

## Loss Prevention Standard

LPS 1501: Issue 1.1

Fire test and performance requirements for innovative methods of building construction

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## **PARTICIPATING ORGANISATIONS**

This standard was approved by the LPC Fire and Security Board and Expert Group D. The following organisations participated in the preparation of this standard:-

Association of British Insurers  
 Association of Building Engineers  
 Association of Chief Police Officers  
 Association for Specialist Fire Protection  
 British Automatic Fire Sprinkler Association  
 British Rigid Urethane Foam Manufacturers' Association  
 British Security Industry Association  
 Chief Fire Officers Association  
 Door & Hardware Federation  
 Electrical Contractors Association  
 Engineered Panels in Construction  
 EURISOL UK  
 European Fire Sprinkler Network  
 Fire Industry Association  
 Glass and Glazing Federation  
 Health & Safety Executive  
 Heating, Ventilation and Air Conditioning Manufacturers' Association  
 International Association for Cold Storage Construction (IACSC)  
 Intumescent Fire Seals Association  
 Metronet  
 Modular & Portable Building Association  
 National Access and Scaffolding Confederation  
 Risc Authority  
 Risk Engineering Data Exchange Group  
 Royal Institution of Chartered Surveyors

## **REVISION OF LOSS PREVENTION STANDARDS**

Loss Prevention Standards will be revised by issue of revised editions or amendments. Details will be posted on our website at [www.redbooklive.com](http://www.redbooklive.com)

Technical or other changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments. (See amendments table on page 15)

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

**USERS OF LOSS PREVENTION STANDARDS SHOULD ENSURE THAT THEY POSSESS THE LATEST ISSUE AND ALL AMENDMENTS.**

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## FOREWORD

This standard is intended to provide a fire test, performance and classification system for innovative building systems used in building construction. The primary objective of this LPS standard is to provide insurers, fire service and regulatory authorities with evidence that such products maintain acceptable levels of fire safety in respect to property protection and thus create confidence in the development and use of innovative building systems for applications of any number of storeys in height. In this context the scope of the standard covers the fire performance and LPCB approval of innovative building systems (pre-assembly or modular buildings)

- that are not wholly covered under current recognised standards and codes for building construction with respect to fire performance;
- that have got a limited track record of service in building construction in the UK.

This standard covers all purpose groups which use these systems.

The objective of the test method detailed in this standard is to establish if there are any potential weak links in the system that prevents pre-assembly or modular buildings from achieving their prescribed performance. The test method provides the facility to correlate the severity of the fire test back to an equivalent standard fire severity.

This standard identifies the evaluation and/or testing practices undertaken by LPCB for the purposes of approval and listing of products and services. LPCB listing and approval of products and services is based on evidence acceptable to LPCB:-

- that the product or service meets the standard
- that the manufacturer or service provider has staff, processes and systems in place to ensure that the product or service delivered meets the standard

and on:-

- periodic audits of the manufacturer or service provider including testing as appropriate
- compliance with the contract for LPCB listing and approval including agreement to rectify faults as appropriate

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## NOTES

Compliance with this LPS does not of itself confer immunity from legal obligations. Users of LPSs should ensure that they possess the latest issue and all amendments.

LPCB welcomes comments of a technical or editorial nature and these should be addressed to “the Technical Director” at [enquiries@breglobal.co.uk](mailto:enquiries@breglobal.co.uk).

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## 1. SCOPE

This Standard provides a specification for fire testing and classification of innovative building systems used for building construction in the UK.

The standard is intended to include the following types of building systems:

Hybrid systems  
Panellised systems  
Volumetric systems

## 2. DEFINITIONS

For the purposes of this standard, the following definitions taken from “Modern methods of house construction – A surveyor’s guide” by K Ross shall apply:

### 2.1 Closed panel systems

Types of panellised systems that can have services, windows, doors, internal wall finishes and external claddings fitted in a factory.

### 2.2 Hybrid systems

A combination of both volumetric and panellised systems.

### 2.3 Open panel systems

Types of panellised systems that comprise a framing system delivered to site before insulation, services etc are fitted.

