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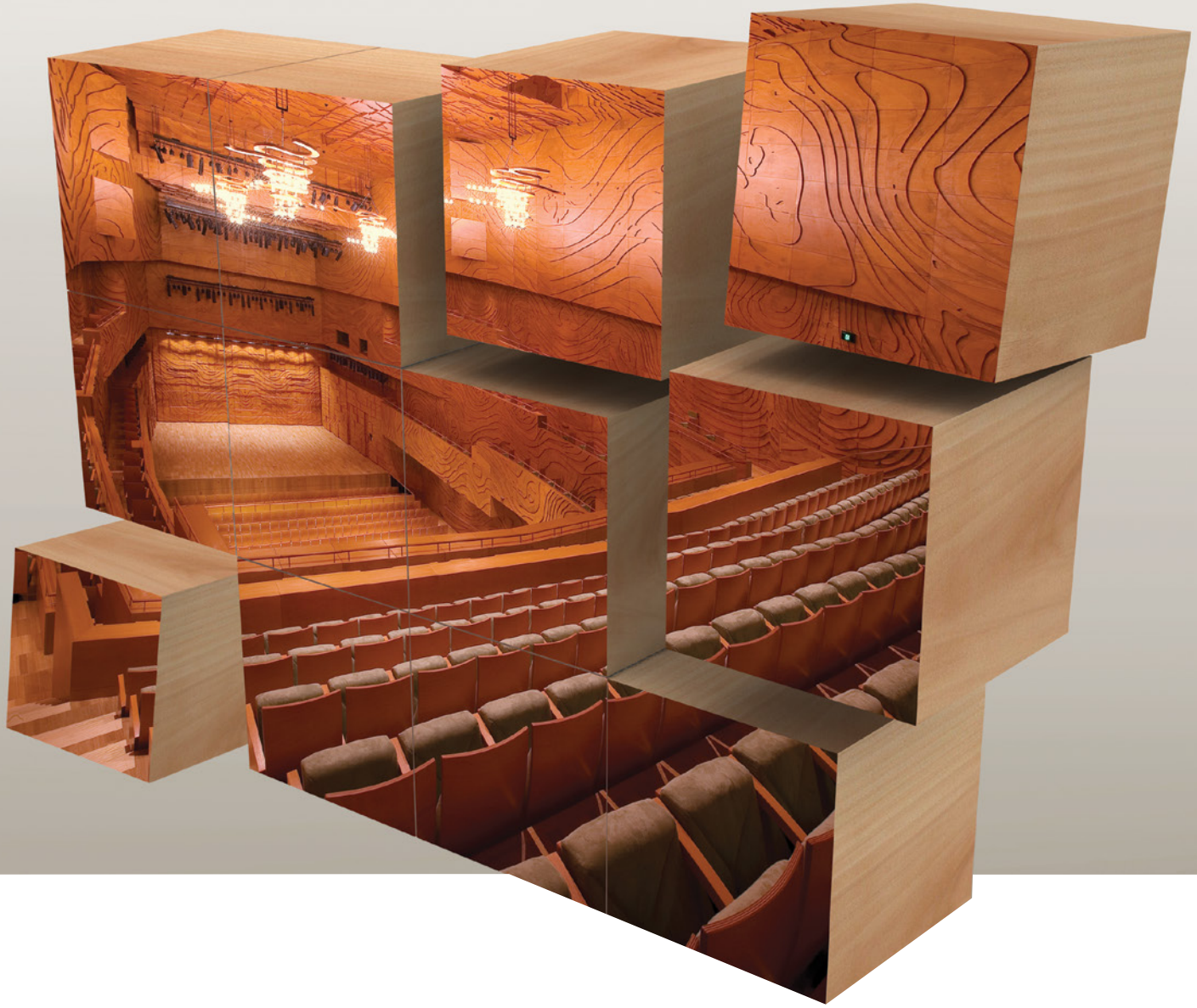

# Alternative Solution Fire Compliance

*Internal Linings*

Technical Design Guide issued by Forest and Wood Products Australia


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WoodSolutions is an industry initiative designed to provide independent, non-proprietary information about timber and wood products to professionals and companies involved in building design and construction.

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**Prepared by:**
Exova Warringtonfire Aus Pty Ltd
Suite 2002a, Level 20, 44 Market Street
Sydney 2000 Australia
www.exova.com

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# Introduction

**The demand for the use of sustainable materials such as timber in the design of buildings is increasing. Timber internal linings are also popular due to their inherent architectural aesthetic and ease of use. Often designers can be frustrated and regulators constrained because the existing Deemed-to-Satisfy Provisions in the National Construction Code (NCC) limit the locations and types of buildings in which timber linings can be used. Fortunately, the NCC allows variations from Deemed-to-Satisfy Provisions (known as Alternative Solutions) to be assessed using fire engineering principles to verify compliance with the Building Code of Australia. Using this approach, the use of timber can be expanded in many circumstances without compromising safety while improving the architectural design.**

In modern buildings, it is common for there to be a number of variations from the Deemed-to-Satisfy Provisions of which the use of timber linings are just one. Fire engineering undertaken by an accredited/registered Fire Safety Engineer can provide a holistic approach to fire safety by working with the design team to ensure aspirations and innovative ideas can be implemented, without compromising safety or delaying the approval process for a building.

