行政院所屬各機關因公出國人員報告書（出國類別：考察）

赴日本京都 ISO/TC92 中尺寸熱量計(ICAL) 國際實驗能力比對研討會」出國報告

出國人　服務機關：內政部建築研究所
職　　稱：副研究員
姓　　名：蘇鴻奇
職　　稱：助理研究員
姓　　名：李鎮宏

出國地點：日本、京都
出國時間：95 年 11 月 3 日至 95 年 11 月 10 日
報告日期：96 年 2 月

目錄

第一章考察緣起

第一節前言

現行 ISO 規範中有關 ICAL（中尺度熱量計）測試標準其文件尚為技術報告格式【Technical Report format ISO TR 14696】，尚未成為 ISO 規範主體之一，本所於 93 年期間應 ISO/TC92,SC1,WG1,ICAL 計畫主持人 Dr. Joe Urbas 邀請參與該計畫，針對完整之 ISO/ICAL 標準規範共同研究發展，進行一連串相同之建材，使其暴露於相同熱輻射量下進行試驗，並提出相關測試結果供規範研修之參考依據。

日前ISO/TC92來文邀請本所參加預計於95年11月4日至9日在日本京都召開之ISO/TC92-ICAL國際實驗能力比對研討會，會中研討內容包括火焰延燒、建材熱釋放率、中大型尺寸材料試驗等，藉由此次參與該研討會，必能更加明瞭目前國際上建築防火科學研究之最新技術發展，供未來國內研發相關技術及法規制度檢討之參考。

第二節依據及計畫內容

一、計畫依據

1. 內政部建築研究所建築防火科技發展方案中程綱要計畫—建築物防火安全技術開發與應用研究五年計畫。
2. 內政部建築研究所建築實驗設施設置計畫(建築防火研究合作)。

二、計畫內容

1. 參加於日本京都舉辦之「ISO/TC92 中尺寸熱量計(ICAL)實驗能力比對國際研討會」。
2. 彙整提供本所中尺寸熱量計(ICAL)實驗成果，並針對實驗過程中規範

未盡說明處提出意見。

3. 蒐集國際最新防火新知，明瞭其他國外實驗室對於目前該相關設備應用與實驗結果之能力比對成果，不僅可使得本所防火實驗中心設備實驗成果符合國際化、標準化，亦可藉此參與國際上標準規範研修會議活動並增加國際會議參與度。

第二章考察行程及概要

本章說明本次奉派赴日本參加「ISO/TC92 中尺寸熱量計(ICAL)實驗能力比對國際研討會」考察成員、時間及研討會概要。

第一節研討會行程

一、考察人員名單

姓名	職稱	專長
蘇鴻奇	副研究員	建築防火、建築施工構造
李鎮宏	助理研究員	建築防火、建築構造

二、考察時間

民國 95 年 11 月 3 日至 11 月 10 日。

三、研討會行程

本所 95 年度赴日本計畫「ISO/TC92 中尺寸熱量計(ICAL)實驗能力比對國際研討會」行程如表 2-1

表 2-1ISO/TC92 國際研討會行程

日　　期	活　　動　　內　　容	備　　註
11 月 4 日(六)	ISO/TC92 國際研討會(開幕)	
11 月 5 日(日)	ISO/TC92 WG3 火焰延燒試驗法研討會 ISO/TC92 WG12 煙氣成分量測法之應用	

11 月 6 日（一）	ISO/TC92 WG7 中大尺度建材測試法小組會議 ISO/TC92 WG10 熱幅射計校正測試法研討會	
11 月 7 日（二）	ISO/TC92 WG5 熱釋放率測試法之比對研討會 ISO/TC92 WG11 火災測試方法於防火工程上之應用	
11 月 8 日(三）	ISO/TC92 SC1 綜合研討	
11 月 9 日（四）	ISO/TC92 國際研討會(閉幕)	

原田和典教授與蘇鴻奇副研究員合照

ISO/TC92 SC1主持人Yoshida,Koichi與蘇鴻奇副研究員合照

京都大學會場外

京都大學會場外

第二節ISO TC 92技術委員會概要

一、ISO TC92 - FIRE SAFETY 歷史沿革

ISO TC92 技術委員會於 1961 年在倫敦召開第 1 次會議。 會議主題為「建築材料和結構之耐火測試」此主題持續至 1977 年第 10 屆會議，於該會議中決定將「建築材料」增修為「建築材料組成」議題。在 1992 年第 15 屆會議中 ISO 技術委員會議簽署決議將 ISO TC92 主題範圍新修訂為「火災安全」。

二、ISO TC92 領域範圍

（一）Standardization of the methods of assessing: 評估的方法的標準化。

（二）fire hazards and fire risk to life and to property; 對生命和財產的火災災害與風險。

三、ISO TC92 組織架構

目前 TC92 架構下有 4 組小組委員會，包含如下。

（一）SC1 - Fire Initiation and Growth　火災引燃和延燒成長。

（二）SC2 - Fire Containment　火災抑制。

（三）SC3 - Fire Threat to People and Environment　對人們和　環境的火災威脅

（四）SC4 - Fire Safety Engineering　火災安全工程

第三章參與研討會過程

第一節 ISO/TC92/SC1/WG3火焰燃燒擴散測試會議

一、會議研討主題：

ISO / TC92 / SC1 / WG3火焰燃燒擴散測試會議火焰燃燒擴散測試會議

二、會議日期：2006/11/05

三、會議地點：日本京都大學

四、會議內容簡要：

1.2006 年 5 月 4 日在 Ischia 的 WG3 會議記錄宣讀及重要報告

2.ISO 5658-2：1996 年版修正

2.1 應用在建築與交通運輸產品上垂直側向延燒測試

2.2 FDIS 5658-2 投票。

經歷 2 個月選舉在 2006 年 8 月 14 日結果出爐，結果是 93.75%贊成

2.3 ISO 5658-2(第 2 版)在 2006 年 9 月 15 日出版。

3. ISO DIS 14697: Revision of ISO TR 14697: 1997

在建築和運輸產品上基層材選用準則

4. ISO TS 5658-1：ISO TR 5658-1: 1997 改版

燃燒擴散準則

5. ISO 5658-4：ISO 5658-4：2001 回顧

五、結論

1. 火焰燃燒傳播數據可用於防火安全工程上。

2. 垂直火焰擴散作用和計算方法(第 7.4 條)

3. 確切說明怎樣確定燃燒的數量-從燃燒的粒子傳播危險(第 9 條)

第二節 ISO/TC/92/SC1/WG5會議報告

一、會議研討主題：

ISO/TC92/SC1/WG5 熱釋放率測試會議

二、會議日期：2006/11/08

三、會議地點：日本京都大學

四、會議內容簡要：

1.上屆在 Ischia &多倫多會議報告

2.ISO CD 5660-4

Reaction to fire tests - Heat release, smoke product-ion and mass loss rate — Measurement of heat release for determination of low levels of combustibility

3.火源設備

4.ISO 5660-1 和 ISO 5660-2 改版

5.進度報告

工作項目	標題	計畫主持人	現在進度	目標	
				CD	DIS
ISO 5660-4	針對可燃性低的材料應用圓錐量熱儀之可行性	T Crimi	DIS 資料準備中	2006	2007
ISO5660-1 &2		S Grayson	NWIP	2007	
	合成聚合物材料可燃性的測量(使用單一火源供應器 FPA)	M Khan	NWIP	2007	
ISO 5660 /?		S Gregory	NWIP	2007	

五、相關 ISO 規範

ISO 5660 由下列部分組成，包括一般火災反應測試－熱釋放、煙濃度及質量損失率等低可燃性熱釋放率量測：

Part1：熱釋放率(圓錐量熱儀方法)

Part2：煙產生率(動態測量)

Part3 :熱和煙釋放率指導方針

六、結論

1.應用圓錐量熱儀測試可燃性低材料之適確性，相關修正完成之文件將於 96 年春天完成投票。

2.建議 ISO 修正之 5660-1 和 2　已經被提交 TPMG 。

3.低氧環境下之測試將包括於 5660 系列。

第三節 ISO TC92/SC1/WG7會議報告

一、會議研討主題：

Large and Intermediate Scale Tests 中大尺寸之測試會議

二、會議日期：2006/11/06

三、會議地點：日本京都大學

四、會議內容簡要：

1.ICAL CD 14696

1.1 投票結果

1.2 意見討論

1.3 決定文件資料的發展進度

2.回顧大樓火災發展特性的測試方法

3.針對管線於實際火災現象之收集

4. 進度報告

工作項目	標題	主持人	計畫起始	現在進展	規劃期限	
					CD	DIS
ISO 24473	開放式熱量計	K Shaw	05-04	DIS 投票於 10 月 06 日結束	05-12	07-03
準備工作	大樓內火災發展特性	P. Van Hees	-	TPMG 簽署 NPWI	-	-
ISO 20632	房間火災管線絕熱測試	D Daems	02-02	DIS 投票進行中	04-09	05-12
ISO DTR 25558	管線參考資料	P Van Hees	05-04-	起草中	06-05	07-12
ISO 14696	ICAL 中尺度熱量計	J． Urbas	04-04	CD 投票通過	05-12	06-12

五、相關 ISO 規範

1. ISO 24473火災引燃與成長：

這國際標準指定一系列在通風良好之條件下模擬真實火災情境之方法。根據不同尺度實驗設備，多種不同火災尺寸可具已研究分析。這方法意圖使用特定之引燃系統，經一物件或多個物件測試來評估火勢成長趨勢，這種火源的類型，因位置和發熱量將影響火勢發展和代表性風險將被調查研究。 在本規範所述之實驗方法中包括所有試驗程序但不含週遭結構所造成之熱回饋影響，且通風環境的影響也應該加以考慮。

這方法能用來提供在通風條件不同的產品組成或者熱、煙與燃燒氣體的生成模式數據比對，並且研究提供數據比對。

2. ISO/CD 14696 中尺度熱量計

此實驗用以量測垂直方位上 1m² 樣本之熱釋放率，樣本暴露於由氣體燃

燒之輻射板（最高至 50KW/m2）產生之均勻熱流，且瞬間點火，亦使用氧氣消耗原理來量測材料在模擬之真實火場之放熱、發煙及有毒氣體產生量。可供應用或研究領域:

(1) 目前對於建材耐燃測試標準，標檢局刻正研擬由 ISO 5660 測試方法，惟測試樣品大小僅 10x10cm，且加熱方式為水平向，如為牆面裝修材，則其燃燒測試行為將不相同，ICAL 則完全符合垂直向燃燒測試行為(垂直加熱)，且樣本尺寸可達 1m×1m，於爾後建立耐燃測試法規上更具擴充性。

(2) 可用於決定電腦模型(如 FDS)所需之參數或數值，包括有效燃燒熱，著火溫度等。

(3) 目前國內尚未建立該試驗之耐燃測試分類標準，故檢測應用上較不普及，惟其後續研究較具發展性。

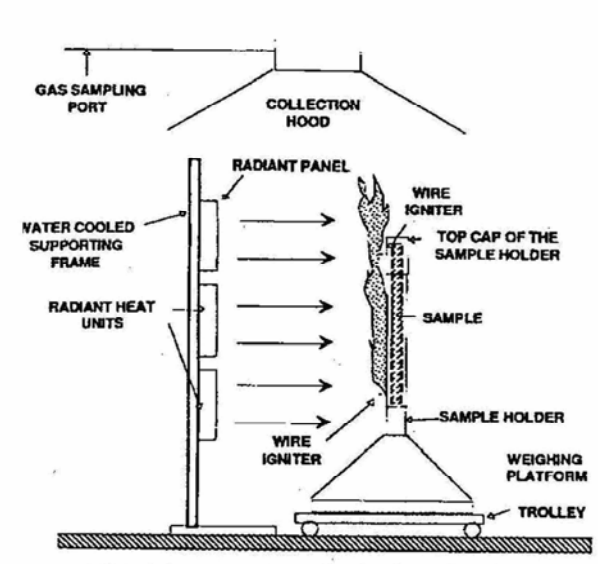
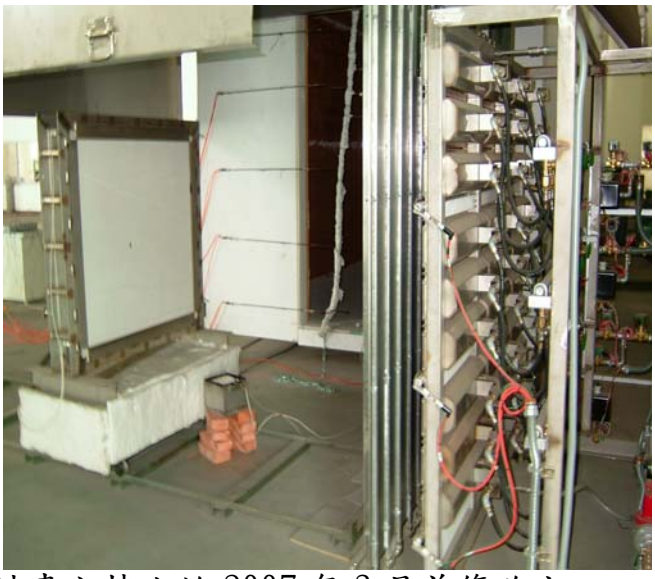


FIG. 3 Intermediate Scale Calorimeter


計畫主持人於 2007 年 3 月前修改完竣。

2. ISO DIS 20632 房間管線絕熱測試已進入 DIS 投票中。

3. ISO DIS 24473 開放式熱量計，其 DIS 投票成員正在組成中。

4. 管線於實際火場中的現象正在收集中，將於下次會議 2007.3 提出討論。

第四節 ISO TC92/SC1/ **WG10**會議報告

一、會議研討主題：

Calibration of Heat Flux Meters (熱通量計校正)會議

二、會議日期：2006/11/06

三、會議地點：日本京都大學

四、會議內容簡要：

1. ISO TS 14934-1 總則

   發展與修改現況

2 ISO 14934-2 主要測試方法

   於 2006-02-15 發表

3. ISO/FDIS 14934-3 次要測試方法

   於 2006-09-15 發表

4. ISO/TS 14934-4 準則提交出版

5. 進度報告

工作項目	標題	主持人	工作開始	現在進展	規劃期限	
					DIS	FDIS
ISO 14934-1	校正和使用熱輻射計一般原則	I Wetter-lund	04-04	文件回顧	PWI	
ISO 14934-3	校正和使用熱輻射計次要原則	K Yoshida	00-10	出版 06-09-06		
ISO 14934-4	在火場中使用熱輻射計之準則	Y Hayashi	00-10	提交 ISO 為 TS 出版	04-08	06-04

五、相關 ISO 規範

ISO/TS 14934 包括下列一般火災測試—校正與使用熱幅設計

— Part 1: 一般準則

— Part 2: 主要校正方法

— Part 3: 次要校正方法

— Part 4: 於火場測試中使用熱通量計指導方針

六、結論

1.ISO TS 14934-1 總則

在有系統的回顧資料中，對於標準的確認已達多數。 Wetterlund 將被提議的為該計畫主持人。

2. ISO / DIS 14934-2

DiCarlo 通知投票表決期限延伸到 2007 年 1 月。

3. ISO/DIS 14934-3

K .Yoshida 已經進入與對 DIS 投票表決意見有關的意見彙整中。有幾項目與 WG10 召集人同步且為 FDIS 選舉票作好了準備。

4. ISO/DTS 14934-4 uidance

K .Yoshida 已經進入與對 DIS 投票表決意見有關的意見彙整中。有幾項目與 WG10 召集人 同步且為 FDIS 選舉票作好了準備。

第五節 ISO TC92/SC1/WG11會議報告

一、會議研討主題：

ISO/DTR 17252「Fire tests — Applicability of reaction to fire tests to fire modeling and fire safety engineering」草案制定討論會議

二、會議日期：2006/11/07

三、會議地點：日本京都大學

四、會議進行主要內容：

1. 草案內容討論：

（1）草案名稱：ISO/DTR 17252「Fire tests — Applicability of reaction to fire tests to fire modeling and fire safety engineering」

草案名稱:ISO/DTR 17252「火災測試方法於防火工程上之應用」

（2）前言：

ISO(國際標準化組織) 是一個國家標準協會組織。 此國際組織參與者包含政府和非政府團體。ISO 與國際電工委員會(IEC)合作於電工技術標準化的工作。國際標準規格根據ISO/IEC的規章起草，技術委員會的主要任務是準備國際標準規格。技術委員會起草國際標準規格並採用會員團體循環投票。出版作為一國際標準規格需要至少百分之75的會員團體投票贊成。在特別的情形裡，技術委員會已經從通常被作為一個國際標準規格(例如的藝術的項目)收集不同的種類的數據時，它可能以多數參加發表一份技術報告的成員的投票決定。一份技術報告必須具備完整訊息，必須被評論直到它提供的數據被認為不再有效或者有用。注意被拉到一些這份資料的要素可能是專利權的主題。ISO 將不對鑑定任何或者全部這樣專利權負責。

（3）簡介

性能規範已逐漸納入於世界各國所採用的規範，已成一趨勢。這個趨勢已經國際上看迅速的發展，在過去的5年內因為引燃模型的應用於防火安全工程的發展過程中， 例如ISO出版的13387-1到8的那樣轉變。ISO 13387轉變的發展， 已經清楚說明在火安全工程(包括引燃模型的應用)的要求之間並且從標準試驗和專門的實驗數據報告的區別。資料意圖是在適當的防火測驗方法對防火安全工程去支持幫助國際上一貫發展過程的方法，可能的話也被用於主要功能於防火安全規章的使用的建築產品。

（4）概要

這份技術報告在現有回應於應用性上給引燃試驗安全工程和火災引燃模型指南。它也確切說明這類型數據為火安全工程計算和為火災引燃模型需要。

第六節ISO TC92/SC1/WG12會議報告

一、會議研討主題：

ISO/DW 24679「Fire Safety Engineering-performance of structures in fire」草案制定討論會議

二、會議日期：2006/11/05

三、會議地點：日本京都大學

四、會議進行主要內容：

1. 草案內容討論：

（1）草案名稱：ISO/DW 24679「Fire Safety Engineering-Performance Of Structures In Fire」

草案名稱：ISO/DW 24679「火災安全工程－火災結構性能」

（2）**簡介**

對於建築結構而言火災是一種嚴格的負載，這是一項重要的影響對於生命、財產與環境而言。防火安全一種建造的環境的設計的部分，提供設計策略使火災對生命、財產和環境的影響的減到最小。結構防火性能對整體火災安全設計策略是一項很重要的部份。結構防火性能的角色是保證於建立一環境使能夠阻止或延緩火災傳播與結構倒塌，所以防火安全的目標例如生命安全（所有者與消防人員）與財產的保護是不可以妥協的。

