firetesting technology

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The most advanced cone calorimeter in the world

Compact, robust and easy-to-use
Automatic
Improved serviceability
Improved laser mounting system
Latest generation gas analyser

*i*Cone^{2+}

Standards are the very framework **FTT** instruments are built on

FTT's instruments feature special facilities or software that enhance functionality and ease of use, but almost all are built to meet national or international standards. Many of these standards and the associated instruments are called up for use in national regulatory codes or Directives for many product applications in construction, transport or electrotechnical areas. It is essential that **FTT** engineers are up to date with activities in relevant national and international standardisation agencies, so that they can contribute to the latest developments and ensure **FTT**'s equipment complies with them.

Within Europe, most National regulations follow European Directives that use European Standard tests, though some national regulations also allow parallel use of national standards. European Standards (EN) for transport, construction and most other applications are produced by CEN, and those for electrotechnical products by CENELEC. Similar standards for each of these sets are developed for wider international use by the International Standards Organisation (ISO) and the International Electro Technical Commission (IEC) respectively. CEN, CENELEC, ISO and IEC committees are composed of experts representing the National Standardisation Bodies, and the standards they develop and modify are confirmed by ballots of new texts when National Standardisation bodies mirror committees vote. Often the same or similar documents are published as EN, ISO and even national standards and they are dual numbered EN ISO standards. **FTT**'s senior staff participate in all national mirror committees and most international and European committees, where our products are standardised.

Developments in Construction Product Standards

Most construction product standards are developed in Europe by CEN 127 or in ISO by ISO TC92, and are often dual numbered. Several key standards that are used throughout Europe for classification purposes have, or are undergoing, changes that require modification in equipment or software to maintain compliance. Three of these EN ISO standards; EN ISO 1716; EN ISO 1182 and EN ISO 11925-2, have recently undergone revisions and EN 13823 (Single Burning Item) is also being revised. ISO 1716 changes focus on corrections and some instrument changes that allow modern technology to be used. ISO 1182 updates mostly focus on the use of additional thermocouples to improve the repeatability and reproducibility. This requires a modification to the furnace assembly; data acquisition and data processing software and users are advised to contact **FTT** to arrange these upgrades to achieve compliance. Changes in ISO 11925-2 require changes in the testing procedure but do not require modification in the instrumentation used. A new edition of the SBI standard, EN 13823, published in 2020 has a number of test and calibration procedure improvements that are readily accommodated by small changes in **FTT** software. In addition, the bidirectional probe that was used to measure flows in the exhaust duct must be replaced by a hemispherical probe to achieve compliance, so this will require upgrades in all SBI instruments.

There have been considerable changes and additions to the ISO 5660 suite of cone calorimeter standards in recent years. For many years ISO 5660-1 covered heat release measurement and ISO 5660-2 covered smoke release measurements whilst ISO 5560-3 dealt with guidance for use of the cone calorimeter. In 2015, smoke measurement was also integrated into 5660-1 and ISO 5660-2 was discontinued. ISO TR 5660-4 was published to extend the lower range of measurement of heat release so that materials with very low levels of heat release could be reliably assessed. This was done principally by the use of lower exhaust flow rates and by fitting a larger cone heater model into the calorimeter to allow much bigger specimens to be irradiated. This facilitated the generation of larger oxygen depletion signals. ISO TR 5660-5 was published in 2020 and describes the apparatus and procedures for testing specimens in the cone calorimeter in reduced oxygen atmospheres so that data for modelling vitiated fire environments can be generated.

Developments in European Railway Fire Standards

In order to facilitate interoperability of railway rolling stock within Europe, railway rolling stock is to be constructed to meet the performances specified in several EN standards. The EN 45545 suite describes these requirements and EN 45545-2 lists all the fire performance requirements and test methods that products must meet to be used in various rolling stock applications. Almost all the fire tests to be used were developed by other specialist fire test committees, but, as it was judged that there were no adequate international test methods for "Fire Tests for Seating" and for "Determination of Toxic Gases", new testing methods were included as Normative Annexes in EN 45545-2. These 2 Annexes have recently been extensively revised and published as full standards and EN 45545-2 revised accordingly. These new standards are EN 16989 "Fire Behaviour Test for a Complete Seat" and EN 17084 "Toxicity Tests for Materials and Components".

Codes and Standards in the USA

In the USA, standards are produced by several private standardisation organisations (SDOs) including ASTM, NFPA and UL. Model codes are developed by ICC and NFPA. Each state can adopt a model code for any application (such as a building code or an electrical code) and is entitled to make some changes to them. Fire Safety in these codes is based on test method standards which were developed by the SDOs and the codes typically incorporate acceptance criteria developed by the code committees. **FTT** directors and our US agent (Marcelo Hirschler and Tim Earl) participate extensively in ASTM and other standardisation organisations as well as in code development at ICC and NFPA.

Many fire tests used in the USA are based on the same instruments and fire tests developed by ISO, albeit with different designations. In recent years there have been many developments in use of heat release test standards in research and in regulation, primarily with regard to large scale tests. The use of ASTM E1354 (US version of ISO 5660-1) is increasing for product development and research and is also included for some building contents, and ASTM E2965 (similar to ISO 5660-4) has recently been adopted in some codes. Construction product regulations still use the ASTM E84 Steiner tunnel but there is an increasing use of large scale heat release tests. This includes a room corner test (NFPA 286, for many construction products, including insulation), and tests based on individual product calorimetry (NFPA 289), combustible vegetation (such as Christmas trees; ASTM E3082), decorative materials, and stage displays. The most recent large-scale heat release test (UL 9540A) is a test for evaluating fire propagation from battery energy storage systems. **FTT** makes, installs and supports almost all of these apparatuses.

SEAN GREGORY (Sales Consultant)

Sean Gregory has a degree in Chemistry and Energy Studies, Ph.D in Fire Safety Science and an MBA.

His Ph.D focused on fire calorimeter instrumentation and modelling which is the core technology upon which much of **FTT**'s business is based. He has continued instrument design and applied research studies in this area since joining **FTT** much of which has been done collaboratively with industry groups and leading European fire research institutes and works extensively in national, European and international standardisation committees dealing with fire safety.

*i*Cone^{2+} – incorporating all of the best features of our cone calorimeter range

The *i*Cone^{2+} is the latest development in **FTT**'s *i*Cone range. It offers cutting edge PCB based technology in a modular and robust build. Remote communication, cone operation and diagnostic facilities give **FTT** the capability to efficiently respond, diagnose problems and service installations in all corners of the world.

It is the most advanced, reliable and user-friendly cone calorimeter in the world!

- Online support and remote diagnostics add control of instruments from **FTT** for quick and effortless support
- Design based on cutting edge surface mounted PCB technology
- PCB modular design facilitates improved serviceability and reliability
- Improved laser mounting system for easier setup and calibration and elimination of thermal drift
- Robust engineering for improved life expectancy of the instrument
- Latest generation gas analysers built with PCB and touchscreen technology
- Remote cone heater assembly positioning control, so that heater-specimen surface separation can be adjusted pre- and mid-test, to facilitate testing of intumescing or thermally distorting specimens
- Programmable heat flux exposure regimes. Up to 10 consecutive heat flux ramping or holding phases can be programmed
- Motorised heat shield to protect specimen from heat exposure before test
- 5.5" colour touchscreen test control panel, adjacent to specimen, supplements principal computer control
- Automatic calibration by ConeCalc Software

FTT Calorimeter Analyser

- Latest generation of gas analyser
- Touch-screen technology
- State of art surface mount PCB technology
- Increased sensitivity

Turn to page 61 for full product description and specifications >

About us

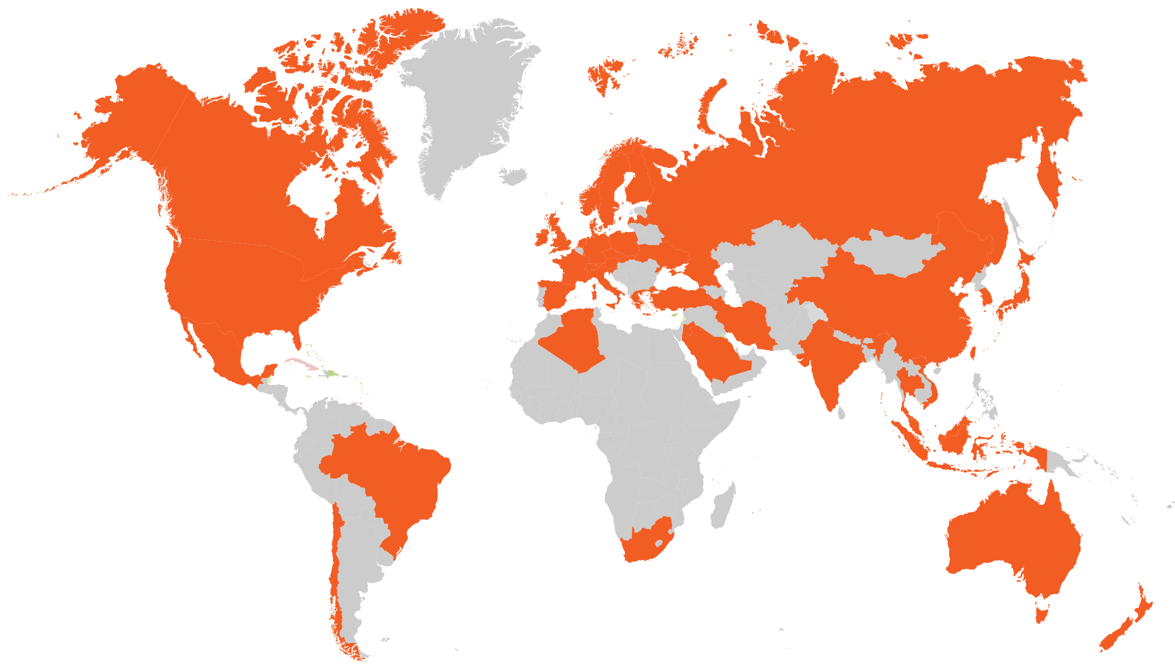
Established in 1989 by instrumentation engineer Stephen Upton and fire scientist Stephen Grayson, Fire Testing Technology Limited (**FTT**) was the first company in the world to specialise in the manufacture, supply and maintenance of reaction to fire testing instrumentation.

Today, **FTT** is internationally recognised as the world's leading supplier of fire testing instrumentation and has supplied the majority of leading fire research groups and testing laboratories around the world. Our directors and senior researchers participate in UK, ISO, CEN and ASTM standardisation committees to ensure that our instruments are always compliant. These include: committees dealing with construction products, electro technical products, furnishing products and transport applications for instruments such as the Cone Calorimeter, NBS Smoke Density Chamber, and the new FAA Micro-Calorimeter etc.

FTT is pleased to offer its clients a full professional service, commencing with an informed discussion of requirements, followed by the assembly of individual instruments, manufactured to order in our own production facility. All software is written and updated by **FTT** engineers and can be customised to meet a specific client brief. **FTT**'s engineers will take care of the complete installation of fire testing equipment at the client site, with training and support offered to instrument users where required, as part of our comprehensive post-sales service.

Our Cone Calorimeters have a world-wide presence

FTT has manufactured and supplied 46 countries globally in the last 30 years



New and existing fire testing instrumentation users are welcome to visit us at our UK facility in East Grinstead – close to London Gatwick Airport, for on-site demonstrations and training. Our engineers are also able to advise on the most suitable layout of a fire testing laboratory, including detailed specifications for instrument location, energy and extraction requirements.

Through our worldwide network of agents, **FTT** provides support to clients, be they test houses, universities or product manufacturers, wherever they are in the world. Tailored to your requirements and financial budget, **FTT** will provide a full, value for money service, and an expert partnership, that's with you at every stage of the process.

To further demonstrate our commitment to continually improve our systems and procedures within the business, **FTT** has been awarded ISO 9001:2015 and ISO 14001:2015 certification by UKAS through the British Standards Institute (BSI). This achievement endorses our ability to meet the highest standards possible, in the delivery of both our products and services.

If you have any suggestions on how we can improve our services, please contact us at:
feedback@fire-testing.com

bsi. ISO 9001:2015 Quality Management

bsi. ISO 14001:2015 Environmental Management

Accreditation and Compliance Services

FTT provides full lab design, training and consultation on getting labs accredited. You can count on **FTT** to deliver seamless compliance solutions that minimise your regulatory risk and harmonise your compliance program across your entire lab or enterprise – even covering other manufacturers' instruments.

Global instrument service and support

Rely on **FTT** to service, calibrate and maximise instrument efficiency whilst you focus on what you do best, knowing every working day that you can count on the efficiency and reliability of your instruments. **FTT**'s experienced service and support team can help you through Gold, Silver or Bronze service programs. Each program is designed for customers with different requirements but are all focussed to maximise the performance of your instruments, minimise downtime, and optimise your laboratory productivity.

Regularly servicing your instruments will ensure continued performance to the specifications defined in appropriate International and National standards relating to your instruments. **FTT** offers the three service programs summarised in the table below, so that you can readily identify the one that fits your needs and budget.

Our software solutions can make your existing instruments more efficient by providing data acquisition, data analysis and report writing facilities.

Option	Bronze	Silver	Gold
Telephone & email support	Yes	Yes	Yes
On-site visits	1	2	2
Discount on spares and additional labour days	5%	10%	15%
Discount on calibrations	5%	10%	N/A
Software update[a]	Yes	Yes	Yes
Software upgrades[b]	No	No	Yes
Rotational calibration[c]	No	No	Yes

a Software updates are issues under the same major release number (for example 3.2 to 3.3)
b Software upgrades are issues between major release number (for example 3.2 to 4.0)
c Replacement calibrated transducers will be provided annually

Technical support at work for you

Have you a hardware, software, application, instrument repair or troubleshooting question?

FTT's fire scientists and technical experts are available to answer your questions. With years of fire testing experience, our technical support specialists can provide advice based on in-depth knowledge and experience.

For questions pertaining to supplies found in this catalogue, contact our authorised distributor or email us on sales@fire-testing.com

Tab Guide

To help you navigate our catalogue, **FTT** has added colour coded tabs to pages. These tabs will help you navigate to the product/standard you are looking for, based on their industry sector and fire test parameter.

This is a digital version of the full catalogue. There are hyperlinks available to help you navigate the pages. If you click the arrow in the document icon on the colour tabs to the right of this page, you will be taken to the first page of each section. On the contents pages (10 and 11), if you click any line you will be taken to the first page of the relevant product.

To return to the contents pages you can click the tabs on the right hand margin and you will be linked back to the contents.

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Instrument Listing by Fire Test Parameters

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European CPR: Wall, ceiling, flooring and linear pipe thermal insulation products

The EU Construction Products Regulation (CPR) is the basis of construction products regulations to be used in all member states.

This Regulation requires construction products to be classified using the new set of fire test methods. These products include all wall lining, flooring, roofing and other fixed products such as linear pipe thermal insulation products and electric cables.

The CPR requires that all member states modify their regulations to allow classification using the test methods and systems described in EN 13501. EN 13501 was revised in 2007 to include classification requirements for linear thermal insulation products and a separate part EN 13501-6 is being published to define the electric cable fire performance classifications requirements.

These test methods, and in some cases the classification system, are now being used extensively beyond the European Union. Both being used by countries wanting to establish or upgrade their own regulations without spending extensive research and development budgets and by producers wanting to export products to Europe.

FTT engineers have worked with CEN in the development of these test methods and supply all equipment required for assessing the reaction to fire performance of construction products which include:

Test Method	
EN 13823:	Reaction to fire tests for building products, excluding floorings exposed to thermal attack by a single burning item
EN ISO 1716:	Reaction to fire tests for building products – Determination of the heat of combustion
EN ISO 1182:	Reaction to fire tests for building products – Non combustibility test
EN ISO 11925:	Reaction to fire tests for building products – Ignitability of building products subjected to direct impingement of flame
EN ISO 9239:	Reaction to fire tests for building products – Horizontal surface spread of flame for floor coverings

European Fire Testing Classification for Construction Products

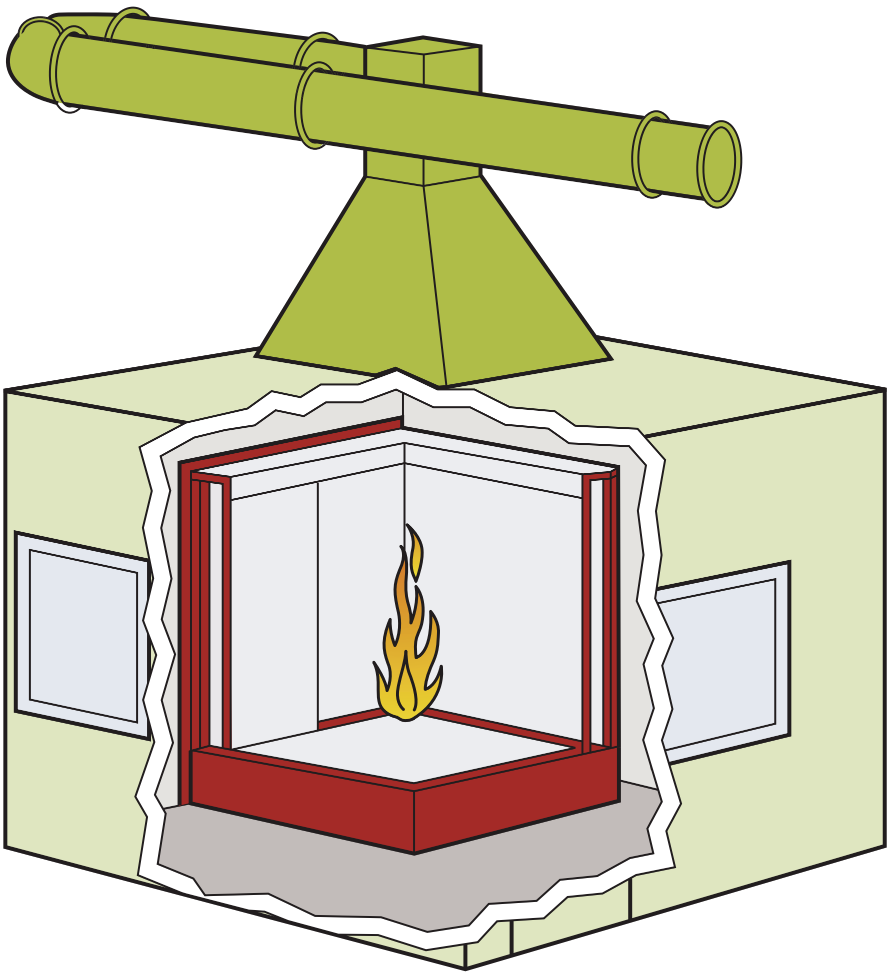
EU Construction Products Regulation

The EU Construction Products Regulation (CPR), is the basis of construction products regulations to be used in all member states. This Regulation will require that all construction products be reclassified using the new set of common test methods. These products include all wall lining, flooring and other fixed products such as linear pipe thermal insulation products and electric cables.

Construction products are currently controlled in National Building Regulations that typically used classifications often derived using the National fire test methods of each member state. e.g. British building regulations require classification using test methods described in the BS 476 test series.

The CPR requires that all member states modify their regulations to incorporate the classification systems described in EN 13501 and using the test methods quoted therein.

EN 13501 was revised in 2007 to include classification requirements for linear thermal insulation product and is, in 2010, being further revised to incorporate the electric cable fire performance classifications requirements.



Each member state is now able to continue to classify the products using the traditional methods alongside the new methods during a transition period. The traditional route will probably be unattractive to most suppliers, as the classification supported by traditional national tests will only be applicable in the host country, whilst those gained to the new test methods will be valid across all member states and the European Economic Area (EEA).

These test methods and in some cases the classification system, are now been used extensively beyond the European Union both by countries and producers wanting to trade these products with Europe and by countries wanting to establish or upgrade their own regulations without spending extensive research and development budgets.

FTT engineers have worked with CEN in the development of these test methods and supply all equipment required for assessing the reaction to fire performance of construction products.

How are Construction Products classified?

The classification criteria and test methods used to assess the reaction to fire performance of products covered by the CPR are described in EN 13501-1: Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests.

The Standard splits the products into 3 sets:

These are:

- Construction product excluding flooring products
- Flooring products
- Linear pipes thermal Insulation products

Please note that electric cables have their own classification system which is given in EN 13501-6 – see the European Cable Testing and Classification section.

Each of these sets has 5 classification levels A1,A2, B, C, D and E and a non-performance determined class "F" and the performance criteria and the fire test methods to be used in assessing the performance are described in 3 tables (one for each set).

Products in the non-flooring set are tested using the SBI test plus all other test methods except the EN ISO 9239-1. Flooring products are tested using the EN ISO 9239-1 instead of the SBI (EN 13823).

Table 1 (on page 18) shows the test methods and performance criteria for all construction products other than flooring products. Table 2 (on page 19) shows the test methods and performance criteria for flooring products and Table 3 (on page 20) shows the test methods and performance criteria for linear pipe insulation products.

Products in class A1 are mostly based on non-organic materials and classification into this group is gained using EN ISO 1716 Determination of the heat of combustion and the EN ISO 1182 Non combustibility test.

Classification into classes A2, B, C and D which are the major classes inhabited by most products, other than those described above, require testing using either the EN 13823 or EN ISO 9239-1, and EN ISO 11925-2; Class E only requires testing to EN ISO 11925-2.

The fire tests are listed below and most are used to assess products in all sets whilst others are just used for one product set.

EN 13823: Reaction to fire tests for building products excluding floorings exposed to thermal attack by a single burning item.

EN ISO 9239-1: Reaction to fire tests for building products – Horizontal surface spread of flame for floor coverings.

EN ISO 11925-2: Reaction to fire tests for building products – Ignitability of building products subjected to direct impingement of flame.

EN ISO 1716: Reaction to fire tests for building products – Determination of the heat of combustion.

EN ISO 1182: Reaction to fire tests for building products – Non combustibility test.

Table 1 – Classes of Reaction to Fire Performance for Construction Products Excluding Floorings

CLASS	TEST METHODS	CLASSIFICATION CRITERIA	ADDITIONAL CLASSIFICATION
A1	EN ISO 1182[(1)] and	$\Delta T \leq 30°C$; and $\Delta m \leq 50\%$; and $t_f = 0$ (i.e. no sustained flaming)	–
	EN ISO 1716	PCS ≤ 2.0 MJ/kg[(1)] and PCS ≤ 2.0 MJ/kg[(2) (2a)] and PCS ≤ 1.4 MJ/m^2 [(3)] and PCS ≤ 2.0 MJ/kg[(4)]	–
A2	EN ISO 1182[(1)] or	$\Delta T \leq 50°C$; and $\Delta m \leq 50\%$; and $t_f \leq 20s$	–
	EN ISO 1716 and	PCS ≤ 3.0 MJ/kg[(1)] and PCS ≤ 4.0 MJ/kg[(2) (2a)] and PCS ≤ 4.0 MJ/m^2 [(3)] and PCS ≤ 3.0 MJ/kg[(4)])	–
	EN 13823	FIGRA ≤ 120W/s; and LFS < edge of specimen; and THR_{600s} ≤ 7.5 MJ	Smoke production[(5)] and Flaming droplets/particles[(6)]
B	EN 13823 and	FIGRA ≤ 120W/s; and LFS < edge of specimen; and THR_{600s} ≤ 7.5 MJ	Smoke production[(5)] and Flaming droplets/particles[(6)]
	EN ISO 11925-2[(8)] Exposure = 30s	Fs ≤ 150mm within 60s	
C	EN 13823 and	FIGRA ≤ 250W/s; and LFS < edge of specimen; and THR_{600s} ≤ 15 MJ	Smoke production[(5)] and Flaming droplets/particles[(6)]
	EN ISO 11925-2[(8)] Exposure = 30s	Fs ≤ 150mm within 60s	
D	EN 13823 and	FIGRA ≤ 750W/s	Smoke production[(5)] and Flaming droplets/particles[(6)]
	EN ISO 11925-2[(8)] Exposure = 30s	Fs ≤ 150mm within 60s	
E	EN ISO 11925-2[(8)] Exposure = 15s	Fs ≤ 150mm within 20s	Flaming droplets/particles[(7)]
F	EN ISO 11925-2[(8)] Exposure = 15s	Fs > 150mm within 20s	

(1) For homogenous products and substantial components of non-homogenous products.
(2) For any external non-substantial component of non-homogenous products
(2a) Alternatively. Any external non-substantial component having a PCS ≤ 2.0 MJ/m³, provided that the product satisfies the following criteria of EN 13823: FIGRA ≤ 20W/s, and LFS < edge of specimen and THR_{600s} ≤ 4.0 MJ and s1 and d0
(3) For any internal non-substantial component of non-homogenous products
(4) For the product as a whole
(5) In the last phase of the development of the test procedure, modifications of the smoke measurement system have been introduced,the effect of which needs further investigation. This may result in a modification of the limit values and/or parameters for the evaluation of the smoke production.
s1 = SMOGRA ≤ 30m²/s² and TSP_{600s} ≤ 50m²; s2 = SMOGRA ≤ 180m²/s² and TSP_{600s} ≤ 200m²; s3 = not s1 or s2
(6) d0 = No flaming droplets/particles in EN 13823 (SBI) within 600s;
d1 = No flaming droplets/particles persisting longer than 10s in EN 13823 (SBI) within 600s;
d2 = not d0 or d1;
Ignition of the paper in EN ISO 11925-2 results in a d2 classification
(7) Pass = no ignition of the paper (no classification); Fail = ignition of the paper (d2 classification)
(8) Under conditions of surface flame attack and, if appropriate to the end–use application of the product, edge flame attack.

Table 2 – Classes of Reaction to Fire Performance for Floorings

CLASS	TEST METHODS	CLASSIFICATION CRITERIA	ADDITIONAL CLASSIFICATION
$A1_{fl}$	EN ISO 1182[1] and	$\Delta T \leq 30°C$; and $\Delta m \leq 50\%$; and $t_f = 0$ (i.e. no sustained flaming)	–
	EN ISO 1716	PCS ≤ 2.0 MJ/kg[1] and PCS ≤ 2.0 MJ/kg[2] and PCS ≤ 1.4 MJ/m^2[3] and PCS ≤ 2.0 MJ/kg[4]	–
$A2_{fl}$	EN ISO 1182[1] or	$\Delta T \leq 50°C$; and $\Delta m \leq 50\%$; and $t_f \leq 20s$	–
	EN ISO 1716 and	PCS ≤ 2.0 MJ/kg[1] and PCS ≤ 2.0 MJ/m^2[2] and PCS ≤ 1.4 MJ/m^2[3] and PCS ≤ 2.0 MJ/kg[4]	–
	EN ISO 9239-1[5]	Critical flux[6] 8.0 kW/m^2	Smoke production[7]
B_{fl}	EN ISO 9239-1[5] and	Critical flux[6] 8.0 kW/m^2	Smoke production[7]
	EN ISO 11925-2[8] Exposure = 15s	Fs ≤ 150mm within 20s	
C_{fl}	EN ISO 9239-1[5] and	Critical flux[6] 4.5 kW/m^2	Smoke production[7]
	EN ISO 11925-2[8] Exposure = 15s	Fs ≤ 150mm within 20s	
D_{fl}	EN ISO 9239-1[5] and	Critical flux[6] 3.0 kW/m^2	Smoke production[7]
	EN ISO 11925-2[8] Exposure = 15s	Fs ≤ 150mm within 20s	
E_{fl}	EN ISO 11925-2[8] Exposure = 15s	Fs ≤ 150mm within 20s	
F_{fl}	EN ISO 11925-2[8] Exposure = 15s	Fs > 150mm within 20s	

(1) For homogeneous products and substantial components of non-homogeneous products
(2) For any external non-substantial component of non-homogeneous products
(3) For any internal non-substantial component of non-homogeneous products
(4) For the product as a whole
(5) Test duration = 30 minutes
(6) Critical flux is defined as the radiant flux at which the flame extinguishes or the radiant flux after a test period of 30 minutes, whichever is lower (i.e. the flux corresponding with the furthest extent of spread of flame).
(7) s1 = Smoke ≤ 750%.min;
s2 = not s1
(8) Under conditions of surface flame attack and, if appropriate to the end use application of the product, edge flame attack.

Table 3 – Classes of Reaction to Fire Performance for Linear Pipe Thermal Insulation Products

CLASS	TEST METHODS	CLASSIFICATION CRITERIA	ADDITIONAL CLASSIFICATION
$A1_L$	EN ISO 1182[1] and	$\Delta T \leq 30°C$; and $\Delta m \leq 50\%$; and $t_f = 0$ (i.e. no sustained flaming)	–
	EN ISO 1716	PCS ≤ 2.0 MJ/kg[1] and PCS ≤ 2.0 MJ/kg[2] and PCS ≤ 1.4 MJ/m² [3] and PCS ≤ 2.0 MJ/kg[4])	–
$A2_L$	EN ISO 1182[1] or	$\Delta T \leq 50°C$; and $\Delta m \leq 50\%$; and $t_f \leq 20s$	–
	EN ISO 1716 and	PCS ≤ 2.0 MJ/kg[1] and PCS ≤ 2.0 MJ/kg² [2] and PCS ≤ 1.4 MJ/m² [3] and PCS ≤ 2.0 MJ/kg[4]	–
	EN 13823	FIGRA ≤ 270W/s and LFS < edge of specimen and THR_{600s} ≤ 7.5 MJ	Smoke production[7]
B_L	EN 13823 and	FIGRA ≤ 270W/s and LFS < edge of specimen and THR_{600s} ≤ 7.5 MJ	Smoke production[5] and Flaming droplets/particles[6]
	EN ISO 11925-2[8] Exposure = 30s	Fs ≤ 150mm within 60s	
C_L	EN 13823 and	FIGRA ≤ 460W/s and LFS < edge of specimen and THR_{600s} ≤ 15 MJ	Smoke production[5] and Flaming droplets/particles[6]
	EN ISO 11925-2[8] Exposure = 30s	Fs ≤ 150mm within 60s	
D_L	EN 13823 and	FIGRA ≤ 2100W/s THR_{600s} ≤ 100 MJ	Smoke production[5] and Flaming droplets/particles[6]
	EN ISO 11925-2[8] Exposure = 30s	Fs ≤ 150mm within 60s	
E_L	EN ISO 11925-2[8] Exposure = 15s	Fs ≤ 150mm within 20s	Flaming droplets/particles[6]
F_L	EN ISO 11925-2[8] Exposure = 15s	Fs > 150mm within 20s	

(1) For homogeneous products and substantial components of non-homogeneous products
(2) For any external non-substantial component of non-homogeneous products.
(3) For any internal non-substantial component of non-homogeneous products.
(4) For the product as a whole
(5) s1 = SMOGRA ≤ 105 m²/s² and TSP_{600s} ≤ 250 m² ; s2 = SMOGRA ≤ 580 m²/s² and TSP_{600s} ≤ 1600 m²;
s3 = not s1 or s2
(6) d0 = No flaming droplets/particles in EN 13823 within 600 s;
d1 = No flaming droplets/particles persisting longer than 10 s in EN 13823 within 600 s;
d2 = not d0 or d1.
Ignition of the paper in EN ISO 11925-2 results in a d2 classification.
(7) Pass = no ignition of the paper (no classification);
Fail = ignition of the paper (d2 classification).
(8) Under conditions of surface flame attack and, if appropriate to the end–use application of the product, edge flame.

Single Burning Item

EN 13823: Reaction to fire tests for building products excluding floorings exposed to thermal attack by a single burning item, the SBI.

The specimen is mounted on a trolley that is positioned in a frame beneath an exhaust system. The reaction of the specimen to the burner is monitored instrumentally and visually. Heat and smoke release rates are calculated and physical characteristics are assessed by observation. The parameters that are quantified in this test and used within the classification criteria are; Total Heat Release (THR), Fire Growth Rate Index (FIGRA) and Smoke Growth Rate index (SMOGRA).

FTT supplies, installs, and trains clients in the use of this apparatus. **FTT** can also supply any of the components to clients wishing to part design and build their own equipment.

The main components of the **FTT** SBI are:

- The Test Apparatus.
- Gas Analysis Instrumentation for Heat Release Measurement.
- Smoke Measurement System.
- Burner, Gas Train and Controls.
- Data Acquisition and Analysis Software.

Single-Flame Source Test

EN ISO 11925-2: Reaction to fire tests for building products – Ignitability of building products subjected to direct impingement of flame.

This ignitability method is based on the Kleinbrenner method and determines the ignitability of building products in the vertical orientation when subjected to impingement of a standard small flame. This test is relevant to classes B, C, D, E and B_{fl}, C_{fl}, D_{fl}, E_{fl}.

The **FTT** Ignitability Apparatus is supplied as a complete, easy-to-use system incorporating the following features:

- Combustion chamber with large front and side doors for easy access and toughened viewing panels
- An extensively adjustable burner assembly
- Specimen holder capable of housing the specimens up to and including 60mm thick
- A fully adjustable specimen support frame
- A digital anemometer/ thermometer and a stopwatch

Flooring Radiant Panel

EN ISO 9239-1: Reaction to fire tests for building products –Horizontal surface spread of flame for floor coverings.

This test method evaluates the critical radiant flux below which flames no longer spread over the horizontal surface of a specimen.

A smoke measuring system based on DIN 50055 is mounted on a separate frame in the exhaust stack and is used to measure smoke generated in the test.

The test is relevant to $A2_{fl}$, B_{fl}, C_{fl}, and D_{fl}.

Oxygen Bomb Calorimeter

EN ISO 1716: Reaction to fire tests for building products – Determination of the heat of combustion.

This instrument determines the potential maximum total heat release of a product when completely burning regardless of its end use. The test is relevant to classes A1, A2, $A1_{fl}$, $A2_{fl}$, $A1_L$ and $A2_L$. The test specimen of a known mass is burned under standardised conditions, at constant volume in an atmosphere of oxygen, in the bomb calorimeter which is calibrated by combustion of benzoic acid. The calorific value determined under these conditions is calculated on the basis of the measured temperature rise while taking account of heat losses.

The Oxygen Bomb calorimeter consists of:

- Bomb calorimeter with embedded computer control, user-friendly interface, LCD graphics display, high accuracy / resolution PRTs, RS232 interface port for printer
- Oxygen bomb and bucket (calorimeter vessel)
- Thermostatically controlled bath, circulator, cooler, pipette (2L)
- EN ISO 1716 sample preparation device, firing wire and cotton, cigarette making device
- Printer (optional)

Non-Combustibility Apparatus

EN ISO 1182: Reaction to fire tests for building products – Non combustibility test.

This apparatus determines the non-combustibility performance, under specific conditions, of homogenous products and substantial components of non homogeneous building products.

The specimen is subjected to temperatures of 750°C in a vertical tube furnace. The specimen is observed for sustained flaming and temperature rises and furnace thermocouples are used to assess combustibility. The test is relevant to classes A1, A2, $A1_{fl}$, $A2_{fl}$, $A1_{L}$ and $A2_{L}$.

The **FTT** non-combustibility apparatus is supplied with:

- Special tube furnace
- Instrument unit which features a temperature controller, an over-temperature alarm and a power controller, which control the furnace temperature at 750°C
- ‘NonComb’ Microsoft Windows analysis software

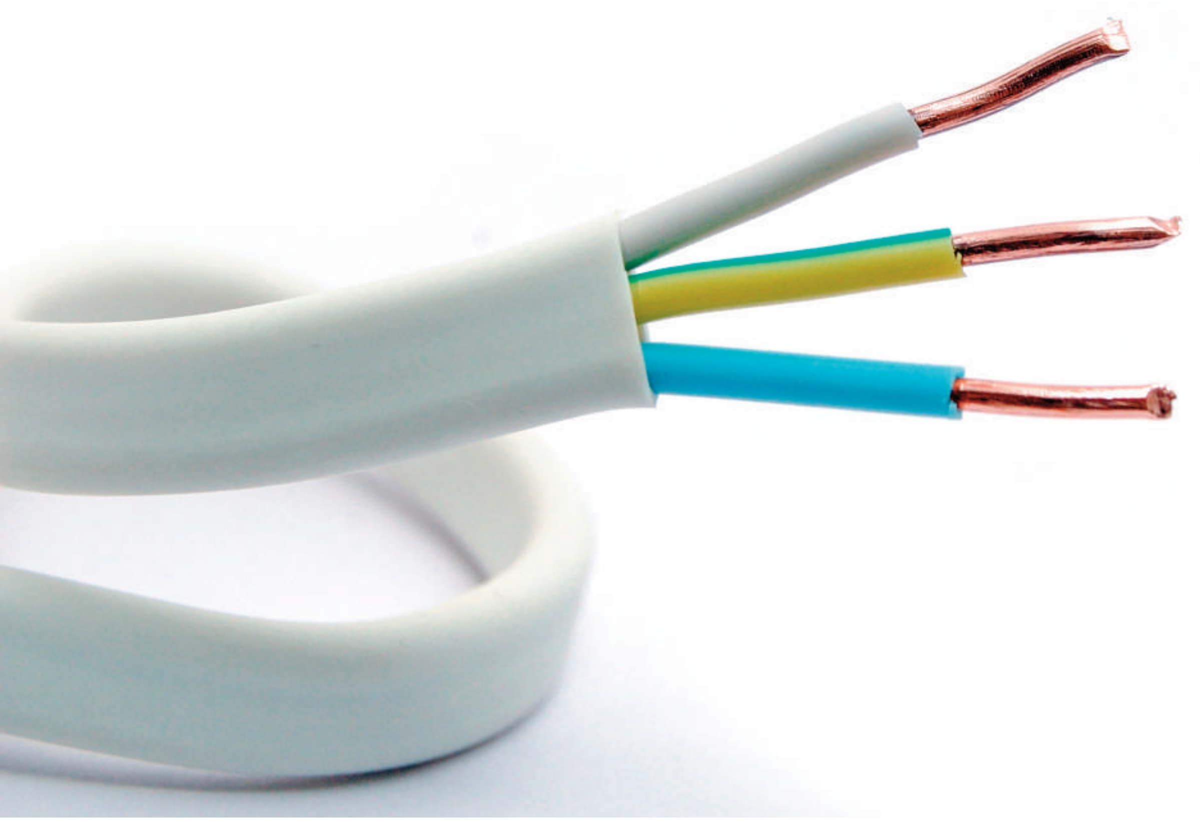
European CPR: Electric cables

The fire performance of electric cables will be uniformly regulated within the European Union.

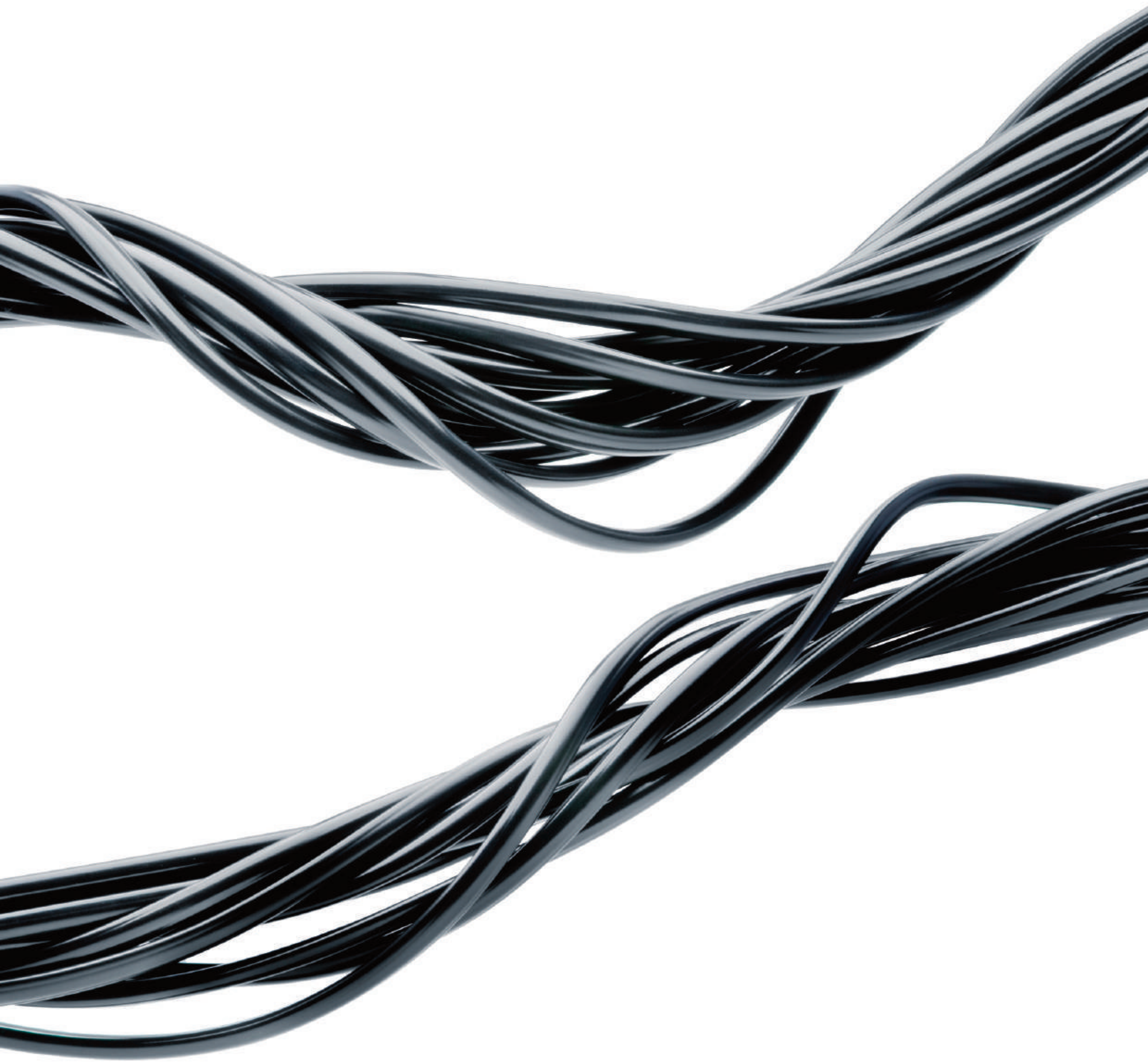
Traditionally these products have not been addressed in national building regulations and classifications had been voluntary or required by larger purchasing agencies. The inclusion of electric cables within the European Union's Construction Products Regulation (CPR) changes this situation. Once implemented all electric cables used in member states will be tested using the same test methods and classified using the same classification system.

Cables are tested using five test methods, and classified by the provisions of EN 13501-6 which is a parallel standard in the existing CPR classification standard EN 13501-1 "Fire classification of construction products and building elements" to include electric cable requirements. EN 13501-6 shows the test methods and performance criteria that must be met in order for a cable to meet a particular classification (A_{ca}, $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}). The five test methods used are:

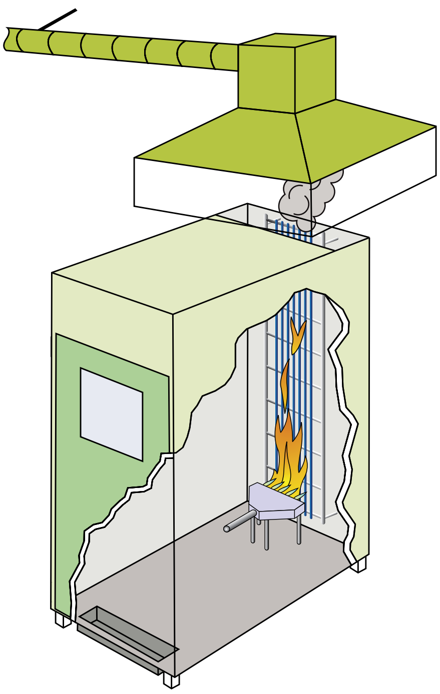
Test Method
Reaction to fire tests for building products (EN ISO 1716) This test determines the heat of combustion of a cable when it is burned under standardised conditions. The test is relevant for the class A_{ca}.
Burning behaviour of bunched cable (EN 50399) 30 kW flame source This test evaluates the potential contribution of a cable to the early stages of development of a fire, under direct exposure to a 30 kW flame source. The test is relevant for the class $B1_{ca}$.
Burning behaviour of bunched cable (EN 50399) 20.5 kW flame source This test evaluates the potential contribution of a cable to the early stages of development of a fire, under direct exposure to a 20.5 kW flame source. The test is relevant for the classes $B2_{ca}$, C_{ca} and D_{ca}.
Test for vertical flame propagation for a single insulated wire or cable (EN 60332-1-2) 1 kW pre-mixed flame This test evaluates the flame spread of a cable under exposure to a small flame. This test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}.
Smoke production of burning cable (EN 61034) This test evaluates the potential contribution of a cable to obscuration of vision when burning under static air flow conditions. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca}, in association with the Additional Classification s1.
Acidity levels produced by burning cables (EN 50267-2-3) This test evaluates the acidity of evolved gases. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca}.



European Cable Testing and Classification



The fire performance of electric cables is now to be uniformly regulated within the European Union. Traditionally these products have not been addressed in national building regulations and classifications had been voluntary or required by larger purchasing agencies. The inclusion of Electric cables within the European Union's Construction Products Regulations (CPR) changes this situation. Once implemented all electric cables used in European Union countries will be tested using the same test methods and classified using the same classification system.



