內政部建築研究所籌備處專題研究計畫成果報告
計畫名稱：建築物防火門牆設計要求及檢驗基準之研究

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* 建築物防火門牆設計要求 *
* 及檢驗基準之研究 *
****

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目　　錄

第一章 緒 論

1－1 計畫背景

我國建築技術規則第七十六條有關防火門的規定僅以鋼鐵板的厚度來區分為甲種及乙種防火門，若以其他材料所製造之防火門，則其防火性能的認定需經中央主管建築機關之測試，但目前不論政府機構或民間團體均缺乏此項測試設備；雖中央標準局已分別在A3223及Z3007之國家標準，訂有防火門及門組件之燃燒防火試驗法，惟前者是根據日本JIS規格，而後者是根據美國ASTM規格，故對防火性能之認定有所出入，應妥為統一，以便依循。

目前由於高層建築物之大量增加，建築物的多樣化、複雜化使得防火計畫的重要性日益顯著。建築防火計畫上以防火區畫為主，而用以區畫之防火門、牆所扮演的角色就更為重要，故本研究針對防火門、牆之檢驗及防火性能測試，有其必要性及重要性。而材料科技的進步，也使得防火門牆的種類有所變化，故必須以一套準確的燃燒測試方法才能公正地評估其防火性能。

1－2 研究方法

本研究首先收集美日等國有關防火門之檢驗規定及標準，同時根據國內防火門的常用尺寸來設計一個燃燒實驗爐，初步將根據日本及ISO 之測試規定來實驗，接著配合建築技術規則之相關規定來探討並修改測試步驟，期能達到有效檢驗評估防火門的目的。

1－3 建築防火理念與性能要求

建築防火有其兩階段的對策，在火災未發生階段，期能降低火災發生機率，其最理想的情況是零火災。而第二階段對策，乃在火災發生時，維護在室者之生命安全與保障財產之不受損害。由於零火災不可能達成，建築所要求之防火的安全性能基本上著重於火災時生命之維護與減少財產損失的理念上。

依此理念，建築所要求之防火安全性能有三：

一、火災時的結構安定性能。

二、火災延燒防止性能。

三、逃生避難安全性能。

而各防火性能所採取的建築之對策手法與其所要求基本性能為

・結構安定性能——結構部材之防火、耐火——遮炎、斷熱

・延燒防止性能——防火區畫(面積、豎道、用途)——遮炎、斷熱

・避難安全性能——安全區畫(逃生)——遮炎、斷熱、遮煙

為求結構部材之防火、耐火，是以防火材料將結構部材區畫包圍之。求得結構安全後，進而求空間之安全(或加害防止)，應而進一步以防火牆、防火樓板，將空間區畫包圍之。區畫基本上應為防火區畫所要求性能為遮炎與斷熱，而防火區畫中供逃生用者為安全區畫，由於除火熱之外煙毒對人命逃生有礙，安全區畫應多要求遮煙這項基本性能。所以區畫空間之防火牆與防火樓板因應其區畫之性質等級有其基本要求性能。

建築物中開口之設置為生活上之必需，逃生上之必需。然而防火牆或防火樓板上設置開口，可能成為其防火性能之弱點所在，所以一般開口部應要求其具有與所在之牆或樓板相同之防火性能。

┌防火區畫之開口——遮炎、斷熱
└安全區畫之開口——遮炎、斷熱、遮煙

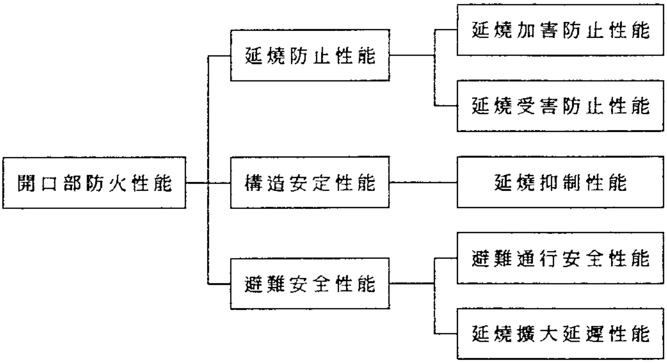
開口又可分為面外開口與室內開口，面外開口之延燒危險性有(A)對上層、鄰室(B)對鄰棟兩種。而室內開口僅須考慮其對鄰室、上層之延燒危險性。另延燒防止性能依(1)加害防止型(2)受害防止型之不同觀點而要求不同性能基準。

以往，日本係以對周邊火災的受害防止性能為其建築物防火對策之基本，也就是假想鄰棟火災時，將受害側建築物的外周部不燃化以防止延燒

擴大。而歐美對於延燒防止的想法係以火災建築物不得擴大影響至其他建築物之加害防止的概念為基本。就建築物相互的延燒防止對策的概念，日本之受害防止性能及歐美之加害防止性能兩者均應考慮並於規準化。

火災中開口部的破損將造成遮炎、斷熱、遮煙等性能的喪失低減，所以開口部之構造安定性亦為其所要求之基本防火性能之一。

綜合以上，火災時開口部所要求防火性能可整理如下：



第二章　各國之開口部相關防火要求

2－1　歐美各國門窗所要求的防火及耐火性能

歐美各國共同的性能項目如下：

一、構造安定性(Stability)....加熱試驗或注水試驗時門窗不得脫落。

二、遮炎性(Integrity)....不因熱氣、火炎的貫穿而引起延燒危險。這項性能可用試驗用棉質品的著火，10秒以上非加熱側延續發炎，超過150×6mm的間隙，門厚以上的變形等來判定其有害性。最近，遮煙性能也漸被重視，不過，閃燃以後的遮煙和避難時間的關係上對安全性有沒有意義這點卻為議論的焦點。在美國由於認定控制煙用的門須有20分的耐火時間而訂定，NFPA105：Installation of Smoke and Draft Control Assemblies.規範NBC, BBC, UBC分別規定防煙門的性能，依ASTM E152，UL10B；NFPA252;UBC43-2試驗時須有20分的遮炎性而至少耐住60分，而不實施灌注水試驗。這灌注水試驗是美國特有的項目，對加熱30分的試驗體實施。

三、斷熱性(Insulation)....背面最高溫度須為氣溫加180℃以下，平均140℃以下。這項性能在法規上多數都不列入。因為隔離門大部分設在通路線上等周邊的可燃物少的位置，因此，由熱輻射而引起延燒的可能性少。UL則從避難安全的觀點評估30分加熱的斷熱性。

由上可知，在歐美對窗、戶的防火性能所要求的共同項目中，以(遮炎性）為主，從燃燒最旺盛的區畫的開口部噴出來的煙焰能控制（特別例除外）的話，應可認為火害已得控制。此外，離火災室比較遠的防火門，有時也被要求能隔絶溫度比較低的煙。特別避難樓梯則被要求60分左右的Stability和Integrity，以減少豎道區畫開口部的延燒，同時為使避難者免受煙、瓦斯之害，要求上述低溫煙隔絶性能的規定也逐漸增加。

2－2　歐美各國之防火門的法令觀點概要

一、英國(UK)

1986年11月28日的英國標準協會(BSI)的「Draft standard code of practice for fire door Assemblies with Non-Metallic Leaves」中，有對木製防火門的要求性能和製品規格的標準觀點的記述。BS標準中規定這項CODE OF PRACTICE(CP)的目的是公告有關防火門材料的規格、形狀、結構、設置及維護管理等的指針。這裡所說防火門係指經過BS476 Part8，ISO3008，或BS476 Part 22所規定的試驗而性能等級明確之製品而言。這CP的內容中之第五章為門材料的耐火規格。

而5-1的防火性能(Fire Performance)項下內容則說「性能項目是Stability和Integrity。因此，30分耐火性能係以30/30表示。不過，國際上有僅採用Integrity一項的趨勢，這觀點在英國也採納於BS 5588(避難方法)中。針對低溫煙(Cold smoke)的抑制則根據BS 476 Part31.1判定，如合格則可附安全記號S。因此，具有遮煙性的耐火30分防火門係以FD 30S表示。耐火性的等級則分為20、30、(45)、60、90、120。規格的詳細內容記載於Published Document；PD 6512， Part1。

二、德國

1972年，Kordina博士曾調查延燒擴大的高層建築物和工廠，謂之防火最重要的一項是做到火災室的完全區畫。針對這點Bub博士則主張，在高層建築物的通往避難路的門應全部具備最低30分的遮煙性。由於門的功能上的關係，門周邊的間隙通常有1～8mm，為塞住這間隙，開發出一種含玻纖的含水矽酸鈉系發泡材料(如BASF的Palusol Fireboard)廣被利用。德國的評估法是從門的兩面加熱，而以目視來觀察門鎖部、門框等的安定性及測定溫度來判定。但門鎖部的背面溫度則不測定。

在比利時，只加熱鉸鏈等沒有露出的面來判定性能。(BASF Document No.1：Palsol Fireboard for Fire Resistant Building Components and Structures)

三、法國

跟德國一樣，也朝符合ISO規定的方向修改各項規定中。政令21.04.83規定承受重荷材料，吊天花、隔間牆、門及關閉裝置、配管、風管、節流片、排煙用通風機等的試驗方法。加熱則依ISO834所規定的曲線進行。(M.C. Mathez & M.C. Moy'e：建築法規上的防火安全條款，CSTB)。

四、美國

1894年創設的UL和1896年創設的NFPA在1900年間共同作成評估防火門的基本規定。現在已分別成為ASTM E152, ANS A2.2, NFPA 252, UL10B, 隨著適用地區和領域加以少許修改作成試驗規格。其中，ASTM規格可以說是匯集共同認識的。試驗方法是把門嵌進於約3m平方的壁內，先加熱至規定耐火時間的1/2時間後，用2.5英寸（63.5mm)的水管以45psi(3.15kg/cm²)的噴嘴壓力注水五分鐘，須沒有水貫穿，且門不可開。這項灌水試驗是美國特有的，至於其他性能項目則與歐洲幾乎相同。

防火門設置的目的如下：

(一)須有和普通門相同的功能(日常功能)。

(二)從火災區避難時有效作用(避難功能)。

(三)能防止延燒(防火功能)。

(四)能保護人和財產不受煙侵襲(防煙功能)。

規定的初期，所有的試驗均以加熱３小時的結果評估，現在已改為依設置目的而訂定，分類為A、B、C、D、E各級，比如防火壁(Fire Wall)的門須符合３小時試驗的Ａ級規格。

各試驗方法中，ASTM E152是門和門框取得許可的基本試驗方法。

2－3 日本新防火門試驗方法修改經緯

日本新防火門評估試驗方法於1990年6月改正

2-3-1 日本以往的防火門試驗方法及新防火門試驗方法的開發

一、日本以往的防火門試驗方法

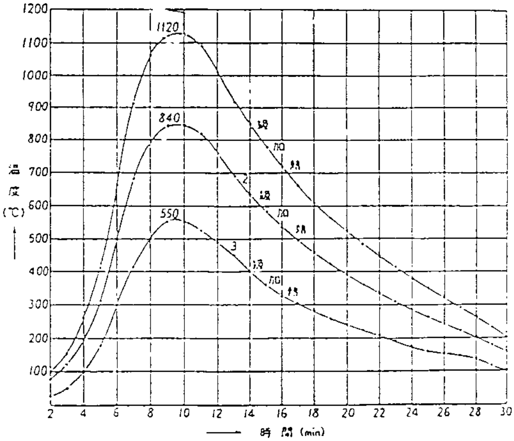
日本以往的防火門試驗方法係由JIS基準化，依設置場所和建築物種類規定加熱方法，如表2-1。

表2-1 JIS-A-1311 的防火門試驗分類

防火門設置場所及建築物構造	加熱等級
設置於建築物外壁者 用於建築物內分隔防火區畫用者	防火用，加熱30分(1、2、3級曲線) 耐火用，加熱30分、1小時、2小時
屋內側有木製部份者(A種) 屋內側無木製部份者(B種)	防火用(在門背測定輻射) 防火用

這裡所說加熱等級(防火用加熱曲線)是根據以前日本實大木屋火災實驗測定的屋內溫度求得的基準曲線(JIS-A-1311戶外1級加熱)，以高度、距離為變數測定鄰近建築物的假想對鄰壁面溫度的結果，再經受熱係數(3/4、1/2)補正，做為JIS-A-1311建築用防火門之防火試驗方法的防火2級、3級加熱曲線。防火加熱線如圖2-1所示。

図2-1



建築基準法則依據防火門設置場所分為甲種防火門及乙種防火門，甲種係由施行令第109條載明構造和材料的一般規格規定，而乙種則除一般規定外，尚有依告示第2546號指定JIS-A-1311所規定的(1)、經戶外２級加熱試驗Ａ種時兩面均合格者。(2)、經同一試驗Ｂ種時兩面均合格者。(3)、門的

戶外側符合同試驗Ａ種者。換言之，甲種防火門係根據一般規格判斷，而對乙種防火門則根據戶外２級加熱曲線(圖2-1)的結果評估防火性能。

二、日本新防火門試驗方法的開發

建築基準法把防火門分為甲種及乙種兩類，並在法令中指定場所強制使用防火門。

在這防火門的法系上，強制設置乙種防火門的場所，除有延燒之虞的場所準防火木造三樓建築的外牆之外，大多數是設置於建物內部的隔牆。這一點是值得一提的。因為，以根據鄰接於火災建物的建築物假想對鄰壁面溫度求得的屋外２級加熱曲線評估的乙種防火門來因應建築物內部火災的狀況時會發生矛盾。一方面，近年來木造房屋的不燃化已相當進步，實大火災實驗的結果也証實，火災時木造建築物內部的溫度分佈隨時間的變化也類似耐火建築物。

近年來，日本對於有機系材料構成的開口部材種的開發研究已有相當進展，提升這些材料的防火性能不少。不過，依據日本以往的防火門試驗方法的話，會發生評估困難的部分，尤其由日本建設省綜合技術開發計畫的「新木造建築技術開發」開發的木質系防火門以及以高分子材料為主要構成材料的開口部材料（塑膠窗框）則多數對試驗評估基準之「殘炎、殘燼」或「主要構成材料的發炎」很難合乎規定。此外，甲種防火門也只承認根據基準法規格規定的結構，試驗法則全無規定。因此，不久前完成的建設省綜合技術開發計畫「防火設計法的開發」也針對這開口部材料應有的防火性能加以檢討，對以往的各種矛盾提出修正。由於這種背景，防火門評估法的整備已迫不及待，於是積極進行了建立一項包括新試驗法在內的新評估法。以下說明針對這開發的基本想法，同時也介紹與國際基準之整合性等技術性檢討。

三、新防火門檢驗法的基本想法

對木質系及高分子材料等有機系材料的開口部材料要求應具有防火性能的聲音與年俱增。但是，依現狀，這類型的門尚未開放許可，即使要開發新材料、新方法也無路可走。此外，對於防火門應具備的性能條件的屋內加熱，戶外加熱問題也待整理。另一方面，為了因應市場開放的趨勢，也要求與國際規格(ISO)的整合，於是，以(1)整理開口部應具備的防火性能。(2)開發包括試驗法在內的新評估方法。藉此提升建築物的防火性能，開發新防火門以及把防火基準合理化及體系化為目的，針對下列各課題進行作業，且收集所需技術資料。

(一)防火門應有的防火性能的檢討及類型化。

(二)含有機系材料的開口部材料的防火性的問題點之整理及檢討。

(三)再檢討現行甲種、乙種防火門的性能及試驗法。（與防火性能的整合性）。

(四)與國際基準之整合性的檢討。

(五)查証實驗等技術資料的收集。

(六)提出甲種、乙種新試驗法。

1、防火門應具備的防火性能的檢討及類型化

在參考防火綜合技術開發計畫及開口部防火研究委員會的成果，依現有法令體系下檢討防火門的應具備基本性能，可分類如下：

基本性能
- (1)級別分類
- (2)依設置場所的分類
- (3)依被要求性能的分類

A、防火門的級別分類及B、依設置場所的分類	
(A)甲種防火門	
(B)乙種防火門	屋內用
(C)乙種防火門	屋外用

C、依被要求性能的分類 基本上應表示所有性能 A.基本性能：遮炎、遮熱、遮煙、結構耐力 B.附屬性能：耐火時間，自動關閉機構 （煙感應，熱感應）

2、含有機系材料的開口部防火性能評估的問題點整理及檢討，依據舊有試驗法及法體系來評估與整理有機系開口部材料的話，應對下列問題點予以檢討。

(1)防火性能上的問題點：A、主要構成材料的著炎

B、加熱後的殘炎，殘燼

C、加熱後的再著炎，燃燒

(2)設置條件..........：由「基準法上的規格」看來須設置甲種防火門的區域當求比較高的防火安全性，其所期待的防火性能在60分以上的耐火，而在上述以外的部位則可設置甲種或乙種防火門，其要求比較緩和，所需耐火或防火性能為30分。

3、舊有甲種、乙種防火門試驗法的再檢討(與被要求防火性能的整合性)。

●防火性能（防火、耐火）的檢討

從防火門設置場所來看要求的防火性能，防火門可分為戶外規格及屋內規格，其要求性能如下：

A.戶外規格：

・防止來自鄰接建築物的延燒受害性能。

・防止對鄰接建築物的延燒加害性能。

・防止在同一建築物內開口部向上方延燒性能。

B.屋內規格：

・防止向區畫外延燒或擴大的性能（面積、豎孔、異種用途）。

・確保避難安全性能的功能(安全區畫)。

這些問題可整理如下：戶外用──┬─戶外面──防火加熱。
　　　　　　　　　　　　　　　└─屋內面──耐火加熱15或20分。

屋內用要求耐火性能，耐火15分、30分、45分、60分....與壁體結構間的整合性。

4、與國際基準之整合性的檢討

● 與ISO基準之比較檢討

近年來，歐洲、美國、加拿大相繼向日本提出要求，凡是通過各該國及國際規格的耐火試驗而認可的木質系開口部材料（尤其是門）應開放市場，但是在日本舊有的法規下只能用建築基準法第38條特別許可的形式。在這種環境下，重新開發防火門的防火性能評估方法而且使之制度化，就必須檢討與國際規格(ISO)的整合性。此外，也有GATT問題，困難重重，這些問題，行政判斷所含的成分也多，於是日本在建設、消防、通產及農林各相關部門進行調整，有必要時則基於查証實驗來收集技術資料，採行ISO 試驗法所提各種測定方法，檢討各種問題，包括是否採為新試驗法。

2-3-2 日本新防火門試驗規格

修訂完成之新法。

建設省告示第1125號

基於建築基準法施行令（昭和25年政令第338號）第110條第1項第5號及第2項第6號的規定,同條第1項第1號至第4號中揭示之甲種防火門及具同等以上防火性能者，同條第2項第1號至第5號中揭示之乙種防火門及具同等以上防火性能者，依附件1 方法指定之。

2－4 各國防火的門試驗規格比較

各國防火門的試驗規格比較整理如表2-2

表　各國防火門之試驗規格比較

項目　規格	JIS A 1311 (1975)	ISO 3008 (1984)	BS 476 part 8 (1985)	ASTM E 152 (1981)	UL 10B (1986)	NFPA 252 (1964)	DIN 4102 part 5 (1975)
加熱條件／試驗體的大小（寬×高）	2.0×2.5m以上	2.0×2.5m以上	2.5×2.5m以上	實大	實大	實大	實大
加熱條件／標準加熱溫度 (註)T_0：初期溫度(℃)	30分 840℃ 60分 925℃ 120分 1010℃ 180分 1050℃ 240分 1095℃	$T=345\log_{10}(8t+1)+T_0$ 30分 $821+T_0$ 60分 $925+T_0$ 120分 $1029+T_0$ 180分 $1090+T_0$ 240分 $1133+T_0$		30分 843℃ 60分 927℃ 120分 1010℃ 180分 1052℃ 240分 1093℃ 480分以上 1260℃			$T=345\log_{10}(8t+1)+T_0$ 30分 $821+T_0$ 60分 $925+T_0$ 120分 $1029+T_0$ 180分 $1090+T_0$
加熱條件／加熱溫度測定／測定位置／相對於試驗面的位置及數目	各邊四等分之位置而對稱配置9個以上	均等配置5個以上	試驗面每1.5m²一個以上，對稱配置。	試驗面每1.5m²一個以上，對稱配置。	均等配置，9個以上		試驗面每1.5m²一個以上，對稱配置，合計5個以上。
加熱條件／加熱溫度測定／測定位置／離試驗面的距離	3 cm	10 cm	10 cm	15 cm	15cm	15cm	10cm
加熱條件／加熱溫度測定／熱電偶／種類、徑	鉻鎳－鋁鎳線 φ1mm	φ0.75～1.5mm	鉻鎳－鋁鎳線 φ0.75～1.5mm	鉻鎳－鋁鎳線 φ1.02mm	沒有特別記載	沒有特別記載	鞘套型 φ3.2mm
加熱條件／加熱溫度測定／熱電偶／熱接點的保護	插入先端封閉的石英管、鐵管、磁性管等內。	貫通先端開放的石英管等，熱接點突出先端25mm。		插入先端封閉的時定數5-7磁性管內	插入先端封閉的磁性管內	插入先端封閉的磁性管內	貫通先端開放的磁性管等，熱接點自先端突出25mm。
加熱溫度容許差／標準加熱溫度容許差	—	±100℃（10分以後）		—	—	—	±100℃（5分以後）
加熱溫度容許差／標準加熱溫度之溫度－時間面積之容許差	1小時以內±10% 2小時以內±7.5% 3小時以上±5%	10分以內±15% 30分以內±10% 30分以上±5%	全時間±10%	1小時以內±10% 2小時以內±7.5% 2小時以上±5%			5～30分以內±10% 30分以上±5%
爐內壓力	正壓（加熱面½以上	正壓（在試驗體的⅓高位置）	（在爐上部）1.5±0.5 mmH O	正壓（對領域沒有特別記載）			0.8～1.2mm H20 試驗體上端的位置）1/3高的位置，正壓
使用天蓋與否	無	有	無	無	無	無	有
背面溫度測定／測定位置及點數	離背面表面3cm的部位,5個以上	在背面中央1個及4等分的各區中央1個合計5個以上。	均等配置,5個以上	試驗面每1.5m²1個以上，合計3個以上			在試驗面中央1個，四等分各區的中央各1個合計5個以上，框上也要有。
背面溫度測定／熱電偶／種類、徑	鉻鎳－鋁鎳線，銅－銅鎳線，設於φ0.65mm，面積4cm2，厚0.2m的銅板上。	熱線點設於φ12mm厚0.2mm的銅板。φ0.7mm以下	熱接點設於φ12mm厚0.2mm的銅板。φ0.5mm以下	φ1.02mm以下	φ0.5mm以下	φ0.5mm以下	φ0.5mm以下
背面溫度測定／熱電偶／熱接點之覆板	石綿板（5×5×1cm）	石綿板（3×3×0.2cm）		石綿板（15×15×1cm）			沒有特別記載

表　各國防火門之試驗規格比較

規格 項目			JIS A 1311 (1975)	ISO 3008 (1984)	BS 476 part 8 (1985)	ASTM E-152 (1981)	UL 10B (1986)	NFPA 252 (1964)	DIN 4102 part 5 (1975)
加熱設備	彎曲形的、側撓定	測定位置	周邊各部長度的中央	沒有特別記載	沒有特別記載	周邊各部			沒有特別記載
		測定方法	沒有特別記載	沒有特別記載	沒有特別記載	沒有特別記載	沒有特別記載	沒有特別記載	沒有特別記載
	間隙的測定		沒有特別記載	以棉花墊包貼試之	沒有特別記載	沒有特別記載	沒有特別記載	沒有特別記載	沒有特別記載
	輻射熱量的測定		——	從能包括試驗體全部的距離來測定	從能包括試驗體全部的距離來測定				
注水試驗	注水方法	注水方向	——	——	——	距離6m的位置，對試驗面直角			——
		注水壓力				(依加熱時間而定)207～310Kg/m²			
		注水時間				(依加熱時間而定)　6～ 32 秒／m²			
衝擊試驗	衝擊方法		自背面以 ϕ 20cm、10Kg的砂袋自由落下。	——	——	——	——	——	從背面以15～25Kg鋼球自由落下
遮煙試驗	試驗體兩面的壓力差		1,2,3 Kg/m²	——	——	——	——	——	——
性能判定條件	加熱試驗	天蓋溫度	——	無規定值	——	——	——	——	平均140+T_0 ℃以下 最高180+T_0 ℃以下
		背面溫度	最高260℃以下	平均140+T_0 ℃以下 最高180+T_0 ℃以下	平均140+T_0 ℃以下 最高180+T_0 ℃以下	——	——	——	平均140+T_0 ℃以下 最高180+T_0 ℃以下
		變形、撓曲量	L^2 6000　以下	沒有特別記載	沒有特別記載	加熱時的前半段：門厚以下 全時段　　　：門厚1.5倍以下 (左右兩面開或一面開時，對門面垂直方向之變位)			沒有特別記載
		間隙的大小	不得有貫通	棉花墊包不得著火	寬6mm以下長150mm以	不得有貫通			棉花墊包不得著火
		有無發炎	不得有發火炎	持續性發炎在10秒以內	持續性發炎在10秒以內	30分以內：無發炎 30分以後：長152mm以下，5分以內			無
		輻射熱度	——	數據由各國自行訂定	沒有特別記載	——	——	——	——
	注水試驗	損傷程度	——	——	——	變形爲門厚的1.5倍以下			——
	衝擊試驗	損傷程度	不得有損傷或間隙	——	——	——	——	——	不發生破壞
	遮煙試驗	通氣量	各壓力差時測定值間的無顯明特性變化	——	——	——	——	——	——

第三章　我國相關規定之探討

3－1　現有設計要求

現有建築技術規則中防火門窗與防火牆之定義規定如下：

1、屬於防火設備——建築設計施工編第七十五條

第七十五條　(防火設備)防火設備：

一、甲種防火門窗。

二、乙種防火門窗。

三、防火牆及防火樓板。

四、裝設於開口處之撒水幕。

五、裝設於開口面積在一００平方公分以內之通風孔，且以鐵板、水泥板或其他類似材料所造之防火屏；或裝設於高出地板面一公尺以內之通風孔，孔目在二公厘以內之金屬製網，視同防火設備。

2、防火門窗之構造—建築設計施工編第七十六條

第七十六條　(防火門窗之構造)防火門窗之構造應依左列規定：

一、甲種防火門窗：

(一)鋼鐵製門窗框、門窗扇，兩面均以厚度０．五公厘以上之鋼鐵板包覆者。

(二)鋼鐵板製，其厚度在一．五公厘以上者。

(三)其他經中央主管建築機關指定認為具有同等防火性能者。

二、乙種防火門窗：

(一)鋼鐵板製，其厚度在０．八公厘以上，未達一．五公厘者。

(二)鋼鐵製或鋁製並鑲嵌鐵絲網玻璃者。

(三)其他經中央主管建築機關指定具有同等防火性

能者。

三、開口面積在〇．五平方公尺以下，利用漆以防火性塗料之木料與鑲嵌鐵絲網玻璃製造之門窗得視為乙種防火門窗。

四、防火門窗與邊框或另一防火門窗相會處應有高低縫等做法，關閉後不得有空隙。鉸鏈五金等之裝設，關閉後亦不得露明在外。

五、依第一款第(一)(二)目及第二款第(一)目規定製作之防火門窗，其周邊十五公分範圍內之牆壁等部份均應以不燃材料建造。

六、防火門之門扇寬度，應在七十五公分以上，高度一八〇公分以上，門扇下緣距離地板面高度，不得大於十分分。

七、設於避難通道或避難出口經常保持關閉狀態之防火門(安全門)，免用鑰匙即可開啓，且設有自動關閉裝置者；除供住宅使用者外，防火門應向避難方向開啓。

八、平時開放式之防火門，應利用保險絲或其他方法控制，使能在火警發生溫度急劇上升時自動關閉。並應附設第七款規定之防火門。

3、防火牆之構造——建築設計施工編第七十七條

第七十七條　(防火門窗之構造)防火門窗之構造應依左列規定：

一、作為防火區劃之防火牆應具有一小時以上之防火時效，外牆之應為防火牆構造者，其防火時效依本編第七十條外牆之規定。

二、防火牆上需設開口者，應依第七十五條及其他有關規定裝設寬度及高度不大於二．五公尺之甲種或乙種防火門窗以及其他防火設備。

三、依本編第七十九條至第八十二條所列構造之建築

物所區劃之防火牆應突出建築物外牆面五十公分以上，但與防火牆交接處之外牆有長度九十公分以上為防火構造者得免突出。

四、木造建築物之防火區劃防火牆應依左列規定：

(一)應為獨立式構造，並不得為無筋混凝土或磚石構造。

(二)防火牆應突出外牆面及屋面五十公分以上，但與防火牆交接處之外牆及屋頂有長度三．六公尺以上為防火構造且無開口，或雖有開口但裝設防火門窗者，該防火牆得免突出。

現有建築技術規則中，防火牆與防火門窗的設置場所與相關條文整理如下之表3-1、表3-2。

表3-1：建築技術規則中要求設置防火牆的場所

設　置　場　所	防火牆之防火時效	相　關　規　定
1.外牆	0.5hr （防火帶以外） 1hr,2hr	建築設計施工編第七十七條之一
2.防火面積區劃	1hr	第七十九條 第八十條 第八十一條 第八十四條 第二百零二條
3.高層建築物之防火面積區劃 （11層以上部份）	1hr	第八十三條
4.非屬防火區劃之餐飲業廚房	1hr	第八十六條之三
5.非屬於防火區劃之一般分界牆	1hr	第八十六條之一
6.非屬於防火區劃之主要分間牆（學校、醫院等建物）	1hr	第八十六條之二
7.樓梯間，昇降機間	1hr	第七十九條之二
8.緊急用昇降機間	1hr	第一百零七條之二
9.地下建築物和特殊建築物之特殊用途區劃	1hr	第七十九條之一 第二百零一條
10.地下建築物之中央管理室	2hr	第一百八十二條
11.地下建築物與地下層之連接	1hr	第一百八十九條
12.豎道區劃	1hr	第二百零三條

＊室內防火牆之時效依第七十條規定至少為1小時以上之防火構造

表3-2：建築技術規則中要求設置防火門窗的場所

設置場所	防火門窗種別	相關法規
1.有延燒危險之外牆開口	甲、乙	建築設計施工編第一條之二八，第七十五條
2.防火牆上之開口	甲、乙	第七十七條
3.防火面積區劃	甲	第七十九條 第八十條 第八十一條 第二百零二條
4.高層建築物之防火面積區劃（建築物自11層以上部份）	甲、乙	第八十三條之一
5.高層建築物之防火面積區劃之緩和獎勵（自11層以上部份）	甲	第八十三條之二、三（適用於合乎內部裝修限制者）
6.非屬防火區劃之餐飲業廚房	乙	第八十六條之三
7.樓梯間、昇降機間	甲	第七十九條
8.緊急用昇降機間	雙向、甲	第一百零七條
9.供避難用之走道或直通樓梯間出入口	甲	第九十一條之三
10.室內安全梯的出入口	甲、乙(鑲嵌鐵絲網玻璃)	第九十七條之一之(二)
11.戶外安全梯的出入口	甲、乙(鑲嵌鐵絲網玻璃)	第九十七條之二之(二)
12.特別安全梯的出入口（自陽台或排煙室進入者）	甲 （甲、乙）	第九十七條之三之(三)
13.地下建築物和特殊建築物的特殊用途區劃	甲	第八十二條 第一百二十八條之三 第二百零一條 第一百四十四條之三 第一百八十二條 第一百八十九條
14.豎道區劃	甲	第二百零三條

3－2 現有試驗方法

我國現行之防火門之試驗方法，依附件二之CNS A3223 之國家標準，其乃依據日本JIS 規格，而建築技術規則中規定之防火門等級分類也參照日本的方式。經由前章之資料研究可知，我國現有防火門相關試驗方法與認定等級基準實有修正之必要。

在現有法令修正最少且合理的原則下，建議參照日本的修正新法來進行檢討。試驗方法的修正重點在加熱試驗部份，甲、乙種防火門之加熱試驗建議皆採標準耐火加熱溫度曲線。

3－3 法令修正相關建議：

一、先提由中央主管建築機關以行政命令公告甲、乙種防火門之性能判定基準與試驗法暫行之（如同日本建設省告示）。本研究所建議關於性能判定基準與試驗法之行政命令文如3-3-1。

二、再由中央主管建築機關建議中標局修正CNS 之防火門試驗方法，回歸CNS 本研究所擬建議修正案如3-3-2。

三、建築技術規則中防火門窗、防火牆之設計構造要求需修正部份提由中央主管建築機關檢討之，關於此部份，由於現在設計構造要求，有待試驗設備完成進行查驗工作後，才能確認是否有修正必要。另外與其他法令整合修正部份，需配合其他單位研究人員作通盤檢討，本案建議儘速召集專家學者以研究修正之。

3-3-1 (防火門窗性能判定基準與試驗法)暫行行政命令文建議案

基於建築技術規則設計施工篇第76條第一項(三)及第二項(三)規定，同條第一項(一)(二)中所揭示之甲種防火門及具同等以上防火性能者，同條第二項(一)(二)中所揭示之乙種防火門及具同等以上防火性能者，依下述方法指定之。

第一　總則

建築技術規則設計施工篇第76條第一項(一)(二)中揭示甲種防火門及具同等以上防火性能者，同條第二項第(一)(二)中揭示之乙種防火門，同條第三項視為乙種防火門及具同等以上防火性能者，為於第二之規定試驗中合格者。

第二　試驗

甲種防火門及乙種防火門之試驗，係為對第一節中規定之試驗體，用第二節中規定之加熱爐，行第三節中規定之加熱試驗而以第四節中規定之項目判定之。

一、試驗體

試驗體為以下所揭示者：

1、試驗體之材料，構成大小及厚度應與實物相同，但實際尺寸較加熱爐的尺寸為大時，該當試驗體大小依該當加熱爐的尺寸。

2、試驗體為氣乾乾燥狀態者。

3、試驗體製作應包括門及框，若有被認定為防火性能上弱點之部份時該當部份應包含於試驗體。

二、加熱爐

加熱爐為中國國家標準A3223第三節規定者。

三、加熱試驗

加熱試驗，依下列規定事項行之：

1、對門的兩面分別加熱，甲種防火門的試驗行六十分鐘，乙種防火門行三十分鐘加熱。試驗體的加熱溫度隨時間的經過，依照中國國家標準A3223第4-2節（表3及圖2所示)規定之耐火用加熱溫度抑制之。

2、加熱溫度之測定，依下列規定事項行之：

(1)加熱溫度用CA熱電偶測定之。

(2)測定加熱溫度之熱電對的熱接點，以9個以上均等配置於加熱面。

(3)加熱溫度的容許誤差為標準加熱時間面積之正負10%以內。

3、加熱試驗針對門的兩面各別行一回以上試驗。

四、判定

甲種防火門及乙種防火門試驗結果之判定，以試驗體合乎下列所揭示條件者為合格：

1、非加熱面加熱中不產生發炎者。

2、不產生因加熱形成之縫隙及火炎可以通達非加熱面的龜裂者，但試驗體的大小與實際尺寸不同時依試驗體的變形進行計算以確定，其實際尺寸者不會因加熱形成縫隙及不產生火炎可以通達非加熱面的龜裂。

3、非加熱面加熱中不產生顯著的發煙者。

4、加熱終了後，試驗體非加熱面側直上綑緊重量3Kg的砂袋，以鉛直距離50cm高處自由落下衝擊時，試驗體不產生防火上有害的破壞、剝離、脫落者。

3-3-2 CNS 修正建議案

一、建築用防火門防火試驗法

1.適用範圍：本標準規定建築物防火門之試驗方法。

2.試　體：

2.1 試體應為與實物同樣製作之防火門及門框。如有防火能力較差之部分，應包含該認為防火弱點之部分。

2.2 試驗面之尺度應與實物相同，但實物尺度較加熱爐尺度為大時，得以加熱爐尺度作為試驗面；厚度應與實物相同。

2.3 試體須置於通風良好之室內，經過大約如表1所示之乾燥期間。但以人工方法乾燥達到上述以上乾燥狀態，或以適當試驗方法確定已達氣乾狀態時，得縮短其乾燥期間。但金屬、玻璃等製品無需乾燥。

表1　防火門試體乾燥時間　　　　單位：月

類別	夏天	冬天
依混凝土、水泥砂漿粉刷等濕式工法等施工之防火門試體	2	3
依矽酸鈣板舖設等乾式工法施工之防火門試體	1	1

3.加熱爐

3.1 加熱爐須能使第4節所示之加熱溫度時間變化大致均勻達及整個試驗面者。

3.2 加熱爐之熱源應為以天然瓦斯、液化瓦斯、重油或其他適當之燃料，其火焰應能直接充分達到試體上。

3.3 安裝試體之框架，應具耐熱性，其構造應使試驗面保持在規定位置。

3.4 試體應置於垂直位置並可於單面加熱。

4.加熱等級

耐火用加熱溫度：應如表2及圖1之標準曲線所示，其加熱等級依加熱時間分為30分鐘、1小時及2小時，分別稱為30分鐘加熱、1小時加熱及2小時加熱。

表2　耐火標準加熱溫度

經過時間(分)	1	2	3	4	5	6	7	8	9	10	11	12
加熱溫度(℃)	100	220	330	440	540	600	640	665	685	705	715	730
經過時間(分)	13	14	15	16	17	18	19	20	21	22	23	24
加熱溫度(℃)	740	750	760	770	775	785	790	795	800	805	816	815
經過時間(分)	25	26	27	28	29	30	35	40	45	50	55	60
加熱溫度(℃)	820	825	830	835	838	840	860	880	895	905	915	925
經過時間(分)	65	70	75	80	85	90	95	100	110	120		
加熱溫度(℃)	930	945	955	965	975	980	985	990	1000	1010		