標準防火測試提供一種非真實性的火源(假定是一種取之不竭的燃料供應）那並不區分包圍通風的差別，並且不解釋架構的抑制的實際的架構的負荷，熱效應或者條件。這樣的一種評價方法只能導致在這結構防火中提供比較等級，但是不能適合防火安全分析的給建造的環境提供全部必要訊息。

另外，這些簡單的計算方法只能提供關於抵抗 ISO 標準火源，但不是為評價為不同可能的防火條件，例如地方性或者被完全吞沒火災一種建造的環境提供必要工具。因此，目前的防火構造設計性能接近仍然基於一般假定。

（3）概要

本技術規格說明指導在於如何估算與建造忍受負荷和非負荷忍受之性能真實火場環境。這份資料遵循在國際標準規格防火安全工程方面略述的原則「防火安全工程－一般準則」提供一性能基於方

法學給工程師確定組織上火安全為新或者現有建造的環境的水準。結構防火安全評價透過一合理設計基於確定數量的架構行為的一種建造的環境接近，(包括冷卻的階段)的一場真正的火災的整個時間過程，建立在這樣行為的結果的知識基礎上在生活安全、財產和環境上這資料作為不同階段在結構防火安全內設計的包含關鍵因素以提供工程師需要的設計導向。這一份文件將主要處理建築火災性能。

第七節 ISO TC92/SC1/TG5 研討內容

一、會議研討主題：

「ISO/TC 92 SC1 回應的將來的防火策略」討論會議

二、會議日期：2006/11/08

三、會議地點：日本京都大學

四、會議進行主要內容：

1. 議題內容討論：

（1）議題名稱：ISO/TC92/SC1/TG5「Future strategy of ISO/TC 92 SC1 Reaction to fire」

議題名稱：「ISO/TC 92 SC1 回應的將來的防火策略」討論會議

（2）**簡介**

TC 92/WG7 與 TC 92 任務小組對於未來的策略已詢問 SC1 小組考量一個新工作計畫對於下一代 10 年的標準。這份文件由 SC1 在 1997 11 月討論，和以 TG5 關於 1998 年 4 月 5 日和未來的策略同意的如下內容。

領域 1：防火安全工程(FSE)

領域 2：性能法規

領域 3：規格法規

領域 4：測試的有效性

領域 5：測試儀器

領域 6：測試環境

（3）概要

領域 1：防火安全工程(FSE)

對 FSE 模型測試輸入數據的協議，測量技術和程式。

一些參數經常用來描述火災現象例如熱慣性和以為他們反映出基本火特性的蒸發的熱。不過沒有標準化的測試過程測量這些參數。另外他們中的一些參數需要被進一步定義。

對 FSE 模式測試輸入數據的協議，測量技術和程式。

有已經許多測試方法用於防火安全工程（FSE)，例如圓錐量熱儀和火焰延燒測試。不過，更多的工作被需要進一步發展對於這些試驗，並且標準化特別致力於防火安全工程。

關於特性火發展有關係的設計火災的標準。

防火設計的建議被提供，例如，在 SC4 的文件中。不過，由於缺乏數據，基於安全這些建議估計將是保守的。不過，也有許多數據，例如關於火災成長特性，可以使用闡明火災設計。標準可以被改進，新的標準可以被使用現有的數據創造。

領域 2：性能法規

測試協議參考方案。

參考方案經常被使用；例如，有用全尺度試驗 以確定小尺度試驗其估計某種火災，在一種實際的火條件下的行為。有一個特殊的例子為 SC1 對於 ISO 9705 標準是由歐洲委員會使用的那些測試去參考協調的裝修材料分級。參

考測試方案也需要正確複雜的評估系統。

測試協議、測量技術與火災量測程序。

火災量熱學是測量火災產物或整個系統熱釋放率的技術。這項技術正發現使用於一個迅速增長的領域裡。另外這種技術的大規模應用正被發展，而且測量技術本身仍然持續精進中。

領域 3：規格法規

不斷改進已經使用中的試驗。

很多 SC1 試驗被廣泛地使用，例如由國際海事組織，工業，保險公司和國家單位，保證這些標準被定期評論並且更新是非常重要的。

領域 4：測試的有效性

確定防火測試過程的精確性

重複性和能再生性數據經常被用使，有多麼難去理解此為試驗的目的一種方式。測試方法需要確定適合在測試過程中被有效運用。

測試協議對於火災成長預測的有效性

火災成長率和各種各樣的參數需要去估算危險，可以被計算使用不同的模型。這些模式程序需要被准許，例如一份標準化測試協議，例如為建造計算的有效性。

領域 5：測試儀器

防火測試過程過程中使的用測量技術

某些測量儀器，例如熱通量計之校正試驗是重要的。國際標準規格被用於這些儀器的校正需要。測試過程中火焰的延燒與燃燒範圍的估計，操作者經常倚賴目視觀察，傳播的燃燒和燃燒的地區的估計的測試過程，因此成為從屬人。因此需要一種標準測量技術。

領域 6：測試環境

環境對於測試程序提供的影響。

火災的煙流出物會影響人，設備和環境。火災煙流項目須以標準化模式描述考慮到對它的對環境的影響的實際的估計。

第八節 ISO TC 92/SC 1/ TG8 研討內容

一、會議研討主題：

「ISO/TC 92 SC1防火試驗量測不確定度」討論會議

二、會議日期：2006/11/06

三、會議地點：日本京都大學

四、會議進行主要內容：

1. 議題內容討論：

討論 ISO/TC 92 各會員國有關量測不確定度問卷調查結果。

2. 問卷調查結果

問卷寄發日期為 2006 年 6 月 22 日，問卷截止日期為 2006 年 9 月 22 日。結果為共有 13 個會員國同意，7 個會員國不同意。

第四章心得與建議

1. ISO/TC92 技術委員會其主要任務乃將有關火災安全規範之評估方法標準化，包括對人與財產之火災危害度與風險評估等，本所參加之 ISO/TC92-ICAL 國際實驗能力比對計劃隸屬 TC92/SC1/WG7,目前該規範技術草案 ISO/TR 14696 已於本次會中審議，惟仍有多項疑義尚待釐清並須配合 Round Robin 試驗成果一併於下次會議中提出再行審查。會中另針對中、大型尺寸試驗之氣體量化分析議題，與會成員提出相關意見，初步採用 FTIR 試驗方法，本所防火實驗中心亦已建置完成該設備並運作中,足見本所試驗設備建置之方向符合國際上建築防火科技領域之需求。
2. 本次研討會議內容包括火焰延燒、建材熱釋放率、中大型尺寸材料試驗等，藉由此次參與該研討會，更加明瞭目前國際上建築防火科學研究之最新技術發展，供未來國內研發相關技術及法規制度檢討之參考。
3. 蒐集國際最新防火新知,明瞭其他國外實驗室對於目前該相關設備應用與實驗結果之能力比對成果,不僅使得本所防火實驗中心設備實驗成果符合國際化、標準化，亦可藉此參與國際上標準規範研修會議活動並增加國際會議參與度。

附錄

ISO TC92/SC1 會議相關資料

ISO/TC92/SC1/WG3N468

Minutes of the meeting of ISO/TC92/SC1/WG3 Spread of flame tests held at the Hotel Continental Terme, Ischia, Italy on 4th May 2006

1. Attendance

Name	Organisation	Country
Peter Briggs	Bodycote Warringtonfire	Convenor, UK
Christine Lukas	BSI	UK
Edith Antonatus	DIN	Germany
Nathan Weyardi	SwRI	USA
Vince Dowling	CSIRO	Australia
Ken Shaw	BSI	UK
Tom Fritz	ANSI	USA
Kuma Sumathipala	ANSI	USA
Yutaka Tanaike	IIBH	Japan
Yoshihiko Hayashi	BRI	Japan
Shinichi Sugahara	JISC	Japan
Tatsuo Ando	Mitsubishi Chemical	Japan
Koichi Yoshida	NMRI	Japan
Tony Crimi	SCC	Canada
Jim Quintiere	University of Maryland	USA
Patrick van Hees	SP	Sweden
Magda di Carlo	SC1 Secretariat	UK
Silvio Messa	LSF	Italy
Loic Chesne	AFNOR	France

Apologies: -
Alain Sainrat (France), Diane Daems (Belgium), Marc Janssens (USA), Wu Ping (China).

2. Minutes of WG3 meeting in San Antonio on 14th November 2005 and matters arising

The minutes (doc N456) were accepted without change. T Fritz provided information on black paint that could be applied to reflective metallic surfaces when testing to ISO 5658-2.

3. ISO FDIS 5658-2: Revision of ISO 5658-2:1996 Lateral flame spread on building products in vertical configuration

This document has been submitted to ISO/CS for 2-month FDIS ballot. An amendment to clause 6.1 will be sent to ISO/CS based on the ASTM text provided at this meeting. It was decided to modify the original text by changing the original note in 6.1 to clause e) but not including the actual manufacturer. The following words will be added:

‘Alternatively spray the exposed top surface of the specimen with a single coat of flat black paint that is designed to withstand temperatures of 540 ± 10°C. Prior to testing, cure the paint coating by conditioning the specimen at a temperature of 23 ± 3°C and a relative humidity of

50 ± 5 % for 48 h. This coating is applied to ensure surface absorption of the imposed radiant heat flux.'

4. ISO DIS 14697: Revision of ISO TR 14697: 1997
Guidance on the choice of substrates for structural products

The DIS text has been prepared and the DIS ballot (5 months) is scheduled for completion on 1st August 2006. The document now covers transport as well as building products.

5. ISO TS 5658-1: Revision of ISO TR 5658-1: 1997
Guidance on flame spread

The TS text has been prepared incorporating the changes agreed from the DTS ballot and this text has now been sent to ISO/CS for publication.

6. Future Work Items on Flame Spread

In San Antonio, some members of WG3 considered that a more fundamental revision of the guidance on flame spread was required and further revision of TS 5658-1 with a revised scope (e.g. with more non-building applications information) was agreed at the last SC1 meeting (ref. Resolution 248).

In Ischia, several members of WG3 expressed their views that the scope of TS 5658-1 should be widened and should provide more guidance on applicability of flame spread data for fire safety engineering purposes. However, there is little support for the conversion of this guidance document into an International Standard. The convenor proposed that WG3 should work within the concept of Resolution 248 and that revision of the new 2nd edition of TS 5658-1 should be the priority of the Group in terms of guidance on flame spread. He presented document WG3N464 and proposed that this form the basis of discussions about guidance documents. A valuable brainstorming session was then held during which each national delegate was asked to give their expert views on future guidance requirements on flame spread and whether there were any new (or modified) national tests that would be interesting for WG3 to address. The detailed notes on this brainstorming session will be incorporated into a revised version of document WG3N464; this will be distributed to WG3 to provide the basis for further considered views at the next meeting.

7. Report of WG3 to SC1

The WG agreed that document WG3N463 be revised to reflect the Ischia discussions and then be presented to SC1.

8. Any other business

None

9. Next meeting

The next meeting will be held at the University of Kyoto, Japan on Saturday, 5th November 2006.

Christine Lukas

7th June 2006

ISO/TC92/SC1/WG3N469

Revision of TS 5658-1 Guidance on Flame Spread:

Proposals for 3rd Edition

1. Scope

1.1 Widen scope of TS in line with scope of ISO/TC92, which now covers more than construction products.

1.2 Delete old references and bring up to date with more text on applications using fire safety engineering principles (FSE).

2. Fire scenarios and product applications

Potential areas of relevance for improved guidance: -

- Corner tests (such as SBI type)
- Roof-coverings
- Curtains
- Corridors (see clause 7.2)
- Facades
- Ceilings and plenums
- Stairs and stairwells
- Cavities and shafts

3. ISO flame spread documents requiring revision (based on consideration of wider scope of TC92)

3.1 ISO 11925-2

3.2 ISO 5658-2 (e.g. clause 11.12)

3.3 ISO DIS 5658-3 (former LIFT document)

3.4 ISO 5658-4 (valuable guidance on how to measure vertical flame spread)

3.5 ISO 9239-1,2 (extend to other horizontally-oriented products and reintroduce rate of spread parameter)

4. Development of specific sections

4.1 Use of flame spread data for fire safety engineering.
Consider adding this as an Annex (which may be too big) or split document into 2 parts with one part dedicated to FSE.

4.2 Vertical flame spread – Expand instrumental and calculation methods (clause 7.4)

4.3 Specify how to quantify flame spread hazards from flaming droplets/particles (clause 9)

5. Bibliography

Review and prune

6. Views of national delegates at WG3 brainstorming session (Ischia, 4th May 2006)

Delegates were asked to comment on the following questions: -

1. What guidance in relation to applications outside of building should be provided?
2. Are there any tests that need revision?
3. Are there any new tests (national or others) that should be considered for adoption by WG3?

6.1 Japan (K. Yoshida, Y. Tanaike, Y. Hayashi, S.Sugahara, T.Ando)

Most national members belong to building area.
Mostly guidance for building is needed but some more guidance is required for maritime uses, and (e.g.) lighting panels in ceilings.
Also, panel partitions in high-rise buildings, e.g. recent fire in Hiroshima for which a BRI report may be available. (iafss reference to be added)
Data for FSE from the LIFT method where the first work is to review the current guidance document and establish if test methods are adequate to derive necessary data or that it needs revision.
KY will get report of passenger ship fire, which occurred recently where the fire started on a balcony. As fire safety expert in IMO he will be asked to recommend specific flame spread testing. The report will be shared with WG3.
IMO spread of flame test has criteria for burning droplets and FRA in Japan has fire test for products which melt and drip (45 degree simple test) .

6.2 Sweden (P. van Hees)

1. Guidance on different tests necessary – is it correct that it has to be a full standard? The information can be seen as a collection of data and not really a standard and would require more severe application. Prefer to see a TR where we provide more data.
2. Not necessary to revise any tests currently.
3. If necessary for fire engineering, otherwise no need.

6.3 USA (J. Quintiere, T.Fritz)

TF – current document is more of a commentary of flame spread tests rather than guidance based on the physics of flame spread mechanism.
JQ – thesis from University of Maryland (presented at Interflam 2004) on

thermoplastics and also flame spread on Lithium batteries. Also there is a report from Ohlemiller at NIST on burning droplets.
There is also a report about to be issued on auto (vehicle) fires. Its recommendations are critical of the FMVSS 302 small-scale test of a small flame on a horizontal specimen. It also addresses issues of fire spread from the engine compartment and from gasoline pool fires.

6.4 Italy (S.Messa)

1. Fire spread related to all products. There is a need to apply to transportation such as ships and trains, especially how fast can people escape? Each test can be characterized by thermal attack (what is the level?)

2. Approach dripping as discontinuous spread of fire – ceiling falls down, part of wall delaminates and not at all restricted to plastics.

3. How fast is fire moving to CFE? CFE and rate of flame spread are parameters that can be used in modelling. Size of specimens is important. Test products in real end-use conditions, i.e. relevant mounting and fixing of test specimens and reproduce the geometry of thermal attack. ISO needs a ceiling spread of flame test. ISO 5658-2 could be modified in a similar way to the Italian test. This would probably involve develop of a new ISO procedure. Italy suggests move to intermediate scale test; e.g. products melting away before ignition need a larger scale test (155 X 800) and suggests move to 1mX 1.5m and end-use conditions. Some thermoplastics are ignited in intermediate scale but not in Italian test and vice versa. Propose ceiling test instead of vertical test.

6.5 UK (C. Lukas, K. Shaw)

1. Building applications and transport (ships and trains), not consumer products and small-scale tests. Keep as TS and not move to Full standard.
2. No revision other than ISO 5658-4
3. Follow the situation in FSE.
   WFRC have recently produced a code of practice on the flame spread of multi-layer paint surfaces; there is some guidance in this code that may of relevance to a new ISO document.

6.6 Germany (E. Antonatus)

1. Support retaining the nature of the document as TS.
2. Revision of other tests – Ensure that the views of other TCs are respected as well as the Vienna agreement.
3. Concern over the ceiling scenario – have to look at scale & end use and that would need to be defined in a separate Work item. ISO 9705 may not be appropriate and need to take into account scenario and application.

6.7 France (L. Chesne)

1. No flame spread requirement for building products but there is for marine products. ISO scope should be larger than building products. Some recent fires in France indicate that the fire spread was downward and spread from items stored on the balcony of a block of flats to products that were beneath. This is not generally a situation for building products but fire safety engineering/management problem.

2. No additions

3. Data is required for FSE. The flame-spread data is relevant for fire development. SC1 and SC4 need to work together to ensure that appropriate data is provided on flame spread parameters.

6.8 Canada (T. Crimi)

1. Two guidance documents would be preferred, i.e. one on flame spread tests and another on flame spread principles that would be useful for fire engineers and designers. Guidance should be in technical reports or TS.
2. No existing test revision, but this does not mean that a test in a different situation/ specimen is not possible or inappropriate. Scale may be more of an issue.
3. Probably textiles are a good area (NFP 701) and worthwhile undertaking.