This guide is intended to provide methods that could be employed by design professionals to develop an Alternative Solution. It is recommended that the guide be read in conjunction with the NCC.

# 1 Alternative Solution Process

## 1.1 NCC Compliance Structure

To demonstrate that a building solution complies with the NCC it is necessary to show that it meets the relevant performance requirements of the NCC. The performance requirements can be met by either complying with the Deemed-to-Satisfy (prescriptive) requirements or demonstrating that an Alternative Solution satisfies the Performance Requirements using an appropriate assessment methods. Objectives and functional statements provide guidance to assist in the interpretation of the performance requirements. The NCC compliance is shown in Figure 1. For further information reference should be made to Part A0 of the NCC.

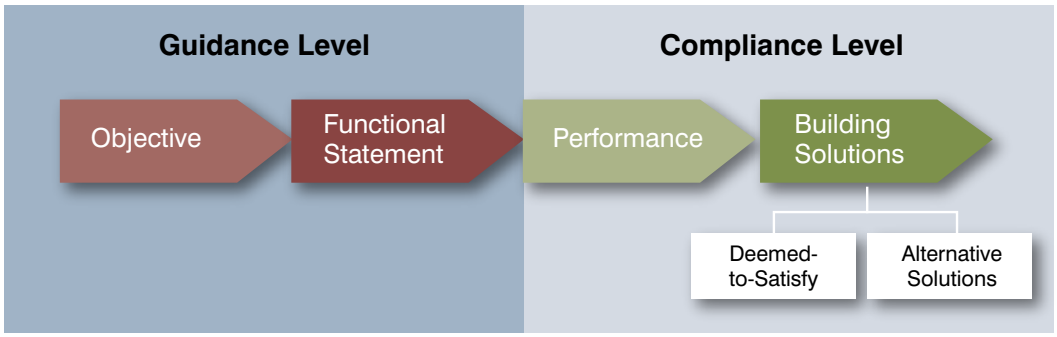


***Figure 1: NCC compliance structure***

## 1.2 Demonstration of Compliance of a Deemed-to-Satisfy Provision

Deemed-to-Satisfy Provisions are specified in the relevant sections of the NCC. In many instances a Deemed-to-Satisfy Provision may reference another document, rule, specification, standard or provision. The NCC includes a number of specifications which may, in turn, reference other documents, standards or similar documents. Part A1.2 to A1.7 of the NCC and referenced Specifications describe the hierarchy for the various types of documents and how they should be interpreted.

## 1.3 Demonstration of Compliance of an Alternative Solution

Most medium to large–scale projects in Australia rely on Alternative Solutions to demonstrate compliance with the NCC with respect to fire safety irrespective of whether or not timber is used as a construction material to enable the design objectives for a building to be attained cost effectively.

Evidence of compliance for nominated variations to the Deemed-to-Satisfy Provisions is commonly in the form of a Fire Engineering Report (FER) prepared by a registered/accredited fire safety engineer. These reports are specific to a subject building and cannot be directly applied to other buildings. Often FERs will nominate levels of performance to be achieved by timber products in fire tests, in which case supplementary documentation will need to be submitted to the regulatory authorities.

Fire safety engineers are normally appointed to prepare an FER in accordance with the method and process described in the International Fire Engineering Guidelines[2] (IFEG), which is submitted to the independent regulatory authorities, e.g. the building surveyor or building certifier for approval. Most States and Territories have specific requirements for registration of fire safety engineers and building certifiers.

Generally a two–stage process is adopted involving relevant stakeholders, which in addition to the design team, client and building certifier, may include the fire brigade, Council, insurer and other interested parties, depending, among other things on the type and significance of the variation from the Deemed-to-Satisfy Provisions.

The first stage is the development of a Fire Engineering Brief (FEB) which, among other things, documents:

- the stakeholder objectives
- a trial fire safety strategy for the building
- potential variations from the Deemed-to-Satisfy Provisions for the trial fire safety strategy
- relevant performance requirements
- engineering / assessment method to the adopted
- fire scenarios to be assessed, if appropriate
- the acceptance criteria.

The FEB/FER will need to determine the relevant performance requirements to be satisfied. The NCC requires the following approach to be adopted:

(a) Identify the relevant Deemed-to-Satisfy Provision of each Section or Part that is to be the subject of the Alternative Solution.

(b) Identify the performance requirements from the same Sections or Parts that are relevant to the identified Deemed-to-Satisfy Provisions.

(c) Identify Performance Requirements from other Sections and Parts that are relevant to any aspects of the proposed Alternative Solution or are affected by the application of the Deemed-to-Satisfy Provisions which are the subject of the Alternative Solution.