5.加熱試驗

5.1 試驗面以外之部分，須以耐火材料覆蓋將火焰隔斷，又該等接縫若有空隙可能會將試驗面以外之部分加熱時，須以耐火材料填塞，經過適當處理後方可進行加熱。

5.2 試體加熱面之爐內氣壓應採取大於大氣壓力之加熱方法，故應於試驗面安裝測壓計，確定至少加熱面之1/2 承受高於大氣壓之爐內氣壓。

5.3 加熱溫度須以CNS 5534熱電側所規定具有0.75級以上性能及直徑1mm之CA 熱電側測定。測定加熱溫度熱電側之熱接點，應如圖2所示設置9個以上，其位置應在試驗面之中心及中心與兩端之中間。

耐火用加熱試驗中測定加熱溫度所用之熱電側，應放入內徑約1cm及前端封閉之石英、鐵或磁性保護管中，其兩端熱接點分別設置於距離試驗面上方約3cm 及10cm之位置，平行試驗面約10cm以上設置。

5.4 加熱須依第5.3 節之規定以熱電偶所示之溫度沿第4 節所規定之標準曲線進行，甲種防火門行1小時加熱；乙種防火門行30分鐘加熱。

5.5 耐火用加熱試驗中之加熱溫度測定，至30分鐘以內須每隔2分鐘測定一次，30分鐘以後須每隔 5分鐘以內測定一次。至於爐內平均溫度標準曲線之許可差，其加熱時間溫度面積至加熱時間1小時範圍內為±10%，至2小時範圍內為±7.5%，但在許可差以上之高溫，而符合第5.7節之規定者，不在此限。

5.6 在認為防火門弱點部分之內側表面（有木條時為木條表面）上，以煤煙塗黑表面之CNS 11073 銅及銅合金板捲片所規定之韌煉銅(C1100P)厚度0.2mm，面積約4Cm²之銅板，與尺度5×5cm厚度1cm之0.8 石棉真珠岩板者在內面 5個以上之位置平面密接，然後測定該銅板之溫度。銅板之溫度，須以CNS 5534所規定具有0.75級以上性能及直徑0.65mm之CA或CC熱電偶銀銲在銅板上測定。但對乙種防火門省略本項測定。

5.7 加熱試驗結果，試體符合下列規定時得認為符合甲種防火門或乙種防火門之規定。

(1)未產生防火上認為有害之變形、破損、脫落等變化者。

(2)有害於防火之火焰未通達內側者。

註1：由試體內側可目視加熱火焰之空隙或孔穴者，得視為火焰通達內側。

(3)加熱試驗中試體周邊各部分L(cm) 圖3所示之L_1，L_2，L_3，L_4，L_5，L_6及L_7之中間，反曲或撓度不得超過L /6000。

(4)構件之任何部分，不得發生對防火有害之火焰發生，加熱終了後5分鐘以上，不得有殘留之火燼。

註2：固定玻璃所用之油灰及塗料燃燒之火焰均應視為無礙於防火上之火焰。

(5)第5.6節所規定之銅板溫度，不得超過260℃。

6.衝擊試驗

6.1 衝擊試驗應使用第5 節所規定加熱試驗終了後30分鐘以內之試體，在試體內側施予第6.2節所規定之衝擊。

6.2 衝擊之進行應如圖4所示，由試體內側之正上方以繩索吊掛質量5kg之球狀砂袋，對準衝擊位置以垂直距離50cm之高度自由落下。

6.3 試體之衝擊位置，應於構造上認為較差之處選擇3個，各進行衝擊試驗一次。

6.4 衝擊試驗結果，試體未破壞、未產生裂縫、或未產生鬆開者得視為合格。

7.遮煙試驗

7.1 使用第2節所規定之試體，依第5節規定之試驗方法經30分鐘（耐火30分鐘之防火門為15分鐘）以上加熱後立即依第7.2節所規定之試驗裝置，測定試體兩面於空氣壓力差為1 kgf/㎡、2kgf/㎡及3kgf/㎡時之通氣量。

7.2 試驗裝置如圖5所示，由壓力箱、送風機、壓力調整機、氣密箱及壓力計所構成，並能對試體全面上施加均勻分布之空氣壓力。

7.3 遮煙試驗結果：以試體在壓力差2kgf/㎡時之單位面積(㎡)、單位時間(min)通氣量換算成標準狀態（空氣溫度20℃，1氣壓）之通氣量，作為遮煙試驗試體之通氣量，以有效數字2位表示之。各壓力差之測定值與於其他壓力差之測定值之間，不得有顯著之變化。

8.判定及報告

1、第5節之加熱試驗試體及第6節之衝擊試驗應進行2次，其結果均應合格。

2、防火門要求遮煙性能者，第7節之遮煙試驗應進行1次，其結果應合格。

3、試驗結果之報告書上，須記載構造種類之名稱，使用材料之詳細資料（包含比重、含水率及其他性能），試體之形狀，尺度、加熱等級，熱源、加熱溫度、內面溫度及其平均值與其測定位置，最高值及其到達之時間，防火上重要之觀察事項，衝擊試驗後試體之狀況行遮煙試驗時，遮煙試驗於各壓力差時之通氣量，結果之判定及其理由，燃料消耗量，試驗日期，試驗機關名稱及負責試驗人員性別。

第四章　試驗設備規格

本研究設計及建立之試驗設備的規格如下：

一、本測試設備需符合CNS 11227 (A3223) 之防火 2級 (點火後10分鐘內可達到爐溫840℃)及耐火3小時(爐溫達1100℃)，同時也需符合JIS A1311及ASTM E152 之同等測試標準。

二、防火門之有效測試面積為2.2公尺高1.2公尺寬，防火牆之有效測試面積為1.8公尺高90公分寬，同時為求爐內溫度之均勻，故最少需裝設六個燃燒器 (burner) 。

三、硬體規格

(一)鋼結構主框架及耐火材料爐體：

1、爐體框架需為鋼板及型鋼構成之鋼結構，鋼板最小厚度需達6mm以上，型鋼則為H100×100×6/8或強度更高者，鋼材外表並需塗上可耐溫300℃ 之銀漆。

2、爐體之耐火材料需能耐溫達1400℃以上，材料之熱傳導率，則需低於0.23Kcal/m°chr(350℃)，比重需達0.13以上，爐內轉角部分需再塗以可鑄性耐火材 (可耐溫1400℃且熱傳導率在400℃ 時低於0.6Kcal/m°chr) ，以達完全密封及保溫效果。

3、燃燒所產生的廢 (排) 氣得採自然通風方式由爐頂排出，故其排氣筒 (煙管) 需達內徑400mm 以上，材料需為4.5mm 以上厚度之鋼板且內襯75mm厚之輕質可鑄性斷熱材 (可耐溫1000℃以上，熱傳導率在400℃ 時應低於0.17Kcal/m°chr) ，可鑄性斷熱材需以SUS 304(8mm厚以上)之Y 形anchor固定之，anchor間隔不得大於150mm ，排氣筒總長度需達10公尺以上以配合廠房，並在爐頂上方之水平部分排氣筒裝置排氣控制板 (damper) ，此控制板及其轉軸均需為不銹鋼SUS 304，並以輕質耐火斷熱保溫材被覆之再以6mm厚(SUS 304)之anchor固定之，其anchor之間隔不得大於

100mm。

4、燃燒用燃料儲存桶（油桶）之容量需達2000公升以上，此以6mm厚之鋼板製成圓筒形構造，並附有油量標尺、通氣孔及人孔（或清掃孔）。

(二)火焰燃燒器(加熱設備)：

1、燃燒裝置必須使用低壓空氣噴霧式之比例調節燃燒器，燃燒器可同時使用煤油及柴油為燃料，而導燃器(pilot burner)則使用液化瓦斯(LPG)為燃料。

2、燃燒器之比例調節範圍為2至10L/hr 最大耗油量低於16L/hr，輸出熱量為18,000至152,000kcal/hr，燃燒器需包括前板，supporter，tile，空氣調節用damper，減壓閥，壓力計等配合零件，並必須配合自動控制系統來精確控制爐溫。

3、微差壓指示計（manostar gage） 之壓力範圍為－10至＋10mm水柱，本體耐壓2kg/Cm²，溫度誤差１％以內，精度需為2.5%以內，最小可讀刻度為0.2mm水柱。

4、燃油減壓閥組合之入口壓力可達10kg/Cm²，而出口壓力則為１至1.5kg/Cm²，其中調壓器（regulator） 之最大減壓比可達20：1，而過濾器（stranier）的容許流量應可達540L/hr，且壓力降不大於0.1kg/Cm²。

(三)空氣及燃油供應裝置：

1、燃燒空氣輸送用之送風機的流量需可達15m³/min，其靜壓應達700mm 水柱以上，送風機型式應為直接式turbo 構造，馬達需用大同或東元或同等級之外國產品，送風機需含出口處之手動控制板（damper），並需提供有關性質之測試報告。

2、燃燒用油之pump的設計流量需達12L/min 以上，其型式為內轉齒輪式，輸出壓力可達6 kg/Cm²以上，機械軸封可耐溫100℃ ，馬達可為大同、東元或同等級之外國產品。

3、供油系統組合需包括油泵、過濾器、迴油閥、底座及必要之閥、drain 等，各零組件之前後管路必需裝設停止閥及旁通管路以利保養維護；過濾器需為複式可切換式，管路尺寸為20A ，過濾面

積為100C㎡以上，過濾量可達400L/hr ；油泵用迴油閥（relief valve） 之管路尺寸為20A ，壓力為可調整0至10kg/C㎡。

4、配管長度分別可長達10公尺，管路材料一律採用SGP 碳鋼管，空氣總管口徑150A（分管為50至80A），燃油總管25A（分管10至15A），瓦斯總管25A(分管10至15A)，各器具前後需設停止閥及旁通管路以利保養。

(四)安全及自動控制裝置：

1、燃燒器及導燃器用空氣與導燃器用瓦斯管路均需配置微壓表，其口徑為75ϕ，壓力範圍為０至1000mm水柱，最小可讀刻度不大於20mm水柱。

2、燃燒器用油則需配置油壓表，口徑為75ϕ，壓力範圍最小需達０至５kg/C㎡，最小可讀刻度不大於0.2kg/C㎡。

3、安全用壓力開關及電磁閥應分別配置於燃油、瓦斯及空氣管路，壓力開關的精度不得大於15%，電磁閥的閥體必須用銅合金鍛造，其操作壓力必須配合設定（直流不超過７kg/C㎡，交流不超過17kg/C㎡）。

4、自動控制裝置應包括程式設定器、溫度控制器及操作機，應配合相關標準之溫度曲線來控制燃燒器以達±10%以內的爐溫控制；其中程式設定器及溫度控制器必須為PID 型式，程式設定器必須能耐溫1200℃及耐電壓500V(１分鐘)，並以數位式設定15pattern及15step以上，輸出精度小於0.1% ，時間設定最小可達１分鐘，並配有RS 232介面以便與電腦連接，而溫度控制器則亦需有顯示的功能，準確度需達±0.1 %，取樣時間（sampling period）可達0.1秒 ，數位式溫度控制範圍－200℃至1370℃ ，可設定８個不同的PID 常數，顯示部分則為彩色LCD ；燃燒器操作機（控制馬達）的最大扭力可達２Kg-m，PID 用之回饋電阻為2KΩ，最大轉角90° ，動作有效長度為28至100mm。

5．控制盤需包括電壓電流指示計，均使用無熔絲開關（需為正字標記之產品），電源為110及220V ，二次配線應使用正字標記之電纜，並依電力公司及相關電工法規來配線。

四、軟體配合規格

(一)設計及試車：

1、為配合國外設計之要求，故本規格要求所有的設計圖均需獲得國外原設計廠家之approved，並要求國外設計廠家需派遣技術人員在最後試車階段來台監督並討論相關技術事項。

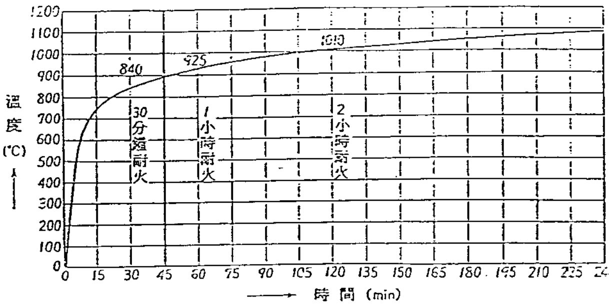
2、完工後必須整理兩套完整的設備組立圖、零件圖、配線圖、配管圖、相關規範及型錄（包括零件、器具、材料等）或原出品廠証明，並附詳細之操作及保養維護手冊各兩套。

(二)測試數據存取：

1、測試數據將存於個人電腦，故設計時需設置相關的介面卡，並建議個人電腦之規格及輸出裝置，同時配合研究單位製作適當的數據輸出用軟體。

2、溫度量測需使用K type熱電偶，並伸入爐內適當位置（依相關標準），故最小長度需為150 公分，並以22φ之SVS 310 管保護之，再配合鋁合金法蘭（flange）而耐火材料上需設置SOS 304 不銹鋼管之安裝孔達180mm（附安裝法蘭）以上，補償導線亦為K type耐潮型外包，總長度可達150公尺。

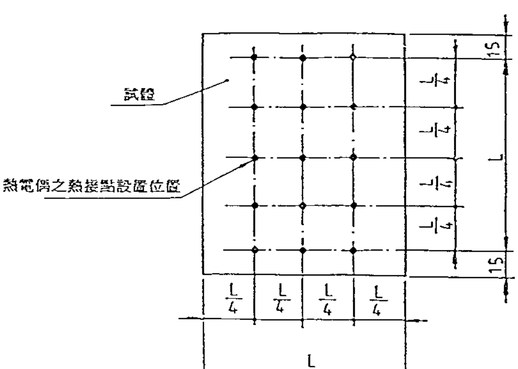
圖 1



1200
1100
1000
900
800
700
600
500
400
300
200
100
0
溫度
(℃)
840
925
1010
30
分鐘耐火
1
小時耐火
2
小時耐火
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
時間 (min)

圖 2

單位：mm



試驗
熱電偶之熱接點設置位置
15
L/4
L
L

圖 3

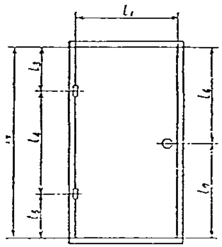


圖 4

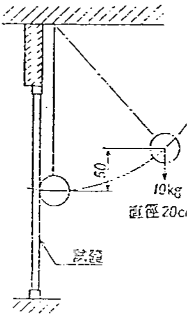
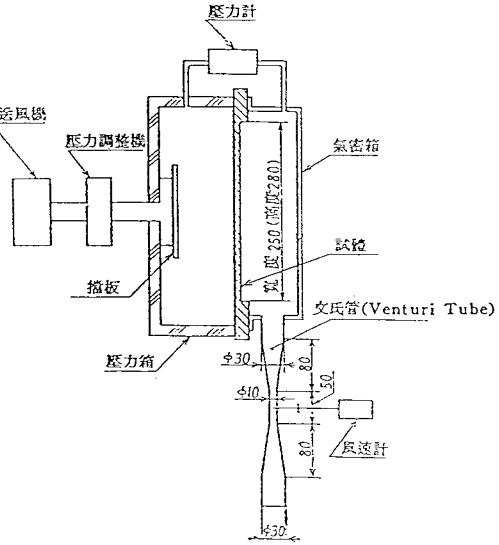


圖 5　試驗裝置（水平斷面圖）



(A) 檢驗文件格式(參考用)

* 建築材料及構件防火性能委託檢驗書表
  一. 委託檢驗申請須知
  二. 委託檢驗申請表
  三. 委託檢驗申請表填寫說明
  四. 委託檢驗契約書

* 防火牆防火性能試驗
  一. 防火牆防火性能試驗試體製作說明書
  二. 防火牆防火性能試驗步驟及判定基準
  三. 建築構件防火性能(防火時效)測試報告書

* 防火門防火性能試驗
  一. 防火門防火性能試驗試體製作說明書
  二. 防火門防火性能試驗步驟及判定基準
  三. 建築防火門防火性能測試報告書

建築材料及構件防火性能委託
檢 驗 書 表

、委託檢驗申請須知

㈠目的：為使申請人了解作業程序，節省作業時間，特訂定本須知。

㈡申請檢驗程序及流程圖（參照附圖一）

1. 塡寫委託檢驗申請表
2. 共同研擬檢驗計劃細節
3. 簽訂檢驗委託契約書
4. 繳交檢驗所需費用
5. 提供檢驗所需試體
6. 進行試驗程序
7. 請領試驗報告書

㈢申請檢驗程序說明

1. 塡寫委託檢驗申請表：

詳閱塡寫說明書後，以正楷、簡潔塡寫。若有任何疑問，請至服務處洽詢。

2. 共同研擬檢驗計劃細節：

為使檢驗計劃順利執行，事前良好的溝通是必需的，以期相互配合達成目標，洽談的主要為檢驗方式、費用、試體處理及運送，委託契約書內容等，各項細節商討。

3. 簽訂檢驗委託契約書：

雙方達成協議後，依規定程序，簽訂合約，確保雙方權益。

4. 繳交檢驗所需費用：

依委託檢驗申請表上委託事項，參照費用一覽表之規定，繳交檢驗所需費用。

5. 提供檢驗所需試體：

在研擬檢驗計畫細節後，依申請表所載日期，將試體送達以利試驗進

行。試體之製作請參照本手冊各類「試體製作說明書」上之說明。

6. 進行試驗程序

試體製作完成，經檢查符合規定後，應依本手冊各類試驗步驟，進行各項試驗工作。

7. 請領試驗報告書：

原則上，試驗完成後，受託單位提供申請人二份試驗報告書，若需要增加份數，請在委託檢驗申請表上塡明數目。

㈣主要表格及參考資料：

1. 各類檢驗項目及費用一覽表
2. 委託檢驗申請表（附塡寫說明書）
3. 委託檢驗契約書
4. 檢驗試體製作說明書
5. 試驗報告書(樣本)

上述文件、表格，請與檢驗測試單位連絡。

委託檢驗申請須知

申 請 流 程 圖

開始

步驟	負責單位
1. 塡寫委託檢驗申請表	檢 驗 測 試 單 位 (未定)
2. 共同研擬檢驗計畫細節	檢 驗 測 試 單 位 (未定)
3. 簽訂檢驗委託契約書	檢 驗 測 試 單 位 (未定)
4. 繳交檢驗所需費用	檢 驗 測 試 單 位 (未定)
5. 提供檢驗所需試體	建築防火試驗室 台北縣五股鄉(五股工業區) 五工六路五十二號
6. 進行試驗程序	建築防火試驗室 台北縣五股鄉(五股工業區) 五工六路五十二號
7. 檢驗測試報告書請領	檢 驗 測 試 單 位 (未定)

結束

二、委託檢驗申請表

申請日期：　　年　　月　　日

<table>
<tr><td rowspan="3">委託單位</td><td>名　　稱</td><td colspan="3"></td></tr>
<tr><td>地　　址</td><td colspan="3"></td></tr>
<tr><td>代 表 人</td><td></td><td>電　　話</td><td></td></tr>
<tr><td rowspan="5">委託事宜</td><td>委託檢驗目的</td><td colspan="3"></td></tr>
<tr><td>材料一般名稱</td><td></td><td>商品名稱</td><td></td></tr>
<tr><td>材料形狀</td><td></td><td>材料尺寸</td><td></td></tr>
<tr><td>材料種類及數量</td><td></td><td>材料成分</td><td></td></tr>
<tr><td>委託檢驗項目</td><td colspan="3"></td></tr>
<tr><td colspan="2">試體提出日期</td><td>年　　月　　日</td><td>預定完成日期</td><td>年　　月　　日</td></tr>
<tr><td colspan="2">報告書請領方式</td><td>□自行前來領取　□郵寄</td><td>報告書數量</td><td>份</td></tr>
<tr><td>備註</td><td colspan="4"></td></tr>
</table>

製品	材料構成　　　　材料斷面圖 化粧層（表面加工）
注意事項	一、申請人在檢驗申請表上所提文件圖說之內容，如有偽造文書、出具不實証明、侵害他人專利時，應分別依其責任。 二、本試驗報告僅證明送驗製品之防火性能，送驗製品乃申請人自行採送，本報告僅對送驗製品負責。
備註	
簽章	試驗委託 單位名稱 及負責人

三、委託檢驗契約書

1.試驗名稱：

2.試驗委託費用：

3.測試地點：

4.試驗日期　　由民國　　年　　月　　日

　　　　　　　至民國　　年　　月　　日

5.試驗項目及內容詳見委託檢驗申請表，如附件。

本契約委託單位　　　　　　　　　　（以下簡稱為甲方）交付檢驗委託于受委託單位　　　　　　　　　　（以下簡稱為乙方），經雙方同意，訂定下列條文：

第一條：甲方以委託檢驗申請表上事宜，委託乙方執行。

第二條：甲方依照乙方所訂定支付標準，繳交檢驗費用。

第三條：若發生下列各項情況時，費用應由甲方支付：

1.甲方變更計劃，致使經費增加時。
2.乙方為實施試驗、測定，而需要出差時。
3.乙方為檢驗試體、試體材料取樣，而需要出差時。
4.檢驗試體之安裝，所需工程費時。
5.甲方檢驗試體製作錯誤，造成乙方工作量或費用增加時。
6.甲方填寫資料或所提文件圖說，有不實內容及錯誤，致使經費增加時。

第四條：檢驗工作完成後，所產生之廢棄，原則上應由甲方負責處理，必要時，可由甲、乙雙方協議所處理。

第五條：本契約內容若欲變更、修改時，需經甲、乙雙方同意。

第六條：乙方在檢驗工作完成後，應將試驗報告書交付甲方，若乙方欲對外

發表詳細試驗結果時，需經甲方同意。

第七條：甲方對於試驗結果報告書之內容，不可有段章取義或歪曲事實之行為。

第八條：乙方在甲方不履行經費支付時，有權逕行解除契約。

第九條：本契約未載明之內容，可由甲、乙雙方協議研擬之。

本契約一式兩份，經甲、乙雙方代表人簽名、蓋章後，各自存留乙份，以為日後履行契約依據。

委託單位(甲方)　　　　　　　　　簽章

受委託單位(乙方)　　　　　　　　簽章

中 華 民 國　　　　　年　　　　　月　　　　　日

防火牆防火性能試驗

一、防火牆防火性能試驗試體製作說明書

(一)試驗體製作要領

1. 尺寸：試驗體尺寸為高220cm ×寬120cm。厚度須與實物相同。
2. 數量：至少五個。得應廠商要求加作其他試驗，而增加個數。

> *說明：依照規定，加熱試驗、衝擊試驗各需要二個試驗體。另外，因下列可能狀況備用試體一個：
> a. 人為因素或儀器故障而致試驗中斷時。
> b. 實驗結果異常，無法確定原因時。

3. 構成：
  (1)試驗體應依實際使用情形製作，若有耐火性能較差之部份，應該包括該弱點。

> *參考：試驗體為骨架組立，外裝面板者，其組立原則如圖1所示。
> 試驗體為預製實心牆板者，其組立原則如圖2所示。

  (2)牆壁構成內部具有中空時，應使其周圍及背面側密封作為試驗體。

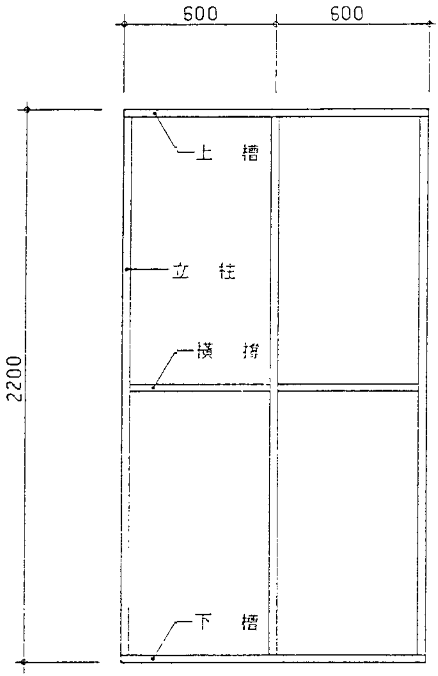
(二)試驗體前置處理

在試驗體進行試驗前，必須經過養護等前置處理，使實驗數據能具再現性，並保証性能判定準確及可靠。

1. 試驗體應放置在通風良好之室內乾燥至達氣乾狀態。或放置如下表所示期間。

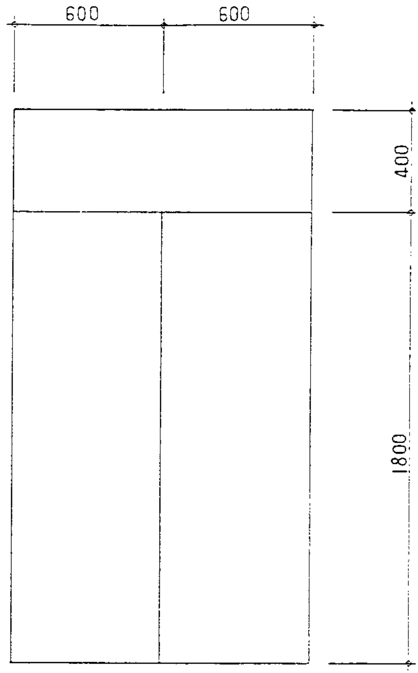
分類	夏季	冬季
依混凝土、粉刷水泥砂漿等濕式工法施工者	2個月	3個月
依張貼面板等乾式工法施工者	1個月	1個月

2. 以人工乾燥方法者，應以適當方法確認已達氣乾狀態或上表放置期間所達乾燥狀態。
3. 金屬、玻璃等製品無須乾燥。



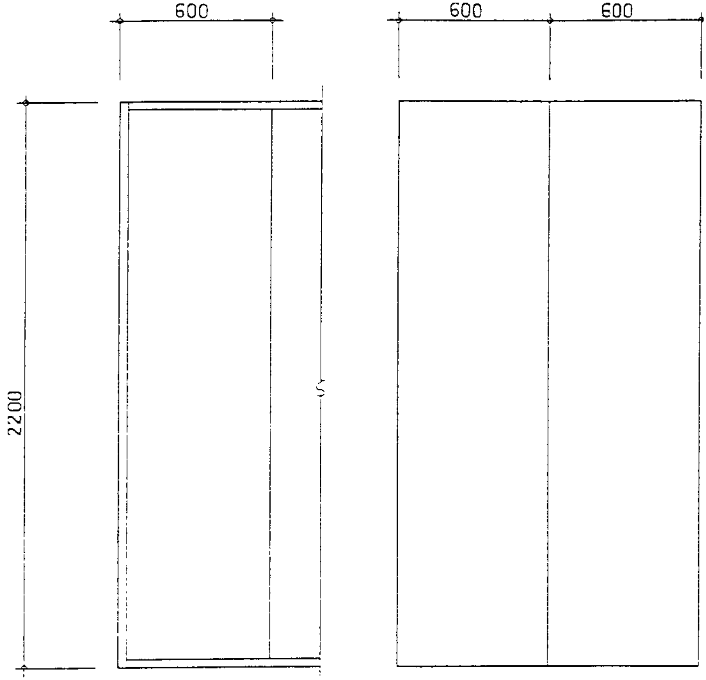
骨架組立方式圖 S:1/20

※橫撐依實際組立情形製作



面板組立方式圖 S:1/20

圖 1



實心牆板組立方式圖　S:1/20

※牆板單元尺寸，以依實際使用尺寸為原則

圖2

二、防火牆防火性能試驗步驟及判定基準

(一)試驗步驟

步驟	試　驗　程　序	處　理、觀　察　及　注　意　事　項
1	試驗體製作	確認試驗體組成與實物相同，並合乎規定。
2	試驗體養護	養護至氣乾狀態。
3	試驗裝置檢查(加熱爐)	核對試驗裝置管理事項，確認試驗裝置正常。
4	加熱試驗	二次加熱試驗規定。
4-1	試驗體尺寸測定	長.寬.厚度測定。以公分爲單位，測至小數點一位
4-2	試驗體固定	試驗體與固定框架間之隙縫以耐火材料充填之。架放上加熱爐。
4-3	記錄器檢查	試驗前五分鐘，打開記錄器開始記錄。
4-4	點火加熱	依照標準熱曲線加熱至任一界限條件發生。
4-5	試驗觀察	溫度：背面溫度 鋼材最高溫度、平均溫度 裂縫：木棉著火與否 變形、破壞、脫落等之目視觀察 殘燼：十分鐘後無殘燼
4-6	時效判定	依判定基準
5	衝擊試驗	三次衝擊試驗規定
5-1	試驗體尺寸測定	同4-1
5-2	試驗體固定	同4-2
5-3	記錄器檢查	同4-3
5-4	點火加熱	依照標準加熱曲線加熱三十分鐘，三十分鐘時效者加熱十分鐘
5-5	試驗體取下平置	試驗面朝上
5-6	重錘自由落下衝擊	30分鐘時效　1Kg重　100cm高 1小時時效　5Kg重　100cm高 2、3、4小時時效　10Kg重　100cm高
5-7	判定	依判定基準
6	總合判定	上述4、5項試驗符合要求者爲合格。

(二)判定基準

判定項目		判定基準
加熱試驗	變形 破壞 脫落	不產生對耐燃性或構造強度有害之變形、破壞、脫落。局部之爆裂僅止於表層之剝離及積層材料加熱側之一部份爆裂，雖然產生大龜裂、剝離、脫落等現象，但未侵入背面側材料或心材者得視為合格。
	裂縫	不得有火焰通過之裂縫。 以木棉放在裂縫處，加熱中若不會著火則視為合格
	背面溫度	背面溫度不超過260℃。 外牆由屋內側加熱時，不在此限
	鋼材最高溫度	鋼骨鋼筋混凝土、鋼筋混凝土：550℃以下 預力鋼筋混凝土：450℃以下 鋼骨:500℃以下
	鋼材平均溫度	鋼骨：400℃以下
	殘燼	加熱終了十分鐘後不得有殘燼存在
衝擊試驗		自由落下衝擊，結果未達耐火被覆材料全厚之剝離或未達背面之開孔者為合格。 30分鐘加熱　1公斤重錘　落下高度100公分 1小時加熱　5公斤重錘　落下高度100公分 2、3、4小時加熱　10公斤重錘　落下高度100公分
其他		依相關(法規)判定基準。
總合判定		試驗體符合上述全部基準時為合格。

三、建築構件防火性能(防火時效)測試報告書

<table>
<tr><td rowspan="2">試驗機關</td><td>名　　稱</td><td></td><td rowspan="2">委託單位</td><td>名　　稱</td><td></td></tr>
<tr><td>委託文號</td><td></td><td>地　　址</td><td></td></tr>
<tr><td rowspan="6">試
驗
體</td><td>構造名稱</td><td></td><td colspan="2">商品名稱</td><td></td></tr>
<tr><td>構造部位</td><td></td><td colspan="2">耐火性能</td><td></td></tr>
<tr><td>比　　重
(氣乾、絕乾)</td><td></td><td colspan="2">含水率(%)</td><td></td></tr>
<tr><td>材　　齡</td><td></td><td colspan="2">備　　註</td><td></td></tr>
<tr><td colspan="5">試驗體材料及其構成(斷面圖)　　單位：mm</td></tr>
<tr><td>備　　註</td><td colspan="4"></td></tr>
</table>

<table>
<tr><td rowspan="7">試驗方法</td><td rowspan="5">加熱試驗</td><td colspan="2">加熱爐燃料</td><td colspan="3"></td></tr>
<tr><td colspan="2">溫度測定位置</td><td colspan="3">如附圖　所示</td></tr>
<tr><td colspan="2">試驗荷重</td><td colspan="3"></td></tr>
<tr><td rowspan="2">撓度測定</td><td>方法</td><td colspan="3">裝設　，測定其移動量</td></tr>
<tr><td>位置</td><td colspan="3">試驗體非加熱側　處，如附圖　所示。</td></tr>
<tr><td colspan="2" rowspan="2">衝擊試驗</td><td>方法</td><td colspan="3">加熱　分，錘重　Kg，落差　M。</td></tr>
<tr><td>位置</td><td colspan="3">如附圖　所示。</td></tr>
<tr><td rowspan="17">加熱試驗結果</td><td colspan="3">試驗體編號</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">試驗日期</td><td>年　月　日</td><td>年　月　日</td><td>年　月　日</td></tr>
<tr><td colspan="3">試驗體尺寸(CM)</td><td>W　×H</td><td>W　×H</td><td>W　×H</td></tr>
<tr><td colspan="3">加熱面</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">實施加熱時間</td><td>分</td><td>分</td><td>分</td></tr>
<tr><td colspan="3">合格加熱時間</td><td>分</td><td>分</td><td>分</td></tr>
<tr><td colspan="3">測定溫度曲線</td><td>如附圖　所示</td><td>如附圖　所示</td><td>如附圖　所示</td></tr>
<tr><td rowspan="3">界溫
限度
時°C
間</td><td colspan="2">裏面最高溫度</td><td>（　分）</td><td>（　分）</td><td>（　分）</td></tr>
<tr><td colspan="2">鋼材最高溫度</td><td>（　分）</td><td>（　分）</td><td>（　分）</td></tr>
<tr><td colspan="2">鋼材平均溫度</td><td>（　分）</td><td>（　分）</td><td>（　分）</td></tr>
<tr><td colspan="3">撓度曲線</td><td>如附圖　所示</td><td>如附圖　所示</td><td>如附圖　所示</td></tr>
<tr><td colspan="3">最大撓度(CM)</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">變形
破壞
脫落
龜裂等</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">殘燼</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">其他觀察事項</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">結果判定</td><td>合格・不合格</td><td>合格・不合格</td><td>合格・不合格</td></tr>
</table>

<table>
<tr><td rowspan="5">衝擊試驗結果</td><td>試驗體記號</td><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td>試驗日期</td><td colspan="3">年 月 日</td><td colspan="3">年 月 日</td></tr>
<tr><td>試驗體尺寸(CM)</td><td colspan="3">W XH</td><td colspan="3">W XH</td></tr>
<tr><td>觀察事項</td><td colspan="3"></td><td colspan="3"></td></tr>
<tr><td>結果判定</td><td colspan="6"></td></tr>
<tr><td rowspan="8">＊構件耐火被覆材料
料相關性能</td><td>密度試驗</td><td colspan="2">1.</td><td colspan="2">2.</td><td colspan="2">平均：</td></tr>
<tr><td rowspan="2">附著力試驗</td><td colspan="2">1.</td><td colspan="2">2.</td><td colspan="2">3.</td></tr>
<tr><td colspan="2">4.</td><td colspan="2">5.</td><td colspan="2">平均：</td></tr>
<tr><td rowspan="2">彎曲試驗</td><td colspan="2">1.</td><td colspan="2">2.</td><td colspan="2">3.</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2">平均：</td></tr>
<tr><td rowspan="2">壓縮試驗</td><td colspan="2">1.</td><td colspan="2">2.</td><td colspan="2">3.</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2">平均：</td></tr>
<tr><td>結果判定</td><td colspan="6"></td></tr>
<tr><td>性能綜合判定</td><td colspan="7"></td></tr>
<tr><td>簽
章</td><td colspan="7">試驗單位 試驗負責人 試驗操作員</td></tr>
</table>

＊參考用實驗

防火門防火性能試驗

一、防火門試驗試體製作說明書

㈠試驗體製作要領

1. 尺寸：試驗體尺寸為高220cm×寬120cm。厚度須與實物相同。
2. 數量：至少五個。得應廠商要求加作其他試驗，而增加個數。

> *說明：依照規定，加熱試驗、衝擊試驗各需要二個。另因應如下等狀況預備一個以為備。
> a. 人為因素或儀器故障而致試驗中斷時。
> b. 實驗結果異常，無法確定原因時。

3. 構成：
   ⑴試驗體(含門框)應依實際使用情形製作，若有耐火性能較差之部份，應該包括該弱點。

   ⑵若試驗體(含門框)之尺寸小於⑴之規定，則應以耐熱框架補足。

㈡試驗體前置處理

在試驗體進行試驗前，必須經過養護等前置處理，使實驗數據能具再現性，並保証性能判定準確及可靠。

1. 試驗體應放置在通風良好之室內乾燥至達氣乾狀態。或放置如下表所示期間。

分類	夏季	冬季
依混凝土、粉刷水泥砂漿等濕式工法施工者	2個月	3個月
依張貼面板等乾式工法施工者	1個月	1個月

2. 以人工乾燥方法者，應以適當方法確認已達氣乾狀態或上表放置期間所達乾燥狀態。
3. 金屬、玻璃等製品無須乾燥，木材則需確保含水量15%以下。

二、防火門耐火性能試驗步驟及判定基準

(一)試驗步驟

步驟	試　驗　程　序	處理、觀察及注意事項
1	試驗體製作	確認試驗體組成與實物相同，並合乎規定。
2	試驗體養護	養護至氣乾狀態。
3	試驗裝置檢查(加熱爐)	核對試驗裝置管理事項，確認試驗裝置正常。
4	加熱試驗	二次加熱試驗規定。
4-1	試驗體尺寸測定	長.寬.厚度測定。以公分為單位，測至小數點一位
4-2	試驗體固定	試驗體與固定框架間之隙縫以耐火材料充填之。架放上加熱爐。
4-3	記錄器檢查	試驗前五分鐘，打開記錄器開始記錄。
4-4	點火加熱	依照標準熱曲線加熱至任一界限條件發生。
4-5	試驗觀察	溫度：背面溫度 　　　鋼材最高溫度、平均溫度 裂縫：木棉著火與否 變形、破壞、脫落等之目視觀察 殘燼：十分鐘後無殘燼
4-6	時效判定	依判定基準
5	衝擊試驗	三次衝擊試驗規定，加熱終了後30分鐘內進行
5-1	試驗體固定	同4-2
5-2	重錘自由落下衝擊	3 Kg重 50cm高
5-3	判定	依判定基準
6	總合判定	上述4、5兩項試驗符合要求者為合格。