7. Recommendations

7.1 That TS 5658-1 be revised as a 2-part TS document: -
Part A – Similar to 2nd Edition with an expanded scope
Part B – Targeted at requirements of fire safety engineers

7.2 That national ceiling tests be reviewed with an objective to develop/adopt one as an ISO standard.

7.3 That national/ISO textile product tests be reviewed with an objective to provide guidance on their use.

ISO/TC92/SC1/WG3 N470

Meeting of ISO/TC92/SC1/WG3 Spread of Flame Tests on Sunday 5th November 2006

Venue: University of Kyoto,
Clock Tower Centennial Hall,
Yoshida – Honmachi,
Sakyo-ku,
Kyoto 606-8501,
Japan

Meeting Time: 14:00 – 17:00h

Draft Agenda

		Doc. Ref:
1	Roll-call, apologies and membership	
2	Approval of Agenda	N470
3	Documentation	
4	Minutes of WG3 meeting in Ischia on 4th May 2006 and matters arising	N468
5	**ISO FDIS 5658-2**: Revision of ISO 5658-2:1996 Lateral flame spread on building and transport products in vertical configuration FDIS 5658-2 ballot and publication status	N453
6	**ISO DIS 14697**: Revision of ISO TR 14697: 1997 Guidance on the choice of substrates for building and transport products DIS 14697 ballot status	N466
7	**ISO TS 5658-1**: Revision of ISO TR 5658-1: 1997 Guidance on flame spread Publication status	N462
8	**ISO 5658-4**: Systematic Review of ISO 5658-4: 2001	
9	New Work Items on Flame Spread (a) PWI on Revision of TS 5658-1: 2006 Ref. SC1 Resolution 248 (San Antonio)	N469

(b) Other proposals

10 Report of WG3 to SC1

11 Any other business

12 Next meeting

peter.briggs@bodycote.com 28.09.2006

ISO/TC92/SC1N

ISO/TC92/SC1/WG3N471

Report of WG3 (Spread of Flame Tests) to ISO/TC92/SC1
Meeting in Kyoto, Japan on 8th November 2006

1. Membership

WG3 has representatives of 20 countries on its mailing list with experts from 10 countries generally attending the WG3 meetings.

2. Meetings

Since the SC1 meeting in Ischia on 5th May 2006, WG3 met in Kyoto on 5th November 2006.
(This report has been prepared prior to the Kyoto meeting and will amended before SC1 meets).

3. Documents

Since the last WG3 meeting in Ischia on 4th May 2006, WG3 has issued 6 documents (N468 to N473).

4. Progress Report on Current Work Items

4.1 **FDIS 5658-2** Lateral flame spread on building products in vertical configuration.

Project leader: P. Briggs Current stage: 60.00

The FDIS text was prepared and sent to ISO/CS.
The FDIS ballot (2 months) closed on 14th August 2006.
The result was 93.75% support; 15 P-members in favour, 1 P-member (France) disapproved). ISO 5658-2 (2nd Edition) was published on 15th September 2006.

Since this test method is specified in some regulations, it is suggested that some areas of this standard (such as updating of the precision statement and use with 'difficult to test' products) be kept under continuous review by WG3 at future meetings.

4.2 **TS 5658-1** Guidance on flame spread

Project leader: P. Briggs Current stage: 60.00

TS 5658-1 was published on 23rd March 2006.

In San Antonio, some members of WG3 considered that a more fundamental revision of the guidance on flame spread was required and further revision of TS 5658-1 with a modified scope (e.g. with more information on non-building applications) was agreed at the SC1 meeting in San Antonio (ref. Resolution 248).

Some preliminary discussions were held in Ischia based on document WG3N464. WG3 members made the following points: -

- A wider scope for the TS on flame spread tests is required.
- More attention should be paid to providing information on flame spread for Fire Safety Engineering. This could be based on data from LIFT, ICAL, etc.
- Some revision of ISO 5658-4 (vertical flame spread) may be useful.
- Test method(s) for ceiling and other products should be explored and considered as Preliminary Work Item(s).

At the WG3 meeting in Kyoto, the following proposals have now been made: -

4.3 **DIS 14697** Guidance on the choice of substrates for building and transport products

Project leader: P. Briggs Current stage: 40.20

The DIS (5 months) ballot terminated on 1st August 2006 and was 100% approved with 17 P-members in favour. Comments from Japan and UK were discussed in Kyoto and an FDIS text for submission to ISO/CS will be prepared for 31st December 2006.

5. Items for consideration by SC1

5.1 To continue more fundamental revision of TS 5658-1 at future WG3 meetings.

5.3 To progress ballot of FDIS 14697.

P J Briggs

Convenor

ISO/TC92/SC1/WG3

13th October 2006

Document: ISO/TC 92/SC 1/WG5N--

SC 1 N---

Date: 2006-09-29

From: ISO/TC 92/SC 1/WG5
To: Technical Programme Management Group

DRAFT NEW WORK ITEM PROPOSAL

Sub-committee: ISO/TC 92/SC1 (Fire Initiation and Growth)

Title of the proposal: Reaction to Fire Tests – Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)

Please answer all the questions below.

1 Proposed action for the proposal:

[X] Preliminary work

[ ] New Work Item ballot

[ ] Vienna Agreement

2 Are the appropriate resources available? Yes

Name of the project leader: M. Khan – USA

[X] Participants identified (at least 5 members – ISO Directives Part 1, clause 2.3.5) – please list if possible: The following countries and individual representatives are among those who are currently using the Fire Propagation Apparatus and would be expected to participate in the development of a standard: V. Dowling (Australia); G. Marlair (France); Tatsuo Ando (Japan); S. Messa (Italy); J. Torero, S. Grayson, S. Gregory (UK); M. Khan, N. Dembsey, R. Alpert (USA).

Note: As agreed at the 7 June 1999 meeting of ISO Technical Management Board, positive votes without the nomination of a technical expert will no longer be accepted as proof of commitment to participate.

3 Source and status of the first draft

[ ] Existing standard – please specify :
[x] Draft document from M. Khan

4 Please identify potential users of the standard (e.g. regulators, industry).

Regulators and the property insurance industry are expected to use results from the test methods and apparatus described in this document either to characterize directly the fire hazard of compartment lining materials in commercial establishments and industrial operations or as a screening tool for existing intermediate-scale and large-scale test methods. Fire measurements obtained from FPA test methods can also be used by fire safety engineers to evaluate material performance in a wide range of fire scenarios as part of a performance-based design.

5 Relationship with the strategy and the current work programme of the SC

The SC has developed and is currently developing small-scale test methods to characterize material flammability and combustibility. This proposed standard provides small-scale test methods for predicting material performance in fires that are based on decades of research published in the fire science literature. At the same time, the proposed standard provides methods quoted extensively in the fire science literature for obtaining measurement data that are needed to engineer the fire safety of materials. The proposed standard thus fits into the SC's strategy of developing test methods that will provide reliable data for fire safety engineering.

6 Consistency with the TC 92 strategy

This PNWI represents an important component of the dual-track TC92 strategy expressed in the document "Framework of Standards for Fire Safety", which describes standards tracks in support of both prescriptive and performance-based fire safety design and assessment. The proposed standard contributes to both of these TC92 objectives.

7 What contribution will this item make to FSE (e.g. as outlined in document N 851)?

See Item 5. The proposed standard will result in more widely accepted measurement data on convective and total heat release rate, ignition time and smoke generation rate to be used in FSE as part of the process of designing and constructing the built environment.

8 Liaison required (please specify)

Formal liaison is proposed as follows:

[ ] Other SCs of TC 92

[ ] Other ISO committees

[ ] IEC committees

[ ]

Regional standards bodies

9 Details of scientific references: See attached first draft
10 Additional information – none

ISO/TC92/SC1/WG5 meeting

8 November 2006,

Kyoto Japan

1. Opening of the meeting
2. Approval of the agenda N416
3. Membership
4. Report of Ischia & Toronto meetings N423/ N426
5 ISO CD 5660-4 N424/N425/ N426
6 Reduced Oxygen Cone calorimeter Std N428
7 Fire Propagation Apparatus N429/N430
8 ISO 5660-1 and ISO 5660-2 revision
9. Report to SC1 N431
10. Any other business
11. Arrangement of the next meeting

New docs for this meeting

N423 Report of Ischia meeting

N424 Convenors market up ISO5660-4 Draft
N425 Post Toronto TG, ISO 5660-4 market up draft
N426 Notes on Toronto TG meeting
N427 Voting Draft CD 5660-4
N428 Literature listing of Low oxygen heat release work
N429 TPMG form for
N430 Draft in support of N429
N431 Report top SC1
N432 Agenda for Kyoto meeting

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WG5 (RATE OF HEAT RELEASE TESTS) REPORT TO ISO/TC92/SC1 N432
8th November 2006

1 Membership

WG5 has 35 experts from 16 P-Members and 1 O-member of SC1.

2 Documents

Since the Ischia meeting of May 2006, WG5 has issued documents N422 through N431.

3 Work Items and their target dates

WG5 has 1 work item of ISO documents and 3 NWIP as shown in Table-1.

Table-1 Work Items in ISO/TC92/SC1/WG5

Work item	Title	Project Leader	Current Status	Target	
				CD	DIS
ISO 5660-4	Determination of low level of combustibility using Oxygen Consumption Calorimeter (cone calorimeter	T Crimi	DIS document under preparation	2006	2007
ISO5660-1&2		S Grayson	NWIP	2007	
	Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)	M Khan	NWIP	2007	
ISO 5660/?		S Gregory	NWIP	2007	

Progress report

4.1. Meetings: 1WG meeting has been held since the last SC1 meeting and 1 TG meeting.
The Task Group met in Toronto in June 2006 to finalise the CD draft for ISO 5660-4. The WG met in Kyoto, Japan in November 2006 and the following actions and recommendations were made.

4.2 CD 5660-4 Determination of low level of combustibility using cone calorimeter
A new draft integrating the comments of the CD1 ballot was undertaken and extensively discussed in Toronto by the TG. The revised document is now being balloted and we anticipate results by the spring meeting

4.3 Review of ISO 5660. A proposal for revision of ISO 5660-1 & 2 has been submitted to TPMG. In anticipation of this being successful the WG ask all interested parties to send details of required revisions to the convenor.

4.4 Inclusion of low oxygen environment testing protocol to ISO 5660 series.
A listing of publication of work using vitiated measurements of heat release in the cone calorimeter has been presented and will be further developed into a review. This showed extensive work in the area,

4.5. A New Work Item Proposal on the Fire Propagation Apparatus has been submitted to TPMG supported by a well developed WD. We ask SC1 to circulate the NWIP proposal ballot asap.

5 Arrangement of the next meeting

WG5 agreed that it needs 1/2 day for its next meeting to be held in ……

…..

ISO TC 92/SC 1

Date: 2006-07

ISO/DIS 5660-4

ISO TC 92/SC 1/WG 5

Secretariat: BSI

Reaction to fire tests - Heat release, smoke production and mass loss rate — Measurement of heat release for determination of low levels of combustibility

Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 5660-4 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

ISO 5660 consists of the following parts, under the general title *Reaction to fire tests - Heat release, smoke production and mass loss rate — Measurement of heat release for determination of low levels of combustibility*:

— *Part 1: Heat release rate (cone calorimeter method)*

— *Part 2: Smoke production rate (dynamic measurement)*

— *Part 3: Guidance on heat and smoke release rate*

Annex A of this part of ISO 5660 is for information only.

Reaction to fire tests - Heat release, smoke production and mass loss rate — Measurement of heat release for determination of low levels of combustibility

Scope

This part of ISO 5660 specifies a method for evaluating materials and products that produce low levels of heat release when exposed to high heat flux typical of fully developed fires. Measurement of heat release rate and total heat release is used to quantify the test specimens' ability to ignite and contribute heat to the fire.
It is based on the observation that generally, the net heat of combustion of a material is directly related to the quantity of oxygen required for its combustion. This relationship is such that approximately 13,1 x 10^3 kJ of heat are released per 1,0 kg of oxygen consumed.
This test method is intended to be used for products and materials that contain only small amounts of combustible elements, e.g. test specimens that yield total heat release less than 15 MJ m^{-2}. For test specimens that yield moderate to high total heat release the apparatus described in ISO 5660-1 should to be used.
Heat release is measured from the moment the specimen is subjected to the radiant thermal exposure of a conical heater and is continued for 20 min. The primary measurements are oxygen concentration and exhaust gas flow rate. Provision is also made for time to sustained flaming. This test method is used to evaluate specimens in a horizontal orientation under an external heat flux.
The information obtained from this test method can also be used for fire safety engineering purposes.
WARNING — The test procedures involve high temperatures and combustion processes. Therefore, hazards may exist for burns, ignition of extraneous objects or clothing, and for inhalation of combustion products. The operator should use protective gloves for insertion and removal of test specimens. Neither the cone heater nor the associated fixtures should be touched while hot except with the use of protective gloves.

Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.
ISO 5660-1:2002, *Fire tests — Reaction to fire — Part 1: Heat release (cone calorimeter method)*
ISO 13943: 2000, Fire safety - Vocabulary

Definitions

For the purposes of this International Standard, the definitions given in ISO 13943, and the following apply.
3.1
essentially flat surface
surface whose irregularity from a plane does not exceed ± 1 mm

3.2
flashing
existence of flame on or over the surface of the specimen for periods of less than 1 s

3.3
ignition
onset of sustained flaming as defined in 3.10

3.4
irradiance
(at a point of a surface) quotient of the radiant flux incident on an infinitesimal element of surface containing the point, and the area of that element

NOTE Convective heating is negligible in the horizontal specimen orientation. For this reason, the term "irradiance" is used instead of "heat flux" throughout this part of ISO 5660 as it best indicates the essentially radiative mode of heat transfer.

3.5
material
single substance or uniformly dispersed mixture

EXAMPLE Metal, stone, timber, concrete, mineral fibre and polymers

3.6
orientation
plane in which the exposed face of the specimen is located during testing, with either the vertical or horizontally face upwards

3.7
oxygen consumption principle
proportional relationship between the mass of oxygen consumed during combustion and the heat released

3.8
product
material, composite or assembly about which information is required

3.9
specimen
representative piece of the product which is to be tested together with any substrate or treatment

NOTE For certain types of product, for example products that contain an air gap or joints, it may not be possible to prepare specimens that are representative of the end-use conditions (see clause 7).

3.10
sustained flaming
existence of flame on or over the surface of the specimen for periods of over 10 s

3.11
transitory flaming
existence of flame on or over the surface of the specimen for periods of between 1 and 10 s

3.12
heat flux
incident flux imposed externally from the heater on the specimen at the initiation of the test. The specimen, once ignited, is also heated by its own flame.

Symbols

For the purpose of this standard the following symbols shall be used.

Symbol	Designations	Unit
A_s	initially exposed surface area of the specimen, 0.0207 m^2	m^2
C	orifice flow meter calibration constant	$m^{1/2}\,g^{1/2}\,K^{1/2}$

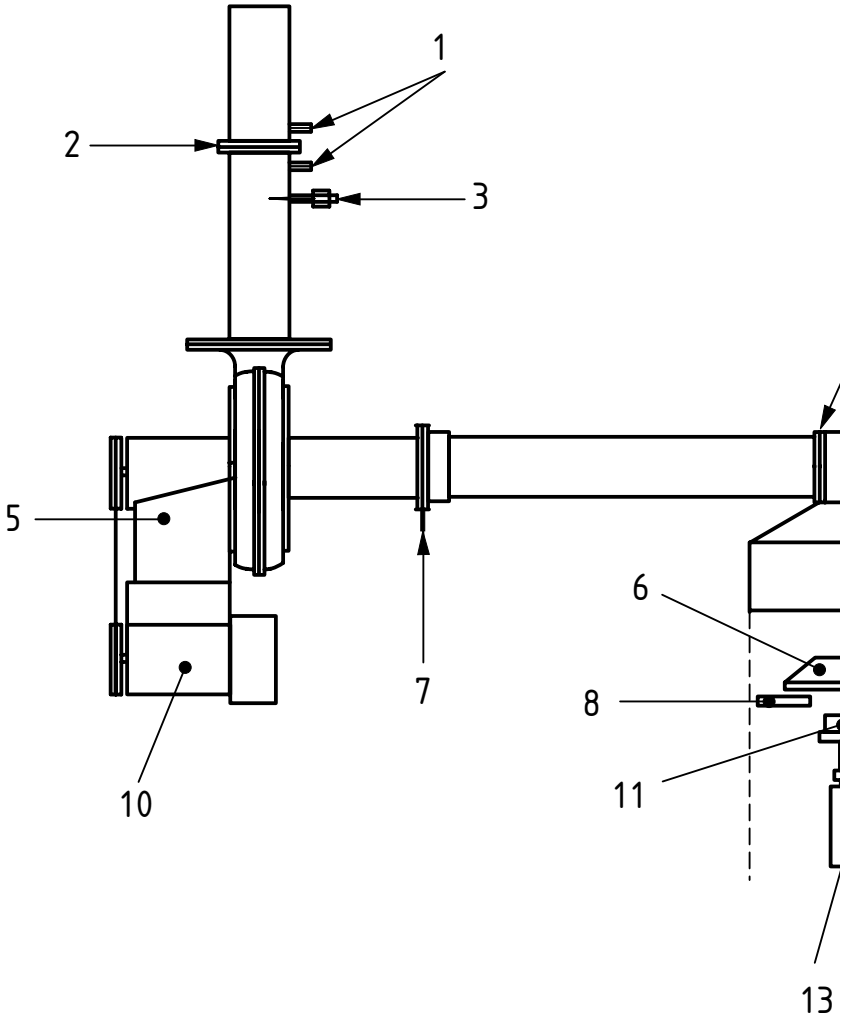
Δh_c	net heat of combustion	kJ g^{-1}
$\Delta h_{c,eff}$	effective net heat of combustion	MJ · kg^{-1}
m	mass of the specimen	G
Δm	total mass loss	G
m_f	mass of the specimen at the end of the test	G
m_s	mass of the specimen at sustained flaming	G
$\dot{m}_{A,10\text{-}90}$	average mass loss rate per unit area between 10 % and 90 % of mass loss	g · m^{-2} · s^{-1}
m_{10}	mass of the specimen at 10 % of total mass loss	G
m_{90}	mass of the specimen at 90 % of total mass loss	G
$\dot{m}$	mass loss rate of the specimen	g · s^{-1}
$\dot{m}_e$	mass flow rate in exhaust duct	kg s^{-1}
Δp	orifice meter pressure differential	Pa
$\dot{q}$	heat release rate	kW
$\dot{q}_A$	heat release rate per unit area	kW m^{-2}
$\dot{q}_{A,max}$	maximum value of the heat release rate per unit area	kW m^{-2}
$\dot{q}_{A,180}$	average heat release rate per unit area over the period starting at t_{ig} and ending 180 s later	kW m^{-2}
$\dot{q}_{A,300}$	average heat release rate per unit area over the period starting at t_{ig} and ending 300 s later	kW m^{-2}
$Q_{A,tot}$	total heat released per unit area during the entire test	MJ m^{-2}
r_o	stoichiometric oxygen/fuel mass ratio	1
T	time	S
t_d	delay time of the oxygen analyzer	S
t_{ig}	time to ignition (onset of sustained flaming)	S
Δt	sampling time interval	S
t_{10}	time at 10 % of total mass loss	S
t_{90}	time at 90 % of total mass loss	S
T_e	absolute temperature of gas at the orifice meter	K
X_{O2}	oxygen analyser reading, mole fraction of oxygen	1
X^0_{O2}	initial value of oxygen analyser reading	1
X^{-1}_{O2}	oxygen analyser reading, before delay time correction	1

Principle

Specimens are exposed in ambient air conditions, while being subjected to a heat flux of 75 kW/m^2 in the presence of a spark ignition source. Alternatively, testing may be conducted at an exposure of 50 kw/m^2 provided that there is ignition of the specimen at the 50 kw/m^2 exposure level, and there is no evidence of continued combustion after the 20 min test duration. The changes in oxygen (O_2) concentration of gases and exhaust gas flow rate are monitored and, from these data, heat release calculated. Additionally, the time to sustained flaming is observed and mass-loss rate is measured.
The exhaust system shall be checked for proper operation before testing and shall discharge into a building exhaust system with adequate capacity. Provision shall be made for collecting and venting any combustion products that shall for whatever reason fail to be collected by the normal exhaust system of the apparatus.