EN 50399 Burning behaviour of bunched cable

Cables will be tested using 5 test methods, and classified by extending the provisions in the existing CPR classification standard EN 13501 "Fire classification of construction products and building elements" to include "Part 6: Classification using data from reaction to fire tests on electric cables". The establishment of these standards has been mandated to CEN and CENELEC by the EU and CENELEC have drafted the modifications to EN 13501 in line with the requirements of the European commission decision and this is currently being progressed within CEN.

Of these standard tests the new standard EN 50399 is the major test procedure for reaction to fire of cables, this test specification derives from work done in an EU funded project called FIPEC, Fire Performance of Electric Cables. This work was performed by a research group consisting of SP, Interscience, ISSEP and CESI. The FIPEC project included a study of cable installations and relevant reference scenarios as well as a comprehensive test program of different kinds of cables. This, together with subsequent Industry test data, was used in the development of the proposal for the European testing and classification system.

Two round robin exercises have been carried out on EN 50399. The first was performed by the developers of the system, the FIPEC laboratories. The second round robin was performed through CENELEC and included many test sites. The results were good and comparable to the results of the SBI test used for linings in Europe. Thus the test procedure used is quite robust and well developed. The test results are validated for real fires by using reference scenarios in the FIPEC project and through further analysis and comparisons to other building products under the CPR.

The reaction-to-fire classification system used in the CPR was developed in co-operation with European regulators and the cable industry in Europe and presented in 2003.

The European Commission decided on a testing and classification system on cables during 2006. The system is built in the same way as that used for linings and pipe insulation. However, it also included the possibility to declare optional acidity of the smoke gases, the sub-classes a1, a2 and a3.

Both EN 50399 and the modifications to EN 13501 were developed in CENELEC TC20 WG10. The latter is now working on the proposals for Extended Applications for assessment of cable family fire performance that will enable representative cables to be used to qualify cable groups.

The Extended Application rules were developed in the CEMAC project which was financed by the European Cable Industry in close co-operation with a group of research laboratories, consisting of SP, Interscience, ISSEP, LSF and VDE. The project was led by Europacable and the RTD contributions were led by SP-Fire Technology. During both the FIPEC and CEMAC projects **FTT** fire scientists were seconded to Interscience to oversee calibration, test, data acquisition and analysis.

We also worked with Interscience in CENELEC on the standard.

How are cables classified?

EN 13501 shows the test methods and performance criteria (see Table 1) that must be met in order for a cable to meet a particular classification (A_{ca}, $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}.)

The 5 test methods used are:

- **Burning behaviour of bunched cables – 20.5 kW flame source (EN 50399):** This test evaluates the potential contribution of a cable to the early stages of development of a fire, under direct exposure to a 20.5 kW flame source. The test is relevant for the classes $B2_{ca}$, C_{ca} and D_{ca}.
- **Burning behaviour of bunched cables – 30 kW flame source (EN 50399):** This test evaluates the potential contribution of a cable to the early stages of development of a fire, under direct exposure to a 30 kW flame source. The test is relevant for the class $B1_{ca}$.
- **Burning behaviour of single cables (EN 60332-1-2):** This test evaluates the flame spread of a cable under exposure to a small flame. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}.
- **Smoke production of burning cables (EN 61034):** This test evaluates the potential contribution of a cable to obscuration of vision when burning under static air flow conditions. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca}, in association with the additional classification for smoke.
- **Acidity levels produced by burning cables (EN 50267-2-3):** This test evaluates the potential contribution of burning cable materials to the hazardous properties of evolved gases. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca}, in association with the additional classification for acidity.
- **Heat of combustion test (EN ISO 1716):** This test determines the potential maximum total heat release of a product when completely burning, regardless of its end use. The test is relevant for the class A_{ca}.

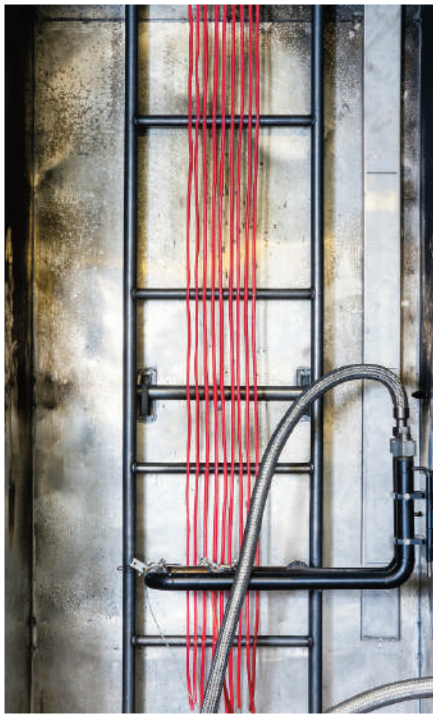
EN 50399 Burning behaviour of bunched cables

The EN 50399 was based on IEC 60332-3 with the addition of heat release measurement and a modified air inlet system. This is accomplished by fitting a small instrumented section of ducting into the exhaust system of the rig and using this with associated FTT gas analysis instrumentation and software. The duct section houses all gas sampling probes, temperature and mass flow probes and has ports for the smoke measuring system.

The gas analysis instrumentation is housed in a 19" instrument rack containing:

- Oxygen Analyser (paramagnetic) supplied with temperature and pressure compensation for primary heat release measurement.

Duct section placed in EN 50399 exhaust



EN 50399 Cable Test Interior detail

- Carbon Dioxide Analyser (infrared) for use in heat release measurement.
- Dual stage soot filter, refrigerant cold trap, drying column, pump and waste regulators for conditioning the sample gases prior to analysis.
- Controls for the smoke measurement system (if purchased).
- Data logger (if purchased). Clients already owning the **FTT** Dual Cone Calorimeter, ISO 9705 Room Corner test or SBI can use their instrumentation to measure heat release rate from their cable test. Conversely the EN 50399 Gas Analysis rack can be used to instrument other calorimeters (e.g. **FTT** Dual Cone Calorimeter etc.).
- **FTT** offers two smoke measurement systems, laser or white light. The laser system is similar to that used in the cone calorimeter and complies with ISO 5660 incorporating an advanced noise reduction specification. The white light system is similar to that used in the SBI test and constructed to DIN 50055.

EN 60332-1-2 Tests on electric and optical fibre cables under fire conditions

Part 1-2: Test for vertical flame propagation for a single insulated wire or cable: Procedure for 1 kW pre-mixed flame

This part of EN 60332 specifies the procedure for testing the resistance to vertical flame propagation for a single vertical electrical insulated conductor or cable, or optical fibre cable, under fire conditions. EN 60332-1-2 specifies the use of a 1 kW pre-mixed flame and the test evaluates the flame spread of a cable under exposure to a small flame. The test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}.

EN 61034 Common test methods for cables under fire conditions: Measurement of smoke density of cables burning under defined conditions

The 3 Metre Cube is used for measuring smoke emission when electric cables are burned under defined conditions, for example, a few cables burned horizontally. These units are produced to meet the specification used in many electric cable tests. The unit can be supplied in a self-assembly kit form or can be fully installed by **FTT** engineers.

The equipment comprises of:

- 3 Metre Cube assembly
- Photometric system, stands, fans and sample mounting frames
- Extraction fan and ducting
- Chart Recorder or Windows Software.

The 3 Metre Cube

EN 50267-2-3 Common test methods for cables under fire conditions: Tests on gases evolved during combustion of materials from cables

Part 2-3: Determination of degree of acidity of gases for cables by determination of the weighted average of pH and conductivity

This test was developed to assess the amount of acid gas which is evolved when cable insulating, sheathing and other materials burn as this acid can cause damage to electrical and electronic equipment not involved in the fire itself. This test method uses pH and electrical conductivity as an indirect assessment of this property and is being used as the assessment method for the additional acid classification with classes $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca}.

The equipment comprises of:

- Control unit
- Furnace
- Magnetic stirrer
- pH meter and calibration pH solutions

EN ISO 1716 Reaction to fire tests for building products – Determination of the heat of combustion

The bomb calorimeter is the instrument most widely used to measure the heat of combustion or calorific value of a material. A test specimen of known mass is burned under standardised conditions. The heat of combustion, determined under these conditions, is calculated on the basis of the measured temperature rise while taking account of heat loss.

The combustion process is initiated in an atmosphere of oxygen in a constant volume container, the bomb, which is a vessel built to withstand high pressures.

The bomb is immersed in a stirred water bath, and the whole device is the calorimeter vessel. The calorimeter vessel is also immersed in a second outer water bath. The water temperature in the calorimeter vessel and that of the outer bath are both monitored and used in the calculation. The test is used to qualify products for the classes A_{ca}.

The Oxygen Bomb calorimeter consists of:

- Bomb calorimeter with embedded computer control, user-friendly interface, LCD graphics display, high accuracy/ resolution PRTs, RS232 interface port for printer
- Oxygen bomb and bucket (calorimeter vessel)
- Thermostatically controlled bath, circulator, cooler, pipette (2L)
- EN ISO 1716 sample preparation device, firing wire and cotton, cigarette making device
- Printer (optional)

The Oxygen Bomb Calirometer

Why FTT?

FTT has been at the forefront of test instrumentation development in reaction to fire applications for over 30 years and now sets the benchmark in this field of testing.

FTT's production and design facility in the UK continues to develop bench-scale instrumentation and large-scale tests for a wide range of regulatory requirements and offers a worldwide sales and technical support service.

Table 1 – EN 13501-6: Classes of reaction-to-fire performance for electric cables

CLASS	TEST METHOD(S)	CLASSIFICATION CRITERIA	ADDITIONAL CLASSIFICATION
A_{ca}	EN ISO 1716	PCS ≤ 2,0 MJ/kg[1]	
$B1_{ca}$	EN 50399 (30 kW flame source) and	FS ≤ 1.75 m and and THR1200s ≤ 10 MJ and Peak HRR ≤ 20 kW and FIGRA ≤ 120 W/s	Smoke production[2, 5] and Flaming droplets/particles[3] and Acidity[4]
	EN 60332-1-2	H ≤ 425 mm	
$B2_{ca}$	EN 50399 (20.5 kW flame source) and	FS ≤ 1.5 m; and THR1200s ≤ 15 MJ; and Peak HRR ≤ 30 kW; and FIGRA ≤ 150 W/s	Smoke production[2, 6] and Flaming droplets/particles[3] and Acidity[4]
	EN 60332-1-2	H ≤ 425 mm	
C_{ca}	EN 50399 (20.5 kW flame source) and	FS ≤ 2.0 m; and THR1200s ≤ 30 MJ; and Peak HRR ≤ 60 kW; and FIGRA ≤ 300 W/s	Smoke production[2, 6] and Flaming droplets/particles[3] and Acidity[4]
	EN 60332-1-2	H ≤ 425 mm	
D_{ca}	EN 50399 (20.5 kW flame source)	THR1200s ≤ 70 MJ; and Peak HRR ≤ 400 kW; and FIGRA ≤ 1300 W/s	Smoke production[2, 6] and Flaming droplets/particles[3] and Acidity[4]
	EN 60332-1-2	H ≤ 425 mm	
E_{ca}	EN 60332-1-2	H ≤ 425 mm	
	F_{ca}	No performance determined	

(1) For the product as a whole, excluding metallic materials, and for any external component (i.e. sheath) of the product.

(2) s1 = TSP1200s ≤ 50 m^2 and Peak SPR ≤ 0.25 m^2/s

s1a = s1 and transmittance in accordance with EN 61034 ≥ 80%

s1b = s1 and transmittance in accordance with EN 61034 ≥ 60% < 80%

s2 = TSP1200s ≤ 400 m^2 and Peak SPR ≤ 1.5 m^2/s

s3 = not s1 or s2

(3) d0 = No flaming droplets/particles within 1200 s; d1 = No flaming droplets/particles persisting longer than 10 s within 1200 s; d2 = not d0 or d1.

(4) EN 50267-2-3: a1 = conductivity < 2.5 µS/mm and pH > 4.3; a2 = conductivity < 10 µS/mm and pH > 4.3; a3 = not a1 or a2. No declaration = No Performance Determined.

(5) The smoke class declared for class $B1_{ca}$ cables must originate from the test according to EN 50399 (30 kW flame source).

(6) The smoke class declared for class $B2_{ca}$, C_{ca}, D_{ca} cables must originate from the test according to EN 50399 (20.5 kW flame source).

European railway

European Regulations such as the Construction Products Regulations have led European industries to harmonise testing methods for the products used in the construction of buildings. As member states move towards harmonising these methods and regulations, there has been a similar initiative to harmonise the interoperability of railway rolling stock. As a result, the European Commission have authorised a working group (CEN 256 WG1) to identify fire test methods, for use in the classification of products and materials employed in railway carriages throughout Europe, producing harmonisation between product standards throughout the European states.

In 2013, CEN/TC 256 and CENELEC/TC 9X published a seven-part standard EN 45545 in which Part 2 describes the reaction to fire test methods, test conditions and reaction to fire performance required for classification of structural products including flooring, seats, cables and non-listed items.

The performance of all the products is determined with respect to flame spread and the amounts of heat, smoke and toxic fumes produced.

All of these test methods are offered by **FTT**.

Test Method		
STRUCTURAL PRODUCTS (incl. flooring)		
STANDARD		**INSTRUMENT**
ISO 5658-2	Lateral spread on building products in vertical configuration	IMO Spread of Flame Apparatus
ISO 5660-1	Heat release, smoke production and mass loss rate – Part 1: Heat release rate	Cone Calorimeter
EN ISO 9239-1	Horizontal surface spread of flame for floor coverings	Flooring Radiant Panel
ISO 5659-2	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	NBS Smoke Density Chamber with FTIR
EN ISO 11925-2	Ignitability of building products subjected to direct impingement of flame	The Single Flame Source Test
SEATS		
STANDARD		**INSTRUMENT**
ISO 9705	Full-scale room test for surface products	Furniture Calorimeter
ISO 5660-1	Heat release, smoke production and mass loss rate – Part 1: Heat release rate	Cone Calorimeter
ISO 5659-2	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	NBS Smoke Density Chamber with FTIR
CABLES		
STANDARD		**INSTRUMENT**
EN 60332-1-2	Tests on electric and optical fibre cables under fire conditions	Electric Cable Test
EN 60332-3-24	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables (for d ≥ 12 mm)	Electric Cable Test
EN 50305	Railway applications – Railway rolling stock cables having special fire performance (for d ≤ 6 mm)	Electric Cable Test
EN 61034-2	Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements	3M Cube
NON-LISTED ITEMS		
STANDARD		**INSTRUMENT**
ISO 4589-2	Plastics – Determination of burning behaviour by oxygen index – Part 2: Ambient-temperature test	Oxygen Index
ISO 5659-2	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	NBS Smoke Density Chamber with FTIR
NF X 70-100	Fire behaviour test – Analysis of pyrolysis and combustion gases – pipe still method	EN 50267-2-3/IEC 60754 Part 1 & 2
ISO 5660-1	Heat release, smoke production and mass loss rate – Part 1: Heat release rate	Cone Calorimeter
ISO 5658-2	Lateral spread on building products in vertical configuration	IMO Spread of Flame Apparatus

The requirements specified in EN 5545-2 depend on the end use of the product and the Hazard Level of the carriage.

Fire Classifications and Fire Test Methods for the European Railway Industry

(EN 45545-2; EN 17084; EN 16989)

European Regulations such as the Construction Products Regulations have led European regulators and industries to utilise harmonised testing methods and classification system for assessing the products used in the construction of buildings. The European Rail Industry is similarly developing harmonised procedures particularly to facilitate interoperability of railway rolling stock. Growth in European crossborder rail movements has further emphasized the need for European harmonisation both of these test methods and classification systems for the materials are used in vehicles.

The European Commission mandated CEN (CEN/TC 256/WG 1) to identify and standardise the fire test methods for use in the classification of products and materials employed in railway carriages throughout Europe. In 2013, CEN/TC 256 and CENELEC/TC 9X published a 7-part standard EN 45545, "Fire Protection on Railway Vehicles" which includes:

- Part 1: General
- Part 2: Requirements for fire behaviour of materials and components
- Part 3: Fire resistance requirements for fire barriers
- Part 4: Fire safety requirements for railway rolling stock design
- Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles
- Part 6: Fire control and management systems
- Part 7: Fire safety requirements for flammable liquid and flammable gas installations

Part 2 describes the reaction to fire test methods, test conditions and reaction to fire performance required for classification of structural products including flooring, seats, cables and non-listed items.

This standard specifies that:

- Railway vehicles are classified in accordance with the fire hazard level associated with their design and operation.
- Three hazard levels HL 1 to HL 3 are defined, HL 1 being the lowest requirement and HL 3 being the highest.
- The test methods used depend on the product under investigation.

The performance of all the products is determined with respect to ignitability, flame spread and the amounts of heat, smoke and toxic fumes produced. These reaction to fire tests aim to qualify and classify the products according to their final applications which are separated into groups, including: structural products, seats, cables and nonlisted items. Each of these product groups are required to meet a specific set of performance requirement levels (listed R1 to R26). Each requirement has a corresponding series of test performance criteria imposed for each fire risk levels HL 1 to HL 3.

TEST GROUP	TEST PARAMETER	STANDARD/TEST METHOD	FTT INSTRUMENT
STRUCTURAL PRODUCTS (including flooring)	Flame spread ISO 5658-2	Lateral spread on building products in vertical configuration	Lateral Flame Spread Test
	Heat release ISO 5660-1	Heat release, smoke production and mass loss rate – Part 1: Heat release rate	Cone Calorimeter
	Flame spread of EN ISO 9239-1 floorings	Horizontal surface spread of flame for floor coverings	Flooring Radiant Panel
	Smoke production ISO 5659-2 and toxicity	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	NBS Smoke Density Chamber with FTIR
	Ignitability and EN ISO 11925-2 flaming droplets	Ignitability of building products subjected to direct impingement of flame	Single Flame Source Test
SEATS	Heat release ISO 9705	Full-scale room test for surface products	Furniture Calorimeter
	Heat release ISO 5660-1	Heat release, smoke production and mass loss rate – Part 1: Heat release rate	Cone Calorimeter
	Smoke production ISO 5659-2	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	NBS Smoke Density Chamber with FTIR
CABLES	Flame spread of EN 60332-1-2 electric cables	Tests on electric and optical fibre cables under fire conditions –single insulated wire or cable, 1 kW pre-mixed flame	EN 60332-1-2 Vertical Flame Propagation Test for a Single Cable
	Flame spread of EN 60332-3-24 electric cables	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables (for d ≥ 12 mm)	EN 60332-3 Vertical Flame Propagation Test for Bunched Cables
	Flame spread of EN 50305 electric cable	Railway applications – Railway rolling stock cables having special fire performance (for d ≤ 6 mm)	EN 60332-3 Vertical Flame Propagation Tests for Bunched Cables
	Smoke production EN 61034-2	Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements	3M Cube Smoke Density Test
NON-LISTED ITEMS	Oxygen index ISO 4589-2	Plastics – Determination of burning behaviour by oxygen index – Part 2: Ambient temperature test	Oxygen Index
	Heat release ISO 5660-1	Heat release, smoke production and mass loss rate – Part 1: Heat release rate	Cone Calorimeter
	Flame spread ISO 5658-2	Lateral spread on building products in vertical configuration	Lateral Flame Spread Test
	Smoke production ISO 5659-2	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	NBS Smoke Density Chamber
	Toxicity NF X 70-100	Fire behaviour test Analysis of pyrolysis and combustion pipe still method	Toxicity Test

Heat release

Heat Release Rate is the key measurement required to assess the fire hazard of products and materials, as it quantifies fire size, rate of fire growth and consequently the release of associated smoke and toxic gases. It is measured using a technique called oxygen consumption calorimetry.

A new Rate of Heat Emission parameter has been introduced in EN 45545-2.

This parameter is known as MARHE or Maximum Average Rate of Heat Emission. The heat release rate is determined using the oxygen consumption technique from which an Average Rate of Heat Emission (ARHE) is calculated. The maximum ARHE over the testing period is MARHE. The MARHE parameter was selected because it is not greatly affected by normal experimental variation or measurement noise. It has also proved to be a fairly robust measure of the propensity for fire development under real scale conditions.

ISO 5660-1 Cone Calorimeter

Heat Release Rate is determined with the Cone Calorimeter according to ISO 5660-1. Thresholds concerning the potential heat release for almost all combustible materials and products used in the railway industry are required by EN 45545-2.

These requirements depend on the end use of the product and the Hazard Level of the carriage.

The 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 researchers or can be used as data for input into correlation or mathematical models used to predict fire development.

The **FTT** Dual Cone Calorimeter has been the benchmark in this field for its ease of use, robustness, sophisticated software that guides users through the calibration, testing and report protocols.

Building on this expertise **FTT** has developed a new generation of the Cone Calorimeter called *i*Cone that utilise state-of-the-art technology to improve the efficiency and accuracy of the fire test process.

The *i*Cone is an automatic and interactive system. Not only does it possess all the advantages of a conventional Cone Calorimeter, it also features an interactive and intuitive interface, flexible control options, and built-in data acquisition technology and reporting with the user-friendly ConeCalc software. It has been designed using **FTT**'s decades of experience in calorimetry and

Figure 1: FTT ISO 5660-1 *i*Cone^{2+} Calorimeter

Table 1: Requirements concerning Heat Release (MARHE)

Requirement set	Heat flux	Test parameter and unit	Maximum threshold		
			HL1	HL2	HL3
R5, R20	25kW/m²	MARHE [kW/m²]	50	50	50
R9			90	90	60
R8			–	50	50
R10			–	–	–
R19, R21			75	50	50
R1, R7	50kW/m²		–	90	60
R6, R11			90	90	60
R12			60	60	60
R17			–	90	60
R2			–	–	90

incorporates many new features, not seen by fire testing laboratories up until now. It is perceived as the new benchmark in calorimetry.

Directly measured properties include:

- Rate of Heat Release
- Time to Ignition
- Critical Ignition Flux
- Mass Loss Rates
- Smoke Release Rates
- Effective Heat of Combustion
- Rates of Toxic Gas Release (e.g. carbon oxides) According to EN 45545-2, the electrical heater within the Cone Calorimeter must impose two different irradiance levels: 25kW/m² and 50kW/m².

ISO 9705-2 Furniture Calorimeter Vandalised Seat

According to EN 45545-2, the burning behaviour of passenger seats should be tested on the complete seat, including upholstery, head rest, seat shell and arm rest. In addition, the seat shell and any vertical faces of the arm rests should also be tested in relation to fire integrity.

In order to determine MARHE, a complete seat assembly should be tested using the ISO 9705-2 as a furniture calorimeter.

FTT builds and supplies the ISO 9705-2, complete with the appropriate instrumentation package or supply instrumentation to clients wishing to upgrade existing facilities or with a wish to build their own apparatus. In the latter cases we supply a Gas Analysis Console and an Instrumented Duct Insert section. The console is housed in a 19" instrument rack and it contains all the necessary instrumentation to measure Heat Release Rates and other associated parameters.

The Gas Analysis Console contains:

- FTT Calorimeter Analyser featuring paramagnetic oxygen sensor with temperature and pressure compensation for primary heat release measurement.

Figure 2: FTT ISO 9705-2 Large Scale Calorimeter with Weight Measurement (Room chamber on left not included in standard configuration)

Courtesy from the Shanghai Fire Research Institute

Figure 3: 19" Gas Analysis Rack

Figure 4: Instrumented Duct Insert

Figure 5: DIN 50055 White Light System Controller

- An Infrared Carbon Dioxide Analyser for use in heat release measurement.
- A Dual Stage Soot Filter, Refrigerant Cold Trap, Drying Column, Pump and Waste Regulators for conditioning the sample gases prior to analysis.
- Controls for the smoke measurement system.
- Data logger.

The specification of this instrumentation is the same for both large and small scale calorimeters and can therefore also be conveniently used with the FTT Dual Cone Calorimeter.

The duct section houses all the sampling, temperature and mass flow probes required for gas sampling and air velocity measurement along with smoke measurement equipment (white light or laser). Most dynamic fire testing apparatuses can be instrumented with this equipment to measure heat released and smoke produced from products burnt in them.

Table 2: Requirements concerning Passenger Seats

Requirement set	Test method	Test parameter and unit	Maximum threshold		
			HL1	HL2	HL3
R18*	ISO 9705-2	MARHE [kW]	75	50	20
		HRR Peak [kW]	350	350	350
R21	ISO 5660-1: 25kW/m²	MARHE [kW/m²]	75	50	50
	ISO 5659-2: 25kW/m²	D_s max	300	250	200
		CIT_G	1.2	0.9	0.75
R19	ISO 5660-1: 25kW/m²	MARHE [kW/m²]	75	50	50
R6	ISO 5660-1: 50kW/m²	MARHE [kW/m²]	90	90	60
	ISO 5659-2: 50kW/m²	$D_s(4)$	600	300	150
		VOF_4 [min]	1200	600	300
		CIT_G	1.2	0.9	0.75

* : – during the test, the flame spread shall not reach the edges of the seat surface or the backrest;
– during the test, the flame height above the highest point of the seat surface shall not exceed 1,000mm;
– if the peak heat release values are too high for test equipment safety then the product is not compliant.

Table 3: Requirements concerning Flame Spread for ISO 5658-2 test

Requirement set	Test parameter and unit	Maximum threshold		
		HL1	HL2	HL3
R1, R7	ISO 5658-2: Critical Heat Flux at Extinguishment	20*	20*	20*
R2, R3, R17		13*	13*	13*
R4		13*	13*	13*
R11		30*	30*	30*
R12		40*	40*	40*

* If droplets/particles that exhibit sustained flaming are reported during the test ISO 5658-2, or for the special case of materials which do not ignite in ISO 5658-2 and are additionally reported as unclassifiable, the following requirements shall be added:
Test to the requirements of EN ISO 11925-2 with 30 s flame application.
The acceptance requirements are:
– flame spread < 150 mm within 60 s;
– no burning droplets/particles.

The requirement sets in relation to passenger seats are:

- R6: Passenger seat shell – Base and Back
- R18: Complete passenger seats
- R19: Seats in staff areas
- R21: Upholstery for passenger seats and head rest

ISO 5658-2 Lateral Flame Spread Apparatus

Flame spread of structural products including floorings and insulation materials is determined according to ISO 5658-2.

The requirements specified in EN 45545-2 depend on the end use of the product and the Hazard Level of the carriage.

The Lateral Flame Spread Apparatus measures the lateral spread of flame on vertically oriented specimens using a rectangular radiant panel and an additional gas burner flame as the ignition source.

It provides data suitable for comparing the performance of essentially flat materials, composites or assemblies, which are primarily used as the exposed surfaces of walls.

Following ignition, any flame front which develops is noted, and the progression of the flame front horizontally along the length of the specimen in terms of the time it takes to travel various distances is recorded.

The results are expressed in terms of the flame spread distance/time history, the flame front velocity versus heat flux, the critical heat flux at extinguishment and the average heat for sustained burning.

Figure 6: FTT ISO 5658-2 Lateral Flame Spread Apparatus

Single Flame Source Test Apparatus

Flame spread of light diffusers and air filters are determined according to EN ISO 11925-2.

This test is also required as part of the European construction products regulation for assessing and qualifying reaction to fire performance of all types of construction products to classes B, C, D and E.

EN ISO 11925-2 is based on the Kleinbrenner method for determining ignitability of materials in the vertical orientation by direct small flame impingement under zero impressed irradiance. It is supplied as a complete easy-to-use system incorporating safety features. The combustion chamber is made from corrosion resistant stainless steel, to maximise operating life. It has large front and side doors which are glazed with toughened glass for full view of the specimen during a test and easy access.

Figure 7: FTT EN ISO 11925-2 Single Flame Source Test Apparatus

Table 4: Requirements concerning Flame Spread for EN ISO 11925-2 test

Requirement set	Test parameter and unit	Maximum threshold		
		HL1	HL2	HL3
R4	Flame spread [mm]	150 (within 60 s)		
	Flaming droplets	0		
R5	Flame spread [mm]	150 (within 60 s)		

EN ISO 9239-1 Flooring Radiant Panel

The burning behaviour of floorings, including any substrates if used, is tested according to EN ISO 9239-1 in a closed chamber using a radiant panel heat source.

The **FTT** Flooring Radiant Panel (FRP) evaluates the critical radiant flux below which flames no longer spread over a horizontal surface.

This test method is used to measure the critical radiant flux of floor covering systems exposed to a flaming ignition source in a graded radiant heat environment, within a test chamber.

A smoke measuring system according to DIN 50055 is mounted on a separate frame at the exhaust stack. It can also be used to measure this same critical radiant flux for exposed attic floor cellulose insulation.

The **FTT** Flooring Radiant Panel can also comply with ASTM E648, ASTM E970, NFPA 253 and DIN 4102 Part 14.

The Critical Heat Flux at extinguishment value (CHF-value) is the incident heat flux at the specimen surface, at the point where the flame ceases to advance and may subsequently go out. For classification purposes, the CHF-values in kW/m^2 for each Hazard Level, are shown in Table 5.

Figure 8:
FTT EN ISO 9239-1
Flooring Radiant Panel

Table 5: Requirements concerning Flame Spread for EN ISO 9239-1 test

Requirement set	**Test parameter and unit**	**Minimum threshold**		
		HL1	**HL2**	**HL3**
R8, R10	CHF [kW/m^2]	4.5	6	8

EN 60332-1-2 and EN 60332-3-24 Vertical Flame Propagation Test Apparatuses

According to EN 45545-2, the fire behaviour and the flame impingement duration of cables should be tested and evaluated in respect to the diameter of the cables in question.

In addition, these cables are separated into two groups:

I. Cables for Interior (Requirement category R15)
II. Cables for Exterior (Requirement category R16)

Figure 9: FTT EN 60332-1 Flame Propagation Test for a Single Wire or Cable

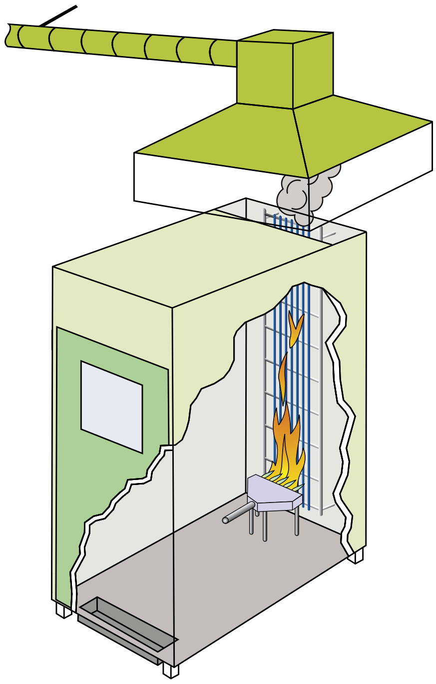


Figure 10: FTT EN 60332-3 Vertical Flame Propagation Test for vertically mounted bunched cables

Table 6: Flame Impingement related to the Outer Cable Diameter

Outer diameter D of specimen (mm)	Flame impingement(s)
D ≤ 25	60
25 < D ≤ 50	120
50 < D ≤ 75	240
D > 75	480

Table 7: Requirements concerning Electric Cables

Requirement set	Test method	Test parameter	Minimum threshold		
			HL1	HL2	HL3
R15, R16	EN 60332-1-2	Unburned length [mm]	Burned part ≤ 540 and unburned part > 50		
	EN 60332-3-24 (for d ≥ 12mm)	Flame propagation [m]	2.5		
	EN 60332-3-24 (for 6mm < d < 12mm)		2.5		
	EN 60332-3-24 (for d ≤ 6mm)		1.5		

Smoke production and toxicity

There are two test methods detailed in EN 45545-2 that can be used for determining the toxic composition of gases and fumes generated by the combustion of specified railway products. These two methods, EN ISO 5659-2 and NF X 70-100-1 are described as follows:

EN ISO 5659-2 Smoke Density Chamber with FTIR Toxicity Test Apparatus

This method consists of a smoke density chamber as described in EN ISO 5659-2 and an FTIR toxicity test and sampling system. The two instruments dedicated respectively to the analysis of the opacity of the smoke and to the qualitative and quantitative analysis of gases emitted during the test, are capable of operating simultaneously as well as independently using two specific procedures for the acquisition of FTIR spectra and smoke opacity.

The NBS Smoke Density Chamber (SDC) has been established for many years and is used widely in all industrial sectors for the determination of smoke generated by solid materials and assemblies mounted in the vertical position

Figure 11: FTT Smoke Density Chamber

with a closed chamber. It measures the specific optical density of smoke generated by materials, when an essentially flat specimen, approximately 25mm thick, is exposed vertically to a heat source of 25kW/m², in a closed chamber, with or without the use of a pilot flame. The **FTT** smoke density chamber has been designed specifically to incorporate the ISO 5659 Conical Radiant Furnace. This extends the potential of the SDC by allowing testing at heat fluxes up to 50kW/m², horizontal orientation of the specimen and the measurement of mass loss rate of the specimen.

Features of the FTT NBS Smoke Density Chamber include:

- Test chamber with full width opening door, allowing easy access for sample loading and chamber cleaning.
- Photomultiplier control unit with all manual controls and digital display of optical density and relative intensity. Computer setting for use with **FTT** software to perform automatic control of the test procedure on the SDC.
- Controls are mounted beside chamber for convenient operation. They are not obstructed when the door is open.
- Smoke density and temperature are on digital displays, for easier use and greater accuracy.
- Chamber walls are preheated for easier start-up and convenient equipment operation.
- Safety blowout panel, easily replaceable, allows for safe operation of test method.
- Gas measurement ports are provided, for optional measurements of toxic gases.
- Cabinet designed with a standard 19" rack, for simple addition of gas analysers, chart recorder and other control units.
- Air cooled radiometer for furnace flux calibration.

The **FTT** SDC is supplied with a software package called SDCSoft, which is designed as a data acquisition and presentation package allowing either manual or automatic control. This enables a more efficient use of the instrument, leading to larger daily throughput of testing and enhanced quality graphical data presentation.

'SDCSoft' is a Microsoft Windows based package which collects test data and assists with all calibration routines.

According to EN 45545-2, the optical density of flat products, i.e. interior walls, floor coverings, seat backs and seat coverings should be determined using the closed chamber according to EN ISO 5659-2.

The smoke opacity during the combustion of the material is determined measuring the attenuation of a white light beam by the effluents.

The obscuration produced from the smoke is measured as a fraction of the light intensity reaching the photometric detector in the presence of smoke to the value corresponding to the luminous transmission in the absence of smoke before the start of the test.

Two different levels of irradiance have been standardised, depending on the application of the product:

- 50kW/m² with no additional gas ignition source.
- 25kW/m² with an additional gas ignition source.

The exposure conditions of the test specimen in the smoke chamber are radiant heat with or without application of a pilot flame. For large area products such as walls and ceilings, the test specimens shall be exposed to radiant heat flux conditions that simulate a developed stage of a fire; that is a heat flux of 50 kW/m² without a pilot flame.

For floor coverings that generally receive lower levels of radiant heat during a fire, the test specimens shall be exposed to a radiant heat flux of 25 kW/m² with a pilot flame.

The optical density of the smoke produced is measured continuously by an optical system. Toxic effluents are analysed using FTIR Spectroscopy. For assessment of toxic gases from railway products the Conventional Index of Toxicity (CIT) is used which is always calculated from test data and is dimensionless. The analysis of the spectrum collected during the test determines the concentration of gases.

According to EN 45545-2 the analysis is carried out using the equipment and the procedures for testing and calibration described in ISO 19702.

Table 8: Reference concentrations of the gas components according to ISO 19702

Gas component	Reference concentration (mg/m³)
CO_2	72,000
CO	1,380
HBr	99
HCl	75
HCN	55
HF	25
NO_x	38
SO_2	262

The 8 gas components need to be analysed and their reference concentrations (see Table 8).

FTT FTIR is a modular construction that typically comprises of a FTIR gas analyser, heated sampling unit and an industrial PC which are mounted in a 19" cabin. The FTIR gas analyser is an integral part of the system which allows simultaneous measurement of multiple gas compounds. Typically concentrations of H_2O, CO_2, CO, SO_2, NO, NO_2, HCl, HF, HBr, HCN, NH_3, etc. are continuously measured. The FTIR gas analyser has a multi-pass sample cell which is heated to 180°C and features gold plated mirrors with protective MgF_2 coating which ensures high performance even in high water vapour concentrations or corrosive gases.

NF X 70-100 Toxicity Test Apparatus

This method is based on the exposure of 1 g of test specimen. The test apparatus and conditions for this method are described in NF X 70-100-2 with additional gas analysis information provided in EN 45545-2.

The exposure conditions of the test specimen in the tube furnace are generally set at 600°C, a fixed ventilation condition which represents a developing fire condition for railway products.

When the CIT for a product on a railway vehicle is required, only one method is used for the testing, gas analysis and calculation of CIT. The method to be used is shown in Table 9.

The test conditions specified for use when performing EN ISO 5659-2 or NF X 70-100-2 depend upon the application and position of the

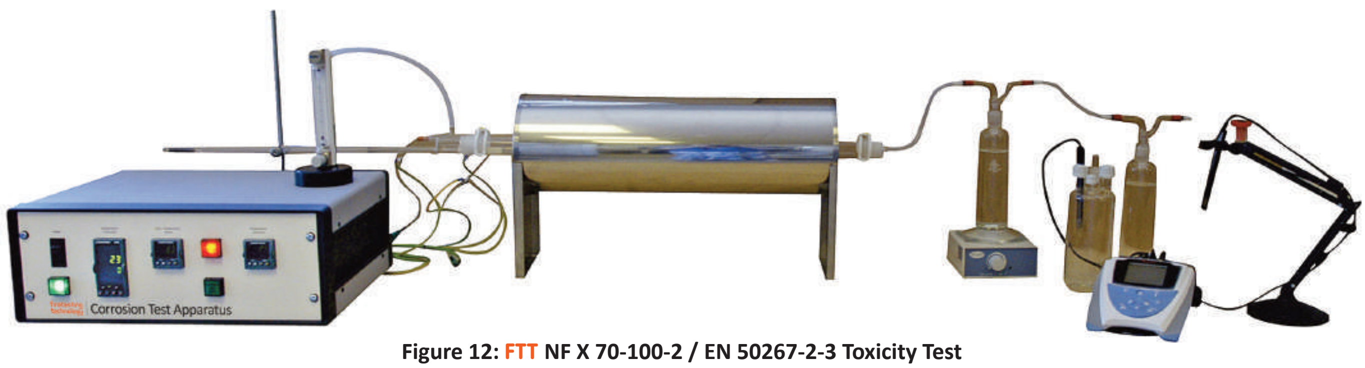


Figure 12: FTT NF X 70-100-2 / EN 50267-2-3 Toxicity Test

Table 9: Test method to be used for determination of Conventional Index of Toxicity (CIT)

Product	EN ISO 5659-2 Smoke Chamber with FTIR	NF X 70-100-2
Products with large areas or significant surface areas; e.g. interior walls, floor coverings, seat backs and coverings	Yes	No
Nonlisted products; e.g. minor mechanical components	No	Yes

product on the railway vehicle. The conditions selected are representative of fires that may impact on the railway product, during either the developing stages or the developed stage of a fire inside or outside the railway vehicle.

EN 61034 3 Metre Cube Smoke Test Apparatus

The 3 Metre Cube is used for measuring smoke emission when electric cables are burned under defined conditions, for example, a few cables burned horizontally. These units are produced to meet the specification used in many electric cable tests. The unit can be supplied in a self-assembly kit form or can be fully installed by **FTT** engineers.

The equipment comprises of:

- A 3 metre cubic chamber assembly
- Photometric system, stands, fans and sample mounting frames
- Extraction fan and ducting
- Chart recorder or Windows based operation software.

Figure 13: FTT EN 61034 3M Cube Smoke Test Apparatus

Table 10: Requirements concerning Smoke Optical Density and Toxicity of Listed Products

Requirement set	Test method reference	Test parameter and unit	Maximum threshold		
			HL1	HL2	HL3
R1, R2, R6, R11, R12	EN ISO 5659-2: 50kW/m²	$D_S(4)$	600	300	150
		VOF_4 [min]	1200	600	300
		CIT_G	1.2	0.9	0.75
R3	EN ISO 5659-2: 50kW/m²	$D_S(4)$	–	480	
		VOF_4 [min]	–	960	480
		CIT_G	1.2	0.9	0.75
R4	EN ISO 5659-2:50kW/m²	CIT_G	1.2	0.9	0.75
R5	EN ISO 5659-2: 25kW/m²	D_S max	300	250	200
		CIT_G	1.2	0.9	0.75
R7	EN ISO 5659-2: 50kW/m²	D_S max	–	600	300
		CIT_G	–	1.8	1.5
R8, R9	EN ISO 5659-2: 25kW/m2	D_S max	–	600	300
		CIT_G	–	1.8	1.5
R10	EN ISO 5659-2:25kW/m²	D_S max	600	300	150
		CIT_G	1.2	0.9	0.75
R17	EN ISO 5659-2: 50kW/m²	D_S max	–	600	300
		CIT_G	–	1.8	1.5
R20	EN ISO 5659-2: 25kW/m²	D_S max	200	200	200
		CIT_G	0.75	0.75	0.75
R21	EN ISO 5659-2: 25kW/m²	D_S max	300	300	200
		CIT_G	1.2	0.9	0.75
R22	EN ISO 5659-2: 25kW/m²	D_S max	600	300	150
	NF X 70-100-1 and 2 600°C	CIT_{NLP}	1.2	0.9	0.75
R23	EN ISO 5659-2: 25kW/m²	DS max	–	600	300
	NF X 70-100-1 and 2 600°C	CIT_{NLP}	–	1.8	1.5

Table 11: Requirements concerning Smoke Production of Electric Cables for EN 61034-2 test

Requirement set	Test parameter	Minimum threshold		
		HL1	HL2	HL3
R15	Transmission %	25	50	70
R16		–	25	50

EN ISO 4589-2 Oxygen Index Test

The Oxygen Index test is specified in EN 45545-2 for testing ignitability of listed and non-listed plastic products, e.g. internal and external seals, isolators, and PCBs. It is also one of the most economical and precise quality control tests for combustible materials. Its ease of use together with high levels of precision has made this technique a primary characterising quality control tool to the plastic and electric cable industries and it has been specified by several military and transport groups.

The technique measures the minimum percentage of oxygen in the test atmosphere that is required to marginally support combustion.

The FTT Oxygen Index (OI) and Temperature Oxygen Index (TOI) offer many improvements such as the latest oxygen analyser technology for high accuracy, reliability and long operating life.

Figure 14: FTT Oxygen Index Test

Table 12: Requirements concerning Oxygen Index test

Requirement set	Test parameter	Minimum Threshold		
		HL1	HL2	HL3
R22	Oxygen Index %	28	28	32
R23				
R24				

Figure 15: FTT Vertical Flame Test Apparatus

EN 60695-11-10 Vertical Flame Test

The EN 45545-2 specifies the EN 60695-11-10 for testing small electro-technical products, e.g. lower power circuit breakers, overload relays, contactors, etc.

The FTT EN 60695-11-10 Vertical Flame Test Apparatus features digital test duration timers, high precision gas control system and a bench mounted draft free stainless steel combustion chamber having a large inside volume.

The chamber is fitted with an interior light and exhaust fan to enable simple evacuation of combustion products from the tests. The apparatus can also comply with UL 94 and several FAR Bunsen burner tests with addition of the dedicated accessories.

Table 13: Requirements concerning Vertical Flame Test

Requirement set	Test parameter	Minimum Threshold		
		HL1	HL2	HL3
R26	Vertical small flame test	V0		

EN ISO 1182 Non-combustibility Test

The EN ISO 1182 Non-Combustibility Test and EN ISO 1716 Bomb Calorimeter are specified in the EN 13501-1 to classify A1 and A2 class construction products.

Brake resistors used in rolling stock, e.g. casing and any heat shields, are tested to this Euroclass criteria. The EN ISO 1182 test identifies products that will not, or significantly not, contribute to a fire, regardless of their end use. The **FTT** system has been designed with significant new features.

Rather than the traditional variac control, where it is possible to supply too high a current to the heater element during the heating cycle, **FTT** has automated the process by using modern electronics which considerably extend the life of the furnace.

Figure 16: EN ISO 1182 Non-combustibility Test

EN 45545-2

Although EN 45545-2 is published and operable in April 2013, CEN/TC 256 WG 1 is still working to improve the test methods used for both seating and toxic gas measurement.

Please contact us for the latest changes and development of this standard..