(二)判定基準

<table>
<tr><th colspan="2">判定項目</th><th>判定基準</th></tr>
<tr><td rowspan="4">加熱試驗</td><td>變形
破壞
脫落</td><td>不產生對耐燃性或構造强度有害之變形、破壞、脫落。局部之爆裂僅止於表層之剝離及積層材料加熱側之一部份爆裂，雖然產生大龜裂、剝離、脫落等現象，但未侵入背面側材料或心材者得視爲合格。</td></tr>
<tr><td>裂縫</td><td>不得有火焰通過之裂縫。</td></tr>
<tr><td>背面溫度</td><td>甲種防火門背面溫度不超過260℃。</td></tr>
<tr><td>殘燼</td><td>加熱終了十分鐘後不得有殘燼存在</td></tr>
<tr><td colspan="2">衝擊試驗</td><td>自由落下衝擊，結果未達耐火被覆材料全厚之剝離或未達背面之開孔者爲合格。
3 公斤重錘　落下高度50公分</td></tr>
<tr><td colspan="2">其他</td><td>依相關(法規)判定基準。</td></tr>
<tr><td colspan="2">總合判定</td><td>試驗體符合上述全部基準時爲合格。</td></tr>
</table>

三、建築防火門防火性能測試報告書

<table>
<tr><td rowspan="2">試驗機關</td><td>名稱</td><td></td><td rowspan="2">委託單位</td><td>名稱</td><td></td></tr>
<tr><td>委託文號</td><td></td><td>地址</td><td></td></tr>
<tr><td rowspan="6">試驗體</td><td>構造名稱</td><td></td><td colspan="2">商品名稱</td><td></td></tr>
<tr><td>構造部位</td><td></td><td colspan="2">耐火性能</td><td></td></tr>
<tr><td>比重
(氣乾、絕乾)</td><td></td><td colspan="2">含水率(%)</td><td></td></tr>
<tr><td>材齡</td><td></td><td colspan="2">備註</td><td></td></tr>
<tr><td colspan="5">試驗體材料及其構成(斷面圖) 單位：mm</td></tr>
<tr><td>備註</td><td colspan="4"></td></tr>
</table>

<table>
<tr><td rowspan="4">試驗方法</td><td colspan="2" rowspan="2">加試
熱驗</td><td>加熱爐燃料</td><td colspan="3"></td></tr>
<tr><td>溫度測定位置</td><td colspan="3">如附圖　　所示</td></tr>
<tr><td colspan="2" rowspan="2">衝擊試驗</td><td>方　　法</td><td colspan="3">錘重　　　Kg，落差　　　M。</td></tr>
<tr><td>位　　置</td><td colspan="3">如附圖　　所示。</td></tr>
<tr><td rowspan="12">加熱試驗結果</td><td colspan="3">試驗體編號</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">試驗日期</td><td>年　月　日</td><td>年　月　日</td><td>年　月　日</td></tr>
<tr><td colspan="3">試驗體尺寸(CM)</td><td>W　　×H</td><td>W　　×H</td><td>W　　×H</td></tr>
<tr><td colspan="3">加　　熱　　面</td><td>門內側　,門外側</td><td>門內側　,門外側</td><td>門內側　,門外側</td></tr>
<tr><td colspan="3">實施加熱時間</td><td>分</td><td>分</td><td>分</td></tr>
<tr><td colspan="3">合格加熱時間</td><td>分</td><td>分</td><td>分</td></tr>
<tr><td colspan="3">測定溫度曲線</td><td>如附圖　　所示</td><td>如附圖　　所示</td><td>如附圖　　所示</td></tr>
<tr><td>界溫
限度
時℃
間</td><td colspan="2">背面最高溫度</td><td>(　　分)</td><td>(　　分)</td><td>(　　分)</td></tr>
<tr><td colspan="3">變形
破壞
脫落
龜裂等</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">殘燼</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">其他觀察事項</td><td></td><td></td><td></td></tr>
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<table>
<tr><td rowspan="5">衝擊試驗結果</td><td>試驗體記號</td><td></td><td></td></tr>
<tr><td>試驗日期</td><td>年 月 日</td><td>年 月 日</td></tr>
<tr><td>試驗體尺寸(CM)</td><td>W ×H</td><td>W ×H</td></tr>
<tr><td>觀察事項</td><td></td><td></td></tr>
<tr><td>結果判定</td><td colspan="2"></td></tr>
<tr><td>性能綜合判定</td><td colspan="3"></td></tr>
<tr><td>簽章</td><td colspan="3">試驗單位 試驗負責人 試驗操作員</td></tr>
</table>

(B) 各國相關法規

中國國家標準 CNS 11227, 4213 及 3407

各國耐火試驗方法概要

國際標準 ISO 3008 及 834

日本法規 建築基準法施行令，建設省告示及 JIS A1311

美國標準 ASTM E152 及 E119

英國標準 BS 476 Part 8

德國標準 DIN 4102

中國國家標準 CNS 總號 11227 類號 A3223

建築用防火門防火試驗法

Method of Fire Protecting Test for Fire Door of Buildings

1. 適用範圍：本標準規定建築物防火門之試驗方法。
2. 試　體
   2.1 試體應為與實物同樣製作之防火門及門框如有防火能力較差之部分，應包含該認為防火弱點之部分。
   2.2 試驗面之尺度應與實物相同，但實物尺度在200×250cm以上時，得以200×250cm作為試驗面；厚度應與實物相同。
   2.3 試體須置於通風良好之室內，經過大約如表1所示之乾燥期間。但以人工方法乾燥達到上述以上乾燥狀態，或以適當試驗方法確定已達氣乾狀態時，得縮短其乾燥期間。但金屬、玻璃等製品無需乾燥。

表1　防火門試體乾燥時間　　　　單位：月

類別	夏天	冬天
依混凝土、水泥砂漿粉刷等濕式工法等施工之防火門試體	2	3
依石棉板舖設等乾式工法施工之防火門試體	1	1

3. 加熱爐
   3.1 加熱爐須能使第4節所示之加熱溫度時間變化大致均勻遍及整個試驗面者。
   3.2 加熱爐之熱源應為以天然瓦斯、液化瓦斯、重油或其他適當之燃料，其火焰須能直接充分達到試體上。
   3.3 安裝試體之框架，應具耐熱性，其構造須使試驗面保持在規定位置。
   3.4 試體應置於垂直位置並可於單面加熱。
4. 加熱等級
   4.1 防火門加熱溫度，應如表2及圖1之標準曲線所示者，其加熱等級依加熱溫度分為1級加熱、2級加熱、及3級加熱。

表2　防火標準加熱溫度　　　　單位：°C

加熱分類＼經過時間（分）	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1級加熱	100	150	260	410	660	910	1060	1120	1120	1090	1010	920	850	780
2級加熱	75	120	190	310	500	660	790	840	840	820	760	690	640	585
3級加熱	25	55	100	180	300	410	500	550	550	525	490	450	400	365

加熱分類＼經過時間（分）	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1級加熱	720	660	610	560	530	480	450	410	380	350	320	290	260	230	200
2級加熱	540	495	460	420	395	360	340	310	285	260	240	220	195	175	150
3級加熱	330	305	280	260	240	225	210	190	175	160	150	140	125	110	100

註1：自第2分鐘起，係由常溫逐次增加溫度。

   4.2 耐火用加熱溫度，應如表3及圖2之標準曲線所示，其加熱等級依加熱時間分為30分鐘、1小時及2小時，分別稱為30分鐘加熱、1小時加熱及2小時加熱。

（共6頁）

表3　耐火標準加熱溫度

經過時間（分）	1	2	3	4	5	6	7	8	9	10	11	12
加熱溫度（°C）	100	220	330	440	540	600	640	665	685	705	715	730
經過時間（分）	13	14	15	16	17	18	19	20	21	22	23	24
加熱溫度（°C）	740	750	760	770	775	785	790	795	800	805	816	815
經過時間（分）	25	26	27	28	29	30	35	40	45	50	55	60
加熱溫度（°C）	820	825	830	835	838	840	860	880	895	905	915	925
經過時間（分）	65	70	75	80	85	90	95	100	110	120		
加熱溫度（°C）	930	945	955	965	975	980	985	990	1000	1010		

5. 加熱試驗
   5.1 試驗面以外之部分，須將火焰隔斷以耐火磚或其他材料覆蓋，又鉸等接縫若有空隙可能會將試驗面以外之部分加熱時，須以石棉或其他材料填塞，經過適當處理後方可進行加熱。
   5.2 試體加熱面之爐內氣壓應採取大於大氣壓力之加熱方法，故應於試驗面安裝測壓計，確定至少加熱面之½承受高於大氣壓之爐內氣壓。
   5.3 加熱溫度須以 CNS 5534 熱電偶所規定具有 0.75 級以上性能及直徑1mm之CA熱電偶測定。
   測定加熱溫度熱電偶之熱接點，應如圖3所示設置15個以上，其位置應在試驗面之中心及中心與兩端之中間。
   防火用加熱試驗中測定加熱溫度應依上述方法設置熱電偶，以圖4所示裝置先測定水泥砂漿表面之溫度，如有困難，應預先在圖4所規定之水泥砂漿表面上設置熱接點，以表2所示之溫度及加熱條件用圖5所示法方之測定其溫度，作為該加熱爐之特訂溫度，藉以代替標準溫度。
   耐火用加熱試驗中測定加熱溫度所用之熱電偶，應放入內徑約1cm 及前端封閉之石英、鎳或磁性保護管中，其兩端熱接點分別設置於距離試驗面上方約3cm及 10cm 之位置，平行試驗面約 10cm 以上設置。
   5.4 加熱須依第5.3節之規定以熱電偶所示之溫度沿第4節所規定之標準曲線進行。
   5.5 防火用加熱試驗中之加熱溫度測定，須每隔一分鐘測定一次，依下列定義 0.9K 以下或 1.1K 以上者，不計入試驗次數。但A在 1.1K 以上且符合第8節之規定，或在0.9K以下而不符合第8節之規定者，分別作為合格或不合格。
   A：實施加熱時間溫度曲線與 260°C線所包圍之面積（單位 100°C分）
   K：圖1所示標準曲線上對應A之面積，依表4之規定。

表　4　　　　單位：100°C分

加熱級別	1級加熱	2級加熱	3級加熱
加熱時間溫度面積	96	56	19

   5.6 耐火用加熱試驗中之加熱溫度測定，至30分鐘以內須每隔2分鐘測定一次，30分鐘以後須每隔5分鐘以內測定一次。至於爐內平均溫度標準曲線之許可差，其加熱時間溫度面積至加熱時間1小時範圍內為±10%，至2小時範圍內為 ±7.5%，超過2小時為±5%以內，但在許可差以上之高溫，而符合第5.8節或第5.9節之規定者，不在此限。
   5.7 在距離認為防火門弱點部分之內側表面（有木條時為木條表面） 3 cm 之位置上，以煤煙塗黑表面之 CNS 11073 銅及銅合金板捲片所規定之韌煉銅（C1100P）厚度 0.2 mm，面積約4cm² 之銅板，與尺度5×5cm CNS＿＿＿石棉水泥真珠岩板所規定厚度1cm之 0.8 石棉真珠岩板須在內面5個以上之位置平面密接，然後測定該銅板之溫度。銅板之溫度，須以 CNS 5534 所規定具有 0.75級以上性能及直徑 0.65mm 之CA或 CC 熱電偶銀銲在銅板上測定。但對乙種防火門省略本項測定。
   5.8 加熱試驗結果，試體符合下列規定時得認為符合甲種防火門之規定。

(1) 未產生防火上認為有害之變形、破損、脫落等變化者。

(2) 有害於防火之火焰未通達內側者。

註 2：由試體內側可目視加熱火焰之空隙或孔穴者，得視為火焰通達內側。

(3) 加熱試驗中試體周邊各部分 ℓ（cm）圖 6 所示之 $\ell_1,\ell_2,\ell_3,\ell_4,\ell_5,\ell_6$及$\ell_7$ 之中間，反曲或撓度不得超過 $\ell^2/6000$。

(4) 構件之任何部分，不得發生對防火有害之火焰發生，加熱終了後 5 分鐘以上，不得有殘留之火焰。

註 3：固定玻璃所用之油灰及塗料燃燒之火焰均應視為無礙於防火上之火焰。

(5) 第 5.7 節所規定之鋼板溫度，不得超過260°C。

5.9 加熱試驗結果，除第 5.8 (5)節外，試試體符合其他各項規定者認為符合乙種防火門之規定。

6. 衝擊試驗

6.1 衝擊試驗應使用第 5 節所規定加熱試驗終了後30分鐘以內之試體，在試體內側施予第 6.2 節所規定之衝擊。

6.2 衝擊之進行應如圖 7 所示，由試體內側之正上方以繩索吊掛質量10kg，直徑 20cm 之球狀砂袋，對準衝擊位置以垂直距離 50cm 之高度自由落下。

6.3 試體之衝擊位置，應於構造上認為較差之處選擇 3 個，各進行衝擊試驗一次。

6.4 衝擊試驗結果，試體未破壞、未產生裂縫、或未產生鬆開者得視為合格。

7. 遮煙試驗

7.1 使用第 2 節所規定之試體，依第 5 節規定之試驗方法經 30 分鐘（耐火 30 分鐘之防火門為 15 分鐘）以上加熱後立即依第 7.2 節所規定之試驗裝置，測定試體兩面於空氣壓力差為 1 kgf/m²、2 kgf/m² 及 3 kgf/m² 時之通氣量。

7.2 試驗裝置如圖 8 所示，由壓力箱、送風機、壓力調整機、氣密箱及壓力計所構成，並能對試體全面上施加均勻分布之空氣壓力。

7.3 遮煙試驗結果，以試體在壓力差 2 kgf/m² 時之單位面積（m²）、單位時間（min）通氣量換算成標準狀態（空氣溫度 20°C，1 氣壓）之通氣量，作為遮煙試驗試體之通氣量，以有效數字 2 位表示之。各壓力差之測定值與於其他壓力差之測定值之間，不得有顯著之變化。

8. 判定及報告

8.1 第 5 節之加熱試驗試體及第 6 節之衝擊試驗應進行 2 次，第 7 節之遮煙試驗應進行 1 次，其結果均應合格。

8.2 試驗結果之報告書上，須記載構造種類之名稱，使用材料之詳細資料（包含比重、含水率及其他性能），試體之形狀，尺度、加熱等級，熱源、加熱溫度、內面溫度及其平均值與其測定位置，最高值及其到達之時間，防火上重要之觀察事項，衝擊試驗後試體之狀況，遮煙試驗於各壓力差時之通氣量，結果之判定及其理由，燃料消耗量，試驗日期，試驗機關名稱及負責試驗人員姓別

圖 1

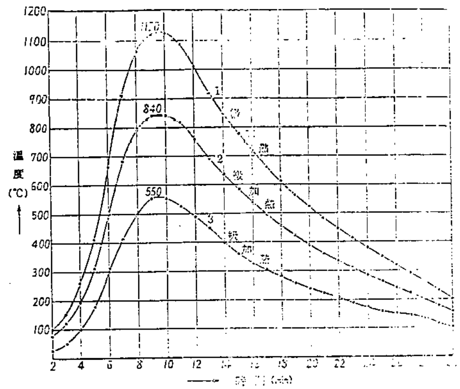


圖 2

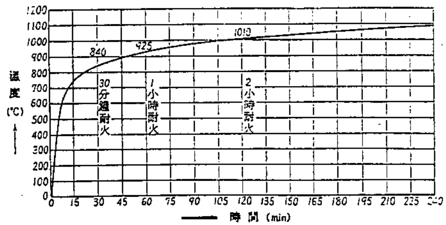


圖 3

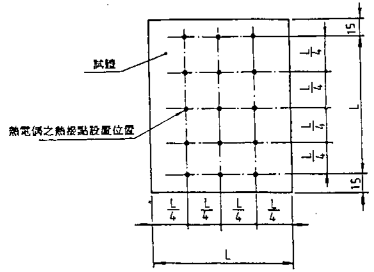


圖 4

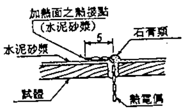


圖 5

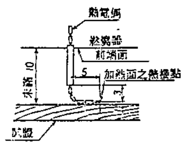


圖 6

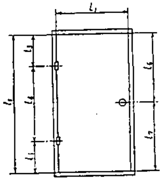


圖 7

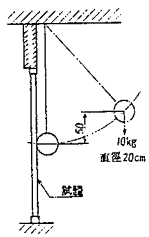
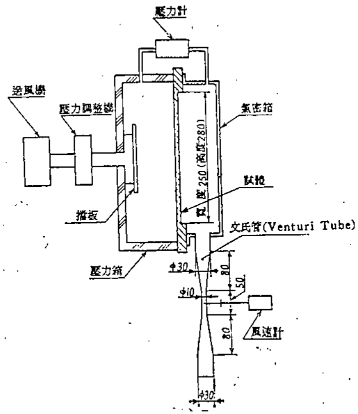


圖 8　試驗裝置（水平斷面圖）



UDC 69.028.154:699.81:620.1

中國國家標準 CNS | 總號 4213 | 類號 A3072

防火鐵捲門檢驗法

Method of Test for Fire-proof Shutters for Buildings

1. 適用範圍：本標準規定防火鐵捲門之檢驗方法。
2. 抽　　樣：依 CNS 2779 計數值檢驗抽樣程序及抽樣表之規定抽樣。
3. 檢　　驗

3.1 外觀檢查：依 CNS 4212 防火鐵捲門第 5.3 節規定檢查。

3.2 機械性能及尺度檢查：依 CNS 4212 第 6 及 7 節所示各項規定檢查。

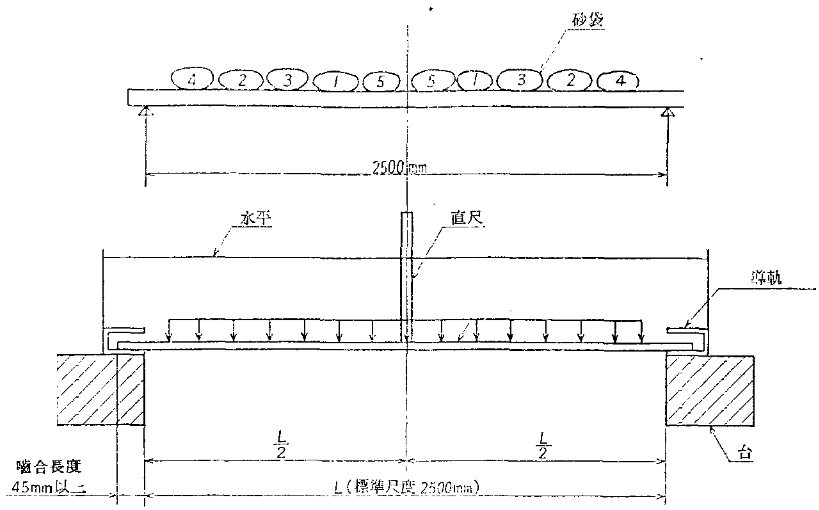
3.3 鐵捲門遮煙依CNS 11227 建築用防火門防火試驗法第 7 節試驗其結果應符合 CNS 4212 第 3.3 節之規定。

3.4 試驗方法

3.4.1 鐵捲門防火試驗：依 CNS 11227 之規定試驗。

3.4.2 葉片彎曲試驗：試片須在同一條件製造之葉片中抽取三片，作橫向嚙合連接：葉片之兩端均不得裝上端夾，如下圖所示，試片表面向上裝在堅固之導軌中，依照 CNS 4212 表 6 所規定之載重，特規定載重以10個等質量之砂袋代替，並依照圖 1 所示順序均佈於載試片上，經10分鐘後測定試片中心點之撓度。撓度之測定是測定水平線與試片中心點撓曲數字値，以測微計讀出。

圖 1　葉片彎曲試驗



3.4.3 開閉試驗

(1) 電動開閉：測驗鐵捲門是否能在任何位置，上限定點及下限定點確實停止，並測定電動時之開閉速度。

(2) 手動開閉：操作手動開閉裝置開閉鐵捲門，測驗鐵捲門是否可以在任何位置停止，確定鐵捲門能夠在任何位置停止後，將鐵捲門停置於離地面 200cm 位置處停止，然後測定手搖把手之回轉力及測定鏈條拉力。

(3) 連動開閉：由自動火警探熱設備感應需要動作時，測驗是否立即動作將鐵捲門完全關閉，並測定鐵捲門當時之自動下降速度。

3.4.4 鍍鋅處理檢驗：依 CNS 1247 鍍鋅檢驗法之規定辦理。

3.4.5 電動開閉噪音試驗結果應符合 CNS 5192 齒輪噪音測定法之規定。

公布日期 67年3月2日　經濟部中央標準局印行　修訂日期 74年4月23日

中國國家標準 CNS

門組件焚燒試驗法

總號 3407
類號 Z3007

Fire Tests of Door Assemblies

1. 適用範圍

1.1 本試驗法規定各種材料及構造型式所組成之門組件（門及門框），用於牆壁開口處以阻止火焰通過之焚燒試驗方法。

1.2 依據試驗法所作之試驗，係指示試驗焚燒期間之性能，但此等試驗不應解釋作爲材料經火燒後可適任之測定。

1.3 本試驗之目的係依照本試驗法所作之試驗後提供數據，使主管機構能依以決定門組件用於規定位置具有合適的防火規定時間。

焚燒試驗控制

2. 時間－溫度曲線：

門組件之焚燒試驗，應加以控制使符合於時間－溫度標準曲線（如圖1所示）之適用部份。決定門組件焚燒特性所用標準曲線上之各點爲：

於 5 分鐘時……………………… 538°C
於 10 分鐘時……………………… 704°C
於 30 分鐘時……………………… 843°C
於 1 小時時……………………… 926°C
於 2 小時時………………………1010°C
於 4 小時時………………………1093°C
於 8 小時或以上…………………1260°C

時間－溫度曲線之更精密定義，見附錄。

3. 爐內溫度

3.1 焚燒面之試驗溫度，應指平均溫度，係由至少九個接近試驗門組件各部份，對稱排列及分配之熱電偶所顯示之平均溫度而得。此種熱電偶應用密封之瓷管保護，此瓷管其外徑爲 19 mm ($^3/_4$ in)，管厚爲 3.2 mm ($^1/_8$ in)，如用卑金屬熱電偶替代時，則以外徑爲 12.7 mm (½ in) 之標準重量級熱鋼管或熱鐵管來保護。在全部焚燒期間，熱電偶接端距試驗門組件或爐壁之燃燒面應爲 152.4 mm（6 in）。

3.2 在最初2小時，每次讀溫間隔不超過5分鐘，此後，其讀溫間隔可增長，但不可超過 10 分鐘。

3.3 爐控制之精度應由熱電偶平均讀值所畫成之時間－溫度曲線下面積與時間－溫度標準曲線下相對面積比較得之。

1小時以內，其值相差在 10 % 範圍之內。
1小時至2小時，其值相差在 7.5 % 範圍之內。
2小時以上，其值相差在5 % 範圍之內。

4. 背燃燒面之溫度：

如未暴露於火焰各表面之溫度須予記錄時，應依照下列方法測定。

4.1 背燃燒面溫度之取得不可少三點，且門面積每 1.5 m² (16 ft²) 至少須有一熱電偶。熱電偶不可置於突伸過門之加强鐵器上，透視面（vision panel）上，或距門之邊緣少於 305 mm (12 in) 處。

4.2 背燃燒面之溫度應由置於一可撓曲，烘乾之石棉襯墊下之熱電偶量得。此石棉襯墊爲每邊 152.4 mm（6in）之見方，10.2 mm (0.4 in) 厚度，其重量不可少於 0.488 g/cm³ （1.0 lb/ft³）或多於 0.683 g/cm³ (1.4 lb/ft³)。襯墊牢牢地固定於門之表面上及緊緊地貼靠於熱電偶之四週。熱電偶引線覆置於襯墊下之距離不可少於 89 mm (3½ in)，且此熱電偶熱接端 (hot junction)，應位於石棉襯墊下之中心處，於襯墊下之熱電偶引線不可大於第 18 號美規（1mm）(No. 18 B & S gage (0.043 in)）且應具有抗熱及抗濕之電絕緣外層。

4.3 背燃燒面之溫度，讀值間隔與第 3.2 節之爐內溫度讀值間隔相同。

試驗用之門組件

5. 構造及大小

5.1 試驗用之門組件，其構造及大小，不論單扇門或双扇門，應爲作焚燒分類及檢定之相當樣品。門與門框之材料及構造、安裝、五金、飾條、塗漆、間隙及搭接等之細節均應記錄正確以供識別或複製。

（共4頁）

5.2 門檻除阻礙門之操作外，應爲牆壁開孔之一部份而予以保護。門檻應由不燃性物質製成，突入爐內約2倍於試驗門之厚度。

6. 安　裝

6.1 推門（swinging door）之安裝應使其能打入爐室。拉門及推門應安裝於爐室爐內靠近內牆面。所有門之安裝應使它們緊密接於門框內，而靠於牆表面或導軌（guide）內，但此種安裝不可妨礙試驗門之自由及容易操作。

6.2 推門之間隙如下：

於頂部 2.4 mm ($\frac{3}{32}$ in)
於底部 4.8 mm ($\frac{3}{16}$ in)
於門與絞，絞與鎖件（lock jam）間 2.4 mm ($\frac{3}{32}$ in)
（以上）許可差爲 1.6 mm ($\frac{1}{16}$ in)。

試驗之進行

7. 試驗時均工須有足够强度，在焚燒試驗及水管噴水試驗（hose stream test）過程中，能穩妥支持門組件於定位。

8. 焚燒持久試驗

8.1 保持爐室之壓力，儘可能約等於大氣壓力。

8.2 繼續試驗直至達到所訂焚燒分類及檢定所須之時間，除非在規定時間內已不能達到第 11 節所規定之合格條件（condition of acceptance）外。

9. 水管噴水試驗

9.1 於焚燒持久試驗後立即使試驗物承受噴水柱之衝擊、冲蝕及冷却等效應。噴水柱首先指向中間，然後慢慢地改變方向噴射於暴露面之各部份。

9.2 輸送水流經由一 63.5 mm (2½ in) 軟水管，發射經由一同樣尺度之國家標準遊管（national standard playpipe）射出。此管具有一 28.6 mm ($1^1/_8$ in) 發射端，此發射端爲標準錐形，且內徑光滑型，在孔口處無突出肩部。在管嘴底部之水壓及門面積每平方公尺噴水之期間，如表1所示，

表1——於管嘴底部之水壓及噴水之期間

所需之檢定	在管嘴底部之水壓 kg/cm² (psi)		門面積每平方公尺所需時間 sec/m² (sec/ft²)	
3小時……………………	3.15	(45)	32.2	(3)
1½ 小時至3小時………	2.1	(30)	16.1	(1.5)
1小時至 1½ 小時 ……	2.1	(30)	9.7	(0.9)
少於1小時…………………	2.1	(30)	6.5	(0.6)

9.3 管嘴端置於垂直於試驗門中心之線上，距門 6.1 m (20 ft) 處。如不能如此安置，則管嘴可置於與試驗門中心垂直之線偏差不超過 30 度之線上。當如此裝置時，每與法線偏差 10 度，距門中心之距離則爲由 6.1 m 減去 305 mm (1 ft) 之值。

10. 報　告：

試驗報告須註明爲依據本試驗法所作各項性能試驗之結果。此報告應指示出，由下列所選出之約定焚燒期間之性能：

20 分鐘，30 分鐘，45 分鐘，1小時，1½ 小時或3小時。此報告應包括爐內溫度之計量及（如欲測定時）試驗物背燃燒面之溫度計量，此報告且應包含所有有關試驗門組件性能之觀察記錄。

合格條件

11. 合格條件：

對性能合格而言，當門組件在焚燒持久試驗及水管噴水試驗期間仍保留於空隙內，於下列限制範圍之內，還視爲合於要求。

11.1 在焚燒分類時間之前半期，推門之移動，不使任何邊緣部份自原來位置有超過門厚度之移動；於完成焚燒分類時期內及水管噴水試驗後，也未有超過門厚度 1½ 倍之移動。

11.2 雙扇推門組件，其分開距離不多於 19 mm (3/4 in) 或是等於在門橫栓 (latch bolt) 之開程 (threw)。

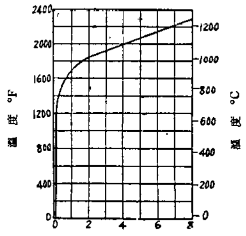
11.3 單扇推門之組件在關門處其分開距離不多於 12.7 mm (½ in)。

11.4 安裝於牆面上之門，移動時與牆面分開距離不多於相當於門邊緣之厚度。

11.5 裝置於導軌之門，不脫離導軌及導軌不鬆動。

11.6 試驗門組件，如無任何部份發生開口，即已通過焚燒持久試驗及水管噴水試驗，但玻璃製品之小部份如因噴水作用而有移動，將不認為一種弱點。

圖 1　時間－溫度標準曲線



附　　錄

表 II 一焚燒試驗控制用之時間－溫度標準曲線值

時間	溫度	20°C 底線以上之面積	
小時：分鐘	°C	°C • 分鐘	°C • 小時
0：00	20	00	0
0：05	538	1 290	22
0：10	704	4 300	72
0：15	760	7 860	131
0：20	795	11 650	194
0：25	821	15 590	260
0：30	843	19 650	328
0：35	862	23 810	397
0：40	878	28 060	468
0：45	892	32 390	540
0：50	905	36 780	613
0：55	916	41 230	687
1：00	927	45 740	762
1：05	937	50 300	838
1：10	946	54 910	915
1：15	955	59 560	993
1：20	963	64 250	1 071
1：25	971	68 990	1 150
1：30	978	73 760	1 229
1：35	985	78 560	1 309
1：40	991	83 400	1 390
1：45	996	88 280	1 471
1：50	1 001	93 170	1 553

1：55	1 006	98 080	1 635
2：00	1 010	103 020	1 717
2：10	1 017	112 960	1 882
2：20	1 024	122 960	2 049
2：30	1 031	133 040	2 217
2：40	1 038	143 180	2 386
2：50	1 045	153 390	2 556
3：00	1 052	163 670	2 728
3：10	1 059	174 030	2 900
3：20	1 066	184 450	3 074
3：30	1 072	194 940	3 249
3：40	1 079	205 500	3 425
3：50	1 086	216 130	3 602
4：00	1 093	226 820	3 780
4：10	1 100	237 590	3 960
4：20	1 107	248 430	4 140
4：30	1 114	259 340	4 322
4：40	1 121	270 310	4 505
4：50	1 128	281 360	4 689
5：00	1 135	292 470	4 874
5：10	1 142	303 660	5 061
5：20	1 149	314 910	5 248
5：30	1 156	326 240	5 437
5：40	1 163	337 630	5 627
5：50	1 170	349 090	5 818
6：00	1 177	360 620	6 010
6：10	1 184	372 230	6 204
6：20	1 191	383 900	6 398
6：30	1 198	395 640	6 594
6：40	1 204	407 450	6 791
6：50	1 211	419 330	6 989
7：00	1 218	431 270	7 188
7：10	1 225	443 290	7 388
7：20	1 232	455 380	7 590
7：30	1 239	467 540	7 792
7：40	1 246	479 760	7 996
7：50	1 253	492 060	8 201
8：00	1 260	504 420	8 407

表1・2・1 各国耐火試験方法の概要（その1）

項目			JIS	ISO	BS	DIN	ASTM
国名			日本	国際	イギリス	ドイツ	アメリカ
正式名称			JIS A 1304 建築構造部分の耐火試験方法	ISO 834 / TC-92 Fire resistance tests -Elements of building construction	BS 476 Part 8 Fire tests on Building Materials and Structures	DIN 4102 Teil 2,3 Brandverhalten von Baustoffen und Bauteilen	ASTM E - 119 Standard Methods of Fire Tests of Building Construction and Materials
制定機関			Japanese Standard Association	International Organization for Standardization	Brititsh Standards Institution	Deutsches Institut fur Normung	American Socienty for Testing and Materials
制定年			1975	1985	1972	1977	1983
試験体の大きさ（cm以上）	壁：高さ×幅		A型：240×180 B型：180× 90 C型： 90× 90	300×300	250×250	250×200	1辺 270 面積 9㎡
	床・屋根：長さ×幅		A型：240×180 B型：180× 90	400×300	400×250	1軸 400×200 2軸 400×400	長さ 370 面積 16㎡
	柱：高さ		A型：240 B型：150	300	（左に同じ）	（左に同じ）	載荷270 （鉄骨造は無載荷240）
	はり：長さ		A型：240 B型：150	400（スパン）	（左に同じ）	（左に同じ）	370
標準加熱温度（℃）	時：分	0：05 0：10 0：15 0：30 1：00 1：30 2：00 3：00 4：00 6：00 8：00	540 705 760 840 925 980 1010 1050 1095	556 659 718 821 925 986 1029 1090 1133 1193 (=T-T₀)	（左に同じ）	556 658 719 822 925 986 1029 1090 1133 1194 (=T-T₀)	538 704 760 843 927 978 1010 1052 1093 1177 1260
	標準曲線式		$T=1080-340^{-6.61t}-130e^{-5.6t}-610e^{-1.9t}$（近似式）2) （T：標準温度（℃） t：時間（時間））	$T-T_0=345\log_{10}(8t+1)$	T：標準温度（℃） T_0：加熱開始時試験体温度（℃） t：時間（分）		———
加熱温度の測定	温度許容誤差	温度の許容最大誤差	———	10分以後 ±100℃ 可燃材料を含む場合 ±200℃	10分以後±100℃	5分以後 ±100℃	———
		時間温度面積の許容最大誤差	1時間まで ±10% 1～2時間 ±7.5% 2時間を超える ±5%	10分まで ±15% 30分まで ±10% 30分以後 ±5%	（左に同じ）	5～30分 ±10% 30分以上 ±5%	（JISに同じ）
	熱電対	径	CA 1mmφ	0.75～1.0mm	0.75～1.5mmφ	外径3.2mm	———
		数・配置（本以上）	壁・床・屋根 ：A型 9，B・C型5 柱 ：A型12，B型8 はり：〃 9，〃6	床・壁・1.5㎡ごとに1，少なくとも5 柱高1mごとに2，少なくとも6	（左に同じ）	床・壁1.5㎡ごとに、柱・はり長1mごとに、5以上均等配置。	壁 ：4 床・屋根：9 柱・はり：8
		保護管	石英，鉄，磁性管 内径 10mmφ	熱接点裸（熱接点から2.5cmまで裸，他は磁性管等で支持）	（左に同じ）	———	磁性管外径 19mmφ 管厚 3mm 黒皮鋼管 13mmφ
		炉内挿入長さ	試験体面10cm以上	———	（左に同じ）	30cm以上	30.5cm以上
		試験体面と熱接点との距離	3cm	10cm	（左に同じ）	（左に同じ）	壁：15.2cm 床・屋根・柱・はり：30.5cm
試験体温度の測定	裏面温度（壁・床・屋根）	熱電対	CA 0.65mmφ	0.5mmφ以下の熱電対を厚さ0.2mm，径12mmの銅円板に接触させる。	（左に同じ）	0.5mmφ	1.02mmφ以下
		熱電対の数・配置（本）	A型：5 B・C型：3	5以上	（左に同じ）	（左に同じ）	床・屋根・壁 9以上
		おおい板	杉板：厚1.5cm 大きさ10×10cm	石綿パッド 厚2±0.5mm 大きさ3×3cm	（左に同じ）	———	柔軟な石綿パッド 厚1.02cm 大きさ15.2×15.2cm
		許容誤差			±1.5%		
	鋼材温度	熱電対の径	CA 0.65mmφ	なし	（左に同じ）	（左に同じ）	———
		熱電対の数	壁・床・屋根： 〃 5，〃 3 柱 ：A型9，B型6 はり：〃 6，〃 4				床・屋根：S各断面S4，RC8，柱：4断面各3，はり：4断面各4

（その３）

項目		JIS	ISO	BS	DIN	ASTM
注水試験	筒先圧力 注水時間	1.4kgf/cm²　2分間 （３０分加熱した後、実施。 ３０分耐火は１０分加熱。）	な　し	（左に同じ）	2kgf/cm²以上１分 （柱のみに規定）	1時間以下加熱2.1kgf/cm² 1～1.5時間〃　〃 1.5～2　〃　〃 2～4　〃　〃 4～8　〃　3.2kgf/cm² 8時間以上〃　〃
注水試験	筒先口径	12.7mmφ	——	——	12mmφ	64mmφ
注水試験	注水距離，角度	水平距離５m。 表面に対して４５°	な　し	（左に同じ）	直角　約３m	直角　6.1m。 角度１０°について 0.3m減
衝撃試験		１，５，１０kg重錘を落高１，２mと組合わせる （３０分加熱後でよい）。	な　し	（左に同じ）	壁：鋼球１５～２５kg 振子1.7m，距離２０cm （加熱終了約３分前）	な　し
載荷加熱試験	端部の拘束	——	実際使用時と同様。	実際使用時と同様。 壁：垂直荷重の場合、垂直の両端が解除。 無載荷は端部を拘束。	実際使用時と同様。	実際と同様。
載荷加熱試験	荷重	長期許容応力度の1.2倍の応力を生ずる荷重（試験体はA型を使用）	①設計荷重 ②構造法規に規定される試験荷重 ③構造用途による作用荷重	常温時の許容耐力	許容設計荷重	設計で意図した作用応力を生ずる荷重 床・屋根・はりは自重のほか、最大固定荷重と積載荷重
試験結果の判定	加熱試験　試験回数	２回以上（B・C型は３回）	１回以上，非対称は２回	——	２回以上	——
試験結果の判定	加熱試験　裏面温度の限界（℃）	加熱終了後も含めて最高が２６０	加熱中、 平均が１４０＋To， 最高が１８０＋To To：初期温度	（左に同じ）	床・屋根・壁、加熱中 平均が１４０＋To， 最高が１８０＋To To：初期温度	加熱中、床・屋根・壁 平均が１３９＋To， 最高が１３９×1.3＋To To：初期温度
試験結果の判定	加熱試験　鋼材温度の限界（℃）	柱・はり　床・屋根・壁 RC最高　500　550 PS〃　400　450 S〃　450　500 〃平均　350　400	特に規定なし。	（左に同じ）	柱（無載荷）のみに規定。 ：最高 500	柱・はり　床・屋根 RC最高　——　593 PS〃　——　427 S〃　649　704 〃平均　538　593
試験結果の判定	載荷加熱試験	耐力上の破壊を示さないこと。 床のたわみ　$\le \ell^2/10000$ 屋根のたわみ$\le \ell^2/6000$ ℓ：スパン（cm）	崩壊しないこと。 床・はりのたわみ$\le \ell/20$ 又は、たわみ速度（cm／分）$\le \ell^2/9000h$ 柱の軸方向収縮変形速度$\le 3 \times h$（mm／分） ℓ：スパン，h：加熱高さ（cm）	・加熱中及び加熱後24時間荷重を保持すること。 加熱中及び加熱後24時間内に崩壊した場合、加熱時間は８０％とする。 ・床・屋根・はりのたわみ$\le \ell/30$　ℓ：スパン	崩壊しないこと。 はり；たわみ速度（cm／分）$\le \ell^2/9000h$ ℓ：スパン，h：せい 柱・壁：耐えること。	柱・はり適用荷重に耐えること。
試験結果の判定	注水試験	はなはだしい破損、欠落不可。	——	——	——	壁は注水の通過不可。
試験結果の判定	衝撃試験	全厚のはく離。裏面に達する穴不可。	——	——	耐えること。	——

INTERNATIONAL STANDARD 834

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION •МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ •ORGANISATION INTERNATIONALE DE NORMALISATION

Fire-resistance tests — Elements of building construction

Essais de résistance au feu — Éléments de construction

First edition — 1975-11-01

UDC 69.02 : 699.81 : 620.1 Ref. No. ISO 834-1975 (E)

Descriptors : buildings, construction materials, structural members, floors, walls, partition walls, columns (supports), beams, roofing, tests, fire tests, testing conditions.

