke meter in the control unit
Specimen holder (x4):	64 × 64mm stainless steel square, of 6 × 6mm, 0.9mm gauge wire
Quench pan (x1):	Stainless steel 150 × 100 × 20mm
Particles boards (x4):	6.35mm thick, 64 × 64mm square calcium silicate
Stainless steel collector tray (x1):	63.5 × 63.5 × 9.525mm deep with 12.7mm square bottom

SOFTWARE

ExitSign

SOFTWARE CAPABILITIES

Calibration routines, acquire test data, product test reports

REQUIREMENTS

Single-phase electrical supply

FTT3-A: **230V / 1ph / 50-60Hz**

A 1500VA transformer is available to accommodate 120V / 1ph / 60Hz

The FTT3 should be situated in a draught-free environment at 23 ± 5°C and a relative humidity of 50 ± 20%.

Two supplies of propane gas, minimum purity 85%. 40psi pressure for main burner, 20psi pressure for auxiliary burner.

The combustion chamber should be situated under a suitably ventilated hood, or the supplied exhaust hose connected to the laboratory extraction system.

OVERALL DIMENSIONS

Length:	0.83m
Height:	0.85m
Depth:	0.41m

SHIPPING SPECIFICATION

Volume:	1.42m^3
Gross weight:	164kg

ORDERING CODES

FTT3-A:	**230V / 1ph / 50-60Hz**
Transformer option:	
TRANSFORMER-1500VA	**120V / 1ph / 60Hz**

ORDERING SPECIFICATION

- Combustion chamber internal dimensions 0.30m (l) × 0.30m (d) × 0.79m (h)
- Specimen holder
- Ignition system
- Photometric system
- A burner with a 0.13mm diameter orifice
- Auxiliary burner with a 1100g weight constructed from stainless steel
- Control unit (including smoke meter)
- PLC – Integrated safety and control system, 24V DC powered
- Independent burner control
- Thermocouple type-K interlock for main and auxiliary burners
- Fan and exhaust damper control with exhaust rate of 1700 l/min
- Light source control 5V DC switch mode power supply
- Light source houses a 1493 compact filament microscope
- Various built-in safety measures including over-voltage and over-current protection
- ExitSign software

OXYGEN BOMB CALORIMETER – FTT4

The FTT4 Oxygen Bomb Calorimeter is a high-resolution isoperibolic temperature-regulated oxygen bomb calorimeter with embedded control computer.

The bomb calorimeter is the most common device for measuring the heat of combustion or calorific value of a material. With this apparatus a test specimen of specified mass is burned under standardised conditions. The heat of combustion determined under these conditions is calculated on the basis of the observed temperature rise while taking account of heat loss.

Calorific value of solid and liquid specimens, such as coal, coke, petroleum and alcohol, can be determined. It usually applies to coal mines, heat engine plants, cement and glass factories, as well as colleges and universities.

FEATURES

- Bomb calorimeter with embedded computer control, user-friendly interface on LCD display
- Oxygen bomb and bucket (calorimeter vessel)
- Thermostatically controlled bath, circulator, cooler, pipette (2l)
- Automatic temperature control and firing
- Automatic test, data storage, result calculation and result printing
- Data export to PC via serial port (optional)
- Thermal capacity: 15 kJ/K
- Thermal capacity repeatability error: ≤0.2%

BENEFITS

- Easy to use
- Automatic firing/ignition of sample
- Microprocessor control
- High repeatability

The FTT4 – Oxygen Bomb Calorimeter

DESCRIPTION

With this apparatus, a test specimen of specified mass is fired automatically and burned under standardised conditions. The heat of combustion determined under these conditions is calculated on the basis of the observed temperature rise while taking account of heat loss. The combustion process is initiated inside an atmosphere of oxygen in a constant-volume container, the bomb, which is a vessel built to withstand high pressures. It is immersed in a stirred water bath, and the whole device is the calorimeter vessel. The calorimeter vessel is also immersed in an outer water bath. The water temperature in the calorimeter vessel and that of the outer bath are both monitored during the test.