The second stage is the development of the FER that details the formulation and analysis of the fire safety design solutions against the fire safety objectives developed in the FEB process. The FER contains all required calculations, analysis of test evidence and fire modelling to support the recommendations for the formulated fire safety design solution for the building. The FEB and FER process is generally undertaken as the design is developed and tender documentation prepared ensuring that the process does not affect the construction program.

Typically, the FER will make use of one or more of the following assessment methods permitted by the NCC:

- Vverification methods specified by the NCC, e.g. NCC's CV1 or CV2
- comparison with the NCC's Deemed-to-Satisfy Provisions
- an analysis of the holistic fire safety strategy performed by a registered fire safety engineer using methods agreed during the FEB process and demonstrating compliance with the acceptance criteria also agreed during the FEB process.

## 1.4 NCC Deemed-To-Satisfy Provisions for Wall, Ceiling and Floor Linings

### 1.4.1 General Provisions from C1.10

The relevant NCC Deemed to Satisfy Provisions that are directly relevant to wall, ceiling and floor linings are provided in Clause 1.10. For simplicity, State and Territory variations are not addressed so the NCC should be checked for relevant variations.

Subclause C1.10(a) outlines fire hazard properties required for timber lining materials for floors, walls and ceilings, fixed seating in an auditorium, escalators and certain types of stairways and ramps and attachments to floors, walls and ceilings. These materials must comply with specification C1.10 of the NCC which is described in more detail in section 1.4.2 and 1.4.3 of this document.

There are a number of exclusions stated in subclause C1.10(c) permitting the use of timber in the following applications irrespective of the Group Number requirements:

- Fire Protective Covering (defined by the NCC in Part A1.1 Definitions)
- timber–framed windows
- solid timber handrails
- solid timber skirtings
- timber faced solid core and fire doors
- a joinery unit, cupboard, shelving, or similar
- material (timber) that does not significantly increase the fire hazard.

The last point is an unqualified catch-all exclusion for building components that, due to their size, construction, or location are unlikely to significantly contribute to the spread of fire and smoke in the building.

This approach can be extended when considering Alternative Solutions involving timber where timber linings may not completely cover all surfaces.

The Guide to the NCC also explains the exclusion elements within buildings such as joinery units, cupboards, shelving and the like. These elements do not form part of the structure and generally are not considered within the building's approval. They are typically attached to the building structure for their support and as such, in most instances are low contributors to the spread of fire and smoke in the building. The NCC guide suggests that these items should be likened to the building's furniture, which is generally not considered for fire hazard properties.

### 1.4.2 Fire–Retardant Coatings

The NCC Clause C1.1 (b) excludes the use of fire-retardant coatings to comply with fire hazard properties. Fire-retardant coatings are applied to the surface of an element and differs from fire-retardant products that penetrate into the element.

One reason often given for prohibiting the use of paint or fire-retardant coatings to make a substrate comply with the required fire hazard properties in subclause C1.10 (b) is the perception that the coating is susceptible to damage from wear and tear or abrasion. The NCC guide clarifies that subclause C1.10(b) does not prohibit the use of impregnated (infused) fire-retardants to achieve the relevant fire hazard properties.

There are, however precedents in the Deemed-to-Satisfy Provisions in the NCC where the use of paints, coatings, lightweight construction and other treatments are permitted for various fire–related applications where susceptibility to damage is either not considered or has been addressed through additional requirements including the following:

- NSW variation to clause C1.10 (b) for Class 9b entertainment venues allows the modification to fire hazard properties by paints or fire-retardant coatings for treatment of fabrics for seating and cinematograph screens. There are additional requirements to provide certification that the fire hazard performance has been met and testing is performed after cleaning cycles.
- Clause C1.8 (b) provides a concession where lightweight construction such as sheet or soft materials can be used for the fire-resisting covering of a steel column providing that, if the material is not in continuous contact with the column, the void between the column and the covering is filled with solid material that prevents denting to a height of at least 1.2 m above the floor. In addition, if equipment, vehicles or materials are liable to damage the columns, then the material must be further protected by steel or the like. It should be noted there are no other specific prohibitions relating to the use of boards or coatings for the protection of structural steel in the NCC.
- Part G5 Construction in Bushfire Prone Area requires Class 2 or 3 building or Class 10a building or deck associated with a Class 2 or 3 building, must comply with AS 3959[4].
- AS 3959 Appendix F Bushfire-Resisting Timber allows fire-retardants that are either coatings or impregnated (infused) if the sample undergoes accelerated weathering prior to undertaking fire tests to AS/NZS 3837[5].

These examples provide useful benchmarks when considering Alternative Solutions.

### 1.4.3 Specification C.10 Requirements for Wall and Ceiling Linings

Specification C1.10 requires wall and ceiling linings to be capable of achieving nominated group numbers that correlate to time taken for flashover to occur in a small room with a controlled ignition source, which can be considered to represent a single burning item.