Apparatus

A schematic representation of the apparatus is given in Figure 1. The individual components are described in detail in 6.1 to 6.5.

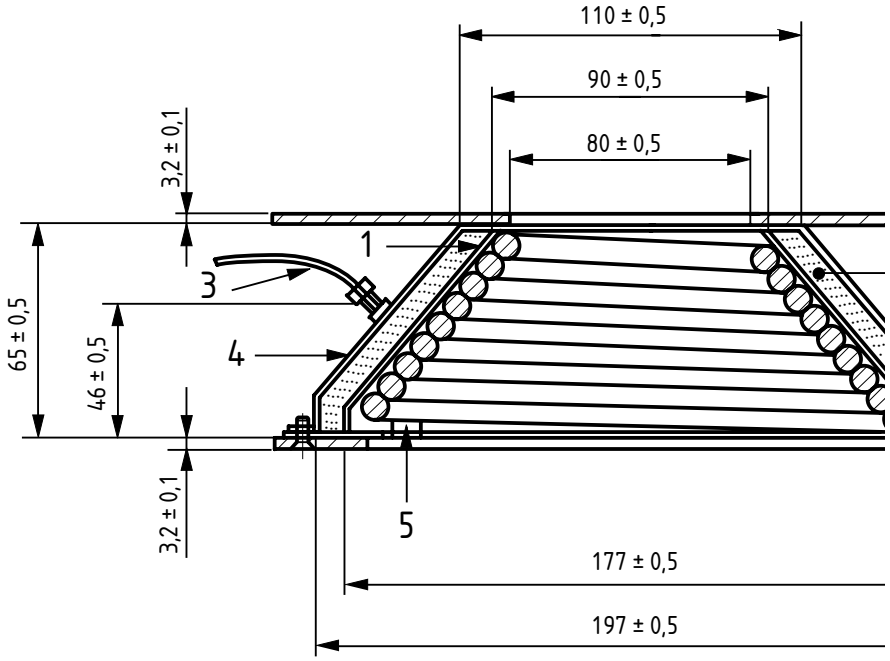


1 Pressure ports
2 Orifice plate
3 Thermocouple (located on stack centreline)
4 Hood
5 Blower
6 Heater
7 Gas sampling ring probe
8 Spark plug
9 Optional screen
10 Blower motor
11 Retainer frame and specimen
12 Specimen holder
13 Weighing device

Figure 1 — Apparatus

Cone-shaped radiant electrical heater

The active element of the heater shall consist of an electrical heater rod, capable of delivering 5 000 W at the operating voltage, tightly wound into the shape of a truncated cone (see Figure 2). The heater shall be encased on the outside with a double-wall stainless steel cone, filled with a refractory fibre blanket of nominal thickness 13 mm and nominal density 100 kg/m^3. The irradiance from the heater shall be maintained at a preset level by controlling the average temperature of three thermocouples (type K stainless steel sheathed thermocouples have proved suitable but Inconel or other high performance materials are also acceptable), symmetrically disposed and in contact with, but not welded to, the heater element (see Figure 2). Either 3,0 mm outside diameter sheathed thermocouples with exposed hot junction or 1,0 mm to 1,6 mm outside diameter sheathed thermocouples with unexposed hot junction shall be used. The heater shall be capable of producing irradiance on the surface of the specimen of up to 100 kW/m^2. The irradiance shall be uniform within the central 50 mm x 50 mm area of the exposed specimen surface, to within ± 2 %.



1 Inner shell
2 Refractory fibre packing
3 Thermocouple
4 Outer shell
5 Spacer block
6 Heating element

Figure 2 — Cone heater

Radiation shield

The cone heater shall be provided with a removable radiation shield to protect the specimen from the irradiance prior to the start of a test. The shield shall be made of non-combustible material, with a total thickness not exceeding 12 mm. The shield shall be one of the following, either:

a) water cooled and coated with a durable matt black finish of surface emissivity e = 0,95 ± 0,05; or

b) not water-cooled, which may be either metal with a reflective top surface or ceramic in order to minimize radiation transfer.

The shield shall be equipped with a handle or other suitable means for quick insertion and removal. The cone heater base plate shall be equipped with a mechanism for moving the shield into position.

Irradiance control

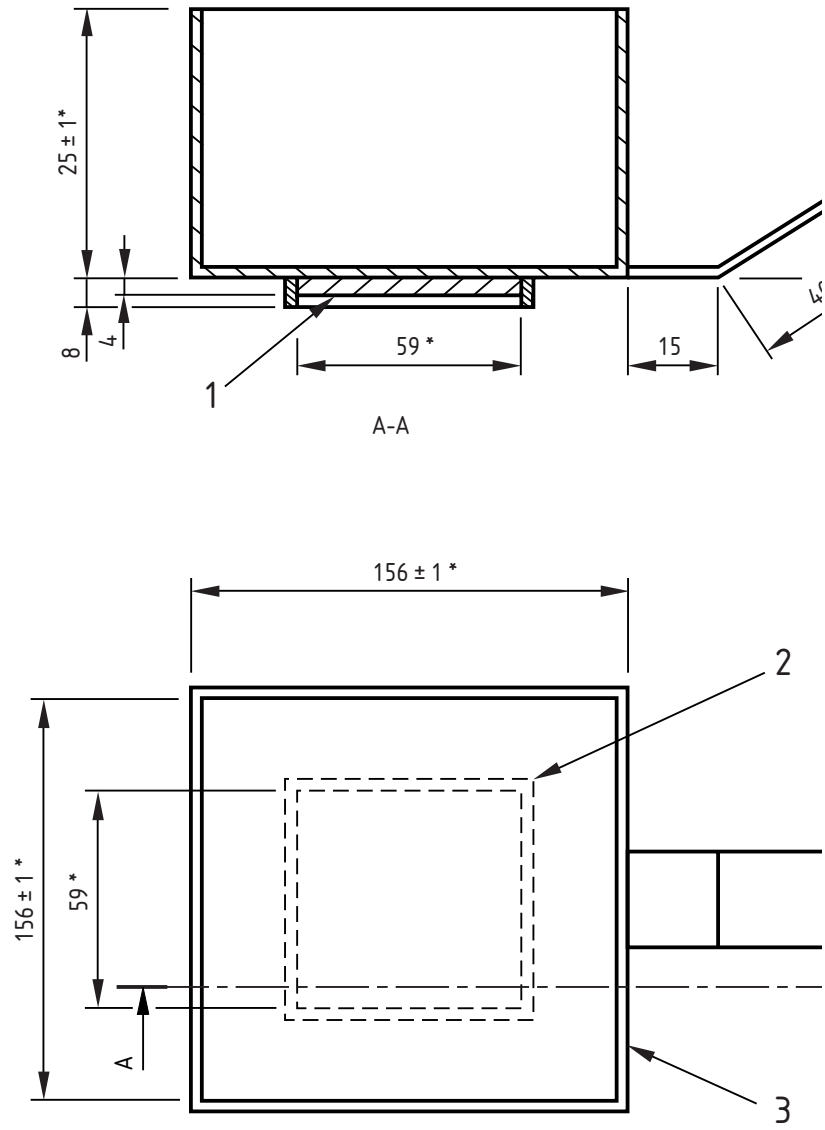
The irradiance control system shall be properly tuned so that it maintains the average temperature of the heater thermocouples during the calibration described in 10.1.2 at the preset level to within ± 10 ^{o}C.

Weighing device

The weighing device shall have an accuracy of ± 0,1 g or better, measured according to the calibration procedure described in 10.2.2. The weighing device shall be capable of measuring the mass of specimens of at least 2,0 kg. The weighing device shall have a 10 % to 90 % response time of 4 s or less, as determined according to the calibration described in 10.1.3. The output of the weighing device shall not drift by more than 1 g over a 30 min period, as determined with the calibration described in 10.1.4.

Specimen holder

The specimen holder is shown in Figure 3. The specimen holder shall have the shape of a square pan with an outside dimension of (156 ± 1) mm x (156 ± 1) mm at the top, and a depth of (25 ± 1) mm. The holder shall be constructed of stainless steel with a thickness of (2,4 ± 0,15) mm. It shall include a handle to facilitate insertion and removal, and a mechanism to ensure central location of the specimen under the heater and proper alignment with the weighing device. The bottom of the holder shall be lined with a layer of low density (nominal density of 65 kg/m^3) refractory fibre blanket with a thickness of at least 13 mm. The distance between the bottom surface of the cone heater and the top of the specimen shall be adjusted to be (25 ± 1) mm, except for dimensionally unstable materials for which the distance shall be (60 ± 1) mm (see 7.5.).

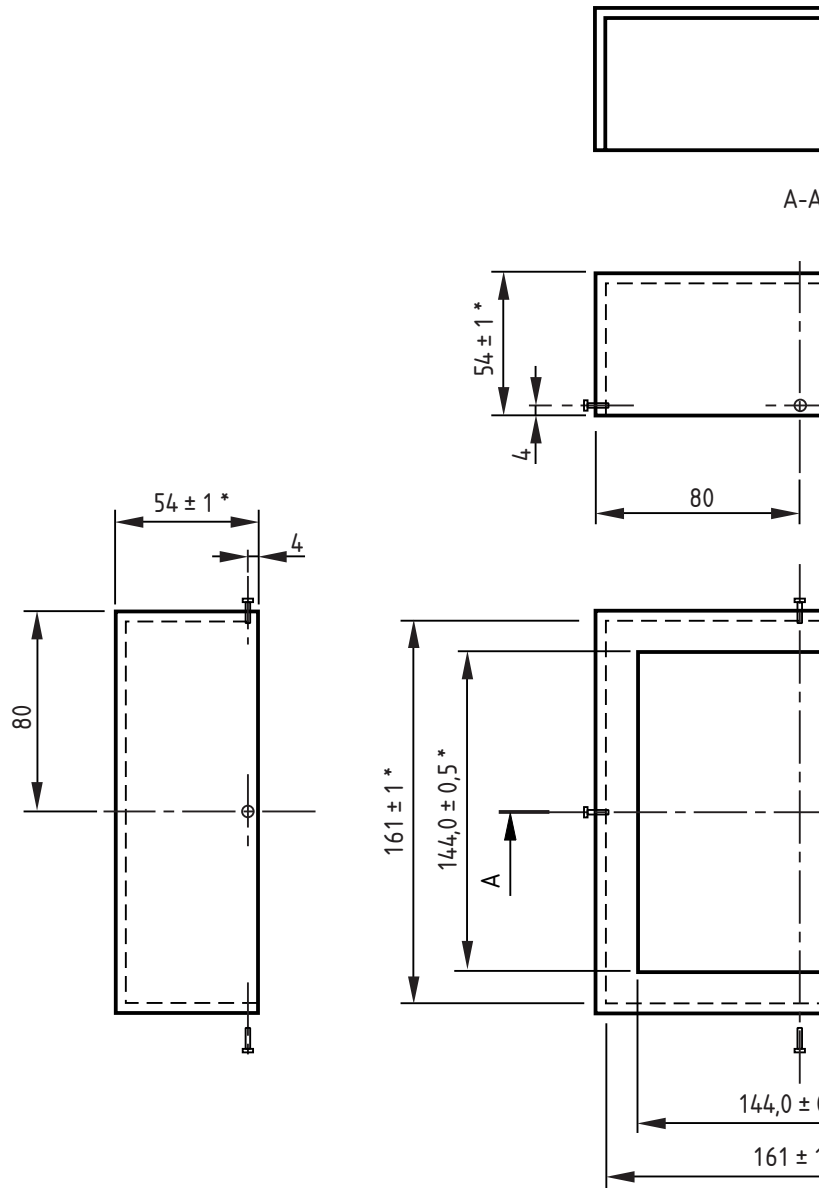


1 Stainless (mill smooth)
2 Spot weld, 4 corners
3 2.4 mm stainless steel

Figure 3 — Specimen holder

Retainer frame

The frame shall be constructed of stainless steel with a thickness of (1,9 ± 0,1) mm, in the shape of a box with an inside dimension of (161 ± 1) mm and a height of (54 ± 1) mm. The opening for the specimen face shall be (144,0 ± 0,5) mm square as shown in Figure 4. The retainer frame shall have an appropriate means to secure it to the specimen holder with the specimen in position.



1 1,9 mm stainless steel

Figure 4 — Edge frame

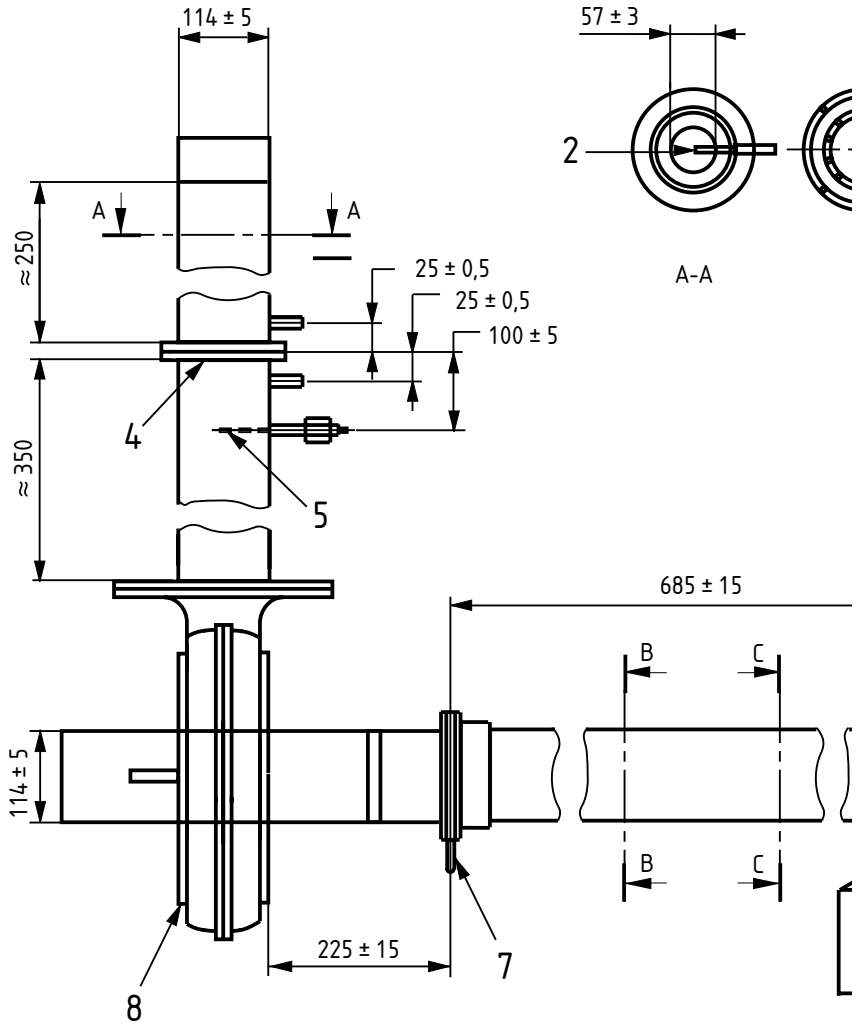
Exhaust gas system with flow measuring instrumentation

The exhaust gas system shall consist of a centrifugal exhaust fan rated for the operating temperatures, a hood, intake and exhaust ducts for the fan, and an orifice plate flow meter (see Figure 5). The distance between the bottom of the hood and the specimen surface shall be (210 ± 50) mm. The exhaust system shall be capable of developing flows up to 0,012 m^3/s, under standard conditions of temperature and pressure. The recommended location of the fan is indicated on Figure 5. As an alternative, it is acceptable to locate the fan further downstream and to have the measuring orifice before the fan, provided that the requirements described in the remainder of this clause are fulfilled.

A restrictive orifice with an internal diameter of (57 ±3) mm shall be located between the hood and the duct to promote mixing.

A ring sampler shall be located in the fan intake duct for gas sampling, (685 ± 15) mm from the hood (see Figure 5). The ring sampler shall contain 12 small holes with a diameter of (2,2 ± 0,1) mm, to average the stream composition, with the holes facing

away from the flow to avoid clogging with soot.
The temperature of the gas stream shall be measured using a 1,0 mm to 1,6 mm outside diameter sheathed-junction thermocouple or a 3 mm outside diameter exposed-junction thermocouple positioned in the exhaust stack on the centreline and (100 ± 5) mm upstream from the measuring orifice plate.
The flow rate shall be determined by measuring the differential pressure across a sharp edge orifice (internal diameter (57 ± 3) mm, thickness (1,6 ± 0,3) mm) in the exhaust stack, at least 350 mm downstream from the fan, if the latter is located as shown on Figure 5. If the fan is located further downstream than indicated in Figure 5, it is acceptable to locate the orifice plate between the ring sampler and the fan. However, in that case the length of the straight duct section on both sides of the orifice plate shall be at least 350 mm.