Price based on 16 pages

FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 834 was drawn up by Technical Committee ISO/TC 92, *Fire tests on building materials and structures*, and circulated to the Member Bodies in September 1973.

It has been approved by the Member Bodies of the following countries :

Australia	Hungary	Romania
Belgium	India	South Africa, Rep. of
Bulgaria	Ireland	Spain
Canada	Israel	Sweden
Czechoslovakia	Italy	Thailand
Denmark	Mexico	Turkey
Egypt, Arab Rep. of	New Zealand	U.S.A.
France	Norway	Yugoslavia
Germany	Portugal	

The Member Body of the following country expressed disapproval of the document on technical grounds :

United Kingdom

This International Standard cancels and replaces ISO Recommendation R 834-1968, of which it constitutes a technical revision.

The revision has been made with the intention of specifying the test conditions more precisely in order to improve the reproducibility of the test results.

Guidance on the planning, performance and reporting of fire-resistance tests in accordance with this International Standard is given in annex A.

Reference should also be made to Technical Report ISO/TR 3956, *Principles of structural fire-engineering design with special regard to the connection between real fire exposure and the heating conditions of the standard fire-resistance test (ISO 834)*.

CONTENTS

Fire-resistance tests — Elements of building construction

1 SCOPE

This International Standard specifies standard heating and pressure conditions, a test method and criteria for the determination of the fire resistance of elements of building construction of various categories.

The test provides for the determination of fire resistance of elements of building construction on the basis of the length of time for which the test specimens, of specified dimensions, satisfy the criteria laid down under the prescribed test conditions during the period of fire exposure.

2 FIELD OF APPLICATION

This International Standard is applicable to such structural elements of building construction as

- walls and partitions;
- columns;
- beams;
- floors (with or without ceilings);[1]
- roofs (with or without ceilings).[1]

This list is not exhaustive. Elements which fall into none of these categories may be tested by analogy with a similar element.

This fire-resistance test should not be used for classification of discrete materials or single components as such of an element of building construction. Tests for doors, shutters and glazing are dealt with in ISO 3008, *Fire-resistance tests on door and shutter assemblies*, and ISO 3009, *Fire-resistance tests on glazed elements.*

3 APPARATUS

The main items of apparatus are :

3.1 Furnace, capable of subjecting a specimen element to the standard heating and pressure conditions specified in clause 4.

3.2 Loading equipment (if necessary).

3.3 Thermocouples for measuring the internal temperature of the furnace and the surface and internal temperatures of the test specimens in conformity with the requirements of 4.1.2, 4.1.3 and 4.1.4.

3.4 Equipment for measuring overpressure in furnaces for testing walls and floors.

4 STANDARD HEATING AND PRESSURE CONDITIONS

4.1 Standard heating conditions

4.1.1 *Temperature rise*

The temperature rise within the furnace shall be controlled so as to vary with time within the limits specified in 4.1.3 according to the following relationship :

$$T - T_0 = 345 \log_{10} (8t + 1)$$

where

t is the time, expressed in minutes;

T is the furnace temperature at time t, expressed in degrees Celsius;

T_0 is the initial furnace temperature, expressed in degrees Celsius.

The curve representing this function, known as the "standard time-temperature curve", is shown in figure 1.

1) An annex concerning the testing of suspended ceilings without roof or floor is in preparation.

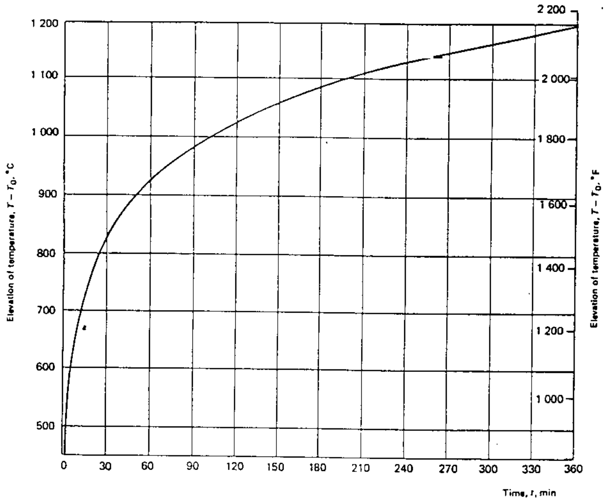


FIGURE 1 – Standard time-temperature curve

The relationship expressed above gives the values shown in the following table.

TABLE – Temperature rise as a function of time

Time, t	Elevation of furnace temperature, $T - T_0$	
min	°C	°F
5	556	1 001
10	659	1 186
15	718	1 292
30	821	1 478
60	925	1 665
90	986	1 775
120	1 029	1 852
180	1 090	1 962
240	1 133	2 039
360	1 193	2 147

4.1.2 *Measurement of furnace temperature*

4.1.2.1 The furnace temperature is deemed to be the average of the temperatures recorded by thermocouples arranged within the furnace to give an approximation to its average temperature.

4.1.2.2 These thermocouples shall not be fewer than

– one to each 1,5 m² of surface for walls and floors;

– two to each 1 m of length for beams;

– two to each 1 m of height for columns.

In any case, the number of thermocouples shall be not less than five.

4.1.2.3 Bare wire thermocouples of wire diameter not less than 0,75 mm and not more than 1,5 mm shall be arranged so that the hot junction is 100 mm from the nearest point of the test specimen. This distance shall be kept as constant as possible during the test.

Sheathed thermocouples may be used provided that they have a sensitivity not less than and time-constant not greater than those of bare wire thermocouples.

The wires of the thermocouples shall be placed in open tubes of heat-resistant material, for example porcelain, within approximately 25 mm from the hot junction.

4.1.3 *Tolerances*

4.1.3.1 FOR MEAN DEVIATION OF FURNACE TEMPERATURE RISE

The mean deviation of the furnace temperature rise is given, as a percentage, by the following expression :

$$\left| \frac{A - B}{B} \times 100 \right|$$

where

A is the integral value of the average furnace temperature as a function of time;

B is the integral value of $T - T_0$ from the equation defined in 4.1.1.

The tolerances on the mean deviations shall satisfy the following conditions :

1) ± 15 % during the first 10 min of test;

2) ± 10 % during the first 30 min of test;

3) ± 5 % after the first 30 min of test.

4.1.3.2 FOR TEMPERATURE DISTRIBUTION WITHIN THE FURNACE

At any time after the first 10 min of test, the temperature, recorded by any thermocouple, shall not differ from the corresponding temperature of the standard time-temperature curve by more than ± 100 °C (180 °F).

For specimens incorporating a significant amount of combustible material, the deviation of any one thermocouple shall not exceed 200 °C (360 °F).

4.1.4 *Measurement of temperature of test specimens*

Surface temperatures of test specimens shall be measured by means of thermocouples with a wire diameter of not more than 0,7 mm.

Each thermocouple junction shall be attached to the centre of the face of a copper disk 12 mm in diameter and 0,2 mm thick, which is secured to the surface of the specimen at the required position.

The disks shall be covered with oven-dry square asbestos pads 30 mm × 30 mm and 2 mm thick. The asbestos material shall have a density of 1 000 kg/m³.

The disk and the pad may be fixed to the surface of the specimen by pins, tape or a suitable adhesive, depending on the nature of the material forming the side of the specimen.

For thermocouples for measuring the temperature in the interior of the test specimen, the wires shall, if possible, follow the isotherm through the hot junction as closely as possible along a distance of at least 30 mm from this junction.

4.2 **Pressure conditions**

An over-pressure[1] of 10 ± 5 Pa (1,0 ± 0,5 mmH_2O or 0,04 ± 0,02 inH_2O)[2] shall exist in the furnace during the whole heating period of fire-resistance tests on separating elements of building construction. For vertical separating elements, this over-pressure shall exist over at least the upper two-thirds of the height of the test specimen. This over-pressure shall be measured and monitored :

a) for horizontal elements – 100 mm from the underneath surface of the specimen;

b) for vertical elements – at a point located approximately at three-quarters of the height of the element under test.

NOTE – The pressure difference may also be achieved by lowering the pressure on the unexposed face.

5 PREPARATION OF TEST SPECIMENS

5.1 **Dimensions**

5.1.1 The test specimens should be full size.

5.1.2 Where this is not possible, the following shall be the minimum dimensions[3] of the parts of a test specimen exposed in the furnace :

Walls and partitions	height 3 m width 3 m
Floors and roofs : Supported on two sides	span 4 m width 2 m
Floors and roofs : Supported on four sides	span 4 m width 3 m
Beams	span 4 m
Columns	height 3 m

1) This condition is not mandatory for the first 10 min of the test.

2) 1 Pa = 1 N/m²

3) For a limited time, tests on walls and partitions of a slightly smaller size are allowed provided that the advice given in A.5 is taken into account.

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5.2 Construction

5.2.1 The test shall be made on a test specimen representative of the complete element of construction on which information is required. Each type of element requires a different approach and an attempt shall be made to reproduce the boundary conditions and the method of fixing or support representative of that used in practice.

A test specimen shall include at least one of each representative type of joint. A specimen wall may include a beam or columns which form an integral part of the element to establish the performance of the composite assembly. A specimen may also include a door or glazing to establish the performance of the whole assembly.

When a ceiling treatment or a suspended ceiling is designed to contribute to the fire-resistance of a floor or a flat roof, the specimen shall incorporate the ceiling installed as in service.

When a specimen represents a column forming the side of an opening in a wall, it shall be suitably shielded on the unexposed face or faces to represent the protection provided by the wall.

5.2.2 The materials and standard of workmanship of the test specimen shall be representative of those applying in good practice, as defined by existing national codes and standards.

5.3 Conditioning

The test specimen shall be conditioned in such a way that it corresponds as closely as possible, in temperature, moisture content and mechanical strength, to the expected state of a similar element in service.

5.3.1 *Moisture content*

The test specimen shall not be tested until its moisture content is in dynamic equilibrium with an ambient atmosphere approximating to that expected in service. This dynamic equilibrium may be checked either on the test specimen itself or on a representative sample.

The drying of the test specimen may be by natural or artificial means, but a temperature shall not be reached which could impair the fire-resisting properties of the element. It is recommended that a temperature of 60 °C (140 °F) should not be exceeded.

When possible, the moisture content of the principal materials of the element shall be measured at the time of the test and the values shall be stated in the test report.

5.3.2 *Mechanical strength*

For load-bearing elements, the constituent materials of the specimen shall have attained a mechanical strength close to that expected for a similar element in service.

6 PROCEDURE

6.1 Test conditions

6.1.1 *Restraint and loading*

6.1.1.1 The role of the element in service shall be analysed so that the methods adopted for supporting or restraining the ends or sides of a test specimen during a test are, as far as possible, similar in nature to those which would be applied to a similar element in service. If restraint is applied in the test, then the restraint conditions shall be specified with regard to free movements of the element and, so far as possible, those external forces and moments which are transmitted to the element by restraint during the test.

6.1.1.2 For floors and beams with uncertain or variable boundary service conditions, the test specimen shall be simply supported all round the edges or at the ends.

For columns and walls with complete or partial restraint to longitudinal elongation, for a full evaluation of the structural behaviour, it may be necessary to conduct a complementary test under longitudinal-restraint conditions which are as close as possible to conditions in practice.

6.1.1.3 At least 30 min before heating, the load-bearing test specimen shall be subjected to a loading which, in the critical regions of the element, produces stresses of the same magnitude as would be produced normally in the full-size element when subjected to the design load.

When it seems appropriate, a preloading shall be applied to the test element to guarantee a stabilization of the deformation and of the support and load equipment. The load application may be repeated a number of times for this stabilization.

6.1.1.4 The level and distribution of the applied loading shall be maintained constant during the test period.

6.1.1.5 Test specimens of non-load-bearing elements shall not be subjected to any external loading in the fire-resistance test. (See annex A).

6.1.2 *Exposure to heat*

6.1.2.1 Free-standing columns shall be tested by applying heat on all sides over their whole height.

6.1.2.2 Separating elements represented by test specimens of elements which have the function of separating spaces shall be heated over the whole of one face only.

Those which may be required to resist fire in one direction only shall be tested in that direction.

Those which may be required to resist fire in either direction shall be tested in the direction considered to possess the lower resistance by the testing authority. When this cannot be prejudged, each face shall be tested on separate test specimens.

6.2 Observations during test

The fire resistance of a load-bearing structure or structural element shall be judged by the criterion of load-bearing capacity, that of a separating element by the criteria of insulation and integrity, and that of a load-bearing and separating element by the criteria of load-bearing capacity, insulation and integrity. In most cases, only a small loss of integrity (initial integrity failure) can be accepted; in other cases, a larger loss of integrity (ultimate integrity failure) can be accepted.

In all cases of separating structural elements, the initial integrity failure shall be determined.

6.2.1 *Load-bearing capacity and deformation*

6.2.1.1 For a load-bearing test specimen, the time at which the specimen can no longer support the test load shall be measured and used to assess the performance.

6.2.1.2 Where possible, the following properties and characteristics shall also be noted during the whole test period :

a) deformations which can facilitate an analysis of the structural behaviour of the element and an application of the test results;

b) free movements of the element;

c) forces and moments transmitted to the element by restraint, according to 6.1.1.1;

d) other phenomena which are of importance for the load-bearing capacity of the element, such as cracking, splitting and structural transformations of materials.

When needed for an application of the test results, the temperature distribution in the interior of the test specimen shall be determined by means of thermocouples placed in such a manner that they provide a satisfactory basis for estimating the function and the behaviour of the specimen during the test.

6.2.1.3 For a separating element, such deformations as may have substantial effects on the function of the element shall be measured and noted during the whole test period. Note shall be made of the time when the test specimen no longer fulfils its functional requirements.

6.2.2 *Insulation*

6.2.2.1 AVERAGE TEMPERATURE OF UNEXPOSED FACE

In the case of elements with an unheated surface, the temperature of the unexposed face shall be measured by means of not fewer than five thermocouples, one placed approximately at the centre of the face and the others approximately at the centres of the straight lines joining the centre and the corners. Any additional thermocouples shall be disposed as uniformly as possible over the unexposed face of the specimen.

None of these thermocouples intended for measurement of mean temperature rise shall be fixed in position with through-metal connections or closer than 100 mm to the edge of the test specimen.

In the case of structures comprising composite elements, the arrangement of the test specimen shall ensure that the joints do not coincide with the points of measurement specified above.

The average of the temperatures measured at the points specified above, omitting temperatures measured at joints, is deemed to be the temperature of the unexposed face.

6.2.2.2 MAXIMUM TEMPERATURE OF UNEXPOSED FACE

In addition, the temperature shall be measured at the point that appears to be the hottest at any time during the test.

This temperature shall not be used in the calculation of average temperature, unless the point at which this temperature occurs corresponds to one of the locations specified in 6.2.2.1, but shall be taken into account in determining whether the maximum temperature criterion has been complied with.

6.2.3 *Integrity*

6.2.3.1 For the determination of the time of initial integrity failure, a pressure difference according to 4.2 shall exist between the side of the furnace and the unexposed side of the test element. Observations shall be made of any sustained flaming on the unexposed face and of the ignition of a cotton pad held for not less than 10 s and not more than 30 s at a distance of between 20 and 30 mm from any opening on the unexposed side, indicating the ignition by hot gases. The pad shall not be re-used if it has absorbed any moisture or become charred during a previous application.

The cotton pad, measuring approximately 100 mm square × 20 mm thick, shall consist of new, undyed soft cotton fibres, without any admixture of artificial fibres, and shall have a mass between 3 and 4 g. The pad shall be conditioned by drying in an oven at 100 °C for at least 0,5 h. The pad shall be attached by wire clips to a 100 mm × 100 mm frame of 1 mm diameter wire to which a wire handle approximately 750 mm long is fixed. Note shall be made of the time when the first ignition of the cotton pad occurs and the position where this takes place.

6.2.3.2 To obtain the time of ultimate integrity failure, the test shall be continued beyond the initial integrity failure and further observations and measurements made of enlargement of cracks, holes or other openings through which flames or gases could pass. The full or partial collapse of non-load-bearing separating elements shall be noted as this will constitute ultimate integrity failure (see 7.2.3.2).

6.2.4 *Additional observations*

Throughout the test, observations shall be made of all changes and occurrences which are not criteria of performance but which could create hazards in a building, including, for example, the emission of smoke or noxious vapours from the unexposed face of a separating element.

6.3 Duration of test

6.3.1 Normally, the test specimen shall be heated in the prescribed manner until failure occurs under any one of the relevant test requirements, namely

- load-bearing capacity (see 7.2.1);
- insulation (see 7.2.2);
- integrity (see 7.2.3).

6.3.2 In tests other than those on test specimens judged only by the criterion of load-bearing capacity (see 7.2.1), the testing may be continued after failure under either of the other two conditions (see 7.2.2 and 7.2.3) by prior agreement between the sponsor of the test and the testing authority, until failure occurs under the other condition, provided that collapse of the specimen has not already occurred.

6.3.3 Alternatively, the test may be concluded after a period determined by prior agreement between the sponsor and the testing authority, even if no failure under any of the conditions has occurred at the end of that time.

6.3.4 The length of time from the commencement of heating for which the test specimen complies with the relevant requirement(s) shall be expressed in minutes.

7 PERFORMANCE CRITERIA

7.1 Fire resistance

The fire resistance of test specimens shall be the time, expressed in minutes, of the duration of heating in accordance with 4.1.1 until failure occurs, under the conditions — load-bearing capacity, insulation, integrity — appropriate to the specimen.

7.2 Criteria of fire resistance

The functional criteria of fire resistance comprise requirements with regard to load-bearing capacity for a load-bearing structural element, insulation and integrity for a separating element, and load-bearing capacity as well as insulation and integrity for a load-bearing and separating element.

7.2.1 *Load-bearing capacity*

For load-bearing elements of structure, the test specimen shall not collapse in such a way that it no longer performs the load-bearing function for which it was constructed.[1)]

7.2.2 *Insulation*

For elements of structure such as walls and floors which have the function of separating two parts of a building,

a) the average temperature of the unexposed face of the specimen shall not increase above the initial temperature by more than 140 °C (252 °F);

b) the maximum temperature at any point of this face

- shall not exceed the initial temperature by more than 180 °C (324 °F) and
- shall not exceed 220 °C (420 °F) irrespective of the initial temperature.

7.2.3 *Integrity*

7.2.3.1 For elements of structure such as walls and floors which have the function of separating two parts of a building, the presence and formation in the test specimen of cracks, holes or other openings through which flames or hot gases can pass so as to cause initial integrity failure, shall not occur.

7.2.3.2 Initial integrity failure shall be deemed to have occurred when the cotton pad referred to in 6.2.3.1 is ignited or when sustained flaming, having a duration of at least 10 s, appears on the unexposed face of the test element.

Ultimate integrity failure shall be deemed to have occurred when collapse of the specimen takes place or at an earlier time on the basis of criteria stipulated from case to case.

NOTE — The words "insulation", "integrity" or "load-bearing capacity" shall follow the time, expressed in minutes, denoting the period of successful compliance under each of these headings.

8 TEST REPORT

The test report shall include the following information :

a) name of testing laboratory;

b) name of sponsor;

c) date of test;

d) name of manufacturer and the trade-name (if any) of the product;

e) details of construction and conditioning of the test specimens, including detailed information on the relevant physical and mechanical properties of the materials used, together with drawings illustrating the essential features;

f) methods of fixing, support and restraint as appropriate for the type of specimen;

g) for load-bearing specimens, the methods used for calculating the test load and its relationship to the maximum permissible load;

h) for asymmetrical separating elements, the direction in which the specimen was tested and the reason for adopting this procedure;

i) observations made during the test according to 6.2;

j) test results as required by 7.1. Where the test is terminated before the occurrence of failure under the relevant criteria, this shall be reported.

1) National standards may specify a value for the limiting deflection for beams and floors.

ANNEX A

COMMENTARY

A.0 INTRODUCTION

NOTE — So that suitable precautions to safeguard health may be taken, the attention of all persons concerned in fire tests is drawn to the possibility that toxic or harmful gases may be evolved in combustion of test elements.

This annex has been drafted to provide a commentary on the body of this International Standard, with the intention of giving guidance on the planning, performance and reporting of results of the test specified therein.

The possibilities of predicting the fire behaviour of a structure on the basis of data from a standard fire-resistance test is discussed in ISO/TR 3956.

This International Standard and the corresponding national standards concerning fire-resistance tests on elements of building construction have been developed on the basis of the classification requirements stipulated in national building codes and regulations.

A fundamental requirement for fire-resistance tests carried out according to this International Standard is that the test results shall be reproducible. This requirement necessitates very accurate detailed specification of the test conditions for the preparation of the test specimens and the characteristics of heating, loading and restraint during the test.

The test results obtained may be used as data for a structural design taking into account real conditions. This presupposes that the test characteristics and results have to be specified, measured and reported with a degree of accuracy and in sufficient detail so that the element of building construction, corresponding to the test specimen, can be analysed with regard to its functional behaviour in the complete structure.

Such detailed data from a fire-resistance test will also facilitate a classification and an international utilization of the test data in countries with different classification requirements. For a satisfactory analysis of the test results, it may be necessary to complement a fire-resistance test by other tests for determination of relevant material properties, for example thermal conductivity, specific heat and strength and deformation properties in the temperature range associated with fires.

The following explanatory notes are intended to serve as guidance for the planning, performance and reporting of a fire-resistance test in conformity with the principles outlined above. The clause numbers correspond to those in the body of this International Standard.

A.1 SCOPE

The fire resistance of an element of building construction is defined as the period of time from the beginning of a heating process fixed in accordance with clause 4 to an instant when the element no longer complies with the functional requirements that is has to fulfil.

These functions can be

a) a load-bearing function (for example a column or a beam);

b) a separating function (for example a partition or a non-load-bearing wall);

c) a load-bearing and separating function (for example a load-bearing wall or a floor).

For a load-bearing element, it is to be shown that the load-bearing capacity during the fire action does not decrease below a prescribed level multiplied by a stipulated safety factor. This factor depends, among other things, on the probability of the occurrence of a fire, the probability of the presence of the prescribed load at a fire outbreak and the statistical characteristics of the fire load and the load-bearing capacity. Unfortunately, the present state of knowledge is inadequate to enable a statistical approach to be made to this essential problem in ordinary cases. Consequently, a simplified routine is applied as a temporary solution of the problem, characterized by putting the test load equal to the design load and the corresponding safety factor required just in excess of unity.

For a separating element, it is to be shown that during the fire action the increase of the average temperature of the unexposed face and the maximum temperature at any point of this face do not exceed specified values (insulation; see 7.2.2) and that neither any sustained flaming nor any ignition of hot gases occurs on the unexposed face of the element (integrity; see 7.2.3). With regard to integrity, the requirements then can be differentiated. In most cases, only a small loss of integrity can be accepted, limited by the criteria of "initial integrity failure" according to 7.2.3.2.

In a fire resistance test of a separating element, this type of integrity failure should always be determined. In some cases, a larger loss of integrity can be permitted without an unacceptable risk of fire spread through the separating element to an adjacent compartment. For a limitation of this risk, the concept "ultimate integrity failure" is introduced and defined according to criteria, stipulated from case to case, for instance on the basis of the canopy test, described in annex B of ISO 3008. The concept "ultimate integrity failure" replaces the former concept of "loss of stability" for non-load-bearing elements.

Finally, a load-bearing and separating element shall be judged by the criteria of load-bearing capacity, insulation and integrity (initial and ultimate integrity failure).

A.2 FIELD OF APPLICATION

This International Standard is limited in application to an experimental determination of the fire-resistance of those elements of building construction which either are located in a fire compartment or constitute parts of the structures enclosing a fire compartment.

In the latter case, only structural elements exposed to a fire on their internal face are included in the field of application.

This standard specification is not directly applicable to load-bearing walls which may be attacked by fire simultaneously on both sides; however, in particular cases, they may be treated as wall-shaped columns.

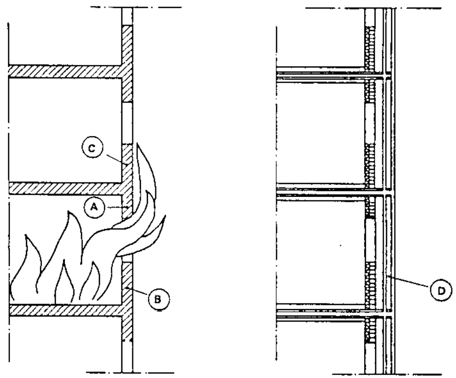

FIGURE 2 – Example of fire exposure of structural elements

This International Standard may not be directly applied to, for instance, external walls, columns and beams, for example as shown by items A, B, C and D in figure 2, or roofs under exterior fire exposure. According to figure 2, a structural element of type A will be directly exposed on the internal as well as on the external surface with different heating conditions for the two surfaces. A structural element of type B will be directly exposed to fire on its internal surface and simultaneously exposed on its external surface to a radiation from flames and combustion gases issuing from the fire compartment. In those cases in which this effect of radiation is unimportant, the structural element can be tested according to this International Standard

For a structural element composed of the two structural details A and B functionally acting together, a compartment fire will lead to complicated heating conditions, which differ from the conditions specified in clause 4. Characteristic of a structural element of type C is fire exposure on the external surface only – provided that the windows above the element are intact – with heating conditions which cannot be described by the time-temperature curve, given in 4.1.1. For an external column of type D, a compartment fire will give rise to a fire exposure with varying heating conditions along the column.

It is essential to emphasize that the fire-resistance test according to this International Standard can be used only for a classification of a complete element of building construction and not for a classification of individual components or discrete materials of the element. This means, for instance, that a complete structural element of the type given in figure 3, composed of a reinforced concrete slab, load-bearing steel beams and an insulating ceiling, can be classified on the basis of the results of a fire-resistance test but not the steel beams or the insulating ceiling separately, unless they form part of a complete, fixed assembly.

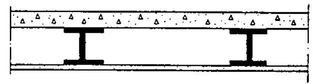

FIGURE 3 – A typical structural element

A.3 APPARATUS

A.3.1 Furnace

An accurate description of a time-temperature curve for a fire-resistance test according to 4.1.1 is not sufficient as the sole characteristic for the determination of the temperature fields in an element of building construction exposed to a fire. Another essential factor which is important in this connection is the coefficient of heat transfer for the surfaces of the element exposed to the fire. This coefficient is primarily influenced by the convection and radiation conditions.

For a prescribed time-temperature curve, the convection and radiation characteristics can vary considerably from one furnace to another, depending on the detailed design of the furnace and the type of fuel. For this reason, test results obtained in different laboratories may be difficult to correlate. In order to facilitate such comparisons of test results, it is recommended that the thermal properties of the furnace be calibrated with reference to a well-defined standard test specimen and be described in terms of that variation in the coefficient of the average heat transfer with the time which is associated with the time-temperature curve given in 4.1.1. It is also recommended that this calibration curve of the furnace be included in the test report.

For vertical and horizontal furnaces, such a standard test specimen can be constituted by, for instance, reinforced concrete elements, 150 mm in thickness, having a dry density of 2 400 kg/m^3.

An additional factor, which can also influence the test results and make comparative estimations more difficult – but to a lesser degree than the convection and radiation conditions within the furnace – is the characteristics of the environment of the furnace. In order to avoid too great variations of the temperature during a test within the space outside the furnace, it is necessary that the volume of the building containing the furnace be large, unless the environment is ventilated, and that the surrounding structure of this building have a comparatively high degree of thermal inertia. If possible, the ambient temperature, at a distance of more than 250 mm from the furnace, should not lie outside the range of 25 ± 15 °C. In testing elements which include combustible material, the oxygen content in the furnace can considerably influence the test results. It should be sufficient to ensure combustion and usually should be within the range of 5 to 10 %.

A.4 STANDARD HEATING AND PRESSURE CONDITIONS

A.4.1 Standard heating conditions

The time-temperature curve for the furnace given by the relationship

$$T - T_0 = 345 \log_{10} (8t + 1)$$

constitutes a simplification of real conditions in a fire.

In reality, the time-temperature relation which represents the development of a fire in an enclosed room depends on several factors. The most important of these are

a) the amount and type of combustible materials in the room (the fire load);

b) the distribution of the fire load in the room;

c) the porosity and particle shape of the fire load;

d) the amount of air per unit time supplied to the room;

e) the geometry of the room;

f) the thermal characteristics of the structures which enclose the fire chamber or are contained in it.

For a discussion of this problem and the question concerning the connection between a real fire exposure and the heating conditions according to the standard fire-resistance test, reference should be made to [1] and [2] in the Bibliography.

At the international level, the principles governing the need for fire-resistance tests and, consequently, the utilization of the test results, vary from country to country. At present, in different countries a classification system and a fire-engineering design of an element of building construction are characterized by one of the following :

a) only the heating period is considered;

b) the whole process of theoretical fire development is taken into account;

c) the test is limited to the heating period but the effect of the subsequent cooling period is included by a prolongation of the heating period;

d) the test is limited to the heating period and the capacity of the test element to resist the subsequent cooling period is estimated on the basis of the results of a residual load test of the element at the end of the heating period.

As a consequence of the varying classification requirements, the following additional recommendations can be given for a fire-resistance test of elements of building construction.

When an element of building construction has to fulfil certain functions during the heating period and during the subsequent cooling period, the loading of the test specimen should be maintained constant also during the cooling period.

If such a test is to be performed, the temperature within the furnace should be controlled so as to have a linear rate of decrease during the cooling period according to the following relationships (see figure 4) :

$dT/dt = 625$ °C/h for $t_h \leqslant 0{,}5$ h
$dT/dt = 250\,(3 - t_h)$ °C/h for $0{,}5\ \text{h} < t_h < 2$ h
$dT/dt = 250$ °C/h for $t_h \geqslant 2$ h

where

t is the time, expressed in hours;

t_h is the duration of the heating period, expressed in hours;

T is the furnace temperature, at time t, expressed in degrees Celsius.

At the end of the cooling period the furnace temperature should have decreased to an average temperature not exceeding 200 °C. During the cooling period the recorded mean value of the mean furnace temperature should not differ from the mean value of the specified time-temperature curve by more than ± 10 % and the mean furnace temperature at any time should not differ from the specified temperature by more than 100 °C.

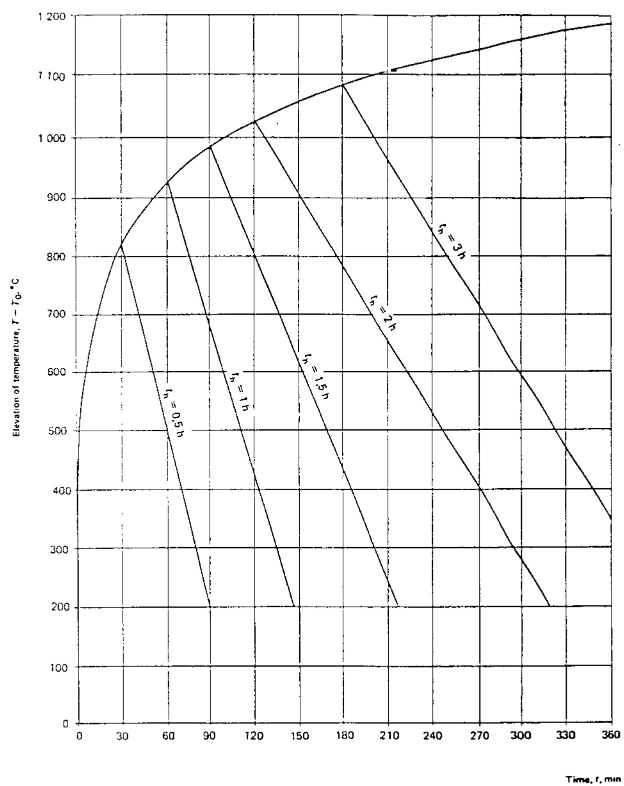

FIGURE 4 – Cooling conditions

A.5 PREPARATION OF TEST SPECIMENS

A.5.1 Dimensions

This International Standard specifies that the test specimens shall be full size wherever possible and specifies minimum dimensions for different types of test element to be applied when the use of a full-size test specimen is not possible. The dimensions of a fire-test specimen should be chosen with due regard to standard dimensions, recommended by ISO or stated in corresponding national standards or regulations.

Generally, the development of the testing facilities for fire-resistance tests towards furnaces of larger size is desirable for increasing the possibilities of doing full-scale fire tests for all types of elements of building construction covered by this International Standard. For instance, the minimum dimensions specified for beams and biaxial floors can be seen as a temporary, unsatisfactory solution, forced by the present state of widely varying testing facilities in the different laboratories. An increase of the minimum dimensions for biaxial floors to 4 m X 4 m may be essential. For beams the span can be frequently much larger than the minimum dimension specified in this International Standard.

For simply supported beams, the limitations posed can be met in many cases, without reducing the dimensions of the full-size test specimen, by an arrangement with the supports outside the furnace and with only a limited part of the beam, including the critical sections, within the furnace. Such an arrangement would require additional insulation to be applied on the beam outside the heated section to avoid a detrimental effect of temperature gradients in the axial direction of the beam.

Alternatively, the limitations mentioned can be met by reducing the span length in combination with such arrangements — an increase of the load level, a decrease of the area of the reinforcement for a concrete beam — so that the maximum stresses, decisive for the collapse, will be the same as for the full-size test specimen.

The strong recommendation to use full-size test elements is dictated by the difficulties in reproducing in detail a functionally correct fire behaviour, in model scale, of a load-bearing or separating element of building construction. For ordinary reinforced and prestressed concrete structures, the determination of fire-resistance by model-scale tests is complicated by the considerable influence of, for instance, the interior thermal stresses, the short-time shrinkage and internal creep from heating and the disintegration of the material at certain temperature conditions. For timber structures the problem of determining the fire resistance by a model-scale test is practically insoluble. For steel structures the possibilities of using model-scale tests for a fire-resistance investigation are comparatively favourable, especially for unprotected steel structures.