This group number of the material can be determined by either physical testing in accordance with AS ISO 9705[6] (room burn test), refer to Figure 2, or prediction using empirical correlations based on tests in accordance with AS/NZS 3837 (cone calorimeter test), refer to Figure 3. The required group number is dependent on the classification of the building, whether the building is sprinkler protected or not, and where the lining is located within the building as summarised in Table 1, which has been extracted from Specification C1.10 of the NCC.

The group number of a material can be Group 1 (least hazardous), Group 2, Group 3 or Group 4 (most hazardous).

**Group 1**: materials include masonry, painted metal and plaster, and materials that do not reach flashover when exposed to 100 kW for 600 seconds followed by exposure to 300 kW for 600 seconds during an AS ISO 9705 test.

**Group 2**: materials can include some fire–retardant–treated timbers and other materials that reach flashover following exposure to 300 kW within 600 seconds after not reaching flashover when exposed to 100 kW for 600 seconds during an AS ISO 9705 test.

**Group 3**: materials include most timber and also some fire–retardant–treated plastics and other materials that reach flashover in more than 120 seconds but within 600 seconds when exposed to 100 kW during an AS ISO 9705 test.

**Group 4**: material that reaches flashover within 120 seconds when exposed to 100 kW during an AS ISO 9705 test.

For further information on specific group numbers and smoke growth/specific extinction on common timbers species and panel products, refer to species information on the WoodSolutions website: **www.woodsolutions.com.au**

Table 1 has a number of terms that have specific requirements or describe an area within a building. The following discuss these requirements:

**Sprinklers**: systems that comply with the NCC Specification E1.5.

**Fire isolated exits**: passageways to the outside of the building being a road or open space. They also include ramps and stairways.

**Fire–control rooms**: areas within a building where emergency situations can be controlled or monitored or equipment is provided.

**Public corridor**: general passageways such as a hall or corridor from a specific area described below.

**Specific area**:

*Class 2 and 3*: sole-occupancy units, such as a dwelling or sleeping facilities.

*Class 5*: office areas that are open plan and where the ratio of floor length to ceiling height is greater than 5.

*Class 6*: retail areas within a retail building where the ratio of floor length to ceiling height is greater than 5.

*Class 9a*: patient areas within a healthcare building

*Class 9b*: the auditorium within theatres and hall buildings.

*Class 9b*: classroom within schools.

*Class 9c*: the residence areas within aged care building.

*Table 1: Permitted wall and ceiling lining materials groups*

| Building Classification | | Fire Isolated Exits and Fire Control Rooms | | Public corridors | | Specific areas | | Other areas | |
|---|---|---|---|---|---|---|---|---|---|
| | | Walls | Ceilings | Walls | Ceilings | Walls | Ceilings | Walls | Ceilings |
| **Class 2** Residential Apartments | Unsprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 3** Short term Accommodation | Unsprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 3** Accommodation for the aged, disabled and for children | Unsprinklered | 1 | 1 | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 5** Office | Unsprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 6** Retail | Unsprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 7** Carpark | Unsprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 8** Factory or Laboratory | Unsprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 9a** Health-care | Unsprinklered | 1 | 1 | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 9b** Schools | Unsprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 9b** Assemby buildings other than schools | Unsprinklered | 1 | 1 | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2, 3 |
| | Sprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| **Class 9c** Aged Care | Sprinklered | 1 | 1 | 1, 2 | 1, 2 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 | 1, 2, 3 |
| | N/A | - | - | - | - | - | - | 1, 2 | 1, 2 |

For buildings not protected by a sprinkler system, Specification C1.10 also places limits on the smoke produced. The limits depend on the applicable test procedure:

(i) AS ISO 9705: a smoke growth rate index not more than 100; or

(ii) AS/NZS 3837: an average specific extinction area less than 250 $m^2$/kg.

Figure 2 shows a whole room assembly lined with the system to be evaluated being tested in accordance with AS ISO 9705. Figure 3 shows a specimen nominally 100 mm x 100 mm being subjected to an AS/NZS 3837 test. Where satisfactory correlations exist to extrapolate AS/NZS 3837 results to obtain an estimate of the time to flashover, it represents the most cost effective approach to determining the group number as defined in the NCC. However, for materials where there are no correlations and multilayer systems and for evaluation of joints in non–homogeneous materials, AS ISO 9705 is the appropriate test procedure.

***Figure 2: AS ISO 9705 test showing fire source***

***Figure 3: Cone calorimeter test***

### 1.4.4 Floor Linings

In relation to floor linings, the NCC Deemed to Satisfy Provisions state the covering is to achieve a required critical radiant flux at extinguishment as determined by AS ISO 9239.1, (refer to Figure 4). The required critical radiant flux is dependent on the classification of the building, whether the building is sprinklered, and where the lining is located within the building. A critical radiant flux limit of 1.2 kW/m$^2$ applies to the most hazardous materials and a 4.5 kW/m$^2$ applies to the least hazardous.