DEMONSTRATION CAPABILITIES

The sample is burned under standardised conditions where the jacket temperature is kept constant while the vessel (bomb and bucket) temperature rises. The calorific value calculation is based on this temperature rise while taking account of residual heat loss.

$$PCS = (E(T_m - T_i + C) - b) / m$$

PCS = Gross heat of combustion in MJ/kg

E = Water equivalent of the calorimeter, the bomb, their accessories and of the water introduced into the bomb, expressed in MJ/K

T_i = Initial temperature in K

T_m = Maximum temperature in K

b = Correction expressed in MJ required for the combustion heat of the fuels used during the test; ie firing wire, cotton thread, cigarette paper and benzoic acid or combustion aid

c = Temperature correction expressed in K required for the exchange of heat with the outside. This is automatically determined by the Bomb Calorimeter

m = Mass of the test specimen in kg

TECHNICAL SPECIFICATION

Working temperature range:	5-30°C
Maximum measuring range:	15,000 J/K
Reproducibility (1g benzoic acid):	0.2% RSD
Temperature measurement resolution:	0.001°C
Max operating pressure:	20 MPa
Oxygen filling:	Semi-auto
Permissible relative moisture:	<85%
Permissible ambient temperature:	<30°C

OPTIONAL ACCESSORIES

- Benzoic acid, 100g
- Sample crucible and firing wire
- Analytical balance
- Oxygen-filling device
- Firing cotton

REQUIREMENTS

Single-phase electrical supply

FTT4-A: **220V / 1ph / 50Hz**
FTT4-B: **110V / 1ph / 60Hz**

OVERALL DIMENSIONS

Length:	0.58m
Height:	0.35m
Depth:	0.42m

SHIPPING SPECIFICATION

Gross weight: 164kg

ORDERING CODES

FTT4-A: **220V / 1ph / 50Hz**
FTT4-B: **110V / 1ph / 60Hz**

ORDERING SPECIFICATION

- Embedded computer control, user-friendly interface on LCD screen
- Oxygen bomb and bucket (calorimeter vessel)
- Thermostatically controlled bath, circulator, cooler, pipette (2l)
- Automatic temperature control and firing
- Automatic test, data storage, result calculation and result printing
- Data export to PC via serial port (optional)
- Thermal capacity: 15 kJ/K
- Thermal capacity repeatability error: ≤ 0.2%
- Working temperature range: 15-30°C
- Measuring range max.: 15,000 J/K
- Temperature measurement resolution: 0.001°C

HEAT RELEASE & MASS LOSS CALORIMETER – FTT5

The FTT5 Heat Release & Mass Loss Calorimeter measures ignitability, mass loss rate and heat release. It is a simplified version of the widely used Cone Calorimeter (FTT7) in fire researches and industries.

The FTT5 enables the user to carry out thermal-exposure studies, under the same precise exposure conditions as those used in the Cone Calorimeter, while visibly observing the time to ignition, measuring the mass change. A flue containing a thermopile can also be added to the unit to measure heat release rate.

FEATURES

- Fire model manufactured from stainless steel for long life
- Three control thermocouples for the cone heater to maintain accurate heat flux
- Special split shutter mechanism is designed to prevent heating of the sample before the test is started
- Spark assembly is used in conjunction with the shutter mechanism. Microswitches are fitted to the spark arm and the shutter mechanism for safe operation
- Sample weight measurement is by a strain gauge load cell with quick electronic tare facility
- Control unit contains switches for power, ignition, load cell and cone heater
- Temperature controller for ramp and control of cone heater
- Load cell controller with a weight-ranging facility to improve performance to suit weight of sample 0-500g
- Fire model and controller designed to be assembled in the FTT cone frame for upgrading to a full Cone Calorimeter at a later stage if required
- Windows-based MLCCalc software makes operations and calibration of the instrument very easy

BENEFITS

The FTT5 is a very helpful tool for those with a major interest in ignitability and mass-loss work, or those working with a limited budget. Using the FTT5 under a suitable hood enables the user to carry out thermal exposure studies, under the same precise exposure conditions as those used in the Cone Calorimeter, while visibly observing the specimen reaction and measuring the mass change.

It consists of a complete fire model and control module, which can be enhanced to be a full Cone Calorimeter at any time by addition of other Cone Calorimeter components.

The FTT5 – Heat Release & Mass Loss Calorimeter

DESCRIPTION

The FTT5 Heat Release apparatus measures time to ignition, mass loss and heat-release rate (option) of specimens exposed in the horizontal orientation to controlled levels of irradiance with an external igniter.