The previous comments about model-scale tests are related to a classification of a real element of building construction on the basis of the results of a fire-resistance test. Nevertheless, model-scale techniques in many cases can be a very useful instrument in fire-engineering research or a valuable complement to full-scale tests for a fire-engineering classification.

It is essential to emphasize the importance of keeping the functional behaviour unchanged when decreasing the dimensions of a test specimen in a fire-resistance test. This means, for instance, that the ratio between the side lengths should be unchanged when the dimensions of a biaxial floor are reduced.

A.5.2 Construction

This International Standard specifies that the test shall be made on a test specimen which is representative of a complete element in the real structure. This means, for instance, that a partition built up of elements should include representative joints. For a satisfactory determination of the fire resistance of such a partition, sometimes more than one test may be necessary. As an example, in figure 5 are shown two alternative joints for a partition of one-storey high elements, which could give different performances in a test.

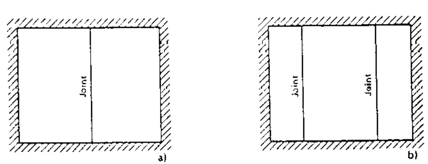

FIGURE 5 – Alternative arrangements of joints for partitions

A.5.3 Conditioning

Except in buildings that are continuously air-conditioned or are centrally heated, elements of building construction are exposed to atmospheres that in varying degree tend to follow the cycling of temperature and/or moisture conditions of the free atmosphere. The nature of the materials comprising the element and its dimensions will determine the degree to which the moisture content of an element will fluctuate about a mean condition.

When possible, elements should be stored in an atmosphere held within 25 ± 15 °C dry bulb temperature and 40 to 65 % relative humidity.

Measurements should be made regularly of some property known to be related directly to the moisture content of the element. These measurements of total mass, electrical conductivity, or some other property such as the relative humidity of an atmosphere in static equilibrium with the interior of the specimen (Monfore, P.C.A. Bulletin 160), should be plotted against time to produce a drying curve for the element. This curve will indicate when the specimen has reached dynamic equilibrium with the atmosphere.

The fire resistance for a given element of building construction can vary considerably with the initial moisture content. For this reason it is desirable that the moisture content of a conditioned test element be determined before the fire-resistance test.

For partitions without joints, according to [3] the fire resistance can be corrected with regard to the effect of the initial moisture content in the following way, provided that spalling does not occur.

If the fire resistance of a test element is known at one moisture content, then the fire resistance at some other moisture content can be calculated according to the following equation (see [3]) :

$$\tau_d^2 + \tau_d(4 + 4b\phi - \tau_\phi) - 4\tau_\phi = 0$$

where

ϕ is the volumetric moisture content;

τ_ϕ is the fire resistance at moisture content ϕ, in hours;

τ_d is the fire resistance in the oven-dry condition, in hours;

b is a factor which varies with the permeability.

For brick, dense concretes, and gun-applied concretes, b may be taken as 5,5, for lightweight concretes as 8,0 and for cellular concretes as 10,0.

A.6 PROCEDURE

A.6.1 Test conditions

RESTRAINT (6.1.1.1 and 6.1.1.2)

From test results it is well known that variations of restraint conditions can considerably influence the time of fire resistance for a structure or a structural element. Usually, the effect of restraints is beneficial for fire resistance but sometimes a restraint can give a detrimental effect on the performance of a specimen in a fire-resistance test. A thrust restraint can accelerate an instability failure in fire. A thrust can also give rise to accelerated spalling of a concrete structure. For a statically indeterminate slab of reinforced concrete under fire action on one side, a moment restraint can cause a serious crack formation in non-reinforced or weakly reinforced regions and through such a crack formation cause a shear fracture of the structure.

From the above-mentioned facts it follows that the results from fire-resistance tests carried out under undefined restraint conditions are very difficult, or sometimes impossible, to use in a structural fire-engineering design.

a) *Columns and walls*

Fire tests on columns and loaded walls carried out in laboratories show idealization with respect to the loads which are applied in an actual fire. For instance, it is not yet possible to reproduce in a test the alterations of the end moments appearing in an actual fire. Nevertheless, the test should comply with reality as far as possible, but it should also lead to clear and reproducible results.

The permissible load of columns and walls depends to a great extent on the supporting conditions. In slender members of this kind, which are assumed to be hinged, even small forces due to friction within the supports may considerably increase the load-carrying capacity. In a fire test, too, an unintentional end restraint of the test specimen may increase the fire resistance. Free rotation can generally be attained in a simple manner by using spherical or cylindrical end supports.

If it is clear how loading and support conditions of the structural member are arranged in practice, similar supporting conditions should be provided in the fire test, and the permissible load should be found by taking into consideration these supporting conditions on the basis of the respective design standard. This means that, if necessary, even an eccentric load can be applied.

If, however, there is no clear evidence of supporting conditions of columns or walls in practice, a fire test on columns should be carried out either with freely hinged ends or with fully restrained ends and the permissible load (centrally applied) be co-ordinated accordingly with the relevant buckling length taken into account.

Walls with freely hinged supports of the loaded edges are generally not used in practice; for experimental reasons full restraint of the bottom as well as of the head is recommended. The vertical edges of the test walls should be prevented from deformation only if this is in accordance with practice.

b) *Beams and girders*

Commonly, fire-resistance tests of one-span and continuous beams and girders are carried out under such support conditions that no axial forces are imposed during the test.

In practice, however, a beam is often placed in a structure in such a manner that a considerable restraint of longitudinal expansion may occur. Under such circumstances, the heating during a fire-resistance test gives rise to an axial, compressive force in the beam. In most cases, this force is applied at a position in the cross-section of the beam such that the corresponding bending moment tends to counteract the bending moment due to the applied load, leading to an increased load-bearing capacity and fire resistance, unless the increased risk of an instability failure or spalling outweighs the favourable bending moment effect. A realization of an accurately specified, partial restraint of the longitudinal expansion of a beam usually requires very advanced fire-testing facilities (see [4]). In [5] a method is presented for estimating the maximum thermal thrust that occurs during a fire-resistance test of a concrete beam, roof or floor. The method is applicable to test specimens restrained both longitudinally and laterally as well as those restrained in only one direction.

In most fire tests, beams and girders fail due to bending stresses. Since, however, in an individual case early failure may occur due to shear, lateral buckling or shear buckling, attention must be given to the fact that neither the test equipment nor the loading device stabilizes the test specimen more than would be the case in practice. The type of failure should be noted in the test report.

LOADING (6.1.1.3 and 6.1.1.4)

The following additional recommendations are given

a) *Level of load*

It is recommended that, if possible, the test load be related to the ultimate load of the test element before heating.

b) *Method of loading*

In a fire-resistance test, a uniformly distributed loading may be simulated by a number of equal point-loads with each point-load not exceeding 25 % of the total load for beams and a value corresponding to a maximum area of 1,3 m² for biaxial floors, unless it can be shown that another load distribution from a structural point of view is preferable or at least equivalent. To avoid high local stress concentrations in floors, the area of distribution of each point-load should have a side length not smaller than the depth of the floor.

c) *Residual load-bearing capacity*

When required, the residual load-bearing capacity of a fire-test element should be determined by loading the element to failure after the termination of the fire-resistance test. Two alternative procedures can be used. One comprises determination of the residual load bearing capacity at the end of the heating period for obtaining information on the capability of the test element to resist the subsequent cooling period under the influence of the test load. The other comprises determination of the residual load bearing capacity by loading the element to failure after cooling according to the data specified in A.4.1.

Alternatively, a determination of the residual load bearing capacity can be replaced by a loading test giving the residual bending stiffness of the fire-exposed test element.

The residual strength or stiffness of a structure or a structural element is of importance in connection with the safety of people who have to work on clearance and repair of a structure after a fire. Information on these properties is further useful for a judgement of actions to be taken after a fire. In multi-storey buildings complete evacuation of people as a result of a fire limited to one section of the building may be difficult in practice or even unnecessary. In such a case it may be necessary for the occupants to remain safely in other parts of the building, above or below the fire section. If, however, the load-bearing structures of that part subjected to fire were weakened to collapse after the end of the heating period, this would endanger the whole building and the occupants remaining in the building.

NON-LOAD BEARING ELEMENTS (6.1.1.5)

In practice, non-load-bearing elements of building construction may be subjected to relatively important loads, for instance due to creep and shrinkage in the load-bearing structural frame. To such an initial loading state, loads of considerable magnitude can be added during a fire. Unfortunately, the present state of knowledge is too limited to enable a safe estimation of these two types of loading and a corresponding specification of loading conditions for a fire-resistance test of assumed non-load-bearing elements to be given.

However, it is essential to keep the phenomenon in mind when using the results of a fire-resistance test of a non-load-bearing element.

EXPOSURE IN FURNACE (6.1.2)

In a fire-resistance test, the test specimens are to be exposed to fire in the furnace in the same manner as would be expected in practice.

This means that columns generally are to be exposed to fire on four sides (exceptions must be noted in the test report) whereas walls are to be exposed to fire on one side only. For beams it means a fire exposure either on three sides only (not on the top surface of the beam) or on all sides. The areas of support are to be protected against fire to the same degree as provided in practice.

A.6.2 Observations during test

A.6.2.1 *Load-bearing capacity and deformation*

A complete record of deformation during a fire-resistance test can facilitate the application of the test results in a fire-engineering design of a structure with the tested element as a component. The deformations can adversely influence the fire protection of a load-bearing structure. The deformations of a load-bearing structure or structural element can give rise to considerable forces and moments in adjacent load-bearing or non-load-bearing elements.

For predicting a collapse of statically determinate beams and slabs in a fire-resistance test, the criteria for maximum deflection or maximum rate of deflection according to Ryan and Robertson [6] may be used (cf. also [7]).

A.6.2.2 *Integrity*

For notes on the concepts of initial and ultimate integrity failure, see the commentary under clause A.1 of this annex.

A.6.2.3 *Additional observations*

Observations should be made throughout the test of all changes and occurrences which could create hazards in a building, including, for example, the emission of smoke or noxious vapours from the unexposed face of a separating element.

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION·МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ·ORGANISATION INTERNATIONALE DE NORMALISATION

Fire-resistance tests — Elements of building construction

AMENDMENT 1

Amendment 1 to International Standard ISO 834-1975 was developed by Technical Committee ISO/TC 92, *Fire tests on materials, components and structures.*

It was submitted directly to the ISO Council, in accordance with clause 6.13.1 of the Directives for the technical work of ISO.

Page 1 : Insert the following text before clause 1 :

So that suitable precautions to safeguard health may be taken, the attention of all persons concerned in fire tests is drawn to the possibility that toxic or harmful gases may be evolved in combustion of test elements.

Replace the footnote by the following :

1) The testing of suspended ceilings forming a part of unventilated load-bearing floor and roof assemblies will form the subject of ISO 6167.

Page 3 : Replace sub clause 4.2 by the following :

4.2 Pressure conditions

An over-pressure[1] of 10 ± 2 Pa (1,0 ± 0,2 mmH_2O or 0,04 ± 0,008 inH_2O)[2] shall exist in the furnace during the whole heating period of fire-resistance tests on separating elements of building construction. For vertical separating elements, over-pressure shall exist over at least the upper two-thirds of the height of the test specimen. The specified over pressure shall be measured and monitored :

a) for horizontal elements — 100 mm from the underside of the specimen;

b) for vertical elements — at a point located approximately at three-quarters of the height of the element under test.

NOTE — The pressure difference may also be achieved by lowering the pressure on the unexposed face.

In footnote 1), replace "10 min" by "5 min".

Page 7 : Delete the note at the beginning of clause A.0.

UDC 69.02 : 699.81 : 620.1 Ref. No. ISO 834-1975/A1-1979 (E)

Descriptors : buildings, construction materials, structural members, floors, walls, partition walls, columns (supports), beams, roofing, tests, fire tests, testing conditions.

Price based on 1 page

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Fire-resistance tests — Elements of building construction

AMENDMENT 2

Amendment 2 to International Standard ISO 834-1975 was developed by Technical Committee ISO/TC 92, *Fire tests on building materials, components and structures,* and was circulated to the member bodies in March 1979.

It has been approved by the member bodies of the following countries :

Australia	Ireland	Romania
Belgium	Israel	South Africa, Rep. of
Brazil	Italy	Spain
Bulgaria	Japan	Sweden
Canada	Korea, Rep. of	Switzerland
Czechoslovakia	Libyan Arab Jamahiriya	Turkey
Denmark	Mexico	United Kingdom
Egypt, Arab Rep. of	Netherlands	USA
Hungary	New Zealand	USSR
India	Norway	Yugoslavia

The member bodies of the following countries expressed disapproval of the document on technical grounds :

France
Germany, F.R.

Page 9

a) Replace A.3.1 by the following :

A.3.1 Furnace

A precise definition of a time-temperature curve for a fire-resistance test according to 4.1.1 is not sufficient as the sole characteristic for determining the temperature fields in an element of building construction exposed to a fire. Another essential factor is the coefficient of heat transfer to the surfaces of the element exposed to the fire. This coefficient is primarily influenced by the convection and radiation conditions.

For a prescribed time-temperature curve, the convection and radiation conditions can vary considerably from one furnace to another, depending on variables such as the geometry of the furnace chamber and the thermal properties of its lining material, the type of fuel, the number, type and location of the burners, and the method of ventilating the furnace. For this reason, test results obtained in different laboratories may be difficult to correlate. Ideally, it would be preferable to control furnaces so as to regulate the total heat flux at the surface of the test assembly. Until the serious instrumental difficulties inherent in such a scheme are solved it is necessary to retain the time-temperature approach.

UDC 69.02 : 699.81 : 620.1 Ref. No. ISO 834-1975/A2-1980 (E)

Descriptors : buildings, construction materials, structural members, floors, walls, partition walls, columns (supports), beams, roofing, tests, fire tests, testing conditions.

Price based on 1 page

Printed in Switzerland

69. 9. 15

INTERNATIONAL STANDARD 3008

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Fire-resistance tests – Door and shutter assemblies

Essais de résistance au feu – Portes et fermetures

First edition – 1976-04-01
Corrected and reprinted – 1978-03-15

UDC 69.028.1 : 699.81 : 620.16 | Ref. No. ISO 3008-1976 (E)

Descriptors : buildings, doors, closures, tests, fire tests, fire resistance.

FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3008 was drawn up by Technical Committee ISO/TC 92, *Fire tests on building materials and structures*, and circulated to the Member Bodies in March 1973.

It has been approved by the Member Bodies of the following countries :

Australia	India	South Africa, Rep. of
Austria	Ireland	Spain
Bulgaria	Israel	Sweden
Canada	Italy	Thailand
Czechoslovakia	Korea, Rep. of	United Kingdom
Denmark	Mexico	U.S.A.
Egypt, Arab Rep. of	Norway	U.S.S.R.
Germany	New Zealand	
Hungary	Romania	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Belgium
France

NOTE – Annexes A and B to this International Standard provide additional information but neither annex forms a mandatory part of this standard. The procedure described in annex B may be used as an optional requirement. Laboratories are advised to gain experience with this method, particularly with the aim of increasing its sensitivity to an acceptable level so that it may be included in the main body of the standard at a future revision.

Fire-resistance tests — Door and shutter assemblies

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies methods of testing and assessing the fire resistance of elements of construction intended for closing openings in walls.

It is applicable to door and shutter assemblies[1] with the exception of fire dampers. The procedure does not provide for a method of classification; national standards may specify the appropriate criteria for doors intended to be used in different buildings and in different positions in a building.[2]

2 REFERENCE

ISO 834, *Fire-resistance tests — Elements of building construction.*

3 PRINCIPLE

The test procedure enables the fire resistance of an element of construction to be determined on the basis of the length of time for which a specimen satisfies one or more criteria when exposed to the specified heating conditions.

The performance of a door or shutter assembly is influenced by the mechanical features of construction. The results of a fire test may not always be valid for a construction having overall dimensions larger or much smaller than those of the test specimen.

4 FURNACE

The furnace shall be capable of subjecting one side of the specimen to the heating condition specified in ISO 834, and the furnace temperatures shall be measured with respect to the specimen and controlled within the tolerances specified in ISO 834.

Means shall be provided for increasing and maintaining the pressure conditions within the furnace chamber to a positive value in relation to the pressure in the laboratory.

5 PREPARATION OF TEST SPECIMEN

5.1 Dimensions

The complete assembly to be tested shall be full size. When either of the dimensions of the full-size construction is larger than it is possible to accommodate in the furnace, the test specimen shall have the maximum size that can be accommodated; in such a case, the appropriate width or height shall be not less than the following :

– width : 2 m

– height : 2,5 m

5.2 Construction

The test shall be performed on a complete door or shutter assembly as intended to be used in practice, incorporating all hardware and other equipment.[3] The finish and form of the specimen shall be representative of the finish and form that would be used in practice.

The door or shutter shall be tested in a wall of the type in which it is intended to be used, particularly when it forms part of a prefabricated or industrialized system. When this cannot be specified, the wall may be of concrete or brick having a thickness of

– about 100 mm for a test having an anticipated duration of 2 h or less;

– about 200 mm for tests of longer duration.

The mounting of the specimen (see figure 1) shall be representative of its use in practice so that appropriate clearances between the door and the frame or the surround exist. In the case of hinged timber doors, the clearance between the door edge and frame shall be representative of that likely to be obtained in practice and, if this cannot be specified, the clearance shall be not less than 3 mm. The clearance shall be stated in the test report.

The assembly shall be fitted[4] with the frame flush with the unexposed face of the wall unless the type of door precludes such fixing or if it is likely to reduce the severity of exposure or be unrepresentative of its use in practice.

1) A complete door or shutter assembly should comprise the door panel or screen, the frame to which it is attached with the fixing and retaining mechanisms to be employed in practice.

2) Tests made in conformity with this procedure indicate the performance of the specimen during the heating period and do not determine its suitability for use after exposure to fire.

3) The term "hardware" includes such items as hinges, latches, door handles, locks, keyholes, letter plates, sliding gear, closing devices, electrical wiring and any other items which may influence the performance of the specimen being tested.

4) It may be necessary to mount sliding or rolling shutter assemblies on the exposed face of the wall to represent the most severe exposure conditions.

5.3 Conditioning

Specimens containing hygroscopic materials or other materials which can be affected by moisture shall be conditioned to equilibrium with the prevailing conditions in the laboratory, which shall be within the following limits :

– temperature (dry bulb) : 25 ± 15 °C

– relative humidity : 40 to 65 %

Doors made entirely of metal or of metal and glass do not require any conditioning. The wall containing the door shall not be constructed less than 2 weeks before the test in the case of a brick wall or less than 4 weeks in the case of a concrete wall. To minimize the effect on frame temperatures of excessive moisture in concrete walls, it may be necessary to condition them to a state of equilibrium.

6 TEST PROCEDURE

The specimen door or shutter assembly shall be exposed on one face to the heating conditions specified in ISO 834. For a full assessment, tests shall be performed on two specimens by exposing opposing faces to the furnace; this may be done simultaneously or separately, depending on the equipment available. To meet special circumstances or if exposure from one side is considered more onerous than from the other, the testing authority may decide to test a single assembly from the more onerous side only.[1]

Measurements and observations specified in clause 7 shall be made during the test. The test shall be terminated when the door no longer satisfies the criteria under which its performance is being judged or at an earlier stage by prior agreement between the sponsor and the testing authority, even if no failure under any of the criteria has occurred.

7 MEASUREMENTS AND OBSERVATIONS

7.1 Furnace pressure

The static pressure in the furnace shall be measured, for example, by using the static pressure probe detailed in figure 2. The measurements of the static pressure shall be made at a minimum of three positions located along a vertical axis on one side of and close to the door or shutter assembly in line with the top and bottom edges of the clear opening and at one-third of the height from the sill level as shown in figure 1. The pressure shall be controlled so that a positive pressure is maintained over the upper two-thirds of the door.

7.2 Unexposed face temperature

The temperature of the unexposed face of the door or shutter assembly shall be measured by means of thermocouples as specified in ISO 834. No temperature measurements are necessary on doors or shutters constructed of sheet steel without insulation or on glass in glazed doors.

For determining the mean temperature rise, at least five thermocouples shall be fixed on the face of the door or shutter, excluding the frame, one at the centre and the others at the centre of each quarter-section. None of these five thermocouples shall be fixed on positions with through-metal connections or closer than 100 mm to the edge of the door leaf, or shutter. If insulation data are required on glazed doors or multi-leafed doors, the thermocouples shall be distributed as uniformly as possible.

The maximum temperature rise on the unexposed face shall be determined from the five thermocouples specified above plus additional thermocouples (fixed or mobile) which may be used over through-metal connections or at other points considered to be of special interest.

Temperature measurements shall also be made on the frame members on the faces parallel to the plane of the wall. Thermocouples shall be fixed at mid-height of the two vertical sides, at the centre of the head member (including the barrel enclosure of a steel rolling shutter) and at any other position where higher temperatures may be expected. The thermocouples shall be located approximately 15 mm from the edge away from the door or shutter.

7.3 Radiation from unexposed face

Radiant heat flux shall be measured from the unexposed face of the specimen, by means of a radiometer or other suitable means, along an axis normal to the centre of the door and at a known distance from the face. This distance shall be such that the field of view just covers the diagonal of the door or shutter assembly.

A description of a type of radiometer suitable for this purpose has been published[2]. Information on the measurement technique and the type of instruments used shall be given in the report.

1) The location of thermocouples for the measurement of furnace temperatures shall be with reference to the exposed face of the wall except in the case of sliding doors fixed on the furnace side of the wall, when the exposed door face shall be used as the reference plane.

2) A wide-angle field type radiometer with provision for water cooling, similar in design to that described in *Journal of Scientific Instruments*, 1960, 37, 128-30, has been found to be suitable for radiation measurements, provided that a screen of polished aluminium is used in conjunction with it to ensure that only the specified area of the door assembly is covered. Where high intensities of radiation are anticipated, the screen may also need to be water cooled. With radiometers having flat-type receivers, the included angle of incidence shall not exceed 50°. Improved types of instrument are being developed for this purpose by a Working Group of ISO/TC 92.

7.4 Cotton pad test

The passage of flames and gases though cracks, holes or other openings in or around a door or shutter shall be determined by applying a cotton pad to such openings at regular intervals during the test. The cotton pad shall not be in contact with the element but shall be held for not less than 10 s and not more than 30 s between 20 and 30 mm away from and centrally opposite any cracks, holes or other openings in or around the door or shutter. The pad shall not be re-used if it has absorbed any moisture or become charred during a previous application.

The cotton pad, measuring approximately 100 mm square × 20 mm thick, shall consist of new undyed and soft cotton fibres without any admixture of artificial fibres, and shall have a mass between 3 and 4 g. The pad shall be conditioned by drying in an oven at 100 °C for at least 0,5 h. The pad shall be attached by wire clips to a 100 mm × 100 mm frame of 1 mm diameter wire, to which a wire handle approximately 750 mm long is fixed. Note shall be made of the time when the first ignition of the cotton pad occurs and the position where this takes place. With doors or shutters having no, or only slight, insulation, it may not be possible to apply this test shortly after the commencement of heating; in such cases note shall be made of the time after which it is not practicable to apply this test.

7.5 Other observations

Note shall be made of the deformation of the specimen and the time when collapse of the whole or part of the specimen takes place. Note shall be made also of any flaming sustained for 10 s or more on the unexposed face and the emission of smoke. The ability of the door or shutter to be opened after the test shall be noted.

8 PERFORMANCE CRITERIA

The fire resistance of the door or shutter assembly shall be judged under one or more of the following criteria. The national standards authorities may, however, introduce acceptance levels under different criteria where none are shown, or may modify those given in this clause.

8.1 Loss of integrity (initial integrity failure)

8.1.1 *Flaming*

The time shall be noted at which flaming is sustained for 10 s or more on the unexposed face.

8.1.2 *Cotton pad test*

The time shall be noted at which the first ignition of the cotton pad occurs.

8.2 Loss of integrity (ultimate integrity failure)[1]

The time shall be noted at which the door collapses or when excessive gaps are formed or when failure of the locking or latching mechanism takes place. In the absence of such failure, the ultimate integrity shall be taken as equal to the duration of test.

8.3 Insulation

8.3.1 *Mean unexposed face temperature — door or shutter*

The time shall be noted at which the mean unexposed face temperature of the door or shutter, as measured by the thermocouples specified in 7.2 for this purpose, exceeds the initial temperature by 140 °C.

8.3.2 *Maximum unexposed face temperature — door or shutter*

The time shall be noted at which the maximum temperature on the unexposed face exceeds the initial temperature by 180 °C. Doors or shutters incorporating glazing and doors and shutters constructed of sheet steel shall be considered to have failed to satisfy this criterion.

8.3.3 *Maximum unexposed face temperature — frame*

The time shall be noted at which the maximum temperature on the unexposed face of the frame exceeds the initial temperature by more than 180 °C.

8.3.4 *Radiation from door or shutter*

The radiation measurements from the unexposed face of the door or shutter shall be used to determine the time at which critical radiation levels exist at specified distances from the door or shutter. The specification of limits which are considered safe for the storage of materials and for personnel is the responsibility of the national standards authorities.

9 TEST REPORT

The test report shall include the following information :

a) name of testing laboratory;

b) name of sponsor;

c) date of test;

d) name of manufacturer and the trade-name (if any) of the product;

[1] Laboratories may find it useful to employ the canopy test described in annex B as a means for defining "ultimate integrity failure".

e) details of construction and conditioning of the specimen and the materials used, together with drawings; these shall be lodged with the testing authority for inclusion in the report where appropriate, clearances and gaps between the door and the frame shall be fully recorded;

f) description of fixing of the test specimen to the surrounding wall and of the joint, if any, between the door assembly and the surrounding wall;

g) description of glazing, if any;

h) the side of the door or shutter exposed to heating;

i) test results :

1) furnace time/pressure chart and temperature curves;

2) time/temperature results as required by 8.3.1, 8.3.2 and 8.3.3;

3) times at which various performance criteria were no longer complied with;

j) data for establishing the effective black-body temperature of the door or shutter and for determining the distances from the unexposed face at which radiation levels exceeded specified limits;

k) any other information about the performance of the specimen during the test, including the ability of the door or shutter to be opened after cooling.

INTERNATIONAL STANDARD ISO 3008-1976 (E)/ERRATUM

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Fire-resistance tests — Door and shutter assemblies

ERRATUM

Page 6

In the title of clause A.6 : replace "7.3" by "7.2".

In the title of clause A.7 : replace "7.4" by "7.3".

ANNEX A

EXPLANATORY NOTES ON VARIOUS CLAUSES

NOTE — So that suitable precautions to safeguard health may be taken, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases may be evolved in combustion of test elements.

A.0 GENERAL

These notes give additional information which could not be included in the body of this International Standard. Their main purpose is to indicate to the testing and the building authorities the limitation of various clauses, the need for caution in the application of data, and the testing aspects which may need to be revised on the availability of further data.

A.1 NOTE TO CLAUSE 1

It is not the primary purpose of this International Standard to classify doors into different categories but to provide a means for doing so. Many practical considerations have to be taken into account in a classification scheme and, depending upon the use of doors, some factors are more important than others.

The national building authorities will also have specific requirements depending upon the circumstances in different situations.

A.2 NOTE TO CLAUSE 3

Attention is drawn to the inadvisability of applying the performance data to doors of sizes much different from those examined. This is particularly so for doors of much larger sizes than tested, as an increase in size can be associated with greater tendency to deform.

Larger doors also require improvements in strength and supporting mechanisms.

A.3 NOTE TO SUB-CLAUSE 5.2

In accordance with the general philosophy of fire resistance, tests on doors should be conducted on complete assemblies fixed in the type of wall in which they are expected to be used in practice, in some cases, the behaviour of the wall may be a critical factor for the door performance. When this is not possible, walls of brick or concrete of standardized thicknesses have been proposed.

The performance of doors, particularly when made of or containing timber, is significantly influenced by the size of the gaps between the door and the frame. To ensure that the performance of timber doors is representative of their use in practice, it is necessary to ensure that unduly small gaps are not introduced into the test specimens.

Different types of door require different methods of fixing in the opening. Hinged doors can be fixed in a number of positions in the opening, whereas sliding doors have to be fixed on the face of the wall. When it is possible to mount a door in a number of positions and no other considerations are involved, it is suggested that the door should be mounted as near the unexposed face as possible. With the frame of the door flush with the unexposed face, the hot gases emitted from any gaps will flow directly to the underside of any canopy without encountering the horizontal projection of the wall openings.

A.4 NOTE TO CLAUSE 6

There are very few doors which are truly symmetrical. Therefore, the performance of a door assembly should be established by testing it with each face exposed to the fire conditions. This will necessitate two tests on identical specimens and, if the doors are not wider than 1 m and the furnace can accommodate a 3 m wide wall, the two specimens could be tested simultaneously. If the canopy test (annex B) is used, a double canopy will be necessary.

Occasionally it may be possible, on the basis of past experience, to indicate the face of the door which on exposure will represent the more severe test condition; in such cases, testing with this particular face exposed will establish the minimum performance of the door. The factors which will influence the decision are the tendency of the door to deform more in one direction than in the other, damage to consumable door-stops, direct exposure of hinges to heating and the damage to the suspension or sliding gear. The national standards authorities may wish to rationalize the situation by specifying particular requirements for different types of door.

There are also instances when a given door is expected to be exposed to severe fire conditions on one side only : in such cases, there is a justification in selecting the appropriate exposure condition

A.5 NOTE TO SUB-CLAUSE 7.1

ISO 834 does not, at present, specify a precise method for the measurement of furnace pressure. An attempt has been made in this procedure to provide a simple system which will measure the static pressure difference between the exposed and the unexposed faces. It is intended that the upper two-thirds of a door is under positive pressure conditions, whilst the pressure below this level is neutral or negative. Most vertical furnaces have linear pressure characteristics over their height with the maximum occurring near the top. Until it is possible to introduce more precise standardization in the design of furnaces, it is not practicable to specify the precise value of the maximum overpressure at the top of the door; it is, suggested, however, that it should be as close to 1,0 mmH_2O* as possible.

A.6 NOTE TO SUB-CLAUSE 7.3

On unglazed doors, the normal surface thermocouples should be distributed as specified, omitting positions with constructional features likely to cause hot spots where additional thermocouples should be attached. It is not normally necessary to measure the temperature of the unexposed face of glazed doors except when information is required on the insulating properties of the unglazed portion. When glazing is present, the thermocouples should be distributed equitably over the solid parts. Temperature measurement on the frame is intended to provide information on the likely hazard when mounting the assembly in a different type of wall to that used in the test.

A.7 NOTE TO SUB-CLAUSE 7.4

The measurement of radiation from the face of the door is complementary to the measurement of temperatures. With uninsulated doors and with doors having glazing, the radiation measurements are likely to be more important and in some cases more practicable. The location of the radiometer and its field of view should be such that it can measure radiation flux emitted from the whole of the door. This may necessitate the use of masks in front of the radiometer having the same profile as the door. The radiometer suggested is only one type of instrument which may be used for this purpose.

Where test assemblies permit the transmission of heat by radiation, the results obtained from the radiometer will reflect both the characteristics of the test specimen and the radiating characteristics of the furnace. The latter are affected by such factors as the type of refractory lining and whether or not luminous flames are present.

The foregoing does not prevent a single laboratory from grading doors according to their relative performance, because the heat transfer characteristic of a single furnace will remain constant.

A.8 NOTE TO CLAUSE 8

The performance of the doors can be judged under the following main criteria :

Loss of integrity (initial integrity failure)

Loss of integrity (ultimate integrity failure)

Insulation

A.9 NOTE TO SUB-CLAUSE 8.1

Loss of integrity (initial integrity failure)

The cotton pad is intended, primarily, for insulated doors which may be required to provide as good a protection as a wall. The canopy test (annex B) measures the combined effect of gases emitted from the door gaps and the transfer of heat by convection and radiation from the face of the door. With insulated doors, the gap sizes are the critical factor.

* 1 $mm H_2O$ = 9,806 65 Pa

A.10 NOTE TO SUB-CLAUSE 8.2

Loss of integrity (ultimate integrity failure)

The application of this criterion to doors raises many problems and in some instances the end-point may be difficult to define.

It has been suggested that doors are unlikely to fail this requirement without having previously failed the initial integrity criterion and that therefore it could be deleted. There are, however, types of door for which the ultimate integrity criterion may need to be retained; for example, uninsulated steel shutters will fail the insulation and the initial integrity criteria within the first 10 min of a test, but by providing a substantial barrier to the passage of flames, they have a useful role to play in buildings. They have been tested for up to 4 h without suffering collapse and, for this type of construction, ultimate integrity is considered to be a useful criterion.

A.11 NOTE TO SUB-CLAUSE 8.3

Insulation

Radiant heat emitted from the unexposed face of the door can cause the ignition of combustible materials or fixtures in the vicinity. In general, doors are not likely to have goods stored within a distance equal to their width, but with completely uninsulated types this may not be a safe distance after prolonged heating. The test data will enable an unsafe zone to be defined within which no combustible contents should be placed.

Heat radiation from doors will also affect people passing the door and the radiation levels that can be tolerated are lower. The concern with the movement of people in front of uninsulated construction is appropriate only during the early stages of a fire.

ANNEX B

CANOPY TEST PROCEDURE

B.0 INTRODUCTION

This annex defines a canopy test procedure which initially was included as part of the specification, but which is now only an optional requirement (see Foreword).

The purpose of the canopy is to try to simulate the conditions produced close to a ceiling when the door is installed in a building. The partial enclosure on the sides is provided to minimize disturbance by the air currents in the laboratory and it is therefore desirable that measures should be adopted, such as closing of the laboratory doors, to provide draught-free conditions in the vicinity of the furnace. The canopy procedure can be used to establish the loss of ultimate integrity of a door.

With a furnace of large enough dimensions, it may be possible to use a double canopy for testing two doors of equivalent performance simultaneously.

B.1 APPARATUS FOR CANOPY TEST

A canopy of the shape and size shown in figures 1 and 4 is provided on the unexposed side of the specimen such that its underside is 500 mm from the top edge of the opening for the door assembly in the test wall. The canopy is constructed of a steel frame with the top and adjustable side panels covered with asbestos insulation board approximately 20 mm thick (density approximately 600 kg/m^3).

The canopy bears against the face of the wall containing the specimen door with any gaps sealed. Six thermocouples each consisting of wires having a diameter not exceeding 1 mm are provided with the hot junctions located as shown in figure 3. Porcelain tubes of a diameter not exceeding 8 mm are used where thermocouples pass through the canopy. The hot junctions of the thermocouples are located 25 mm below the lower surface of the canopy with the porcelain tubes projecting not more than 10 mm below the surface. The holes for the porcelain tubes are on an axis parallel to the front face of the canopy.

B.2 TEMPERATURE FOR CANOPY TEST

The temperature of the gases below the canopy is measured by means of six thermocouples having bare junctions arranged and constructed as shown in figures 1 and 3.

B.3 OBSERVATIONS

Times are noted at which the mean and maximum temperatures measured by the thermocouples described in B.2 exceed the initial temperature by prescribed amounts. Present knowledge does not permit any precise recommendations to be made, but limited experience indicates that temperatures in the range of 150 to 200 °C would be appropriate to express "ultimate integrity failure" for certain types of door.