***Table 2: Minimum permitted critical radiant flux (CRF in kW/m$^2$) of floor materials and floor coverings***

| Building Classification | | Fire Isolated Exits and Fire Control Rooms | General |
|---|---|---|---|
| **Class 2** Residential Apartments | Unsprinklered | 2.2 | 2.2 |
| | Sprinklered | 2.2 | 1.2 |
| **Class 3** Short term Accommodation | Unsprinklered | 2.2 | 2.2 |
| | Sprinklered | 2.2 | 1.2 |
| **Class 3** Accommodation for the aged, disabled and for children | Unsprinklered | 4.5 | 4.5 |
| | Sprinklered | 4.5 | 2.2 |
| **Class 5** Office | Unsprinklered | 2.2 | 2.2 |
| | Sprinklered | 2.2 | 1.2 |
| **Class 6** Retail | Unsprinklered | 2.2 | 2.2 |
| | Sprinklered | 2.2 | 1.2 |
| **Class 7** Carpark | Unsprinklered | 2.2 | 2.2 |
| | Sprinklered | 2.2 | 1.2 |
| **Class 8** Factory or Laboratory | Unsprinklered | 2.2 | 2.2 |
| | Sprinklered | 2.2 | 1.2 |
| **Class 9a** Health-care – All areas other than Patient Care Area | Unsprinklered | 4.5 | 4.5 |
| | Sprinklered | 4.5 | 2.2 |
| **Class 9a** Health-care – Patient Care Area | Unsprinklered | 4.5 | 2.2 |
| | Sprinklered | 4.5 | 1.2 |
| **Class 9b** General | Unsprinklered | 2.2 | 2.2 |
| | Sprinklered | 2.2 | 1.2 |
| **Class 9b** Auditorium or Audience Seating Area for indoor pool or ice skating | Sprinklered | 2.2 | 1.2 |
| | N/A | 2.2 | 1.2 |
| **Class 9b** Auditorium or Audience Seating Area for sports or multipurpose functions | Unsprinklered | 2.2 | 2.2 |
| | Sprinklered | 2.2 | 1.2 |
| **Class 9c** Aged Care residence use | Sprinklered | 4.5 | 2.2 |
| **Class 9c** Aged Care – other than residence use | Sprinklered | 4.5 | 1.2 |
| **Lift Cars** | N/A | - | 2.2 |

In a building not protected by a sprinkler system a maximum smoke development rate of 750 percent-minutes determined in accordance with AS ISO 9239.1 is also applicable.

Further information on the critical heat flux for common timbers is available at WoodSolutions website: **www.woodsolutions.com.au**

Figure 4 shows the AS ISO 9239.1 Critical Radiant Flux Test apparatus and Figure 5 shows a typical flooring material during testing.

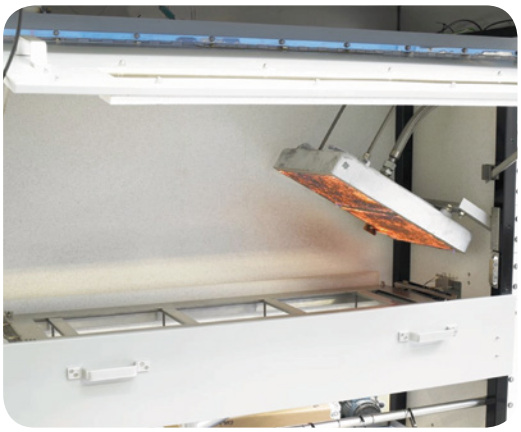

***Figure 4: AS ISO 9239.1 Critical Radiant Flux Test apparatus***

***Figure 5: Specimen during AS ISO 9239.1 Test***

### 1.4.5 Specification C1.10 Requirements for Attachments

Specification C1.10 Clause 7 covers materials that are not covered above. This includes materials used in the structure itself, attachments to floors, walls and ceilings, insulation and sarking.

For materials other than sarking, there is separate range of fire performance indicators termed Early Fire Hazard Indices: Spread-of-Flame Index and Smoke-Developed Index.

These indices are tested in accordance with AS 1530.3 and their limits are listed in Table 3 below.

***Table 3: AS 1530.3 indices applied to attachments and other materials.***

| Material or assembly location | Element | Spread-of-Flame Index | Smoke-Developed Index |
|---|---|---|---|
| Fire control rooms[1] and fire-isolated exits | - | 0 | 2 |
| Class 9b buildings used as a theatre, public hall or similar | Fixed seating in the audience area or auditorium. | 0 | 5 |
| | A proscenium curtain[2] | 0 | 3 |
| Escalators, moving walkways or non- required non- fire-isolated stairways or pedestrian ramps[3] | - | 0 | 5 |
| Insulation materials other than sarking-type materials | - | 9 | 8 if the Spread-of-Flame Index is more than 5 |
| All other materials or locations | - | 9 | 8 if the Spread-of-Flame Index is more than 5 |

*Note:*
*1. Required by Specification E1.8*
*2. Required by Specification H1.3.*
*3. Required by Specification D1.12.*

Fire control rooms or fire isolated exits have additional requirements when combustible materials are used as an attachment or part of an attachment to a building element. In such instances the combustible material cannot exceed 1 mm finished thickness and must be attached directly to a non-combustible substrate.