Summary of referenced test methods available from FTT:

EN 45545-2 TEST METHOD REF.	STANDARD	SHORT DESCRIPTION	REQUIREMENT SET	FTT INSTRUMENT
T01	EN ISO 4589-2	Determination of burning behaviour by oxygen index – Part 2: Ambient temperature test	R22, R23, R24	EN ISO 4589-2 Oxygen Index Test
T02	ISO 5658-2	Lateral flame spread	R1, R2, R3, R4, R7, R11, R12, R17	ISO 5658-2 Lateral Flame Spread Apparatus
T03	ISO 5660-1	Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method)	R1, R2, R3, R5, R6, R7, R8, R9, R10, R11, R12, R17, R19, R20, R21	iCone Calorimeter, Dual Cone Calorimeter
T04	EN ISO 9239-1	Radiant panel test for horizontal flame spread of floorings	R8, R10	EN ISO 9239-1 Flooring Radiant Panel
T05	EN ISO 11925-2	Ignition when subjected to direct impingement of flame	R4, R5	EN ISO 11925-2 Single-Flame Source Test Apparatus
T06	ISO 9705-2	Furniture calorimeter vandalised seat	R18	ISO 9705-2 Large Scale Calorimeter
T09.01	EN 60332-1-2	Tests on electric and optical fibre cables under fire conditions – Part 12: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW premixed	R15, R16	EN 60332-1 Vertical Flame Propagation Test for flame a Single Cable
T09.02	EN 60332-3-24	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables– Part 24: Procedures – Category C	R15, R16	EN 60332-3 Vertical Flame Propagation Test for Bunched Cables
T09.03-04	EN 50305:2002 Clause 9.1	Railway applications – Railways rolling stock cables having special fire performance – Test methods	R15, R16	EN 60332-3 Vertical Flame Propagation Test for Bunched Cables
T10	EN ISO 5659-2	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R17, R20, R21, R22, R23	NBS Smoke Density Chamber
T11	EN 45545-2:2013 Annex C	Gas analysis in the smoke chamber EN ISO 5659-2, using FTIR technique	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R17, R20, R21	NBS Smoke Density Chamber with FTIR Gas Analyser
T12	NF X 70-100-1 NF X 70-100-2	Gas analysis for the 8 gases described on 3.1.5	R22, R23	EN 50267-1 Cable Toxicity Test Apparatus
T13	EN 61034	Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements	R15, R16	3M Cube Smoke Test Apparatus
T14	EN 13501 (EN ISO 1182 and EN ISO 1716:2010)	Fire classification of construction products and building elements – Part 1: Classification using test data from reaction to fire tests	R13	EN ISO 1182 Non-Combustibility Apparatus, EN ISO 1716 Bomb Calorimeter
T15	EN 50305	Railway applications – Railway rolling stock cables having special fire performance – test methods	R15, R16	EN 50276-1 Cable Toxicty Test Apparatus
T16	EN 60695-2-11	Fire hazard testing – Part 2-11: Glowing/hotwire based test methods Glowwire flammability test method for end-products	R25	EN 60695-2-11 Glow Wire Test Apparatus
T17	EN 60695-11-10	Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods	R26	EN 60695-11-10 Vertical Flame Test Apparatus

European roofing products

This European Specification ENV 1187 specifies four methods for determining the performance of roofs to external fire exposure. The four methods assess the performance of roofs under the following conditions:

Test Method
Test 1 – with burning brands
Test 2 – with burning brands and wind
Test 3 – with burning brands, wind and supplementary radiant heat
Test 4 – with two stages incorporating burning brands, wind and supplementary radiant heat

The tests assess the fire spread across the external surface of the roof, the fire spread within the roof (Tests 1, 2 and 3), the fire penetration (Tests 1, 3 and 4) and the production of flaming droplets or debris falling from the underside of the roof or from the exposed surface (Tests 1, 3 and 4). Tests 2 and 3 are not applicable to geometrically irregular roofs or roof mounted appliances e.g. ventilators and roof lights.

The four tests listed above do not imply any ranking order. Each test stands on its own without the possibility to substitute or exchange one for another.

US transportation

Regulation for fire safety in intercity and interstate trains in the US is addressed by the Federal Railroad Administration (FRA), and was published in “Passenger Equipment Safety Standards; Final Rule”, found in the Code of Federal Regulations (49CFR238 Appendix B). More extensive requirements can be found in NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems, a consensus standard issued by NFPA and widely adopted for trains and underground systems. Guidance on fire hazard assessment of passenger trains is found in ASTM E2061: Fire Hazard Assessment of Rail Transportation Vehicles. This guide can be used to develop a fire hazard assessment and it discusses different fire scenarios as well as the tests required by the Federal Railway Administration and by NFPA 130.

The key fire tests are ASTM E162, ASTM D3675 (similar to ASTM E162 for foams), ASTM E648 (for flooring), ASTM E119 (a fire resistance test for structural components), and ASTM C1166 (a small burner test for cellular elastomeric gaskets and accessories). Fabrics are tested with a small vertical Bunsen burner test and smoke obscuration is assessed with the ASTM E662 test. In order to conduct fire hazard assessment, it is acceptable to run complete seat assemblies to ASTM E1537 (CA TB 133 upholstered furniture test) or complete mattresses to ASTM E1590 (CA TB 129). NFPA 130 also contains requirements for wires and cables, which must meet the UL 1685 vertical cable tray test, including smoke obscuration criteria (absent from FRA regulations). NFPA 130 also contains circuit integrity requirements for some cables, based on a fire resistance test.

Subways fall under the jurisdiction of the Federal Transit Administration (FTA), so the FRA regulations do not apply. There are guidelines (but no requirements) which reference the same set of fire tests as shown above and, in practice, many (or even most) local transportation authorities reference NFPA 130. Buses often also follow the same guidelines voluntarily.

Test Method
Large Scale Mattress Fire Test CA TB 603, 16 CFR Part 1633
FMVSS 302, ISO 3795
NBS Smoke Density Chamber ASTM E662
Radiant Panel Flame Spread Apparatus ASTM E162

Motor Vehicles

There are very few fire tests associated with road transportation in the US. The National Highway Traffic Safety Administration (NHTSA) established and enforces safety performance standards for road motor vehicles and road motor vehicle equipment. The only fire test mandated by NHTSA is FMVSS 302 (also known as ASTM D6132), which is required for everything within 13mm of the passenger compartment. It is a small scale burner test conducted in a small cabinet (15" × 14" × 8").

Test specimens 4" × 14" are exposed to a flame for 15s and a burn rate is calculated. A material passes if the burn rate is < 102mm/min. ISO 3795 is a technically equivalent standard used in Europe, Canada, and Japan. While NHTSA mandates FMVSS 302 for school buses, much of the industry, and some local education authorities, also voluntarily conducts a very simple test that involves burning a paper bag filled with newspaper on a set of school bus seat assemblies. This test has recently been standardised at ASTM as ASTM E2574, Standard Test Method for Fire Testing of School Bus Seat Assemblies, by replacing the paper bag by a gas burner 50% more severe than the ASTM E1537 fire test.

Shipping

There are many standards for materials used on ships. The key one is the surface flammability test (ASTM E1317, often known as the LIFT or IMO test) and others include the non-combustibility test (ISO 1182) and the ISO smoke chamber test (ISO 5659-2). All maritime tests are contained in the IMO (International Maritime Organization) Fire Test Procedures Code. Cables on ships are often required to be tested to the UL 1685 test, an intermediate scale cable tray test, with requirements also for smoke obscuration.

Plastics

Plastics used in most industrial and transport applications and particularly those used in higher fire hazard environments, are compounded with flame retardants to enhance their fire performance.

Several methodologies have been developed to assess the burning characteristics of the materials so that performance of the plastics themselves and the products into which they are made can be comparatively assessed. Some of these methods are simple flame tests and others can be used in numerical models.

Listed below are some flammability tests that are widely used in the industry to measure different fire response characteristics:

Test Method
Micro Calorimeter
Cone Calorimeter (ISO 5660, ASTM E1354)
NBS Smoke Density Chamber (BS 6401, ASTM E662, ISO 5659, NES 711)
Fire Propagation Apparatus ASTM E2058
Oxygen Index ISO 4589-2, ASTM D2863
Elevated Temperature Oxygen Index ISO 4589-3
UL 94 Horizontal/Vertical Flame Chamber
UL 1581 Vertical Wire Flame Test Apparatus
Radiant Panel Flame Spread Apparatus ASTM E162
Toxicity (or Corrosivity) Test Apparatus ASTM E1678

Aviation

The Federal Aviation Administration (FAA) regulates aircraft operating in the US but its guidelines are followed worldwide. Fire tests for materials used in passenger aircraft are detailed in the FAA Aircraft Materials Fire Test Handbook. **FTT** provides the following fire testing equipment which are all described in the FAA Fire Test Handbook and are used for regulation:

Test Method
ASTM E906 OSU Calorimeter
NBS Smoke Density Chamber (BS 6401, ASTM E662, ISO 5659, NES 711)
Thermal/Acoustic Insulation Flame Propagation Apparatus (FAR Part 25 Appendix F Part VI, Airbus AITM 2.0053, Boeing BSS 7365)
FAR Bunsen Burner Test Apparatus

iCone^2+ Calorimeter

(ISO 5660; ASTM E1354)

Heat Release

The *i*Cone2+ is the latest development in the **FTT** *i*Cone range and incorporates all of the best features of our range of cone calorimeters. It offers cutting edge PCB based technology in a modular and robust build with remote communication, cone operation and diagnostic facilities that allow **FTT** the capability to efficiently respond, diagnose problems and service installations, in all corners of the world.

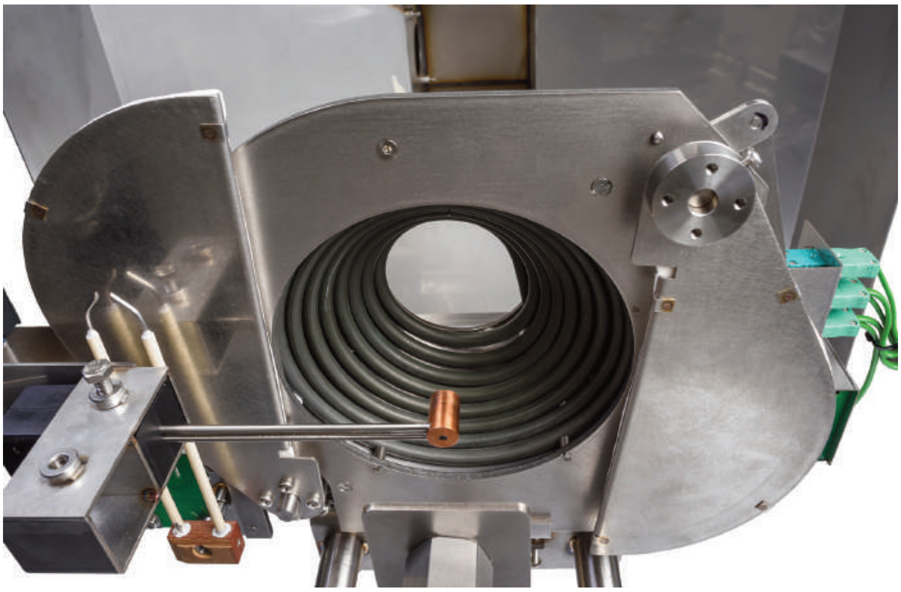
The *i*Cone2+ is the most advanced, reliable and user-friendly cone calorimeter in the world.

Cone Calorimeter

The name "Cone Calorimeter" was derived from the shape of the truncated conical heater that Babrauskas used to irradiate the test specimen (100mm × 100mm) at fluxes up to 75-100kW/m^2 in the bench-scale oxygen consumption calorimeter that he and his co-workers developed at NIST. The Cone Calorimeter is the most significant bench-scale instrument in the field of fire testing because it measures important, real properties of the material being tested under a variety of preset fire conditions. These measurements can be used directly by researchers or they can be used as data for input into correlation or mathematical models, used to predict fire development.

Directly measured properties include:

- Heat release rate
- Time to ignition
- Mass loss rate
- Smoke production rate
- Effective heat of combustion
- Rates of release of combustion gas (e.g. carbon oxides)



Base view of conical heater

Oxygen Consumption Principle and Heat Release Rate

The heat release rate is the single most important parameter that can be used to characterise fire. It provides a measurement of the size of the fire, and the rate of fire growth, and allows calculation of the time available for escape or suppression. Most fire parameters are directly proportional to the size of the fire so by knowing the heat release we also have a good indicator of the level of smoke and other combustion products being generated. Huggett and Parker examined in detail Thornton's assumption that constant quantity of heat was released per unit of oxygen consumed using a variety of fuels, and assessed its effect on the accuracy of heat release measurement based on it. They concluded:

1. The heat release rate in a fire can be estimated with good accuracy from two simple measurements, the flow of air through an exhaust and the concentration of oxygen in the exhaust.
2. The heat release from a fire involving conventional organic fuels is 13.1kJ per gram of oxygen consumed, with an accuracy of ± 5% or better.
3. Incomplete combustion and variation in fuel have only a minor effect on this result. Appropriate corrections can be made if necessary.
4. The oxygen consumption technique for heat release measurement is adaptable to a wide range of applications ranging from small scale laboratory experiments to very

large scale fire system tests. A number of heat release apparatuses have been developed since and are based on these findings. The most important of these is the 'Cone Calorimeter'.

Oxygen Consumption Calorimetry

$$\dot{q} = (13.1 \times 10^3)\,1.10C \sqrt{\frac{\Delta P}{T_e}} \frac{(X^0_{O_2} - X_{O_2})}{(1.105 - 1.5\,X_{O_2})}$$

Where:

$\dot{q}$ = Rate of heat release (kW)
C = Orifice plate coefficient ($kg^{1/2} \cdot m^{1/2} \cdot K^{1/2}$)
ΔP = Pressure drop across the orifice plate (Pa)
T_e = Gas temperature at the orifice plate (K)
X_{O_2} = Measure mole fraction of O_2 in the exhaust air (no units)
$X^0_{O_2}$ = Initial mole fraction of O_2 in the exhaust air (no units)

Modelling with Calorimeter Data

Early work carried out in the USA and Sweden showed how successful the Cone Calorimeter was in generating good input data for models.

After the EUREFIC project demonstrated excellent prediction of Room Corner test (ISO 9705) performance for wall lining materials from Cone Calorimeter data, the European Commission funded several large multi-lab research projects to develop models for prediction of the performance of finished construction products from small scale calorimeter tests. These include the CBUF (Combustion Behaviour of Upholstered Furniture Project) for Furniture, and FIPEC (Fire Performance of Electric Cables) for electric cables.

FTT's Contribution to the Development of Calorimetry

In the mid 1980s **FTT** directors worked with Babrauskas and other colleagues to help develop international test standards based upon oxygen consumption calorimetry.

They also designed European prototypes and Stanton Redcroft's commercial Cone Calorimeter. **FTT** has been the world's leading manufacturer of all calorimeters, including full scale calorimeters (e.g. Furniture Calorimeter, the ISO 9705 Room Corner test and the SBI) since 1989. Throughout this period **FTT** scientists and engineers have worked on several calorimetry research projects and contributed extensively to International, European, ASTM and British Standardisation groups.

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.

- Furniture (ASTM E1474)
- Wall lining materials (ASTM E1740)
- Prison mattresses (ASTM F1550)
- Electric Cables (ASTM D6113)
- Railway rollingstock applications (EN 45545-2)
- Maritime applications (IMO)

FTT has supplied more than 400 Cone Calorimeters to customers, in approximately 50 countries, for both research studies and testing in accordance with fire safety standards. **FTT**'s specialist calorimetry design engineers ensure their products integrate new developments. **FTT**'s production engineers are the world's most experienced Cone Calorimeter builders and its team of specialist service engineers ensure that **FTT** calorimeters are promptly maintained, on all five continents.

*i*Cone^{2+} Calorimeter

The *i*Cone^{2+} has all the advantages of the conventional single purpose Cone Calorimeter and has been produced to be the most easily maintained cone in the marketplace. It fits into the smallest labs and is easy to operate using the **FTT** user-friendly, menu driven software, which guides users through the calibration, testing and reporting protocols. The apparatus meets all existing Standards (including ISO 5660-1, ASTM E1354, ASTM E1474, ASTM E1740, ASTM F1550, ASTM D5485, ASTM D6113, CAN ULC 135 and BS 476 Part 15). It features an interactive and intuitive interface, sophisticated and flexible control options, and built-in data acquisition technology for robust data collection, analysis and reporting and is the most advanced Cone Calorimeter produced in the world.

Features of *i*Cone^{2+}

- Online support and remote diagnostics and control of instruments from **FTT** for internet connected system
- Design based on cutting edge surface mounted PCB technology
- PCB modular design facilitates improved serviceability and reliability

- Improved laser mounting system for easier setup and calibration and elimination of thermal drift
- Robust engineering for improved life expectancy of the instrument
- Latest generation gas analysers built with PCB and touchscreen technology
- Remote cone assembly positioning control, so that heater-specimen surface separation can be adjusted pre- and mid-test, to facilitate testing of intumescing or thermally distorting specimens
- Motorised heat shield to protect specimen from heat exposure before test
- Automatic positioning and control of spark igniter to ignite the combustion gases from the specimen
- Retractable 4-sided heat resistant glass protective screen which provides a draft-free environment around the fire model with clear viewing from all sides
- Heat resistant glass protective screen electronically controlled
- 5.5" colour touchscreen test control panel adjacent to specimen supplements principal computer control
- Automatic calibration by ConeCalc Software
- Load cell resolution of 0.01g and load capacity up to 8.2kg (Sartorius cell)
- Load cell mounted on an independent table to avoid any vibration from exhaust fan
- All round access to specimen platform for specimen preparation and cleaning
- Easy to clean large, highly durable black granite working surface
- Fire model protection alarm system
- Optional larger Cone fire model for testing specimens with very low heat release rates. 150mm × 150mm specimens are exposed to uniform heat flux over entire surface

A full *i*Cone^{2+} system consists of:

Conical Heater

- 5kW electrical heating element wound in the form of a truncated cone, rated 5000W at 230V with a heat output up to 75-100kW/m^2
- Motorised height adjustment and control via 5.5" touchscreen during test for materials that intumesce
- Facility for testing horizontally or vertically orientated specimens

Temperature Controller

- Software controls the temperature of the conical heater to give the desired heat flux via 3 type-K thermocouples and a 3-term (PID) temperature controller
- Cone temperatures relating to heat fluxes are established before the test using the Heat Flux Calibration routine in the ConeCalc software

Motorised Heat Shield

- Automatic/Manual control of a split shutter mechanism via 5.5" touchscreen or ConeCalc software to protect specimen from heat exposure before test
- Ensures the initial mass measurement is stable and the operator has additional time for 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.

5.5" touchscreen

Specimen Holders

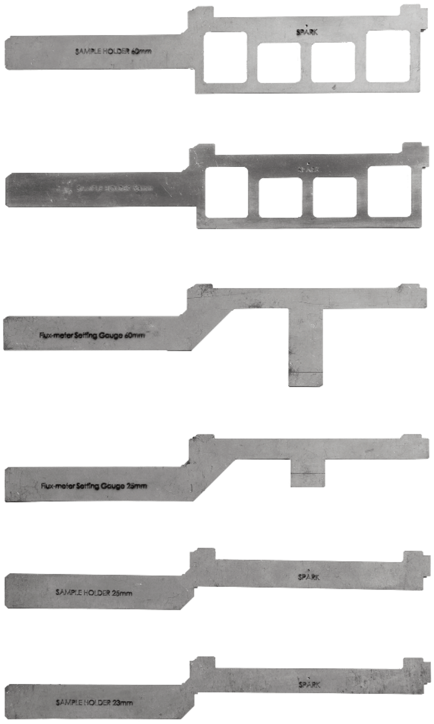
- Made of stainless steel
- For specimens 100mm × 100mm up to 50mm thick, in the horizontal and vertical orientation

Specimen Spacers

- A set of 6 different specimen spacers are provided for easy and precise adjustment

Load Cell

- Mass measurements are taken using a strain gauge load cell with a resolution of 0.01g
- Mounted on an independent table to avoid any vibration from exhaust fan



Specimen spacers

Spark Ignition

- 10 kV spark generator fitted with a safety cutout device
- Automatic positioning and control of spark igniter via 5.5" touchscreen or ConeCalc software to ignite the combustion gases from the specimen

Glass Protective Screen

- Made of heat resistant glass
- Manual and automatic control via 5.5" touchscreen or ConeCalc software
- Provides a large draft-free environment around the fire model
- When in the lower position, the screens are retracted below the large working granite surface which allows unrestricted access to the fire model
- Screen assembly rises from below the working surface to enclose the specimen area on all four sides

Exhaust System

- Manufactured from stainless steel for long life
- Comprising large hood (to ensure all combustion gases collected), gas sampling ring probe, exhaust fan (with adjustable flow controls from 0-50g/s, at a resolution of 0.1g/s) and an orifice plate flow measurement (thermocouple and differential pressure transducer)
- Normal operation is at a nominal 24 ℓ/s (range 0-50 ℓ/s)

Gas Sampling

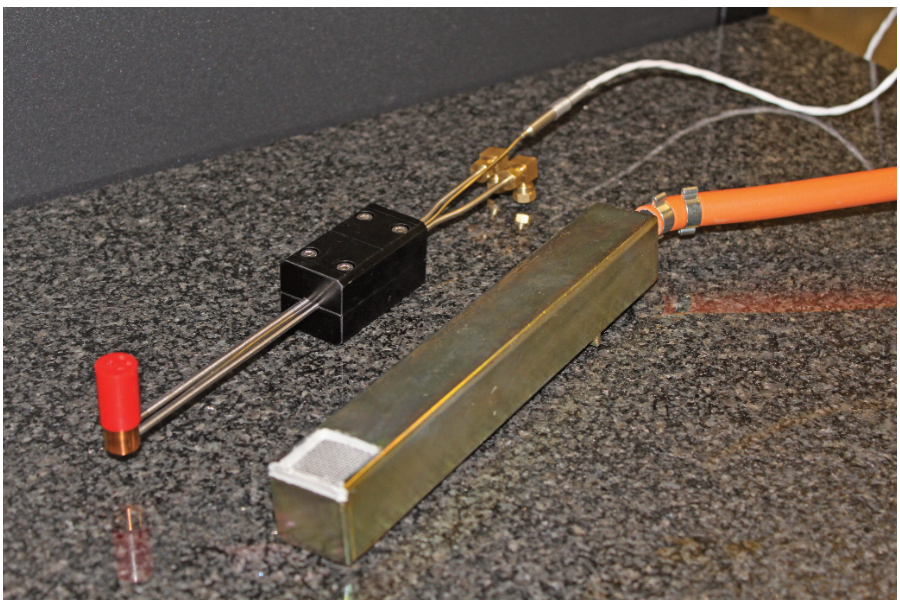
- Comprising soot filters, pump, moisture trap (CO_2 removal trap, if not measured) and mass flow controller (MFC). The MFC allows maximum control of flow to the analyser during calibration and test, reducing errors and drift

Peltier cooling device

- All **FTT** calorimeters use a Peltier cooling device and drying agent to ensure that all moisture is removed from the sample gas stream to prevent drift in the Oxygen base-line concentration. Tests have shown that just using a Peltier cooling device leads to base line oxygen drift beyond the limits of the standard and resulting in incorrect Heat Release measurement.

Gas Analysis

- **FTT** Calorimeter Analyser featuring Paramagnetic oxygen sensor with atmospheric pressure compensation. Infrared carbon dioxide sensor (0-10%) and carbon monoxide are optional.
- Developed and optimised specifically for the **FTT** calorimeters this analyser features flow control and bypass for fast response, low drift and noise and is compatible with small, medium and large calorimeters.



Heat flux meter and calibration burner

Smoke Obscuration

- Measured with a laser system, using Silicon 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
- The heat flux is automatically set using the ConeCalc software, heat flux meter and temperature controller

Calibration Burner

- For calibrating the rate of heat release measured by the apparatus using methane of 99.5% purity. Mass flow of methane is controlled via ConeCalc software and a mass flow controller for optimising accuracy of the system calibration

5.5" Colour Touchscreen and PLC Control System

- Simple to use HMI user interface and set-up menus for operating the Cone Calorimeter and providing control and display of all main system parameters, e.g.
  - Frequency of Exhaust Blower
  - Spark igniter positioning (in-out) and control (on-off)
  - Fire Model Heat Shield control
  - Fire Model Glass Protection Screen control
  - Height adjustment of Heater
  - Fire Model Protection Alarm System

17" touchscreen PC and ConeCalc software

Data Acquisition

- Data Acquisition/Switch Unit featuring a 3-slot cardcage with up to 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 USB and Ethernet interface as standard. All readings can be automatically time stamped and can be stored in a non-volatile 50,000-reading memory

ConeCalc Software

- User-friendly Windows based ConeCalc user interface with push-button actions, data entry fields and capable of:
  - Instrument control and showing status of the instrument

Large Cone Fire Model and Control Unit

- Fully automatic calibration of gas analysis instrumentation and storage of calibration results
- Fully automatic C-factor calibration with the use of mass flow controller
- C-factor calibration via pool fire (ethanol) routine
- Collecting data generated during a test
- Calculating the required parameters
- Averaging of multiple tests
- Presenting the results in a manner in accordance with ISO 5660-1, ASTM E1354 and EN 45545-2
- Exporting calculated data to CSV (comma separated variable) files for quick transfer to spreadsheets.

Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.

Test Parameters

- Heat flux (kW/m²)
- Flow rate in exhaust duct (ℓ/s)
- C-factor ($m^{1/2} \cdot kg^{1/2} \cdot K^{1/2}$)
- Ignition time and extinction time (s)
- Heat release rate (kW/m²)
- Smoke production rate (m²/s)
- Mass loss, Mass loss rate (g, g/s)
- Effective heat of combustion (MJ/kg)
- Specific extinction area (m²/kg)
- CO_2 yield (kg/kg)
- CO yield (kg/kg)
- Total heat release (MJ/m²)
- MARHE (kW/m²) [Maximum average rate of heat evolved]
- Total oxygen consumption (g)

Options

- Integrated Carbon Dioxide and Carbon Monoxide NDIR gas analysers
- Sartorius Load Cell (increased range)
- Soot Mass Sampling
- Large Cone Fire Model (ISO/TS 5660-4, ASTM E2965) – for testing samples 150mm × 150mm and gives uniform heat flux over entire sample surface
- Controlled Atmosphere Attachment – for testing specimens in low oxygen atmospheres (0-21%) that may be found in well developed fires, or for studying the effects of gaseous suppressants or other dynamic controlled-atmosphere environments. The cone assembly is located on top of

FTIR Combustion Gas Analysis System

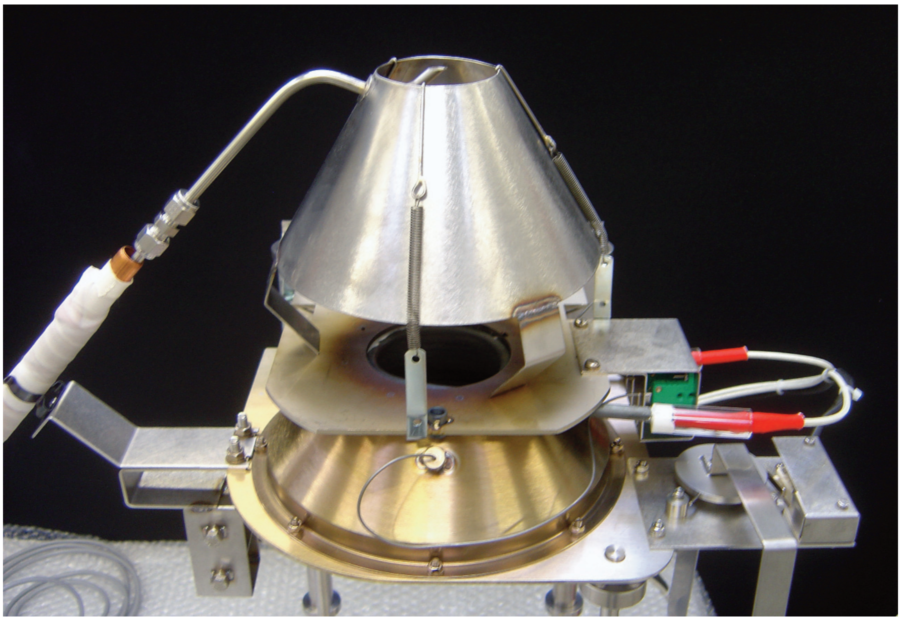
Controlled Atmosphere Attachment

Heat Release

the enclosure with exhaust gas exiting through the cone only. The cabinet replaces the conventional cone assembly but uses the same controllers as the normal cone. There is a door on the front of the assembly with a viewing window. Changing between the standard fire model and this unit is simple. The Cone Calorimeter is fitted with a gas mixing attachment to mix air and nitrogen which can be supplied at flows between 0-200ℓ/min to the chamber. The gas supply lines are fitted with flow meters and flowstat flow controllers and a mixing chamber. These are external to the enclosure chamber and housed in a mobile control unit

- FTIR – The **FTT** FTIR is an advanced gas analyser used for continuous measurement of combustion gases in conjunction with **FTT**'s Cone Calorimeter, Smoke Density Chamber or SBI. The analysis of gases in fire effluents is very complex and challenging due to the great number of different organic and inorganic chemicals which these atmospheres can contain. **FTT**'s FTIR is fully configurable to meet the requirements of several international standards including ISO 19702, ISO 9705 and EN 45545-2. It is capable of individual analysis of airborne concentrations of CO, CO_2, NO, NO_2, SO_2, HCl, HF, Phenol, Acrolein, water vapour, etc. The **FTT** FTIR is a modular construction comprising of FTIR gas analyser, heated sampling unit and a touch screen PC which are mounted in a 19" rack
- Cone Corrosimeter – Built in accordance with ASTM D5485 and used for assessing the corrosive potential of combustion products

Gas Analysis Rack



Cone Corrosimeter

Flexibility with FTT Calorimeters

When used with the Cone Calorimeter, the analysis rack is elegantly located with the *i*Cone^{2+} unit. When required for the Large Scale Calorimeter this gas analysis rack is quickly decoupled from the *i*Cone^{2+} main frame and transferred, on the factory-fitted castors, to the new location for equally quick connection to power and sampling lines of the larger calorimeter.

FTT calorimeters are designed to have interchangeable modules that give our clients maximum operational or upgrade flexibility. The analysis systems of the *i*Cone^{2+} can be transported to large calorimeters within minutes. Almost all ducted rigs like the IEC 60332-3 can be readily converted to large calorimeters by use of the rack from the *i*Cone^{2+} and an instrumented duct insert which **FTT** provides. The latter houses all necessary gas sampling, temperature and duct flow rate probes.

Unrivalled Experience in Design and Manufacturing

FTT's site in East Grinstead, is home to the largest group of fire scientists and instrumentation design engineers working on fire testing instrumentation, and is at the heart of our design and manufacturing. For more than 30 years FTT has provided the highest quality instruments and service for fire testing and research professionals worldwide, directly and through its extensive global sales and support network.

Quality

- World-class manufacturing in accordance with multiple international and national standards, including: EN, ISO & ASTM
- ISO 9001, ISO 14001 certified

Integrity

- A dedicated team passionate about fire testing instrumentation and continuous product improvement
- Delivering reliable, robust and easy-to-use instruments for the past 30 years

Excellence

- A world-class team made up of qualified fire scientists, mechanical, electrical and electronic fire instrument design engineers and production, installation and maintenance engineers

Global

- World-wide distribution network for global sales, installations, training, maintenance and technical support
- Leading global supplier of the Cone Calorimeter, Large Scale Calorimeter, NBS Smoke Chamber and Oxygen Index

Truncated Conical Heater and Fire Model

Element

- 5kW electrical heating element

Heater

- Heat flux up to 75-100kW/m^2
- Motorised height adjustment and control via 5.5" touchscreen during test for materials that intumesce

Heat shield

- Motorised
- Automatic/Manual control via 5.5" touchscreen or software to protect specimen from heat exposure before test

Spark igniter

- Automatic positioning and control via 5.5" touchscreen or software to ignite the combustion gases from the specimen
- Spark gap of 3mm located 13mm above the centre of the specimen

Heat resistant glass protective screen

- Manual and automatic control via 5.5" touchscreen or software
- Provides a draft-free environment around the fire model
- When in the lower position, the screens are retracted below the large working granite surface and allows unrestricted access to the fire model
- Screen assembly rises from below the working surface to enclose the specimen area on all four sides

Large cone fire model (optional)

- For testing samples 150mm × 150mm
- Uniform heat flux over entire surface

Specimen Holder, Weighing Device & Specimen Handling

Specimen holder

- A square pan with an opening of 106mm × 106mm at the top, and a depth of 25mm, constructed from stainless steel

Retainer edge frame

- A stainless steel frame with inside dimension 111mm × 111mm, and opening of 94mm × 94mm

Sample size

- 100mm × 100mm

Sample thickness

- Up to 50mm

Load cell

- Resolution of 0.01g
- Mounted on an independent table to avoid any vibration from exhaust fan

Load capacity

- Up to 8.2kg (Sartorius Load Cell)
- Up to 5.0kg (Standard Load Cell)

***i*Trap**

- Moisture removal controlled by a microprocessor with built-in stainless steel heat exchanger
- Adjustable set-point temperature
- Status display

Black granite working surface

- Easy to clean, durable
- Additional working space compared with traditional Cone Calorimeters

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, moisture trap and optional CO_2 removal trap, mass flow controller (for precise control of flow to analyser and reducing drift) controlled via software

Soot mass sampling (optional)

- Operated by mass flow controller automatically from software

Calibration Burner

Construction

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

Control

- Methane flow controlled at required heat release using a mass flow controller

Instrumentation for Gas Analysis

19" Gas analysis rack

- Detachable to be used with other large scale calorimeters, e.g. SBI, Room Corner test, etc.

Oxygen analyser (FTT Calorimeter Analyser)

- Paramagnetic type with a range of 0-25% Oxygen. t_{10}-t_{90} response time less than 12s. Drift typically less than 20ppm in 30 minutes
- Low noise. Specially designed for FTT

Carbon dioxide (optional)

- Non-dispersive infrared type with a range of 0-10%. Fast response. Specially designed for FTT

Carbon monoxide (optional)

- Non-dispersive infrared with a range of 0-1%. Fast response. Specially designed for FTT

Smoke Density Measurement

Light source

- 0.5mW Helium-Neon laser beam

Detectors

- Silicone photodiode

Data Logger

Resolution

- Up to 22 bits

Recording time

- Up to 250 channels per second

Storage

- Raw data recorded for each test is stored and can be retrieved

5.5" Colour Touch Screen and PLC Control System

Simple to use HMI user interface and set-up menus for operating the Cone Calorimeter and providing control and display of all main system parameters, e.g.

- Frequency of Exhaust Blower
- Spark igniter positioning and control
- Fire Model Shield control
- Fire Model Glass Screen control
- Height adjustment of Heater

17" Touch Screen PC (inside Gas Analysis Rack)

User-friendly Windows based ConeCalc user interface with push-button actions and data entry fields and capable of:

- Instrument control and showing status of the instrument
- Fully automatic calibration of gas analysis instrumentation and storage of calibration results
- Fully automatic C-factor calibration with the use of a mass flow controller
- C-factor calibration via pool fire (ethanol) routine
- Collecting data generated during a test
- Calculating the required parameters
- Presenting the results in a manner in accordance by ASTM E1354, ISO 5660-1 and EN 45545-2

Test Parameters

- Heat flux (kW/m^2)
- Flow rate in exhaust duct (ℓ/s)
- C-factor ($m^{1/2} \cdot kg^{1/2} \cdot K^{1/2}$)
- Ignition time and extinction time (s)
- Heat release rate (kW/m^2)
- Smoke production rate (m^2/s)
- Mass loss, Mass loss rate (g, g/s)
- Effective heat of combustion (MJ/kg)
- Specific extinction area (m^2/kg)
- CO_2 yield (kg/kg)
- CO yield (kg/kg)
- Total heat release (MJ/m^2)
- MARHE (kW/m^2)
  [Maximum average rate of heat evolved]
- Total oxygen consumption (g)

Vitiated Atmosphere System (optional)

For testing reduced oxygen atmospheres – 0% to 21%

FTIR Toxicity Test Apparatus (optional)

Measuring Principle

- FTIR (Fourier Transform Infrared)

Performance

- Unlimited simultaneous analysis of multiple gases
- Pre-loaded analysis for 21 gas species
- User-friendly and comprehensive software package to enhance gas analysis
- Detachable 19" rack system which can be disconnected and used with other fire test applications

Zero Point Calibration

- 24 hours, calibration with Nitrogen (5.0 or higher N_2 recommended)

Zero Point Drift

- < 2% of measuring range per zero point calibration interval

Sensitivity Drift

- None

Linearity Deviation

- < 2% of measuring range

Temperature Drifts

- < 2% of measuring range per 10 K temperature change

Pressure Influence

- Pressure measured and compensated for in gas cell

Gas Species:

• H_2O	• CO_2	• CO	• NO	• NO_2	• N_2O
• SO_2	• HCl	• HCN	• HBr	• HF	• NH_3
• CH_4	• C_2H_6	• C_3H_8	• C_2H_4	• C_6H_{14}	• HCHO
• Phenol	• Acrolein	• COF_2			

Service Requirements

Electric:

220-250VAC, 28A, 50/60 Hz. Single Phase for the main frame
220-250VAC, 6A, 50/60 Hz. Single Phase for the gas analysis rack

Water:

210 kPa (30 psi)

Exhaust Extraction:

250-500 ℓ/s

Standard Gases:

Nitrogen (oxygen-free), Methane (UHP 99.5%)

Optional:

Span gas consisting of CO 0.85%, CO_2 8.5%, balance nitrogen

Due to the continuous development policy of FTT technical changes could be made without prior notice.

FTT Single Burning Item (SBI)

(EN 13823)

EN 13823:

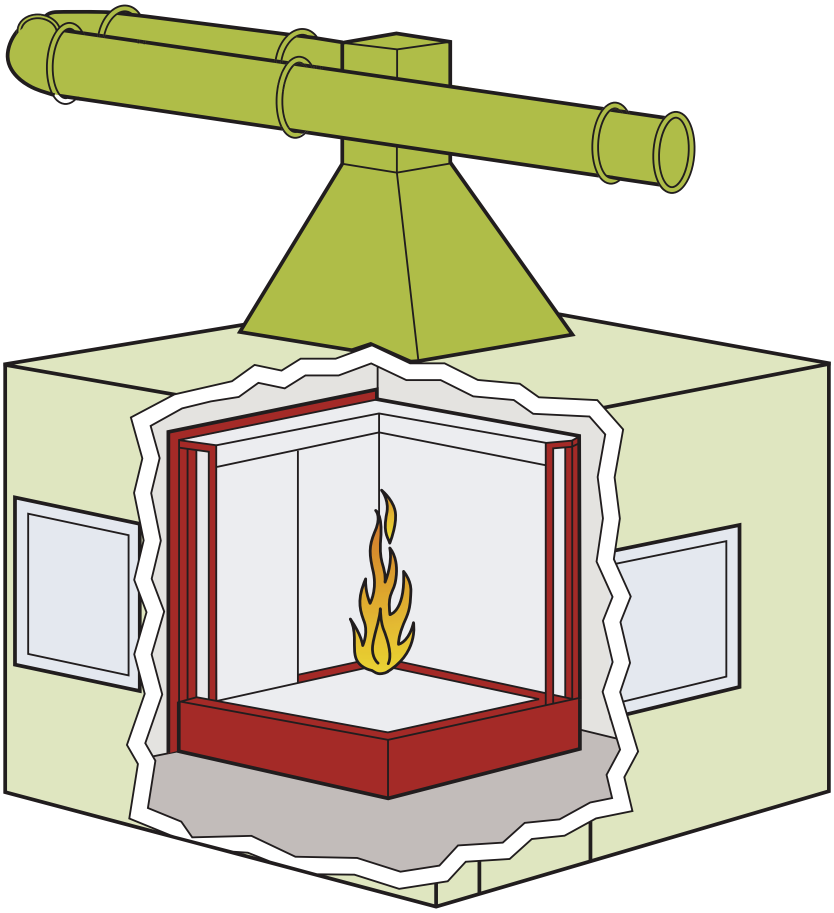
Reaction to fire tests for building products excluding floorings exposed to thermal attack by a single burning item, the SBI.

The importance of the SBI

The European Construction Products Regulation requires that all European Member states use this test method to evaluate reaction to fire performance for all construction products excluding flooring. These test methods will eventually take precedence over national regulatory methods to classify most building products and will be required by all suppliers of building materials into the EU and neighbouring states adopting these regulations.

The SBI Test

The Single Burning Item (SBI), is a method of test for determining the reaction to fire behaviour of building products (excluding floorings) when exposed to the thermal attack from a single burning item (modelled by a propane fuelled sand-box burner). The specimen is mounted on a trolley that is positioned in a frame beneath an exhaust system. The reaction of the specimen to the burner is monitored instrumentally and visually. Heat and smoke release rates are calculated and physical characteristics are assessed by observation. The parameters that are quantified in this test and used within the classification criteria are Total Heat Release (THR), Fire Growth Rate Index (FIGRA) and Smoke Growth Rate index (SMOGRA).



How the SBI is used to classify products

The European Commission recently defined the classification criteria for building products. These performance classes range from A to F. Although other test methods are required for assessment, SBI testing is needed to classify all non flooring products qualifying for classes A2, B, C and D, which are the major classes inhabited by most products other than those that are principally inorganic and classified as non-combustible (A1).

The FTT SBI

FTT supplies and installs the apparatus and train clients in its use. **FTT** can also supply any of the components to clients wishing to part design and build their own equipment.

The main components of the **FTT** SBI are:

- Frame, trolley, hood and ducting.
- Gas analysis instrumentation for heat release measurement.
- Smoke measurement system.

CLASS	CLASSIFICATION CRITERIA	ADDITIONAL CLASSIFICATION	OTHER TEST METHOD(S)
A2	FIGRA ≤ 120W/s; and LFS < edge of specimen; and THR_{600s} ≤ 7.5 MJ	Smoke production; and Flaming droplets/particles	EN ISO 1716
B	FIGRA ≤ 120W/s; and LFS < edge of specimen; and THR_{600s} ≤ 7.5 MJ	Smoke production; and Flaming droplets/particles	EN ISO 11925-2
C	FIGRA ≤ 250W/s; and LFS < edge of specimen; and THR_{600s} ≤ 15 MJ	Smoke production; and Flaming droplets/particles	EN ISO 11925-2
D	FIGRA < 750W/s	Smoke production; and Flaming droplets/particles	EN ISO 11925-2

- Burner, gas train and controls.
- Data acquisition and analysis software.

Test apparatus includes:

- Trolley, which holds the specimen and which docks into the frame.
- Primary and secondary burners.
- Frame, which is built into the test room.
- Collector with baffles, fitted to the hood.
- Ducting with guide vanes.
- Duct section containing gas sampling probe, bi-directional probe and thermocouples for mass flow measurement and smoke measuring ports.

The FTI SBI frame trolley

Gas Analysis Instrumentation

Housed in a 19" rack containing:

- **FTT** Calorimeter Analyser featuring Paramagnetic oxygen sensor with atmospheric pressure compensation and Infrared carbon dioxide sensor (0-10%). Carbon monoxide (0-1%) is optional.
- Developed and optimised specifically for the **FTT** calorimeters this analyser features flow control and bypass for fast response, low drift and noise and is compatible with small, medium and large calorimeters.
- Soot filter, refrigerant cold trap, drying column(s), pump and waste regulators for conditioning the sampled gases prior to analysis.
- Controls for the smoke measurement system (if purchased).

Clients owning an **FTT** Dual Cone Calorimeter can use the instrument rack from the cone for this function. Similarly clients purchasing this equipment will own a substantial section of a **FTT** Dual Cone Calorimeter and later be able to purchase a Cone Calorimeter with significant savings.

19" Gas Analysis Rack

Smoke Measurement System

Includes:

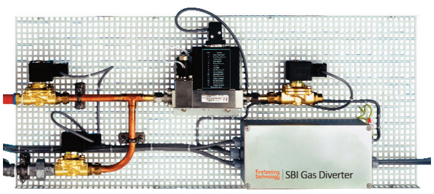
- White light source and lens built in accordance with DIN 50055.
- Silicon photodiode detector and voltage output of transmission
- SBI support cradle
- Full set of calibration filters.
- Analysis is via software.

Burner, Gas Train and Controls

Includes:

- Two non-aerated sandbox burners and an ignition system.
- UV burner flame detector units for safe gas supply monitoring.
- 'Gas Control Box', housed next to the test room observation window so the operator can simultaneously see the test specimen and digital propane mass flow rate (mg/s). This unit includes three flow level controllers, warning lights and override facilities.
- 'Gas Diverter' consisting of a mass flow controller to control the propane gas flow. Solenoid valves and flash back arrestors in both gas supply lines for automated safe operation of the gas flow to the burners. These are housed close to the test frame to improve the response time of the burners by reducing the pipe length between the solenoids and burners. The propane mass flow rate and the corresponding heat release (kW) are additionally displayed via software.

Gas Control Box



Gas Diverter

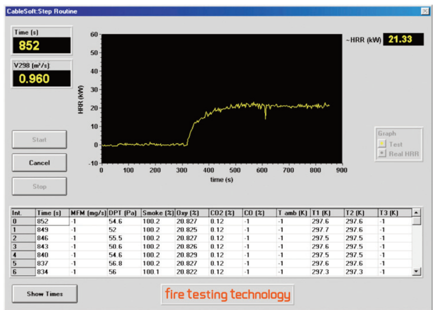
Data aquisition and analysis

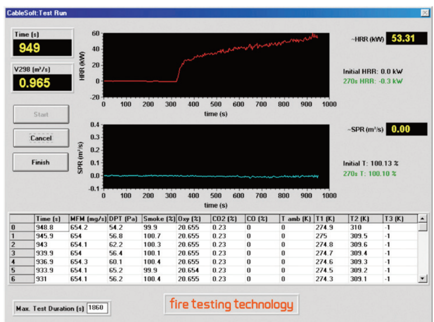
Includes:

- A Windows based software package enabling simple data collection and manipulation to determine the various parameters needed for heat release determination. The software generates files that integrate with the current spreadsheets, (which are also supplied) for the calculation of the Fire Growth Rate Index (FIGRA) and Smoke Growth Rate Index (SMOGRA).
- Data logger, which features a 3-slot cardcage with 6 1/2 digit (22 bit) internal DMM enabling up to 120 single-ended or 48 double-ended measurements, collects signals from the instrumentation. Scan rates up to 250 channels/s are available with a 115 kbaud RS232 interface as standard. Also supplied with GPIB interface.

Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.





Services required for complete instalation of an SBI

FTT supplies all instrumentation and ducting for the SBI and can help with laboratory design, supplying of additional items or supervision of local building works or installation of essential services. The test may produce large quantities of combustion products so smoke handling facilities and suitable extinguishing agents are recommended.

You will also need:

- Minimum height of 4.5m to house full apparatus
- Minimum floor space required (3m × 3m)
- Extraction (0.5m^3/s to 0.65m^3/s)
- Air supply
- Oxygen-free nitrogen
- Drying agents
- Calibration gas of CO_2/nitrogen (and CO if this option is purchased)
- Commercial propane supply
- Electrical power providing 230VAC 50/60 Hz 16A at the instrument rack must be available.

Other Euroclass test methods

To classify the reaction to fire of the full range of wall lining and flooring construction products, the SBI and up to 4 other European Standard test methods may be required. **FTT** supplies instrumentation complying with all these European Standard test methods.

The test methods are:

- Single-Flame Source Test
  EN ISO 11925-2. Reaction to fire tests for building products – Ignitability of building products subjected to direct impingement of flame.
- Oxygen Bomb Calorimeter
  EN ISO 1716. Reaction to fire tests for building products – Determination of the heat of combustion.
- Non Combustibility Apparatus
  EN ISO 1182. Reaction to fire tests for building products – Non combustibility test.
- Flooring Radiant Panel
  EN ISO 9239-1. Reaction to fire tests for building products – Horizontal surface spread of flame for floor coverings.

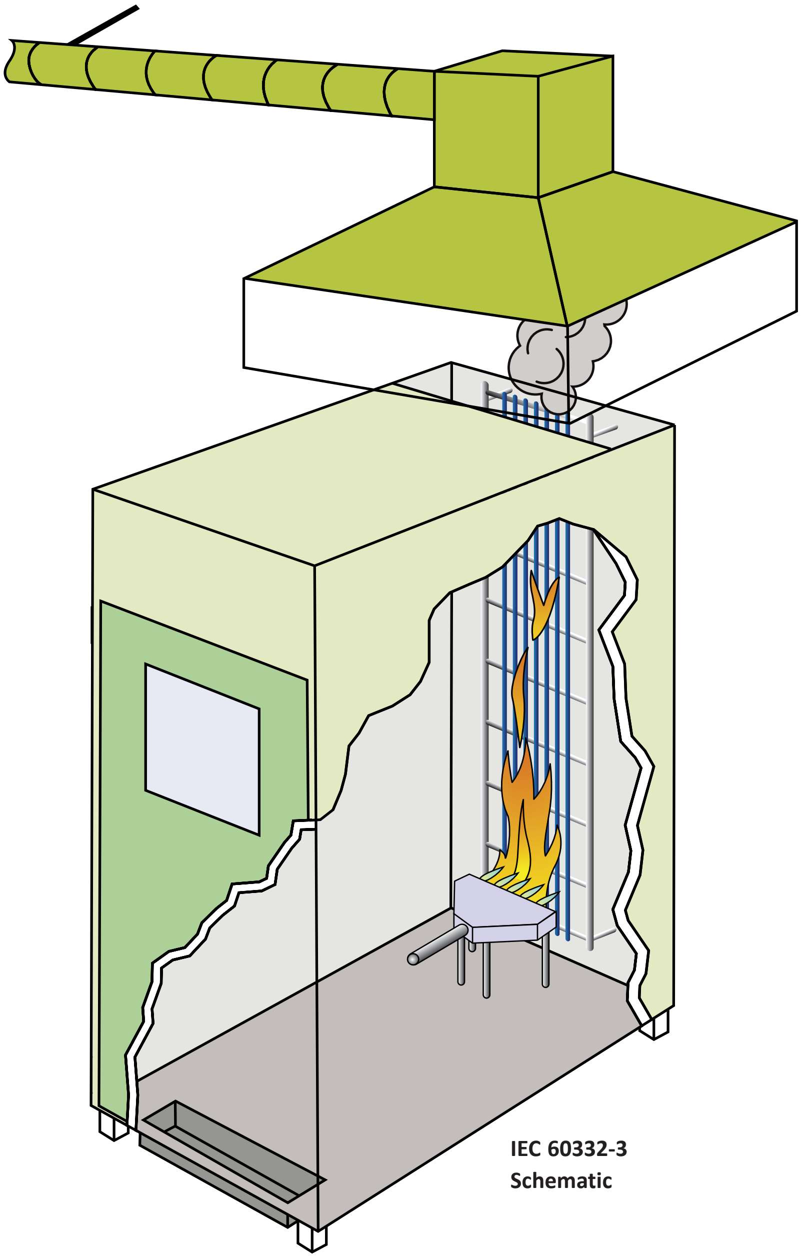
TECHNICAL SPECIFICATIONS	
Measuring Principle	**Paramagnetic oxygen analysis. Infrared carbon dioxide analysis.**
System Dimensions (mm) Trolley Frame Ducting	 1500 (W) × 1620 mm (D) × 2200mm (H) 1500(W) × 1700 mm (D) × 2500mm (H) 315 internal diameter (to length and specification as per Standard)
Gas flow rate (for burner)	647 mg/s and 2000 mg/s
Smoke detector	Silicon photodiode detector
Software	Windows based data acquisition and analysis

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

Common test methods for cables under fire conditions

(EN 50399; IEC 60332-3)

Heat release and smoke production measurement on cables during flame spread test. (Test apparatus also meets IEC 60332-3 series tests specification)



IEC 60332-3 Schematic

Construction Product Regulations

Traditionally electric cables have not been included or classified in national building regulations. The inclusion of electric cables within the Construction Products Regulations (CPR) changes this situation. Cables are to be tested using 5 test methods, and classified by the provisions of EN 13501-6 which is a parallel standard in the existing CPR classification standard EN 13501-1. EN 13501-6 covers electric cable requirements and defines all the test methods and performance criteria that must be met in order for a cable to meet a particular fire classification (A_{ca}, $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}).

According to EN 13501 Part 6: “Classification using data from reaction to fire tests on electric cables”, cables are tested using 5 test methods in which the EN 50399 is the major test protocol for Classes $B1_{ca}$, $B2_{ca}$, C_{ca} and D_{ca}. This test protocol was developed by SP (Sweden), ISSeP (Belgium), CESI (Italy) and Interscience (UK) with the help of **FTT** fire scientists, in an EU funded project called FIPEC, Fire Performance of Electric Cables. The FIPEC project included a study of cable installations and relevant reference scenarios as well as a comprehensive test program of different families of cables. This, together with subsequent industry test programmes, was used in the development of the proposal for the European testing and classification system. The classification utilises the results obtained from IEC 60332-3 test equipment fitted with heat and smoke release measurement instrumentation.

IEC 60332 Series Tests on electric and optical fibre cables under fire conditions

Parts 1 and 2 of IEC 60332 specify methods of test for flame spread characteristics for a single vertical insulated wire or cable. IEC 60332 Part 3 specifies methods of test for the assessment of vertical flame spread of vertically mounted wires or cables, electrical or optical.

Gas mass flow control, ignition and flame detection system mounted on the Gas Diverter plate (cover not shown)

Gas control box mounted on wall

FTT IEC 60332-3 Series Test Apparatus

The test rig comprises of a vertical test chamber of 1000mm (W) × 2000mm (D) × 4000mm (H); the floor of the chamber is raised above ground level. The test chamber is nominally airtight along its sides, air being supplied at the base of the test chamber through an aperture of 800mm × 400mm situated 150mm from the front wall of the test chamber.

The standard requires the air flow rate to be 5000 l/min, measured at the inlet before the test commences. This parameter can be regulated during the test.

An outlet of 300mm × 1000mm is at the rear edge of the top of the test chamber. The back and sides of the test chamber are thermally insulated to give a coefficient of heat transfer of approximately 0.7W/(m^2·K). The distance between the ladder and the rear wall of the chamber is 150mm and between the bottom rung of the ladder and the ground 400mm. Cables can be mounted on two types of ladder; a standard ladder of 500mm width and a wide ladder of 800mm width.

Side view of cable test chamber, hood and ducting

Front view of cable test chamber and hood

This apparatus also consists of all inlet air and exhaust ducting, gas supply and control system, and two 20.5kW propane burners as specified in the IEC 60332-3 standard.

EN 50399 Common test methods for cables under fire conditions – Heat release and smoke production measurement on cables during flame spread test

IEC 60332-3 apparatus can be modified to measure heat release and smoke production by fitting a small instrumented section of ducting into the exhaust system of the rig and using this with associated **FTT** gas analysis instrumentation and software and using a modified test protocol.

The standard specifies the cable mounting methods and both the air inlet duct design and air flow rates into the chamber. The combustion gases are collected in a hood above the test chamber and conveyed through an exhaust system which contains a duct section housing the sampling probes, thermocouples, mass flow probes and smoke measuring system. Test results are calculated from data on continuous measurement of the oxygen consumed and carbon dioxide generated in the combustion process using **FTT**'s data acquisition and analysis software.

The Heat Release and Smoke Production Measurement Apparatus includes:

1. Probe and Sensor Duct Section

A stainless steel duct section of approximate dimensions 0.4m diameter by 0.762m long fitted to an exhaust system. The duct will contain ports for:

- Sampling tube for flue gas extraction (for gas analysis)
- Smoke obscuration system
- Mass flow monitoring
- Thermocouple for measuring exhaust gas temperature

Duct section for EN 50399

19" Gas Analysis Rack

DIN 50055 white light system

By connecting this duct section to the gas analysis rack the client is able to make measurements on the effluent from the rig to determine oxygen consumption and carbon dioxide production in the exhaust duct to calculate heat release and smoke density in the exhaust duct with either the DIN 50055 white light system or laser smoke system.

2. Gas Analysis Instrumentation

Heat release measurement is obtained by sampling combustion products from the exhaust and computing heat release rates from the volume flow rates and the measured oxygen consumption and carbon dioxide generation in the The **FTT** Calorimeter Analyser is housed in a 19" rack that can be placed in the laboratory.

The **FTT** Calorimeter Analyser contains:

- **FTT** Calorimeter Analyser featuring Paramagnetic oxygen sensor with atmospheric pressure compensation and Infrared carbon dioxide sensor (0-10%). Carbon monoxide (0-1%) is optional.
- Developed and optimised specifically for the **FTT** calorimeters this analyser features flow control and bypass for fast response, low drift and noise and is compatible with small, medium and large calorimeters.

Flue gas conditioning train comprising:

- Soot filtration
- Refrigerant cold trap
- Drying columns
- Pump and waste regulators

Instrumentation for volume flow measurement:

- Bi-directional probe
- Differential pressure transducer

Clients already owning the **FTT** Dual Cone Calorimeter, ISO 9705 Room Corner Test or EN 13823 SBI Test can use their gas analysis instrumentation to measure heat release rate of the EN 50399 test. Alternatively the EN 50399 gas analysis instrumentation can be used with other **FTT** calorimeters (e.g. Dual Cone Calorimeter, ISO 9705, SBI, etc.).

3. Smoke Measurement Systems

FTT offers two smoke measurement system options, laser or white light systems. The laser system is similar to that used in the Cone Calorimeter and complies with that specified in ISO 5660. The white light system is similar to that used in the SBI test and constructed to DIN 50055.

- **Density Photometric System DIN 50055**
  A photometric system consisting of a white light source and lens, a silicon photodiode detector, along with housings and controls.

  The photodiode detector consists of an achromatic system of lenses, a silicon photo-electric cell and a high-gain low-noise amplifier. The latter is capable of measuring relative light intensity against time as percentage

Test chamber interior detail with propane burner

transmission continuously over the ranges to be studied. The system has a linear response with respect to transmission and an accuracy of better than ±1.5% of the maximum reading. The photodiode is housed in an assembly with a collimating lens, in a tube mounting on the side of the exhaust duct.

- **Laser Smoke System**
  As an alternative to the DIN 50055 system, a laser smoke system can be used.
  It features a 0.5mW Helium Neon laser smoke and support system, power supplies, calibration and zeroing device for smoke extinction coefficient. The detector output is designed with a Main and Compensating Detector to eliminate drift and is supplied with 0.3 and 0.8 neutral density filters for calibrating the unit. Calibration and calculation of the associated smoke obscuration parameters can be performed by **FTT** software.

4. Data Acquisition and Analysis Software

The signals are collected using a Data Acquisition Unit. A Windows based software package enables data acquisition and analysis to determine the various parameters needed for heat release determination.

5. Burner Gas Control Unit

The system supplied comprises of a gas flow control and ignition system for the burner. A spark igniter is provided and a type-K thermocouple monitors the presence of a flame. Two mass flow controllers (MFCs) control the propane gas and air flow and a Venturi air gas mixer.

Each MFC is housed on the 'Gas Diverter' plate fitted on the outside wall of the test chamber. This is normally protected behind a cover.

The Gas Control Box enables each gas to have 3 pre-set levels. After pre-setting, the burner output can be switched between these levels. It also houses the numerous power supply units for the MFCs and solenoid valves, the ignition system and controls for the safety features.

The signals from the MFCs are displayed on screen using **FTT** CableSoft software, which shows the mass flow rate of the respective gas and the corresponding heat output and facilitates any required adjustment. The mass flow rate of each gas is also stored by the software enabling heat release from the burner to be subtracted from the total measured heat release rate (of specimen and burner) so that the heat release rate from the specimen alone can be determined.

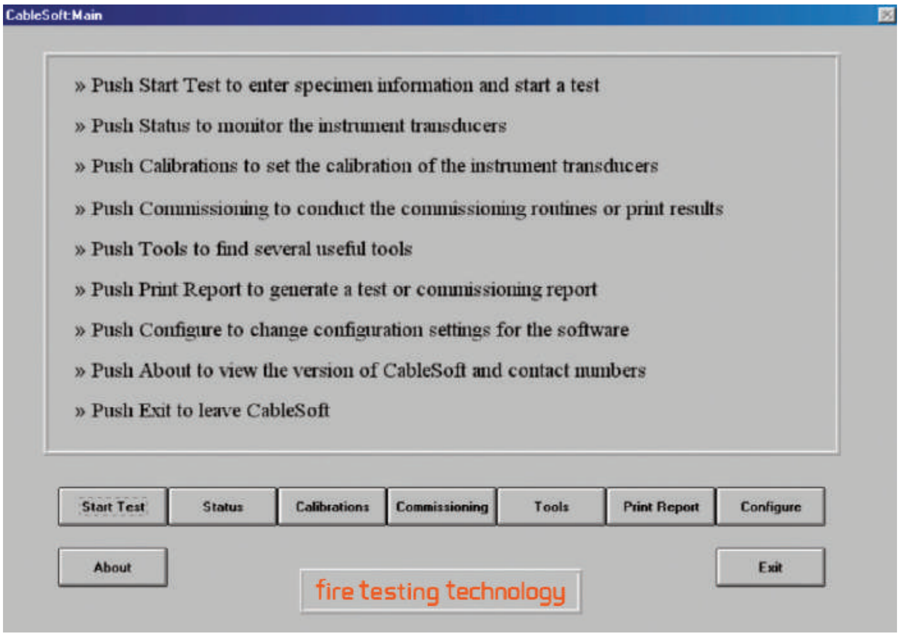
CableSoft Software

The **FTT** EN 50399 test apparatus uses sophisticated instrumentation and we supply the CableSoft software package to make the calibration and use of the instrument as easy as possible.

CableSoft is a powerful, yet easy to use, Microsoft Windows based application that allows the user to perform most operations required on the apparatus with a computer. It is based on push buttons and Windows data entry boxes and selectors and 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 required by the Standards

All the functions available in CableSoft can be accessed from the Main Menu which offers 7 options:



Main menu of CableSoft

- **Start Test**

This allows quick and easy setup of a test with the cable and ignition burner or a set of dummy tests which should be conducted every day to check the system is working correctly.

- **Status**

This displays the signals from all the transducers and shows the exhaust volume flow rate, inlet air volume flow rate, the heat release rate from the burner, the mean duct temperature and the extinction coefficient.

- **Calibrations**

This allows the user to calibrate the transducers in the system. These are oxygen, carbon dioxide and (if fitted) carbon monoxide cells, differential pressure transducer, smoke system (white light or laser) and the gas and air mass flow meters (if fitted). Each transducer should be calibrated to ensure the validity of the test results.

- **Commissioning**

A set of three commissioning routines are performed to determine the k_t constant used in the calculation of the exhaust volume flow rate before using the test apparatus and after any major changes. These three sets of commissioning routines are determining the flow profile, conducting propane burns at three different heat release levels, and a methanol pool burn. The commissioning results can also be viewed and reports printed.

- **Tools**

This gives access to the useful tools of Oxygen analyser drift calculator, Smoke system drift calculator, Commissioning kt calculator and Gas flow calculator.

- **Print Report**

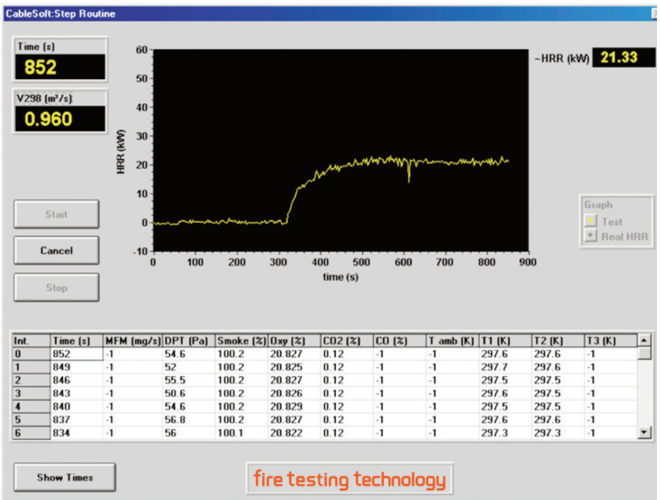
The results from a cable test, a daily check test or the three commissioning tests can be viewed and reports printed.

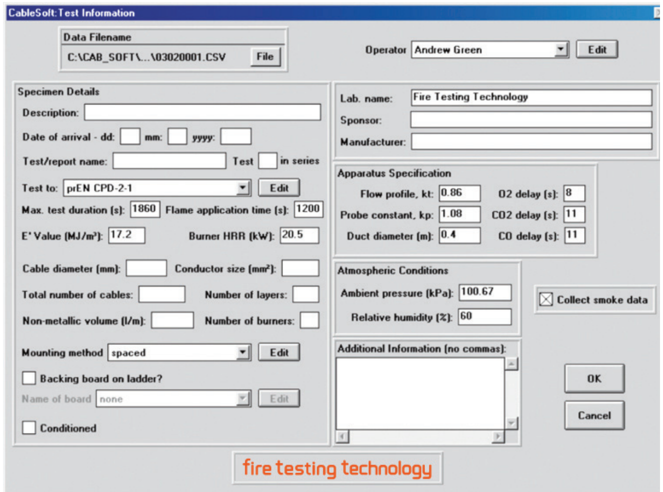
- **Configure**

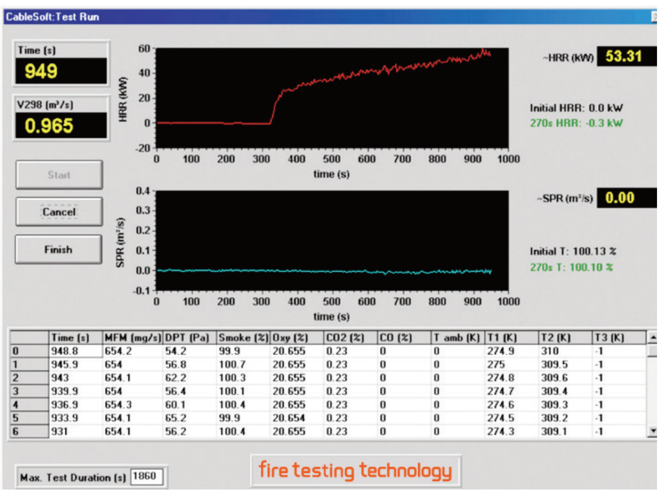
This allows settings for the software and system to be viewed and modified.

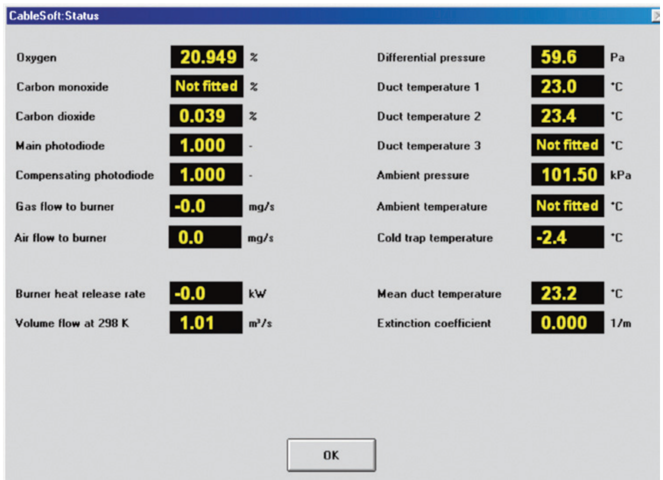
Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.









Technical Specification

IEC 60332-3/EN 50399 Burning Behaviour of Bunched Cable Test

Burners	
Burner	Two 10" ribbon burners • 20.5 kW • Spark ignition • Thermocouple and solenoid valve interlock system for gas safety
Propane Supply System	PLC gas control system
	Venturi mixer
	Mass flow controllers • Burner 1: 0.06-1.2 g/sec for propane • Burner 2: 0.035-0.7 g/sec for propane • Air: 0.21-4.2 g/sec for air

Enclosure and Air Supply	
Enclosure	Vertical test chamber 1000 mm W × 2000 mm D × 4000 mm H; the floor of the chamber is raised above ground level.
	Nominally airtight along its sides, air being admitted at the base of the test chamber through an aperture of 800 mm × 400 mm situated 150 mm from the front wall of the test chamber.
Air Supply	Single inlet centrifugal fan • 480 m^3/hr • Altivar 30 W inverter
Ladder Types	There are two types of ladder; a standard ladder of 500 mm width and a wide ladder of 800 mm width
Ladder Lifting	Electric winch (Max 500 kg) Pulley system

Control Unit	
Control Unit	Solid state gas control system with PLC control 5V PSU 4 process control meters to display process parameters 2 Type K temperature controllers for interlock and safety

Heat Release and Smoke Measurement (For EN 50399 only)	
FTT Calorimeter Analyser	Gas analyser • Paramagnetic oxygen sensor with flow control and by-pass for fast response and pressure compensation • Infrared carbon dioxide (0-10%) sensor with flow control and by-pass for fast response • Can also be supplied with infrared carbon monoxide (0-1%) sensor with flow control and by-pass for fast response
Gas Sampling	Double ended sample pump (diaphragm) • Max flow: 33.0 l/min • Pressure: 2.5 bar Soot filter • Primary: 93% efficiency at 0.01 µm • Secondary: 100% efficiency at 0.3µm Water removal • Chiller unit • Drying columns with desiccant Pressure controller relief valve • Relief pressure 0.07-0.7 bar
Probe and Sensor Duct Section	Stainless steel duct section of approximate dimensions 0.4 m diameter by 0.762 m length containing ports for: 1. Sampling tube for flue gas extraction (for gas analysis) 2. Smoke obscuration system 3. Volume flow monitoring 4. Thermocouple for measuring exhaust gas temperature 5. Thermocouple for measuring gas temperature at smoke measuring position
	By connecting this duct section to an FTT gas analysis rack the user is able to make measurements on the effluent from the rig to determine oxygen consumption and carbon dioxide production for calculating heat release and smoke density in the exhaust duct.
Data Acquisition	Signals are collected using a Keysight data acquisition/switch unit • 3-slot cardcage • Scan rates up to 250 channels/s are available with a 115 kbaud RS232 and PCI GPIB interface as standard

Heat Release and Smoke Measurement (For EN 50399 only)	
Smoke Density Photometric System DIN 50055	Light source • Gas filled tungsten filament lamp • Power provided and regulated by a triple output power supply with accuracy ±5% • Housed with an appropriate collimating lens to ensure parallel light projection across the duct, in one of the tube mounting sites on the side of the exhaust duct Photodetector • Achromatic system of lenses • Silicon photo-electric cell and a high-gain low-noise amplifier, which is capable of continuously measuring relative light intensity against time as percentage transmission over the ranges to be studied • Linear response with respect to transmission and an accuracy of better than ±1.5% of the maximum reading • Housed in an assembly with a collimating lens, in one of the tube mounting sites on the side of the exhaust duct • Power provided by a regulated triple output power supply with accuracy ±5% • Active area: 3.6 × 3.6 mm • Spectral response rate: 320 – 1100 nm Calibrated filters • 0.04 Neutral Density • 0.10 Neutral Density • 0.30 Neutral Density • 0.50 Neutral Density • 0.80 Neutral Density • 2.00 Neutral Density
Laser Smoke Measurement (Option)	Light source • 0.5 mW He Ne laser • 632.8 nm Photodetector • Silicon photodiodes Calibrated filters • 0.30 Neutral Density • 0.80 Neutral Density

SEVICES REQUIRED	
Extraction	Connected to the **FTT** electric cable fire test rig Continuous extraction of a volume flow of 0.50m³/sec to 2m³/sec
Electrical Power	230VAC 50/60 Hz 10A at the control panel
Air Supply	Pressure regulated clean, oil-free shop air at a maximum flow rate of 200 l/min Alternatively, a small compressor situated on the roof
Gas Supply	Commercial propane 95% minimum purity at a pressure between 3-4 bar

Due to **FTT**'s continuous development policy, technical changes could be made without prior notice.

Large Scale Oxygen Consumption Calorimetry

(ISO 9705; ISO 24473; EN 14390; ASTM D5424;
ASTM D5537; ASTM E603; ASTM E1537; ASTM E1590;
ASTM E1822; NFPA 265; UL 1685; UL 9540a;
NT FIRE 25; NT FIRE 32)

Gas Analysis Instrumentation Console

Among other options, **FTT** also offer burners constructed to ISO 9705 Annex A1 and A2 complete with gas train. A mass flow controller with digital display controls the gas flow.

The gas controls include an autoignition unit incorporating several safety features.

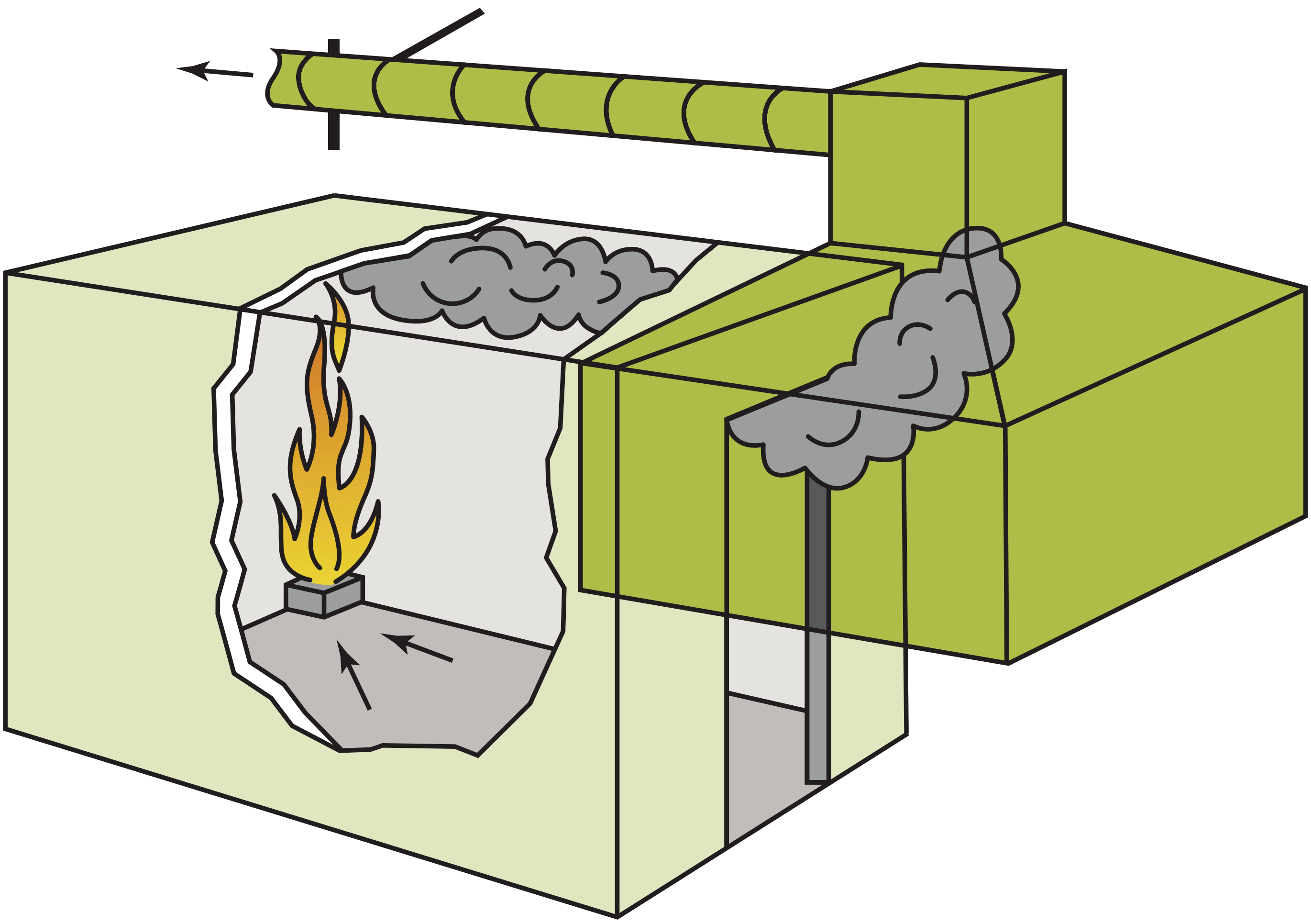
The method evaluates the fire characteristics of a surface product in a room fire scenario. The main field of application is for building products that, for some reason, cannot be tested in small scale, for example thermoplastic materials, joint systems and large irregular shaped materials. Other products can also be evaluated in the method, for example pipe insulation and upholstered furniture.

The Consumption Corner tests simulate a fire that starts under well-ventilated conditions, in a corner of a small consumption with a single open doorway. The method is intended to evaluate the contribution to fire growth provided by a surface product using a specified ignition source. The test provides data for a specified ignition source for the early stages of a fire from ignition up to flashover. The standards listed above require specific measurement techniques inside and outside the consumption.

FTT Room Corner Test

FTT supply the Room Corner test with the appropriate instrumentation depending on customer's requirements; a complete system and installation, an upgrade to existing facilities or just the gas analysis instrumentation console (**FTT** Calorimeter Analyser) and a duct section for those with a wish to build their own apparatus.

The **FTT** Calorimeter Analyser contains all the necessary instrumentation to measure heat release rate and other associated parameters. The **FTT** Calorimeter Analyser has been developed specifically for **FTT** Calorimeters; incorporating a high stability



On-site system in a fire research institute

temperature controlled paramagnetic oxygen sensor (optional CO/CO_2) with flow control and by-pass for fast response. The specification of this instrumentation is the same for both large and small scale calorimeters and can therefore also be conveniently used with the **FTT** Cone Calorimeter.

When used with the Cone Calorimeter the console is conveniently located with the Cone Calorimeter unit.

The Duct Insert contains probes for gas sampling and exhaust flow measurement along with smoke measurement equipment (white light or laser). Most dynamic fire testing apparatuses can be instrumented with this equipment to measure heat release and smoke production rates from products burnt in them.

Main Features

- Gas Analysis Instrumentation Console. For the measurement of:
  - Oxygen consumption
  - CO_2 production (optional)
  - CO production (optional extra)
  - Laser measuring circuitry for dynamic smoke measurement (optional extra)
  - Cooling column/cold trap for the removal of moisture
  - Moisture and CO_2 drier tubes
  - Vent valve to ensure correct gas pressure
- Duct insert for Room Corner test showing laser smoke unit and sampling ports. Fitted with:
  - Sampling probe for the oxygen consumption and CO/CO_2 gas train
  - Bi-directional probe for volume flow monitoring
  - 0.5 mW Helium-neon laser system with photometric detector, all in a rigid cradle with a retaining strip around the duct (optional) or White Light Smoke Measurement System (optional)
  - Flow thermocouple and smoke thermocouple
  - Soot filter for removal of fine particulate

19" Gas Analysis Rack

Duct insert

LSHRCalc Software

LSHRCalc is a Microsoft Windows based software package that enables automatic data collection and manipulation from the sophisticated data logger supplied with the Gas Analysis Instrumentation Console.
It automatically calculates the heat release rate and associated parameters generating a detailed report for the product(s) being tested.

The user friendly software interface allows the operator:
- To see the status of the instrument
- Calculate the required parameters
- Calibrate the instrument and store calibration results
- Collect and view data generated during a test
- Present the results in a manner approved by the Standards

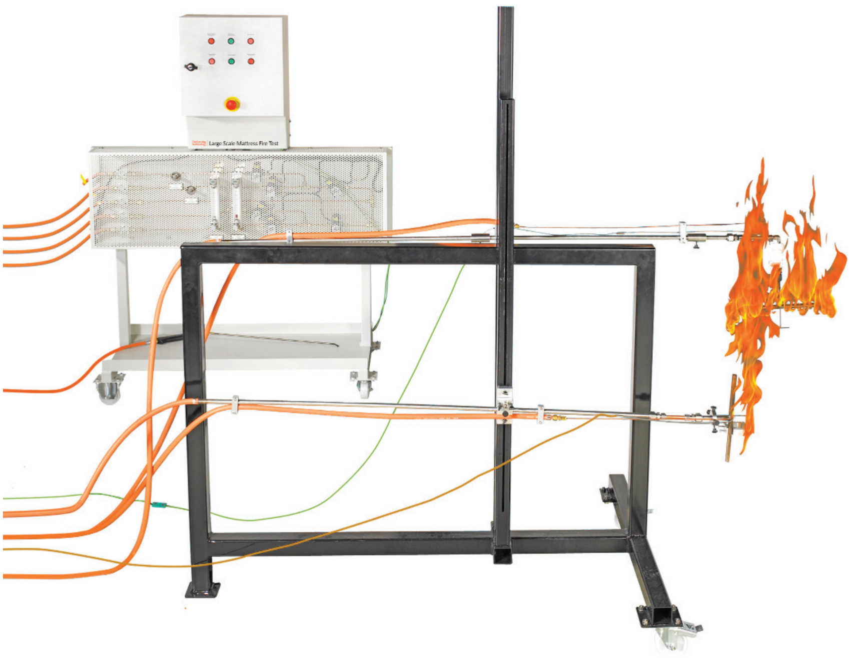
Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.

Options

- Laser smoke measurement system. A 0.5mW helium-neon laser system with twin photo detectors
- White light smoke measurement system. Tungsten filament lamp, lens and detector system
- Large scale mattress fire test CA TB 603/16 CFR Part 1633. This test method is a full scale flammability test which exposes a mattress specimen to a pair of T-shaped propane burners and allows it to burn for a specified period of time. The combination of burner stand-off distance and propane gas flow rate to the burners determines the heat flux they impose on the surface of the test specimen so that both of these parameters are tightly controlled. The heat release rate is measured by means of oxygen consumption calorimetry.

White light smoke measurement system



Mattress test CA TB 603.16 CFR Part 1633

Open Calorimeters up to 40MW

Testing principles from large scale calorimeters can be applied to open calorimeters for measuring fires up to 10, 20 or even 40MW, by increasing the hood size, exhaust diameter and exhaust flow rate, as explained in ISO 24473, Open Calorimetry – Measurement of the rate of production of heat and combustion products for fires up to 40MW.

The UL 9540a:2019 Battery Energy Storage System set of tests require heat release rate tests to be conducted at different large scales with systems up to 20MW. **FTT** can provide all of these scales of testing.

TECHNICAL SPECIFICATIONS	
Measuring principle	Measurement of fire characteristics of a surface product in a room fire scenario
Dimensions of gas analysis console	600mm (W) × 600mm (D) × 1800mm (H)
Sampling probe	Cylindrical with a series of holes along its length. 10 mm external diameter stainless steel.
Burners	Twin sandbox (main and auxiliary) includes automatic safety cut-off solenoid valve
Cooling column	Operating temperature 0 to 4°C
Sample pump	Double ended Teflon coated diaphragm pump; capacity 30ℓ/min
Exhaust system	Stainless steel – (a minimum distance of 3500mm from exhaust hood to measurement system is required). Exhaust hood dimensions as per customer requirements
Duct insert	Stainless steel – 400mm/16 inches diameter (customer to specify), 762mm long. Custom inserts available on request.
Particle filter	Eliminates all particles > 0.3µm.
Oxygen Analyser (**FTT** Calorimeter Analyser)	0-25% for O_2 0-10% for CO_2 (option) 0-1% for CO (option)
Laser smoke measurement system (option)	0.5mW He-Ne laser system
White light smoke measurement system (option)	Tungsten filament lamp; colour temperature 2900 ± 100K
Mattress test (option)	T-shaped propane burners with flow control Portable burner frame Burner wand assembly

Due to **FTT**'s continuous development policy specifications could change without prior notice.

SERVICES	
Electrical power	220/240VAC 8A, 50Hz or 110/120VAC 16A, 60Hz (specify at the time of order)
Extraction	A fan rating of at least 12000m³/hr is recommended
Gases	• Oxygen-free nitrogen is required for calibration of the oxygen analyser and for leak testing purposes. Commercial propane minimum 95% purity is required for the gas burner calibration • Span gas
A collection vessel is required for cold trap condensation	

OSU Rate of Heat Release Apparatus

(FAR 25.853 (a-1); ASTM E906)

FAR 25.853 (a-1):
FAA Fire Test Handbook – Chapter 5

ASTM E906:
Configuration A Standard Test Method for Heat Release Rate for Materials and Products

The OSU Rate of Heat Release Apparatus is used to expose aircraft interior cabin materials to an incident radiant heat flux of 35kW/m^2. This will determine if the material complies with FAR 25.853 [a-1] requirements.

FTT OSU incorporates comprehensive safety features and is fully equipped to provide reliable test data for both FAA and ASTM tests. The apparatus, built in accordance with Chapter 5 of the FAA Fire Test Handbook, is provided in four parts: test chamber, control unit, air distribution system and data acquisition and analysis system.

The heat release is measured by the temperature difference between the air entering and leaving the environment chamber by a thermopile with five hot and five cold Type K junctions.

OSU Main Unit

Test Chamber
Stainless steel insulated test chamber, with gasketed door and viewing window. The Test Chamber consists of:

- Four silicon carbide elements Type LL 508mm by 16mm with nominal resistance 1.4 Ohms as a heat source with corrosion-resistant stainless steel housing.
- A reflector made from stainless steel is situated behind the elements.
- In front of the elements, a truncated diamond-shaped mask, constructed of stainless steel, this provides uniform heat flux density over the area occupied by the 151 × 151mm vertical sample.
- Dual 110VAC transformers at 5.5kVA are provided for separate control of the upper and lower element pairs.
- Wand Assembly for lighting the upper pilot and calibration burners.
- Dual globar power controllers for ease of heat flux uniformity adjustment.
- Upper pilot and lower pilot (with spark ignition) and calibration methane gas burners.
- Thermopile for heat release rate measurement, with five hot thermocouple junctions in the chimney and five cold thermocouple junctions in the air chamber.

Air Distribution System
The air entering the apparatus is controlled to 21-24°C (70-75°F) and set at approximately 0.04m^3/s (85ft^3/min) using an orifice meter.

- The orifice meter comprises of a squared-edged, circular plate orifice, 0.024 inch (0.5mm) thick, and is located in a circular pipe with a nominal diameter of 1.5 inch (38mm). There are two pressure measuring points located 1.5 inch (38mm) upstream and 0.75 inch (19mm) downstream of the orifice and connected to a mercury manometer. (Mercury not supplied)
- The air entering the environmental chamber is distributed by an aluminium plate which has eight holes, and mounted at the base of the environmental chamber. A second plate having 120 evenly spaced holes is mounted 152mm above the aluminium plate.

- The air supply manifold at the base of the pyramidal chimney section has 48 evenly spaced holes, resulting in an airflow of approximately three to one within the apparatus.

Specimen Holder and Drip Pan

- Two specimen holders are provided with each OSU.
- Each specimen holder and the drip pan are fabricated from stainless steel.
- Each holder has two studs top and bottom which allows two wires to be attached vertically in front of the holder to secure the face of the specimen.

Control Unit

Stand-alone Control Unit housed in 19" Rack, with flow control for both burners

Calibration Flow Rate Control

- This is only used when a Calibration is required.
- There are 5 latching push-button switches which allow accurate control of calibration gas flow rates.
- Under each flow control switch is a 10 turn potentiometer for fine adjustment of the calibration gas flow rates.

Lower Burner Ignition

- Lower burner ignition button allows the gas to the lower and upper burners to flow.
- In the event of a power failure the solenoid will automatically stop the flow of gas and hence extinguish any burner flames.
- Five On/Off ball valves for controlling the Lower and Upper pilot burners and Calibration.
- Four flow meters are fitted with needle valve adjustment for controlling the lower and upper pilot burner's gas and air mixtures.

Calibration Heat Flux Meter

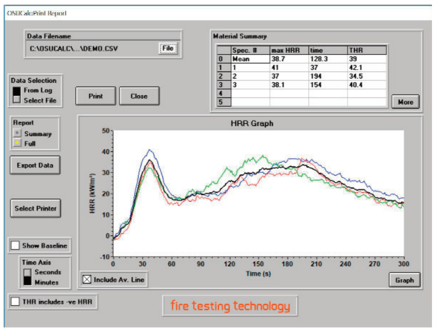
Two water-cooled, heat flux sensors are supplied to measure the heat flux density at the centre and each corner.

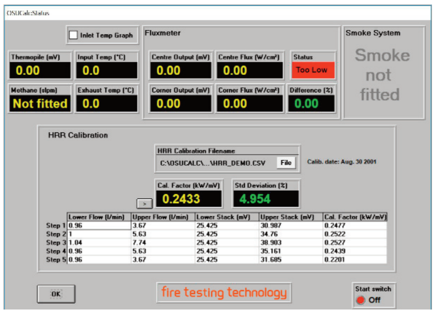
Software

FTT offer a data acquisition and analysis stand-alone software package for the OSU that can be used either with our instrumentation or with existing equipment.

The OSU Apparatus is a sophisticated instrument, designed to make the calibration and use of the instrument user-friendly. The OSUCalc software package acquires test data, assists with calibration routines and automatically generates test reports.

Instrument supplied with software at no extra charge. Software updates provided free of charge.





The software interfaces with the OSU apparatus via a data logger system, into which all the required signals are connected

The user interface is a Microsoft Windows based system with push button actions and standard Windows data entry fields, drop down selectors, check boxes and switches.

The Software has the following features:

1. View of Transducer Signals
2. Heat Release Rate Calibration
3. Automatic File Naming
4. Data Collection
5. Data Presentation.

TECHNICAL SPECIFICATIONS	
Measuring principle	Exposure of materials to incident radiant heat flux
Main body dimensions	1500mm (L) × 1200mm (D) × 2260mm (H)
Main body weight	250kg
Control rack dimensions	600mm (L) × 600mm (D) × 1700mm (H)
Control rack weight	40kg

SERVICES	
Extraction	The exhaust stack 133mm by 70mm in cross section and 254mm tall is fabricated from stainless steel and mounted on the outlet of the pyramidal section. Inside the exhaust stack is a baffle, this is perpendicular to the airflow, 76mm above the base of the stack. An exhaust hood system with the following criteria is required: • Recommended hood size 60cm wide × 150cm long. • The bottom of hood should be 15-20cm above the apparatus exhaust stack. • Adjustable to produce a maximum volume 70m^3/min (2470 CFM) • Pressure 1.4mmHg
Power	230VAC 50A 50Hz for the OSU Main Unit 230VAC 8A 50Hz for the Control Unit 400VAC 3Ph 16A 50Hz + Neutral 3.5kW for Air Handling Unit
Gas	Bottled Methane is required, at a pressure of approximately 250mBar (4 psi)
Air supply	For OSU: 4 psi, flow rate of 0.04m^3/s at 21-24°C For Control Unit: Filtered compressed air to rack, at a pressure of approximately 20psi
Water	200-300 ml/min water flow through the system at room temperature, i.e. 15-30°C (To cool heat flux meter assembly)
Mercury	100ml for the manometer

Fire Propagation Apparatus

(ASTM E2058; FM 4910; ISO 12136)

The **FTT** FPA can be used to determine:

- Critical heat flux for ignition
- Thermal response parameter
- Effective heat of combustion
- Chemical and convective heat release rates
- Fire Propagation Index

It can also be instrumented to measure:

- Average Corrosion Index
- Smoke yield

ASTM E2058 FM 4910

FTT manufactures the FM Global Fire Propagation Apparatus (FPA), a heat release calorimeter.