### 2.4 Panellised systems

Flat panel units produced in a factory that are transported to site for assembly. These include open panel systems and closed panel systems.

### 2.5 Volumetric systems

Three – dimensional units produced in a factory. All necessary internal finishes, services and potentially furnishings can be installed at the factory. However, furnishings or contents are outside of the scope of this standard.

## 3. PERFORMANCE IN FIRE

### 3.1 General Requirements

The requirements given below are specifically in relation to the method of test described in this standard. The basis for performance criteria are;

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- to minimise the effect of fire on the building itself;
- to limit the effects of interruption to the use of a building;
- to allow the building to be re-occupied as soon as possible after a fire incident.

### 3.2 Passive fire protection requirements

#### 3.2.1 Structural collapse

The building system shall have adequate fire protection to prevent collapse or partial collapse and exhibit restricted deflections.

#### 3.2.2 Compartmentation

The building system shall be constructed in such a manner that, if a fire starts, the extent of fire and smoke damage will be minimised. Fire shall not enter into an adjoining property and shall, as far as possible, be prevented from entering concealed cavities or roof voids. If fire does enter any cavities or voids, its spread shall be minimised by appropriate design and /or fire protection measures. Consideration shall be given in the design of the building to limit the spread of smoke into adjoining properties.

Note: although smoke densities are not measured as part of this test and do not form part of the acceptance criteria, fire spread routes will provide a good indicator of potential smoke spread routes.

### 3.3 Active fire protection systems

The building system shall comply with the acceptance criteria in clause 4.2 without any active protection during the test.

Note: *enhanced fire protection to approved building systems may be achieved by the installation of LPCB approved active fire protection systems and should therefore be considered in order to further reduce the risk.*

## 4. TEST METHOD AND REQUIREMENTS

### 4.1 Full-Scale Natural Fire Test

Due to the inherent risks involved with large scale fire tests, great care shall be taken at all stages of the procedure (including, but not exclusive to, build and preparation, loading and unloading, test, monitoring and inspection, and dismantling). A full risk assessment and method statement shall be prepared and agreed by all parties for each system test undertaken.

#### 4.1.1 General

In order to demonstrate performance in fire of innovative building systems, including the interaction between floors and walls, fire stopping around openings and the correct

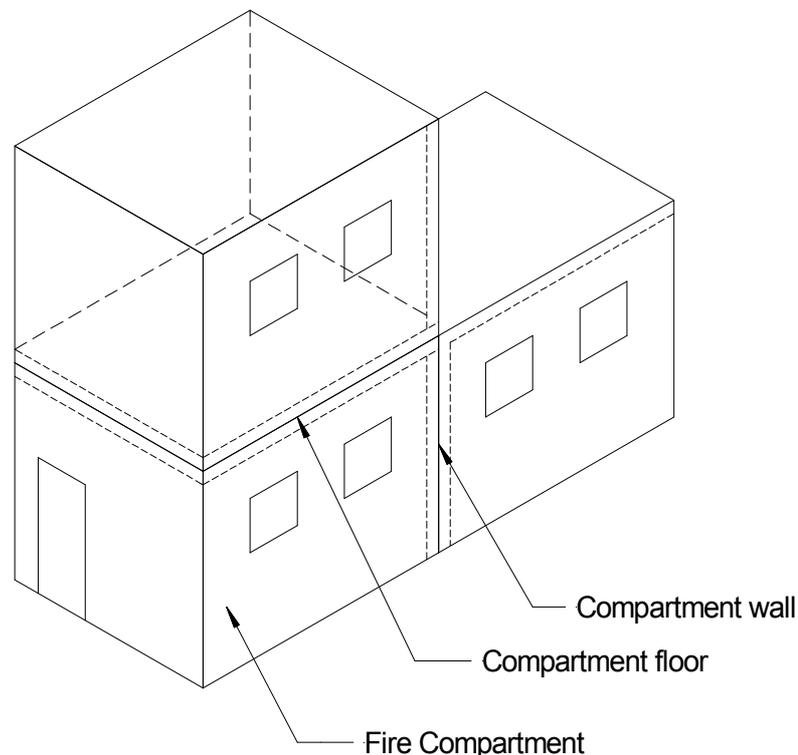
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functioning of cavity barriers, the full-scale test described in this standard is required. LPCB shall advise the manufacturer of the precise specification for the test so as to obtain the broadest application from the results, but taking into account the generic configuration described in 4.1.2. This is normally interpreted to select the specification that is anticipated to achieve the lowest level of performance.