On the front panel, the following are mounted:

- Temperature controller
- Load cell controller
- Tare button
- Control switches comprising four red on/off push-button switches, which operate by firm pressure and light up when activated:
- Power – switches on mains electricity to the unit
- Cone – switches on the Eurotherm controller. This, in turn, energises a solid state relay, which switches the power to the cone heater (5kW)
- Ignition – switches on the spark-generator circuit housed in the test chamber base
- Load cell – switches on the Newport controller

DEMONSTRATION CAPABILITIES

Soon after starting the test, the operator should take a look at the reading on the load cell indicator, to make sure that a value fairly close to the actual specimen mass is seen.

The burning specimen should be observed during the entire course of the test. The operator should look for:

- Pieces falling off
- Dripping
- Excessive swelling – the specimen should not swell so much as to foul any metal portions of the apparatus
- Explosive spilling
- Any other anomalous behaviour

The test is normally ended when all signs of combustion have ceased, with the possible exception of a very small, continued mass loss. The end has not yet been reached if there is any flaming or any visible pyrolysis or smoking.

TECHNICAL SPECIFICATION

Truncated conical heater:

Electrical heating element: 5kW
Heat flux: Up to 100 kW/m^2
Heat shield: Placed between the cone heater and specimen

Specimen holder and weighing device:

Specimen holder: A square pan 106 × 106mm at the top, with a height of 25mm, constructed from stainless steel

Retainer edge frame: A stainless steel frame with inside dimensions of 111 × 111mm, and an opening of 94 × 94mm

Sample size: 100 × 100mm
Sample thickness: Up to 50mm
Balance sensitivity: <0.1g
Load capacity: Up to 2.0kg

Ignition circuit:

Spark igniter: Spark gap of 3.0mm located 13mm above the centre of the specimen

SOFTWARE

MLCCalc

OPTIONAL ACCESSORIES

Chimney with thermopile to measure heat release

REQUIREMENTS

Single-phase electrical supply

FTT5-A
Control unit: 220-240V / 1ph / 50Hz
Cone heater: 220-240V / 1ph / 50Hz at 32 amp

A 1500VA transformer is available to accommodate 120V / 1ph / 60Hz

Low-pressure water supply: 250kPa (35psi)

OVERALL DIMENSIONS

Fire model:

Length: 0.35m
Height: 0.50m
Depth: 0.32m

Control unit:

Length: 0.52m
Height: 0.15m
Depth: 0.30m

SHIPPING SPECIFICATION

Volume: 0.09m^3
Gross weight: 104kg

ORDERING CODES

FTT5-A
Control unit: 220-240V / 1ph / 50Hz
Cone heater: 220-240V / 1ph / 50Hz at 32 amp

Transformer option:

TRANSFORMER-1500VA 120V / 1ph / 60Hz

ORDERING SPECIFICATION

- Manufactured from stainless steel for long life
- Retainer edge frame stainless steel with inside dimension 111 × 111mm, and opening of 94 × 94mm
- Three control thermocouples for the cone heater to maintain accurate heat flux
- Special split shutter mechanism is designed to prevent heating of the sample before the test is started
- Spark assembly is used in conjunction with the shutter mechanism. Microswitches are fitted to the spark arm and the shutter mechanism for safe operation
- Sample weight measurement is by a strain gauge load cell with quick electronic tare facility
- Specimen holder square pan 106 × 106mm at the top, and a height of 25mm, constructed from stainless steel
- Sample size up to 100 × 100mm
- Sample thickness up to 50mm
- Balance sensitivity < 0.1g
- Load capacity up to 2.0kg
- Control unit contains switches for power, ignition, load cell and cone heater
- Temperature controller for ramp and control of cone heater
- 5kW electrical heating element
- Heat flux up to 100 kW/m^2
- Heat shield placed between the cone heater and specimen
- Load cell controller with weight ranging facility to improve performance to suit weight of sample (0-500g)
- Fire model and controller designed to be assembled in the FTT Cone frame for upgrading to a full Cone Calorimeter at a later stage if required
- Windows-based MLCCalc software makes operations and calibration of the instrument very easy

TOXICITY APPARATUS – FTT6

The FTT6 Toxicity Apparatus measures the toxicity of combustion products when a material is completely burnt in excess air in a closed chamber of fixed volume. The combustion products are collected in the chamber and then analysed using colorimetric tubes to measure the concentrations of various toxic gases. These concentrations are used to calculate the toxicity index. The toxicity index is defined as the numerical summation of the toxicity factor of selected gases produced by complete combustion of the material in air under the conditions specified. The toxicity factors are derived from the calculated quantity of each gas that would be produced when 100g of the material is burnt in air in a volume of $1m^3$.