Instrument features:

- **Infrared Heaters:** Four heaters each supplied with six 500W lamps and associated water and air cooling connectors, controlled by a single phase power controller to provide heat flux up to 65 kW/m^2.
- **Mass Loss Measurement:** A 0-2000 g load cell, with an accuracy of 0.1g.
- **Air Distribution Chamber and Air Supply Pipes:** Quartz Cylinder and Water Cooled Shield: Two quartz cylinders fitted above the aluminium cylinder, allow supply of oxidant to the specimen flame, while enabling radiant energy from the Infrared heating system to reach the specimen surface. A water-cooled shield protects the specimen from the heat from the Infrared heaters prior to testing.
- **Ignition Pilot Tube:** A pilot ignition tube, with a 4-hole ceramic insert.
- **Exhaust System:** Intake funnel, mixing duct, and test section.
- **Gas Sampling:** Sampling probe, filters, traps, and flow control.
- **Oxygen, Carbon Dioxide and Carbon Monoxide Analysis:** Inlet concentration of oxygen and exhaust concentrations of oxygen, carbon dioxide and carbon monoxide are measured.
- **Heat Flux Meter:** For calibration of the Infrared heating system.
- **Instrument Frame:** Developed for 19" rack mounting.

Windows based software

A Windows based software package enables simple data acquisition, analysis and storage via a 22-bit data logger.

All parameters are displayed. The versatile data logger may be used in other applications and is supplied with software that allows the data stored in the logger to be downloaded to a PC for further analysis.

Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.

Services required

Prior to operating the Fire Propagation Apparatus, the following services must be provided for the laboratory:

a) **Fire Products Extraction:** a collection hood system is required above the FPA exhaust stack. The blower of the collection hood system shall have the flow capacity in excess of 300 ℓ/s (0.3 m^3/s) (635 cfm) of the FPA.

b) **Electrical Power:** 277 VAC, 50/60 Hz, single phase – single hot leg from 480 VAC referenced to ground – 2 AWG wire and 125/160 ampere fuse disconnect or circuit breaker for the IR heaters and power controller.

c) **Water Supply:** pressure regulated clean water (on line filter should be used) with a flow rate of 2.0 ℓ/min allowing each IR heater to receive at least

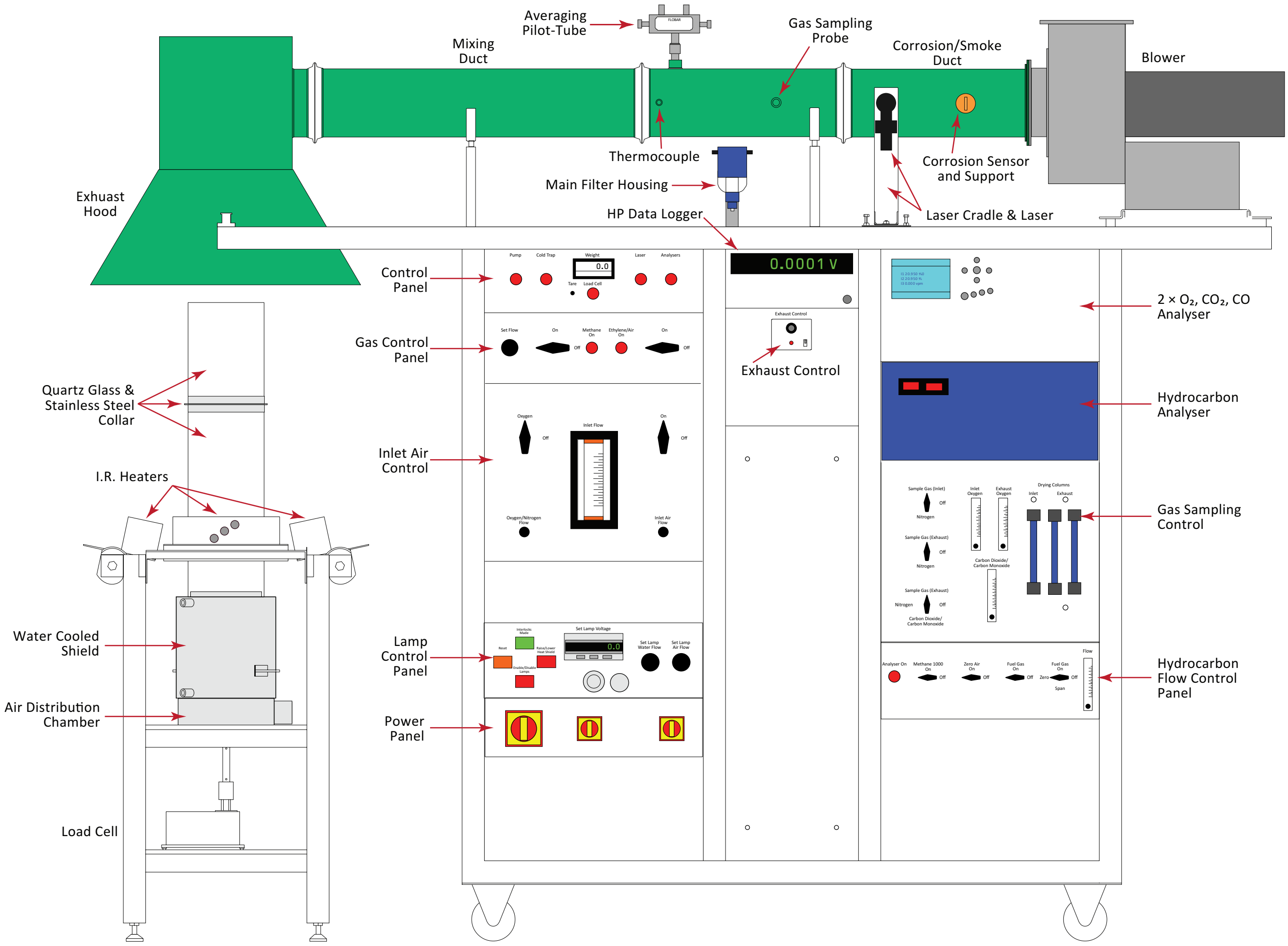
0.34 ℓ/min at 50 psi. The inlet temperature shall not exceed 70°F (22°C). A supply is also necessary for the water-cooled sample shield, which should prevent a temperature increase of the shield in the up-position of more than 4-5°C. For safety reasons, no quick disconnects shall be used on water lines.

d) **Air Supply** – Pressure regulated clean, oil free air (a desiccant dryer should be used to verify this) at a flow rate of 1.5m^3/min allowing each IR heater to receive at least 0.3 m^3/min.

e) **Drain:** a drain is required to handle the water being provided for the IR heaters and water-cooled sample shield (a close-loop system is also an option).

f) **Calibration Gases** Primary standard grade 'span gases' and grade 5 N_2 for 'zero gas' for CO_2, CO analyzers; Ethylene gas and compressed air for pilot flame. Typical span gases required:
2300 ppm CO_2 balance N_2;
400 ppm CO balance N_2;
21% O_2 balance N_2.

Schematic Diagram



NBS Smoke Density Chamber

(ASTM E662; BS 6401; NFPA 258)

And options for:
(ISO 5659; ABD0031 (ATS 1000.001); NES 711)

ASTM E662:
Standard test method for specific optical density of smoke generated by solid materials

BS 6401:
Method for measurement, in the laboratory, of the specific optical density of smoke generated by materials

NFPA 258:
Recommended practice for determining smoke generation of solid materials

And options for:
ISO 5659:
Plastics Smoke generation. Determination of optical density by a single chamber test

IMO FTP Part 2:
Smoke and toxicity test

ABD0031 (ATS 1000.001):
for smoke emission for non-metallic components

NES 711:
Determination of smoke index

The NBS Smoke Density Chamber is widely used in all industrial sectors for the determination of smoke generated by solid materials and assemblies mounted in the vertical orientation within a closed chamber.

It measures the specific optical density of smoke generated by materials when an essentially flat specimen, up to 25 mm thick, is exposed to a radiant heat source of 25kW/m^2, in a closed chamber, with or without the use of a pilot flame. The radiant heat source can be easily replaced with the Conical Radiant Furnace for testing of specimens in the horizontal orientation according to ISO 5659 and IMO FTP Part 2 requirements.

Features of the FTT NBS Smoke Density Chamber (SDC)

- Test chamber with full width opening door, allowing easy access for sample loading and chamber cleaning.
- Photomultiplier control unit with manual zero and span controls designed to be used with the **FTT** software to perform automatic control of the test procedure on the SDC.
- Controls are mounted beside the chamber for convenient operation. They are not obstructed when the door is open.
- Three term temperature controller for radiant heat source with digital display.
- Chamber walls are pre-heated for easier start-up and convenient equipment operation.
- Safety blowout panel, easily replaceable, allows for safe operation of test method.
- Gas measurement ports are available, for optional measurements of toxic gases.
- Cabinet designed with a standard 19" rack, for simple addition of gas analysers, chart recorder and other control units.
- Air cooled radiometer for furnace flux calibration.

The **FTT** SDC has been designed specifically to incorporate the ISO 5659 Conical Radiant Furnace. This extends the potential of the SDC by allowing testing at heat fluxes up to 50 kW/m^2, horizontal orientation of the specimen and the measurement of mass loss rate of the specimen. It takes approximately 15 minutes to change from ASTM E662 to the ISO 5659 configuration and the equipment conforms to the recent IMO test protocols.

Software

The **FTT** SDC is supplied with a software package called SDCSoft, which was designed as a data acquisition and presentation package allowing either manual or automatic control. This enables a more efficient use of the instrument, leading to larger daily throughput of testing and enhanced quality graphical data presentation. ‘SDCSoft’ is a Microsoft Windows based package which collects test data and assists with all calibration routines. It can be used for several applications including standardised testing to ASTM E662, ISO 5659 and BS 6401 etc.

Instrument supplied with software at no extra charge. Software updates provided free of charge.

SDCSoft enables:

Calibration of the photomultiplier amplifier: Full scale and zero transmission values are calibrated into the software. All recorded and displayed transmission values are corrected, in real time, by the software for calibration, whatever the amplifier range setting.

Automatic file naming: SDCSoft will save the data to a file name automatically generated from the date and test number. This is to prevent any valuable data being overwritten. Alternatively the user can manually enter a file name.

Data collection:

The start of an experiment is initiated by the activation of a foot-switch or the push of a button on the computer screen. Information about the test and the sample is entered prior to the run. This is stored to disk, together with the numerical data generated during the test. Data is collected and stored at user defined intervals. The intervals can be defined over a range from 1 to 60 seconds. Real time data is displayed on the VDU during the course of a test. The information is displayed in graphical and textual form.

The graphical form is an auto-scaling graph with time on the x-axis and transmission (%) and specific optical density on two y-axes.

Textual data includes:

- Instantaneous transmission (%) and specific optical density (D_S)
- Time from start of test
- Maximum D_S and time to maximum D_S
- Current range setting and filter position
- Mass (ISO 5659)
- Prompts (visual and audio) when the range setting or filter position requires changing when operating in manual mode. When operating under software control the range setting is automatically changed.

The experimental data stored during a run includes:

- Time (seconds), *t*
- Transmission (%) at time *t*
- Specific optical density at time *t*
- Range and filter positions at time *t*
- Mass (g) at time *t* (ISO 5659)

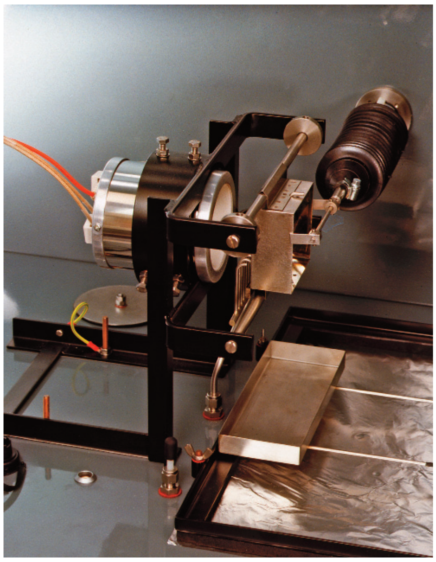
On completion of the test, the clear beam transmission is recorded to correct the data for deposits on the optical system. A report including a graph and table of specific optical density (D_S) against time is produced. The report can be printed on any device with a Windows driver.

Options

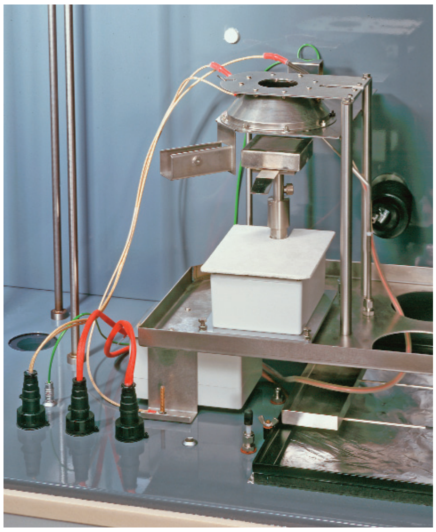
AITM 3.0005 – Airbus ABD 0031:

The ABD0031 (formerly ATS 1000.001) option is a gas sampling system which includes a vacuum chamber, vacuum pump, hand metering pump and gas analysis detection tubes.

Provision is made for gaseous/volatile test products to be drawn through three ports on the top of the chamber at any time for subsequent analysis. One of these ports is used to connect to the ABD0031 vacuum box.



ASTM E662



ISO 5659/IMO

FTIR EN 45545-2 and ISO 19702:

The **FTT** FTIR system can be used with the SDC or other instruments to measure the concentration of toxic species in accordance with these standards to aid in providing data for use in combustion toxicity assessment.

Heated Line:

FTT also offers a heated gas sampling system. The system includes a heated filter, 2m heated line and 2 × temperature controllers.

NES 711:

The NES 711 attachment comprises a spark ignition burner and stirrer fan. The **FTT** SDCSoft software is compatible with this option.

ABD0031 Vacuum Box

TECHNICAL SPECIFICATIONS	
Measuring principle	Specific optical density – white light source and photomultiplier tube
Light source	6.5 V 2.75 A tungsten filament lamp
Operating heat flux of radiant heat furnace	25 ± 0.5 kW/m^2 (standard furnace) up to 50 kW/m^2 for ISO 5659/IMO fire model
Dimensions (mm)	1900 (H) × 1630 (L) × 660 (D)
Internal dimensions of chamber (mm)	914 (H) × 914 (L) × 610 (D)

SERVICES	
Power Supply	110/230 VAC - 50/60 Hz - 16 A
Extraction system	Flow rate of at least 50ℓ/s
Gas supply	Propane at 1 bar (14.5psi) Filtered compressed air at 2 bar
Water (ISO 5659 only)	Flow rate of 200-300ml/min
Mass Balance	Accurate to 0.5%

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

The 3 Metre Cube

(IEC 61034; BS 6853; BS 6724; BS 7622)

FTT 3M Cube comprises:

- 3 Metre Cube assembly
- Photometric system, stands, fans and sample mounting frames
- Extraction fan and ducting
- Windows Software.

The 3 Metre Cube is used for measuring smoke emission when electric cables are burned under defined conditions, for example, when several cables are burned horizontally. The tests are carried out in a cubic enclosure, a photometric system is used to measure increase in smoke density.

This unit was developed by London Transport scientists in England and is designed to replicate the fire conditions found in enclosed spaces (such as an underground tunnel).

These units are produced to meet the specification used in many electric cable tests including IEC 61034. It permits the comparison between the standard absorbance of airborne particulates evolved under the specified conditions of each test method. The variables include thermal characteristics, form, dimensions and positions of the test piece.

The unit can be supplied in a self-assembly kit form or can be fully installed by **FTT** Engineers. The unit is made of steel sheet panels and can be supplied with customised extraction facilities and all instrumentation, fans, stands and sample mounting frames. The photometric system has a horizontal optical path of 3 m between two opposite faces of the cube and the attenuation of light transmitted through the chamber is measured during the test.

Features and Benefits

The enclosure is constructed from Zintec sheet steel of 0.8 mm thickness fixed to a steel framework. A door with a window enabling observation is placed at the front of the cube, with sealing at all appropriate joints.

Sealed windows (100mm × 100mm) are provided in the two laterally opposed faces for the transmission of light from the horizontal photometric system (source and receiver). The centres of these windows are situated at a height of 2.15m.

The photocell receiver is mounted at one end of a 150 ± 10mm tube with a dust protection window at the other end.The inside of the tube is matt black to minimise reflections. The signal from the photocell is proportional to the transmission of light and is recorded continuously during the test, using a chart recorder or data acquisition system.

The walls of the cube at floor level have orifices for atmospheric pressure equalisation. In order to avoid stratification of smoke, homogenisation is achieved by a fan placed on the floor inside the cube which blows horizontally throughout the test.

The method was developed for electric cables, but can be adapted also to materials, equipment and components.

Detail of door with viewing panel and control box at the front of the cube

Detail of light source and detector at opposing apertures

3M Cube Software (CubeCalc)

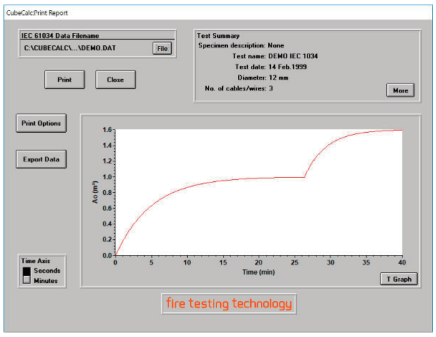
A Microsoft Windows based user-friendly software interfaces with the 3 Metre Cube Chamber via a multi-channel A/D board. One channel monitors the transmission output from the photocell via an interface box.

The Software has the following features:

- Calibration of the Photometric System
- Specimen Information such as:
  - laboratory name
  - specimen description, diameter and number of cables tested
  - test name
  - data file name
  - time interval for processed data
  - conditioning environment
- Test Run: Data is collected and displayed during the course of the test. The information is displayed in both graphical and textural form.
- The following experimental data is processed after the test:
  - time, *t*
  - transmission at *t*
  - absorbance at *t*
- A test report can be produced and printed after a test.

Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.



Smoke Production

TECHNICAL SPECIFICATIONS	
Measuring principle	Comparative measurement of airborne particle absorbance using photometric detection
Chamber	• Volume 27m³ • Galvanised Steel Sheet • Supplied in a self-assembly kit form
Chamber Dimensions	3m (W) × 3m (D) × 3m (H)
Photometric System	The photometric system comprises of a light source and a photocell placed horizontally in the mid vertical plane of the cube at a height of 2.15 ± 0.10 m Optical path – 3.00 ± 0.03m
Photometric System – Light Source	A halogen lamp with a tungsten filament and a clear quartz bulb with the following characteristics: • Power: 100W • Stabilised Voltage: 12V • Luminous Flux: 2000 lumens • Colour Temperature: 3000K It is supplied with a stabilised voltage adjusted to 12.00 ± 0.01V.
Photometric System – Receiver	Selenium type with an S4 spectral response or similar.
Fire Source – Alcohol Tray	Galvanised sheet metal with joined edges, pyramidal trunk of rectangular section.
Interior dimensions:	• Bottom Base: 210mm × 110mm • Top Base: 240mm × 140mm • Height: 80mm 1.00 ± 0.01dm³ of 95% alcohol. Protected from the fan by a sheet metal screen of 1.5m × 1.0m, curved along its length and put on the floor.
Fan	Flow rate 10 to 15m³/min, and a blade diameter of 300 ± 30mm.
Stands and Specimen Supports	Vertical supports with horizontal brackets.
Extraction System	Ducting leading from high in the cube fitted with a valve to seal the opening during a test.

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

SERVICES	
Electrical power	220-240VAC 50/60 Hz
Extraction	An extraction duct and fan motor assembly is supplied for connection to a 140mm diameter extraction outlet
Environment	In order to obtain the best possible repeatability it is recommended that the air surrounding the outside of the cube should be still and of a temperature of 20 ± 5°C. The chamber should be located away from direct sunlight and not subject to climate variations.

Density of Smoke from the Burning or Decomposition of Plastics

(ASTM D2843)

This reaction to fire test method covers a laboratory procedure for measuring and observing the relative amounts of smoke obscuration produced by the burning or decomposition of plastics. It is intended to be used for measuring the smoke-producing characteristics of plastics under controlled conditions of combustion or decomposition. The measurements are made in terms of the loss of light transmission through a collected volume of smoke produced under controlled, standardised conditions. This test is used by model code organisations in controlling the use of plastic materials in light transmitting applications. It can be used as an alternative to the ASTM E84 smoke measurement because this test method can readily be performed on thermoplastic materials that may drip and fall out of the E84 test apparatus. Other smoke test apparatus, for example, ASTM E1354 Cone Calorimeter, E662 Smoke Density Chamber, etc. are also available from **FTT**.

FTT ASTM D2843 Exit Sign Test Apparatus

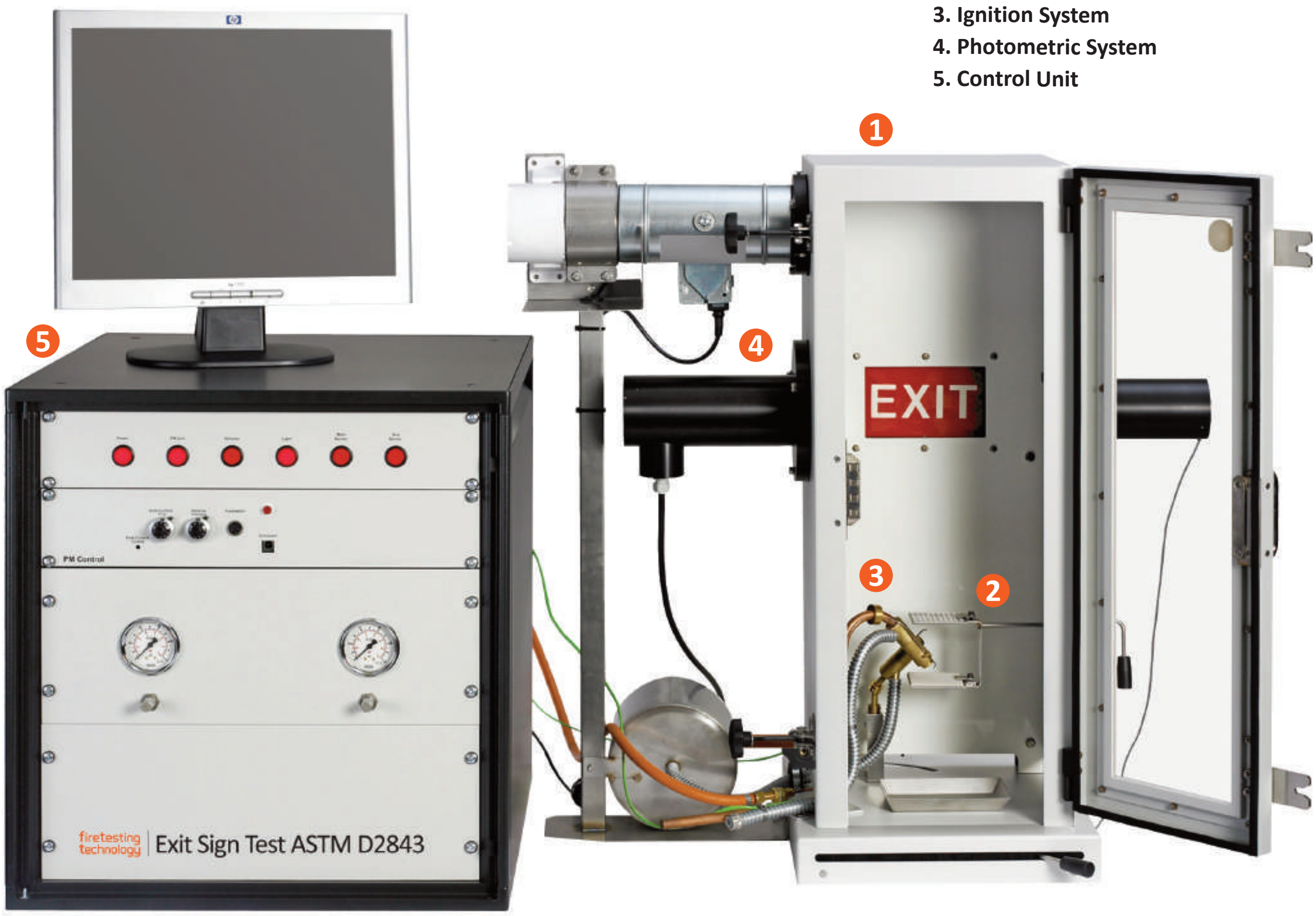
The **FTT** Exit Sign Test is designed for the measurement and observation of the smoke-producing characteristics of plastics under controlled conditions of combustion or decomposition according to ASTM D2843-10 but not to be used for measuring any other characteristics of the plastic combustion.

The apparatus consists of:

- Combustion Chamber
- Specimen Holder
- Ignition System
- Photometric System
- Control Unit (incl. Smoke Meter)

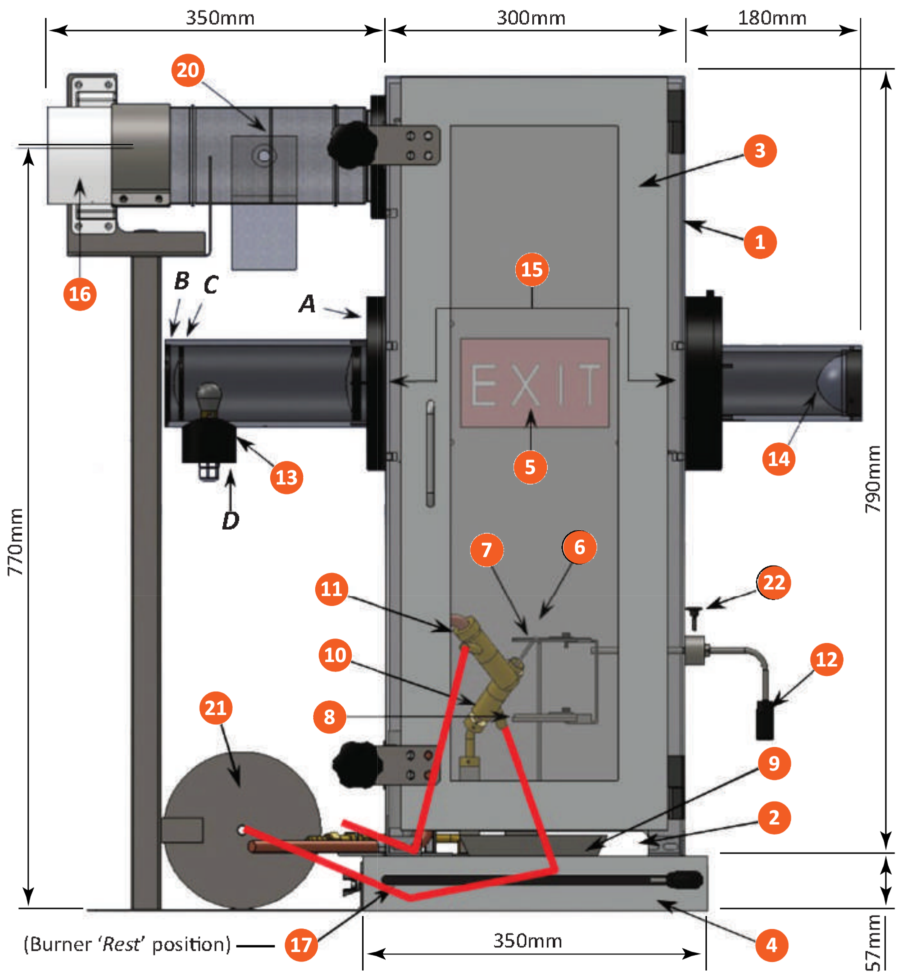
The test specimen is exposed to flame for the duration of the test, and the smoke is substantially trapped in the chamber in which combustion occurs. A 25mm × 25mm x 6mm (1" × 1" × ¼") specimen is placed on a supporting metal screen and burned in the test chamber under active flame conditions using a propane burner operating at a pressure of 276 kPa (40 psi). The 300mm × 300mm × 790mm (12" × 12" × 31") test chamber is instrumented with a light source, photoelectric cell, and

1. Combustion Chamber
2. Specimen Holder
3. Ignition System
4. Photometric System
5. Control Unit

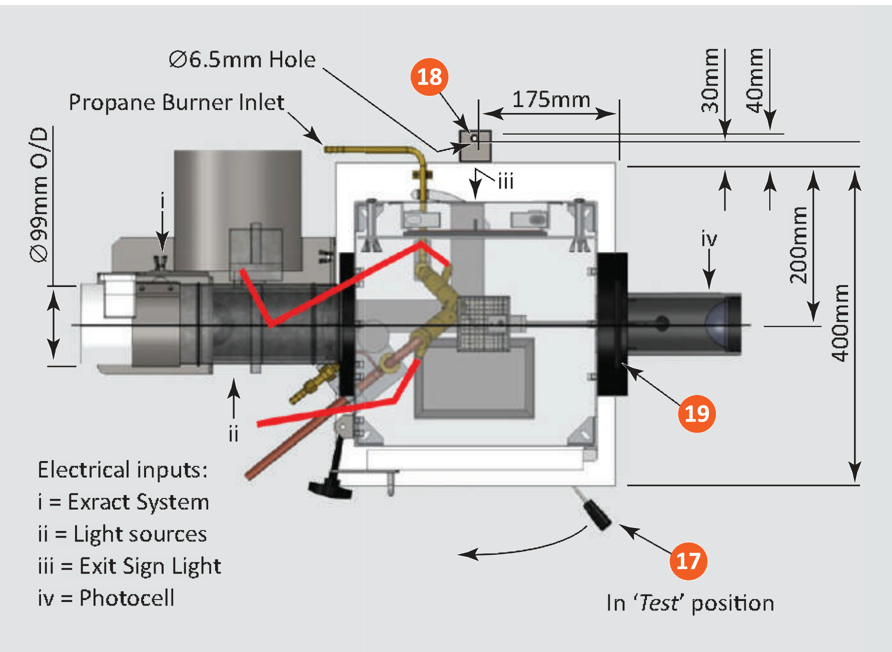


Front View (partial section)

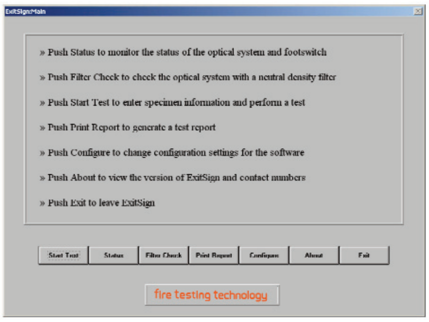
— Air supply flexi-hose to burner (not drawn)

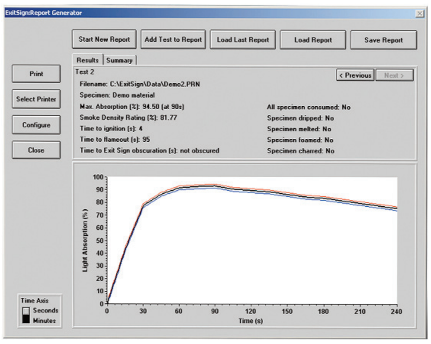


Top View (partial section)



1. **Combustion Chamber: 300mm × 300mm × 790mm**
2. **Chamber Ventilation Slots (all 4 sides)**
3. **Heat Resistant Glazed Door**
4. **Base: 350mm × 400mm × 57mm**
5. **White on Red Illuminated Exit Sign: 90mm × 150mm**
6. **Test Specimen: 25.4mm × 25.4mm × 6.2mm (not shown)**
7. **Specimen Holder: 64mm² of 6mm × 6mm, 0.9mm gauge**
8. **Calcium-silicate Sheet or Collector Tray**
9. **Quench Pan (filled with water when in use)**
10. **Main Burner: Propane (operating at 276kPa (40psi))**
11. **Aux Burner: Propane (operating at 138kPa (20psi))**
12. **Sample Adjusting Handle**
13. **Light Source**
14. **Light Receiver**
15. **Heat Resistant Glazed Windows for Light Beam 2 × Ø70mm (int.)**
16. **Extraction Fan: 1700ℓ/min**
17. **Main Burner Adjustment Handle**
18. **Anti-tilt Bracket**
19. **Filter Assembly**
20. **Butterfly Valve**
21. **Air Flow Device**
22. **Specimen Holder Clamp Screw (used only with the aux. burner)**





horizontally across the 300mm (12") light beam path. The chamber is closed during the 4 minute test period except for the 25mm (1") high ventilation openings around the bottom of the chamber.

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 and are plotted versus time. Two indexes, the maximum smoke produced and the smoke-density rating, are used to rate the material. A heat resisting glass door is fitted to allow observation of the test whilst it is in progress.

ExitSign Software

FTT Exit Sign Test Apparatus is a sophisticated instrument and in order to make the calibration and use of the instrument extremely easy, the ExitSign software package is specially designed to complement the instrument. ExitSign is a Microsoft Windows based application which assists with calibration routines, acquires test data and produces test reports.

The Main panel is used to access all the functions available in ExitSign software:

- Start Test
- Status
- Filter Check
- Print Report
- Configure
- About
- Exit

Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.

TECHNICAL SPECIFICATIONS	
Test Chamber	
Overview	Bench mounted draft free painted aluminium chamber with large lift-off door with window made from toughened glass giving a generous view of the specimen during a test. Mounted on a 360mm × 400mm × 57mm base.
Electrical power	96-264V 50/60Hz 1A
Internal dimensions (m)	0.3 (L) × 0.3 (D) × 0.79 (H)
Voltage	96-264V 50/60Hz 1A
Exhaust	In-Line axial industrial extraction fan with over temperature/current protection. Low noise plastic frame and plastic impeller. Outer diameter of exhaust fan: 104mm.
Exhaust flow rate (l/min)	1700
Interior light	2 × 6W fluorescent lights, 240V 50/60Hz, 3400 K

Burner, Gas Control System	
Burners	A burner in compliance with ASTM D 2843 with a 0.13mm diameter orifice Auxiliary burner with a 1100g weight constructed from stainless steel to prevent movement of the burner during testing.
Burner positioning system	Quick burner positioning system controlled via handle on the front of the chamber Air supply device 160mm diameter stainless steel duct providing air to main burner
Gas type and pressure	Commercial grade 85.0% minimum propane pressure regulated @ 40 psi for the main burner and @ 20 psi for the auxiliary burner Pressure displayed by two independent 63mm diameter bourdon tube gauges on front panel
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 – Input voltage 85-265V 47-63Hz – Cooling convection cooling – Operating ambient temperature -10-70°C – Over voltage protection – Over current protection
Flash back arrestor	Safety precaution fitted on both burners
Photometric system	Optical system positioned on the right houses a selenium cell. The light source houses a 1493 compact filament microscope lamp running between 5.3V DC and 6.3V DC which is situated on the left hand side of the chamber. The signal is monitored and processed via a Smoke Meter in the control unit.

Smoke Production

SPECIMEN HOLDERS AND SUPPORT	
Specimen Holder (× 4)	64mm × 64mm stainless steel square of 6mm × 6mm, 0.9mm gauge wire
Quench Pan (× 1)	Stainless steel 150mm × 100mm × 20mm
Particles Boards (× 4)	¼" Thick x 64mm x 64mm square calcium silicate
Stainless Steel Collector Tray (× 1)	2½" × 2½" × 3/8" deep with ½" square bottom

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

Smoke Density Photometric System

(DIN 50055)

The **FTT** 'Smoke Density Photometric System' (DIN 50055) is designed to be used in conjunction with equipment that measures smoke from burning materials. The unit can be fitted to several instruments such as the Room Corner test, (ISO 9705), Single Burning Item (SBI) (EN 13823), Heat Release and Smoke Production Apparatus for IEC 60332 Part 3 (EN 50339), Steiner Tunnel (ASTM E84) or Flooring Radiant Panel (EN 9239-1) etc.

The apparatus consists of:

- Light Source
- Light Measuring System
- Control Unit

The Light Source is a gas filled tungsten filament lamp. Power for the lamp is provided by a regulated power supply housed in the Control Unit.

The Light-Measuring Device consists of:

- Achromatic system of lenses
- Silicon photo-electric cell
- High gain low noise amplifier

These components are housed in an assembly with a collimating lens.

The signal from the Light-Measuring Device is taken to the Control Unit, which is capable of continuously measuring relative light intensity against time as percentage transmission over the ranges to be studied.

The system has a linear response with respect to transmittance and an accuracy of better than ±1.5% of the maximum reading. The Control Unit also regulates the damping of the amplifier so that the response times required to achieve 95% accuracy (t_{95}) correspond to the specifications given in the standard.

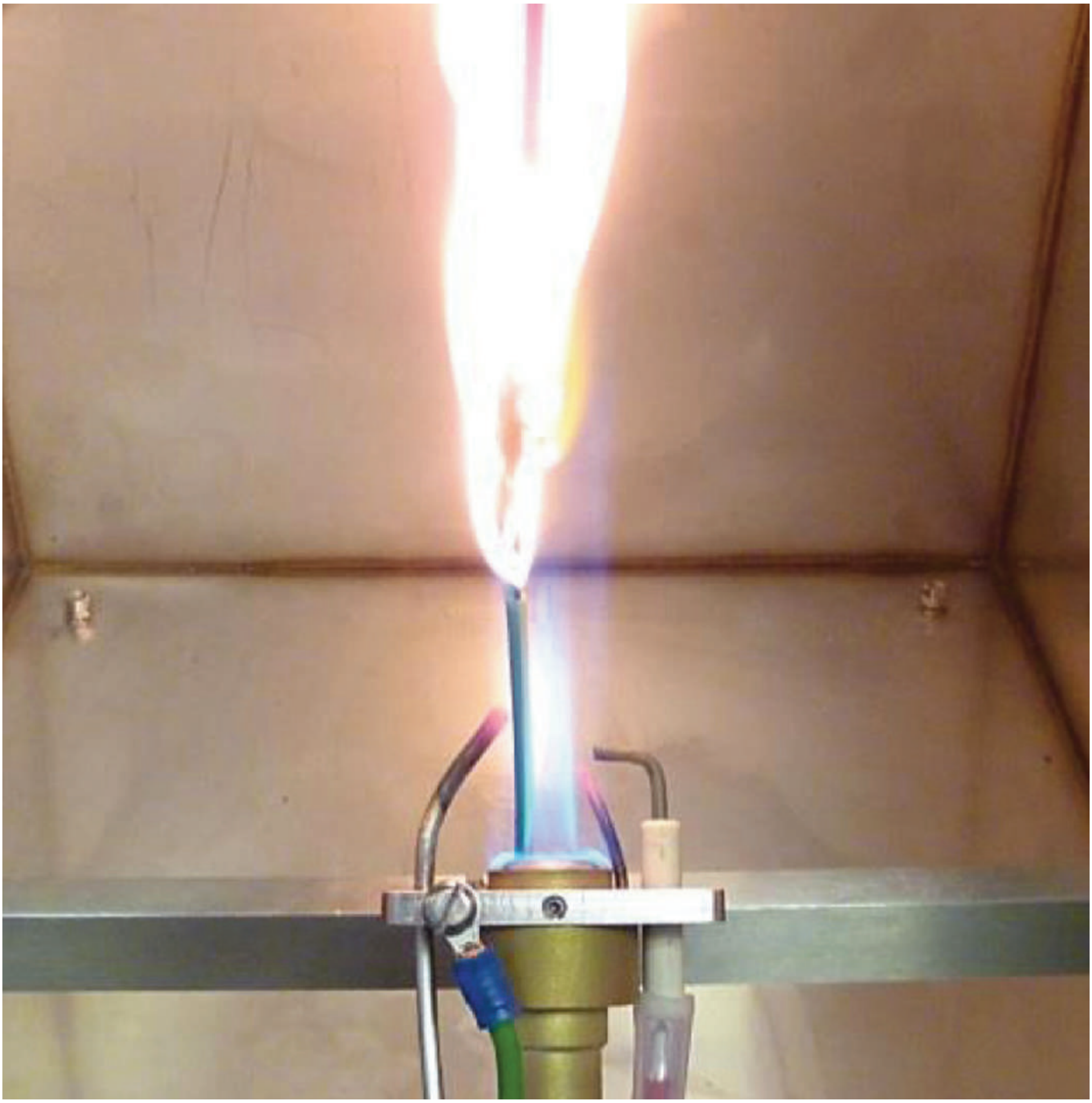
An analogue output on the control unit of 0-1V = 100% transmission is available to be taken to a data acquisition unit. A Windows based software package is also available to enable simple data acquisition, analysis and storage via a data logger. All parameters are displayed. The versatile data logger may be used in other applications and is supplied with software that allows the data stored in the logger to be downloaded to a PC for further analysis.

Smoke Density Photometric System

SBI Smoke Measuring System

Vertical Flame Propagation for a Single Insulated Wire or Cable Test

(IEC 60332-1)



IEC 60332-1:
Tests on electric and optical fibre cables under fire conditions

IEC 60332-1 specifies the procedure for testing the resistance to vertical flame propagation for a single vertical electrical insulated conductor or cable, or optical fibre cable, under fire conditions.
Part 1-2 specifies the use of a 1 kW pre-mixed flame and the test evaluates the flame spread of a cable under exposure to a small flame. This test is relevant for the classes $B1_{ca}$, $B2_{ca}$, C_{ca}, D_{ca} and E_{ca}.

FTT IEC 60332-1 Vertical Flame Propagation Test Apparatus

The **FTT** IEC 60332-1 tests for the vertical flame propagation of a single insulated wire or cable is a bench scale test to determine the resistance of a single cable to a 1kW flame application.

The apparatus is supplied as a complete system incorporating all the features necessary for ease of use and safety. It conforms IEC 60332-1-2 (test for flame propagation) and IEC 60332-1-3 (test for flaming droplets).

This equipment uses a 1 kW pre-mixed flame propane burner and is for general use, except that it may not be suitable for the testing of small single insulated conductors, cables of less than 0.5 mm^2 total cross-section or small optical fibre cables. In these cases, the procedure given in IEC 60332-2-2 is recommended.

The apparatus features include:
- Bench Mounted Open Test Screen
- Horizontal Specimen Supports
- Ignition Burner compliant with IEC 60695-11-2, with simple angle adjustment from 90° to 45° and a gas safety system
- Electronic Spark Ignition
- Control Unit with Safety Interlocks and Gas and Air Flow Adjustment
- Diverter Panel with Gas and Air Mass Flow Controllers for accurate and stable flow when a flame is detected.

TECHNICAL SPECIFICATIONS	
Test Screen	
Material	Stainless steel
Internal dimensions (m)	0.3 (W) × 0.45 (D) × 1.2 (H)
Features	Open front and closed top and bottom Horizontal specimen supports

Burner, Gas Control System	
Burner	1 kW pre-mixed burner in compliance with IEC 60695-11-2
Burner positioning	Adjustable from 90° to 45°
Gas type	Technical grade propane 95% minimum purity
Flash back arrestor	Safety precaution fitted on burner
Control unit dimensions (m)	0.4 (W) × 0.24 (D) × 0.4 (H)
Diverter panel dimensions (m)	1.2 (W) × 0.17 (D) × 0.5 (H)

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

SERVICES	
Gas supply	Propane of 95% minimum purity at a pressure between 1-1.5 bar and flow rate up to 1 l/min
Air supply	Pressure regulated clean, oil-free shop air at a pressure between 1-2 bar and flow rate up to 15 l/min
Extraction	Draught-free environment; laboratory fume hood or chamber of a minimum inside volume of $1.0m^3$
Power	230 VAC 50/60 Hz 13A for powering gas control unit and diverter assembly

LIFT, IMO Spread of Flame Apparatus

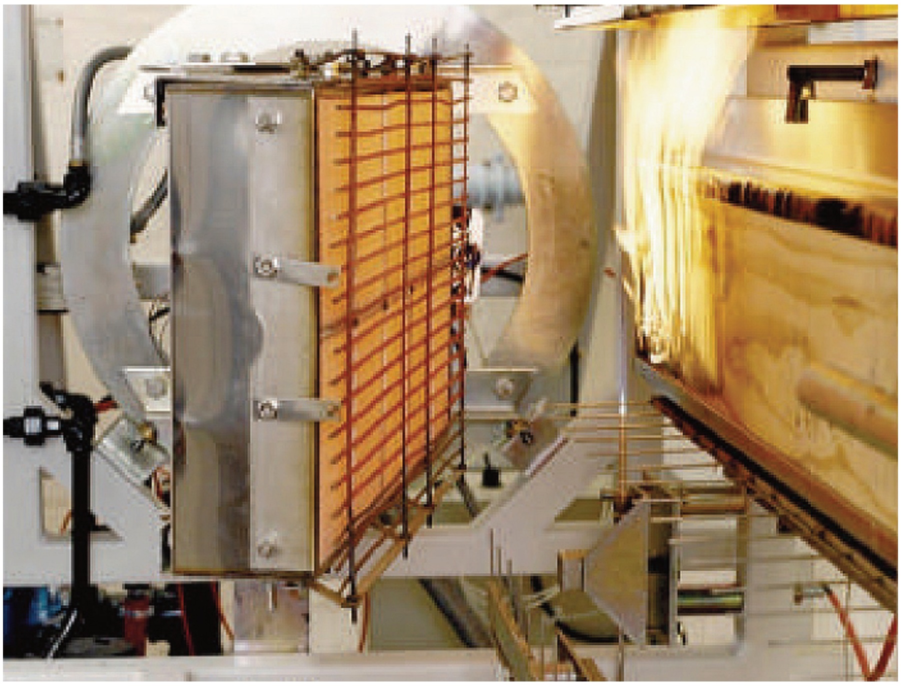
(ISO 5658-2; IMO FTP Part 5; ASTM E1317; ASTM E1321)

The Spread of Flame Apparatus is an important test for comparing the performance of essentially flat materials, composites or assemblies, which are used primarily as the exposed surfaces of walls. Comparative test data is generated from measurement of the lateral spread of flame along the surface of a specimen of a product vertically orientated. The specimen is subject to radiated heat in the presence of a pilot flame.