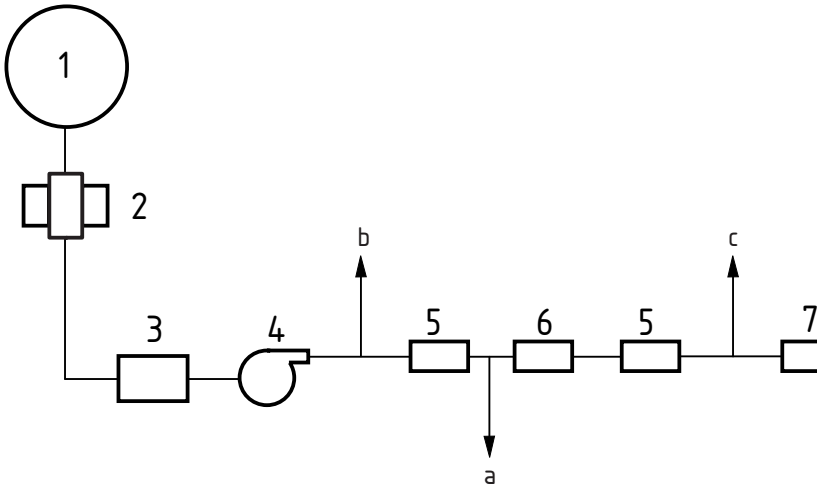
1 Gas sampling ring probe
2 Thermocouple
3 Hood
4 Orifice plate
5 Gas sampling ring probe (sample holes face blower)
6 Fan

Figure 5 — Exhaust system

Gas sampling apparatus

Gas sampling apparatus incorporates a pump, a filter to prevent entry of soot, a cold trap to remove most of the moisture, a by-pass system set to divert all flow except that required for the gas analysers, a further moisture trap and a trap for CO_2 removal. A schematic view of an example of the gas sampling apparatus is shown in Figure 6. Other arrangements which satisfy the requirements may be used. The transport delay time of the oxygen analyser, t_d, shall be determined according to 10.1.5, and shall not exceed 60 s.

NOTE If an (optional) CO_2 analyser is used, the equations to calculate the heat release rate can be different from those for the standard case (see clause 12 and annex F).



1 Ring sampler
2 Particulate filter
3 Cold trap and drain
4 Pump
5 Moisture tap
6 CO_2 removal trap
7 Flow controls
8 Oxygen analysers

a To optional CO_2 and CO analysers
b Waste
c Alternative position for waste

Figure 6 — Gas sampling and measurement system

Ignition circuit

External ignition is accomplished by a spark plug powered from a 10 kV transformer or spark igniter. The spark plug shall have a gap of (3,0 ± 0,5) mm. The electrode length and location of the spark plug shall be such that the spark gap is located (13 ± 2) mm above the centre of the specimen, except for dimensionally unstable materials for which the distance is (48 ± 2) mm (see 7.5).

Ignition timer

The ignition timer shall be capable of recording elapsed time to the nearest second and shall be accurate to within 1 s in 1 h.

Oxygen analyser

The oxygen analyser shall be of the paramagnetic type, with a range of at least 0 %

oxygen to 25 % oxygen. The analyser shall exhibit a drift of not more than 50 ppm of oxygen over a period of 30 m, and a noise of not more than 50 ppm of oxygen during this 30 min period, as measured according to 10.1.6. Since oxygen analysers are sensitive to stream pressures, the stream pressure shall be regulated (upstream of the analyser) to minimise flow fluctuations, and the readings from the analyser compensated with an absolute pressure transducer to allow for atmospheric pressure variations. The analyser and the absolute pressure transducer shall be located in an isothermal environment. The temperature of the environment shall be maintained to within 2 ^{o}C of a preset value between 30 °C and 70 ^{o}C. The oxygen analyser shall have a 10 % to 90 % of full-scale response time of less than 12 s, as measured according to 10.1.5.

Heat flux meters

The working heat flux meter shall be used to calibrate the heater (see 10.2.5). It shall be positioned at a location equivalent to the centre of the specimen face during this calibration.

This heat flux meter shall be of the Schmidt-Boelter (thermopile) type with a design range of (100 ± 0) kW/m^2. The target receiving the heat shall be flat, circular, of approximately 12,5 mm in diameter and coated with a durable matt black finish of surface emissivity e = 0,95 ± 0,05. The target shall be water-cooled. A cooling temperature which would cause condensation of water on the target surface of the heat flux meter shall not be used.

Radiation shall not pass through any window before reaching the target. The instrument shall be robust, simple to set up and use, and stable in calibration. The instrument shall have an accuracy of within ± 3 % and a repeatability to within ± 0,5 %.

The calibration of the working heat flux meter shall be checked according to 10.3.1, by comparison with two instruments of the same type as the working heat flux meter and of similar range held as reference standards and not used for any other purpose (see annex E). One of the reference standards shall be fully calibrated at a standardizing laboratory at yearly intervals.

Calibration burner

The calibration burner shall be constructed from tube with a square or circular orifice with an area of (500 ± 100) mm^2 covered with wire gauze through which the methane diffuses. The tube is packed with refractory fibre to improve uniformity of flow. The calibration burner is suitably connected to a metered supply of methane of at least 99,5 % purity. The accuracy of the flow meter shall be ± 2 % of the readout corresponding to a heat release rate of 1 kW. The accuracy verification shall be performed according to 10.3.3.

Data collection and analysis system

The data collection and analysis system shall have facilities for recording the output from the oxygen analyser, the orifice meter, the thermocouples and the weighing device. The data collection system shall have an accuracy corresponding to at least 50 ppm of oxygen for the oxygen channel, 0,5 ^{o}C for the temperature measuring channels, 0,01 % of full-scale instrument output for all other instrument channels, and at least 0,1 % for time. The system shall be capable of recording data every second. The system shall be capable of storing minimum of 720 data per parameter. The raw data recorded for each test shall be stored so that they can be recovered and used to check the accuracy of the software.

Optional side screens

For operational or safety reasons, it is permitted to guard the heater and sample holder

with side screens. However, it shall be demonstrated that the presence of the screens does not affect the ignition time and heat release rate measurements according to the procedure described in 10.1.7.

NOTE If the screens form an enclosure, attention is drawn to the fact that there is a possible explosion hazard when the instrument is not operated under conditions prescribed by this part of ISO 5660, in particular for experiments in oxygen enriched atmosphere. If an explosion hazard exists, proper precautions should be taken to protect the operator, e.g. by installing an explosion vent facing away from the operator.

Suitability of a product for testing

Surface characteristics

A product having one of the following properties is suitable for testing:

a) an essentially flat exposed surface;

b) a surface irregularity which is evenly distributed over the exposed surface provided that

   1) at least 50 % of the surface of a representative 225 mm^2 area lies within a depth of 10 mm from a plane taken across the highest points on the exposed surface; or

   2) for surfaces containing cracks, fissures or holes not exceeding 8 mm in width or 10 mm in depth, the total area of such cracks, fissures or holes at the surface does not exceed 30 % of a representative 225 mm^2 area of the exposed surface.

When an exposed surface does not meet the requirements of either 7.1 a) or 7.1 b), the product shall be tested in a modified form complying as nearly as possible with the requirements given in 7.1. The test report shall state that the product has been tested in a modified form, and clearly describe the modification.

Asymmetrical products

A product submitted for this test can have faces which differ or can contain laminations of different materials arranged in a different order in relation to the two faces. If either of the faces can be exposed in use within a room, cavity or void, then both faces shall be tested.

Materials of short burning time

For specimens of short burning time (3 min or less), the heat release rate measurements shall be taken at not more than 2 s intervals. For longer burning times, 5 s intervals may be used.

Composite specimens

Composite specimens are suitable for testing, provided they are prepared as specified in 8.3 and are exposed in a manner typical of end use conditions.7.5.

Dimensionally unstable materials

Samples that intumesce or deform so that they contact the spark plug prior to ignition, or the underside of the cone heater after ignition, shall be tested with the separation of 60 mm between the base plate of the cone heater and the upper surface of the specimen. In this case the heater calibration (see 10.2.5) shall be performed with the heat flux meter positioned 60 mm below the cone heater base plate. It should be noted that the time to ignition measured with this separation is not comparable to that measured with the separation of 25 mm.

Other dimensionally unstable products, for example products that warp or shrink during testing, shall be restrained against excessive movement. This shall be accomplished with 4 tie wires, as described below. Metal wires of (1,0 ± 0,1) mm diameter and at least 350 mm long shall be used. The sample shall be prepared in the

standard way as described in clause 8. A tie wire is then looped around the sample holder and retainer frame assembly, so that it is parallel to and approximately 20 mm away from one of the 4 sides of the assembly. The ends of the wire are twisted together in such a way that the wire is pulled firmly against the retainer frame. Excess wire is trimmed from the twisted section before testing. The 3 remaining wires shall be fitted around the specimen holder and retainer frame assembly in a similar manner, parallel to the three remaining sides.

Specimen construction and preparation

Specimens

8.1.1 Unless otherwise specified, three specimens shall be tested at each level of irradiance selected and for each different exposed surface.

8.1.2 The specimens shall be representative of the product and shall be square with sides measuring 150 $^{0}_{-2}$ mm.

8.1.3 Products with normal thickness of 50 mm or less shall be tested using their full thickness.

8.1.4 For products with a normal thickness greater than 50 mm, the requisite specimens shall be obtained by cutting away the unexposed face to reduce the thickness to 50 mm.

8.1.5 When cutting specimens from products with irregular surfaces, the highest point on the surface shall be arranged to occur at the centre of the specimen.

8.1.6 Assemblies shall be tested as specified in 8.1.3 or 8.1.4 as appropriate. However, where thin materials or composites are used in the fabrication of an assembly, the nature of any underlying construction can significantly affect the ignition and burning characteristics of the exposed surface.

The influence of the underlying layers should be understood and care taken to ensure that the test result obtained on any assembly is relevant to its use in practice.
When the product is a material or composite which would normally be attached to a well defined substrate, it shall be tested in conjunction with that substrate using the recommended fixing technique, for example bonded with the appropriate adhesive or mechanically fixed. In the absence of a unique or well-defined substrate, an appropriate substrate for testing shall be selected in accordance with ISO TR 14697.

8.1.7 Products that are thinner than 6 mm shall be tested with a substrate representative of end-use conditions, such that the total specimen thickness is 6 mm or more.

Conditioning of specimens

Before the test, specimens shall be conditioned to constant mass at a temperature of (23 ± 2) ^{o}C, and a relative humidity of (50 ± 5) % in accordance with ISO 554.
Constant mass is considered to be reached when two successive weighing operations, carried out at an interval of 24 h, do not differ by more than 0,1 % of the mass of the test piece or 0,1 g, whichever is the greater.
Materials such as polyamides, which require more than one week in conditioning to reach equilibrium may be tested after conditioning in accordance with ISO 291[1]. This period shall be not less than one week, and shall be described in the test report.

Preparation

Specimen wrapping

A conditioned specimen shall be wrapped in a single layer of aluminium foil, of 0,025 mm to 0,04 mm thickness, with the shiny side towards the specimen. The

aluminium foil shall be pre-cut to a size to cover the bottom and sides of the specimen and extend 3 mm or more beyond the upper surface of the specimen. The specimen shall be placed in the middle of the foil and the bottom and sides shall be wrapped. The excess foil above the top surface shall be cut if necessary so that it does not extend more than 3 mm above the top surface of the specimen. The excess foil at the corners shall be folded around the corners to form a seal around the top surface of the specimen. After wrapping, the wrapped specimen shall be placed in the specimen holder and covered by a retainer frame. No aluminium foil shall be visible after the procedure is completed.
For soft specimens, a dummy specimen having the same thickness as the specimen to be tested may be used to pre-shape the aluminium foil.

Specimen preparation

All specimens shall be tested with the retainer frame shown in Figure 4. The following steps shall be taken to prepare a specimen for testing:

c) put the retainer frame on a flat surface facing down;

d) insert the foil-wrapped specimen into the frame with the exposed surface facing down;

e) put layers of refractory fibre blanket (nominal thickness 13 mm, nominal density 65 kg/m^3) on top until at least one full layer, and not more than two layers extend above the rim of the frame;

f) fit the sample holder into the frame on top of the refractory fibre and press down; and

g) secure the retainer frame to the specimen holder.

Test environment

It is imperative to the results of this test method that good laboratory and operating procedures are practised at all times. For example, placement of the cone calorimeter in a draught free environment in an atmosphere of relative humidity of between 20 % and 80 % and a temperature between 15 °C and 30 °C; ensuring that the oxygen analyser and the pressure transducer are located in an isothermal environment to reduce the pressure variations; checking the CO_2 trap and the moisture traps daily, replacing sorbent daily if necessary and draining any accumulated water daily if necessary and performing daily calibrations of all operating instruments, including calculation of the “C” constant C.

Calibration

Preliminary calibrations

General

The calibrations in this section, except for that in 10.1.7, shall be performed before conducting experiments, when commissioning a cone calorimeter; or after maintenance, repair or replacement of the heater assembly or irradiance control system (10.1.2), the weighing device (10.1.3 and 10.1.4), the oxygen analyser or other major components of the gas analysis system (10.1.5 and 10.1.6). The calibration tests to determine the effect of side screens in 10.1.7 are conducted at the time the screens are installed. For a new instrument that is delivered with side screens, this shall be done by the manufacturer.

Weighing device response time

The cone heater shall not be turned on for this calibration. Place an empty specimen

holder with a (2000 ± 500) g non-combustible weight piece on the weighing device. The weight piece accounts for the retainer frame, which is not used during this calibration. Measure the weighing device output, and mechanically or electronically adjust the value to zero. Gently add a second non-combustible weight piece with a mass of (2000 ± 500) g on the holder and record the weighing device output. After equilibrium is reached, gently remove the second weight piece from the holder, and again record the weighing device output. Determine the response time of the weighing device as the average of the times for the weighing device output to change from 10 % to 90 % of its ultimate deflection.

Weighing device output drift

Set the height of the cone heater to the same position as when testing a specimen with the retainer frame. Place a thermal barrier on the weighing device. Turn on power to the exhaust fan and cone heater. Set an exhaust flow rate of (0,012 ± 0,002) m^3/s and an irradiance of (50 ± 1) kW/m^2. After reaching equilibrium of the heater temperature, remove the thermal barrier and place an empty specimen holder with a (2000 ± 500) g weight piece on the weighing device. The weight piece accounts for the retainer frame, which is not used during this calibration. After equilibrium is reached, measure the weighing device output and mechanically or electronically adjust the value to zero. Gently add a second weight piece with a mass of (1500± 500) g on the specimen holder. After equilibrium is reached, record the weighing device output. After 30 min, record the weighing device output. Calculate the drift of the weighing device output as the absolute value of the difference of the initial and final values.

Oxygen analyser delay and response times

The cone heater shall not be turned on for this calibration. Turn on the exhaust fan, and set an exhaust flow rate of (0,012 ± 0,002) m^3/s. Determine the delay time of the oxygen analyser by delivering a methane flow rate equivalent to 1 kW to the calibration burner. Light the burner outside the hood and allow flame to stabilize. Quickly introduce the burner underneath the hood, and leave the burner in position for 3 min. Then, remove the burner from underneath the hood and turn off the methane supply. Record the output of the analyser from the moment of insertion of the burner underneath the hood, until 3 min after removal of the burner. The turn-on delay is the time difference between insertion of the burner and the oxygen reading reaching 50 % of its ultimate deflection. Calculate the turn-off delay similarly. The delay time t_d is the average of at least three turn-on and turn-off delays. The oxygen concentration at a given time shall be taken as the concentration registered after the time interval t_d.
The response time of the oxygen analyser is calculated as the average for the turn-on and turn-off experiments of the time for the oxygen analyser output to change from 10 % to 90 % of its ultimate deflection.
For the purpose of measurement of the oxygen analyser delay and response time, the methane flow rate need not be controlled accurately, because the delay and response time is not sensitive to the oxygen level.

Oxygen analyser output noise and drift

The cone heater shall not be turned on for this calibration. Turn on the exhaust fan, and set an exhaust flow rate of (0,012 ± 0,002) m^3/s. Feed the oxygen analyser with oxygen- free nitrogen gas. After 60 min, switch to dried ambient air from the exhaust duct at the normal flow rate and pressure as for the sample gases. After reaching equilibrium, adjust the oxygen analyser output to (20,95 ± 0,01) %. Start recording the oxygen analyser output at 5 s intervals for a period of 30 min. Determine the drift by use of a least squares fitting procedure to fit a straight line through the data points. For the straight line fit, the absolute value of the difference between the reading at 0 and at 30 min represents the short-term drift. Determine the noise by computing the

root-mean-square deviation around the linear trend line according to the following formula:

$$rms = \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n}}$$

where

x_i is the absolute difference between the data point and the linear trend line.

Record this rms noise value in terms of ppm of oxygen.

Operating calibrations

General

The following calibrations shall be performed at the start of testing each day, in the order given below. The heater calibration shall also be performed when changing to a different irradiance level.

Weighing device accuracy

The weighing device shall be calibrated with standard weight pieces in the range of test specimen mass. The cone heater shall be turned off and the apparatus shall be cooled down to ambient temperature before this calibration is performed. Place an empty specimen holder with a (1000 ± 100) g weight piece on the weighing device. The weight piece accounts for the retainer frame, which is not used during this calibration. Measure the weighing device output, and mechanically or electronically adjust the value to zero. Gently add a weight piece with a mass between 500 g and 2000 g on the holder and measure the weighing device output after it reaches a steady value. Repeat this procedure at least four times after adding weight pieces of the same mass range. At the end of the calibration, the total mass of all weight pieces on the holder shall be at least 2000 g. The accuracy of the weighing device is determined as the maximum difference between the mass of the weight pieces and the weighing device output recorded during the calibration.

Oxygen analyser

Zero and calibrate the oxygen analyser. This calibration may be performed with the cone heater operating or not, but shall not be performed during heater warm-up. Turn on the exhaust fan, and set an exhaust flow rate of (0,012 ± 0,002) m^3/s. For zeroing, feed the analyser with oxygen-free nitrogen gas, with the same flow rate and pressure as for the sample gases. Adjust the analyser response to (0,00 ± 0,01) %. Calibration shall be similarly achieved using dried ambient air and adjusting for a response of (20,95 ± 0,01) %. Carefully monitor analyser flow rates and set to be equal to the flow rate used when testing specimens. After each specimen has been tested, ensure that a response level of (20,95 ± 0,01) % is obtained using dried ambient air.