FEATURES

- The combustion chamber has a strong steel framework and is constructed from fire-retardant-grade polypropylene with welded seams and a volume of $0.7m^3$
- The door, which gives full access to the chamber for easy cleaning, incorporates a clear polycarbonate sheet, backed with laminate for strength and rigidity
- The gas burner has a spark ignition system that automatically reignites should the flame extinguish
- An internally mounted stirring fan for rapid mixing of combustion products
- Solenoid-operated vent seal
- 12 sampling ports on the side of the chamber
- Provision is made for gaseous/volatile test products to be drawn from the chamber for analysis through ports on the side of the chamber. At least 12 sampling positions are provided for use with colorimetric gas reaction tubes or optional specific gas analysers
- A separate control unit houses the flow meters, timer, methane and air controls
- A forced-air extraction system for evacuating the chamber after a test

DESCRIPTION

The FTT6 test explores the toxicity of the products of combustion in terms of a limited set of small molecular species arising when a small specimen of a material is completely burnt under specified conditions. A combined toxicity index is calculated from the test results using the exposure level (in ppm) of each gas to produce fatality in 30 minutes.

The test is intended to form part of the preselection screening process for materials and should not be interpreted as an assessment of toxicity hazard under actual fire conditions. The test method is directed at the analysis of a specified set of gaseous species, which are commonly present in combustion products of materials used in military applications and which may cause lethality at the time of the fire.

The FTT6 – Toxicity Apparatus with controller

The FTT6 is a closed chamber of fixed volume (728 × 982 × 982mm) in which specimens can be subjected to a premixed burner.

The system comprises the combustion chamber, combustion control unit and a gas analysis system with colorimetric tubes.

DEMONSTRATION CAPABILITIES

Small specimens of predetermined mass (usually approx 1g) are completely burnt inside a sealed chamber of volume 0.7-1.0m^3, using a Bunsen burner fed with air and gas to give a non-luminous (blue) flame, having a temperature of 1150 ± 25°C.

The resulting chamber atmosphere is quantitatively analysed for a specified set of gases. Background corrections are subtracted for the amounts of carbon monoxide, carbon dioxide and oxides of nitrogen produced by the burner.

For each gas, the measured concentration (C_i) is scaled up for 100g of material and recalculated as though the combustion products were diffused into a volume of exactly $1m^3$. The resulting concentration (C_g) is expressed as a ratio of the critical factor (C_f), which is equal to the concentration of that gas considered fatal to man for a 30-minute exposure. The ratios (C_g/C_f) are summed for all gases detected to give a toxicity index (TI) for the material.

$$C_g = (C_i \times 100 \times V) / m$$

where:

C_i = concentration of gas i in test chamber, resulting from combustion of the test specimen (ppm)
m = mass of test specimen (g)
V = volume of test chamber (m^3)

TECHNICAL SPECIFICATION

Chamber:	Volume 0.7m³ Fire-retardant polypropylene Full-size door with polycarbonate window 15 gas measurement ports Solenoid operated vent seal Internal stirring fan
Chamber dimensions:	1100mm (w) × 800mm (d) × 1300mm (h)
Burner:	Spark igniter with safety sensor, spark automatically reignites burner if flame is extinguished Temperature range maximum 1200°C
Control unit:	Flow meter, valves for air Flow meter, valves for natural gas/methane Second/minute timer Power control switches
Control unit dimensions:	530mm (w) × 270mm (d) × 280mm (h)

Colorimetric gas detection tubes (optional)

Carbon dioxide:	0.1-6%	± 5-10%
Carbon monoxide:	5-700ppm	± 10-15%
Hydrogen sulphide:	1-200ppm	± 15%
Ammonia:	0.5-10%	± 10-15%
Formaldehyde:	0.04-25ppm	± 20-30%
Hydrogen chloride:	1-20ppm	± 10-15%
Acrylonitrile:	0.5-200ppm	± 15-20%
Sulphur dioxide:	1-25ppm	± 10-15%
Nitrous fumes:	5-150ppm	± 10-15%
Hydrogen cyanide:	2-150ppm	± 10-15%
Hydrogen fluoride:	1.5-600ppm	± 15-20%
Phosgene:	0.02-1ppm	± 10-15%
Phenol:	1-20ppm	± 10-15%
Hydrogen bromide:	1-20ppm	± 10-15%