Dimensions in millimetres

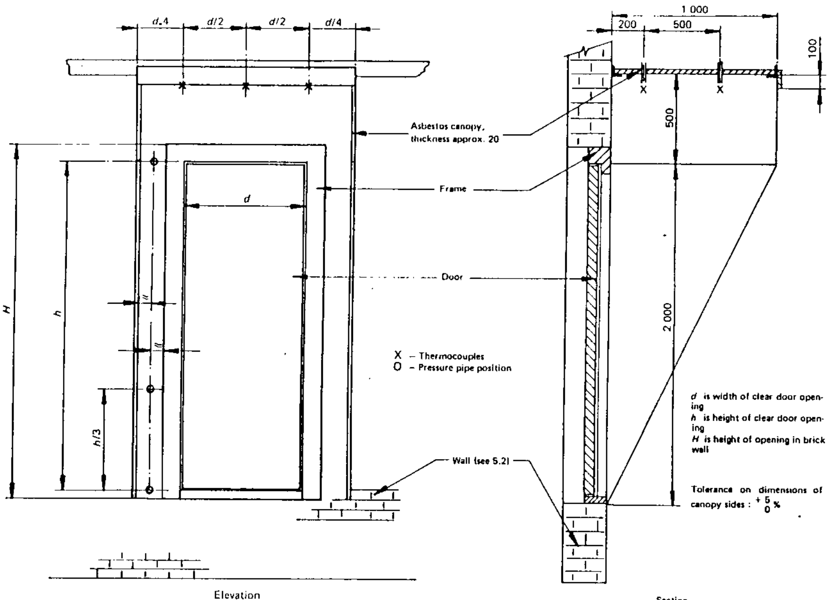

FIGURE 1 – Door mounting and canopy details

Dimensions in millimetres

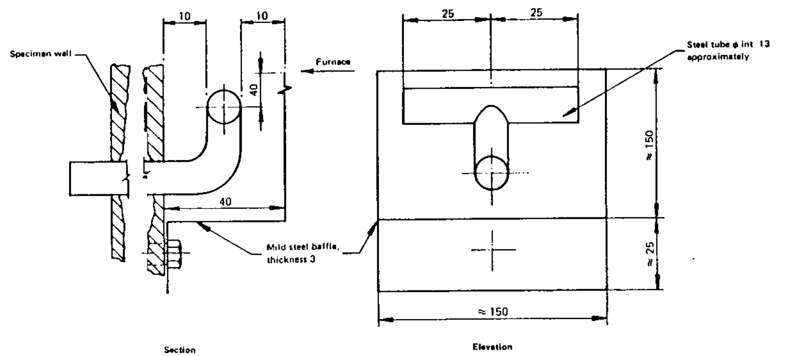

FIGURE 2 – Static pressure probe

Dimensions in millimetres

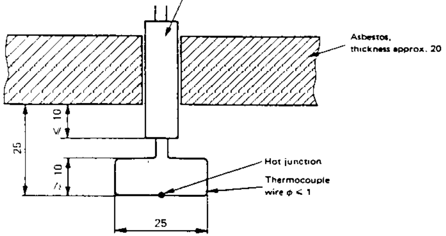

FIGURE 3 – Canopy thermocouple

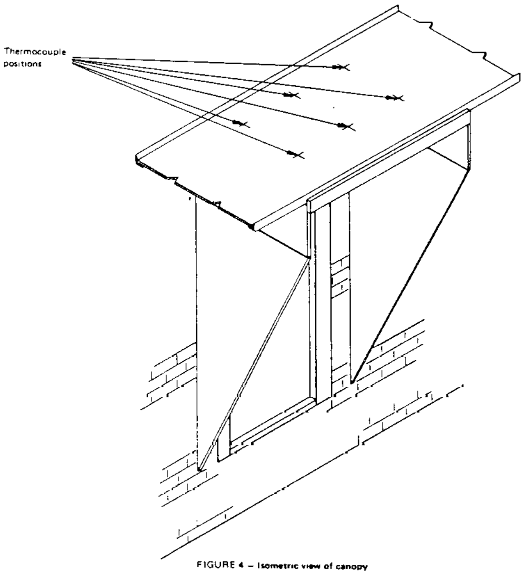

FIGURE 4 – Isometric view of canopy

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Fire-resistance tests — Door and shutter assemblies
AMENDMENT 1

Essais de résistance au feu — Portes et fermetures
Amendement 1

Page 3

8 Performance criteria

Delete the first sentence, and substitute :

"The fire resistance of the door or shutter assembly shall be judged by one or both of the criteria for loss of integrity and insulation."

8.1 Loss of integrity (initial integrity failure)

Delete the term in parentheses from the title.

8.2 Loss of integrity (ultimate integrity failure)[1]

a) Delete the title and the existing text, and substitute :

"8.2 Collapse[1]

If it is required to determine collapse, the test should be continued after the loss of integrity has occurred (see 8.1) or when insulation failure has taken place (see 8.3). In such cases, the time should be noted at which the door collapses or through openings[1] are formed or when failure of the locking or latching mechanism takes place."

b) Delete the existing footnote "1)", and substitute :

"1) Laboratories may find it useful to employ the canopy test described in annex B as a means of defining the occurrence of through openings."

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A.8 Note to clause 8

Delete the existing text, and substitute :

"The performance of the doors can be judged under the following main criteria :

Loss of integrity
Collapse
Insulation

When the test is carried out as described in 8.2, the occurrence of any of the events may be considered as collapse."

A.9 Note to sub-clause 8.1

Loss of integrity (initial integrity failure)

Delete the term in parentheses from the sub-title.

Page 7

A.10 Note to sub-clause 8.2

Loss of integrity (ultimate integrity failure)

Delete the sub-title and the existing text, and substitute :

"**Collapse**

In most cases, a test on a door is terminated when the door fails to satisfy the requirements either for integrity or for insulation. However, there are types of doors which may fail the integrity criterion at the beginning, due to the presence of gaps and orifices, for example uninsulated steel shutters, but, in the view of safety authorities, such doors may still function as barriers to the spread of fire. Such doors have been tested for up to 4 h without suffering collapse and are regarded as useful contributors to fire safety. In such cases, national authorities may wish to retain the occurrence of collapse as defined in 8.2 as a useful criterion."

Page 8

B.0 Introduction

Delete the last sentence of the second paragraph, and substitute :

"The canopy test procedure can be used to establish the collective influence of gaps at different places on the door if a test is required to establish freedom from collapse in 8.2".

B.3 Observations

Line 3. Delete the text after "150 to 200 °C", and substitute :

"would be appropriate to indicate the formation of through openings as referred to in 8.2."

UDC 69.028.1 : 699.81 : 620.16 Ref. No. ISO 3008-1976/A1-1984 (E)

Descriptors : buildings, doors, closures, tests, fire tests, fire resistance.

Price group A (E)

一　燃焼せず、かつ、防火上有害な変形、溶融、き裂その他の損傷を生じないこと。
二　防火上有害な煙又はガスを発生しないこと。

（防火戸その他の防火設備）

第百九条　法第二条第九号の二若しくは第九号の三又は法第六十四条の規定により政令で定める構造の防火戸その他の防火設備は、次の各号の一に該当するものとする。（を）

一　甲種防火戸
二　乙種防火戸
三　開口部に設けるドレンチヤーで消防庁の行なう検定に合格したもの（に）（わ）（の）

2　隣地境界線、道路中心線又は同一敷地内の二以上の建築物（延べ面積の合計が五百平方メートル以内の建築物は、一の建築物とみなす。）相互の外壁間の中心線のあらゆる部分で、開口部から一階にあつては三メートル以下、二階以上にあつては五メートル以下の距離にあるものと当該開口部とをさえぎる耐火構造又は防火構造の外壁、そで壁、へいその他これらに類するものは、前項の防火設備とみなす。（を）

3　開口面積が百平方センチメートル以内の換気孔に設ける鉄板、モルタル板その他これらに類する材料で造られた防火おおい又は地面からの高さが一メートル以下の換気孔に設ける網目二ミリメートル以下の金網は、第一項の防火設備とみなす。（を）

（簡易耐火建築物の屋根等の構造）

第百九条の二　法第二条第九号の三イの規定により政令で定める防火性能を有する構造は、不燃材料で造り、又はふくほか、法第八十六条第二項の場合を除き、屋根の延焼のおそれのある部分を耐火構造又は防火構造としたものとする。（を）

2　法第二条第九号の三ロの規定により政令で定める不燃材料に準ずる材料は、準不燃材料とする。（を）

3　法第二条第九号の三ロの規定により政令で定める防火性能を有する構造は、次の各号に掲げるものとする。（を）

一　外壁の延焼のおそれのある部分にあつては、耐火構造又は防火構造としたもの
二　屋根にあつては、不燃材料で造り、若しくはふいたもの又は建設大臣が消防庁長官の意見を聞いて、これらと同等以上の防火性能を有すると認めて指定するもの（わ）
三　床にあつては、不燃材料又は準不燃材料で造るほか、三階以上の階におけるもの（直下の天井を第百八条第一号イからハまでの一に該当する構造又は建設大臣が消防庁長官の意見を聞いて、これらと同等以上の防火性能を有すると認めて指定する構造とし、かつ、そのつり木、受木その他これらに類するものを不燃材料で造つた部分を除く。）を耐火構造又は防火構造としたもの（わ）（の）

（防火戸の構造）

第百十条　第百九条第一項第一号の「甲種防火戸」とは、次の各号の一に該当する構造の戸とする。（に）（を）

一　骨組を鉄製とし、両面にそれぞれ厚さが〇・五ミリメートル以上の鉄板を張つたもの
二　鉄製で鉄板の厚さが一・五ミリメートル以上のもの
三　鉄骨コンクリート製又は鉄筋コンクリート製で厚さが三・五センチメートル以上のもの

四　土蔵造の戸で厚さが十五センチメートル以上のもの

五　前各号に掲げるものを除くほか、建設大臣が消防庁長官の意見を聞いて、これらと同等以上の防火性能を有すると認めて指定するもの（に）（を）（わ）（の）

2　第百九条第一項第二号の「乙種防火戸」とは、次の各号の一に該当する構造の戸とする。（に）（を）

一　鉄製で鉄板の厚さが〇・八ミリメートル以上一・五ミリメートル未満のもの（の）

二　鉄骨コンクリート製又は鉄筋コンクリート製で厚さが三・五センチメートル未満のもの

三　土蔵造の戸で厚さが十五センチメートル未満のもの

四　鉄及び網入ガラスで造られたもの

五　骨組を防火塗料を塗布した木材製とし、屋内面に厚さが一・二センチメートル以上の木毛セメント板又は厚さが〇・九センチメートル以上の石こうボードを張り、屋外面に亜鉛引鉄板を張つたもの（を）（の）

六　前各号に掲げるものを除くほか、建設大臣が消防庁長官の意見を聞いて、これらと同等以上の防火性能を有すると認めて指定するもの（に）（わ）（の）

3　開口面積が〇・五平方メートル以内の開口部に設ける戸で、防火塗料を塗布した木材及び網入ガラスで造られたものは、前項の乙種防火戸とみなす。（を）

4　防火戸が枠又は防火戸と接する部分は、相じやくりとし、又は定規縁若しくは戸当りを設ける等閉鎖した際にすき間が生じない構造とし、かつ、防火戸の取付金物は、取付部分が閉鎖した際に露出しないように取り付けなければならない。（を）

第二号又は第三項第一号若しくは第四号に掲げる防火戸は、周囲の部分（防火戸から

ル以内の間に設けられた建具がある場合においては、その建具を含む。）が不燃材料で

けなければならない。（を）

しない居室等）

第百十一条　法第三十五条の三の規定により政令で定める窓その他の開口部を有しない居室は、次の各号の一に該当する窓その他の開口部を有しない居室とする。（の）

一　面積（第二十条第一項又は第二項の規定により計算した採光に有効な部分の面積に限る。）の合計が、当該居室の床面積の二十分の一以上のもの

二　直接外気に接する避難上有効な構造のもので、かつ、その大きさが直径一メートル以上の円が内接することができるもの又はその幅及び高さが、それぞれ、七十五センチメートル以上及び一・二メートル以上のもの

2　ふすま、障子その他随時開放することができるもので仕切られた二室は、前項の規定の適用については、一室とみなす。（の）

（防火区画）

第百十二条　主要構造部を耐火構造とした建築物又は法第二条第九号の三イ若しくはロのいずれかに該当する建築物で、延べ面積（スプリンクラー設備、水噴霧消火設備、泡消火設備その他これらに類するもので自動式のものを設けた部分の床面積の二分の一に相当する床面積を除く。以下この条において同じ。）が千五百平方メートルをこえるものは、床面積（スプリンクラー設備、水噴霧消火設備、泡消火設備その他これらに類するもの

第一　総則

建築基準法施行令第百十条第一項第一号から第四号に掲げる甲種防火戸と同等以上の防火性能を有するもの及び第二項第一号から第五号に掲げる乙種防火戸と同等以上の防火性能を有するものは、第二に規定する試験に合格したものとする。

第二　試験

甲種防火戸及び乙種防火戸の試験は、第一号に規定する試験体について、第二号に規定する加熱炉を用いて、第三号に規定する加熱試験を行い、第四号に規定する判定を行うものとする。

一　試験体

試験体は次に掲げるものとする。

イ　試験体の材料、構成、大きさ及び厚さは、実際のものと同一とすること。ただし、実際の大きさが使用される加熱炉の大きさより大きい場合においては、当該試験体の大きさは、当該加熱炉の大きさとすることができる。

ロ　試験体は、気乾状態に乾燥したものとすること。

ハ　試験体は、戸及び枠を含めて製作し、防火性能が劣る部分があると認められる場合においては、当該部分が試験体に含まれるようにすること。

二　加熱炉

加熱炉は、日本工業規格A一三一一の3に規定するものとする。

三　加熱試験

加熱試験は、次に定めるところにより行う。

イ　加熱は、戸の両面についてそれぞれ、甲種防火戸の試験にあつては六十分間、乙種防火戸の試験にあつては二十分間行い、試験体の加熱温度が時間の経過に従い、昭和四十四年建設省告示第二千九百九十九号の別記第一の四の二の表に規定する耐火標準加熱温度となるように制御すること。

ロ　加熱温度の測定は、次に定めるところにより行うこと。

(1)　加熱温度は、CA熱電対により測定すること。

(2)　加熱温度を測定する熱電対の熱接点は、加熱面に均等に九個以上配置すること。

(3)　加熱温度の許容差は、標準加熱時間面積に対して正負十パーセント以内とすること。

ハ　加熱試験は、戸の両面についてそれぞれ一回以上行うこと。

四　判定

甲種防火戸及び乙種防火戸の試験結果の判定は、試験体が次に掲げる条件に適合しているものを合格とする。

イ　加熱により加熱面の裏面側に発炎を生じないこと。

ロ　加熱によりすき間、加熱面の裏面側に達する亀裂等を生じないこと。ただし、試験体の大きさが実際のものと同一でない場合においては、実際のものと同一の大きさのものでも加熱によりすき間、加熱面の裏面側に達する亀裂等を生じないことを試験体の変形について計算を行うことにより確かめること。

ハ　加熱により加熱面の裏面側に著しい発煙を生じないこと。

ニ　加熱終了後、試験体の加熱面の裏面側直上からロープでつり下げられた重量三キログラムの砂袋を鉛直距離五十センチメートルの高さから落下させて衝撃を与えた場合において、試験体が防火上有害な破壊、はく離、脱落等を起こさないものであること。

附　則

1　この告示は、平成二年六月三十日から施行する。

2　昭和三十四年建設省告示第二千五百四十六号は、廃止する。

日 本 工 業 規 格　　JIS

建築用防火戸の防火試験方法　A 1311-1975

1982 確認

Method of Fire Protecting Test of Fire Door for Buildings

1. 総 則

1.1 適用範囲　この規格は，建築物の開口部に設ける防火戸の防火試験方法について規定する。

1.2 この防火試験は，2. に規定する試験体に，3. に規定する加熱炉によって，4. に規定する加熱温度を与えて，5. に規定する加熱試験を行い，必要に応じて 6. に規定する衝撃試験及び 7. に規定するしゃ煙試験を行う。

1.3 防火戸は，次に示す区分によって表示する。

加熱試験の級別

防 火 用　1級，2級，3級

耐 火 用　30分加熱，1時間加熱，2時間加熱

しゃ熱力の有無

A　種　5.8 に合格のもの

B　種　5.9 に合格のもの

その他の試験の有無

衝撃試験　S

しゃ煙試験　G—○○

記 号 例：防火A種2S

防火2級加熱試験に合格し，しゃ熱力があり，衝撃試験にも合格したもの

耐火1時間B種 SG—1.2

耐火1時間加熱試験に合格し，非しゃ熱性で衝撃試験に合格し，しゃ煙試験における通気量が $1.2 m^3/min \cdot m^2$ 以下のもの

備 考 1. 防火用は，建築物の外壁に用いる防火戸に適用する。
2. 耐火用は，主に建築物の屋内防火区画に用いる防火戸に適用する。
3. A種は木造建築物のように防火戸の内側に木造部分がある場合に適用し，B種はそれ以外の場合に適用する。

2. 試 験 体

2.1 試験体は，防火戸及びわくを含めて実際のものと同一に製作し，部分により防火力に差がある場合は，防火上弱点と思われる部分を含ませる。

2.2 試験面の大きさは実際のものと同一とする。ただし，実際のものの大きさが 200 cm × 250 cm 以上のときは 200 cm × 250 cm とすることができる。厚さは実際のものと同一とする。

2.3 試験体は通風のよい室内で，おおむね表1の期間乾燥させる。ただし人工乾燥によって前記以上の乾燥状態とした場合，又は気乾状態であることを適当な試験方法で確かめた場合は，この期間を短縮することができる。また，金属，ガラス製品などは乾燥の必要がない。

引用規格：JIS A 5413　石綿セメントパーライト板
JIS C 1602　熱 電 対
JIS H 3103　タフピッチ銅板

表 1

区　分	夏	冬
コンクリート，モルタル塗など湿式工法によるもの	2 箇月	3 箇月
石綿スレート張など乾式工法によるもの	1 箇月	1 箇月

3. 加 熱 炉

3.1 加熱炉は，4. に示す加熱温度の時間的変化を試験面の全面にほぼ一様に与えられるようなものとする。

3.2 加熱炉の熱源は，都市ガス，プロパン，重油その他適当な燃料とし，その炎は直接試験体に十分達しうるものとする。

3.3 試験体取付用わくは，耐熱性のものとし，試験面を所定の位置に保持できるような構造のものとする。

3.4 試験体は，鉛直位置で片面から加熱する。

4. 加熱等級

4.1 防火用の加熱温度は，表2及び付図1の標準曲線によるものとし，その加熱等級は，加熱温度によって，1級，2級及び3級とする。

表 2　防火標準加熱温度

単位 °C

加熱区分 ＼ 経過時間(分)	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1級加熱	100	150	260	410	660	910	1060	1120	1120	1090	1010	920	850	780
2級加熱	75	120	190	310	500	680	790	840	840	820	760	690	640	585
3級加熱	25	55	100	180	300	410	500	550	550	525	490	450	400	365

加熱区分 ＼ 経過時間(分)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1級加熱	720	660	610	560	530	480	450	410	380	350	320	290	260	230	200
2級加熱	540	495	460	420	395	360	340	310	285	260	240	220	195	175	150
3級加熱	330	305	280	260	240	225	210	190	175	160	150	140	125	110	100

備 考　2分目までは，常温から漸増させる。

4.2 耐火用の加熱温度は，表3及び付図2の標準曲線によるものとし，加熱等級は加熱時間が 30 分，1時間及び2時間のものを，それぞれ 30 分加熱，1時間加熱及び2時間加熱という。

表 3　耐火標準加熱温度

経過時間 (分)	1	2	3	4	5	6	7	8	9	10	11	12
加熱温度 (°C)	100	220	330	440	510	600	640	665	685	705	715	730
経過時間 (分)	13	14	15	16	17	18	19	20	21	22	23	24
加熱温度 (°C)	740	750	760	770	775	785	790	795	800	805	810	815
経過時間 (分)	25	26	27	28	29	30	35	40	45	50	55	60
加熱温度 (°C)	820	825	830	835	838	840	860	880	895	905	915	925
経過時間 (分)	65	70	75	80	85	90	95	100	110	120		
加熱温度 (°C)	935	945	955	965	975	980	985	990	1000	1010		

5. 加熱試験

5.1 試験面以外の部分は，火炎をしゃ断するように耐火れんがその他の材料で覆い，更にこれらの間がすいていて試験面以外の部分が加熱されるおそれがある場合は，石綿その他のものを充てんするなど，適当に処理して加熱する。

5.2 試験体の加熱側の炉内気圧が大気圧より大となるような加熱方法をとる。このため，試験面にマノメータ類を取り付け，少なくとも加熱面の約 $\frac{1}{2}$ が大気圧より高い炉内気圧を受けていることを確かめるものとする。

5.3 加熱温度は，JIS C 1602 (熱電対) に規定する 0.75 級以上の性能をもつ径 1 mm の CA 熱電対によって測定する。

加熱温度を測定する熱電対の熱接点は，付図3のように試験面の中心及び中心と端部との中間に合計9箇所以上を標準として設置する。

防火用加熱試験における加熱温度測定用熱電対の熱接点の設置方法は，付図4のようにモルタル表面温度で測定する。付図4のモルタル表面温度で測定することが困難な場合には，あらかじめ付図4に規定するモルタル表面に熱接点を設けて，規定の温度を示す加熱条件を付図5に示す方法で測定しておき，これをその加熱炉の特性加熱温度として標準温度に代えて付図5の方法で測定することができる。

耐火用加熱試験における加熱温度測定用熱電対は，内径約 1 cm の先端を封じた石英，鉄又は磁性保護管に入れ，その熱接点をそれぞれ試験面から約 3 cm 離した位置で 10 cm 以上試験面に平行するように置く。

5.4 加熱は 5.3 に規定した熱電対の示す温度を 4. に規定した標準曲線に沿わせるように行う。

5.5 防火用加熱試験における加熱温度の測定は，1分以内ごとに行うものとし，次に規定する A が $0.9K$ 以下又は $1.1K$ 以上の場合は，試験回数には算入しない。ただし A が $1.1K$ 以上で 5.8 の規定に合格の場合又は $0.9K$ 以下で不合格の場合は，それぞれ合格又は不合格とする。

A：実施した加熱時間温度曲線と 260°C 線との囲む面積 (単位 100°C 分)

K：付図1に示す標準曲線上の A に対応する面積で表4による。

表 4

単位 100°C 分

加熱級別	1級加熱	2級加熱	3級加熱
加熱時間温度面積	96	56	19

5.6 耐火用加熱試験における加熱温度の測定は，30分までは2分以内ごとに，30分以後は5分以内ごとに行う。炉内平均温度の標準曲線に対する許容差は，加熱時間温度面積で加熱時間1時間までは ±10%，2時間までは ±7.5%，2時間を超えるものは ±5% 以内とする。ただし，その許容誤差以上の高温で 5.8 又は 5.9 の規定に合格した場合は，この限りでない。

5.7 防火戸の弱点部と思われる裏側表面 (さんがあるときはさん表面) から 3 cm 離した位置に，JIS H 3103 (タフピッチ銅板) に規定する厚さ 0.2 mm，面積約 4 cm^2 の銅板の表面をすすで黒くし，大きさ 5 cm×5 cm の JIS A 5413 (石綿セメントパーライト板) に規定する厚さ 1 cm の 0.8 石綿パーライト板に密着させたものを5箇所以上裏面に平行に置き，その銅板の温度を測定する。銅板の温度は JIS C 1602 に定める 0.75 級以上の性能をもつ径 0.65 mm の CA 又は CC 熱電対を銅板に銀ろう付けして測定する。ただし，B種にあってはこの測定を省略する。

5.8 加熱試験の結果，試験体が次の条件に適合するものをA種に合格とする。

(1) 防火上有害と認められる変形・破壊・脱落などの変化を生じないこと。

備 考 局部的な爆裂で表層のはく離にとどまるもの，及び防腐材料又はしん材が，これらに該当しないものは合格とする。

(2) 防火上有害と思われる火炎を裏側に通さないこと。

備 考 試験体の裏面側から，加熱炎が目視できるすき間又は孔を生じたときは，火炎が裏面側に通ったものとみなす。

(3) 加熱試験中付図6に示す防火戸周辺各部の長さ l(cm) の中間における反り又はたわみが $l/500$ を超えないこと。ここで l とは付図6の l_1，l_2，l_3，l_4，l_5，l_6，l_7 をいう。

(4) 構成材料のいずれからも防火上有害と認められる発炎をせず，加熱終了後5分間以上，火気が残存しないこと。

備 考 ガラスを止めるパテなどの燃焼による火炎及び塗料の燃焼による火炎は，防火上支障ないものとみなす。

(5) 5.7 に規定した銅板温度が 260°C を超えないこと。

5.9 加熱試験の結果，試験体が 5.8 (5) を除いた各項に適合するものをB種に合格とする。

6. 衝撃試験

6.1 衝撃試験は，5. に規定する加熱試験終了後30分以内の試験体を用い，試験体の裏面から 6.2 に規定する衝撃を与えて行う。

6.2 衝撃は，付図6に示すように，試験体裏面側直上からロープでつり下げられた重量 10 kg，直径 20 cm の球状砂袋を，衝撃箇所に対して鉛直距離 50 cm の高さから落下させて行う。

6.3 試験体の衝撃箇所は，構造上弱点と思われる部分を3箇所選び，それぞれ1回ずつ行う。

6.4 衝撃試験の結果，戸が破壊したり，すき間を生じたり，開いたりしないものを合格とする。

7. しゃ煙試験

7.1 2. の試験体を用い 5. の試験方法により30分 (耐火30分加熱のものは15分) 以上加熱したのち，7.2 の試験装置によって，試験体両面における空気の圧力差が 1 kg/m^2，2 kg/m^2 及び 3 kg/m^2 のときの通気量を測定する。

7.2 試験装置は付図8に示すように，圧力箱，送風機，圧力調整機，気密箱及び圧力計で構成され，試験体の全面に空気圧で等分布荷重を加えることができるものとする。

7.3 しゃ煙試験の結果，圧力差 2 kg/m^2 における試験体全面についての単位面積 (m^2)・単位時間 (min) 当たりの通気量を標準状態 (空気温度 20°C，1気圧) に換算し，これをしゃ煙試験における試験体の通気量とし，有効数字2けたで表す。この場合，各圧力差における測定値と他の圧力差における測定値との間に著しい特性変化がないこと。

8. 判定及び報告

8.1 5. の加熱試験及び 6. の衝撃試験は2回，7. のしゃ煙試験は1回とし，それぞれ合格しなければならない。

8.2 試験結果の報告書には，構造種類の名称，使用材料の詳細 (比重，含水率その他の品質を含む)，試験体の形状・寸法，加熱等級，熱源，加熱温度，裏面温度及びその平均値などとその測定位置，最高値とこれに達した時間，防火上重要な観察事項，衝撃試験後の試験体の状況，しゃ煙試験の各圧力差における通気量，結果の判定とその理由，燃料消費量，試験期間，試験機関名及び試験担当者名を記載する。

Standard Methods of
FIRE TESTS OF DOOR ASSEMBLIES[1]

This standard is issued under the fixed designation E 152, the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

These methods have been approved for use by agencies of the Department of Defense and for listing in the DoD Index of Specifications and Standards.

ε1 Note—Paragraphs 10.2 and X1.13.1 were changed editorially and all references were renumbered in July 1984.

1. Scope

1.1 These methods of fire test are applicable to door assemblies of various materials and types of construction, for use in wall openings to retard the passage of fire (see commentary in Appendix).

1.2 Tests made in conformity with these test methods will register performance during the test exposure; but such tests shall not be construed as determining suitability for use after exposure to fire.

1.3 It is the intent that tests made in conformity with these test methods will develop data to enable regulatory bodies to determine the suitability of door assemblies for use in locations where fire resistance of a specified duration is required.

1.4 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elemens of a fire risk assessment which takes into account all of the factors which are pertinent in an assessment of the fire hazard of a particular end use.*

2. Significance

2.1 These methods are intended to evaluate the ability of a door assembly to remain in an opening during a predetermined test exposure.

2.2 The tests expose a specimen to a standard fire exposure controlled to achieve specified temperatures throughout a specified time period, followed by the application of a specified standard fire hose stream. The exposure, however, may not be representative of all fire conditions, which may vary with changes in the amount, nature, and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment. It does, however, provide a relative measure of fire performance of door assemblies under these specified fire exposure conditions.

2.3 Any variation from the construction or conditions that are tested may substantially change the performance characteristics of the assembly.

2.4 The methods do not provide the following:

2.4.1 Full information as to performance of all door assemblies in walls constructed of materials other than that tested.

2.4.2 Evaluation of the degree by which the door assembly contributes to the fire hazard by generation of smoke, toxic gases, or other products of combustion.

2.4.3 A specific requirement that the unexposed surface temperatures be reported although the temperature measurement procedure is described.

2.4.4 A limit on the number of openings allowed in glazed areas or of the number and size of lateral openings between the door and frame.

2.4.5 Measurement of the degree of control or limitation of the passage of smoke or products of combustion through the door assembly.

CONTROL OF FIRE TESTS

3. Time-Temperature Curve

3.1 The fire exposure of door assemblies shall be controlled to conform to the applicable portion of the standard time-temperature curve shown in Fig. 1. The points on the curve that determine its character are:

1000°F (538°C)	at 5 min
1300°F (704°C)	at 10 min
1550°F (843°C)	at 30 min
1700°F (926°C)	at 1 h
1850°F (1010°C)	at 2 h
2000°F (1093°C)	at 4 h
2300°F (1260°C)	at 8 h or over

3.1.1 For a closer definition of the time-temperature curve, see Table A1.1.

4. Furnace Temperatures

4.1 The temperatures of the test exposure shall be deemed to be the average temperature obtained from the readings of not less than nine thermocouples symmetrically disposed and distributed to show the temperature near all parts of the test assembly. The thermocouples shall be protected by sealed porcelain tubes having ¾-in. (19-mm) outside diameter and ⅛-in. (3-mm) wall thickness, or, as an alternative, in the case of base metal thermocouples, protected by ½-in. (13-mm) wrought steel or wrought iron pipe of standard weight. The junction of the thermocouples shall be 6 in. (152 mm) from the exposed face of the test assembly or from the masonry in which the assembly is installed, during the entire test exposure.

4.2 The temperatures shall be read at intervals not exceeding 5 min during the first 2 h, and thereafter the intervals may be increased to not more than 10 min.

4.3 The accuracy of the furnace control shall be such that the area under the time-temperature curve, obtained by averaging the results from the thermocouple readings, is within 10 % of the corresponding area under the standard time-temperature curve for fire tests of 1 h or less duration, within 7.5 % for those over 1 h and not more than 2 h, and within 5 % for tests exceeding 2 h in duration.

5. Unexposed Surface Temperatures

5.1 Unexposed surface temperatures shall be recorded and shall be determined in the following:

5.1.1 Unexposed surface temperatures shall be taken at not less than three points with at least one thermocouple in each 16 ft^2 (1.5 m^2) area of the door. Thermocouples shall not be located over reinforcements extending through the door, over vision panels, or nearer than 12 in. (305 mm) from the edge of the door.

5.1.2 Unexposed surface temperatures shall be measured with thermocouples placed under flexible, oven-dry, felted asbestos pads 6 in. (152 mm) square, 0.4 in. (10 mm) in thickness, and weighing not less than 1.0 nor more than 1.4 lb/ft^2 (4.88 to 6.83 kg/m^2). The pads shall be held firmly against the surface of the door and fit closely about the thermocouples. The thermocouple leads shall be immersed under the pad for a distance of not less than 3½ in. (89 mm) with the hot junction under the center of the pad. The thermocouple leads under the pads shall be not heavier than No. 18 B & S gage (0.04 in.) (1.02 mm) and shall be electrically insulated with heat-resistant and moisture-resistant coatings.

5.1.3 Unexposed surface temperatures shall be read at intervals not exceeding 5 min for the first 30 min of the test.

TEST ASSEMBLIES

6. Construction and Size

6.1 The construction and size of the test door assembly, consisting of single doors, doors in pairs, special-purpose doors (such as Dutch doors, double-egress doors, etc.), or multisection doors, shall be representative of that for which classification or rating is desired.

6.2 A floor structure shall be provided as part of the opening to be protected, except where such floor interferes with the operation of the door. The floor segment shall be of noncombustible material and shall project into the furnace approximately twice the thickness of the test door, or to the limit of the frame, whichever is greater.

7. Mounting for Test

7.1 Swinging doors shall be mounted so as to open into the furnace chamber. Sliding and rolling doors, except horizontal slide-type elevator shaft doors, shall be mounted on the exposed side of the opening in the wall closing the furnace chamber. Horizontal slide-type elevator shaft doors shall be mounted on the unexposed side of the opening in the wall closing the furnace chamber. Access-type doors

[1] These methods are under the jurisdiction of ASTM Committee E-5 on Fire Standards.

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and chute-type doors and frame assemblies shall be mounted so as to have one assembly open into the furnace chamber and another assembly open away from the furnace chamber. Dumb-waiter and service-counter doors and frame assemblies shall be mounted on the exposed side of the opening in the wall.

7.2 The mounting of all doors shall be such that they fit snugly within the frame, against the wall surfaces, or in guides, but such mounting shall not prevent free and easy operation of the test door.

7.2.1 Clearances for swinging doors shall be as follows: With a minus 1/16-in. (1.6-mm) tolerance: 1/8 in. (3.2 mm) along the top, 1/8 in. along the hinge and latch jambs, 1/8 in. along the meeting edge of doors, in pairs, and 3/8 in. (9.5 mm) at the bottom edge of a single swinging door, and 1/4 in. (6.3 mm) at the bottom of a pair of doors.

7.2.2 Clearances of horizontal sliding doors not mounted within guides shall be as follows: With a minus 1/8-in. (3.2-mm) tolerance: 1/2 in. (12.7 mm) between the door and wall surfaces, 3/8 in. (9.5 mm) between the door and floor structure and 1/4 in. (6.3 mm) between the meeting edges of center-parting doors. A maximum lap of 4 in. (102 mm) of the door over the wall opening at sides and top shall be provided.

7.2.3 Clearances of vertical sliding doors moving within guides shall be as follows: With a minus 1/8-in. (3.2-mm) tolerance: 1/2 in. (12.7 mm) between the door and wall surfaces along the top and/or the bottom door edges with guides mounted directly to the wall surfaces and 3/16 in. (4.8 mm) between the meeting edges of bi-parting doors or 3/16 in. between the door and floor structure or the sill.

7.2.4 Clearances for horizontal slide type elevator doors shall be as follows: With a minus 1/8-in. (3.2-mm) tolerance: 3/8 in. (9.5 mm) between the door and wall surfaces, 3/8 in. between the multisection door panels, and 3/8 in. from the bottom of a panel to the sill. Multisection door panels shall overlap 3/4 in. (19.0 mm). Door panels shall lap the wall opening 3/4 in. at the sides and top.

CONDUCT OF TESTS

8. Time of Testing

8.1 *Time of Testing*—Masonry shall have sufficient strength to retain the assembly securely in position throughout the fire and hose stream test.

9. Fire Endurance Test

9.1 Maintain the pressure in the furnace chamber as nearly equal to the atmospheric pressure as possible.

9.2 Continue the test until the exposure period of the desired classification or rating is reached unless the conditions of acceptance set forth in Section 12 are exceeded in a shorter period.

10. Hose Stream Test

10.1 Immediately following the fire endurance test, subject the test assembly to the impact, erosion, and cooling effects of a hose stream directed first at the middle and then at all parts of the exposed surface, making changes in direction slowly.

10.2 Deliver the hose stream through a 2½-in. (64-mm) hose discharging through a National Standard Playpipe of corresponding size equipped with a 1⅛-in. (28.5-mm) discharge tip of the standard-taper smooth-bore pattern without shoulder at the orifice. The water pressure at the base of the nozzle and duration of application in s/ft^2 (m^2) of exposed area shall be as prescribed in Table 1.

10.3 The tip of the nozzle shall be located 20 ft (6 m) from and on a line normal to the center of the test door. If impossible to be so located, the nozzle may be on a line deviating not to exceed 30° from the line normal to the center of the test door. When so located the distance from the center shall be less than 20 ft by an amount equal to 1 ft (0.3 m) for each 10° of deviation from the normal.

11. Report

11.1 Report results in accordance with the performance in the tests prescribed in these test methods. The report shall show:

11.1.1 The performance under the desired exposure period chosen from the following: 20 min, 30 min, ¾ h, 1 h, 1½ h, or 3 h.

11.1.2 The temperature measurements of the furnace.

11.1.3 The temperature measurement of the unexposed side.

11.1.4 All observations having a bearing on the performance of the test assembly.

11.1.5 Flaming, if any, on the unexposed surface of the door leaf during the first 20 min of the fire test.

11.1.6 The amount of movement of any portion of the edges of the door adjacent to the door frame from the original position (see Section 12).

11.1.7 The materials and the construction of the door and frame, and the details of the installation, hardware, hangers, guides, trim, finish, and clearance or lap shall be recorded or appropriately referenced to ensure positive identification or duplication in all respects.

11.1.8 Pressure measurements made in the furnace and their relationship to the top of the door.

CONDITIONS OF ACCEPTANCE

12. Conditions of Acceptance

12.1 A door assembly shall be considered as meeting the requirements for acceptable performance when it remains in the opening during the fire endurance test and host-stream test within the following limitations:

12.1.1 The movement of swinging doors shall not permit any portion of the edges to move from the original position more than the thickness of the door, during the first half of the classification period, nor more than 1½ times the thickness during the entire classification period, nor more than 1½ times the thickness immediately following the hose stream test.

12.1.2 An assembly consisting of a pair of swinging doors shall not separate more than ¾ in. (19 mm) or equal to the throw of the latch bolt at the latch location.

12.1.3 An assembly consisting of a single swinging door shall not separate more than ½ in. (13 mm) at the latch location.

12.1.4 The lap edges of passenger (A17.1 horizontal slide-type) elevator doors, including the lap edges of multisection doors, shall not move from the wall or adjacent panel surfaces sufficiently to develop a separation of more than 2⅞ in. (73.0 mm) during the entire classification period, or immediately following the hose stream test. The meeting edges of center-parting elevator door assemblies, for a fire and hose stream exposure of 1½ h or less, shall not move apart more than 1¼ in. (31.7 mm) as measured in any horizontal plane during the entire classification period or immediately following the hose stream test.

12.1.5 Doors mounted in guides shall not release from guides and guides shall not loosen from fastenings.

12.1.6 The test assembly shall have withstood the fire endurance test and hose-stream test, without developing openings anywhere through the assembly, except that small portions of glass dislodged by the hose stream shall not be considered a weakness.

13. Precision and Bias

13.1 Precision and bias data are not available at this time; however, a task group of Subcommittee E05.12 has been established to investigate the subject and prepare a statement.

TABLE 1 Water Pressure at Base of Nozzle and Duration of Application[A]

Desired Rating	Water Pressure at Base of Nozzle, psi (kPa)	Duration of Application, s/ft² (0.09 m²) exposed area
3 h	45 (310)	3
1½ h and over, if less than 3 h	30 (207)	1.5
1 h and over, if less than 1½ h	30 (207)	0.9
Less than 1 h	30 (207)	0.6

[A] The exposed area may be calculated using the outside dimensions of the test specimen, including a frame, hangers, tracks, or other parts of the assembly if provided, but normally not including the wall into which the specimen is mounted. Where multiple test specimens are mounted in the same wall, the rectangular or square wall area encompassing all of the specimens will have to be considered as the exposed area since the hose stream must traverse this area during its application.