Heat release rate calibration

Perform a heat release rate calibration to determine the orifice constant *C*. This calibration shall be performed with the cone heater operating or not, but shall not be performed during heater warm-up. Turn on the exhaust fan, and set an exhaust flow rate of (0,012 ± 0,002) m^3/s. Start collecting baseline data at 5 s intervals for a period of at least 1-minute. Introduce methane into the calibration burner using a calibrated flow meter at a flow rate corresponding to $\dot{q}_b$ = (1 ± 0,1) kW based on the net heat of combustion of methane (50,0 x 10^3) kJ/ kg). After the output from all instruments reach equilibrium, collect data at 5 s intervals over a 3 min period. Calculate the orifice constant *C* according to equation (5) in clause 12, using averages over the 3 min period of the measured values of $\dot{q}_b$, T_e, ΔP, and X_{O2}. X^0_{O2} is determined as the average of

the oxygen analyser output measured during the 1 min baseline measurements. An alternate procedure for performing this calibration consists of burning a suitable liquid fuel (e.g. ethanol) in a special pan that is placed on the weighing device. The average theoretical heat release rate is then obtained as the total mass of fuel burnt multiplied by the net heat of combustion of the fuel, and divided by the duration of flaming.

Heater calibration

At the start of testing each day or when changing to a different irradiance level, adjust the irradiance control system so that the conical heater produces the required irradiance to within ± 2 %, as measured by the heat flux meter. No specimen or specimen holder shall be used when the heat flux meter is inserted into the calibration position. Operate the cone heater for at least 10 min when stable at set point, and ensure that the controller is within its proportional band before beginning this calibration.

Less frequent calibrations

Operating heat flux meter calibration

At maximum intervals of 100 working hours, check the operating heat flux meter against the reference heat flux meter using one of the procedures described in Annex E. Comparisons shall be made at irradiance levels of (10, 25, 35, 50, 65, 75, and 100) kW/m^2. The readings from the two meters shall agree to within ± 2 %. If the operating heat flux meter is found to disagree with that of the reference meter by a constant factor (to within a ± 2 % spread) over the whole flux range, a new calibration factor is established for the operating heat flux meter and used for the heater calibration described in 10.2.5. If the operating heat flux meter can not be brought to within a ± 2 % agreement over the entire range by the use of a single, new factor, the operating meter shall be replaced.

Linearity of heat release rate measurements

At maximum intervals of 100 working hours, with the instrument calibrated at 5 kW according to 10.2.5, perform a further calibration with a flow rate corresponding to 1 kW ± 10 % and 3 kW ± 10 %, using the basic procedure as described in 10.2.5. With the value for *C* from the 1 kW calibration, the measured heat release rate at 2 and 3 kW shall be within ± 5 % of the set value.

Accuracy of calibration burner flow meter

The accuracy of the calibration burner flow meter shall be verified every 6 months or when the calibration factor determined according to 10.2.2 differs by more than 5 % from the value obtained during the first heat release rate calibration following the previous flow meter verification. To verify the accuracy of the flow meter, perform the burner calibration described in 10.2.4, with a reference flow meter in series with the operating flow meter. During the 3 min period of data collection, both flow meters shall agree to within ± 3 %. If the difference between the two measurements exceeds ± 3 %, the operating flow meter shall be re-calibrated as recommended by the manufacturer.

Test procedure

General precautions

WARNING - So that suitable precautions are taken to safeguard health, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases can be evolved during exposure of test specimens.
The test procedures involve high temperatures and combustion processes. Therefore,

hazards can exist such as burns or the ignition of extraneous objects or clothing. The operator shall use protective gloves for insertion and removal of test specimens. Neither the cone heater nor the associated fixtures shall be touched while hot except with the use of protective gloves. Care shall be taken never to touch the spark igniter which carries a substantial potential (10 kV). The exhaust system of the apparatus shall be checked for proper operation before testing and shall discharge into a building exhaust system with adequate capacity. The possibility of the violent ejection of molten hot material or sharp fragments from some types of specimens when irradiated cannot totally be discounted and it is therefore essential that eye protection be worn.

Initial preparation

11.2.1 Check the CO_2 trap and the final moisture trap. Replace the solvent if necessary. Drain any accumulated water in the cold trap separation chamber. The normal operating temperature of the cold trap shall not exceed 4 ^{o}C.

If any of the traps or filters in the gas sampling line have been opened during the check, the gas sampling should be checked for leaks (with the sample pump on), e.g. by introducing pure nitrogen, at the same flow rate and pressure as for the sample gases, from a nitrogen source connected as close as possible to the ring sampler. The oxygen analyser shall then read zero.

11.2.2 Adjust the distance between the base plate of the cone heater and the upper surface of the specimen as specified in 6.5 or 7.5.

11.2.3 Turn on power to the cone heater (see A.4.1) and the exhaust fan. Power to the gas analysers, weighing device and pressure transducer shall not be turned off on a daily basis.

11.2.4 Set an exhaust flow rate of (0,012 ± 0,002) m^3/s.

11.2.5 Perform the required calibration procedures specified in 10.2. Put a thermal barrier on top of the weighing device (for example, an empty specimen holder with refractory fibre blanket or water cooled radiation shield) in place during warm up and between tests to avoid excessive heat transmission to the weighing device.

11.2.6 Set the heat flux level of 75 kW/m^2. Alternatively, testing may be conducted at an exposure of 50 kw/m^2 provided that there is ignition of the specimen at the 50 kw/m^2 exposure level, and there is no evidence of continued combustion after the 20 min test duration.

Test procedure

11.3.1 Start data collection. Collect at least 3 min of baseline data prior to start a test. The scan interval shall be equal to or less than 2 s.

11.3.2 Insert the radiation shield in position. Remove the thermal barrier protecting the weighing device.

NOTE The radiation shield shall be cooler than 100 ^{o}C immediately prior the insertion.

11.3.3 Place the specimen, held in the specimen holder, onto the sample mount assembly. The holder shall be at room temperature initially.

11.3.4 Remove the radiation shield. This moment is the start of the test. Start the ignition timer, move the spark plug into place, and turn on spark power.

11.3.5 Record the times when flashing or transitory flaming occur. When sustained flaming occurs, record the time, turn off the spark, and remove the spark igniter. If the flame extinguishes in less than 60 s after turning off the spark, reinsert the spark igniter and turn on the spark. If flaming recurs, stop the test, discard the test data, and repeat the test without removing the spark until the entire test is completed. Report these events in the test report. Continue the test until 20 min pass after the start of the test.

NOTE For reporting the time of sustained flaming, the time to be reported is when the flaming was initially observed, not when the 10 s period elapsed.

11.3.6 At the end of the time period specified in 9.2.5, remove the sample from the holder and wait until all combustion products are gone. Record the end of test value for the oxygen analyser. The value should be within 100 ppm from the value recorded at the beginning of the test. If the value is not within the 100 ppm value, the test shall be run again.

NOTE Stop the test if explosive spalling or excessive swelling occur.

11.3.7 Insert the thermal barrier to protect the weighing device from irradiance.

11.3.8 Collect data at least 3 min after the specimen removal.

11.3.9 Make three determinations and report as specified in clause 11.

Test data limitations

The test data shall not be valid if:

a) explosive spalling occurs; or

b) the specimen swells sufficiently prior to ignition to touch the spark plug or swells up to the plane of the heater base during combustion.

Calculations

General

The equations in this clause assume only O_2 is measured as indicated on the gas analysis system in Figure 6. Appropriate equations for cases where additional gas analysis equipment (CO_2, CO and possibly H_2O) is used and CO_2 is not removed from the O_2 sampling lines can be found in annex F. If CO_2 is removed from the O_2sampling lines (even when CO_2 is separately measured), then the equations (5) to (7) hall be used.

Calibration constant for oxygen consumption analysis

The heat release calibration specified in 10.2.4 shall be performed daily to check for the proper operation of the instrument and to compensate for minor changes in determination of mass flow. A calibration more than 5 % different from the previous one is not normal and suggests instrument malfunction. The calibration constant, *C*, is calculated using

$$C = \frac{\dot{q}_{\mathrm{b}}}{(12{,}54 \times 10^3)(1{,}10)} \sqrt{\frac{T_{\mathrm{e}}}{\Delta \mathrm{p}}} \cdot \frac{1{,}105 - 1{,}5 X_{\mathrm{o}_2}}{X^0_{\mathrm{o}_2} - X_{\mathrm{o}_2}} \qquad (5)$$

where $\dot{q}_b$ corresponds to the rate of heat release (in kW) of the methane supplied (see 10.2.4), (12,54 x 10^3) kj/kg is $\Delta h_c/r_o$ for methane, 1,10 is the ratio of the molecular weights of oxygen and air.

Heat release rate

13.3.1 Prior to performing other calculations, calculate the oxygen analyser reading from the recorded analyser data and the delay time, t_d, using the following equation:

$$X_{\mathrm{o}_2}(t) = X^1_{\mathrm{o}_2}(t + t_{\mathrm{d}}) \qquad (6)$$

13.3.2 Calculate the heat release rate, $\dot{q}$ (*t*), from

$$\dot{q}(t) = (\Delta h_{\mathrm{c}} / r_{\mathrm{o}})(1{,}10) C \sqrt{\frac{\Delta p}{T_{\mathrm{e}}}} \cdot \frac{X^0_{\mathrm{o}_2} - X_{\mathrm{o}_2}}{1{,}105 - 1{,}5 X_{\mathrm{o}_2}} \qquad (7)$$

where $\Delta h_c/r_o$ for the specimen is taken as (13,1 x 10^3) kJ/kg, unless a more accurate

value is known, and X^0_{O2} is determined as the average of the oxygen analyser output measured during the 1-min baseline measurements.

13.3.3 Heat release per unit area can be obtained from

$$\dot{q}_A(t) = \dot{q}(t) / A_S \quad (8)$$

where A_s is the initially exposed area of the sample, .

Exhaust duct flow rate

The mass flow rate, in grams per second, in the exhaust duct is given by

$$\dot{m}_e = C\sqrt{\frac{\Delta p}{T_e}} \quad (9)$$

Mass loss rate

13.5.1 The mass loss rate, $-\dot{m}$, at each time interval can be calculated using the following five-point numerical differentiation equations:

For the first scan (i=0):

$$-[\dot{m}]_{i=0} = \frac{25m_0 - 48m_1 + 36m_2 - 16m_3 + 3m_4}{12\Delta t} \quad (10)$$

For the second scan (i=1):

$$-[\dot{m}]_{i=0} = \frac{3m_0 + 10m_1 - 18m_2 + 6m_3 - m_4}{12\Delta t} \quad (11)$$

For any scan for which 1 < I < n-1 (where *n* is the total number of scans):

$$-[\dot{m}]_i = \frac{-m_{i-2} + 8m_{i-1} - 8m_{i+1} + m_{i+2}}{12\Delta t} \quad (12)$$

For the next to last scan (i=n-1):

$$-[\dot{m}]_{i=n-1} = \frac{-3m_n - 10m_{n-1} + 18m_{n-2} - 6m_{n-3} + m_{n-4}}{12\Delta t} \quad (13)$$

For the last scan (i=n):

$$-[\dot{m}]_{i=n} = \frac{-25m + 48m_{n-1} - 36m_{n-2} + 16m_{n-3} - 3m_{n-4}}{12\Delta t} \quad (14)$$

$$\dot{m}''_{10-90} = \frac{m_{10} - m_{90}}{t_{90} - t_{10}} \cdot \frac{1}{A_s} \quad (14)$$

13.5.2 The mass loss rate which includes the "main" burning period, i.e., from 10 % of ltimate mass loss being lost to 90 %, is given by

$$\dot{m}_{A,10-90} = \frac{m_{10} - m_{90}}{t_{90} - t_{10}} \times \frac{1}{A_s} \quad (15)$$

where

$\Delta m = m_s - m_1$

$m_{10} = m_s - 0{,}10\Delta m$

$m_{90} = m_s - 0{,}90\Delta m$

NOTE Equations for the effective heat of combustion, $\Delta h_{c,eff}$, are given in annex C.

Test report

The test report shall contain the following information for each specimen except as noted:

a) name of manufacturer (and submitter where applicable);

b) date of test;

c) composition or generic identification;

d) specimen mass, kg;

e) specimen thickness, mm;

f) details of specimen preparation;

g) specimen mounting or other special mounting procedures used;

h) time to sustained flaming, s;

i) heat release rate curve;

j) peak heat release rate, kW/m^2;

NOTE Certain specimens may not show any visible signs of combustion or thermal degradation but may release heat.

k) total heat released by specimen, MJ/m2;

l) mass remaining after test, kg;

m) values determined in H, J and K above, averaged for all specimens;

n) additional observations, if any; and

o) difficulties encountered in testing, if any.

Annex A
(informative)

A.1 Background

A.1.1 Introduction

A.1.1.1 A brief history to give insight into the development of this method and to describe the rationale for the design of the various features of the apparatus is described in a paper by Carpenter, Karen and Janssens, M. [14]

A.1.2 Rate of heat release measurements

A1.2.1 The rate of heat release is one of the most important variables, in many cases the single most important variable, in determining the hazard from a fire. This rate of heat release is the total rate, as a function of time and irradiance. With many items, composed of many surfaces, contributing to a fire, the evaluation of rate of heat release is quite complex. For each separate surface, it should first be determined when, if at all, it will become ignited. The size of the fire from any already burning items should be known, since that constitutes the external irradiance to nearby items. Next, the flame spread over the surface in question should be evaluated. The rate of heat release from the whole surface can then be evaluated knowing the rate of heat release per unit area for a given irradiance, as a function of time. This last quantity is the only one that can be measured in a bench-scale test.

A.1.2.2 The total heat release from a fire then involves a summation of the heat release per unit area over the surface. Also to be considered is the fact that some elements may burn out and then no longer contribute to the fire. This procedure is conceptually straightforward but can be very cumbersome to compute.

A.1.2.3 Many common combustibles do not have the geometrically simple surfaces that are required to make computations of this kind. Other complications, such as melting, dripping, or collapsing can also preclude a detailed mathematical analysis. In such cases a simpler, more empirical model is appropriate. An example of the use of bench-scale heat release rate measurements in deriving a fire hazard assessment is available [1]. A number of apparatus have been developed over the years for measuring rate of heat release; most of these have been reviewed in detail [2]. Traditionally, the simplest measurement scheme is a direct measurement of flow enthalpy from a chamber thermally lagged to present an adiabatic environment. A truly abiabatic apparatus, with the use of guard heaters, would be possible but would also be prohibitively expensive and has not been implemented. A combustion chamber that is insulated in a simpler manner leads to a significant under measurement of the heat release, so that only an empirical calibration is possible. An example of such an insulated chamber method is ASTM Test Method E906. Furthermore, that calibration may be sensitive to the radiant fraction (or sootiness) of the combustible [3, 4]. A more advanced scheme is an isothermal instrument, rather than an adiabatic one, with the heat release rate taken to be that which should be supplied by a substitution burner to maintain isothermal conditions [5]. This scheme gives better results, since only second-order heat loss error terms remain; however, its practical implementation is complex and costly.

A.1.2.4 It can be concluded that it is difficult to measure heat directly without losing some of it. However, it is simple to capture all combustion products without losing any and to measure the oxygen levels in that stream. Heat release can be computed from such measurements with the availability of the oxygen consumption principle [6]. This principle states that for most common combustibles an amount of heat equal to 13,1 x 10^3 kJ is released for each kilogram of oxygen consumed from the air stream. This constant varies only about ± 5 % for most common combustibles; certain exceptions are given in [6]. The method remains useful even if a significant fraction of the products become CO or soot, rather than CO_2; in these cases, correction terms are known [6, 7] and can be applied.

A.1.3 Variability of rate of heat release results

A.1.3.1 The rate of heat release depends on many factors, some of which cannot be controlled. Samples that produce a surface char, a layer of adherent ash, or those that are composites or laminates, may not attain a steady-state release rate. Thermally thin specimens, that is, specimens whose unexposed surface changes temperature during the period of test, will also not attain a steady-state release rate. Therefore, release rates for a given material will depend, for example, on how the material is used, its thickness, and the method of mounting.

A.1.4 Heater design

A.1.4.1 Experience with various rate-of-heat-release measurement techniques suggests that for minimal errors in irradiance, the specimen should see only: (a) a thermostatically controlled heater, (b) a water-cooled plate or (c) open air. Nearby solid surfaces, if they are not temperature-controlled, can rise in temperature due to specimen flame heating and then act as further sources of radiation back to the specimen. Further, when oxygen consumption is used as the measurement principle, a gas-fired heater is not desirable because it can contribute a noisy baseline to the oxygen readings, even though it can be subtracted out in steady state.

A.1.4.2 A heater in the shape of a truncated cone was first explored for use in an ignitability apparatus by ISO (see ISO 5657). The heater adopted in the present method is similar, but not identical to the ISO one. The main differences include higher heat fluxes, temperature control, and more rugged design details. In the horizontal orientation, the conical shape approximately follows the fire plume contours while the central hole allows the stream to emerge without impacting on the heater. A thin layer of cool air is pulled along and the flames do not attach to the sides of the cone. The central hole has a further function; in its absence the middle of the specimen would receive a higher irradiance than the edges. With the hole, the irradiance is uniform to within ± 2 %. In the vertical orientation, the hole still serves the purpose of providing radiation uniformity; although because of the presence of a natural convection boundary layer, the deviations are higher (from ± 5 % to ± 10 %) [8].

A.1.5 Pilot ignition

A.1.5.1 Ignition of test specimens in many apparatus is achieved by a gas pilot. This tends to have numerous difficulties - sooting, deterioration of orifices, and contribution to heat release rate. It is difficult to design a pilot that can be centrally located over the specimen, is resistant to blowout, and yet does not apply an additional heat flux to the specimen. A point of elevated heating on the specimen makes it difficult to analyze mathematically the response of the specimen. An electric spark is free of most of these difficulties, requiring only an occasional cleaning and adjustment of the electrodes. For these reasons, an electric spark ignition was adopted.