Where materials don't comply with the requirements in Table 3, they may still be used if they are composite member or assembly. The member or assembly must have any of the material not complying protected on all sides and edges from exposure with the air; and the complete member or assembly must comply with the requirement of Table 3 when tested. The member or assembly is also required to prevent ignition of the material and continues to screen it from access to free air for a period of not less than 10 minutes during the test.

Further information on AS 1530.3 indices (Spread of Flame and Smoke Development) for common timbers species is available at: **www.woodsolutions.com.au**

*Sarking–type materials*
Sarking–type materials are required to meet a different early fire hazard property - the Flammability Index. Further discussion lies outside the scope of this document.

## 1.5 NCC / BCA Performance Requirements for Wall, Floor and Ceiling Linings

The NCC performance requirements relevant to interior linings and the identified Deemed-to-Satisfy Provisions (C1.10) discussed above is CP4. This requires that the linings must resist the growth in fire and limit the development of smoke, heat, and toxic gases for the time necessary for the occupants to evacuate the area, taking into account the number, mobility and other attributes of the occupants along with the function and use of the building and active fire safety systems installed. Refer to NCC CP4 for the precise requirement.

It is also necessary to identify performance requirements from other Sections and Parts of the NCC that are relevant to any aspects of the Alternative Solution proposed, or that are affected by the application of the Deemed-to-Satisfy Provisions that are the subject of the Alternative Solution. Therefore, Performance Requirement E2.2 is also relevant in most instances since it relates to the maintenance of tenability in an evacuation route.

Performance Requirement EP2.2 describes the conditions of any evacuation route to be maintained in the event of a fire and for it to be maintained for the period of time occupants take to evacuate that part of the building, so that:

- the temperature in the evacuation path does not endanger human life
- the level of visibility will enable the evacuation route to be determined
- the level of toxicity will not endanger human life.

Again, the performance requirement requires consideration for the period of time occupants will take to evacuate and to take account of the number of occupant, their mobility or other matters affecting their evacuation. Other issues that need to be considered are the function or use of the building and any active fire safety systems installed. In addition, the travel distance and uniqueness of the building, fire load, potential fire intensity and hazard and possibility of fire brigade intervention must be considered.

Depending on the nature of an Alternative Solution and method of demonstrating compliance, other performance requirements may also be relevant since limiting the rate of fire spread in buildings through the control of materials can affect the time available for occupant evacuation, facilitate fire fighting activities and limit fire spread.

## 1.6 International Approaches

### 1.6.1 Fire Test Procedures for Wall and Ceiling Linings

The Australian system allows wall and ceiling lining performance to be determined either by using the International Standard ISO 9705 for wall and ceiling linings and the time it takes to flashover using a 1 MW heat release rate, or using a predictive method from data obtained from the AS/NZS 3837 cone calorimeter test where appropriate empirical correlations are in place.

AS/NZS 3837 cone calorimeter test is generally similar to the ISO 5660 series except for a few subtle differences that can affect the interpretation of results for regulatory assessments or classifications. Figure 3 shows a cone calorimeter test being undertaken.

Attachments continue to be evaluated using AS 1530.3 for which there are no closely aligned international test procedures.

The European classification method described in EN 13501-1 uses a number of Standards as summarised in Table 4.

***Table 4: Overview of the Australian and European test procedures for assessing fire hazard properties of materials***

| European Standard | Description | Nearest Australian Equivalent | Comments |
|---|---|---|---|
| EN ISO 1182:2010[11] | Non–combustibility test | AS 1530.1[12] | There are minor differences between AS 1530.1 and ISO 1182:2011 that could yield slightly different results. The Australian requirements for non-combustibility are outside the scope of this document. |
| EN ISO 1716:2010[13] | Determination of the gross heat of combustion. | - | Not used in NCC Deemed-to-Satisfy Provisions. |
| EN 13823:2010[14] | Single Burning Item test. | AS ISO 9705 / AS/NZS 3837 | While these methods are used to assess the rate of fire growth/spread across linings the procedures and configurations are significantly different. |
| EN ISO 11925-2:2010[15] | Ignitability of building products subjected to direct impingement of a flame – Part 2: Single flame source | AS 1530.2[16] | While these methods are used to evaluate ignitability from a small flaming source the procedures and configurations differ. The Australian requirements for ignitability are outside the scope of this document. |

The above European system is replacing various national standards providing greater consistency across the European Union.

There is no general prohibition on the use of fire–retardant coatings, as is the case in Australia. However, some countries require certification for products which have an improved performance, this would include products treated with fire–retardant coatings.