REQUIREMENTS

Single-phase electrical supply:

FTT6:	**110-240V / 1ph / 50-60Hz**
Gas:	Methane gas up to 2 l/min flow rate minimum 95% purity
Air:	Compressed air up to 15 l/min flow rate
Extraction:	A fume chamber or proprietary extraction system is recommended. A 3m flexible extraction hose (internal diameter 75mm) is supplied

OVERALL DIMENSIONS

Chamber

Length:	1.10m
Height:	1.30m
Depth:	0.80m

Controller

Length:	0.53m
Height:	0.28m
Depth:	0.27m

SHIPPING SPECIFICATION

Volume:	2.56m³
Gross weight:	227kg

ORDERING CODES

FTT6	**110-240V / 1ph / 50-60Hz**

ORDERING SPECIFICATION

- The combustion chamber has welded seams and a volume of 0.7m³
- The gas burner has a spark ignition system that automatically reignites should the flame extinguish
- An internally mounted stirring fan for rapid mixing of combustion products
- 12 sampling ports on the side of the chamber
- A separate control unit houses the flow meters, timer, methane and air controls
- The unit has a forced-air extraction system for evacuating the chamber after a test
- Chamber has a full-size door with polycarbonate window
- Chamber has 15 gas measurement ports
- Chamber has a solenoid operated vent seal
- Chamber dimensions: 1100mm (w) × 800mm (d) × 1300mm (h)
- Temperature range maximum 1200°C
- Flow meter and valves included for air
- Flow meter and valves included for natural gas/methane
- Second/minute timer included

CONE CALORIMETER – FTT7

The FTT7 Cone Calorimeter is the most significant bench-scale instrument in the field of fire testing because it measures important real fire properties of the material being tested under a variety of preset conditions. These measurements can be used directly by students/academics, or used as data for input into correlation or mathematical models used to predict fire development. Directly measured properties include (depending on optional accessories):

- Time to ignition
- Mass loss rates
- Smoke release rates (optional)
- Rate of heat release
- Rates of release of toxic gas (optional)

FEATURES

- Conical heater of a truncated cone, rated 5000W at 230V with a heat output of up to 100 kW/m^2
- Facility for testing horizontally or vertically orientated specimens
- Temperature control by the use of three type K thermocouples and a three-term (PID) temperature controller
- A split shutter mechanism – protects the sample area before the test. This ensures the initial mass measurement is stable and the operator has additional time for system checks before starting the test. This added time is very important for easily ignitable samples, which often ignite prematurely if a shutter mechanism is not used
- Specimen holders – for specimens 100 × 100mm up to 50mm thick, in the horizontal and vertical orientation
- Load cell – mass measurements are conducted via a strain gauge load cell with an accuracy of 0.1g. Fitted with a quick electronic tare facility and mechanical stops to avoid movement damage, give stable results and long life
- Spark ignition – by 10kV spark generator fitted with a safety cut-out device. The igniter is automatically positioned by a lever linked with the shutter mechanism
- Exhaust system – manufactured from stainless steel for long life. This comprises a hood, gas-sampling ring probe, exhaust fan (with adjustable flow controls from 0-50 g/s, at a resolution of at least 0.1 g/s) and an orifice plate flow measurement (thermocouple and differential pressure transducer). Normal operation is at a nominal 24 l/s
- Gas sampling – comprising particulate filters, pump, drying columns and flow control
- Oxygen analysis – oxygen analyser, which has a range of 0-25% and a performance compliant with the standards
- Smoke obscuration – measured with a laser system, using photodiodes, and a 0.5mW helium neon laser, with main and reference (compensating) photo detectors. Supplied with alignment cradle and 0.3, 0.8 neutral density filters for calibration