#### 4.1.2 Test Building

The test building shall comprise 3 building system units (see figure 1). It shall be constructed with its intended internal and external finishes but excluding any contents including floor coverings or furnishings. The overall dimensions of the test compartment will be representative of the intended end use application and will simulate the accommodation area of one floor of a single building system unit. The test compartment will be constructed with a similar building system unit adjoining the property connected through a party wall and a similar unit above the fire compartment.

The units adjoining and above the fire compartment will be lined in accordance with the manufacturer's requirements. The unit above will be loaded uniformly over the floor area to provide a value of imposed load as defined in 4.1.6. Each building system unit shall be supplied with cables and service connections and penetrations appropriate to the intended end use.



**Figure 1 Basic arrangement of test building**

Ventilation shall be provided by unglazed window openings usually on the front elevation of the test building. Their size and location will reflect normal building practice and will be typical for the intended end use application. Door openings shall be provided for access and

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gress to the test building, the number and location of these door openings shall be determined in consultation with LPCB prior to building the test buildings. The ventilation conditions operable during the fire test will be determined by LPCB in order to provide the relevant ventilation requirements for the given fire load, however this will, as far as is practical reflect the situation related to the end use application. Prior to the fire test, shut doors shall be sealed by plasterboard.

#### 4.1.3 Fire load/ Ignition source

The fire load for the test shall comprise a number of softwood cribs distributed uniformly on the floor of the fire compartment. Each crib shall consist of rough sawn lengths of kiln dried Redwood/Scots Pine or similar softwood sticks each 50mm x 50mm x 1000mm long \*. The timber sticks shall be laid with alternate layers arranged mutually perpendicular in a criss-cross fashion. The timber sticks shall be spaced 50mm apart in each layer. The moisture content of the timber shall be measured prior to testing and shall be in the range of 7-13%. Cribs shall be equally spaced over the entire floor area and be a minimum of 300mm apart from each other. Consideration shall be given to suitable and safe access for ignition.

\* Note; the length of the sticks may be reduced to a minimum of 500mm should the size of the test building be such that longer sticks cause problems with loading, however the nominal fire loads described below shall be maintained.

Each crib shall be ignited by applying a flame to strips of paraffin-soaked fibre insulation board (12mm x 12mm section) connecting each crib to the adjacent cribs and positioned between the lower two layers.

The crib specification shall be calculated by LPCB to represent a nominal fire load as indicated in table 1 based on the floor area and the intended end use of the building system (see Appendix A).

Purpose group	Nominal fire Load (kg/m <sup>2</sup> )
Residential	33
Office	22
Hotel	15
Shop	34
School	14

Table 1. Nominal fire load applicable to different purpose groups.

For purpose groups not included in the table, the appropriate fire load density will be determined through a specific fire engineering risk assessment. For grading purposes, some of the fire loads given above are not used (see clause 4.5).

#### 4.1.4 Temperature measurements

Internal atmosphere temperatures shall be measured 100mm and 300mm below the ceiling of the fire compartment using 1.5mm diameter stainless steel sheathed thermocouples (or equivalent in terms of response time) with at least one location per 2m<sup>2</sup> of ceiling area.

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Temperatures of the outer surfaces of the fire compartment (internal surface of adjoining compartment and floor surface of the compartment above) shall be measured using thermocouples of the type specified in BS476: Part 20: 1987 (Method for determination of the fire resistance of elements of construction) for measuring the temperatures of the unexposed surface of partitions/roofs. They shall be positioned on the surface of the wall and floor above with at least 5 on each element to measure mean temperatures. Additional temperature measurements shall be required on both sides of all cavity barriers to assess performance. Additional instrumentation may be installed at the request of the manufacturer to provide information on the response of floor (joists), wall (studs) and connecting elements.