A.1.6 Back face conditions

A.1.6.1 The heat losses through the specimen back face can have an influence on the burning rate near the end of its burning time. For reproducible measurements, the losses through the back face should be standardized. The simplest theoretical boundary conditions - an adiabatic boundary, or an isothermal one at ambient temperature - are not achievable. However, a reasonable approximation to the former can be made by using a layer of an insulating material. This is easier to do for the horizontal orientation case, in which case a very low density refractory blanket is used. In the vertical orientation some structural rigidity of the backing is desired; consequently, a layer of higher density backing may be necessary.

A.1.7 Oxygen analyzer

A.1.7.1 The analyzer should be of the paramagnetic type, with baseline noise and short-term drift of approximately ± 50 ppm oxygen. Other types of analyzers (for example, electrochemical and catalytic) generally cannot meet this requirement. Paramagnetic analyzers also exhibit an intrinsically linear response. The linearity is normally better than can be determined with ± 0,1 % oxygen gas mixtures. Since an oxygen analyzer is sensitive to stream pressures, either the readings have to be compensated with an absolute pressure transducer, connected to the analyzer, or the pressure has to be mechanically regulated both against flow fluctuations and atmospheric pressure variations. The analyzer and the pressure regulating or measuring devices should be located in a constant temperature environment to avoid flow errors.

NOTE For additional information pertaining to the oxygen analyser delay and response time as well as noise and drift, it is suggested that 10.1.5 and 10.1.6 be performed for 1 day, thereby providing a better understanding of the performance of the O_2 analyser.

A.1.8 Effective heat of combustion

A.1.8.1 The effective heat of combustion is a constant during combustion of homogeneous specimens having only a single mode of degradation and is less than the value of the theoretical net heat of combustion. Examples of a material with a single mode of degradation and, therefore, a constant effective heat of combustion include most organic liquids. Cellulosic products, by contrast, typically show more than one mode of degradation and a varying effective heat of combustion. For materials having more than one mode of degradation, or for composites or non-homogeneous materials, the effective heat of combustion is not necessarily constant.

A.1.9 Specimen mounting methods

A.1.9.1 The test method presented here is a general method, suitable for testing different types of products and materials. These are not the only specimen mounting methods available to the testing laboratory. Reference [9] suggests some additional procedures. For more unusual specimen types, the testing laboratory will have to devise appropriate mounting methods. Since different mounting methods may give different test results, the method used should be documented in the test report, as stated in 11.16. Since test results are inevitably affected by such mounting devices, they should not be used unless prior testing indicates that they are necessary to alleviate anomalous burning conditions.

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ISO/TC92/SC1/WG10 – Calibration of Heat Flux Meters

Place: SWRI, San Antonio, Texas, USA
Date: November 16, 2005

1 Attendants

V. Dowling	Australia
E. Antonatus	Germany
S. Messa	Italy
B. Messa	Italy
Y. Hayashi	Japan
H. Onuma	Japan
K. Yoshida	Japan (SC1 Conv)
P. Van Hees	Sweden (Act. Conv)
P.J. Briggs	UK
M. Di Carlo	UK (SC1 secr.)
S. Grayson	UK
S. Gregory	UK
C. Lukas	UK
K. Shaw	UK
T. Fritz	USA

2 Opening of the meeting and approval of the agenda

P. Van Hees opened the meeting and mentioned that he would act as convenor as I. Wetterlund could not attend. The agenda N109 was approved.

3 Membership and apologies for absence

Apologies for absence were received from I. Wetterlund, J. Nakos, J-R Filtz, A. Cornelissen.

4 Documents

The following documents have been released for the meeting or discussed at the meeting. Documents N111 and N112 were distributed at the meeting:

107	Sweden	04/05	I. Wetterlund	Minutes Ulster-05 meeting
108,rev1	Sweden	04/05	I. Wetterlund	Updated document list for San Antonio meeting
109	Sweden	10/05	I. Wetterlund	Agenda San Antonio-05 meeting
110	Sweden	10/05	I. Wetterlund	Report to SC1 meeting San Antonio -05 (SC1 N927)
111	Japan	11/05	K.Yoshida	DIS text 14934-3
112	Japan	11/05	K.Yoshida	DTS text 14934-4

5 Minutes of Belfast meeting

No comments were given on the minutes. The minutes from the meeting were approved. The acting convenor thanked himself for taking the notes.

6 ISO TS 14934-1 – General principles

(SC1 N924)

The convenor explained that WG10 and SC1 had decided to start a PWI to launch the

revision of the part 1 document. However in the systematic review of the document there was a majority for confirmation of the standard. The need for revision is high so it was decided to ask the SC1 to decide on a review anyhow and to take appropriate actions. This could mean a start of a NWI ballot but M. Di Carlo would try to solve this through a resolution and send this to Geneva. If a NWI ballot had to be prepared it was decided that I. Wetterlund would prepare the necessary forms and be the proposed project leader.

7 ISO/DIS 14934-2 –Primary methods

The convenor explained that the document was out for FDIS ballot. M. DiCarlo informed that the deadline for ballot was extended to January. The convenor advised the members to check with their standardisation body whether a vote was submitted. As the document was out for ballot no further discussion was made.

8 ISO/DIS 14934-3 –Secondary methods

(N111)

K. Yoshida had entered the changes with respect to the comments on the DIS ballot. He explained the changes by means of the comment table N105. There were a few items to be synchronised with the WG10 convenor but it was clear that the document was ready for FDIS ballot. The proposed text from W. Grosshandler was not received so K. Yoshida had provided a text he thought would cover the comment. As the members only received the document in the morning it was decided that they could consult the document and check if the changes decided on were introduced in N111. The deadline for remaining remarks to be sent to K. Yoshida and I. Wetterlund would be the 15th of December. After that date the document would be sent out for FDIS ballot. No decision was necessary from SC1 as this was already decided on.

9 ISO/DTS 14934-4 –Guidance

(N112)

K. Yoshida had entered the changes with respect to the comments on the ballot. He explained the changes by means of the comment table N94. There were a few items to be synchronised with the WG10 convenor but it was clear that the document was ready for publication. Only the figures needed some changes but this would be done the week after the SC1

meetings at BSI by K. Yoshida and M. Di Carlo. As the members only received the document in the morning it was decided that they could consult the document and check if the changes decided on were introduced in N112. The deadline for remaining remarks to be sent to K. Yoshida and I. Wetterlund would be the 15th of December. After that date the document would be sent out for publication. No decision was necessary from SC1 as this was already decided on.

10 Report to SC1

(N110)

It was decided to adapt the draft report according to N110rev taking into account the decisions made at the meeting.

11 Next meeting

The next meeting will be in Ischia, Italy on Wednesday May 4 at 1100.

12 Any other business

None

13 Closing of meeting

The convenor thanked the members for the constructive meeting, thanked the hosts SWRI and closed the meeting.

P. Van Hees

DTR25752 US comments

2006/10/07 (Sat) 2:26
Magda
I have decided to put it on the agenda for ISO TC92/SC1 WG11 for one last try to resolve the US comments. If there isn't anyone there who can explain what they are looking for and who is prepared to sit down with me and make the changes, then we should progress it as it is.
Regards
Debbie

From: Magda DiCarlo [mailto:Magda.DiCarlo@BSI-GLOBAL.COM]
Sent: 14 September 2006 13:40
To: Smith, Debbie; koichiy@nmri.go.jp
Subject: RE: Result of DTR ballot - 17252
Dear Debbie
It is basically up to you as the project leader and WG convener. As far as the official ballot is concerned, your document has received 100 % approval and no comment. On this basis, we could proceed to publication and ignore the US vote, which was sent by e-mail (and therefore not the accepted route).

Even if we accept the US vote, it will be the only negative vote and therefore will not make a difference to the overall result. However, as we want to publish the best document we can, could you please read the US comment again and see whether there is anything in there that could improve the document or should be included (e.g. the standards they are suggesting). Please let me know if you would like to introduce any changes.

If you don’t accept their comment, you could just report to WG 11 that the US comment was noted, but no action taken (for whatever reason) and the document has been sent for publication. Or you could table the US comment at the WG 11 meeting and ask members’ views. You will probably hear something from the US delegation whatever you choose to do.
Please let me know what you decide to do.
Kind regards
Magda

From: Smith, Debbie [mailto:SmithDA@bre.co.uk]
Sent: 13 September 2006 18:21
To: Magda DiCarlo; koichiy@nmri.go.jp
Subject: RE: Result of DTR ballot - 17252
Magda
What is normally done in such a case ? Are we required to respond to the USA comments or can we simply ignore them ? Your advice would be appreciated.
Best wishes
Debbie

From: Magda DiCarlo [mailto:Magda.DiCarlo@BSI-GLOBAL.COM]
Sent: 13 September 2006 16:42
To: Smith, Debbie; koichiy@nmri.go.jp
Subject: FW: Result of DTR ballot - 17252
Hello
I have not heard from either of you. Should I tell ISO to publish the document or would you like to discuss it in Kyoto?
Many thanks
Magda

From: Magda DiCarlo
Sent: 30 August 2006 11:43
To: Debbie Smith (SmithDA@bre.co.uk)
Cc: 'Koichi Yoshida'
Subject: Result of DTR ballot - 17252
Dear Debbie

I enclose the official result of the DTR ballot on your document. The result is positive, with no comment.

I have also received the vote below using e-mail rather than the new voting application. This is the only negative vote with comments.

The United States vote to disapprove document ISO/DTR 17252, Fire tests - Applicability of reaction to fire tests to fire modeling and fire safety engineering. The reason is given below:

The United States rejects this document because it fails to deliver the information promised in the Scope and Introduction. The promised information on the extraction of data from fire tests for use in FSE may possibly be somewhere in the Annex, but that is not easily determined. If the information is indeed to be found in the Annex, it should have been summarized in a one-page Table and put into the main body of the report as the final Clause.

In addition, the subject document should reference and acknowledge the latest (as of 29 June 06) published ISO FSE standards, namely ISO IS 16734, 16736 and 16737, as well as ISO TS 16732, as ongoing examples of work actively being done to extend and implement with more detailed standards the abstract concepts in TR 13387 upon which the first several Clauses in the subject document are based.

The document is an excellent compilation and description of the fire standards within TC92/SC1, and as such, the information should not be lost. Perhaps it can be published under a different Title, Scope and Introduction, more indicative of the type of document it is.

Best regards,

Maryse Depas-Medina
For the ANSI ISO Team

I also enclose the document as circulated for DTR ballot. As the vote is overwhelmingly positive and there was only one comment, we could proceed to the publication without waiting for the November meeting.

Please let me know how you propose to deal with the US comments and whether I should submit the document for publication (subject to any final corrections you might suggest).

I am copying this e-mail to Koichi for his opinion.

Many thanks

Magda

ISO TC 92/SC 1

Date: 2006-07-13

ISO/DIS 5660-4

ISO TC 92/SC 1/WG 5

Secretariat: BSI

Reaction to fire tests - Heat release, smoke production and mass loss rate — Measurement of heat release for determination of low levels of combustibility

Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21489 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

Introduction

In recent years, there has been an increased demand to specify methods of analysis of fire gases for use in toxic hazard assessment. Although scientific consideration on such toxic hazard assessment should be conducted based upon the international standards of ISO TR 9122 series and ISO TR 13387 series, a simplified and practicable gas measurement technique has been anticipated, because such toxic threat has been a great concern to the public.

International Maritime Organization (IMO) has developed international regulations applied to ships within the framework of the International Convention of Safety of Life at Sea (SOLAS Convention) by which the use, in ships, of interior finish materials/products which give off extensive heat, smoke and toxic gases/vapours in fire is prohibited. The evaluation method of characteristics of heat release, flame spread, smoke and toxicity produced from such materials/products is provided in the International Code for the Application of Fire Test Procedures (FTP Code) of IMO, which is a mandatory instrument under SOLAS. The evaluation method for smoke and toxicity uses ISO 5659-2 *Plastics - Smoke generation - Part 2: Determination of optical density by a single-chamber test* as heating and burning method for specimen and specifies additional fire effluent gas measurement requirements to be applied during the smoke tests. However, it does not specify any gas measurement method. Therefore, there is also a need to specify such gas measurement method.

ISO 5659-2 is currently under revision and changes introduced in the second edition concerning the heating methods for test specimens will also apply to ISO 21489.

WARNING -- So that suitable precautions can be taken to safeguard health, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases can be evolved during combustion of test specimens.

Reaction to fire tests - Heat release, smoke production and mass loss rate — Measurement of heat release for determination of low levels of combustibility

Scope

This draft International Standard specifies methods of measurement of gases developed in cumulative smoke/fire tests, using Fourier transform infrared spectroscopy (FTIR) . Particular attention is given to the gas sampling systems and conditions of gas measurement.
It should be noted that there are fire effluents other than gases, such as particles, smoke or vapours which may be toxic and that some gases such as hydrogen halides may be trapped by moisture in sampling lines or by filters designed to remove only smoke particles.
Gas measurement using FTIR in cumulative smoke/fire tests is useful in providing information for qualitative and quantitative hazard analysis in a fire safety engineering approach. Gas measurement by FTIR can be carried out in a short time interval, and will give a set of time-base data of gas concentration. Measurement of gas concentration by FTIR can be carried out in a regular short intervals throughout the test.

Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.
ISO 5659-2:1999, *Plastics — Smoke generation — Part 2: Determination of optical density by a single-chamber test*
ISO 13943 2000, *Fire safety — Vocabulary*
ISO 19702, *Toxicity testing of fire effluents — Analysis of gases and vapours in fire effluents using FTIR technology*

Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 and ISO 19702 apply.

Principle

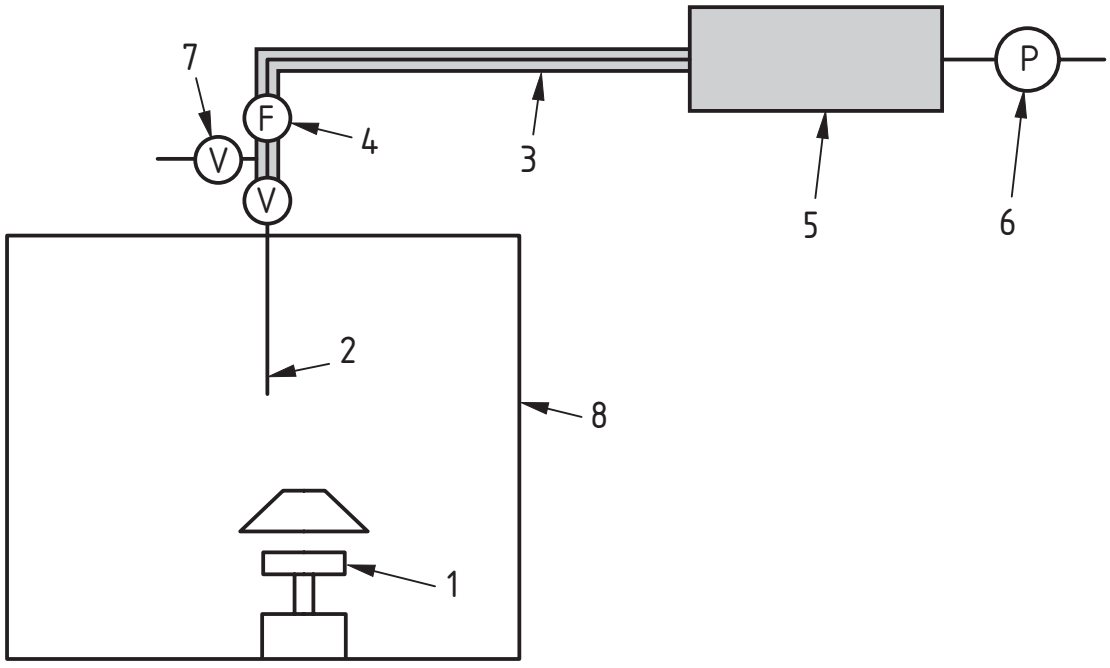
Fire effluents are sampled from a cumulative smoke chamber of a smoke test (ISO 5659-2) where the volume of the chamber is known. The fire conditions in these tests shall be established for the application of data from gas measurement to fire hazard analysis using fire safety engineering. Gas sampling shall be such that the sample represents the gas, the fire effluent, in quality and quantity, in the chamber, and that any affect of gas sampling systems (probes, pipes, tubes and pumps) is minimized. It is also recommended to minimize the travelling time and distance of fire effluent through the gas sampling system. A filtering system for fire effluent shall be installed within the gas sampling system to prevent smoke particles from entering the gas analyser. FTIR shall be used to analyse the sampled gas.

Apparatus for combustion of specimen

Test apparatus and ancillary equipment specified in ISO 5659-2 (e.g. smoke chamber, specimen support and heating arrangements, fuel gas supply, photometric system and other measurement devices) shall be used.

Gas sampling system

Gas sampling system shall consists of a probe, filter, gas transfer line, gas flow indicator, gas temperature monitor, gas pressure indicator and pump. Gas analyser shall be at the end of the sampling line up-stream of the pump. An example of the gas sampling system is shown in Figure 1



Key

(1)	cylindrical heater of the chamber and sample	(6)	pump for gas circulation
(2)	sampling probe of fire effluents	(7)	valve
(3)	heated gas sampling line	(8)	smoke chamber
(4)	heated soot filter		
(5)	heated measuring cell of the IRTF spectrometer		

Figure A.1 — An example of gas sampling system

Probe an gas sampling line

A suitable probe for sampling gases in the cumulative smoke chamber is a pipe of inner diameter of (4,0 ± 1,0) mm. The open end shall be directed downwards at the geometric centre of the chamber. The material of the probe shall be of corrosion resistant type and shall not be affected by the temperature in the smoke chamber during the tests.

The sampling line, which transfers the gases from the chamber and filter unit to the analyser, shall be made of corrosion resistant material. The line shall be kept at a constant temperature of (175 ± 5) ^{o}C. The inner diameter of the sampling line shall be (4,0 ± 1,0) mm. The length between the probe and the soot filter shall be as short as possible and in any case no more than 4 m. The presence of bends and joints shall be minimised.

If HF is to be analysed, glass sampling probe shall be prohibited.

Filter

General

The FTIR and other analysers shall be protected, by a filter unit, from contamination of soot and other solid particles that are often contained in fire effluents. The filter unit shall be such that the filter element can be easily changed. The filter unit shall be placed, as far as practicable, between the chamber and the sampling line.