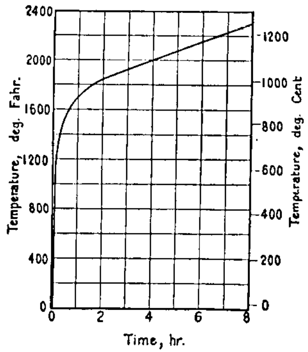

FIG. 1 Time - Temperature Curve

ANNEX

(Mandatory Information)

TABLE A1.1 Standard Time-Temperature Curve for Control of Fire Tests

Time	Temperature, °F	Area Above 68°F Base		Temperature, °C	Area Above 20°C Base	
h:min		°F-min	°F-h		°C-min	°C-h
0:00	68	00	0	20	00	0
0:05	1 000	2 330	39	538	1 290	22
0:10	1 300	7 740	129	704	4 300	72
0:15	1 399	14 150	236	760	7 860	131
0:20	1 462	20 970	350	795	11 650	194
0:25	1 510	28 050	468	821	15 590	260
0:30	1 550	35 360	589	843	19 650	328
0:35	1 584	42 860	714	862	23 810	397
0:40	1 613	50 510	842	878	28 060	468
0:45	1 638	58 300	971	892	32 390	540
0:50	1 661	66 200	1 103	905	36 780	613
0:55	1 681	74 220	1 237	916	41 230	687
1:00	1 700	82 330	1 372	927	45 740	762
1:05	1 718	90 540	1 509	937	50 300	838
1:10	1 735	98 830	1 647	946	54 910	915
1:15	1 750	107 200	1 787	955	59 560	993
1:20	1 765	115 650	1 928	963	64 250	1 071
1:25	1 779	124 180	2 070	971	68 990	1 150
1:30	1 792	132 760	2 213	978	73 760	1 229
1:35	1 804	141 420	2 357	985	78 560	1 309
1:40	1 815	150 120	2 502	991	83 400	1 390
1:45	1 826	158 890	2 648	996	88 280	1 471
1:50	1 835	167 700	2 795	1 001	93 170	1 553
1:55	1 843	176 550	2 942	1 006	98 080	1 635
2:00	1 850	185 440	3 091	1 010	103 020	1 717
2:10	1 862	203 330	3 389	1 017	112 960	1 882
2:20	1 875	221 330	3 689	1 024	122 960	2 049
2:30	1 888	239 470	3 991	1 031	133 040	2 217
2:40	1 900	257 720	4 295	1 038	143 180	2 386
2:50	1 912	276 110	4 602	1 045	153 390	2 556
3:00	1 925	294 610	4 910	1 052	163 670	2 728
3:10	1 938	313 250	5 221	1 059	174 030	2 900
3:20	1 950	332 000	5 533	1 066	184 450	3 074
3:30	1 962	350 890	5 848	1 072	194 940	3 249
3:40	1 975	369 890	6 165	1 079	205 500	3 425
3:50	1 988	389 030	6 484	1 086	216 130	3 602
4:00	2 000	408 280	6 805	1 093	226 820	3 780
4:10	2 012	427 670	7 128	1 100	237 590	3 960
4:20	2 025	447 180	7 453	1 107	248 430	4 140
4:30	2 038	466 810	7 780	1 114	259 340	4 322
4:40	2 050	486 560	8 110	1 121	270 310	4 505
4:50	2 062	506 450	8 441	1 128	281 360	4 689
5:00	2 075	526 450	8 774	1 135	292 470	4 874
5:10	2 088	546 580	9 110	1 142	303 660	5 061
5:20	2 100	566 840	9 447	1 149	314 910	5 248
5:30	2 112	587 220	9 787	1 156	326 240	5 437
5:40	2 125	607 730	10 129	1 163	337 630	5 627
5:50	2 138	628 360	10 473	1 170	349 090	5 818
6:00	2 150	649 120	10 819	1 177	360 620	6 010
6:10	2 162	670 000	11 167	1 184	372 230	6 204

TABLE A1.1 *Continued*

Time, h:min	Temperature, °F	Area Above 68°F Base °F·min	Area Above 68°F Base °F·h	Temperature, °C	Area Above 20°C Base °C·min	Area Above 20°C Base °C·h
6:20	2 175	691 010	11 517	1 191	383 900	6 398
6:30	2 188	712 140	11 869	1 198	395 640	6 594
6:40	2 200	733 400	12 223	1 204	407 450	6 791
6:50	2 212	754 780	12 580	1 211	419 330	6 989
7:00	2 225	776 290	12 938	1 218	431 270	7 188
7:10	2 238	797 920	13 299	1 225	443 290	7 388
7:20	2 250	819 680	13 661	1 232	455 380	7 590
7:30	2 262	841 560	14 026	1 239	467 540	7 792
7:40	2 275	863 570	14 393	1 246	479 760	7 996
7:50	2 288	885 700	14 762	1 253	492 060	8 201
8:00	2 300	907 960	15 133	1 260	504 420	8 407

APPENDIX

(Nonmandatory Information)

X1. COMMENTARY

X1.1 Introduction

X1.1.1 This commentary has been prepared to provide the user of Methods E 152 with background information on the development of the standard and its application in fire protection of buildings. It also provides guidance in the planning and performance of fire tests and in the reporting of results. No attempt has been made to incorporate all of the available information on fire testing in this commentary. The serious student of fire testing is strongly urged to peruse the referenced documents for a better appreciation of the history of fire-resistant design and the intricate problems associated with testing and with interpretation of test results.

X1.2 Application

X1.2.1 Compartmentation of buildings by fire-resistive walls has been recognized for many years as an efficient method of restricting fires to the area of origin (**1, 2, 3, 4, 5, 6, 7, 8, 9**)[2] or limiting their spread. The functional use of buildings however, demands a reasonable amount of communication between compartments necessitating openings in these fire-resistive walls. Fire door assemblies are utilized to protect these openings and maintain the integrity of the fire barrier (**10**). Openings in walls have been classified by fire protection standards (**6, 11, 12**) and building codes in accordance with the location and purpose of the wall in which the opening occurs, and these standards and codes specify the fire rating of the assembly required to protect the openings.

X1.2.2 These fire protection standards and building codes permit labeled wire glass panels and other penetrations, such as labeled ventilation louvres, in some rated doors. The reader is referred to the model building codes, NFPA Standard No. 80, and the specific fire door manufacturer's label service for information on the types and sizes of these openings.

X1.2.3 Fire doors must also be properly installed to maintain their fire rating. Again, NFPA Standard No. 80 and the specific fire door manufacturer's label service should be consulted for details on the installation of fire door assemblies and for limitations on the application of specific labeled fire doors.

X1.3 Historical Aspects

X1.3.1 The first effort to test fire doors is reported in a series of tests conducted in Germany in 1893 (**13, 14, 15**). The British Fire Prevention Committee began testing in 1899 and produced a Standard Table of Fire Resisting Elements including Fire Resisting Doors (**1**). Underwriters Laboratories Inc. was involved in testing and listing fire doors shortly after 1900 using their own standards. ASTM adopted Methods E 152 on fire door assembly tests in 1941.

X1.4 Scope and Significance

X1.4.1 Methods E 152 are intended to provide methods for measuring the relative performance of fire door assemblies when exposed to predetermined standard fire conditions. The standard provides for testing of several classifications, types, and methods of door operation including swinging, sliding, rolling, and sectional doors (**6**). Since the effectiveness of the opening protection is dependent upon the entire assembly, proper attention must be paid to the installation as a unit. Accordingly, fire door assemblies are required to be tested as an assembly of all necessary elements and equipment, including the door frame and hardware.

X1.4.2 Fire protection ratings are assigned to indicate that the assembly has continued to perform as required for periods of 3, 1½, 1, ¾, ½ or ⅓ h. Labels on assemblies also carry the lettered designations of A, B, C, D, or E. These letter designations are not a part of the E 152 standard classification system but are used to designate the class of opening for which the door is designed as determined by other standards (**6, 11**).

X1.4.3 The ⅓-h, or 20 min fire-rated door is relatively new. Concern about the uniform adequacy of the 1¾ in. (44.5-mm) solid bonded wood core construction and the difficulty of determining equivalency of other types of doors, led to a voluntary consensus to test such doors for 20 min in the E 152 furnace using the same acceptance criteria as specified for door assemblies traditionally tested for a longer period of time except that the hose stream test is required by the test method but may not be required by regulatory codes.

X1.4.4 It is usual for fire door to have a fire protection rating lower than the wall in which it is installed, for example, a 1½-h fire door in a wall having a fire-resistance rating of 2 h. This is justified by the fact that under normal conditions of use the potential fire exposure in the vicinity of a door opening is lessened since there will be a clear space on both sides of the opening for traffic purposes. If the opening is not used, combustibles may be piled against the door, and the assumed enclosure protection will not be maintained. In these instances, the openings should be made equal to the rating of the wall or precautions taken to prevent storage of combustibles against the doors (**2, 6**).

X1.5 Limitations

X1.5.1 Methods intend that the door be tested until the conditions of acceptance are met for the desired exposure period unless the conditions of acceptance are exceeded in a shorter period. It is not intended that a fire door subjected to a building fire will be satisfactory for reuse after the fire.

X1.5.2 The variations in material performance preclude any prediction of an assembly's performance in walls other than those types used in the test. The standard also makes no provisions for measuring the generation of smoke and gases or other products of combustion from the unexposed side of the door. Temperature measurements on the unexposed side, when recorded, are stopped after 30 min.

X1.6 Furnace

X1.6.1 The methods provide details on the operating characteristics and temperature-measurement requirements of the test furnace. The walls of the furnace should be typically of furnace refractory materials and should be sufficiently rugged to maintain the overall integrity of the furnace during the fire-exposure period.

X1.6.2 The thermocouples in the furnace are located 6 in. (152 mm) from the face of the door or the wall in which the door is installed. Otherwise no furnace depth is specified. A depth of 8 to 18 in. (203 to 457 mm) has been considered desirable by most laboratories. The reader is urged to consult reference documents for a more comprehensive review of furnace design and performance (**16, 17**).

X1.7 Temperature – Time Curve

X1.7.1 A specific temperature – time relationship for the test fire is defined in the standard and in the Annex. The actual recorded temperature – time condition obtained in the furnace is required to be within specified percentages of those of the standard curve. The number and type of temperature-measuring devices are outlined in the standard. Specific standard practices for location and use of these temperature-measuring devices are also outlined in the standard.

X1.7.2 The standard temperature – time ($T - t$) curve used in E 152 is considered to represent a severe building fire (**3**). The curve was adopted in 1918 as a result of several conferences by eleven technical organizations, including testing laboratories, insurance underwriters, fire protection associations, and technical societies. It should be recognized that the $T - t$ relationship of these test methods represent only one real fire situation (**7, 8, 9, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27**).

X1.8 Furnace Control

X1.8.1 The standard contains specific instruction for measuring temperatures in the furnace and for selection of the required thermocouples. Thermocouples of the design specified are sufficiently rugged to retain accuracy throughout anticipated test periods. However, their massive construction results in a significant time delay in response to temperature change and results in temperatures exceeding the indicated temperatures during the early stages of the test period when the temperature rises rapidly. The iron or porcelain tubes surrounding the junction and leads of the thermocouple provide a shield against degradation of the junction and increase the thermal inertia. It is customary for laboratories to replace furnace thermocouples after three or four accumulated hours of use.

X1.9 Unexposed Surface Temperature

X1.9.1 Conditions of acceptance for fire-resistive walls specify that the temperature increase on the unexposed side of the wall not exceed an average of 250°F (139°C) above ambient, and that there be no passage of flames or gases hot enough to ignite combustibles. It is obvious that the necessity of maintaining some clearances for efficient operation of the door and the possibility of warping preclude completely any attempt to restrict escape of gases and minor flames on the periphery of doors.

X1.9.2 The standard describes a standard procedure for measuring the unexposed surface temperatures. However, unexposed surface temperatures are not a condition of acceptance for E 152. Building regulations do restrict temperature transmission for some wall-opening protectives (**6, 11**). For instance, it is usual for codes to limit the temperature rise on the unexposed side of fire doors protecting exit stairways to 450°F (250°C) during the first 30 min of test. This criterion assumes that a higher temperature would provide enough radiant heat to discourage if not prevent occupants from passing by the door during an emergency. It is present practice for testing laboratories to provide labels on fire doors indicating that the maximum transmitted temperature on the unexposed side is 250°F, 450°F, or 650°F (139°C, 250°C, or 361°C) above ambient. If not indicated on the label, the temperature rise during the first 30 min may or may not

[2] The boldface numbers in parentheses refer to the list of references at the end of this appendix.

unexposed side of glass panels and louvres is not measured.

X1.9.3 Information on the properties of pads used to cover the thermocouples on the unexposed surfaces may be found in Appendix A2 of ASTM Standard E 119.

X1.10 Test Assemblies

X1.10.1 Standard E 152 provides a relative measure of performance for door assemblies. In order to establish confidence that the tested doors will perform in a building as expected, the tested assembly and its installation in the test frame must be representative of actual use conditions. Therefore, the National Fire Protection Assn. Standard No. 80 (6) or such other standards or specifications should be consulted before testing an assembly.

X1.10.2 Methods E 152 provide additional minimum requirements including direction of door swing, location in relation to the exposed side of the wall, and specific clearance between the door and its frame or wall, or both. Regardless of other specifications, these instructions must be followed in order to make a comparative judgment on test results.

X1.11 Conduct of Tests

X1.11.1 The test frame or wall in which a door assembly is installed should be rugged enough to endure the exposed fire during the time period, without affecting the door assembly. Traditionally, this wall has been of masonry construction. Today, fire doors are installed in other than masonry walls and have been tested in walls framed with metal and wood studs covered with a number of materials.

X1.12 Furnace Pressures

X1.12.1 A fire in a building compartment will assemblies depending upon atmospheric conditions, height above ground, wind conditions, and ventilation of the compartment at the beginning and during the fire.

X1.12.2 Methods E 152 specify that the pressure in the furnace be maintained as nearly equal to atmospheric pressure as possible. Experience has shown this practice to be acceptable. The pressure in the furnace is required to be reported but the method of measuring it is optional with the laboratory.

X1.13 Hose Stream Test

X1.13.1 Immediately following a fire test, the test frame is removed from the furnace and the door assembly is subjected to the impact, erosion, and cooling effects of a stream of water from a 2½-in (63.5-mm) hose discharging through a standard playpipe equipped with a 1⅛-in. (28.5-mm) tip under specified pressures (see 10.2). The application of water produces stresses in the assembly and provides a measure of its structural capability. Weights were once used to provide a measure of the ability of the assembly to withstand impact. The hose stream is considered to be an improvement in uniformity and accuracy over the weights.

X1.14 Conditions of Acceptance

X1.14.1 The standard provides a specific set of conditions by which the performance of the door is measured, the most important being that it remain in place during both the fire test and the hose stream test. Instructions for conducting the hose stream test are detailed in the standard.

X1.15 Additional Information

X1.15.1 Inquiries concerning Methods E 152 should be addressed to ASTM Subcommittee E05.12.

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Standard Test Methods for Fire Tests of Building Construction and Materials[1]

This standard is issued under the fixed designation E 119; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which was adopted by the Department of Defense.

INTRODUCTION

The performance of walls, columns, floors, and other building members under fire exposure conditions is an item of major importance in securing constructions that are safe, and that are not a menace to neighboring structures nor to the public. Recognition of this is registered in the codes of many authorities, municipal and other. It is important to secure balance of the many units in a single building, and of buildings of like character and use in a community; and also to promote uniformity in requirements of various authorities throughout the country. To do this it is necessary that the fire-resistive properties of materials and assemblies be measured and specified according to a common standard expressed in terms that are applicable alike to a wide variety of materials, situations, and conditions of exposure.

Such a standard is found in the methods that follow. They prescribe a standard exposing fire of controlled extent and severity. Performance is defined as the period of resistance to standard exposure elapsing before the first critical point in behavior is observed. Results are reported in units in which field exposures can be judged and expressed.

The methods may be cited as the "Standard Fire Tests," and the performance or exposure shall be expressed as "2-h," "6-h," "½-h," etc.

When a factor of safety exceeding that inherent in the test conditions is desired, a proportional increase should be made in the specified time-classification period.

1. Scope

1.1 These test methods are applicable to assemblies of masonry units and to composite assemblies of structural materials for buildings, including bearing and other walls and partitions, columns, girders, beams, slabs, and composite slab and beam assemblies for floors and roofs. They are also applicable to other assemblies and structural units that constitute permanent integral parts of a finished building.

1.2 It is the intent that classifications shall register performance during the period of exposure and shall not be construed as having determined suitability for use after fire exposure.

1.3 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditons. However, 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.*

NOTE 1—A method of fire hazard classification based on rate of flame spread is covered in Test Method E 84.

1.4 The results of these tests are one factor in assessing fire performance of building construction and assemblies. These test methods prescribe a standard fire exposure for comparing the performance of building construction assemblies. Application of these test results to predict the performance of actual building construction requires careful evaluation of test conditions.

1.5 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 569 Test Method for Indentation Hardness of Preformed Thermal Insulations[2]

E 84 Test Method for Surface Burning Characteristics of Building Materials[3]

3. Significance and Use

3.1 This test method is intended to evaluate the duration for which the types of assemblies noted in 1.1 will contain a fire, or retain their structural integrity or exhibit both properties dependent upon the type of assembly involved during a predetermined test exposure.

3.2 The test exposes a specimen to a *standard fire exposure* controlled to achieve specified temperatures throughout a specified time period. In some instances, the *fire exposure may be* followed by the application of a *specified standard* fire hose stream. The exposure, however, may not be representative of all fire conditions which may vary with changes in the amount, nature and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment. It does, however, provide a relative measure of fire performance of comparable assemblies under these specified fire exposure conditions. Any variation from the construction or conditions (that is, size, method of assembly, and materials) that are tested may substantially change the performance characteristics of the assembly.

3.3 The test standard provides for the following:

3.3.1 In walls, partitions, and floor or roof assemblies:

3.3.1.1 Measurement of the transmission of heat.

3.3.1.2 Measurement of the transmission of hot gases through the assembly, sufficient to ignite cotton waste.

3.3.1.3 For load bearing elements, measurement of the load carrying ability of the *test specimen* during the test exposure.

3.3.2 For individual load bearing assemblies such as beams and columns: Measurement of the load carrying ability under the test exposure with some consideration for the end support conditions (that is, restrained or not restrained).

3.4 The test standard does not provide the following:

3.4.1 Full information as to performance of assemblies constructed with components or lengths other than those tested.

3.4.2 Evaluation of the degree by which the assembly contributes to the fire hazard by generation of smoke, toxic gases, or other products of combustion.

3.4.3 Measurement of the degree of control or limitation of *the passage of* smoke or products of combustion through the assembly.

3.4.4 Simulation of the fire behavior of joints between building elements such as floor-wall or wall-wall, etc., connections.

3.4.5 Measurement of flame spread over surface of tested element.

3.4.6 The effect of fire endurance of conventional openings in the assembly, that is, electrical receptacle outlets, plumbing pipe, etc., unless specifically provided for in the construction tested.

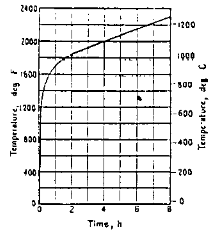

FIG. 1 Time-Temperature Curve

CONTROL OF FIRE TESTS

4. Time-Temperature Curve

4.1 The conduct of fire tests of materials and construction shall be controlled by the standard time-temperature curve shown in Fig. 1. The points on the curve that determine its character are:

1000°F (538°C)	at 5 min
1300°F (704°C)	at 10 min
1550°F (843°C)	at 30 min
1700°F (927°C)	at 1 h
1850°F (1010°C)	at 2 h
2000°F (1093°C)	at 4 h
2300°F (1260°C)	at 8 h or over

4.2 For a closer definition of the time-temperature curve, see Appendix X1.

NOTE 2—*Recommendations for Recording Fuel Flow to Furnace Burners*—The following provides guidance on the desired characteristics of instrumentation for recording the flow of fuel to the furnace burners. Fuel flow data may be useful for a furnace heat balance analysis, for measuring the effect of furnace or control changes, and for comparing the performance of assemblies of different properties in the fire endurance test.[4]

Record the integrated (cumulative) flow of gas (or other fuel) to the furnace burners at 10 min, 20 min, 30 min, and every 30 min thereafter or more frequently. Total gas consumed during the total test period is also to be determined. A recording flow meter has advantages over periodic readings on an instantaneous or totalizing flow meter. Select a measuring and recording system to provide flow rate readings accurate to within ± 5 %.

Report the type of fuel, its higher (gross) heating value, and the fuel flow (corrected to standard conditions of 60°F (16°C) and 30.0 in. Hg) as a function of time.

5. Furnace Temperatures

5.1 The temperature fixed by the curve shall be deemed to be the average temperature obtained from the readings of not

[1] These test methods are under the jurisdiction of ASTM Committee E-5 on Fire Standards and are the direct responsibility of Subcommittee E05.11 on Building Construction.

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These test methods, of which the present standard represents a revision, were prepared by Sectional Committee A2 on Fire Tests of Materials and Construction, under the joint sponsorship of the National Bureau of Standards, the ANSI Fire Protection Group, and ASTM, functioning under the procedure of the American National Standards Institute.

[2] *Annual Book of ASTM Standards*, Vol 04.06.

[3] *Annual Book of ASTM Standards*, Vol 04.07.

[4] Harmathy, T. Z., "Design of Fire Test Furnaces," *Fire Technology*, Vol. 5, No. 2, May 1969, pp. 146–150; Seigel, L. G., "Effects of Furnace Design on Fire Endurance Test Results," *Fire Test Performance*, ASTM STP 464, ASTM, 1970, pp. 57–67; and Williamson, R. B., and Buchanan, A. H., "A Heat Balance Analysis of the Standard Fire Endurance Test."

less than nine thermocouples for a floor, roof, wall, or partition and not less than eight thermocouples for a structural column symmetrically disposed and distributed to show the temperature near all parts of the sample, the thermocouples being enclosed in protection tubes of such materials and dimensions that the time constant of the protected thermocouple assembly lies within the range from 5.0 to 7.2 min (Note 3). The exposed length of the pyrometer tube and thermocouple in the furnace chamber shall be not less than 12 in. (305 mm). Other types of protecting tubes or pyrometers may be used that, under test conditions, *give the* same indications as the above standard within the limit of accuracy that applies for furnace-temperature measurements. For floors and columns, the junction of the thermocouples shall be placed 12 in. (305 mm) away from the exposed face of the sample at the beginning of the test and, during the test, shall not touch the sample as a result of its deflection. *In the case of walls and partitions, the thermocouples* shall be placed 6 in. (152 mm) away from the exposed face of the sample at the beginning of the test, and shall not touch the sample during the test, in the event of deflection.

NOTE 3—A typical thermocouple assembly meeting these time constant requirements may be fabricated by fusion-welding the twisted ends of No. 18 gage Chromel-Alumel wires, mounting the leads in porcelain insulators and inserting the assembly so the thermocouple bead is ½ in. (25 mm) from the sealed end of a standard weight nominal ½-in. iron, steel, or Inconel[3] pipe. The time constant for this and for several other thermocouple assemblies was measured in 1976. The time constant may also be calculated from knowledge of its physical and thermal properties.[4]

5.2 The temperatures shall be read at intervals not exceeding 5 min during the first 2 h, and thereafter the intervals may be increased to not more than 10 min.

5.3 The accuracy of the furnace control shall be such that the area under the time-temperature curve, obtained by averaging the results from the pyrometer readings, is within 10 % of the corresponding area under the standard time-temperature curve shown in Fig. 1 for fire tests of 1 h or less duration, within 7.5 % for those over 1 h and not more than 2 h, and within 5 % for tests exceeding 2 h in duration.

6. Temperatures of Unexposed Surfaces of Floors, Roofs, Walls, and Partitions

6.1 Temperatures of unexposed surfaces shall be measured with thermocouples or thermometers (Note 5) placed under dry, *felted pads meeting the requirements* listed in Annex A1. The wire leads of the thermocouple or the stem of the thermometer shall have an immersion under the pad and be in contact with the unexposed surface for not less than 3½ in. (89 mm). The hot junction of the thermocouple or the bulb of the thermometer shall be placed approximately under the center of the pad. The outside diameter of *protecting or insulating* tubes, and of thermometer stems, shall be not more than 5⁄16 in. (8 mm). The pad shall be held firmly against the surface, and shall fit closely about the thermocouples or thermometer stems. Thermometers shall be of the partial-immersion type, with a length of stem, between the end of the bulb and the immersion mark, of 3 in. (76 mm). The wires for the thermocouple in the length covered by *the pad shall be not heavier than* No. 18 B & S gage (0.04 in.) (1.02 mm) and shall be electrically insulated with heat-resistant and moisture-resistant coatings.

NOTE 4—*For the purpose of testing roof assemblies, the unexposed* surface shall be defined as the surface exposed to ambient air.

NOTE 5—Under certain conditions it may be unsafe or impracticable to use thermometers.

6.2 Temperature readings shall be taken *at not less than* nine points on the surface. Five of these shall be symmetrically disposed, one to be approximately at the center of the specimen, and four at approximately the center of its quarter sections. The other four shall be located at the discretion of the testing authority to obtain representative information on the performance of the construction under test. None of the *thermocouples shall be located nearer to the* edges of the test specimen than one and one-half times the thickness of the construction, or 12 in. (305 mm). An exception can be made in those cases where there is an element of the construction that is not otherwise represented in the remainder of the test specimen. None of the thermocouples shall be located opposite or on top of beams, girders, pilasters, or other *structural members* if temperatures at such points will obviously be lower than at more representative locations. None of the thermocouples shall be located over fasteners such as screws, nails, or staples that will be obviously higher or lower in temperature than *at a more representative* location if the aggregate area of any part of such fasteners on the unexposed surface is less than 1 % of the area within any 6-in. (152-mm) diameter circle, unless the fasteners extend through the assembly.

6.3 Temperature readings shall be taken at intervals not exceeding 15 min until a reading exceeding 212°F (100°C) has been obtained *at any one point. Thereafter the readings* may be taken more frequently at the discretion of the testing body, but the intervals need not be less than 5 min.

6.4 Where the conditions of acceptance place a limitation on the rise of temperature of the unexposed surface, the temperature end point of the fire endurance period shall be determined by the average of the measurements taken at individual points; *except that if a temperature rise* 30 % in excess of the specified limit occurs at any one of these points, the remainder shall be ignored and the fire endurance period judged as ended.

CLASSIFICATION AS DETERMINED BY TEST

7. Report of Results

7.1 Results shall be reported in accordance with the performance in the tests prescribed in these test methods. They shall be expressed in time periods of resistance, to the nearest integral minute. Reports shall include observations of significant details of the behavior of the material or construction during the test and after the furnace fire is cut off, *including information* on deformation, spalling, cracking, burning of the specimen or its component parts, continuance of flaming, and production of smoke.

7.2 Reports of tests involving wall, floor, beam, or ceiling constructions in which restraint is provided *against* expansion, *contraction, or rotation of the construction* shall describe the method used to provide this restraint.

7.3 Reports of tests in which other than maximum load conditions are imposed shall fully define the conditions of loading used in the test and shall be designated in the title of the report of the test as a restricted load condition.

7.4 When the indicated resistance period is ½ h or over, *determined by the average or maximum* temperature rise on the unexposed surface or within the test sample, or by failure under load, a correction shall be applied for variation of the furnace exposure from that prescribed, where it will affect the classification, by multiplying the indicated period by two thirds of the difference in area between the curve of average furnace temperature and the standard curve for the first three fourths of the period and dividing the product by the area between the standard curve and a base line of 68°F (20°C) for the same part of the indicated period, the latter area increased by 54°F·h or 30°C·h (3240°F·min or 1800°C·min) *to compensate for the thermal lag of the furnace thermocouples* during the first part of the test. For fire exposure in the test higher than standard, the indicated resistance period shall be increased by the amount of the correction and be similarly decreased for fire exposure below standard.

NOTE 6—The correction can be expressed by the following equation:

$$C = 2I(A - A_s)/3(A_s + L)$$

where:

C = correction in the same units as I,
I = indicated fire-resistance period,
A = area under the curve of *indicated average furnace* temperature for the first three fourths of the indicated period,
A_s = area under the standard furnace curve for the same part of the indicated period, and
L = lag correction in the same units as A and A_s (54°F·h or 30°C·h (3240°F·min or 1800°C·min)).

7.5 *Unsymmetrical wall assemblies* may be tested with either side exposed to the fire, and the report shall indicate the side so exposed. Both sides may be tested, and the report then shall so indicate the fire endurance classification applicable to each side.

TEST SPECIMEN

8. Test Specimen

8.1 The test specimen shall be truly representative of the construction for which classification is desired, as to materials, workmanship, and details such as *dimensions of parts*, and shall be built under conditions representative of those obtaining as practically applied in building construction and operation. The physical properties of the materials and ingredients used in the test specimen shall be determined and recorded.

8.2 The size and dimensions of the test specimen specified *herein are intended to apply for rating* constructions of dimensions within the usual general range employed in buildings. If the conditions of use limit the construction to smaller dimensions, a proportionate reduction may be made in the dimensions of the specimens for a test qualifying them for such restricted use.

8.3 When it is desired to include a built-up roof covering, the test specimen shall have a roof covering of 3-ply, 15-lb (6.8-kg) type felt not in excess of 120 lb (54 kg) per square (100 ft² (9 m²)) of hot mopping asphalt without gravel surfacing. Tests of assemblies with this covering do not preclude the field use of other coverings with a larger number of plys of felt and asphalt or with gravel surfacing.

8.4 Roofing systems designed for other than the use of built-up roof coverings shall be tested using materials and details of construction representative of field application.

CONDUCT OF FIRE TESTS

9. Fire Endurance Test

9.1 Continue the fire endurance test on the specimen with its applied load, if any, until failure occurs, or until the *specimen has withstood the test conditions for* a period equal to that herein specified in the conditions of acceptance for the given type of construction.

9.2 For the purpose of obtaining additional performance data, the test may be continued *beyond the time the fire* endurance classification is determined.

10. Hose Stream Test

10.1 Where required by the conditions of acceptance, subject a duplicate specimen to a fire exposure test for a period equal to one half of that indicated as the resistance period in the fire endurance test, but not for more than 1 h, immediately after which subject the specimen to the impact, erosion, and cooling effects of a hose stream directed first at the middle and then at all parts of the exposed face, changes in direction being made slowly.

10.2 *Exemption*—The hose stream test shall not be required in the case of constructions having a resistance period, indicated in the fire endurance test, *of less than 1 h*.

10.3 *Optional Program*—The submitter may elect, with the advice and consent of the testing body, to have the hose stream test made on the specimen subjected to the fire endurance test and immediately following the expiration of the fire endurance test.

10.4 *Stream Equipment and Details*—The stream shall be delivered *through a 2½-in. (64-mm) hose discharging* through a National Standard Playpipe of corresponding size equipped with a 1⅛-in. (28.5-mm) discharge tip of the standard-taper smooth-bore pattern without shoulder at the orifice. The water pressure and duration of application shall be as prescribed in Table 1.

10.5 *Nozzle Distance*—The nozzle orifice shall be 20 ft (6 m) from the center of *the exposed surface of the test* specimen if the nozzle is so located that when directed at the center its axis is normal to the surface of the test specimen. If otherwise located, its distance from the center shall be less

TABLE 1 Conditions For Hose Stream Test

Resistance Period	Water Pressure at Base of Nozzle, psi (kPa)	Duration of Application, min/100 ft² (9 m²) exposed area
8 h and over	45 (310)	6
4 h and over if less than 8 h	45 (310)	5
2 h and over if less than 4 h	30 (207)	2½
1½ h and over if less than 2 h	30 (207)	1½
1 h and over if less than 1½ h	30 (207)	1
Less than 1 h, if desired	30 (207)	1

[3] Inconel is a registered tradename of INCO Alloys, Inc., 3800 Riverside Dr., P. O. Box 1958, Huntington, WV 25720.

[4] Supporting data are available from ASTM Headquarters. Request RR: E05-1001.

than 20 ft by an amount equal to 1 ft (305 mm) for each 10 deg of deviation from the normal

11. Protection and Conditioning of Test Specimen

11.1 Protect the test specimen during and after fabrication to assure normality of its quality and condition at the time of test. It shall not be tested until a large portion of its final strength has been attained, and, if it contains moisture, until the excess has been removed to achieve an air-dry condition in accordance with the requirements given in 11.1.1 through 11.1.3. Protect the testing equipment and sample undergoing the fire test from any condition of wind or weather, that might lead to abnormal results. The ambient air temperature at the beginning of the test shall be within the range of 50 to 90°F (10 to 32°C). The velocity of air across the unexposed surface of the sample, measured just before the test begins, shall not exceed 4.4 ft (1.3 m)/s, as determined by an anemometer placed at right angles to the unexposed surface. If mechanical ventilation is employed during the test, an air stream shall not be directed across the surface of the specimen.

11.1.1 Prior to fire test, condition constructions with the objective of providing, within a reasonable time, a moisture condition within the specimen approximately representative of that likely to exist in similar construction in buildings. For purposes of standardization, this condition is to be considered as that which would be established at equilibrium resulting from drying in an ambient atmosphere of 50 % relative humidity at 73°F (Note 7). However, with some constructions, it may be difficult or impossible to achieve such uniformity within a reasonable period of time. Accordingly, where this is the case, specimens may be tested when the dampest portion of the structure, the portion at 6-in. (152-mm) depth below the surface of massive constructions, has achieved a moisture content corresponding to drying to equilibrium with air in the range of 50 to 75 % relative humidity at 73 ± 5°F (23 ± 3°C). In the event that specimens dried in a heated building fail to meet these requirements after a 12-month conditioning period, or in the event that the nature of the construction is such that it is evident that drying of the specimen interior will be prevented by hermetic sealing, these requirements may be waived, except as to attainment of a large portion of final strength, and the specimen tested in the condition in which it then exists.

11.1.2 If, during the conditioning of the specimen it appears desirable or is necessary to use accelerated drying techniques, it is the responsibility of the laboratory conducting the test to avoid procedures which will significantly alter the structural or fire endurance characteristics of the specimen or both from those produced as the result of drying in accordance with procedures given in 11.1.1.

11.1.3 Within 72 h prior to the fire test information on the actual moisture content and distribution within the specimen shall be obtained. Include this information in the test report (Note 8).

NOTE 7—A recommended method for determining the relative humidity within a hardened concrete specimen with electric sensing elements is described in Appendix I of the paper by Menzel, C. A., "A Method for Determining the Moisture Condition of Hardened Concrete in Terms of Relative Humidity," *Proceedings*, ASTM, Vol 55, 1955, p. 1085. A similar procedure with electric sensing elements can be used to determine the relative humidity within fire test specimens made with other materials.

With wood constructions, the moisture meter based on the electrical resistance method can be used, when appropriate, as an alternative to the relative humidity method to indicate when wood has attained the proper moisture content. Electrical methods are described on pages 320 and 321 of the 1955 edition of the *Wood Handbook of the Forest Products Laboratory*, U.S. Department of Agriculture. The relationships between relative humidity and moisture content are given by the graphs in Fig. 23 on p. 327. They indicate that wood has a moisture content of 13 % at a relative humidity of 70 % for a temperature of 70 to 80°F (21 to 27°C).

NOTE 8—If the moisture condition of the fire test assembly is likely to change drastically from the 72-h sampling time prior to test, the sampling should be made not later than 24 h prior to the test.

12. Precision[7]

12.1 No comprehensive test program has been conducted to develop data on which to derive statistical measures of repeatability (within-laboratory variability) and reproducibility (among-laboratory variability). The limited data suggest that there is a degree of repeatability and reproducibility for some types of assemblies. Results depend on factors such as the type of assembly and materials being tested, the characteristics of the furnace, the type and level of applied load, the nature of the boundary conditions (restraint and end fixity), and details of workmanship during assembly.

TESTS OF BEARING WALLS AND PARTITIONS

13. Size of Sample

13.1 The area exposed to fire shall be not less than 100 ft² (9 m²), with neither dimension less than 9 ft (2.7 m). The test specimen shall not be restrained on its vertical edges.

14. Loading

14.1 Throughout the fire endurance and fire and hose stream tests apply a constant superimposed load to simulate a maximum load condition. The applied load shall be as nearly as practicable the maximum load allowed by design under nationally recognized structural design criteria. The tests may also be conducted by applying to the specimen a load less than the maximum. Such tests shall be identified in the test report as having been conducted under restricted load conditions. The applied load, and the applied load expressed as a percentage of the maximum allowable design load, shall be included in the report. A double wall assembly shall be loaded during the test to simulate field use conditions, with either side loaded separately or both sides together (Note 9). The method used shall be reported.

NOTE 9—The choice depends on the intended use, and whether the load on the exposed side, after it has failed, will be transferred to the unexposed side. If, in the intended use, the load from the structure above is supported by both walls as a unit and would be or is transferred to the unexposed side in case of collapse of the exposed side, both walls should be loaded in the test by a single unit. If, in the intended use the load from the structure above each wall is supported by each wall separately, the walls should be loaded separately in the test by separate load sources. If the intended use of the construction system being tested involved situations of both loading conditions described above, the walls should be loaded separately in the test by separate load sources. In tests conducted with the walls loaded separately the condition of acceptance requiring the walls to maintain the applied load shall be based on the time at which the first of either of the walls fail to sustain the load.