The FTT7 – Cone Calorimeter with data logging computer

- Heat flux meter – for setting the irradiance level at the surface of the specimens
- Calibration burner – to calibrate the rate of heat release measured by the apparatus using methane of 99.5% purity
- Data acquisition – Agilent data acquisition / switch unit featuring a three-slot card cage with 6½-digit (22-bit) internal DMM enabling up to 120 single-ended or 48 double-ended measurements. Scan rates up to 250 channels/s are available with a 115 KBaud RS232 and PCI GPIB interface as standard. All readings are automatically time stamped and can be stored in a nonvolatile 50,000-reading memory
- FTT ConeCalc software – The user interface is a Windows-based system with user-friendly push-button actions and standard Windows data entry fields, drop-down selectors, check boxes and switches capable of:
  - > Showing the status of the instrument
  - > Calibrating the instrument and storage of calibration results
  - > Collecting data generated during a test
  - > Calculating the required parameters
  - > Presenting the results in a manner approved by the Standards
  - > Averaging of multiple tests
  - > Exporting files as CSV files for quick transfer to spreadsheets

DESCRIPTION

The name of the cone calorimeter derives from the shape of the truncated conical heater the designer, Babrauskas, used to irradiate the test specimen (100 × 100mm) at fluxes up to 100 kW/m^2 in the bench-scale oxygen-depletion calorimeter he and his coworkers developed at NIST.

The FTT7 Cone Calorimeter has been produced to be the most compact and easily maintained unit in the marketplace. It fits into the smallest of labs and is easy to operate using the user-friendly, menu-driven software, which guides users through the calibration, testing and reporting protocols.

DEMONSTRATION CAPABILITIES

Most leading fire-research groups now use cone calorimeters both as a prime source of data on properties of materials and as a source of input data to models used for predicting the fire behaviour of finished products. International standards have been published describing the equipment and several national standardisation bodies have now published product standards for use of the Cone Calorimeter in assessing performances of finished products. The FTT7 does not conform to international standards but measures the same properties.

Principle of measurement

This technique is based on the empirical observation that heat released by burning materials is directly proportional to the quantity of oxygen used in the combustion process.

Most fuels were found to generate 13.1 x 10^3 kJ/kg of oxygen consumed. Measurement of the precise concentrations of oxygen in the exhaust duct and the volumetric flow of air gives the rate of oxygen consumption from which the heat release rates can be calculated. In the Cone Calorimeter the rate of heat released is given by:

$$\dot{q} = (13.1 \times 10^3)\ 1.10C \sqrt{\frac{\Delta P}{T_e}}\ \frac{(0.2095 - Xo_2)}{(1.105 - 1.5\ Xo_2)}$$

where:

q =	Rate of heat release (kW)
c =	Orifice plate coefficient (kg$^{1/2}$•m$^{1/2}$•K$^{1/2}$)
ΔP =	Pressure drop across the orifice plate (Pa)
T_g =	Gas temperature at the orifice plate (K)
Xo_2 =	Measured mole fraction of O_2 in the exhaust air (no units)

TECHNICAL SPECIFICATION

Truncated conical heater

Element:	5kW electrical heating element
Heat flux:	Up to 100 kW/m^2
Heat shield:	Placed between cone heater and specimen

Specimen holder and weighing device

Specimen holder:	A square pan 106 × 106mm at the top, with a height of 25mm, constructed from stainless steel
Retainer edge frame:	A stainless steel frame with inside dimensions of 111 × 111mm, and an opening of 94 × 94mm
Sample size:	100 × 100mm
Sample thickness:	Up to 50mm
Balance sensitivity:	<0.1g
Load capacity:	Up to 2.0kg

Exhaust gas system with flow-measuring instrumentation

Duct diameter:	114mm
Nominal exhaust flow rate:	24 l/s
Orifice plate:	Internal diameter 57mm located in chimney to measure duct flow
Sampling ring:	685mm from the hood, contains 12 small holes with a diameter of 2.2mm
Gas sampling apparatus:	Incorporates a pump, soot filter, cold trap, moisture and CO_2 removal traps when CO_2 analyser is not fitted

Ignition circuit

Spark igniter:	Spark gap of 3.0mm located 13mm above the centre of the specimen

Calibration burner

Construction:	A tube with a 500mm^2 square orifice covered with wire gauze

Instrumentation for oxygen and gas analysis

Oxygen analyser:	Paramagnetic type with a range of 0-25% oxygen
Carbon dioxide (optional):	Non-dispersive infrared type with a range of 0-10%
Carbon monoxide (optional):	Non-dispersive infrared with a range of 0-1%

Smoke density measurement (optional)

Light source:	0.5mW helium-neon laser beam
Detector:	Silicone photodiode

Data collection and analysis system

Resolution:	16 bits
Recording time:	Once every second
Storage:	Raw data recorded for each test is stored and can be retrieved