Subject to the agreement of LPCB, instrumented indicative protected steel elements may also be placed within the centre of the fire compartment (supported on protected steel trestles) to provide information on the time equivalent value of the fire in relation to an equivalent period in a standard test furnace (see Appendix B2).

#### 4.1.5 Video record

A photographic and video recording of the fire test shall be provided by the test laboratory. This shall include video coverage of the internal aspects of the adjoining test buildings with one or more cameras positioned to monitor the compartment wall/floor as applicable.

#### 4.1.6 Loading

The floor of the compartment above the test compartment shall be loaded to provide a uniformly distributed load equal to:

Purpose group	Load (kN/m <sup>2</sup> )
Residential	0.75
Offices	1
Hotel	0.75
Shop	2
School	1

Table 2. Compartment floor loadings

#### 4.1.7 Full-scale natural fire test procedure

The test shall be conducted under cover to avoid variations due to weather. Ambient temperatures shall be between 5°C and 25°C.

##### 4.1.7.1 Start of test

The test shall be started by igniting the timber cribs simultaneously or in succession, provided that all of the cribs are ignited within 60 seconds.

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#### 4.1.7.2 Gas temperatures

Gas temperatures shall be recorded continuously or at intervals not exceeding 30 seconds. Surface or component temperatures shall be recorded at intervals not exceeding 1 minute.

#### 4.1.7.3 Integrity

Integrity shall be monitored throughout the test by visual inspection to record any signs of flames outside the compartment of origin.

#### 4.1.7.4 End of test

The fire shall be allowed to burn out and the test continued until conditions have stabilized. Any residual burning embers can be extinguished at this point.

Note: The laboratory shall reserve the right to end the test at any time if there is considered to be any risk to the health and safety of the persons or property involved in the test.

### 4.2 Acceptance criteria

Fire breaking through windows shall not be taken as failure under the criteria given below:

#### 4.2.1 Integrity criteria

The integrity of the building system shall be demonstrated if the fire is restricted to the compartment of origin for the duration of the test.

##### 4.2.1.1 Adjoining building system units

Any break through into the adjoining building system units will constitute a failure and will be recorded with respect to the time from ignition.

##### 4.2.1.2 Cavities

Any break through into any cavity will be assessed in terms of restricted extent of damage. Spread beyond the cavities immediately adjacent to the compartment of origin (wall or floor (not both)) will constitute a failure.

#### 4.2.2 Insulation criteria

The insulation criteria shall be met if the temperature on the unexposed surface of adjoining building system units, i.e. the party wall and the floor of the compartment above, remains below an average value of 140°C and a peak value of 180°C.

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#### 4.2.3 Stability criteria

The load bearing capacity of the building system shall be met if the floor above continues to support the applied load for the duration of the test or exhibits deflection not exceeding span/20.

#### 4.2.4 Equivalent time of fire exposure

In order to assess performance, the severity of the natural fire shall be evaluated with respect to an equivalent period in a standard fire test. The equivalent period of fire resistance shall be determined either by calculation or direct measurement in accordance with Appendix B.

#### 4.3 Test report

The test report shall provide the following information:

- a full description of the building tested including drawings. These shall include full cross sectional details of the building envelope and material specifications;
- loading calculations as appropriate;
- graphs and tables of all measured temperatures;
- observations and photographs taken before, during and after the test;
- results in terms of clause 4.2 of this LPS;
- a statement provided as either an annex to the report or as a separate document regarding the field of application of the test results.

#### 4.4 Field of application of test results

##### 4.4.1 General

The results of the test shall apply only to the specification tested or by application of LPCB extended application rules.

#### 4.5 Classification

The grading below takes into account the variations between structural load and fire load. To reduce the number of classes, some increase in fire load for specific purpose groups has been introduced.