[7] Supporting data are available from ASTM Headquarters. Request RR: E05-1003.

15. Conditions of Acceptance

15.1 Regard the test as successful if the following conditions are met:

15.1.1 The wall or partition shall have sustained the applied load during the fire endurance test without passage of flame or gases hot enough to ignite cotton waste, for a period equal to that for which classification is desired.

15.1.2 The wall or partition shall have sustained the applied load during the fire and hose stream test as specified in Section 10, without passage of flame, of gases hot enough to ignite cotton waste, or of the hose stream. The assembly shall be considered to have failed the hose stream test if an opening develops that permits a projection of water from the stream beyond the unexposed surface during the time of the hose stream test.

15.1.3 Transmission of heat through the wall or partition during the fire endurance test shall not have been such as to raise the temperature on its unexposed surface more than 250°F (139°C) above its initial temperature.

TESTS OF NONBEARING WALLS AND PARTITIONS

16. Size of Sample

16.1 The area exposed to fire shall be not less than 100 ft² (9 m²), with neither dimension less than 9 ft (2.7 m). Restrain the test specimen on all four edges.

17. Conditions of Acceptance

17.1 Regard the test as successful if the following conditions are met:

17.1.1 The wall or partition shall have withstood the fire endurance test without passage of flame or gases hot enough to ignite cotton waste, for a period equal to that for which classification is desired.

17.1.2 The wall or partition shall have withstood the fire and hose stream test as specified in Section 10, without passage of flame, of gases hot enough to ignite cotton waste, or of the hose stream. The assembly shall be considered to have failed the hose stream test if an opening develops that permits a projection of water from the stream beyond the unexposed surface during the time of the hose stream test.

17.1.3 Transmission of heat through the wall or partition during the fire endurance test shall not have been such as to raise the temperature on its unexposed surface more than 250°F (139°C) above its initial temperature.

TESTS OF COLUMNS

18. Size of Sample

18.1 The length of the column exposed to fire shall, when practicable, approximate the maximum clear length contemplated by the design, and for building columns shall be not less than 9 ft (2.7 m). Apply the contemplated details of connections, and their protection if any, according to the methods of acceptable field practice.

19. Loading

19.1 Throughout the fire endurance test expose the column to fire on all sides and load it in a manner calculated to develop theoretically, as nearly as practicable, the working stresses contemplated by the design. Make provision for transmitting the load to the exposed portion of the column without unduly increasing the effective column length.

19.2 If the submitter and the testing body jointly so decide, the column may be subjected to 1¾ times its designed working load before the fire endurance test is undertaken. The fact that such a test has been made shall not be construed as having had a deleterious effect on the fire endurance test performance.

20. Condition of Acceptance

20.1 Regard the test as successful if the column sustains the applied load during the fire endurance test for a period equal to that for which classification is desired.

ALTERNATIVE TEST OF PROTECTION FOR STRUCTURAL STEEL COLUMNS

21. Application

21.1 This test procedure does not require column loading at any time and may be used at the discretion of the testing laboratory to evaluate steel column protections that are not required by design to carry any of the column load.

22. Size and Character of Sample

22.1 The size of the steel column used shall be such as to provide a test specimen that is truly representative of the design, materials, and workmanship for which classification is desired. Apply the protection according to the methods of acceptable field practice. The length of the protected column shall be at least 8 ft (2.4 m). The column shall be vertical during application of the protection and during the fire exposure.

22.2 Restrain the applied protection against longitudinal temperature expansion greater than that of the steel column by rigid steel plates or reinforced concrete attached to the ends of the steel column before the protection is applied. The size of the plates or amount of concrete shall be adequate to provide direct bearing for the entire transverse area of the protection.

22.3 Provide the ends of the specimen, including the means for restraint with sufficient thermal insulation to prevent appreciable direct heat transfer from the furnace.

23. Temperature Measurement

23.1 Measure the temperature of the steel in the column by at least three thermocouples located at each of four levels. The upper and lower levels shall be 2 ft (0.6 m) from the ends of the steel column, and the two intermediate levels shall be equally spaced. So place the thermocouples at each level as to measure significant temperatures of the component elements of the steel section.

24. Exposure to Fire

24.1 Throughout the fire endurance test expose the specimen to fire on all sides for its full length.

25. Conditions of Acceptance

25.1 Regard the test as successful if the transmission of heat through the protection during the period of fire expo-

British Standard Fire Tests
on

Building Materials and Structures

Part 8. Test methods and criteria for the fire resistance of elements of building construction

1. General

1.1 Scope

This Part of this British Standard specifies heating conditions, methods of test and the criteria for the determination of the fire resistance of elements of building construction. The tests are appropriate to the following:

- Walls and partitions (loadbearing and non-loadbearing)
- Floors
- Flat roofs
- Columns
- Beams
- Suspended ceilings protecting steel beams
- Door and shutter assemblies
- Glazing

1.2 Details of specimen

1.2.1 Size. The specimen shall be full size whenever possible.

1.2.2 Construction. The test shall be made on a specimen which is representative of the element of construction. For example, a partition shall include at least one of each type of joint; the method of fixing and supporting the components, the finishes and workmanship used shall be as intended in service. The materials and standard of workmanship of the test specimen shall be representative of those applying in practice, such as defined by relevant British Standards and Codes of Practice.

The testing laboratory can request or carry out tests to establish those properties of the materials which may be necessary for the interpretation of the results of a fire resistance test.

1.2.3 Conditioning. The specimen shall be conditioned to approximate to the state of strength and moisture content which the element is expected to attain when in service in a building.

NOTE. The fire resistance test should not be made until the specimen has reached equilibrium with the laboratory atmosphere. This is determined by measurement of weight or of relative humidity at suitable points within the section of the specimen or of a representative sample. During the conditioning period it is desirable that the laboratory atmosphere should not exceed 70% r.h. Drying may be either under natural or controlled conditions, but drying at temperatures exceeding 60 °C should not be carried out if it will result in abnormal changes in the properties of the specimen.

1.3 Loading and restraint

1.3.1 Loading. Before the heating period, a loadbearing specimen shall be subjected to a loading which produces stresses of the same nature and of the same order of magnitude as would be produced at normal temperatures in the full-size element by the maximum permissible loads which the element is capable of carrying when designed in accordance with the requirements of the appropriate British Standards or Codes of Practice; loads other than these may be applied only by agreement between the sponsor of the test and the testing laboratory. The load shall be maintained constant during the test period.

1.3.2 Restraint. The methods adopted for supporting or restraining the ends or sides of a specimen during test shall be as far as possible similar in nature to those which would be applied to the element in service.

Where these conditions cannot be defined or applied the procedure is indicated in the appropriate clauses dealing with particular elements.

1.4 Test procedure

1.4.1 Furnace. The specimen shall be heated as specified in 1.4.2 in a furnace which can produce a positive pressure in accordance with the requirements of 1.4.4.

1.4.2 Standard heating conditions. The temperature of the furnace shall be controlled to vary with time as closely as possible in accordance with the following relationship.

$T - T_0 = 345 \log_{10}(8t + 1)$

where t = time of test in minutes,

T = furnace temperature in °C at time t, and

T_0 = initial furnace temperature in °C.

The temperature T_0 shall be between 10 °C and 40 °C.

The relationship is illustrated by the following points calculated by means of the above formula to give the standard time/temperature curve (see Fig. 1):

Time t min	Temperature rise in furnace $(T - T_0)$ °C
5	556
10	659
15	718
30	821
60	925
90	986
120	1029
180	1090
240	1133
360	1193

The accuracy of furnace control shall be such that:

(1) During the first ten minutes of test the area under the curve of mean furnace temperature does not vary by more than ± 15% of the area under the standard curve.

(2) During the first half-hour of test the area under the curve of mean furnace temperature does not vary by more than ± 10% of the area under the standard curve.

(3) For any period after the first half-hour of test the area under the curve of mean furnace temperature does not vary by more than ± 5% of the area under the standard curve.

(4) At any time after the first ten minutes the mean furnace temperature does not differ from the standard curve by more than ± 100 °C.

When testing glazing and uninsulated doors and shutters the maximum tolerance given in (2) is permitted for tests of any duration.

1.4.3 Measurement of furnace temperature. The temperature shall be measured by bare wire thermocouples, not less than 0.75 mm and not more than 1.50 mm in diameter, symmetrically arranged within the furnace and of the number specified in the relevant clauses dealing with particular elements. Temperatures shall be measured with an accuracy of at least ± 1.5%. The wires of the thermocouples shall be located in a heat resisting material such as porcelain tube with the hot junction projecting about 25 mm from the open end, suitably supported so that the hot junction is 100 mm from the nearest point of the specimen. This distance shall be kept constant, as nearly as possible, during the test.

The furnace temperature shall be deemed to be the average of the temperatures given by the thermocouples.

1.4.4 Determination of integrity. When testing for integrity the upper part of the furnace shall be maintained at a positive pressure of 15 ± 5 N/m² (1.5 ± 0.5 mm water gauge).

The method for determining whether a crack or an opening in the specimen is one through which flames and hot gases can pass is by holding a cotton wool pad close to any aperture in the specimen under test.

The pad shall not be in contact with the element and shall be not more than 30 mm from the aperture, located centrally over it in a plane parallel to the surface of the specimen. The pad shall be applied at frequent intervals and held in position for not less than 10 s to determine if hot gases can cause its ignition. The pad shall not be re-used.

The cotton wool used for the test shall consist of new undyed and soft fibres without any admixture of artificial fibres. A pad shall be cut measuring approximately 100 mm square by 20 mm thick and weighing between 3 g and 4 g. The pad shall be conditioned by drying in an oven at 100 °C for at least a half-hour. The pad shall be attached by means of wire clips to a 100 mm × 100 mm frame of approximately 1 mm diameter wire. A wire handle approximately 750 mm long attached to the frame facilitates its use.

Other methods shall be permitted only where the cotton wool test cannot be carried out as mentioned in 7.4 and 8.4.

1.4.5 Measurement of insulation. Temperatures on the unexposed face of the specimen apart from any glazing shall be measured by means of thermocouples, each with its junction attached to the centre of the face of a 12 mm diameter copper disc 0.2 mm thick which shall be secured to the surface of the specimen at the required position. The disc shall be covered with an oven dry asbestos pad 30 mm square by 2 mm thick and the thermocouple wires shall have a diameter not exceeding 0.5 mm. The disc and the pad shall be fixed to the surface in such a way as to ensure that the disc makes intimate contact, e.g. by pins, tape or an adhesive. Temperatures shall be measured to an accuracy of at least ± 1.5%.

1.4.6 Observations during test.

1.4.6.1 *Stability.* Note shall be made of the deformation of the specimen, occurrence of collapse, or any other factor which could affect its stability.

1.4.6.2 *Integrity.* In elements which have a separating function the presence of cracks or other openings which result in any flaming of the cotton wool pad described in 1.4.4 shall be noted.

1.4.6.3 *Insulation.* In elements which have a separating function the temperature conditions of the unexposed face of the specimen shall be recorded, preferably continuously, but at least at intervals not exceeding 5 min.

1.4.6.4 *Additional information.* Throughout the test observations shall be made of all changes and occurrences which, although not criteria of performance, could create hazards in a building; for example, the emission of appreciable volumes of smoke or noxious vapours from the unexposed face of a separating element. These should be included in the test report observations.

1.4.7 Duration of test. The test specimen shall be heated in the prescribed manner until failure has occurred under all the relevant test criteria, except that by agreement between the sponsor of the test and the testing laboratory the test may be terminated at any time whether or not failure has occurred under any of the relevant test criteria.

1.5 Criteria of failure

1.5.1. Stability.

1.5.1.1 *Non-loadbearing constructions.* Failure shall be deemed to occur when collapse of the specimen takes place.

1.5.1.2 *Loadbearing constructions.* A loadbearing specimen shall support the test load during the prescribed heating period and also 24 h after the end of the heating period. However, should collapse occur during heating or during the reload test the notional maximum period for stability for such a specimen shall be construed as 80% of the time to collapse or the duration of heating if failure occurs in the reload test. In addition, failure for floors, flat roofs and beams shall be deemed to occur when a specimen deflects in excess of the limits specified in 3.5 and 5.5.

1.5.2 Integrity. Failure shall be deemed to occur when cracks or other openings exist through which flame or hot gases can pass which would cause flaming of the cotton wool pad as noted in 1.4.6.2.

1.5.3 Insulation. Failure shall be deemed to occur when the mean temperature of the unexposed surface of the specimen increases by more than 140 °C above the initial temperature, or the temperature of the unexposed surface increases at any point by more than 180 °C above the initial temperature.

1.6 Test results

The test results shall be stated in terms of the time in minutes from the start of the test until failure has occurred under one or all of the criteria in 1.5, or if no failure has occurred, until the test is terminated. For example, a test result as follows:

Stability	120
Integrity	120
Insulation	15

would mean that a specimen failed in respect of insulation after 15 min but complied with the other requirements for at least 120 min.

1.7 Determination of fire resistance

1.7.1 General application. The fire resistance of an element of construction shall be the time in minutes from the start of the test on the specimen until failure first occurs under any one of the criteria defined in 1.5.1, 1.5.2 or 1.5.3 or, if no failure occurs, until the test is terminated.

1.7.2 Specific application. Where, for a particular application, either or both of the requirements of 1.5.2 and 1.5.3, if relevant, are waived or their fulfilment is required only for some predetermined period, or a loadbearing element is not subjected to the maximum loading described in 1.3.1, the element may then be regarded, for the purpose of the particular application only, as providing a fire resistance equal to the period for which the remaining test requirement or requirements are fulfilled.

1.8 Test report

The test report shall contain the following information:

(1) Name of testing laboratory.

(2) Name of sponsor.

(3) Date of test.

(4) Name of manufacturer and trade name of element (if any).

(5) Details of construction of the specimen, together with drawings, and details of conditioning.

(6) Important physical properties of materials together with the source of information.

(7) Method of support and restraint.

(8) Test load and basis of calculation together with the maximum permissible load on the specimen.

(9) For asymmetrical separating elements the direction in which the specimen was tested and the reason for adopting this procedure (see 2.3.1 and 7.3).

(10) Observations during test, including test results as provided for in 1.6. Where a test is terminated before a failure has occurred under all the relevant criteria this shall be stated in the report.

(11) The fire resistance of the elements of structure as provided for in 1.7.

2. Walls and partitions

2.1 Details of specimen

2.1.1 Size. When it is not possible to test a full size specimen the minimum dimensions of the part exposed in the furnace shall be:

width 2.5 m, height 2.5 m

2.1.2 Construction. A specimen may include a beam or columns which form an integral part of the element to establish the performance of the composite construction. A specimen may also include a door or glazing to establish the performance of the whole assembly.

2.2 Loading and restraint

2.2.1 Loading. A loadbearing specimen shall be subjected to a load computed as specified in 1.3.1. An element which is intended to carry only its own weight shall be termed non-loadbearing and the corresponding test specimen shall have no external loads applied to it.

2.2.2 Restraint. The vertical edges of a specimen subjected to vertical loading shall be free from restraint. Non-loadbearing specimens shall be restrained on all sides unless allowance is specified for the element in service to permit thermal movement, when the appropriate edge conditions shall be simulated in the specimen.

2.3 Method of test

2.3.1 General. Specimens of elements which may be required to resist fire from either direction shall be tested in the direction considered as giving the lower fire resistance. In case of doubt tests shall be made to establish the fire resistance from either side.

Specimens of elements which may be required to resist fire from one direction only shall be tested from that direction.

Furnace temperatures shall be measured by means of thermocouples arranged so that there is not less than one thermocouple to each 1.5 m^2 of surface area.

2.3.2 Composite construction. Specimens of elements which incorporate a beam or column either built completely into the wall or with one or more exposed faces, shall be tested following the procedure outlined in **2.3.1**. Where the resistance of any part of the wall against penetration of fire is less than the resistance to collapse of the beam or column, in order to determine the fire resistance of the beam or column such part may be sealed as necessary on the outer side by a sheet of non-combustible insulation board not less than 25 mm thick and approximately 100 mm from the face. Where the built-in beam or column forms the boundary of an opening in the wall, the test shall be conducted following the procedure outlined in Section 4 or 5, as appropriate. Where a door is included in the specimen the conditions of Section 7 shall be applied.

2.4 Observations during test

The temperature of the unexposed face of the specimen shall be measured at not less than five points, one at approximately the centre of the area and one at approximately the centre of each quarter section. In the case of specimens incorporating glazing, the thermocouples shall be distributed as uniformly as possible, excluding any glazing. The mean temperature of the unexposed face shall be deemed to be the average of the temperatures measured at these points. Where, in the direction of heat flow, the specimen is not of uniform geometry or material, as for example in a partition of cavity construction, additional points of measurement will be required. In addition, temperatures shall be measured at any point including a joint that appears to be hotter than the standard locations at any time during the test. These temperatures shall not be used in computing the mean temperature but will be taken into account in determining compliance with the maximum temperature criterion (see **1.5.3**).

2.5 Determination of fire resistance

A wall or partition shall be judged on the compliance of the specimen with the three criteria specified in **1.5**. The fire resistance of the wall or partition shall be determined in accordance with the provisions of **1.7**.

3. Floors and flat roofs

3.1 Details of specimen

3.1.1 Size. When it is not possible to test a full size specimen, the minimum dimensions of the part exposed in the furnace shall be:

width 2.5 m, span 4 m

3.1.2 Construction. Where a ceiling treatment or a suspended ceiling is intended to contribute to the fire resistance of a floor or a flat roof the specimen shall incorporate the ceiling. If the ceiling is a suspended ceiling it shall comply with the provision of **6.1.2** for the construction of the specimen. The ceiling shall be installed as in service.

NOTE. Where it is required to ascertain only the fire resistance of a steel beam suspended ceiling assembly the test described in Section 6 is appropriate.

3.2 Loading and restraint

3.2.1 Loading. The load to be applied to the specimen shall be computed in accordance with the requirements of **1.3.1** for the particular span and edge conditions.

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DEUTSCHE NORMEN

September 1977

Fire Behaviour of Building Materials and Building Components

Fire Walls and Non-load-bearing External Walls

Definitions, Requirements and Tests

DIN 4102 Part 3

Brandverhalten von Baustoffen und Bauteilen; Brandwände und nichttragende Aussenwände – Begriffe, Anforderungen und Prüfungen

This Standard has been prepared in the Special Section "Einheitliche Technische Baubestimmungen" (Mandatory Standards concerning Technical Buiding Regulations) of the Normenausschuss Bauwesen (Standards Committee for Building and Civil Engineering) (NABau). It has been recommended to the Chief Building Inspectorates by the Institut für Bautechnik (Institute for Building Technology), Berlin, for introduction in the building code procedure.

This Standard gives concrete form to the definitions-by-test for fire protection technology of the State (regional) Government Building Codes, the associated Implementation Orders and other legal orders and administrative orders concerning fire protection in buildings.

It refers in particular to para. 34 and para. 36 of the Model Building Regulation (MBO) or to the corresponding paragraphs of the relevant State (regional) Government Building Codes.

In conjunction with the revision of

DIN 4102 Part 2 Fire behaviour of building materials and building components; definitions, requirements and tests on building components

DIN 4102 Part 3 Fire behaviour of building materials and building components; definitions, requirements and tests on special building components

DIN 4102 Part 4 Fire behaviour of building materials and building components, allocation to definitions

and the "Supplementary regulations for DIN 4102" – in each case February 1970 issue – the content of the Standard has also been rearranged:

DIN 4102 Part 1 Fire behaviour of building materials and building components; building materials; definitions, requirements and tests (formerly covered by the supplementary regulations mentioned above)

DIN 4102 Part 2 Fire behaviour of building materials and building components; building components; definitions, requirements and tests

DIN 4102 Part 3 Fire behaviour of building materials and building components; fire walls and non-load-bearing external walls; definitions, requirements and tests

DIN 4102 Part 4 Fire behaviour of building materials and building components; schedule and application of classified building materials, building components and special building components (at present circulating as draft)

DIN 4102 Part 5 Fire behaviour of building materials and building components; fire barriers, barriers in lift wells and glazings resistant against fire; definitions, requirements and tests

DIN 4102 Part 6 Fire behaviour of building materials and building components; ventilation ducts; definitions, requirements and tests

DIN 4102 Part 7 Fire behaviour of building materials and building components; roofings; definitions, requirements and tests

DIN 4102 Part 8 Fire behaviour of building materials and building components; small scale test furnace (at present in draft form)

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Dimensions in mm

1 Scope

This Standard lays down fire prevention definitions, requirements and tests of fire walls and of non-load-bearing external walls, including parapets and aprons.

Load-bearing or non-load-bearing walls, beams and joists are dealt with in DIN 4102 Part 2.

Note: Because of differences in requirements, fire walls and non-load-bearing external walls cannot be classified into fire resistance categories F 30 – F 180 according to DIN 4102 Part 2.

2 Other relevant Standards

DIN 4102 Part 1 Fire behaviour of building materials and building components; building materials; definitions, requirements and tests

DIN 4102 Part 2 Fire behaviour of building materials and building components; building components; definitions, requirements and tests

DIN 4102 Part 4 Fire behaviour of building materials and building components; allocation to definitions (February 1970 issue)

DIN 4102 Part 4 (at present in draft form) Fire behaviour of building materials and building components; schedule and application of classified building materials, building components and special building components

3 Proof of fire resistance categories

3.1 With fire tests

Proof of the fireresistance category of fire walls and non-load-bearing external walls is to be provided by a test certificate based on tests according to this Standard. The least favourable result of tests on at least two test specimens is decisive for the assessment.

3.2 Without fire tests

The fire walls and non-load-bearing external walls listed in DIN 4102 Part 4 are to be allocated to the fire resistance categories indicated there without determination according to Section 3.1.

4 Fire walls[1]

4.1 Definition

Fire walls are walls for separating or delimiting fire compartments. They are intended to prevent the spread of fire to other buildings or sections of buildings.

Fire walls must satisfy the requirements of Sections 4.2.1 to 4.2.4, unless they are required for a longer fire resistance time (see Section 4.2.5) in accordance with special building code regulations.

4.2 Requirements

4.2.1 Fire walls must consist of building materials of category A according to DIN 4102 Part 1.

4.2.2 Fire walls must satisfy the requirements of Sections 4.2.3 and 4.2.4 without claddings.

4.2.3 In the case of central and eccentric loading, fire walls must at least satisfy the requirements of fire resistance category F 90 according to DIN 4102 Part 2.

4.2.4 When tested according to Section 4.3.3 under the impact stress defined therein, fire walls must fulfil the load-bearing function and the separating function within the meaning of DIN 4102 Part 2; that is to say:

4.2.4.1 Stability must be maintained during and after the first two impacts when subjected to a load p, and under the dead weight g of the test specimen after the third impact.

4.2.4.2 The separating function must be maintained during and after the impact stresses in accordance with DIN 4102 Part 2, September 1977 issue, Section 5.2.1.

4.2.4.3 During and after the impact stresses, the average temperature of the unexposed side shall not increase above the initial temperature by more than 140 K, the minimum temperature by more than 180 K.

4.2.5 Fire walls having a longer fire resistance time are fire walls which, in contrast to Section 4.2.3, fulfil the requirements of fire resistance category F 120 of F 180[2])

4.3 Tests

4.3.1 Test equipment, test specimens and test procedure

DIN 4102 Part 2, September 1977 issue, Sections 6.1 and 6.2, applies as appropriate to the test equipment, test specimens and the test procedure; in addition, the following is to be observed:

4.3.2 Eccentric load p

In both tests required according to Section 3.1, one-leaf test specimens are to be stressed at a distance d/3 from the unexposed side in such a way that the edge stress results in $\sigma_R = \sigma_{zul}$ over the whole of the edge near the load.

Walls which, during the test period, are so seriously damaged or destroyed on the exposed side that this condition by itself brings about a significantly eccentric load are to be tested again by the application of a load at a distance d/3 from the exposed side.

Multi-leaf walls are to be tested correspondingly.

1) According to building code regulations, fire walls which do not fulfil all the requirements of Section 4.2 are also permissible; additional evidences of applicability are to be provided for such fire walls (e.g. in the context of the granting of a general "bauaufsichtliche Zulassung" (building code licence).

2) According to the regulations of the Association of Insurers against Material Losses, fire walls which, in contrast to Section 4.2.3, belong to fire resistance category F 180 and, in contrast to Sections 4.2.4 and 4.3.3, fulfil the load-bearing and the separating function within the meaning of DIN 4102 Part 2 under an impact stress of 4000 Nm, are deemed to be "complex constructed partitions"; in other respects, the provisions of DIN 4102 Part 3, Section 4, apply.

4.3.3 Impact stress

To determine the impact resistance, the test specimen, set up in front of the test furnace, is subjected, about 5 minutes before the time of classification, twice under the eccentric load p described in Section 4.3.2 and then once without the load p – with only the deadweight g of the wall – to the impact of a sack of lead shot weighing 200 kg and having an impact energy of 3000 Nm in each case, over an area of about 400 cm² on the unexposed side. The blows are delivered in the form of pendulum blows. The length of the pendulum should be about 3 m.

The impact stress should normally be applied in the centre of the wall. If the test specimens are stiffened by, e.g., columns of spanning members, the stressed area is to be so selected that, after one fire test, the unstiffened surface of the wall is stressed and the stiffening is stressed after the second fire test.

If, in view of the static system of the wall or of a special method of fixing, it appears desirable to cover a number of different impact zones, then the impact stress must be applied to all zones of interest; in special cases, additional tests must take place where necessary.

4.3.4 Supporting of test specimens during impact stressing

In order to absorb the impact stresses, the test specimens are to be supported in conformity with nomal practice on not more than two sides. Unless special support conditions are envisaged, the upper and lower edges of the aperture of the furnace may be used as load-transferring supports in the case of test specimens supported on two sides; they are to be of sufficiently rigid design to prevent their deformations as a result of the impact stresses.

4.3.5 Evaluation after impact stresses

The requirements listed in Section 4.2.4 apply to the evaluation of the test specimens after the impact stresses.

4.4 Test certificate

A test certificate shall be prepared covering the test procedure and test results. DIN 4102 Part 2, September 1977 issue, Section 8, applies hereto as appropriate.

5 Non-load-bearing external walls

5.1 Definition

Non-load-bearing 3) external walls within the meaning of this Standard are room-sized, separating building components such as external wall elements, infill walling, etc. – termed briefly external walls – which, in the event of fire, are stressed only by their dead load and which do not contribute to any stiffening of building components. In addition, however, the building components may also transmit to load-bearing building components, e.g. shear-walls or floors, any wind loads and horizontal live loads acting on their surface.

Non-load-bearing external walls also include

a) parapet-height, non-separating, non-load-bearing external wall elements – termed briefly parapets – and

b) apron-shaped, non separating, non-load-bearing external wall elements – hereinafter termed briefly aprons –,

which in any case increase the distance over which the fire has to jump on the outside of buildings.

5.2 Fire resistance categories, requirements

5.2.1 General

A distinction is drawn between the fire resistance categories listed in Table 1.

Table 1. Fire resistance categories W

Fire resistance category	Fire resistance time in minutes
W 30	≧ 30
W 60	≧ 60
W 90	≧ 90
W 120	≧ 120
W 180	≧ 180

5.2.2 Requirements placed on external walls

5.2.2.1 When subjected to fire attack from inside by exposure to flame according to DIN 4102 Part 2, September 1977 issue, Section 6.2.4 (ETK = time-temperature function) as appropriate to their fire resistance categories, external walls must not collapse.

5.2.2.2 External walls must withstand the impact test according to DIN 4102 Part 2, September 1977 issue, Section 6.2.9 in such a way that, as appropriate to their fire resistance category, they do not collapse.

5.2.2.3 When subjected to fire attack from outside by exposure to flame according to Section 5.3.2 (reduced ETK) as appropriate to their fire resistance category, external walls must fulfil the requirements according to DIN 4102 Part 2, September 1977 issue, Section 5.

5.2.3 Requirements placed on parapets 4)

5.2.3.1 Parapets which, in accordance with Fig. 2 and Fig. 3, are built above the lower edge of the unplastered floor, must not collapse when subjected from inside to fire attack by exposure to flame according to DIN 4102 Part 2, September 1977 issue, Section 6.2.4 (ETK) as appropriate to their fire resistance category.

5.2.3.2 Parapets must withstand the impact test according to DIN 4102 Part 2, September 1977 issue, Section 6.2.9 in such a way that, as appropriate to their fire resistance category, they do not collapse.

5.2.3.3 If, in the assembled condition, there is a vertical joint between the parapet and the unplastered floor, then in the event of fire attack from outside and below by exposure to flame according to DIN 4102 Part 2, September 1977 issue, Section 6.2.4 (ETK), as appropriate to the fire resistance category, the requirements according to DIN 4102 Part 2, September 1977 issue, Section 5, must be fulfilled on the unexposed side of this joint.

5.2.3.4 When subjected to fire attack from outside by exposure to flame according to Section 5.3.2 (reduced ETK) as appropriate to their fire resistance category, parapets must fulfil the requirements according to DIN 4102 Part 2, September 1977 issue, Section 5.

3) Components which take loads or which stiffen components, are load-bearing and stiffening components to be evaluated according to DIN 4102 Part 2.

4) In accordance with building code regulations, parapets, aprons or parapets in conjunction with aprons must have certain minimum heights.

When evaluating the increase of temperature on the unexposed side, the upper 10 cm wide edge strip of the test specimen may be ignored.

If the requirements are already fulfilled by the test of the vertical joint, proof according to Section 5.2.3.4 is not necessary.

5.2.4 Requirements placed on aprons 4)

5.2.4.1 Aprons which, in accordance with Fig. 4, are built below the upper edge of the unplastered floor, must not collapse when subjected to fire from inside and outside in the course of two tests by exposure to flame according to DIN 4102 Part 2, September 1977 issue, Section 6.2.4 (ETK) as appropriate to their fire resistance category; they must remain in the form of a single unit to maintain the fire gap required by bulding code regulations.

5.2.4.2 If, in assembled condition, there is a vertical joint between the apron and the unplastered floor, then, as appropriate to the fire resistance category, the requirements according to DIN 4102 Part 2, September 1977 issue, Section 5, must be fulfilled on the unexposed side of this joint.

5.2.5 Requirements placed on parapets in conjunction with aprons 4)

5.2.5.1 Parapets in conjunction with aprons, in accordance with Fig. 5, must not collapse when subjected from inside to fire attack by exposure of the parapet to flame according to DIN 4102 Part 2, September 1977 issue, Section 6.2.4 (ETK) as appropriate to their fire resistance category.

5.2.5.2 Parapets in conjunction with aprons must withstand the impact test according to DIN 4102 Part 2, September 1977 issue, Section 6.2.9 in such a way that, as appropriate to their fire resistance category, they do not collapse.

5.2.5.3 In the event of fire attack from outside and below by exposure to flame according to DIN 4102 Part 2, September 1977 issue, Section 6.2.4 (ETK), as appropriate to the fire resistance category, the requirements according to DIN 4102 Part 2, of September 1977 issue, Section 5, must be fulfilled on the unexposed side of vertical joints.

5.2.5.4 When subjected to fire attack from outside by exposure to flame according to Section 5.3.2 (reduced ETK) as appropriate to their fire resistance category, parapets in conjunction with aprons must fulfil the requirements according to DIN 4102 Part 2, September 1977 issue, Section 5, in the area of the parapet. When evaluating the increase of temperature on the unexposed side, the upper 10 cm wide edge strip of the test specimen may be ignored.

If the requirements are already fulfilled by the testing according to Section 6.2.5.3, further proof is not necessary.

5.3 Tests

5.3.1 General

DIN 4102 Part 2, September 1977 issue, Sections 6.1 and 6.2, applies as appropriate to the test equipments, test specimens and the test procedure. Particular attention is to be paid to external walls, parapets and aprons being constructed with structural joints, methods of fixing and fitting materials, as used in practice.

Where it is necessary to maintain in the test furnace the static overpressure called for according to DIN 4102 Part 2, September 1977 issue, Section 6.2.5, the information in Figs 2 to 5 applies to the location of the pressure measuring points.

5.3.2 Reduced temperatures in the fire room

To provide evidence of the fire resistance time in accordance with Sections 5.2.2.3, 5.2.3.4 and 5.2.5.4, the fire room is to be exposed to flame in accordance with the time-temperature-function according to Fig. 1, which represents a reduction as compared with the time-temperature-function (ETK) according to DIN 4102 Part 2. DIN 4102 Part 2, September 1977 issue, Section 6.2.4, applies to the permissible variations.

5.3.3 Testing of external walls

External walls are to be tested as appropriate in the same way as for separating, non-load-bearing walls according to DIN 4102 Part 2.

5.3.4 Testing of parapets

5.3.4.1 Parapets are to be installed in conformity with practical use in a test furnace in accordance with Fig. 2 and Fig. 3.

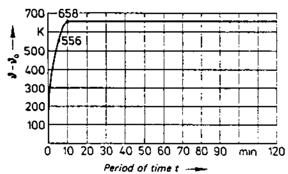


Figure 1. Time-temperature-function (reduced ETK)

In the case of parapets which, in practical use, rest entirely on a reinforced concrete construction, the load-bearing structure in accordance with Fig. 2 may be replaced by masonry.

In the case of parapets with other types of supporting structure and of parapets which, in accordance with Fig. 3, project partly or wholly, the load-bearing structure is to be built to a width of ≧ 1.0 m as used in practice.

5.3.4.2 The surface of the test furnace above the parapets is to be covered in such a way that penetration of fire within this surface is prevented during the tests. The covering is to be fitted so that the test specimens are not thereby subjected to additional thermal stresses or to stresses caused by deformations. The covering is to be fitted flush with the test specimen; the gap between the covering and the parapet is to be sealed with mineral fibre of materials category A.

5.3.5 Testing of aprons

Aprons are to be installed in conformity with practical use in a test furnace in accordance with Fig. 4.

4) See page 3

The load-bearing structure is, in conformity with practice, to be built to a width ≧ 1.0 m.

Section 5.3.4.2 applies as appropriate to the covering of the surface of the test furnace.

5.3.6 Testing of parapets in conjunction with aprons

Parapets in conjunction with aprons are to be installed in conformity with practical use in a test furnace in accordance with Fig. 5.

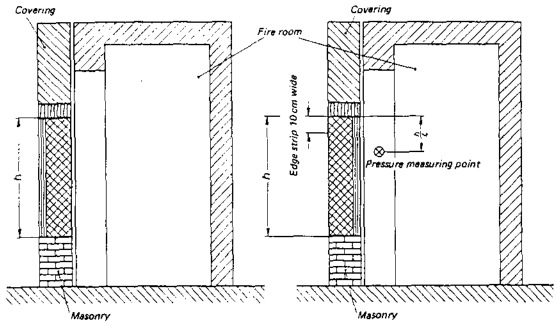
The load-bearing structure is, in conformity with practice, to be built to a width ≧ 1.0 m.

Section 5.3.4.2 applies as appropriate to the covering of the surface of the test furnace.

For the impact test according to DIN 4102 Part 2, September 1977 issue, Section 6.2.9, the unexposed side is to be stressed in each case.

5.4 Test certificate

A test certificate shall be prepared covering the test procedure and the test results. DIN 4102 Part 2, September 1977 issue, Section 8, applies hereto as appropriate.



a) for fire test at ETK – see Section 5.2.3.1

b) for fire test at reduced ETK – see Section 5.2.3.4

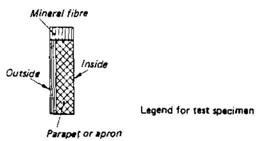
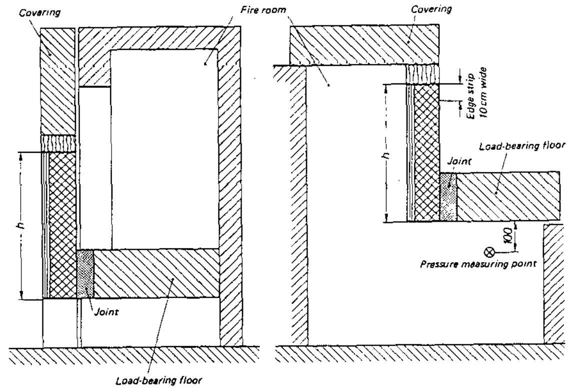


Figure 2. Test arrangement for parapets (diagrammatic) which, in practice, rest entirely on a reinforced concrete base.



a) for fire test at ETK – see Section 5.2.3.1

b) for fire test at ETK – see Section 5.2.3.3
for fire test at reduced ETK – see Section 5.2.3.4

Figure 3. Test arrangement for parapets (diagrammatic) which, in practice, are built partly or wholly in front of the load-bearing floor (see Fig. 2 for legend for the test specimen).

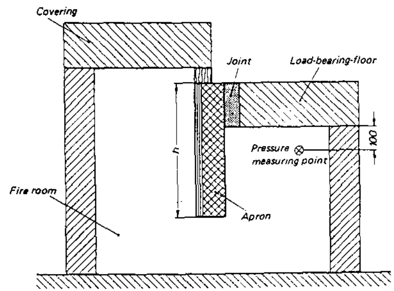


Figure 4. Test arrangement for aprons (diagrammatic) for fire test at ETK – see Section 5.2.4 (see Fig. 2 for legend for th test specimen).