SOFTWARE

ConeCalc

SOFTWARE CAPABILITIES

The user interface is a Windows-based system with user friendly push-button actions and standard Windows data entry fields, drop-down selectors, check boxes and switches capable of:

- Showing the status of the instrument
- Calibrating the instrument and storage of calibration results
- Collecting data generated during a test
- Calculating the required parameters
- Presenting the results in a manner approved by the Standards
- Averaging of multiple tests
- Exporting files as CSV files for quick transfer to spreadsheets

REQUIREMENTS

Single-phase electrical supply

FTT7-A: **220-240V / 1ph / 50-60Hz at 30A**

Transformer available: See Ordering codes

Water: 250kPa (35psi)

Exhaust extraction: 50-500 l/s

Standard gases: Nitrogen (oxygen-free), methane (UHP 99.5%)

Additional gases: Carbon dioxide (8.5%), carbon monoxide (0.85%), nitrogen (balance) if three-cell analyser option purchased

Chemicals: Drierite (8 mesh), ascarite (8-20 mesh) if one-cell analyser option purchased

Aluminium foil: 0.025-0.04mm thick

OVERALL DIMENSIONS

Length: 1.60m
Height: 2.54m
Depth: 0.53m

SHIPPING SPECIFICATION

Volume: Box 1 – 3.47m^3; Box 2 – 0.97m^3
Gross weight: Box 1 – 461kg; Box 2 – 120kg

ORDERING CODES

FTT7-A: **220-240V / 1ph / 50-60Hz at 30 amp**

Transformer option:

ETRAN-4000VA **120V / 1ph / 60Hz**

ORDERING SPECIFICATION

- Conical heater of a truncated cone, rated 5000W at 230V with a heat output of up to 100 kW/m^2
- Facility for testing horizontally or vertically orientated specimens
- Temperature control by the use of three type-K thermocouples and a three-term (PID) temperature controller
- A split-shutter mechanism protects the sample area before the test. This ensures the initial mass measurement is stable and the operator has additional time for system checks before starting the test. This added time is very important for easily ignitable samples, which often ignite prematurely if a shutter mechanism is not used
- Specimen holders for specimens 100 × 100mm up to 50mm thick, in the horizontal and vertical orientation
- Load cell mass measurements are conducted via a strain gauge load cell with an accuracy of 0.1g. Fitted with a quick electronic tare facility and mechanical stops to avoid movement damage, give stable results and long life
- Spark ignition by 10kV spark generator fitted with a safety cut-out device. The igniter is automatically positioned by a lever linked with the shutter mechanism
- Exhaust system manufactured from stainless steel for long life. This comprises hood, gas sampling ring probe, exhaust fan (with adjustable flow controls from 0-50 g/s, at a resolution of at least 0.1 g/s) and an orifice plate flow measurement (thermocouple and differential pressure transducer). Normal operation is at a nominal 24 l/s
- Gas sampling comprising particulate filters, pump, drying columns and flow control
- Oxygen analysis by oxygen analyser, with a range of 0-25%
- Smoke obscuration measured with a laser system, using photodiodes, and a 0.5mW helium neon laser, with main and reference (compensating) photo detectors. Supplied with alignment cradle and 0.3, 0.8 neutral density filters for calibration
- Heat flux meter for setting the irradiance level at the surface of the specimens
- Calibration burner to calibrate the rate of heat release measured by the apparatus using methane of 99.5% purity
- Agilent data acquisition / switch unit featuring a three-slot card cage with 6.5-digit (22-bit) internal DMM enabling up to 120 single-ended or 48 double-ended measurements. Scan rates up to 250 channels/s are available with a 115 kbaud RS232 and PCI GPIB interface as standard. All readings are automatically time stamped and can be stored in a nonvolatile 50,000-reading memory
- FTT ConeCalc software

Head Office:
Armfield Limited
Bridge House, West Street,
Ringwood, Hampshire
BH24 1DY England
Telephone: +44 1425 478781
Fax: +44 1425 470916
E-mail: sales@armfield.co.uk

U.S. Office:
Armfield Inc.
9 Trenton - Lakewood Road
Clarksburg NJ 08510
Tel/Fax: (609) 208-2800
E-mail: info@armfieldinc.com

armfield
Innovators in Engineering Teaching Equipment
learn more! www.armfield.co.uk

Scan for website