ISO 5658-2 and ASTM E1321 allow wider use of the test beyond marine applications. The major differences between ISO 5658-2 and the IMO test are that ISO 5658-2 is limited in scope to testing the spread of flame over vertical specimens and does not include the stack for estimating heat release rate.

The **FTT** Spread of Flame Apparatus uses a gas-fired radiant heat panel with pilot flame ignition to ignite a test specimen. Following ignition, any flame front which develops is noted and a record is made of the progression of the flame front horizontally along the length of the specimen in terms of the time it takes to travel to various distances. The results are expressed in terms of the flame spread distance/time history, the critical heat flux at extinguishment, the average heat for sustained burning and the flame front speed.

To meet the IMO specification a stack is fitted complete with thermopile for estimating heat release rate. The **FTT** Spread of Flame Apparatus is supplied with all necessary controls, flux meter and specimen holder. The complete test apparatus consists essentially of three main components, a radiant panel support framework and a specimen support framework which are linked together to bring the test specimen into the required configuration in relation to the radiant panel, and the specimen holder, which carries the test specimen. The radiant heater system is fully automatic, with spark ignition and safety interlocks.



Panel box assembly with reverberatory screen as mounted in equipment test frame.

The IMO software

The **FTT** Spread of Flame Apparatus is a sophisticated instrument, designed to make the calibration and use of the instrument very user-friendly. The IMOSoft software package acquires test data, assists with calibration routines and automatically generates test reports.

The software interfaces with the IMO apparatus via a multi-channel A/D converter, into which all the required signals are connected. This interface unit connects to the computer via a USB cable.

The user interface is a Microsoft Windows based system with push button actions and standard Windows data entry fields, drop down selectors, check boxes and switches.

The Software has the following features:

1. View of Transducer Signals
2. Heat Release Rate Calibration
3. Automatic File Naming
4. Data Collection
5. Data Presentation

Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.

Features and Benefits

- The control panel is located on the radiant panel frame. This incorporates all of the electrical indicators and controls for daily use and connections for the computer.

- Fitted to the rear of the radiant panel is a type-K thermocouple which monitors the temperature of the assembly. Should a blowback occur in the chamber of the radiant panel, the temperature rise will be sensed by the thermocouple and will cut-out the gas supply to the unit.
- The mass flow meter is used during calibration of the stack for heat release rate measurements. This can be connected to the computer if supplied or a chart recorder.
- The On/Off Controls for the Sample Pilot Flame, Radiant Panel and Air Blower are located along the lower edge of the radiant panel frame.
- User friendly IMOSoft software package acquires test data, assists with calibration routines and automatically generates test reports. It allows for a more efficient use of the instrument, leading to a larger daily throughput of testing and enhanced quality data presentation.

TECHNICAL SPECIFICATIONS	
Measuring principle	Measurement of flame spread over a vertically orientated material subject to uniform radiant heat flux Measurement of heat release rate using a calibrated thermopile system
Calibration burner	The output from the mass flow meter is calibrated for 0-5V = 0-25slpm of methane gas
Software	IMOSoft, Windows PC
Flux meter	Schmidt-Boelter heat flux meter for measuring the flux profile along the specimen
Dimensions	1600mm (W) × 900mm (D) × 1650mm (H excluding chimney) A minimum ceiling height of 2400mm is required to accommodate chimney and extraction hood
A minimum floor space of 4m × 2m is required to allow for removal of calibration burner	

Due to **FTT**'s continuous development policy specifications could change without prior notice.

SERVICES	
Extraction	A ceiling mounted fume exhaust system with a capacity of at least $0.5m^3/s$
Power	230 VAC at 50/60 Hz 10 Amp
Gas	Radiant Panel requires Propane or Methane at least 4 Bar and a flow rate of up to 0.6g/s Pilot Flame Acetylene gas at least 0.5 ℓ/min at 1 bar (24.5 psi) Calibration Burner Methane gas of at least 95% purity with a maximum flow of 25ℓ/min at a maximum pressure of 30 psi. (IMO Only) Not supplied with ISO 5658-2
Air	For the radiant panel an air flow up to 11g/s at 100psi is required
Water	200-300 ml/min water flow through the heat flux meter at room temperature, i.e. 15-30°C

Flooring Radiant Panel

(EN ISO 9239-1)

EN ISO 9239-1:
Reaction to fire tests for building products – Horizontal surface spread of flame for floor coverings

ASTM E970:
Standard test method for critical radiant flux of exposed attic floor insulation using a radiant heat energy source

NFPA 253:
Standard method of test for critical radiant flux of floor covering systems using a radiant heat energy source

Reaction to fire test requirements for flooring products

The European Construction Products Regulation requires that all European Member states use this test method as part of the requirements needed to evaluate reaction to fire performance for all flooring products. This test method will eventually take precedence over national regulatory methods to classify most flooring products and will be required by all suppliers of flooring materials into the EU and neighbouring states adopting these regulations. The instrument also fulfils the equivalent test requirements of ASTM E648, ASTM E970 and NFPA 253 standards in the USA.

The flooring radiant panel (FRP) test

This flooring radiant panel is used to measure the critical radiant flux of horizontally mounted floor covering systems exposed to a flaming ignition source in a graded radiant heat environment. It can also be used to measure this same critical radiant flux for exposed attic floor cellulose insulation.

The FTT FRP Apparatus

The radiant heat is applied by means of a gas-fuelled panel, inclined at 30°, and directed at a horizontally mounted floor covering system specimen.

The radiant panel generates a radiant energy flux distribution ranging from a nominal maximum of 10.9 kW/m^2 to a minimum of 1.0 kW/m^2.

A small stainless steel pilot burner aids in specimen ignition.

The distance burned until flame-out is reached is converted, by calibration, into an equivalent critical radiant flux, in kW/m^2.

A smoke measuring system is mounted on a separate frame at the exhaust stack.

Main Features

- Attached Control Rack for convenience in use, allowing observation of the apparatus during equipment set-up and calibration.
- Automatic ignition of the radiant panel and safety cut-out.
- Data Analysis and Acquisition Software.
- Hinged access to test area, via a 2 position door with observation window and sliding platform.
- Stainless steel hood with smoke measurement ports.

Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.

TECHNICAL SPECIFICATIONS	
Measuring Principle	Surface spread of flame on flooring material exposed to radiant heat source
Heat Flux Range	1.0 kW/m^2-10.9 kW/m^2
Specimen Dimensions	1050mm (L) × 230mm (W)
Instrument Dimensions (approximate)	1900mm (W) × 750mm (D) × 1900mm (H)

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

SERVICES	
Test Room	The FRP apparatus should be situated in a draught free environment at 23 ± 5°C and a relative humidity of 50 ± 20%.
Electrical Supply	230 VAC 50/60Hz, 12 Amps
Hood	The apparatus should be situated under a suitable extraction system.
Gas	Propane at a pressure of 2 bar with a calorific value of approximately 83MJ/m^3 is required for the radiant panel and the pilot burner. Compressed air at a pressure of 6-7 bar is required for the radiant panel.
Water	Water at 15-25°C is required for cooling the total heat flux meter.

Radiant Panel Flame Spread Apparatus

(ASTM E162; ASTM D3675)

ASTM E162, ASTM D3675: Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source

The Radiant Panel Flame Spread Apparatus measures the surface flammability of building products (ASTM E162) and cellular plastics (ASTM D3675) by using a gas-fired radiant heat panel. It is intended to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and the results of this test may be used as elements of a fire risk assessment that takes into account all of the factors that are pertinent to an assessment of the fire hazard of a particular end use. An index, Is, is determined from the flame spread and heat evolution factors. This radiant panel index is a required parameter in various specifications, especially for the mass transit industry (buses and trains).

The test is made on specimens of small size that are representatives, to the extent possible, of the material or assembly being evaluated. The rate at which flames will travel along surfaces depends upon the physical and thermal properties of the material, its method of mounting and orientation, the type and level of fire or heat exposure, the availability of air, and properties of the surrounding enclosure.

Summary of Test Method

This test method of measuring surface flammability of materials employs a radiant heat source consisting of a 12" × 18" (300 × 460mm) panel in front of which an inclined 6" × 18" (150 × 460mm) specimen of the material is placed. The orientation of the specimen is such that ignition is forced near its upper edge and the flame front progresses downward.

A factor derived from the rate of progress of the flame front and another relating to the rate of heat liberation by the material under test is combined to provide a flame spread index.

The flame spread index, I_s, of a specimen as the product of the flame spread factor, F_s, and the heat evolution factor, Q, as follows: $I_s = F_s Q$

FTT E162 Test Apparatus

The **FTT** Radiant Panel Flame Spread apparatus is supplied as a complete easy-to-use system.

Features include:

- Porous cement and cast iron gas operated radiant panel (12" × 18") with electric spark igniter and automatic safety flame out detector.
- Stainless steel specimen holder, with observation marks every 75mm (3") for assessing the progress of the flame front.
- Stainless steel specimen support.
- Stainless steel pilot burner assembly.
- Pyrometer to determine the surface temperature of the radiant panel, including mounting bracket.
- Air flow meter and gas control valve to control the mixture to the radiant panel.
- Stainless steel exhaust stack with a removable panel to enable easy cleaning of thermocouples.

- The stack is provided with 8 thermocouples as required by the standards.
- Calibration burner with methane gas flow meter.
- Safety gas controls and cut off circuitry.
- 1Data logger and analysis software 162Soft.

162Soft Data Analysis Software

This test apparatus is complemented with the 162Soft software package to make the calibration and use of the instrument extremely easy.

162Soft is a Windows based software which enables simple data acquisition, analysis and storage via a 22-bit data logger. All parameters are displayed. The software interface can be retrofitted to any existing ASTM E162 apparatus. The versatile data logger may be used in other applications and is supplied with software that allows the data stored in the logger to be downloaded to a PC for further analysis.

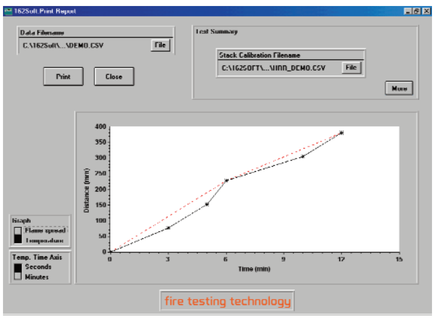
The Status Panel displays the signals from all the transducers (the eight thermocouples in the stack and the pyrometer) on the left to indicate when the stack temperature and pyrometer meet the test criteria. On the right of the Status Panel is a stack calibration graph and the value of as used in the calculation of the heat evolution factor which is equal to Heat Release Rate recorded for a change in temperature of 100°C. The calibration and test routines are very easy to conduct by following the option menu on the 162Soft software.

Result processing is very simple by using the available curve fit feature. The temperature rise Vs time graph can be displayed and printed. The calibration data used for processing the results can be changed and recalculated after the test run. Report can be generated and printed by one push of a button on the Print Report Panel.

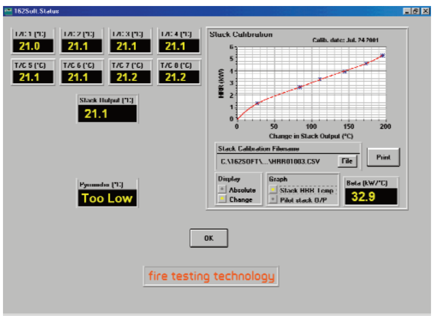
Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.

Radiant Panel, Specimen Holder and Exhaust Stack



Print Report



Status Panel

Gas Panel, Control Box and Data Logger

TECHNICAL SPECIFICATION	
ASTM E162 Test Chamber	
Overview	Test frame consisting of steel frame and outer panels which hold the control panel and stack assembly
External dimensions	1.2m (L) × 0.6m (D) × 1.9m (H)
Exhaust	Made from 1mm 304 stainless steel 8 type k thermocouples of equal resistance, supported with insulators End formed to 0.020" (0.5mm) Diameter Easy clean hatch
Exhaust flow rate	30-85m^3/min
Voltage	240VAC, 50/60Hz, 13A

Burner, Gas Control System	
Burner	In compliance with ASTM E162 and ASTM D3675 manufactured from a porous refractory material
Burner dimensions	12 × 18" (300 × 450mm) mounted in a metal frame
Pyrometer	Calibration pyrometer for confirmation of radiant panel output, meter 310°C, 600°C, 880°C, with 4m cable Measurement range: +300°C - +900°C Response time: ≤2ms for T>+600°C Analogue output: 4-20mA Rugged stainless steel housing Digital signal processing Precision lens non-hygroscopic
Air/Gas flow meters	Air Mass Flow Controller 0-10g/sec Gas Mass Flow Controller 0-0.6g/sec Powered via 15V 60W switch mode DC duel voltage power supply 47-63Hz Accuracy +/- 1% Start-up rise time <150ms Shock 15g, 11ms Ripple and Noise 50mV pk-pk
Venturi Mixer	Number 3 Air/Gas Venturi mixer
Pilot Burner	Stainless Steel Burner 203-229mm ID 3.2mm OD 4.8mm Porcelain tube ID 5.16mm, OD 6.84mm Methane flowmeter range 1-18L/min Viton seals Borosilicate glass tube ¼" Brass connections
Flash back arrestor	Safety precaution
Ignition system	Ceramic housed sparker powered by 230V ZT931 ignition device producing 15kV spark
Control system	Solid state gas control system with PLC control 24V switch mode DC 10A duel voltage power supply 47 – 63Hz Accuracy +/- 1% Start-up rise time <150ms Shock 15g, 11ms Ripple and noise 50mV pk-pk Thermocouple interlock safety system MFC control voltage 5V DC 0-100% F_S via high precision control circuits Adjustable 60-600 L/min air flow meter Gas solenoids 240VAC, 50/60Hz Temperature alarm module: • Sample rate 4Hz • Accuracy +/- 0.25% of reading • Linearization accuracy <0.1% of reading

SOFTWARE	
162Soft	Microsoft Windows based application that acquires test data and assists with several calibration routines
Data logger	A 3-slot cardcage 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 available
PCIe-GPIB	IEEE-488 interface converts any PCI express bus PC into an instrumentation control and data acquisition system making any PC equipped with a PCIe GPIB capable of controlling a GPIB instrument such as the Data logger with data transfer rates in excess of 300KB

Services Required

- A hood with exhaust blower placed over the stack is required
- Electrical power providing 230VAC, 50Hz, 13A
- Commercial grade propane, compressed air, acetylene gas, methane gas

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

Thermal/Acoustic Insulation Flame Propagation Apparatus

(FAR Part 25 Appendix F Part VI; Airbus AITM 2.0053; Boeing BSS 7365)

This test method is used to evaluate the flammability and flame propagation characteristics of thermal/acoustic insulation when exposed to both a radiant heat source and flame in a test chamber.

The radiant heat is applied by means of an electric panel, inclined at 30°, and directed at a horizontally mounted specimen. The radiant panel generates a radiant energy flux distribution ranging from a nominal maximum of 1.0W/cm^2 to a minimum of 0.1W/cm^2, operating at temperatures up to 816°C. The flux is controlled with a thyristor power unit and measured with a 25.4mm cylindrical water-cooled total heat flux density, foil type Gardon Gage. The outputs from the thyristor and heat flux meter are displayed on a programmable LCD meter.

To ignite the specimen a propane venturi pilot burner with an axially asymmetric burner tip is moved back and forth from the outside of the test chamber.

The electric panel and pilot burner are located in a test chamber. The sides, ends and top of the chamber are insulated with a fibrous ceramic insulation. The front side has a high temperature, draft free observation window. Below the window is a sliding platform to enable the user to easily insert either the calorimeter holding frame or specimen holding system (retaining and securing frames).

The chamber temperature is monitored with a thermocouple and displayed on a programmable LCD meter. The test duration is measured with a programmable electronic LCD timer.

Options include a:

- User friendly software package that automatically configures a data acquisition unit. This user interface is a Microsoft Windows based system with push button actions and standard Windows data entry fields, drop down selectors, check boxes and switches.
- Stainless steel hood to collect the smoke gases.
- Smoke measurement system

Software

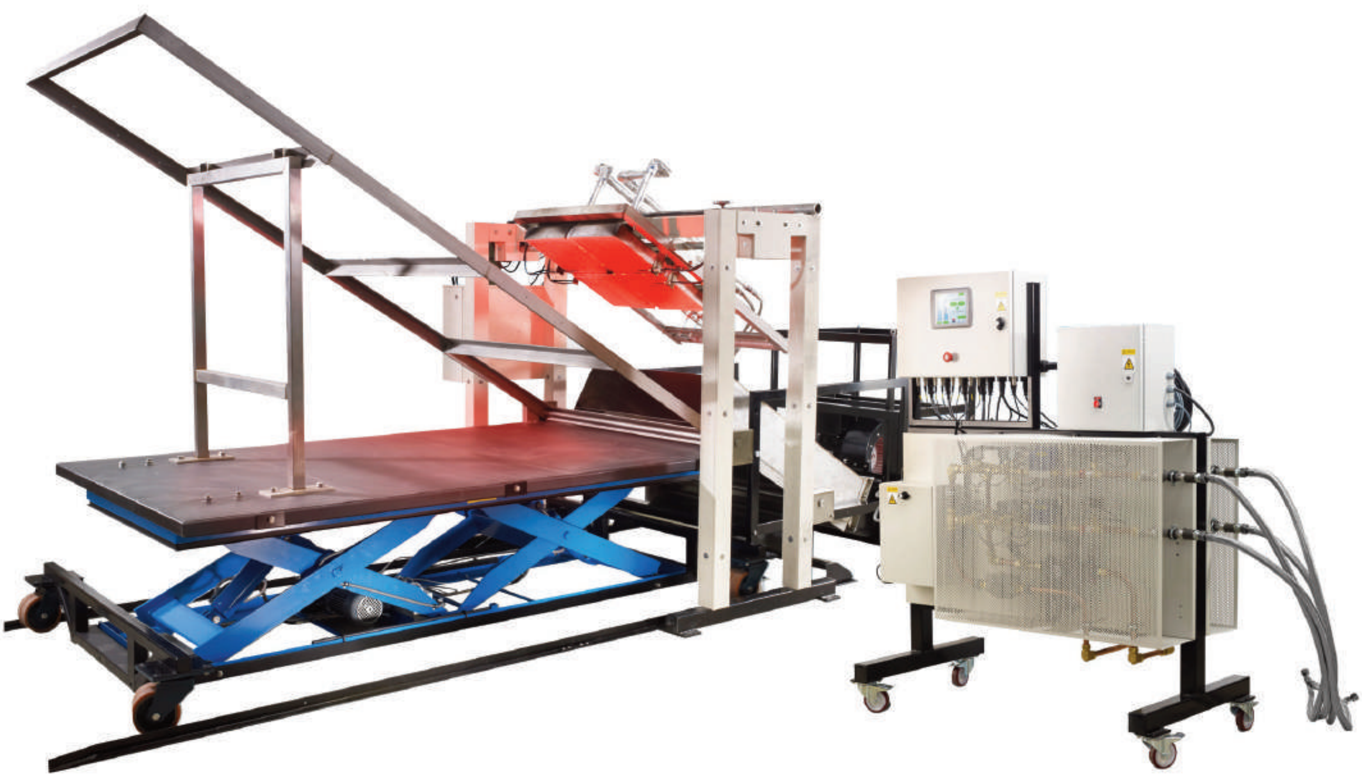
Instrument supplied with software at no extra charge. Software updates provided free of charge.

TECHNICAL SPECIFICATIONS	
Dimensions	1.9m (W) × 1.9m (H) × 0.75m (D)
Hood	2.5m (W) × 2.0m (H) × 1.4m (D)

SERVICES	
Water	15-25°C, 2.4bar (35 psi), 200-300 mℓ/min.
Electrical	40A supply at 230VAC
Gas	Commercial grade propane
Extraction system	30-85m^3/min

Roofing Tests for European Roofing Products

(ENV 1187 Test 1, 2, 3 and 4)



This ENV 1187 describes four methods for determining the performance of roofs to external fire exposure. The four methods assess the performance of roofs under the following condition

Test 1 – with burning brands

Test 2 – with burning brands and wind

Test 3 – with burning brands, wind and supplementary radiant heat.

Test 4 – with two stages incorporating burning brands, wind and supplementary radiant heat.

The tests assess the fire spread across the external surface of the roof, the fire spread within the roof (Tests 1, 2 and 3), the fire penetration (tests 1, 3 and 4) and the production of flaming droplets or debris falling from the underside of the roof or from the exposed surface (tests 1, 3 and 4). Tests 2 and 3 are not applicable to geometrically irregular roofs or roof mounted appliances e.g. ventilators and roof lights.

The four tests listed above do not imply any ranking order. Each test stands on its own without the possibility to substitute or exchange one for another. This document provides information on instrumentation of all four Tests that are available from **FTT**.

ENV 1187 Test 3 – with burning brands, wind and supplementary radiant heat.

The ENV 1187 Test 3 Roofing Test is an instrument used to determine the performance of roofs to external fire exposure. The test method incorporates burning brands, wind and supplementary radiant heat.

Main Frame

In the ENV 1187 Test 3 Roofing Test, the test sample is placed on the Specimen Holder which lays on the Lifting Bed as part of the Sample Assembly. The Specimen Holder can be tilted and supported on stands in a 5° or 30° position depending on the type of roof sample being tested. The Sample Assembly is used to move the Sample into the correct position for testing. The height of the Sample Assembly can be adjusted by the electrically powered lift table and it can be wheeled into position between the Guide Rails. The Sample Alignment Jig and a system of Stops are provided to ensure the correct position of the assembly.

The Air Nozzle Blower Assembly is positioned behind the Sample Assembly so that a uniform airflow is applied over the surface of the test sample. The air velocity is established using the anemometer according to the requirements

The Main Frame on the left includes Radiant Panel Assembly, 4 Flexible Gas Burner Hoses, Sparker Box, Guide Rails and Guide Rails Extensions. On the right is a Dual Diverter Stand and Control Box Assembly.

detailed in the standard. The volume flow rate of the blower is controlled via the Touch Screen interface on the Diverter Stand.

The Radiant Panel Assembly (mounted on the Main Frame) provides the supplementary radiant heat source directed onto the surface of the test sample. The Radiant Panel can be tilted to provide the 5° or 30° position and consists of four surface combustion heaters which are independently controlled from the Dual Diverter Assembly and Control Box. The air and gas flow to each burner can be adjusted to provide an incident radiant heat flux distribution in accordance with the standard (such that the heat flux meters each measure 12 ± 0.5 kW/m² at the centre and 10 ± 0.5 kW/m² at the four locations on the major axes).

The Calibration Assembly Trolley contains the Calibration Element holding the five Heat Flux Meters. The Calibration Element is tilted to the 5° or 30° position and supported on the arms of the trolley. The Assembly is wheeled into position between the calibration guide rails. The Heat Flux Meters are supplied with water via a manifold mounted on the assembly.

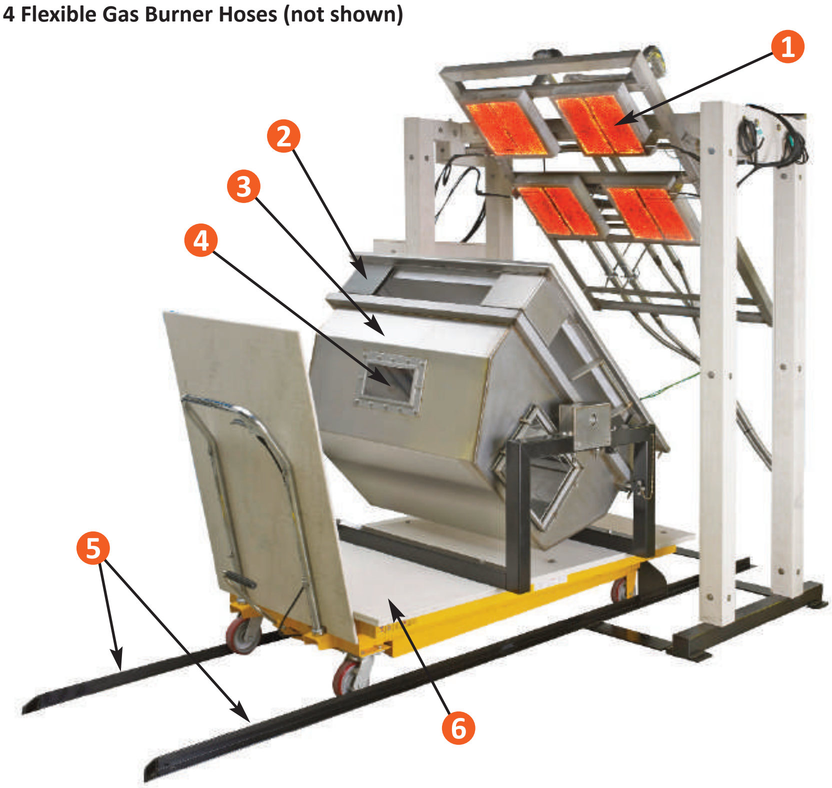
ENV 1187 Test 4 – with two stages incorporating burning brands, wind and supplementary radiant heat.

The ENV 1187 Test 4 Roofing Test is a two stage test method incorporates burning brands, wind and supplementary radiant heat. Similar to ENV 1187 Test 3 it is also used to determine the performance of roofs to external fire exposure.

In the ENV 1187 Test 4 Roofing Test, the test sample is placed in a Sample Holder which is placed on the Specimen Cover and an air seal is created. The Specimen Cover can be tilted and supported at an angle of 45° or horizontal depending on the type of roof sample being tested. The underside of the sample can be viewed during the test through the viewing window in the Specimen Cover which is mounted on the Sample Trolley Assembly to move the Sample into the correct position for testing. The height of

The Main Frame includes:

1. **Radiant Panel**
2. **Sample Holder with Calibration Assembly**
3. **Specimen Cover with Suction Box Assembly**
4. **Viewing Window**
5. **Guide Rails**
6. **Sample Trolley**
7. **Sparker Box (not shown)**
8. **4 Flexible Gas Burner Hoses (not shown)**



Flame Spread

the Sample Trolley can be adjusted. The Sample Alignment Jig and a system of Stops are provided to reach the correct position.

The Burner Wand Assembly is used as the 'burning brand'. The brand comprises a simulated town gas flame.

The Suction Box Assembly is connected to the Specimen Cover with a Suction Hose to simulate the effect of 'wind'. A pressure reduction on the underside of the sample is established and controlled using the Inclined Tube Manometer and Speed Controller Assembly mounted on the Dual Diverter Stand. There is also a blow-out panel on the other side of the Specimen Cover.

The Radiant Panel Assembly (mounted on the Main Frame) provides the 'supplementary radiant heat' source directed onto the surface of the test sample. The Radiant Panel can be tilted and supported at an angle of 45° or horizontal. The Radiant Panel consists of four surface combustion heaters which are individually controlled from the Dual Diverter Assembly and Control Box. The air and gas flow to each burner can be adjusted to provide an incident radiant heat flux distribution such that the heat flux meters each measure 12 ±1.5 kW/m^2.

The Calibration Assembly contains the Calibration Element holding the four Heat Flux Meters. The Assembly is contained on a Sample Holder which rests on the Specimen Cover. The Heat Flux Meters are supplied with water via a Manifold mounted on the assembly.

Touch Screen Interface and Control System for Test 3 and Test 4

The instrument is controlled using the supplied Touch Screen interface and Control System. This system provides safety interlocking to ensure the four gas burners which form the Radiant Panel can be operated in a safe and controlled manner. All operations are conducted through the Touch Screen with the exception of the Blower Motor Reset and the 2 Emergency Stops.

Dual Diverter Assembly and Control Box

The FTT ENV 1187 Roofing Tests consist of:

TEST 1
300 mm × 300 mm × 200 mm open basket made from 3 mm diameter mild steel wire mesh
Balance
Timing Device

TEST 2
Steel Air Channels with Fans and Dampers
Crib Ignition Stand with Flow meter
Balance
Stopwatch
Air Velocity Anemometer

TEST 3
Main Frame incl. Radiant Panel Assembly, 4 Flexible Gas Burner Hoses, Sparker Box, Guide Rails and Guide Rails Extensions
Sample Holder Trolley Assembly
Calibration Assembly
Dual Diverter Stand and Control Box Assembly with full colour touchscreen control
30° and 5° Support Assemblies
Air Nozzle Assembly and Blower Frame Assembly
Calibration Guide Rails
Sample Alignment Jig
Buffer Stop Assembly and 2 Buffer Locking Plates

TEST 4
Main Frame incl. Radiant Panel Assembly, 4 Flexible Gas Burner Hoses, Sparker Box and Guide Rails
Sample Trolley Assembly including Specimen Cover and Sample Holder
Calibration Assembly
Dual Diverter Stand and Control Box Assembly with full colour touchscreen control
Sample Holders (each is supplied with 4 Sample Holder Edge Boards)
Suction Fan Assembly
Suction Hose
Burner Wand Assembly
Sample Alignment Jig
Buffer Stop and 2 Buffer Locking Plates

SERVICES	
Electrical Power	
Control Box	230 VAC at 50/60 Hz 6 Amp
Fan	Test 2: Consult FTT for details Test 3: 3PH 380-480 VAC at 50/60 Hz 16 Amp Test 4: 230 VAC at 50/60 Hz 6 Amp
Scissor Lift Table	Test 3: 230 VAC at 50/60 Hz 13 Amp

Extraction System	
Test 1 & 2: Suitable extraction system is required, consult **FTT** for details.	
Test 3 & 4: An exhaust system of 3.5 m³/sec with a duct diameter of 400mm and adjustable flow is recommended.	
Hood Size (recommended)	Test 3: 3m × 8m, stainless steel Test 4: 3m × 3m, stainless steel

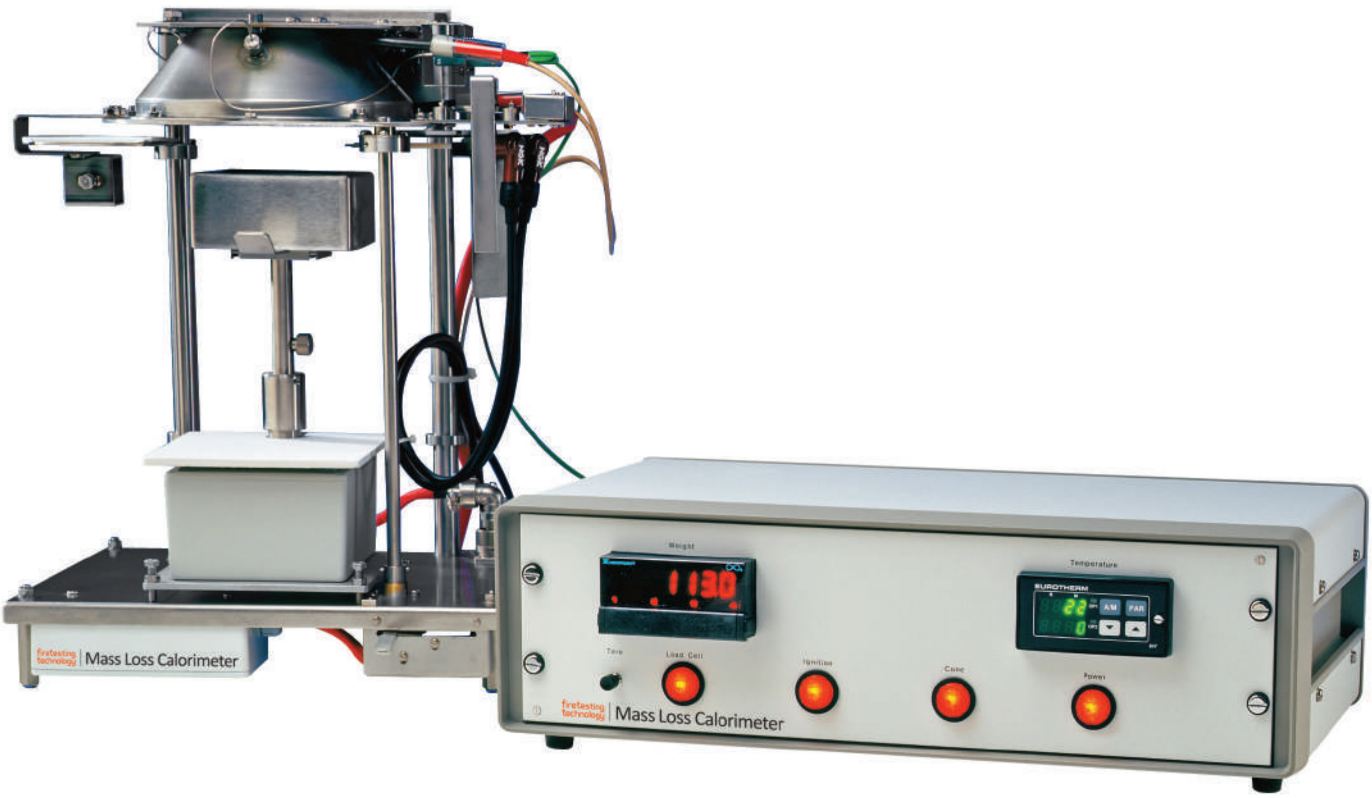
Gas Supply
Test 2, 3 & 4: Commercial propane 95% minimum purity is used to supply the four radiant panels.
Test 3 & 4: The required supply pressure is 3-4 bar (43.5-58 psi) with a suitable pressure regulator.

Compressed Air Supply
Test 2: Suitable air supply is required, consult **FTT** for details.
Test 3 & 4: The air supply is used to supply the four radiant panels. The required supply pressure is 6-7 bar (87-101 psi) with a suitable pressure regulator.

Water Supply	
Water at 15-25°C is required for cooling the heat flux meters. A pressure of approximately 2.4 bar (35 psi) is recommended at a low flow rate 200-300 ml/min.	
Interface Cables	Please refer to instrument instruction manual for detailed requirement.
Brand	**FTT** do not supply any brands, please refer to standard ENV 1187 for detailed requirement.

Mass Loss Calorimeter

(EN ISO 13927; EN ISO 17554)



Mass Loss Calorimeter – Simple Heat Release Test Using a Conical Radiant Heater

The test method is used to assess the mass loss rate of a product under test conditions. The International Standards ISO 13927 and ISO 17554 specify this method for assessing the mass loss rate of essentially flat specimens exposed in the horizontal orientation to controlled levels of radiant heating with an external igniter under well-ventilated conditions.

The mass loss rate is determined by measurement of the specimen mass and is derived numerically. The time to ignition (sustained flaming) is also measured in this test. Mass loss rate can be used as an indirect measure of heat release rate for many products. However, some products, e.g. those with high water content, will have mass loss rates that are not so closely linked to heat release rates.

Such products need to be tested in accordance with ISO 5660-1 for correct assessment of heat release.

FTT Mass Loss Calorimeter

The **FTT** Mass Loss Calorimeter consists of a complete fire model from the Cone Calorimeter. It is an economical solution for those working to a limited budget and with a major interest in ignitability and mass loss work.

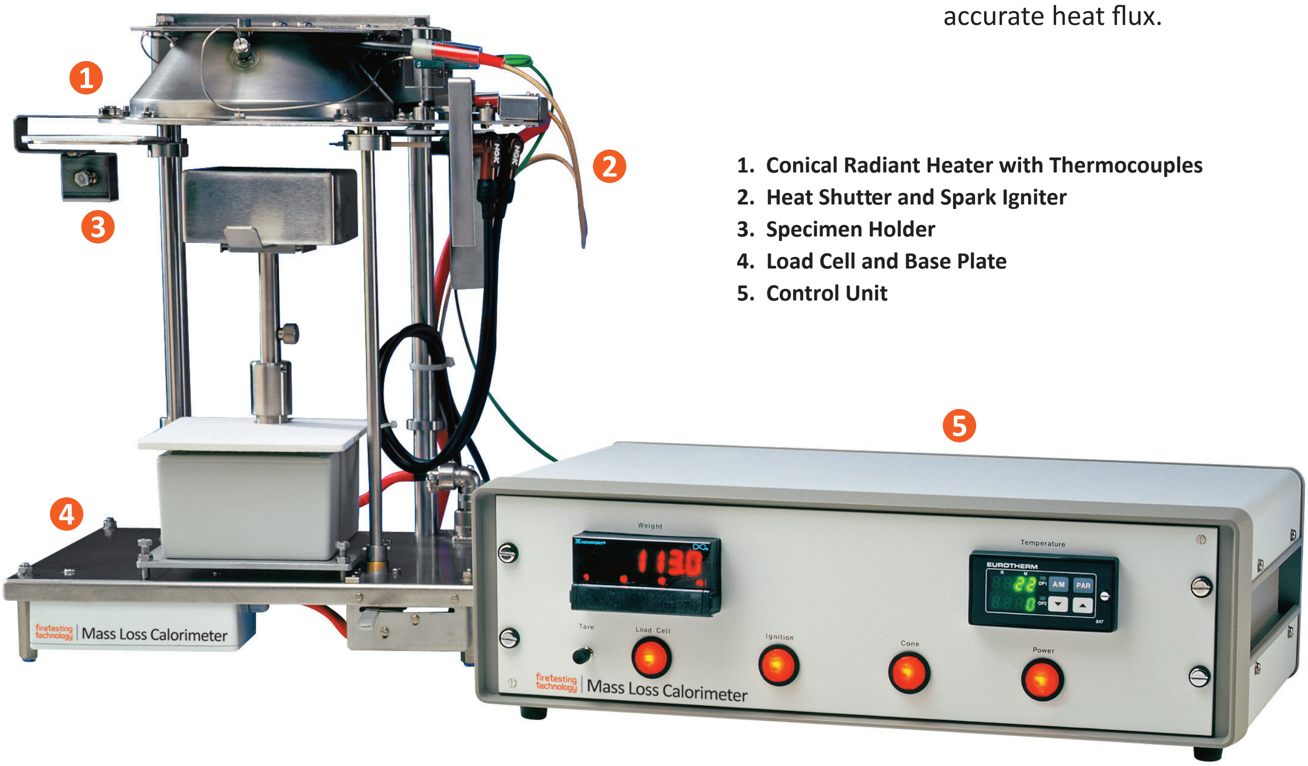
The apparatus consists of:

- Conical Radiant Heater
- Thermocouples
- Water Cooling Collar
- Heater Shutter Assembly
- Spark Igniter
- Specimen Holder
- Load Cell
- Cold Plate (optional)
- Control Unit
- Flux Meter
- MLCCalc Software
- Methane Calibration Burner (optional)
- Chimney with Thermopile (optional)

Use of this instrument 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, whilst visibly observing the specimen reaction and measuring the mass change. A flue containing a thermopile can also be added to the unit. Once calibrated using a methane burner the thermopile output can be used to quantify heat release.

Features and Benefits

- Fire Model meets the specification of the ISO 5660 Cone Calorimeter.
- Fire Model manufactured from stainless steel for long life.
- 3 Control Thermocouples for the cone heater to maintain accurate heat flux.



1. **Conical Radiant Heater with Thermocouples**
2. **Heat Shutter and Spark Igniter**
3. **Specimen Holder**
4. **Load Cell and Base Plate**
5. **Control Unit**

- The special **FTT** split shutter mechanism is designed to reduce the radiated heat from affecting the sample support system and more importantly allowing time after the sample is positioned on the load cell before the test is started. The shutter is permanently in place on the apparatus and is operated using a simple lever which opens the shutter symmetrically from the centre.
- The **FTT** spark assembly is manually inserted into position using a lever mechanism. This is used in conjunction with the shutter mechanism. The sequence of operation is such that the electrodes can be positioned above the sample with the shutter closed. At the start of a test the operator opens the shutter lever which, in turn, automatically starts the spark sequence. Micro-switches 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. The weight of the sample holder is zeroed electronically on touching a button.
- The load cell is housed in an enclosed case to reduce the effect of temperature change.
- Control unit is supplied in its own case with switches for power, ignition, load cell and cone heater.
- Eurotherm temperature controller for ramp and control of cone heater.
- Load Cell controller with weight ranging facility to improve performance to suit weight of sample (0-500 g).
- 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.

MLCCalc Software

The **FTT** Mass Loss Calorimeter is a sophisticated instrument and in order to make the calibration and use of the instrument extremely easy, the MLCCalc software package is specially designed to complement the instrument. MLCCalc is a powerful, yet easy to use, Microsoft Windows based application which allows the user to perform most operations required on the apparatus with the aid of a computer. It assists with calibration routines, acquires test data and produces test reports.

Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.

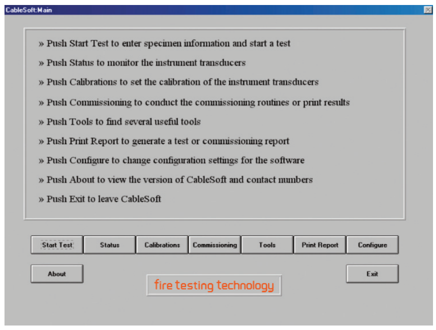
The Main panel is used to access all the functions available in MLCCalc software:

- Start Test
- Status
- Load Cell Calibration
- Heat Flux
- HRR Calibration
- HRR Check
- Print Report
- Configure
- About
- Exit

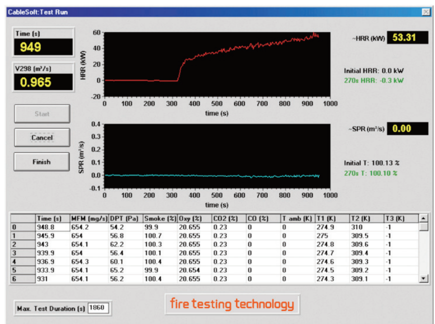
The Test Run panel shows the readings from the transducers in real time, the heat release rate and peak heat release rate (if thermopile fitted). If the specific equipment is fitted then graphs of mass, heat release rate and thermopile output are displayed. It also shows the total test time (including the baseline time), the test time (the time that the specimen has been exposed to the heat from the cone heater) and the recorded times to ignition and flameout.

When the test is finished comments about the test and the observations for any events marked during the test can be entered. Also the ignition and flameout times can be edited if required.

The results from a test or heat release rate calibration can be viewed and reports printed by simply pressing the Print Report button.



Main Panel of MLCCalc



Test Run Panel of MLCCalc

TECHNICAL SPECIFICATIONS	
Truncated Conical Heater and Spark Igniter	
Element	5kW electrical heating element
Heat flux	Up to 75-100kW/m^2 Heat shield Placed between the cone heater and specimen
Spark igniter	10kV spark generator with 3.0mm spark gap located 13mm above the centre of the specimen

Specimen Holder and Weighing Device	
Specimen Holder	A square pan 106mm × 106mm at the top, and a height of 25mm, constructed from stainless steel
Retainer edge frame	A stainless steel frame with inside dimension 111mm x 111mm, and opening of 94mm × 94mm
Sample size	100mm × 100mm
Sample thickness	Up to 50mm
Load cell	Total capacity up to 5.0kg Specimen capiticy up to 500g Resolution 0.1g

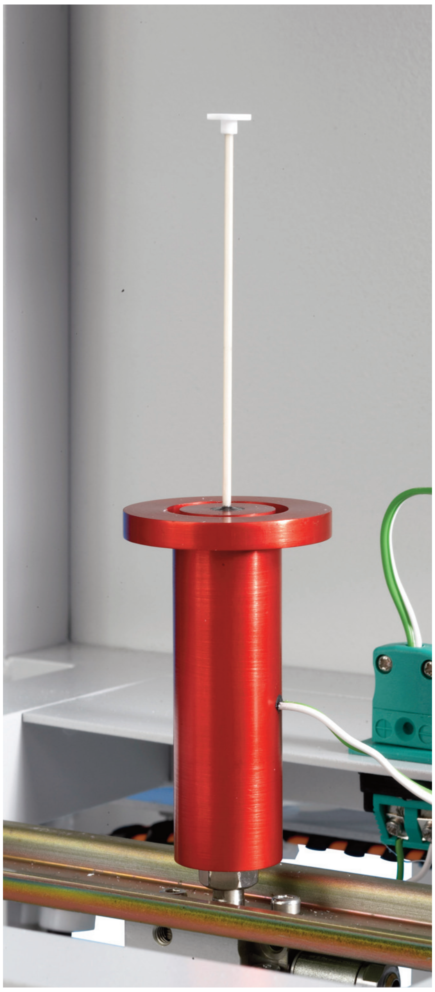
Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

SERVICES	
Electric	220-240VAC/1ph/50Hz for control unit 220-240VAC/1ph/50Hz/32A for cone heater
Water	Low pressure water 250kPa (35psi) supply

FAA Micro Calorimeter

(ASTM D7309)

Accurate and cost effective micro calorimetry using a Pyrolysis Combustion Flow Calorimeter (PCFC) ASTM D7309



The **FTT** Micro Calorimeter was developed in co-operation with the Federal Aviation Administration (FAA). It determines fundamental thermo-chemical data in seconds and predicts fire properties of materials.