<b>Grading system for innovative methods of building construction</b>			
<b>Grade designation</b>	<b>Purpose groups covered</b>	<b>Load (kN/m<sup>2</sup>)</b>	<b>Nominal fire load (kg/m<sup>2</sup>)</b>
MMC1	Retail	2	34
MMC2	Residential	0.75	33
MMC3	Offices, Hotels, Hostels, Schools	1	22

Table 3. Grades of performance for Innovative methods of building construction.

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Note: A product graded as MMC1 could be used also for the purpose groups defined in MMC2 and MMC3 because both the structural load and the fire load are higher. However, a product graded as MMC2 should not be used for the other purpose groups because it is not tested at the higher structural loads as defined

## 5. PUBLICATIONS REFERRED TO

- BS EN 1991-1-2      Eurocode 1: Actions on structures – Part 1-2: General actions – Actions on structures exposed to fire
- BS PD 7974:Part 3    Structural response and fire spread beyond the enclosure of origin (sub-system 3)
- Ross, K.              Modern methods of house construction – A surveyor’s guide. Published by BRE bookshop, 2005

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### **Appendix A (Informative)**

#### **Calculation of fire load specified in Table 1 clause 4.1.3**

The fire load specified in Table 1 clause 4.1.3 is based on informative annex E of BS EN 1991-1-2 and involves multiplying the characteristic fire load density (from BS PD 7974 - 3) by four factors.

The first is a combustion factor  $m = 0.8$  typically used for cellulosic fire loads. The second is a factor taking into account the risk of fire activation and will vary depending on the size of the structure. For typical compartment sizes between 25 and 250 square metres the appropriate value would be 1.5. The third is to account for the risk of fire activation according to occupancy (offices, dwellings and hotels would be assigned a value of 1.0). The last factor accounts for normal detection measures and fire service intervention. Where smoke detectors are fitted and normal fire service attendance is assumed, the appropriate value would be  $0.73 \times 0.78$ .

This method allows the fire load to be varied according to the specific circumstances of the end use application.

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## Appendix B (Normative) Time equivalent

### B1. Time equivalent by calculation

According to BS EN 1991-1-2, Eurocode 1: Actions on structures – Part 1-2: General actions – Actions on structures exposed to fire, the equivalent time of fire exposure is given by:

$$t_{e,d} = q_{f,d} \cdot w_f \cdot k_b$$

where :

$t_{e,d}$  is time equivalent (min)

$q_{f,d}$  is the design fire load density (MJ/m<sup>2</sup>)

$k_b$  is a conversion factor to account for the thermal properties of the compartment lining. Where no detailed assessment of the thermal properties of the enclosure is made, the conversion factor  $k_b$  may be taken as 0.09 (min.m<sup>2</sup>/MJ)

$w_f$  is the ventilation factor in the absence of horizontal openings given by:

$$w_f = (6.0/H)^{0.3} [0.62 + 90(0.4-\alpha_v)^4]$$

H is the height of the enclosure (m)

$\alpha_v = A_v / A_f$  is the area of vertical openings in the façade ( $A_v$ ) related to the floor area of the compartment ( $A_f$ ) where the limit  $0.025 \leq \alpha_v \leq 0.25$  should be observed

### B2. Time equivalent by direct measurement

Time equivalent may be assessed by comparing the maximum temperature of a protected structural element in a natural fire to the time taken to achieve that temperature in a standard fire test. To this end an instrumented test specimen for which standard test data is available shall be placed in the centre of the fire compartment and the equivalent period assessed based on the recorded data.

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Amendments Issued Since Publication

DOCUMENT NO.	AMENDMENT DETAILS	SIGNATURE	DATE
LPS 1501-1.1	<ol style="list-style-type: none"> <li>1. New front cover</li> <li>2. Title added to header</li> <li>3. Content moved to Page 1</li> <li>4. Notes added on Page 3</li> <li>5. Numbering of paragraphs as 'Sub-clauses' removed in Clause 1 Page 6</li> <li>6. Definitions in Clause 2 numbered</li> <li>7. Numbering corrected in Clause 3.2</li> <li>8. Repagination</li> <li>9. Changes to copyright information</li> </ol>	DC	Jan. 2014