There is currently no requirement for CE-marking (European Conformity brand) for these coatings, but in practice many products are covered by product standards which can result in mandatory certification, and certification bodies may require evaluation of the durability and resistance to damage of coatings. Manufacturers or suppliers of coatings will in many instances be able to provide test evidence to demonstrate the durability or fitness for purpose of their coatings.

In the United States, requirements can vary between States. With respect to surface linings the primary test method is ASTM E84 Surface Burning Characteristics of Building Materials[17].
The test apparatus comprises a 7.6 m long tunnel furnace with a 305 mm x 405 mm cross–section and a burner applied to one end of the tunnel. It is difficult to correlate the results of this test with the time to flashover determined in AS ISO 9705 tests, the basis of the Australian system.

There are, however, applications when tests in accordance with ISO 9705 or ISO 5660 or similar methods are undertaken in the US, which can yield useful data for evaluation of Alternative Solutions.

The acceptability of fire–retardant coatings by prescriptive standards and regulations varies across the US. There are test procedures such as ASTM D2898 - 10 Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing[18] which defines accelerating weathering procedures that can be applied to small specimens before fire testing. This standard is also the basis of the Accelerated Weathering called up for fire retardant use in AS 3959.

### 1.6.2 Fire Test Procedures for Flooring

The Australian system is based on AS ISO 9239.1-2003 Reaction to fire tests for floor coverings - Determination of the burning behaviour using a radiant heat source. This is commonly referred to as the Flooring Radiant Panel Test and is the same as the EN ISO 9239-1[19] test that is required under the European classification system. The US system is also based on a Flooring Radiant Panel Test (ASTM E 648[20]) which is similar to AS ISO 9239.

# 2

# Case Study – Use of Timber Linings in a School Building Corridor

## 2.1 General Description of Case Study

This case study relates to a school building where the architectural design requires timber linings to be used in corridors to provide an impact–resistant and aesthetically pleasing wall lining.

The Building Certifier has identified that Specification C1.10 of the NCC requires Group 2 linings in corridors for a Class 9b building (school) which are not protected by a compliant sprinkler system. Reference to the test reports from the WoodSolutions website (www.woodsolution.com.au) indicates that the proposed timber achieves Group 3 and therefore varies from the Deemed-to-Satisfy Provision.

Three potential solutions are evaluated below:

- Provide an automatic fire sprinkler system throughout the building.
- Use either fire–retardant–treated timber or apply a fire retardant coating.
- Restrict the height of the timber lining on the walls and line the ceilings and remaining wall area with plasterboard.

## 2.2 Option 1 - Automatic Sprinkler System

If the building is protected by a compliant automatic fire sprinkler system, Specification C1.10 of the NCC relaxes the Deemed-to-Satisfy requirements for linings having regard for the additional protection provided by the sprinkler system to Group 3, and therefore an Alternative Solution would not be required.

This is an option that should be discussed during the Fire Engineering Brief process, despite the additional cost of an automatic sprinkler system, because some stakeholders may require an automatic sprinkler system for property protection or the automatic sprinkler system may be introduced as part of a holistic strategy involving a large number of variations from the Deemed-to-Satisfy Provisions.

## 2.3 Option 2 - Use of Fire–Retardant Treatments

### 2.3.1 Impregnation of Timber with Fire Retardant

If compliance with Specification C1.10 Group 2 can be demonstrated for the impregnated timber, then this option would comply with the Deemed-to-Satisfy Provisions of the NCC and no further analysis would be required.

### 2.3.2 Fire-Retardant Surface Coating

The performance of the timber may be improved to achieve Specification C1.10 Group 2 by applying appropriate fire–retardant treatments to the surface, but the NCC Deemed to Satisfy Provisions do not permit coatings to be employed under clause C1.10 (b).

Following the NCC process for Alternative Solutions, it is then necessary to identify the appropriate performance requirements which in this case would include: CP4 and EP2.2 (refer section 2.5).

The Guide to the NCC describes that the prohibition is due to its susceptibility to damage and also states that this does not prohibit the use of suitable impregnated materials that achieve the relevant fire hazard properties.

Therefore a practical approach to this problem would be to demonstrate how the durability and susceptibility to damage has been addressed to the necessary degree and demonstrate compliance based on equivalence to a Group 2 material not requiring a fire–retardant coating.

During the Fire Engineering Brief process the following risks were identified:

- loss of performance as a result of inadequate durability (e.g. aging / leaching of critical components of the coating during cleaning)
- loss of performance as a result of surface damage to the coating (e.g. a deep scratch/dent)
- over–painting of the coating during the life of the building.

For the proposed coating material, a good correlation was demonstrated between the extrapolated results of an AS /NZS 3837 small–scale cone calorimeter test series and the large–scale AS ISO 9705 room test for the proposed coating applied to a timber substrate. Therefore, it was considered appropriate in this instance to use the AS/NZS 3837 test method to evaluate durability and the susceptibility to damage in a cost effective manner.