The technique enables parameters such as Specific Heat Release Rate (W/g), Heat of Combustion (J/g) and Ignition Temperature (°C) to be quickly determined from very small (1-5mg) specimens. It is a low cost and accurate technique; typical repeatability is ± 5%.

Micro Calorimeter data has been shown to correlate with fire test data (Cone Calorimeter, OSU), flammability results (LOI, UL94) and combustion tests (Bomb Calorimeter) and is therefore seen as a powerful, low cost tool to assess and predict flammability properties.

The **FTT** Micro Calorimeter uses the same oxygen consumption calorimetry technique used in our bench and room scale calorimeters. The specimen is first heated at a constant rate of temperature rise (typically 1°C/s) in a pyrolyser and the degradation products are purged from the pyrolyser by an inert gas (nitrogen). The gas stream is mixed with oxygen and enters a combustor at 900°C where the decomposition products are completely oxidised. Oxygen concentrations and flow rates of the combustion gases are used to determine the oxygen consumption involved in the combustion process and the heat release rates are determined from these measurements.

Software

The **FTT** Micro Calorimeter is supplied with a Microsoft Windows based data acquisition and analysis software with an intuitive user interface using standard Windows data entry fields, drop down selectors, check boxes and switches.

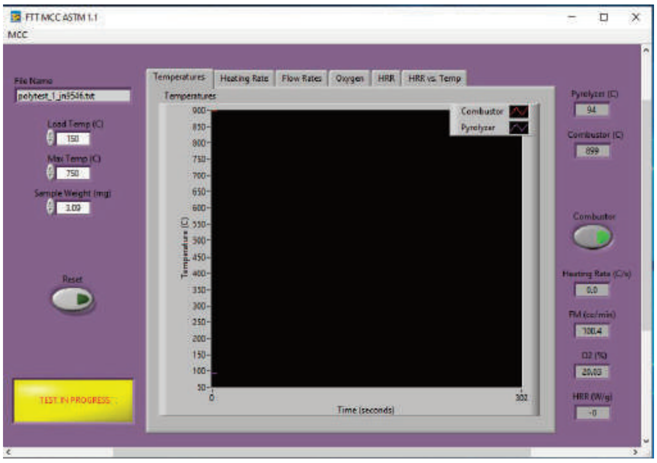
Instrument supplied with software at no extra charge. Software updates provided free of charge.

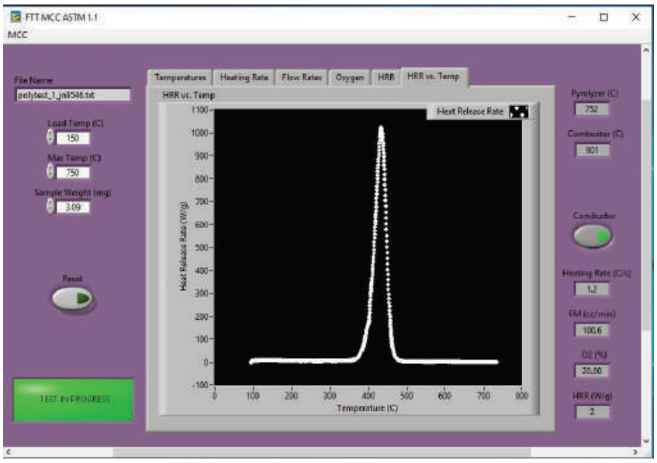
The software enables:

- The instrument status to be shown
- Calibration of the instrument and storage of calibration results
- Collection of data generated during a test
- Calculating the required parameters
- Presenting the results in a manner approved by the Standard

Features and Benefits

- Ability to generate quantitative results in minutes
- Automatic control of temperature and gas flow rates
- Small sample size (1-5mg)
- Over temperature protection of both furnaces
- Removable rear cover to access all serviceable parts such as the Fuel Cell for ease of maintenance
- Dual voltage 96-264VAC, 50-60Hz (No need to switch)





TECHNICAL SPECIFICATIONS	
Measuring Principle	**Pyrolysis Combustion Flow Calorimetry**
Combustor operating temperature range	25 to 1000°C
Heating rate	0.2 to 3°C/s
Sample size	1 to 5mg
Detection limit	5mW
Repeatability	± 5%
Dimensions	1050mm (H) × 350mm (W) × 550mm (D)
Built in accordance with EMC 89/336/EEC, LVD 72/23/EEC, BS EN 60204-1, BS EN 746-2	

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

SERVICES	
Gas supply	Pressure regulated Nitrogen (oxygen free) at approximately 2 bar Pressure regulated Oxygen at approximately 2 bar
Power	Dual voltage 96-264VAC 10A, 50/60Hz
Extraction	Fume cupboard or extraction system capable of extracting a volume flow of 100cc/min
Scales	With a capacity of 250 mg or greater and a sensitivity of 0.01mg, to weigh specimens or containers, or both.
Drierite	Drierite is required to remove the water from the sample.

Large Scale Mattress Fire Test

(CA TB 603; 16 CFR Part 1633)

Recently the California Bureau of Home Furnishings and the Consumer Product Safety Commission determined that all residential mattresses to be sold in the US must meet a large scale heat release test based on the dual burner shown here. **FTT** can offer the complete instrumentation to clients wishing to upgrade existing fire test facilities or to build their own test apparatus. In the later case **FTT** supplies a variety of modules, including a Gas Analysis Instrumentation Console, a duct section, a burner, a load cell and software/data acquisition.

The Console contains all the necessary instrumentation to measure heat release rates and other associated parameters. The specification of this instrumentation is the same for both large and small scale calorimeters and can therefore also be conveniently disconnected and used with the **FTT** Cone Calorimeter. The duct section contains probes for gas sampling and air velocity measurement along with smoke measurement equipment (white light or laser).

Oxygen Bomb Calorimeter

(ISO 1716)

EN ISO 1716:
Reaction to fire tests for building products – Determination of the heat of combustion

ISO 1928:
Determination of gross calorific value by the bomb calorimetric method and calculation of net calorific value

ASTM D240:
Standard test method for heat of combustion of liquid hydrocarbon fuels by bomb calorimeter

ASTM D4809:
Standard test method for heat of combustion of liquid hydrocarbon fuels by bomb calorimeter

ASTM D5468:
Standard test method for gross calorific and ash value of waste materials

ASTM D5865:
Standard test method for gross calorific value of coal and coke

ASTM E711:
Standard test method for gross calorific value of refuse-derived

The bomb calorimeter is a widely used 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 measured temperature rise while taking account of heat loss.

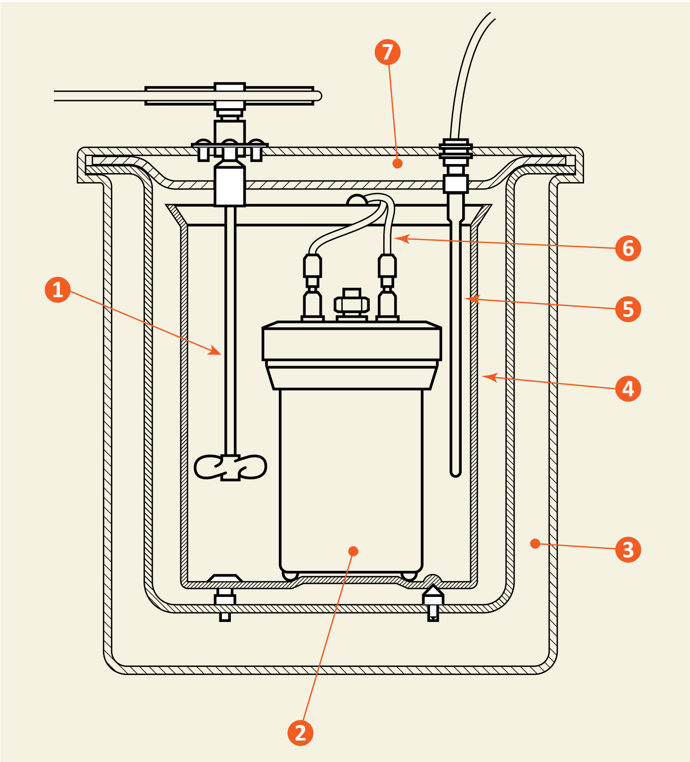
The combustion process is initiated inside an atmosphere of oxygen in a constant volume container, the bomb, which is a vessel built to withstand high pressures. It is immersed in a stirred water bath, and the whole device is the calorimeter vessel. The calorimeter vessel is also immersed in an outer water bath. The water temperature in the calorimeter vessel and that of the outer bath are both monitored.

The Oxygen Bomb Calorimeter is a versatile instrument and can be used to measure the heat generated from several applications and has been designed to conform to current ASTM, ISO, EN, BS and DIN standards.

- Building materials (EN ISO 1716)
- Coal, coke (ASTM D5865)
- Fuel (ASTM D240: gasoline, kerosene, fuel oil, Nos. 1-D and 2-D diesel fuel and Nos. 0-GT, 1-GT, and 2-GT gas turbines fuels and ISO 1928)
- Fuel derived from waste material (ASTM E711)
- Hydrocarbon fuels (ASTM D4809)
- Food, supplements, crops
- Waste and refuse

The Oxygen Bomb Calorimeter consists of:

- Measuring cell
- Decomposition vessel
- Oxygen filling station
- Consumables for calibrations and installation



1 Stirrer
2 Calorimeter bomb
3 Jacket
4 Calorimeter vessel
5 Platinum resistance thermometer, PRT
6 Ignition lead
7 Jacket lid

TECHNICAL SPECIFICATIONS	
Calorimeter type	Isoperibolic
Range of measurement	40,000 J
Reproducibility (1g benzoic acid)	≤0.1%
Temperature measurement resolution	0.0001°C
Working temperature max.	25°C
Oxygen operating pressure	30 bar
Measuring time approx.	17 min
Ambient temperature	20-25°C
Ambient humidity	80%
Interfaces	1 × serial (RS 232); 1 × parallel (Centronics)
Dimensions (W × D × H)	400 × 400 × 400 mm
Weight	21 kg
Voltage	100-240 VAC, 50/60 Hz
Power input	120 W

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

The Single-Flame Source Test

(EN ISO 11925-2)

Ignitability

EN ISO 11925-2:

Reaction to fire for tests – Ignitability of building products subjected to direct impingement of flame – Part 2: Single-flame source test.

The test is required as part of the European construction products regulation classification of reaction to fire performance for wall and roofing products and floor coverings. “The Single Flame Source Test” (Ignitability Apparatus) is built in accordance with EN ISO 11925-2.

Full classification and performance criteria can be found in a separate **FTT** document “New European Fire Testing Classification EN ISO 11925-2: Reaction to fire for Construction Products.”

Product Classification

The European Construction Products Regulation classification criteria for all building products, has performance classes from A-F. Although other tests are required for assessment, the single flame source apparatus is needed for qualifying all types of construction products to classes B, C, D and E.

The classification criteria for each product group are shown in the tables below.

CLASSIFICATION FOR CONSTRUCTION PRODUCTS EXCLUDING FLOORINGS

Class	Classification Criteria	Additional Classification	Other Test Method
B	F_s ≤ 150mm within 60s (Exposure = 30s)	Smoke production and Flaming droplets/particles	EN 13823
C	F_s ≤ 150mm within 60s (Exposure = 30s)	Smoke production and Flaming droplets/particles	EN 13823
D	F_s ≤ 150mm within 60s (Exposure = 30s)	Smoke production and Flaming droplets/particles	EN 13823
E	F_s ≤ 150mm within 20s (Exposure = 15s)	Flaming droplets/particles	–
F	Fs > 150mm within 20s (Exposure = 15s)	–	–

CLASSIFICATION FOR FLOORING PRODUCTS

Class	Classification Criteria	Additional Classification	Other Test Method
B_{fl}	F_s ≤ 150mm within 20s (Exposure = 15s)	Smoke production	EN ISO 9239-1
C_{fl}	F_s ≤ 150mm within 20s (Exposure = 15s)	Smoke production	EN ISO 9239-1
D_{fl}	F_s ≤ 150mm within 20s (Exposure = 15s)	Smoke production	EN ISO 9239-1
E_{fl}	F_s ≤ 150mm within 20s (Exposure = 15s)	–	–
F_{fl}	Fs > 150mm within 20s (Exposure = 15s)	–	–

CLASSIFICATION FOR LINEAR PIPE THERMAL INSULATION PRODUCTS

Class	Classification Criteria	Additional Classification	Other Test Method
B_L	F_s ≤ 150mm within 60s (Exposure = 30s)	Smoke production and Flaming droplets/particles	EN 13823
C_L	F_s ≤ 150mm within 60s (Exposure = 30s)	Smoke production and Flaming droplets/particles	EN 13823
D_L	F_s ≤ 150mm within 60s (Exposure = 30s)	Smoke production and Flaming droplets/particles	EN 13823
E_L	F_s ≤ 150mm within 20s (Exposure = 15s)	Flaming droplets/particles	–
F_L	Fs > 150mm within 20s (Exposure = 15s)	–	–

The FTT Ignitability Apparatus

EN ISO 11925-2 is based on the Kleinbrenner method for determining ignitability of building products in the vertical orientation by direct small flame impingement under zero impressed irradiance.

The **FTT** Ignitability Apparatus is supplied as a complete easy-to-use system incorporating safety features. It has large front and side doors for easy access. These are glazed with toughened glass for full view of the specimen during a test.

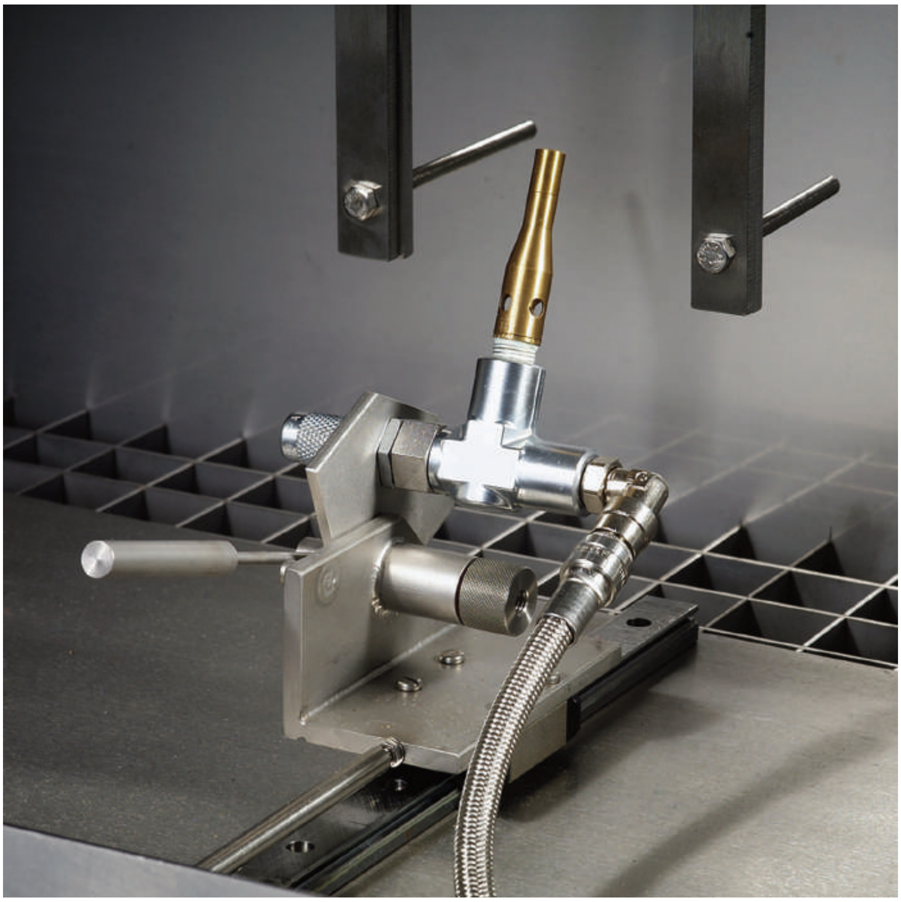
Fully Adjustable Burner

An extensively adjustable burner assembly, mounted on runners enables the small premixed flame to be tilted at an angle of 45° to the specimen and offered to it in one fluid movement.

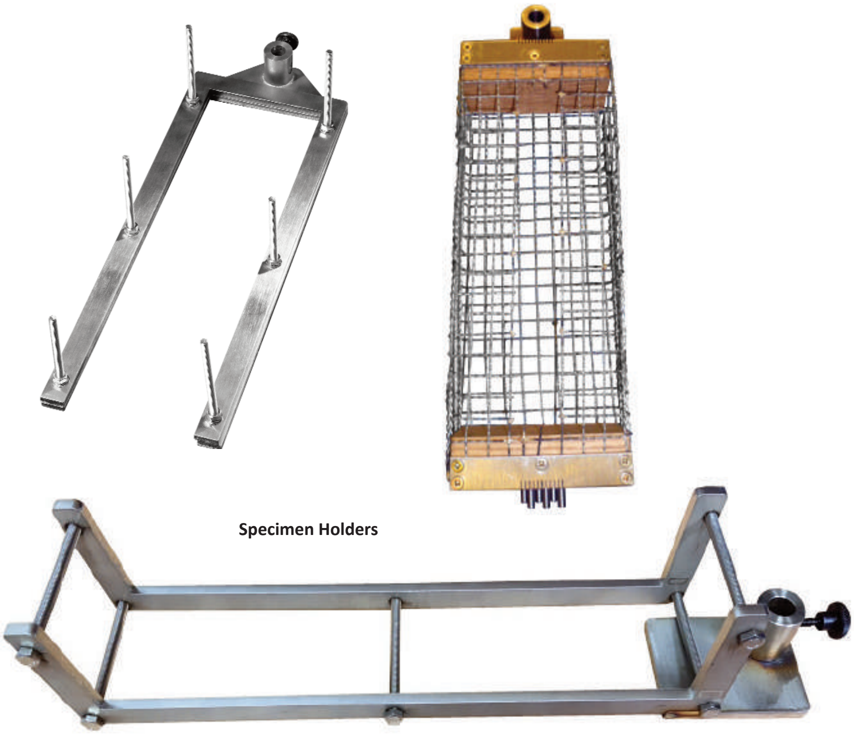
A fully adjustable specimen support frame facilitates lateral and vertical movement of the specimen holder so that the flame can be applied at the correct position for either surface exposure or edge exposure.

Specimen Holder

The specimen holders are capable of housing the specimens up to and including 60 mm thick. The **FTT** ignitability apparatus is supplied with one specimen holder. Optional extras: multi-layered and loose fill materials.



Fully Adjustable Burner



Specimen Holders

Accurate Measurement

A digital anemometer/thermometer and a stopwatch are incorporated for simple but accurate measurement of the flow, temperature and time.

TECHNICAL SPECIFICATIONS	
Measuring Principle	Ignitability from small flame source
Cabinet Dimensions (exterior)	700mm (W) × 400mm (D) × 800mm (H)
System Dimensions	1500mm (W) × 1200mm (D) × 900mm (H)
Sample holder	Standard holder and options for multi-layer and loose fill materials
Anemometer	± 0.1 m/s accuracy
Stopwatch	Accuracy better than 1 second in 60 minutes

SERVICES	
Test Room	The ignobility apparatus should be situated in a draught free environment at 23 ± 5°C and a relative humidity of 50 ± 20%.
Gas Supply	A supply of natural gas of minimum 95% purity. In order to obtain flame stability the gas pressure shall be between 10kPa and 50kPa.
Hood	The combustion chamber should be situated under a suitable extraction system.

Due to the continuous development policy of FTT technical changes could be made without prior notice.

Other Euroclass Test Methods

Detailed product catalogues are also available for:

- **Single Burning Item**
  EN 13823 Reaction to fire tests for building products excluding floorings exposed to thermal attack by a single burning item, the SBI.
- **Oxygen Bomb Calorimeter**
  EN ISO 1716 Reaction to fire tests for building products – Determination of the heat of combustion.
- **Non Combustibility Apparatus**
  EN ISO 1182 Reaction to fire tests for building products – Non combustibility test.
- **Flooring Radiant Panel**
  EN ISO 9239-1 Reaction to fire tests for building products – Horizontal surface spread of flame for floor coverings.

Non-Combustibility Apparatus

(EN ISO 1182; ASTM E2652; IMO FTPC Part 1)

EN ISO 1182:

Reaction to fire tests for building products – Non-combustibility test

This apparatus determines the non-combustibility performance, under specific conditions, of homogenous products and substantial components of non-homogeneous building products. This test is part of the requirements of the European construction products regulation classification of reaction to fire performance for wall lining and roofing products and floor-coverings. Full classification and performance criteria can be found in a separate document "Reaction to fire instruments for testing according to New European Fire Testing and Classification for Construction Products."

How the non-combustibility apparatus is used to classify products

The European Construction Products Regulation classification criteria for all building products, has performance classes from A-F. Although another test is required for assessment, the non-combustibility apparatus is needed for qualifying all types of construction products to the highest performance criteria – A1 and $A1_{fl}$ (non-combustible).

The classification criteria are shown in the table below. This principally applies to non-organic materials.

Classification for construction products excluding floorings

CLASS	TEST METHODS	CLASSIFICATION CRITERIA	OTHER TEST METHODS
A1, $A1_{fl}$	EN ISO 1182	$\Delta T \geq 30°C$: and $\Delta m \geq 50\%$; and $t_f = 0$ (i.e. no sustained flaming)	EN ISO 1716

The FTT Non-Combustibility Apparatus

The **FTT** system has been designed with accuracy and longevity in mind. The apparatus is safeguarded to ensure that the heater element cannot be damaged during the heating cycle if the electrical current is too high. The benefits of this system over traditional variac systems are: soft start, ramp rate, power limit and over temperature prevention. This design also helps to considerably extend the life of the furnace.

Special Tube Furnace

Manufactured from steel with a painted black finish. This single zone furnace has a maximum operating temperature of 900°C. The furnace is easily replaceable during maintenance and servicing procedures. The furnace and stabilising cone are held in a frame which also includes the specimen holder support and viewing mirror.

Two furnaces are available – one which meets the requirements of ISO 1182: 2020 where there are two furnace thermocouples and one which meets the previous version of ISO 1182 and other international standards (with only one furnace thermocouple).

Instrumentation

A 19" instrument case houses all the instrumentation. This unit features a temperature controller, an over-temperature alarm and a power controller, which control the furnace temperature at 750°C, compensating for supply voltage fluctuations and displaying the power being supplied to the furnace.

Software

The 'NonComb' software is a Microsoft Windows based application with simple push button actions, data entry fields, check boxes and other standard Windows operations.

The operator can monitor temperatures on a Status panel before performing a test without recording any data. Before a test, the specimen information (material name, density, mass, laboratory name, etc.) is entered into the computer and saved to a file.

During a test, the temperature of the furnace, specimen surface and specimen centre thermocouples are recorded at a rate of 2 Hz (i.e. every 0.5 seconds) and the temperatures displayed on a graph in real time.

The status of the furnace stabilisation (temperature, drift and deviation) is shown on the test screen so that the user knows when it is possible to start a valid test.

Also the initial, maximum and final temperatures recorded by the thermocouples are displayed during the test run. The end of test criteria is determined by the computer software based on the drift of the furnace thermocouple(s), so the user knows when a test can be stopped in order for it to be valid.

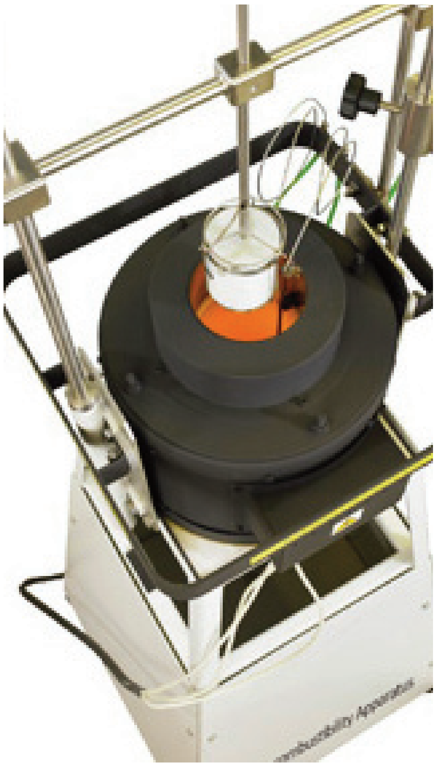
After the test, the user is prompted to enter any comments about the material performance, the total time of sustained flaming and the final mass. The appropriate temperature rises are calculated and then a report for the test specimen can be generated.

The test report shows the material information, the initial, maximum and final temperatures, the required temperature rises, the total flaming time, the mass loss (actual and as a percentage of the initial mass) and a graph of the recorded temperatures against time. The test report also includes a reference to the pass-fail criteria given in the appropriate Standards and states whether the specimen meets these criteria.

All the test data is saved to the hard disk as an ASCII file which can then be imported into spreadsheets for additional analysis.

Software

Instrument supplied with software at no extra charge. Software updates provided free of charge.



TECHNICAL SPECIFICATIONS	
Measuring Principle	Single zone furnace with three-term (PID) control and power control
Alarm	Over temperature alarm included as standard
Standard Operating Temperature	Furnace thermocouple = 750°C
Furnace Tube Dimensions	Inner diameter: 75 mm height: 150 mm
Instrument Dimensions (approximate)	400mm (W) × 400mm (D) × 1800mm (H)
Software	NonComb included as standard (Windows PC required)

SERVICES	
Test Room	The non-combustibility apparatus should be situated in a draught free environment at 23 ± 5°C and a relative humidity of 50 ± 20%.
Electrical Supply	230 VAC, 12 Amps
Hood	The apparatus should be situated under a suitable extraction system.

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

Other Euroclass Tests

Detailed product catalogues are also available for:

- **Single Burning Item**
  EN 13823 Reaction to fire tests for building products excluding floorings exposed to thermal attack by a single burning item, the SBI.
- **Oxygen Bomb Calorimeter**
  EN ISO 1716 Reaction to fire tests for building products
  – Determination of the heat of combustion.
- **Ignitability Apparatus**
  EN ISO 11925-2 Reaction to fire tests for building products
  – Ignitability of building products subjected to direct impingement of flame.
- **Flooring Radiant Panel**
  EN ISO 9239-1 Reaction to fire tests for building products
  – Horizontal surface spread of flame for floor coverings.

Oxygen Index

(ISO 4589-2; ASTM D2863)

Elevated-Temperature Oxygen Index

(ISO 4589-3)

ASTM D2863:

Standard test method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (oxygen index)

ISO 4589-2:

Plastics

– Determination of burning behaviour by oxygen index
– Part 2: Ambient-temperature test

ISO 4589-3:

Plastics

– Determination of burning behaviour by oxygen index
– Part 3: Elevated-temperature test

NES 714 and NES 715:

UK naval engineering standards

Determination of Flammability by Oxygen Index

The **FTT** Oxygen Index (OI) measures the minimum percentage of oxygen in a test atmosphere that is required to marginally support combustion. The OI is an economical and precise quality control test of combustible materials. 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.

The **FTT** apparatus enables the oxygen index to be determined in accordance with ASTM D2863, ISO 4589 Part 2 or the UK Naval Engineering Standard NES 714.

The OI features:

- New Paramagnetic 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 chimney
- 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

The Elevated-Temperature Oxygen Index module (TOI) is used alongside the OI to determine the oxygen index at temperatures up to 125°C. Research shows that the elevated temperature at which the materials will burn in air is a better determinant of combustibility than is the conventional oxygen index. Oxygen Index values fall when the gas temperatures are increased.

Elevated test temperatures are set by adjustment of the pre-heated gas temperature levels and setting the heated glass furnace wall temperature. The temperatures of both heated sections are continuously displayed on the TOI control unit. When experiments are being carried out using different oxygen levels, gas conservation is achieved by using air from an integral quiet running pump between tests. Bottled nitrogen and oxygen supplies are only switched into the system for testing.

The **FTT** apparatus enables the oxygen index at elevated temperature to be determined in accordance with ISO 4589 Part 3 or the UK Naval Engineering Standard NES 715.

The TOI features:

- Test temperature to 400°C
- Digital display of sample temperature
- Digital display of column and pre-heater temperatures
- Transparent radiant heated test column
- Highly efficient gas pre-heater
- Air pump to conserve oxygen and nitrogen supply during standby period
- Propane ignition source

The **FTT** OI and TOI have been designed to be compact for efficient use in a standard fume cupboard (or under a simple ventilation hood that can be supplied if required). The instruments give continuous digital readout of oxygen concentration in the test atmosphere to facilitate quick settings of test concentration. Stabilised oxygen percentages are automatically read from the digital readout and no additional flow adjustments are required.

This is a considerable improvement over systems that use analogue gauges or require flow matching and the use of graphs or tables to calculate oxygen concentration.

TECHNICAL SPECIFICATIONS	
Oxygen Index	
Measuring principle	Paramagnetic cell (accurate to <0.1% concentration by volume)
Digital readout for oxygen concentration	0.1% resolution
Dimensions (mm)	350 (W) × 370 (D) × 280 (H)
Column size (mm)	75 or 100 (dia) × 450(H)
Weight	17 kg (approx)

SERVICES	
Power	230V 50/60Hz 1A or 110V 60Hz 2A
Gas supply	Bottled O_2, N_2 and Propane or methane (depending on the Standard)
Extraction hood	Extraction rate of at least 50l/s

Elevated-Temperature Oxygen Index	
Measuring principle	Radiant heated glass furnace tube
Dimensions (mm)	350 (W) × 370 (D) × 280 (H)
Column size (mm)	160 max (dia) × 570 (H)
Weight	20 kg (approx)
Power	230V 50/60Hz 10A

SERVICES	
Gas supply	Bottled O_2, N_2 and Propane
Extraction hood	Extraction rate of at least 50l/s

A standard Oxygen Index is required to operate alongside the TOI

Due to **FTT**'s continuous development policy, specification is liable to change without prior notice

UL 94 Chamber

UL 94:
Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

The UL 94 tests are conducted on plastic materials to measure flammability characteristics, giving a preliminary indication of their suitability for a particular application.

FTT provides the complete solution for reliable testing for all UL 94 classifications in a robust, easy to use instrument. The tests determine 12 flame classifications of materials for specific applications:

- Six of the classifications relate to materials commonly used in manufacturing enclosures, structural parts and insulators found in consumer electronic products (5VA, 5VB, V-0, V-1, V-2, HB).
- Three of the remaining six classifications relate to low-density foam materials commonly used in fabricating speaker grills and sound-deadening material (HBF, HF-1 and HF-2).
- The last three classifications are assigned to very thin films, generally not capable of supporting themselves in a horizontal position (VTM-0, VTM-1, and VTM-2). These are usually assigned to substrates on flexible printed circuit boards.

These tests determine the material's tendency either to extinguish or to spread the flame once the specimen has been ignited.

FTT UL 94 Test Apparatus

The apparatus is supplied as a complete system incorporating all the features necessary for ease of use and safety.

It conforms to all five UL 94 horizontal and vertical Bunsen burner tests and associated international standards. These are:

- Horizontal Burning Test; UL 94 HB (ASTM D635, IEC 60695-11-10, IEC 60707, ISO 1210).
- Vertical Burning Test: UL 94 V-0, V-1, or V-2 (ASTM D3801, IEC 60695-11-10, IEC 60707, ISO 1210).
- 500W (125mm) Vertical Burning Test: 5VA or 5VB (ASTM D5048, IEC 60695-11-20, IEC 60707, ISO 9772).
- Thin Material Vertical Burning Test: VTM-0, VTM-1, or VTM-2 (ASTM D4804, ISO 9773).
- Horizontal Burning Foamed Material Test: HBF, HF-1 or HF-2 (ASTM D4986, ISO 9772).
- Burners (ASTM D5025, ASTM D5207, ISO 10093, ISO 10351)

Features and Benefits

- A bench mounted draft free combustion chamber with a large inside volume of 1.0m^3 and exhaust fan to enable simple evacuation of combustion products.
- Large sliding window made from heat resistant ceramic glass giving a generous view of the specimen during a test. An interior light is also fitted.
- Specimen holders
- Fully adjustable horizontal and vertical specimen supports.

- A burner in compliance with ASTM D5025, with simple angle adjustment (0°, 20°, 45°) and precision gas control system including gas flow meters, pressure regulator and pressure gauge (manometer).
- Two access ports enabling easy entry to the chamber for movement of the burner and specimen.
- A burner wing tip.
- Three digital test duration timers for accurate but simplified operation with remote handset.

TECHNICAL SPECIFICATIONS	
Test Chamber	
Measuring principle	Flammability of plastic materials subject to direct impingement of flame
External dimensions	1.47m (L) × 0.74m (D) × 1.3m (H)
Internal dimensions	1.4m (L) × 0.6m (D) × 1.2m (H)
Internal volume	$1m^3$
Exhaust	Self-starting industrial frame size extraction fan with over temperature/current protection. Low noise metal frame and metal impeller meet UL94V-0. Outer diameter of exhaust chimney = 100mm Exhaust flow rate 19 ℓ/s
Interior light	610mm fluorescent, 240VAC 50/60Hz or 110V 50/60Hz (specify at time of order)
Digital timers (3pcs)	8 digit battery powered panel mount programmable timer with 10 timer ranges and 9mm high reflective LCD display

Burner and Gas Control System	
Burner	A burner in compliance with ASTM D5025
Burner wing tip	Dimensions of slit 48 ± 1 mm in length by 1.3 ± 0.05 mm in width. Used for the test procedure in Horizontal Burning Foamed Material Test.
Burner mounting fixtures	Simple angle adjustment (0°, 20°, 45° available) from the vertical axis
Gas flow meter	Flow adjustment valves and flowmeters, 0.1-1.7 ℓ/min & 10-300 cm^3/min methane
Manometer	0-200 mm WC
Safety precaution	Flash back arrestor

Easy entry to the chamber via one of the two access ports

Ignitability

Specimen Holders and Support	
Retort stand tripod base (2pcs)	180mm from rod to centre of foot. Cast iron with central hole tapped for retort rod. Blue acrylic gloss finish with rubber feet
Retort rod (2pcs)	600mm stainless steel retort rod
Swivel post holder	Two Q-clamp rod holders with centre swivel allows tilting of clamp at any angle in parallel planes. Outside adjustment screw allows close proximity between items.
Three prong clamp (medium) (2pcs)	Three-prong clamps for holding circular or irregular objects. Dual adjustment allows both jaws to be moved to the object without having to move the entire clamp and enables even weight distribution around the rod axis. Non-corrosive nickel finish with slip on vinyl and fibreglass finger covers. Maximum jaw capacity = 57mm.
Three prong clamp	As per three prong clamp (medium) but maximum (small) (2pcs) jaw capacity = 25mm
Boss head (3pcs)	Diecast, nickel-plated with heavy nickel-plated brass thumb head clamping screws.
Flexible specimen support	Used in the Horizontal Burning Test; HB
Wire gauze	125mm × 125mm, having 20 openings per 25mm, made with 0.43 ± 0.03mm diameter iron wire, used in the Horizontal Burning Test, HB
Foam support stand	Used in the Horizontal Burning Foamed Material Test: HBF, HF-1, or HF-2
Foamed sample	Stainless steel, 215mm long × 75mm wide with 13mm support gauze of its length bent to form a right angle at one end
Specimen mandrel form	12.7 ± 0.5mm diameter rod, used in Thin Burning Material Test

Due to **FTT**'s continuous development policy, specification could change without prior notice

SERVICES	
Gas Supply	A supply of technical grade methane gas, (min 98% pure), with a regulator for uniform gas flow. The connection to the chamber is a 6mm diameter hose barb.
Extraction	The extraction from the chamber must be connected to a suitable exhaust point, e.g. fume cupboard.
Power	Electrical power providing, 230VAC 50/60Hz, 1A or 110VAC 50/60Hz, 2A must be available at the test apparatus. (Check services label)
Conditioning	Specimens are preconditioned in accordance with ASTM D 618 (ISO 921) at 23 ± 2°C and 50% relative humidity for a minimum of 48 hours. Specimens for certain tests are to be preconditioned in an air-circulating oven for 168 hours at 70 ± 1°C and then cooled in the desiccator for at least 4 hours at room temperature, prior to testing. Once removed from the desiccator, specimens shall be tested within 30 minutes. All specimens are to be tested in a laboratory atmosphere of 15-35°C and 45-75% relative humidity. Cotton shall be conditioned in the desiccator for at least 24 hours prior to use. Once removed from the desiccator, the cotton shall be used within 30 minutes.
Test Accessories	Cotton – a supply of absorbent cotton wool, (100% cotton). Adhesive tape.

Vertical/Horizontal Wire Flame Test

(UL 1581)

UL 1581:
UL Standard for Safety for Electrical Wires, Cables, and Flexible Cords

1. Adjustable sample support brackets
2. Calibration arm and clamp
3. Burner assembly
4. Burner cotton table

Fire safety for electric cable products is more important than ever. Manufacturers, re-sellers and end-users of wire and cable products need to be aware of the latest regulations and the products which meet those standards. The UL 1581 is an internationally recognised standard test for these products.

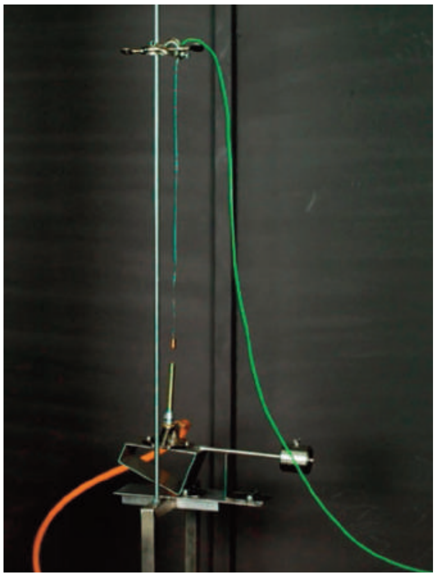
The **FTT** UL 1581 test for flammability of cable materials gives a preliminary indication of their suitability for a particular application. The apparatus is supplied as a complete system incorporating all the features necessary for ease of use and safety. It conforms to UL 1581 vertical specimen Bunsen burner tests and associated international standards.

These are:

1. 1060. Vertical Flame and FT1 Tests
2. 1061. Cable Flame Test
3. 1080. VW-1 (Vertical Specimen) Flame Test
4. 1090. Horizontal-Specimen Appliance-Wire Flame Test
5. 1100. Horizontal-Specimen/ FT2 Flame Test

Features and Benefits

- 2 Large doors with windows made from heat resistant ceramic glass giving a generous view of the specimen during a test.
- Fully adjustable vertical specimen supports.
- Fully adjustable horizontal specimen supports.
- A burner in compliance with ASTM D5025, with pre-determined angle adjustment (0°, 20°, rest) and integral gas control, gas/air mix controls and manometer.
- A solid state gas safety system ensuring maximum operator safety during the test setup and testing activities.
- Two access ports with airtight gauntlets enabling access to the chamber for movement of the burner and specimen.
- Digital test duration timer supplied.
- Low voltage chamber lighting.
- Smoke extraction system with automatic inlet and exhaust dampers.
- Digital differential pressure gauge.



The tip of the Copper Slug is positioned at 25mm above the burner tube during the calibration procedure

Instrument access via airtight gauntlets and viewing panel

TECHNICAL SPECIFICATIONS	
Measuring principle	Assessment of combustibility of cable or wire subject to Tirrill burner
Sample	455mm long cut from a sample length of the finished cord, wire, cable, or cord conductor
Burner	Adjustable 0°, 20° and rest positions ASTM D5025 compliant Tirrill burner
Thermal sensor	Type-K, stainless steel thermocouple
Manometer	0-150mmWC
Burner cotton table	305mm (H) × 305mm (W) × 355mm (L)
External dimensions (approx.)	2500mm (L) × 2000mm (H) × 1060mm (D)
Internal test chamber dimensions	2450mm (L) × 1800mm (H) × 900mm (D)
Internal chamber volume	$4.0m^3$

The instrument is certified to EMC 2004/108/EC

1. **Extraction outlet (not shown)**
2. **Safety glass observation panels**
3. **Gauntlet access**
4. **Control panel**
5. **Automatic air intake vent (when extraction is in use)**

SERVICES	
Electricity	96-264 AC 8A, 50/60Hz
Gas	A supply of technical grade methane gas (min. 98% pure) with regulator and meter for uniform gas flow. (Connection via 6mm compression fitting)
Extraction	The supplied exhaust fan must be connected to a suitable exhaust point,e.g. fume cupboard or external extraction system. Outer diameter of exhaust chimney =100mm. An air intake vent automatically opens when extraction is switched on.
Conditioning	This test is to be performed on un-aged specimens. The specimens,the apparatus, and the surrounding air are to be in thermal equilibrium with one another at a temperature of 23.0 ± 5.0°C.
Test Accessories	Cotton – a supply of absorbent 100% cotton. A strip of un-reinforced 60lb or $94g/m^2$ Kraft paper that is ½ inch or 10mm wide, at or near 5mils or 0.1mm thick.

Ignitability Apparatus

(ISO 5657, BS 476 Part 13 Ignitability of building products using a radiant heat source)

ISO 5657, BS 476 Part 13: Ignitability of building products using a radiant heat source

The capability of a material to be ignited is a critical property to measure and is a highly important element in any assessment of fire hazard.

The Ignitability Test Apparatus allows the user to carry out crucial tests that conform to ISO 5657 and BS 476 Part 13. The Apparatus has been designed, principally for testing building materials and composites, but it is capable of testing any sample of size 165mm × 165mm and up to a maximum of 70mm thick. The apparatus measures the ignition characteristics of exposed surfaces of essentially flat materials and specimens mounted in a horizontal orientation.

The FTT Ignitability Apparatus

The test apparatus consists of a support framework which clamps the test specimen horizontally between a pressing plate and a masking plate such that a defined area of the upper surface of the specimen is exposed to radiation.

This radiation is provided by a radiator cone positioned above and supported from the specimen support framework. An automated pilot flame application mechanism is used to bring a test flame through the radiator cone to a position above the centre of the surface of the specimen. A specimen insertion and location tray is used to position the specimen accurately on the pressing plate of the specimen support framework and a screening plate is used to shield the surface of the specimen during its insertion into the apparatus.

Main Features

Test apparatus

- Framework for the cone sample support mechanism
- Radiator cone assembly
- Radiation levels between 10-50kW/m^2 using a conical radiation furnace
- Counter weight for pressing plate
- Pilot gas line with flashback arrestor and provision for re-ignition
- Pilot flame application mechanism and motor drive assembly to bring pilot flame into the correct position above the plane of sample every 4 seconds
- Secondary ignition source.

Control Unit

- 3-term temperature controller
- Temperature indicator and over temperature alarm
- Pilot speed controller
- Timer

The apparatus is also supplied with a Flux Meter for calibration purposes.

TECHNICAL SPECIFICATIONS	
Measuring principle	Ignitability of material sample subject to radiant heat source
Radiator cone	10-50 kW/m^2
Temperature control	2 × Type K thermocouple
Heat flux measurement	Schmidt-Boelter heat flux meter for measuring the test heat flux
Control unit (Front panel)	• Heater Control – Temperature Controller. • Temperature Indicator and over-temperature alarm. • Timer. • Pilot speed controller. • Propane on/off valve – turns off propane to pilot and secondary ignition. • Propane flowmeter – measures gas flow to pilot, setting required approximately 20cm^3/min. • Air on/off valve – turns off air to pilot flame. • Air flowmeter – measures air flow to pilot, setting required approximately 160cm^3/min. • Needle valve for adjusting height of flame for secondary ignition. • Control switches comprising: – 3 red on/off push button switches which operate by firm pressure and light up when activated. – Power – switches on mains electricity to the control unit. – Cone – switches on power to the cone heater. – Motor – switches on power to the pilot drive motor.
Control unit (Back panel)	• Mains in cable. Supply required 230VAC 15A, 50/60Hz • 4-pin socket power output to cone heater • 3-pin socket power output to pilot drive motor • 2-off thermocouple sockets, type K • Propane gas inlet • Air inlet • Pilot outlet • Secondary ignition outlet

Due to **FTT**'s continuous development policy, specification could change without prior notice

SERVICES	
Power	230VAC 15A, 50/60Hz
Gas	Propane and Air for the pilot flame
Water	200-300 ml/min water flow through the system at room temperature, i.e. 15-30°C
Extraction	A proprietary extraction system or fume chamber is recommended

The Federal Motor Vehicle Safety Standard No. 302

(FMVSS 302; ISO 3795)

Ignitability

The **FTT** FMVSS 302 consists of:

- Stainless Steel combustion chamber
- Gas controls and safety flash back device
- Ignition source with fine adjustment valve
- Specimen holder

The **FTT** FMVSS 302 is manufactured according to the Federal Motor Vehicle Safety Standard No. 302. The FMVSS 302 specifies the burn resistance requirements for materials used in the occupant compartments of motor vehicles (i.e. passenger cars, multipurpose passenger vehicles, trucks and buses). This is to reduce the deaths and injuries to motor vehicle occupants caused by vehicle fires, especially those originating in the interior of a vehicle from sources such as matches or cigarettes.

Combustion Chamber

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

The test is conducted within the chamber which protects the test specimens from drafts. The interior of the cabinet is 381mm long × 203mm deep × 356mm high. It has a high temperature resistant glass observation window which can be easily removed for cleaning, a thermal warning indicator to warn of hot surfaces, 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. For ventilation, the chamber is elevated 10mm by feet fitted to the base of the chamber. Additionally, the chamber roof is raised by 13mm to allow ventilation.