NOTE 1 Some laboratories use a ‘dirty cell’ in their FTIR apparatus and this allows small amounts of soot to enter the gas cell. However, this equipment is not recommended for regular use when fire tests are conducted for a wide variety of materials and products. When testing sooty materials in cumulative smoke procedures such as ISO 5659-2, it has been found that the needle valve controlling the pressure in the FTIR apparatus can become blocked within a few minutes.

NOTE 2 Depending on the gases to be analysed, a special care should be taken when choosing the filter. Interaction between the media of filter and gases should be checked.

Filter material

A cylindrical filter of diameter of (20 ± 2) mm with a length of (75 ± 5) mm and porosity of 2 micron should be used.
If a planar filter is used, it should have a porosity of 5 micron and a diameter of approximately 47 mm. Glass wool or glass fibre membranes are suitable for filtering most gas effluents but they should not be used when testing fluorine-containing materials. The filter housing should be made of stainless steel or other corrosion resistant material. The filter and the housing shall not be affected by the temperature, to which the filter unit is heated.

NOTE 1 Filters of different size and porosity may be suitable. The selection of filter porosity in the range 1 to 5 microns is based on compromise between trapping the soot before it reaches the gas cell and avoidance of choking up the filter. For test in which dense soot is produced, clogging of 47 mm diameter planer filter may happen.

NOTE 2 Glass wool filter is not suitable for sampling gas contained HF and/or HBr condition of the filter

Conditions of the filter

The temperature of the filter and sampling line shall be maintained at (175 $\pm$ 5) ^{o}C, which shall be measured at the housing of the filter and the appropriate place(s) of the outer surface of the sampling line.

Filter correction

Some gases (such as HCl and HBr) may be absorbed on the filter and it will be necessary to determine the quantity retained at the end of the test. A correction may then be applied to the total yields of these gas species (see ISO 19702). The correction cannot be applied to the concentration/ time curve since the quantity of gas species trapped on the filter cannot be determined at every gas measuring time during the test.

NOTE Annex A gives the details of analysis method.

Gas temperature indicator

A gas temperature indicator shall be placed in the sampling line, at least at the inlet, at the outlet to soot filter and one in a middle point between them, to indicate that the gas temperature is maintained at (175 ± 5) ^{o}C.

Gas pressure indicator

A gas pressure indicator shall be placed in the sampling line close to the entrance of the FTIR cell to indicate that pressure in the sampling line and the gas cell is kept constant and no pressure drop due to clogging occurs. For this purpose, a gas pressure indicator installed to the gas cell can be used.

Pump

A pump shall be connected to the outlet of the gas cell of FTIR (see Figure 1). The pump shall have a capacity of approximately twice the inner volume of the gas cell plus gas sampling line per minute and the sampling flow rate of the heated gases shall be kept constant. Clogging is avoided in the sampling line and the filter unit and the flow is sufficient to provide the necessary volume of gases to the analyser. The pump shall be heat resistant at a temperature of (175 ± 5) ^{o}C

Gas analysis technique

An FTIR system described in ISO 19702 shall be used. Gas analysis during a cumulative smoke test shall be done at least when smoke density reaches the maximum (see clause 8).

Calibration

Calibration of gas measurement for gases to be measured shall be carried out in accordance with ISO 19702.

Test procedure

Operation before each test

p) Make sure that no gas other than gases in ambient air is indicated when the gas cell is filled with clean ambient air.

q) The filter element shall be changed prior to the start of the test.

r) The inlet of the probe shall be cleaned and a new prime tube filter, if used, shall be fitted.

s) Temperature of the filter unit, the sampling line and gas return line shall be increased and maintained to a constant temperature of (175 ± 5) ^{o}C.

t) Start the pump and ensure that pressure in the sampling line or the gas cell remain constant close to the ambient pressure and temperature of the gas (air) in the sampling line and gas rerun line remain within (175 ± 5) ^{o}C for 10 min. Then, the pump is stopped.

NOTE It is recommended, before any smoke test is started in a day, to carry out a dummy gas measurement where the ambient air in smoke chamber is sampled and analysed by the normal test procedure, and make sure that no gas is detected. It is also recommended that such a dummy gas measurement be carried out whenever a questionable gas measurement result is obtained. It is also recommended that this screening measurement be carried out after the smoke chamber is cleaned by volatile solvent.

Operation during a test

8.2.1 The pump shall be started at the commencement of the test. The valves in the sampling line are placed so that the air outside the smoke chamber is introduced into the gas cell of FTIR.

8.2.2 When the measured value of smoke density in the test chamber reaches the maximum equilibrium level, gas sampling shall be started by switching the valves in the sampling line.

NOTE 1 Because smoke in the test by ISO 5659-2 is accumulated in the smoke chamber, it is normally observed that the smoke density during the test shows a single increase after the commencement of the test and then shows a maximum equilibrium level, and the smoke density goes down. The maximum equilibrium level of smoke density is easily determined as the smoke density stops increasing and reaches equilibrium.

NOTE 2 If the gas analysis is conducted in a interval, the gas sampling and analysis may be started immediately after the commencement of the test. The interval can be determined according to the performance of the FTIR.

If the smoke chamber pressure drops below the permitted minimum as specified in ISO 5659-2 by any phenomena of the combustion of the sample, the gas inlet valve fitted to the smoke chamber will be automatically opened according to ISO 5659-2. If this happens, this shall be reported.

If the smoke chamber pressure goes up beyond the permitted maximum as specified in ISO 5659-2 by any phenomena of the combustion of the sample, the gas outlet valve fitted to the smoke chamber will be automatically opened according to ISO 5659-2. If this happens, this shall be reported.

Gas analysis

Gas analysis shall be carried out in accordance with ISO 19702.

NOTE For the tests carried out under the requirement of SOLAS, types of gas to be analysed is specified in FTP Code of IMO.

Precision

Precision of gas measurement at cumulative smoke tests has not been obtained.

NOTE 1 Precision of gas measurement by FTIR methodology in conjunction with dynamic heat release measurement by ISO 5660-1 has been presented in ISO 19702, which gives precision data of gas measurement by FTIR.

NOTE 2 Precision data of smoke measurement as well as burning/smouldering behaviour of materials are available in ISO 5659-2.

NOTE 3 A round robin exercise is being conducted and precision data, which will be obtained by the round robin exercise, will be added to this standard.

Test report

The test report shall contain the following information for each specimen:

u) name and address of the test laboratory;

v) name and address of the sponsor of the test(s);

w) name and address of the manufacturer or supplier of the specimen;

x) date of test;

y) full description of the product tests including trade name, identification mark, construction, thickness, density and where appropriate the face subject to test

z) description of the substrate used, and method of fixing the specimen onto the substrate;

aa) data from the test including:

bb) duration of the test (from the start of the exposure of the specimen to the heat source until the end of the gas analysis);

1) time delay from the start of the exposure of the specimen to the heat source to the determined time when smoke density reaches the maximum;

2) time delay from the start of the exposure of the specimen to the heat source to the start of the gas analysis;

3) results of measurement of gas concentration;

4) interval of gas measurement, if the measurements were carried out in a interval;

5) data regarding the test equipment, including

i) the inner volume of the gas cell and the sampling line

ii)capacity of the pump

iii) reference to this standard;

iv) reference to a test report of smoke measurement which is carried out in conjunction of the test.

Annex B
(informative)

Analysis of filtering materials and sampling lines for gas retention evaluation

Acid gases may be absorbed on soot retained by the filter. When the total amount of one specific acid gas has to be measured, the quantity retained on the filter has to be added to the total amount of HCl analysed by FTIR.

B.1 Washing procedures for filters

— circular filters :

  — after each test, the filter is removed and placed in a minimum volume of water (analytical quality) ;

  — the solution (water and filter) is placed in an ultrasonic bath for at least 10 min ;

  — the solution is gauged to a known volume before analysis. (Analytical methods such as titrimetry or Ion Chromatography could be used information can be found in the ISO CD 19701)) ;

— cylindrical filters :

  — two methods could be proposed. The first one is the same as those described for circular filters:

  — for the second one, the filter is washed with hot water in a Soxlhet for approximately 20 min. Then the solution is gauged to a known volume before analysis. (Analytical methods such as titrimetry or Ion Chromatography could be used.)

NOTE The same protocol (with Soxlhet) can be used to wash new filters. The filters have to be dried before use (250 °C in an oven is acceptable).

B.2 Washing procedures for transfer line and probe

The transfer line and the probe are rinsed with water (analytical quality). Before rinsing the systems their temperatures should be around 70 °C to avoid the vaporisation of water. For each part of the sampling system the washing solutions are collected in volumetric flasks and the solutions are gauged to a known volume before

analysis by appropriate analytical methods.

B.3 Adjusting total concentration

When a total amount of gas evolved during combustion is measured, the calculation for the gases adsorbed on the filter should be made adding the total amount of gas analysed by FTIR (area under the curve concentration versus time) and the total amount of “trapped” gas analysed in the “washing” solution.

NOTE Before performing the calculation it might be necessary to transform the two values of concentration to the same unit.

ISO/TC92/SC1/TG5 N 022

Future strategy of ISO/TC 92 SC1 Reaction to fire

TC 92/WG7 and the TC 92 Task Group on future strategy have asked SC1 to consider a new work programme to develop a new generation of standards for the next ten years.

This issue was discussed by SC1 at its November 1997, and by TG 5 on April 5 1998 and the following future strategy was agreed.

Area 1. Fire safety engineering (FSE)

Test protocols, measuring techniques and procedures for securing data of fundamental fire properties.

Some parameters are frequently used to describe fire phenomena for example thermal inertia and heat of vaporisation assuming that they reflect fundamental fire properties. However, there are no standardised test procedures to measure these parameters. In addition some of them needs to be better defined.

Test protocols, measuring techniques and procedures for input data to FSE models.

There is already a number of tests used for FSE, for example the cone calorimeter and the spread of flame tests. However, more work is needed to further develop these tests and to standardise new procedures that are specially dedicated to FSE.

Standards on design fires relating to scenarios and characteristic fire growth of products.

Recommendations of design fires are given, for example, in the SC4 documents. However, due to lack of input data they often represent a worst case scenario and the safety estimates based on these recommendations will be conservative. However, there is a lot of input data, for example on characteristic fire growth, that can be used better to define design fires. Standards can be improved and new ones can be created using existing data.

Area 2. Performance codes

Test protocols for reference scenarios.

Reference scenarios are frequently used; for example, there are large scale tests used to determine the capacity of a small scale test to estimate the hazard of a certain product or to predict a certain burning behaviour under a realistic fire condition. A prominent example of this principle is the use of the SC1 test ISO 9705 by the European Commission as a reference scenario for the harmonised classification system of surface linings. Reference scenario tests are also needed for direct assessments of complicated systems. Examples are tests for facades, sandwich panels and staircases.

Test protocols, measuring techniques and procedures for fire calorimetry.

Fire calorimetry is the technology to measure heat release rate from a fire in a product or a whole system. This technology finds its use in a quickly growing field. However, the standards for the different applications vary in quality in as regards the fire calorimetry. In addition, large scale applications of this technique are being developed. Furthermore, the measurement technology itself is still being refined. Therefore, standardisation of general measuring procedures of high quality is much needed.

Area 3. Prescriptive codes

Updating tests already in use.

Many SC1 tests are widely used, for example by IMO, industry, insurance companies and national regulators. It is very important to ensure that these standards are regularly reviewed and updated.

Area 4. Test Validation

Protocols to determine the precision of fire test procedures

Repeatability and reproducibility data are often presented in a way that makes it very difficult to understand how useful a test is for its purpose. An approach is needed to define a procedure for determining the precision of a test procedure in directly applicable way for the user/specifier. In addition levels of acceptable precision for a fire test should be defined.

Test protocols for validation of fire growth predictions

The fire growth rate and various parameters needed to estimate the hazard can be calculated using different models. Procedures are needed to validate these models, for example a standardised test protocol, for example validation of calculations for building and tunnels.

Area 5. Instrumentation

Protocols for measurement technologies used in fire test procedures

Certain measuring instruments, for example heat flux meters, are crucial when calibrating test apparatus. International standards are needed for calibration of these instruments. Other examples of urgent need for standards are measurement techniques of combustion gases including certain toxic gas species (FTIR) and smoke particle characterisation. Test procedures for flame spread and estimates of the burning area often rely on visual observations and therefore become operator dependant. Therefore a standard measuring technique is needed.

Area 6. Environment

Procedures for providing input on environmental issues arising from the production of fire effluents.

Fire effluents can affect people, equipment and/or the environment. The source term ”fire effluent” needs to be expressed and characterised in a standardised way to allow for realistic estimates of its impact on the environment. The situation today is often unclear and open to speculation.

ISO/TC 92/SC1/TG5
Future strategy

NOTES OF THE FOURTH MEETING OF ISO/TC 92/SC 1/TG 5 HELD ON 26 MARCH 2002 AT SAI, SYDNEY, AUSTRALIA

PRESENT:

Bjorn Sundstrom	**Chairman**
Peter Briggs	Convener, WG 3

Alicje Cornelissen	Canada
Tom Fritz	USA
Patrick Van Hees	Convener, WG 7
Sylvio Messa	Italy
Ken Shaw	Acting Convener, TG 6
Nigel Smithies	ISO/TC 21 liaison
Joe Urbas	USA
Koichi Yoshida	Convener, WG 5

Magdalena Di Carlo **Secretary**

1 APOLOGIES FOR ABSENCE

Apologies were received from Debbie Smith and Ingrid Wetterlund.

2 NOTES OF THE 19 MAY 1999 MEETING

The notes in document N 019 were approved.

3 REPORT FROM TPMG

The Chairman reported from the last TPMG meeting, held on 23 March 2002. The meeting had mainly concentrated on the framework document and a number of changes had been agreed. A revised document had been circulated for consideration by the sub-committees and TC 92. It was important for SC 1 to identify any tests suitable for FSE, as there would be support for this work.

The Chairman further reported that two work item proposals from SC 3 had been endorsed. Also, a proposal from the International Finance Corporation (World Bank) to develop a document on fire safety management had been discussed. Funding would be provided for this work.The next plenary meeting of TC 92 would be held in September 2003 in Norwood near Boston, USA. The next TPMG meeting was scheduled for October in Europe and its main purpose would be to develop a model level 1 standard, which would influence all the other new generation standards produced by TC 92.

4 FRAMEWORK FOR THE LONG-TERM FUTURE OF FIRE SAFETY

The Chairman invited members to consider the revised framework document. Dr Yoshida suggested that it would be useful to have one reference scenario for all staircases, not just one. The Chairman said that any reference scenario should represent a number of cases, as for example ISO 9705 represented a number of situations. It was suggested that the reference scenarios should be evaluated for their correlation with real world situations. It was also suggested that more realistic tests should be produced as reference scenarios could be confusing.

It was agreed that reference scenarios were very important and should be included in Figure 2. It was suggested that the framework document should be circulated outside TC 92 for comment, especially to product TCs. It was also suggested that the terms 'end use', 'product', 'material' and 'assembly' should be clarified in the document. Dr Yoshida suggested that TC 92 should provide test methods and guidance documents to product TCs, otherwise they would produce their own fire tests. TC 92 could ask product TCs about their needs and try to meet those needs. It was suggested that a new figure should be added, illustrating the concept of TC 92 as a horizontal committee, developing fire tests for various product TCs.

The Chairman agreed to present these views at the SC 1 meeting.

5 LONG-TERM STRATEGY FOR SC 1

The Chairman took members through the strategy document (N 022) and highlighted the areas, in which there was no activity at present. There was no work in area 1 on fundamental fire properties and in area 4 on validation of fire growth predictions. Also, nothing had been done in area 6 on environmental issues.

The Chairman outlined his ideas for new work items for SC 1.

A reaction to fire test for post-flashover conditions had been suggested by Japan some time ago, but no written proposal had been submitted so far. This would include information on how particular materials burned and what they produced, such as toxic effluent. It was suggested that existing small-scale tests could be used to determine how materials decomposed at high temperatures, such as the reduced box test. Also, the contribution to flashover from the linings in the room corner test could be considered. As some research in this area was available in Japan, Dr Yoshida agreed to produce an

outline for the next meeting of SC 1.

Action: Dr Yoshida

The Chairman also suggested a reference scenario for cables, based on the existing research (FIPEC, NIST and BRE) which would allow comparison of different test methods. This was not intended as a test method assessing the performance of cables in fire. Different types of cables would be taken into account and also the role of cables in suspended ceilings. It was agreed that Dr Van Hees would review the existing research material with a view to finding reference scenarios. The work item would be allocated to WG 7.

Action: Dr Van Hees

The Chairman proposed an item on pipe insulation using the room corner test, both vertical and horizontal. It was agreed that this item could be developed in WG 7, with Dr Daems as project leader.

The Chairman said that SC 1 had no activity on validation of models. He suggested an item on a model data set based on the room corner test. This could be produced on a CD.

The Chairman also proposed an item on open calorimetry for testing large items (furniture, TV sets), using ISO 9705 extraction system. Existing ASTM and Nord tests could be used as a basis of this project. The document would provide guidance on the procedure and open configuration. It was agreed that Mr Fritz would collect all the available data in this area, for consideration at the next meeting of SC 1.

Action: Mr Fritz

The Chairman suggested organising a workshop on fire growth, using the standard package and how it was used for performance design. It was intended for fire safety engineers and designers, industry and regulators.

Mr Briggs suggested an item on roof lights, which would cover both reaction to fire and fire resistance, but would not overlap with any work in SC 2. This would cover discontinuous flame spread associated with flaming debris. Mr Briggs agreed to prepare a proposal for the next meeting of SC 1.

Action: Mr Briggs

6 PACKAGING OF SC 1 STANDARDS

The Chairman suggested that information about the SC 1 standards and guidance on how to use them could be posted on the publicly available area of the ISO server. This could include the scopes of all the documents.

7 SC 1 DEFINITIONS

This would be discussed at the SC 1 meeting.

8 ANY OTHER BUSINESS

Dr Van Hees and Dr Yoshida reported on the problems with ISO editors and delays in the circulation of documents caused by ISO.

9 DATE OF NEXT MEETING

The next meeting would be arranged when required.

MAGDALENA DI CARLO