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 flash back arrestor, which is a standard 6mm hose barb.

Ignition Source

A choice of Bunsen burner tubes is provided. The tube marked with ISO has a 9.5mm inside diameter and is suitable for the ISO 3795 test. The tube marked with FM has a 10mm inside diameter and is suitable for the FMVSS test. The Bunsen burner tube can be interchanged and cleaned very easily. 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 38MJ/m^3. The suggested gas supply is natural gas or a flame temperature equivalent.

Specimen Holders

The test specimen is inserted between two matching U-shaped stainless steel frames 25mm wide × 10mm high. The interior dimension of the FMVSS and the ISO 3795 U-shaped frame is 50mm wide × 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 diameter, spanning the width of the U-shaped frame under the specimen at 25mm intervals.

Results

The burn rate is calculated from the following formula:

$$B = 60 \times \left[\frac{D}{T}\right]$$

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

Key Advantages

- Fully compliant to FMVSS 302 and ISO 3795 requirements depending on which sample holder is used.
- Complete and ready to use system.
- Low maintenance requirement.

TECHNICAL SPECIFICATIONS	
Measuring Principle	Horizontal Flammability Test
Bunsen Burner Tubes Diameter	9.5mm & 10mm supplied
Cabinet Dimensions (interior)	381mm (W) × 203mm (D) × 356mm (H)
System Dimensions	450mm (W) × 205mm (D) × 390mm (H)
Optional sample holders	FMVSS & ISO 3795 (specify at time of order)

SERVICES

Condition	Requirement
Test Room	The FMVSS should be situated in a draught free environment and the requirements for the temperature and relative humidity for the test room/fume cupboard should be followed as specified in the standard used (ISO 3795, FMVSS 302 etc.)
Gas Supply	A supply of natural gas. In order to obtain flame stability the gas pressure shall be between 10kPa and 50kPa.
Hood	The combustion chamber should be situated under a suitably ventilated hood.

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

Federal Aviation Regulation Bunsen Burner Test Apparatus

The **FTT** Federal Aviation Authority (FAA) Bunsen Burner Test Apparatus conforms to the fire test methods described in FAA Aircraft Material Fire Test Handbook for aircraft materials. The apparatus is supplied as a complete system incorporating all the features necessary for ease of use and safety. It enables the user to test according to five Federal Aviation Regulation (FAR) test methods. These are:

- Vertical Bunsen burner test for cabin and cargo compartment materials
- 45-Degree Bunsen burner test for cargo compartment liners and waste stowage compartment materials
- Horizontal Bunsen burner test for cabin, cargo compartment, and miscellaneous materials
- 60-Degree Bunsen burner test for electric wire
- Recommended procedure for the 4-ply horizontal flammability test for aircraft blankets.

Features

- A bench mounted draft free stainless steel combustion chamber having a large inside volume of $0.85m^3$ and fitted with an interior light and exhaust fan to enable simple evacuation of combustion products
- In addition to the chamber five sample mounting systems are offered for the five test methods listed above. Any one is readily replaced by a an alternative mounting system
- Three digital test duration timers for accurate but simplified operation
- A burner and precision gas control system including gas flow meter, pressure regulator and pressure gauge
- Two access ports enabling easy entry to the chamber for movement of the burner and specimen
- Large door and window made from toughened safety glass giving a generous view of the specimen during a test
- Flame height indicator

FTIR: an Advanced FTIR for Toxic Gas Analysis

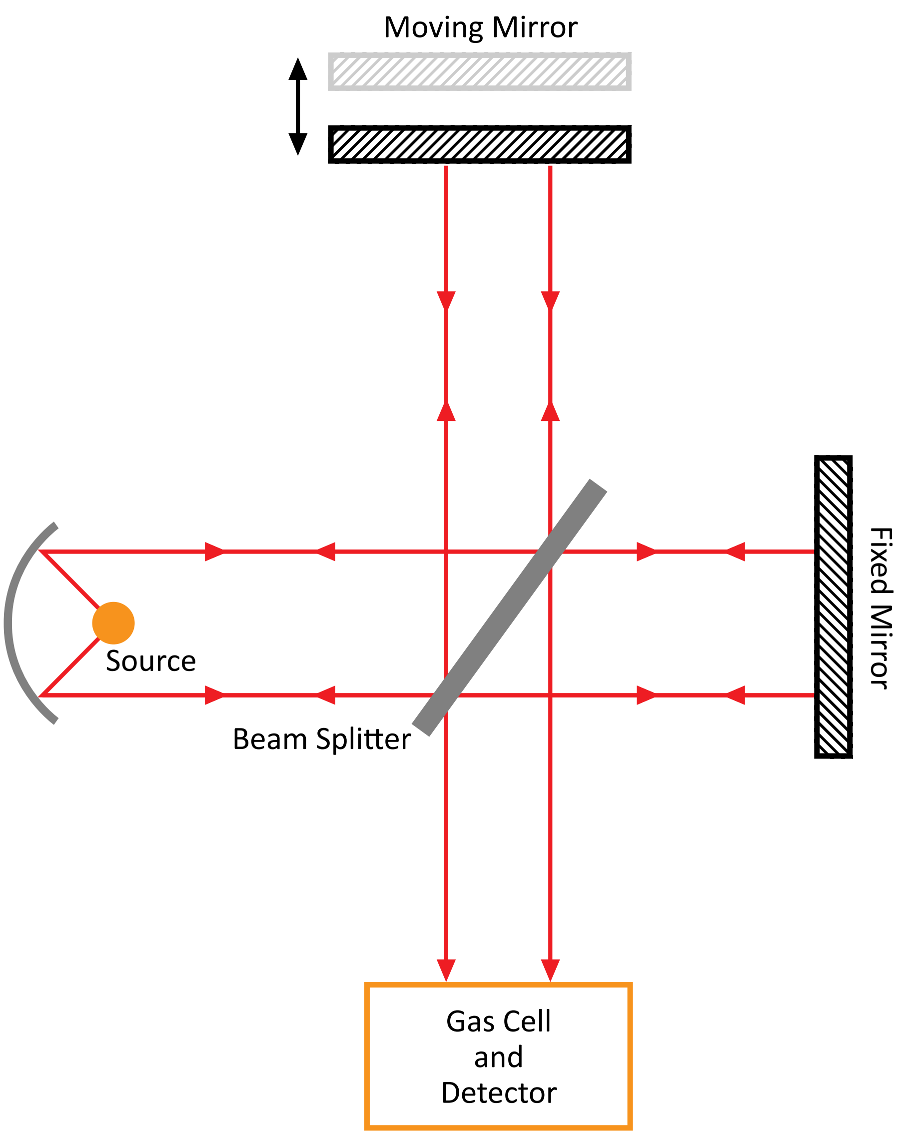
(ISO 19702; EN 45545-2; IMO)

Toxicity analysis of fire effluents is an important aspect for developing modern materials used in aircrafts, trains and buildings to ensure public safety. Analytical techniques and performance criteria have been specified in various fire safety standards and regulatory codes. FTIR is the technique that has been chosen by the ISO, EN and IMO standardisation committees as the most suitable method for measuring toxic fire effluents. The commonly targeted toxic species are CO, CO_2, HCN, SO_2, NO_x, HCl, HBr and HF.

Fourier Transform InfraRed (FTIR) Spectroscopy

FTIR spectroscopy is a full-spectrum analytical technique that allows all IR absorbing species to be detected and measured by a single instrument.

The infrared light from the source is modulated by the interferometer. This device allows for the light to be split into two different paths and recombined, producing an interference wave known as an interferogram. The light is split via an optical device known as a beam splitter.



Classic Michelson Interferometer

The use of a monochromatic or single wavelength light source, typically a laser, is used to provide a reference signal in the interferometer. Measurement of the interference pattern of the single wavelength allows the speed of interferometer's mirror movement and alignment to be controlled precisely.

The light is passed through a sample compartment which is often referred to as the sample cell or gas cell. Sample cells can be of various designs in order to achieve the most suitable pathlength i.e. total length that the IR light passes through the absorbing medium. For long pathlengths (of the order of meters) this usually involves the use of mirror arrangements to bounce the light through the sample medium. As the sample cell contains the extracted sample medium, care has to be taken that the sample cell is constructed of suitable materials and operates at the required temperature and pressure.

An infrared detector, e.g. deuterated triglycine sulfate (DTGS) detector, and associated electronics are required to make single point measurements of the infrared signal as the interferometer scans.

An FTIR analyser does not directly produce a spectrum for analysis; an interferogram is produced. This is time-domain measurement of IR signal and contains the modulated wave of the entire broad band source. To extract the IR spectrum a mathematical manipulation called a

FTT FTIR (left) and FTT Smoke Density Chamber (right)

Fourier Transform must be applied to the interferogram. The mathematics of this are all handled in software in real-time.

The resulting single-beam or intensity spectrum is then compared against a zero or background spectrum to produce an absorbance spectra. This absorbance spectrum is what we need to run a spectral analysis, applying Beer's Law.

Beer's Law describes the linear relationship between IR absorbance and concentration when variables such as temperature, pressure and path length are kept the same. With absorbance spectra collected and saved, chemometric techniques can be applied to extract concentration information. FTIR spectroscopy is considered the most suitable analytical technique for measuring toxic gas species in fire effluents because:

- a variety of gases across wide concentration ranges can be determined by a single method;
- monitoring of species development throughout the fire is possible with time resolved measurements;
- toxicants can be identified or reanalysed retrospectively in the stored spectra from previous experiments.

FTT FTIR System

FTT has been at the forefront of supplying a turnkey solution of FTIR system in analysing toxic gases in fire effluents. The makeup of this turnkey solution comprises of an advanced FTIR analyser, heated sampling system including all the pneumatics, control/processing electronics and an industrial PC, which are mounted in a 19" cabinet for easy accessibility and service.

FTT FTIR is an advanced FTIR gas analyser used for continuous gas monitoring in conjunction with FTT's Cone Calorimeter, Smoke Density Chamber and Single Burning Item (SBI) for online measurements of combustion gases in fire tests.

Spectroscopic data are often complex, containing large numbers of features which often overlap. The analysis of gases in fire effluents is especially challenging due to the great number of different organic and inorganic chemicals which representative atmospheres can contain.

FTT FTIR software uses chemometrics to resolve data into meaningful and accurate information. It offers users the ability to perform chemometrics analysis on data sets. This software is designed so that untrained users can simply run preloaded models, but will also allow more advanced users to build and develop models.

FTT's application specialists have experience of developing and implementing chemometric techniques on various projects. We can provide in depth training courses on chemometric techniques and data analysis of spectroscopic measurements, enabling users to fully benefit from this powerful software.

As any chemometric technique will only ever be as good as the calibration data it is based on, FTT FTIR is calibrated in a purpose built calibration lab using certified traceable standards.

FTT FTIR is fully configurable to meet the requirements of EN 45545-2, ISO 19702 and IMO standards. In addition, various process monitoring applications are also possible. Measured components and calibration ranges can be selected according to application.

FTIR Gas Analyser

The FTIR gas analyser is an integral part of the system which allows simultaneous measurement of multiple gas compounds.

Typically concentrations of H_2O, CO_2, CO, SO_2, NO, NO_2, N_2O, HCl, HF, NH_3, etc. are continuously measured.

The analyser has a multi-pass gas cell which is heated to 180°C. The gas cell mirror is gold plated with protective MgF_2 coating which ensures high performance even in high water vapour concentrations or corrosive gases.

The analyser also has an internal solenoid valve to allow zero gas (usually 99.999% N_2) to pass to the gas cell for cell evacuation and zero background measurements. This can be set as a Normally Open (NO) valve which provides a failsafe in case of power failure to ensure the gas cell is purged and gas does not condense on the optics.

Pressure transducer is installed to monitor the pressure inside the gas cell. Fluctuations in the cell pressure will be corrected for in real-time by software.

FTT FTIR System Interior (front door opened)

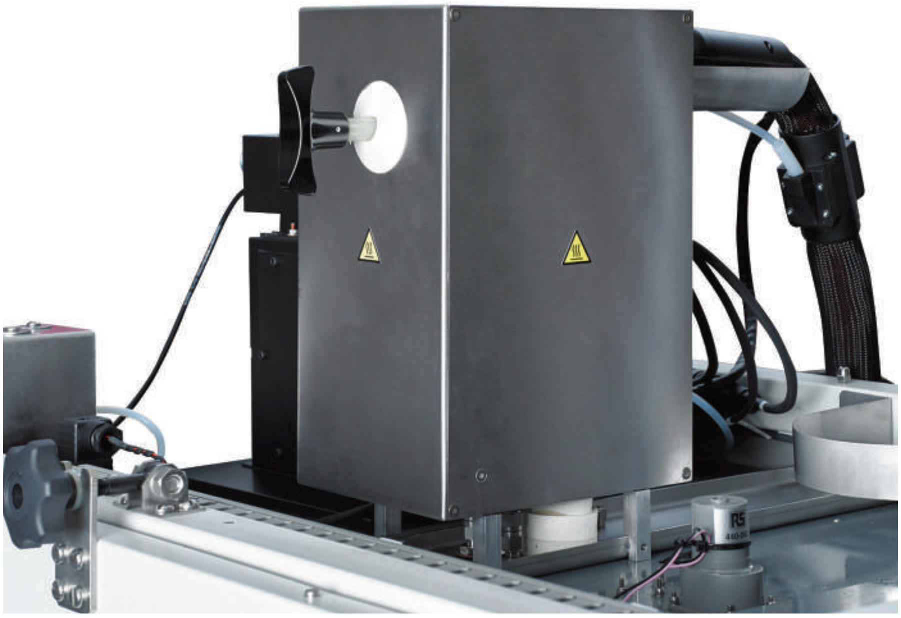
Sampling System

The hot extractive sampling system consists of a heated sample probe, heated filter, heated sample lines and heated pump unit. The whole system is kept at 180°C to avoid condensation and subsequent washing of soluble fire gases out of the sample. Two stage particle filtration is used in order to remove particles from the sample gas. The sample pump unit includes gas connections for the FTIR gas analyser. All sample lines have a PTFE core sample line of 6mm OD, 4mm ID, together with a secondary line for calibration/span gas. End fixtures are stainless steel which is robust and provides long lifetimes.

Panel PC

The touchscreen panel PC is required to operate the analyser, to control the sampling system, to translate measured and analysed concentrations and send alarms to higher level automation and control systems. It is also used for processing and storing the sample spectra.

FTT FTIR is supplied with a suite of three analytics software.



Heated filter/valve unit, PTFE filter can be easily replaced from the front

valuable tool for the analyst working with spectra, e.g. adding, subtracting, multiplying and dividing spectra, peak position locator, baseline correction, etc.

PAS – From Spectrum to Results

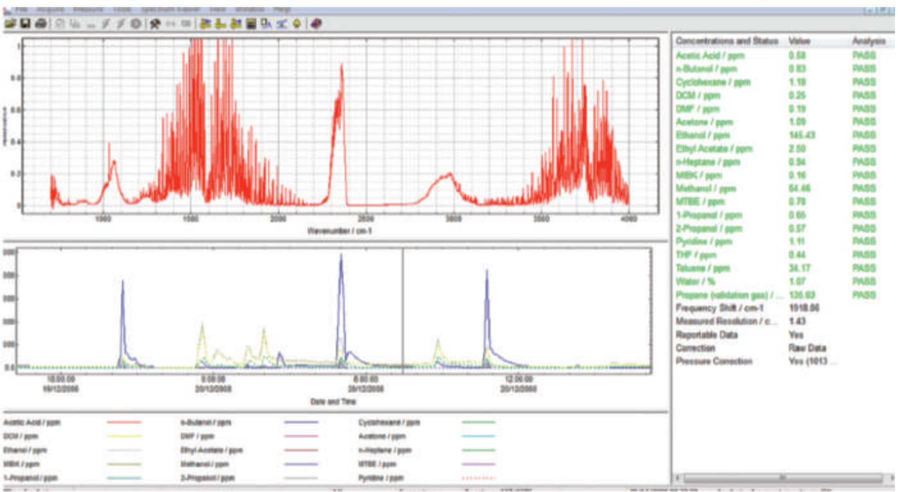
The advanced, easy to use PAS software provides outstanding analytical performance. It analyses the sample spectrum using sophisticated chemometrics. It is capable of simultaneous detection, identification and quantification of multiple gas species.

i. **PAS-Pro**
   Analyser Software for Process (installed on built in touchscreen PC) PAS-Pro is a very simple to use but comprehensive user interface with setup menus for running the FTIR and control of all system parameters. It displays real time analytical measurements for the selected gases with an optional “Pass” and “Fail” result quality indicator next to each measurement. There is an alarm window which indicates any faults with the system and an event log updates with each task the system has carried out.

ii. **PAS Analyser Software (installed on standalone PC)**
   Collected FTIR data (results and spectra) can be downloaded from the test station and transferred to another PC for further analysis using PAS which allows the analysis to be checked and interfering species to be identified. It gives the user complete flexibility over the FTIR acquisition parameters and allows complex analytical models to be built. Models can be span corrected to match reference gas cylinders and linearity checks can be made for compliance with performance standards.

iii. **Spectrum Viewer (installed on standalone PC)**
   It is a standalone application for manipulating spectra and identifying species that are present. It contains no analytical or collection routines, but is a valuable tool for the analyst working with spectra, e.g. adding, subtracting, multiplying and dividing spectra, peak position locator, baseline correction, etc.

Cross-interference effects are compensated for and analysis accuracy is maintained even when analysing complex gas mixtures where there is a possibility of spectral overlapping. Resolution is carefully optimised to meet requirements in fire tests. This allows the collection of several measurements every minute whilst retaining high sensitivity. PAS also allows for model switching based on constants or other variables. For example, two chemometric models can be built over different ranges, one 0-100ppm, and one 100-



1000ppm. PAS will automatically switch and use the most suitable model for the current concentration mix.

PAS software is designed for easy and efficient processing of the results. Advanced modelling methods of PLS (Partial Least Squares) are used for accurate and robust analytical predictions, even in the presence of unknown interfering gases. PLS models are built on a component specific basis

and are factor based, constructing a model with the optimum number of factors that models the specified gas in the full matrix.

There is no limit to the number of gases that can be measured at one time with PAS software. Sample spectra are stored as separate files on the computer, they can be easily reanalysed with different analysis settings for previously unknown interfering gases. PLS models are built on a component specific basis

and are factor based, constructing a model with the optimum number of factors that models the specified gas in the full matrix.

There is no limit to the number of gases that can be measured at one time with PAS software. Sample spectra are stored as separate files on the computer, they can be easily reanalysed with different analysis settings for previously unknown species retrospectively.

Key Features and Benefits

- Complete turnkey solution for reliable and accurate analysis of toxic gas species in fire effluents
- Time resolved results enabling continuous monitoring of multiple gas speciesdevelopment
- Hot extractive sampling; no sample loss or change of composition
- Fully automated measurement system with comprehensive safety functions
- Fully modular system for maximum flexibility
- Fully configurable to meet requirements of ISO 19702, EN 45545-2 and IMO standards.
- Capable of individual analysis of airborne concentrations of CO, CO_2, NO, NO_2, SO_2, HCl, HF, Phenol, Acrolein, water vapour, etc.
- Powerful PAS software suite for different operational and analysis requirements
- Span and linearity correct models
- Pressure correction, dilution correction, dry/O_2 correction of data
- Spectra saved with date and time stamped name
- Specially configured file contains all chemometric models and analysis information
- Final results selection allows best model to be selected for given range
- Report concentration results as ppm, mg/m^3 or %Vol

TEST PARAMETERS	
General Parameters	
Measuring Principle	FTIR (Fourier Transform Infrared) Spectroscopy
Performance	Unlimited simultaneous analysis of multiple gases, preloaded analysis for 21 gas species
Operating Temperature	+5°C to +35°C, non-condensing, dust free ambient air
Storage Temperature	20 - +60°C
Response Time (T_{90})	Depending on the gas flow and measurement time
Resolution	4 cm^{-1} standard. 1 cm^{-1} optional
Wavenumber Range	399.718 – 5000.088 cm^{1}
Gas Cell	Ni-plated aluminium gas cell of volume 0.3 litres Ambient pressure during normal operation
Gas Cell Temperature	180°C (variable)
Gas Cell Volume	0.3 litres
Gas Cell Path Length	4.2 m (standard, but changeable)
Optics	Non-hygroscopic Zinc Selenide beam splitter Barium Fluoride gas cell windows (changeable dependent on application) Diamond turned aluminium gas cell mirrors with protected gold coating
Reference Laser	Solid state laser
Source	MidIR source, ceramic Globar With advanced electronic stabilisation and temperature measurement
Detector	DTGS
Sample Gas	Non-condensing, particle free
Flow Rate	Approximately 4 l/min (variable via external flow orifice)
Sample Gas Pressure	Ambient
Dimensions	600 mm (L) × 600 mm (W) × 1400 mm (H) (not incl. castors or plinth)
Net Weight	Approx. 125 kg

Measuring Parameters	
Zero Point Calibration	24 hours, calibration with Nitrogen (5.0 or higher N_2 recommended)
Zero Point Drift	< 2% of measuring range per zero point calibration interval
Sensitivity Drift	< 2% of measuring range over 24 hours
Linearity Deviation	< 2% of measuring range
Temperature Drifts	< 2% of measuring range per 10 K temperature change
Detectable Limits	Gas dependent, but all <2% measurement range
Pressure Influence	1% per 1% change in sample pressure. Pressure measured and compensated for in gas cell

Heated Line	
Tube Size	4 mm ID/6 mm OD
Core Material	PTFE core
Operating Pressure	Max. 400 kPa (4 bar)
Temperature	180°C
Fittings	6mm Swagelok
Power Supply	230 VAC or 115 VAC
Power Density	90 Watts/metre
Length	Varies for different application requirement. Lengths from 3 metre to 50 metre can be supplied

Electrical Connections	
Main Supply	115V or 230V 50/60Hz
Power Consumption	The full system including the FTIR Gas Analyser, Touchscreen PC, Heated Filter/Valve Sampling Unit, Sampling Probe and Heated Sampling Lines approximately 2 kW

Gas Species

• H_2O	• CO_2	• CO	• NO	• NO_2	• N_2O	• SO_2
• HCl	• HCN	• HBr	• HF	• NH_3	• CH_4	• C_2H_6
• C_3H_8	• C_2H_4	• C_6H_{14}	• HCHO	• C_6H_5OH	• C_3H_4O	• COF_2

GAS	UNIT	RANGES	
H_2O	%Vol	0-30	
CO_2	%Vol	0-2	0-5
CO	ppm	0-3000	0-10000
NO	ppm	0-500	
NO_2	ppm	0-500	
N_2O	ppm	0-500	
SO_2	ppm	0-1000	
HCl	ppm	0-100	0-5000
HCN	ppm	0-500	
HBr	ppm	0-100	0-1000
HF	ppm	0-100	0-1000
NH_3	ppm	0-500	
CH_4 (Methane)	ppm	0-1000	
C_2H_6 (Ethane)	ppm	0-100	
C_3H_8 (Propane)	ppm	0-100	
C_2H_4 (Ethene)	ppm	0-100	
C_6H_{14} (nHexane)	ppm	0-100	
HCHO (Formaldehyde)	ppm	0-20	
C_6H_5OH (Phenol)	ppm	0-200	
C_3H_4O (Acrolein)	ppm	0-300	
COF_2 (Carbonyl Fluoride)	ppm	0-50	

Due to the continuous development policy of **FTT** technical changes could be made without prior notice.

SERVICES	
Power Supply	230 VAC – 50/60 Hz – 13 A
Gas Supplies	Purge gas: dry, filtered, oil-free compressed air at 1.0 bar, flow rate approx. 1 ℓ/min, with pressure regulator Zero gas: Nitrogen 5.0 at 1.0 bar, flow rate approx. 3 ℓ/min, with pressure regulator Check gas: typically 200 ppm Sulphur Dioxide + 90 ppm Ethylene + balance of Nitrogen at 1.0 bar, flow rate approx. 3 ℓ/min, with pressure regulator
Extraction	Exhaust from the analyser flowing at 4 ℓ/min through a 6 mm tube must be vented safely to atmosphere
Operating environment	15°C-25°C, non-condensing atmosphere

Toxicity Test Attachment for NBS Smoke Density Chamber

(ABD0031)

Using in conjunction with the NBS Smoke Density Chamber, gaseous/volatile test products are drawn from the chamber at any time for analysis through three ports on the top of the chamber. One of these ports is used to connect to the ABD0031 vacuum box.

This test method is used for evaluating materials or constructions used in the interior of aerospace vehicles, but may be utilised for other applications as specified in applicable procurement and regulatory documents. It is used to measure and describe the properties of materials, products or assemblies in response to heat and flame under controlled laboratory conditions. Results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

Test on Gases Evolved During Combustion of Electric Cables

(IEC 60754 Part 1 and Part 2)

The International Electrotechnical Commission IEC 60754 Part 1 and Part 2 test is performed to determine the degree of acidity of gases evolved during the combustion of materials taken from electric cables by measuring the pH and conductivity.

Cable users have expressed concern over the amount of acid gas which is evolved when cable insulating, sheathing and other materials are burnt as this acid can cause extensive damage to electrical and electronic equipment not involved in the fire itself. It has been considered necessary, therefore, to develop an approved method (by extensive round robins) for determining the amount of acid gases evolved by burning cable components so that limits can be agreed for cable specifications. As the test is not carried out on a complete cable test piece, for a hazard assessment the actual material volumes of the cable components should be taken into consideration.

Instrument Features

- Tube furnace, support stand and thermocouples
- Quartz work tube and sample lading assembly
- Control unit with digital temperature controller for tube furnace, optional over temperature device and sample temperature indicator
- 2 gas collection bottles
- Gas cell 1 litre
- pH and conductivity measuring instruments with digital display and electrodes
- Stirrer
- Air flowmeter and all necessary tubes and connections
- 10 ceramic sample boats

Naval Engineering Standard

(NES 713)

NES 713:

U.K. Naval engineering standard for the determination of the toxicity index of the products of combustion from small specimens of material

The NES 713 test explores the toxicity of the products of combustion in terms of small molecular species arising when a sample of a material is completely burnt in excess air under specified conditions. The test does not necessarily determine the total toxicity of all the constituents of the products of combustion.

The test is useful for the quality control of materials and for research and development. It may be used to compare the particular combustion characteristic of a series of both natural and synthetic materials.The test may be used to specify a quality of a raw material or product. Combustion characteristics tests alone are not suitable for assessing the total fire hazard of products under actual fire conditions.

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 $1m^3$.

The Control Unit houses the flowmeters, timer, methane and air controls

Features and Benefits

The **FTT** NES 713 is a closed chamber of fixed volume in which specimens can be subjected to a premixed burner.

The system comprises of the Combustion Chamber, Combustion Control Unit and a Gas Analysis System with colorimetric tubes.

- 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 which automatically re-ignites should the flame extinguish.
- An internally mounted stirring fan for rapid mixing of combustion products.
- Solenoid operated vent seal
- 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 flowmeters, timer, methane and air controls.
- A forced-air extraction system for evacuating the chamber after a test.

TECHNICAL SPECIFICATION	
Combustion Chamber	
Measuring principle	Determination of combined toxicity index of gaseous species arising from a material subject to flaming combustion
External dimensions	1100mm (W) × 800mm (D) × 1300mm (H)
Internal dimensions	728mm (W) × 982mm (D) × 982mm (H)
Internal volume	0.7m^3
Burner	Bunsen burner and spark igniter with safety sensor
Maximum temperature	1200°C
Weight	70kg

Control Unit	
Dimensions	530mm (W) × 270mm (D) × 280mm (H)
Flowmeter	Valves for Natural Gas/Methane and Air
Second/Minute timer	Digital timer

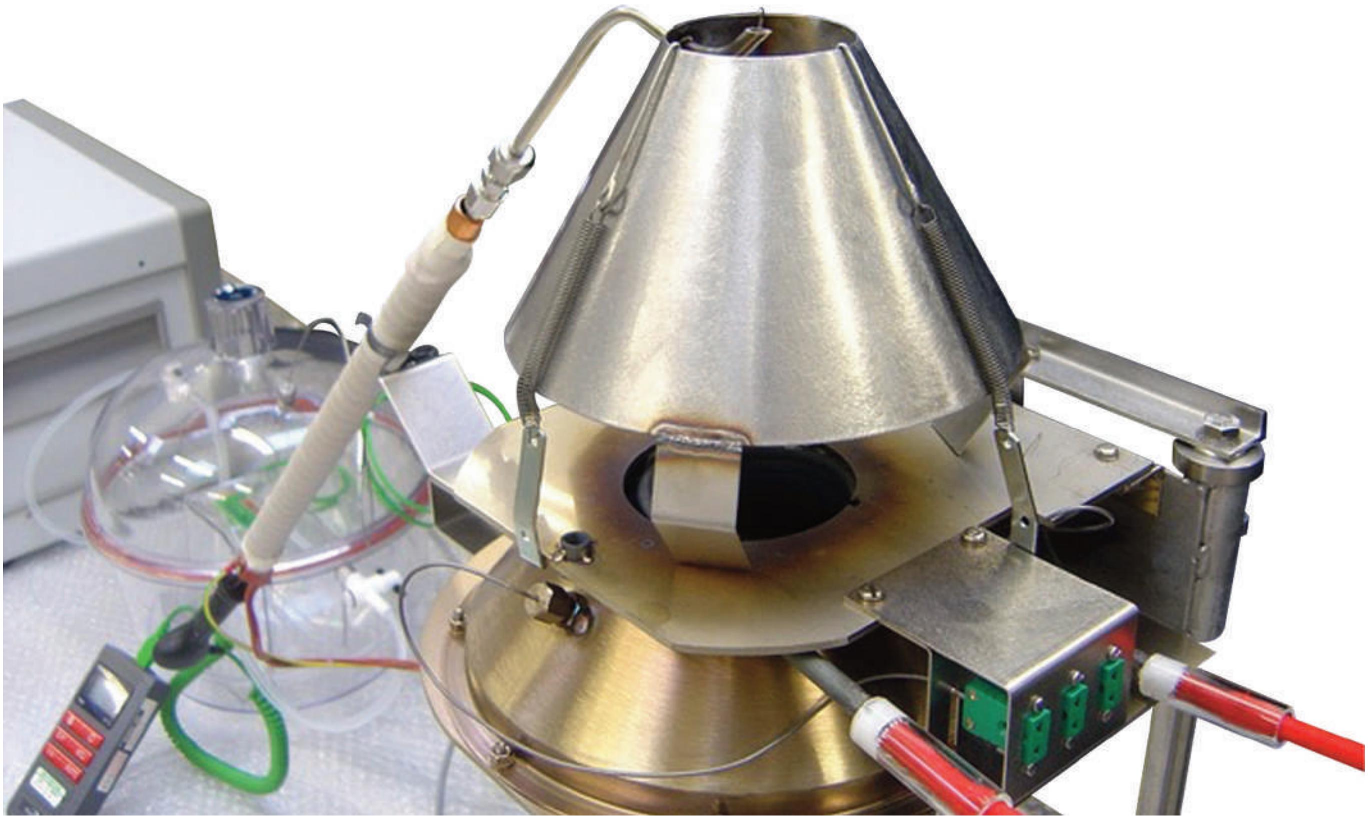
Drager Gas Detection Tubes		
Carbon Dioxide	0.1-6%	± 5-10%
Carbon Monoxide	5-700 ppm	± 10-15%
Hydrogen Sulphide	1-200 ppm	± 15%
Ammonia	0.5-10%	± 10-15%
Formaldehyde	0.2-5 ppm	± 20-30%
Hydrogen Chloride	1-10 ppm	± 10-15%
Acrylonitrile	0.2-50 ppm	± 15-20%
Sulphur Dioxide	1-25 ppm	± 10 -15%
Nitrous Fumes	2-100 ppm	± 10-15%
Hydrogen Cyanide	0.5-50 ppm	± 10-15%
Hydrogen Fluoride	0.5-90 ppm	± 20-30%
Phosgene	0.02-1 ppm	± 10-15%
Phenol	1-20 ppm	± 10-15%
Hydrogen Bromide	1-10 ppm	± 10-15%

Due to **FTT**'s continuous development policy specifications could change without prior notice.

SERVICES	
Power	Dual voltage - 110VAC 3A, 60Hz; 230VAC 2A, 50Hz
Gas	Methane gas up to 2l/min flow rate
Air	Compressed air up to 15l/min flow rate
Extraction	A fume chamber or proprietary extraction system is recommended

Cone Corrosimeter

(ASTM D5485; ISO 11907-4)



The Cone Calorimeter and Mass Loss Calorimeter can be used to determine the corrosive effect of combustion products when used with a cone corrosimeter.

To do this in accordance with the Standards protocol the combustion products generated in the unit are drawn through a dynamic exposure cell which houses a copper corrosion target.

The change in resistance of the corrosion target is used to assess the corrosive effect of the combustion products generated.

Combustion Toxicity Test Apparatus

(ASTM E1678; NFPA 269)

ASTM E1678 Test

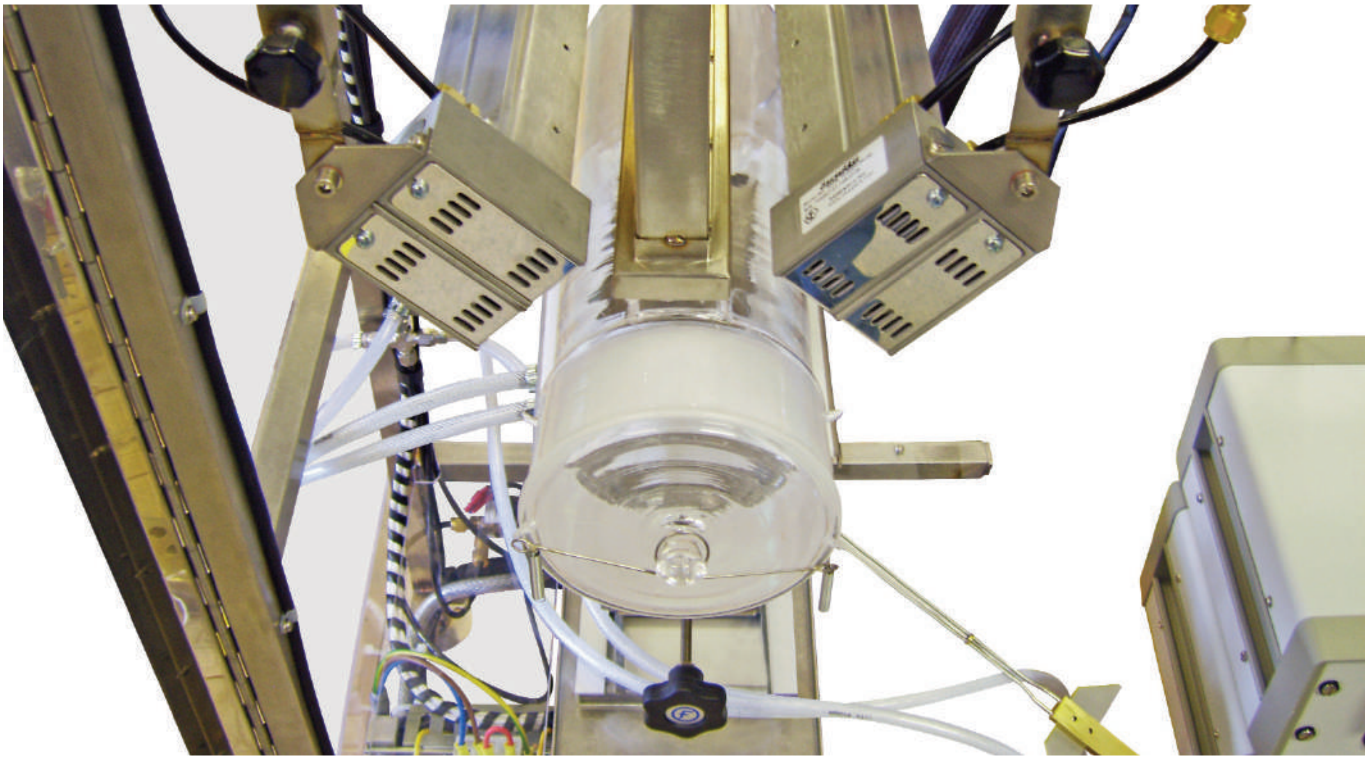
This instrument uses radiant heat with spark ignition to combust a sample of material and helps to characterise the product by measuring ease of ignition (time), rate of smoke generation (mass loss) and toxicity (gas analysis). These are essential parameters in the evaluation of the potential fire hazard of products. Future possibility of being up-graded with additional instrumentation to monitor corrosivity. The overall apparatus consists of a combustion cell and a test chamber connected by an enclosed passage (chimney).

External to the combustion cell which contains the specimen platform, are radiant heat lamps and a load cell. The test chamber has provision for colorimetric gas reaction tubes in one side of the chamber. Gas analysis instrumentation is located external to the apparatus with gas samples extracted from the test chamber. The combustion cell/test chamber and chimney are assembled in such a manner that they may be separated for cleaning.

The unit has not been designed for animal testing.

Main Features

- The sample orientation is horizontal
- Suitable for testing sample assemblies
- Polycarbonate chamber of 200 litres
- Heat flux meter
- Irradiation levels 1 0-50kW/m^2 Spark ignition
- Load Cell with sample capacity of 500g
- 15 ports for outlet to gas analyzers



TECHNICAL SPECIFICATION	
Dimensions	1600 (H) × 1200 (W) × 480 (D)
Weight	1.05kg

Due to FTT's continuous development policy specifications could change without prior notice.

SUPPLY REQUIREMENTS	
Voltage	230V - 50I60Hz m 40A
Water	For cooling apparatus

NFPA 269 Test

The NFPA 269 smoke toxicity fire test apparatus is designed to assess the toxic potency of combustion products from various materials or products, presented as planar specimens. The apparatus consists of a combustion cell and an exposure chamber, connected by an enclosed passage (chimney).

External to the combustion cell, which contains the specimen platform, are placed 4 radiant heat lamps and a load cell. The exposure chamber has six tubular housings, provided for exposing targets. Optional gas analysis instrumentation, for determination of smoke toxicity, can be purchased separately. The combustion cell, exposure chamber and chimney are assembled in such a manner that they may be separated for cleaning purposes (after a test).

Main Features

- **Exposure Chamber:** a clear polycarbonate box, 200 liters nominal volume, with inside dimensions of 1.22 × 0.37 × 0.45 m. It contains two doors: one in the front wall near the connection to the combustion cell and one in the end wall nearest the target housing ports
- **Combustion Cell:** a horizontal quartz tube with a 127 mm (5") inside diameter and approximately 320 mm (12.5") long, sealed at one end and with a large standard taper outer joint at the other end
- **Chimney:** a stainless steel assembly connecting the combustion cell to the exposure chamber
- **Smoke shutter:** inside the exposure chamber, to close over the chimney opening.
- **Radiant Heaters:** The active element of the heater consists of four quartz infrared lamps (with tungsten filaments), rated at 2000 W/240 V. The lamps are encased in water cooled holders with parabolic reflectors
- **Spark Igniter:** located inside the combustion cell, directly above the specimen.
- **Specimen Holder and Load Cell:** The specimen holder is a stainless steel assembly approximately 76 × 127 mm, inside dimensions, and 50 mm (2") deep. The specimen is backed by a layer of ceramic fibre blanket (nominally 65 kg/m^3 density). The specimen holder is placed, for testing, on a platform, inside the combustion cell and under the lamps, and connected by a rigid rod to a load cell, for continuously monitoring sample mass.

TECHNICAL SPECIFICATION	
Dimensions	1600 (H) × 1200 (W) × 480 (D)
Weight	1.05kg

Due to FTT's continuous development policy specifications could change without prior notice.

Circuit Integrity Under Fire Conditions Apparatus

(BS 6387; IEC 60331; EN 50200)

The apparatus is supplied with ability to assess:

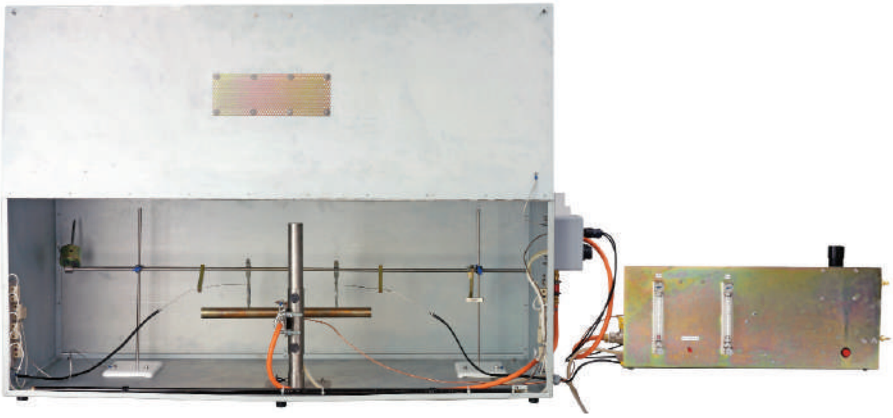
- Resistance to fire alone (BS 6387 Protocol C)
- Resistance to fire with Water (BS 6387 Protocol W)
- Resistance to fire with Mechanical Shock (BS 6387 Protocol Z)
- Resistance to fire with Mechanical Shock IEC 60331-1
- Resistance to fire with Mechanical Shock IEC 60331-2
- Resistance to fire with Mechanical Shock IEC 60331-3
- Resistance to Fire Alone IEC 60331-11
- Shock Test with Optional Water Add-on IEC 50200

1. Resistance To Fire Alone Testing (as prescribed in BS 6387 Protocol C / IEC 60331-11)

The cable in question is mounted horizontally into a chamber, constructed of Zintec, with up to 5 ring clamps. It is then exposed to a 610mm long tube-type gas burner.

Electrical continuity is checked throughout a 3-hour exposure to the gas burner set at an appropriate temperature.

Ring Clamps for Resistance to Fire Alone Testing



Resistance to Fire Alone Testing

2. Resistance to Fire with Water (as prescribed in BS 6387 Protocol W)

The cable is held with a metal support and the assembly is housed in an electrically earthed test frame which is held in a large, watertight, Stainless Steel trough.

The frame is also fitted with gas burners, a water sprinkler head and means to power and test the continuity of the cables.

A 400mm section of the cable in question is exposed to flames at 650°C, produced by a gas burner, for a period of 15 minutes.

The water spray is then switched on, in order to comply with the standard BS 6387 (Protocol W), the cable must maintain electrical integrity whilst both water and flames impinge on the cable for a further 15 minutes.

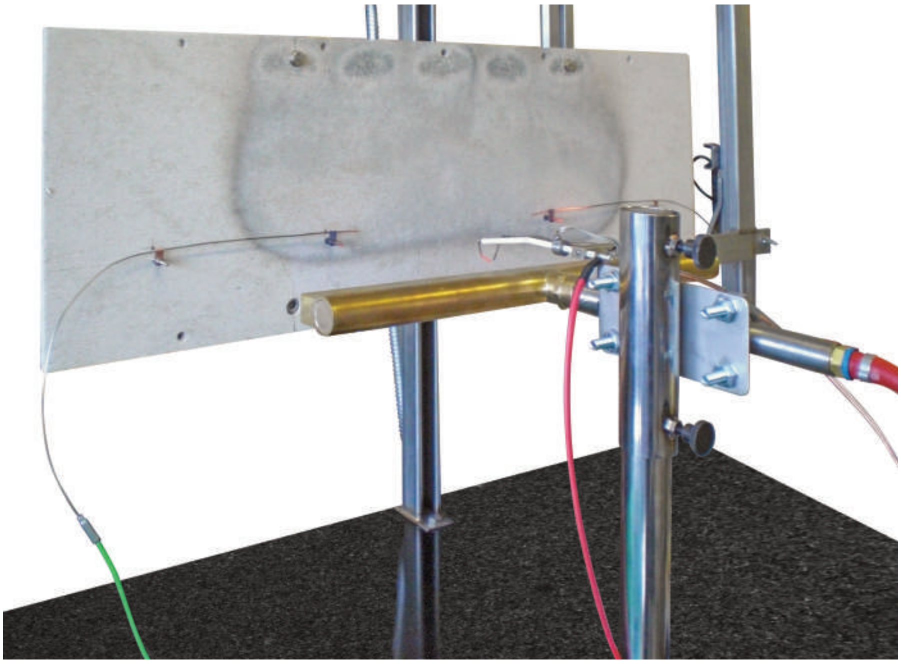
Resistance to Fire with Water (Protocol W)

3. Resistance to Fire with Mechanical Shock (as prescribed in BS 6387 Protocol Z / IEC 60331 parts 1, 2 and 3 / EN 50200)

The cable is mounted on a vertical framework or board made from non-combustible material, depending on the standard.

This vertical framework / board is mounted onto rubber bushes such that it will be hit by a bar which is driven to fall on to the top edge of the framework / board at regular intervals during the test.

The powered cable must maintain electrical continuity when exposed to the flames from the burner and impact from the falling bar.



Resistance to Fire with Mechanical Shock

firetesting technology

Global | Quality | Innovation

FTT is internationally recognised as the world's leading supplier of fire testing instrumentation, supplying the majority of leading fire research groups and fire testing laboratories around the world.

FTT is a dedicated and passionate team who have been delivering reliable, robust and easy-to-use instruments for over 30 years.

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