A conservative approach to evaluate the durability of the coating was adopted by:

a) Subjecting the coating to a modified version of ASTM D2898 Method B, where the water flow rate is decreased to be the same as that in the accelerated weathering regime of ASTM D2898 Method A. This was adopted because fire–retardant coatings are permitted to be used in external applications under the NCC (refer Appendix F of AS 3959) if this exposure is shown not to compromise the fire performance of the system. While this could be considered excessive for internal use it was adopted because there was a precedent for its acceptance.

b) Subjecting the coating to accelerated aging by exposure to elevated temperatures.

Susceptibility to damage was evaluated by applying a deep scratch to a series of cone calorimeter specimens and simulating heavy impacts (indentations). The ability to reinstate the performance was ascertained by coating specimens, sanding them back and reapplying the coating.

Cone calorimeter test series were performed after testing to ASTM D2898 as described above, after accelerated aging, with imposed damage and after recoating. The time to flashover was then calculated and if Group 2 was achieved the Alternative Solution was considered to be at least equivalent to the NCC Deemed-to-Satisfy Provisions. In many instances the supplier of the coating may have existing data available and the above approach could be modified to take this into account.

Conditions could be nominated in the Fire Engineering Report to prohibit recoating other than sanding back and reapplication of the specified coating and to require inspections as part of the required maintenance measures. It should be noted that the behaviour of non-combustible materials can be degraded by application of multiple coats of paint and therefore the specified controls could be considered enhancements to the NCC Deemed-to-Satisfy measures.

## 2.4 Option 3 - Partial Cladding of Walls with Timber

Group Numbers in Specification C1.10 correlate to the time to flashover when a lining material is applied to the wall and ceiling of an enclosure measuring 2.4 m x 2.4 m x 3.6 m and tested in accordance with AS ISO 9705.

Again the relevant performance requirements are CP4 and EP2.2

A Group 2 material reaches flashover following exposure to 300 kW within 600 seconds after not reaching flashover when exposed to 100 kW for 600 seconds.

A Group 3 material reaches flashover in more than 120 seconds but within 600 seconds when exposed to 100 kW.

During the FEB process it was agreed that if a test in accordance with AS ISO 9705 was undertaken but the test configuration modified such that the dado lining was fitted to a limited height (refer to Figure 6) and the rest of the wall and ceiling was clad with plasterboard, and if flashover does not occur within 600 seconds when exposed to a 100 kW fire, the Alternative Solutions would be considered to be equivalent to the Deemed-to-Satisfy solution and hence satisfy the relevant NCC performance requirements.

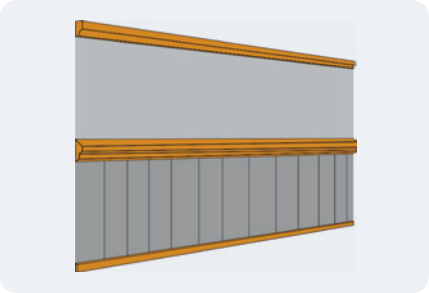

*Figure 6: Timber dado wall panel*

## 2.5 Selection of the Preferred Option

Normally, during the FEB process a preferred option would be selected. Each of the five major options (and two sub–options) has its merits and limitations and the selected option would vary from project to project.

# 3 Further Reading and References

**Wood Solutions Technical Design Guides**

The WoodSolutions technical design guides are available to download free from www.woodsolutions.com.au in the resources section.

#1 Timber-framed Construction for Townhouse Buildings Class 1a – information about complying with the fire safety and sound insulation performance requirements in the BCA for Class 1a attached buildings.

#2 Timber-framed Construction for Multi-residential Buildings Class 2, 3 & 9c – information about complying with the fire and sound performance requirements in the BCA for Class 2, 3 and 9c buildings.

#3 Timber-framed Construction for Commercial Buildings Class 5, 6, 9a & 9b – information about complying with the fire performance requirements in the BCA for Class 5, 6, 9a and 9b buildings.

#6 Timber-framed Construction - sacrificial timber construction joint – this provides common details for using sacrificial timber blocks to maintain a Fire Resistance Level.

#17 Alternative Solution Fire Compliance, Timber Structures – information about using alternative solutions to allow the use of timber in structural applications not covered by the Deem-to-Satisfy Provisions of the NCC. Includes case study of a five storey residential apartment (Class 2) building.

#18 Alternative Solution Fire Compliance, Facades – information about using timber facades not covered by the Deem-to-Satisfy Provisions of the NCC. Includes a case study on the use of combustible facades.

**References**


1. Building Code of Australia Volume 1 NCC 2012, Australian Building Codes Board
2. International Fire Engineering Guidelines, 2005, Australian Building Codes Board
3. Guide to NCC
4. AS 3959 – 2009 Construction of Buildings in Bushfire-Prone Areas, Standards Australia
5. AS/NZS 3837:1998 Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter, Standards Australia
6. AS ISO 9705 – 2003 Fire tests – Full scale room test for surface products, Standards Australia
7. AS ISO 9239.1 – 2003 Reaction to fire tests for floorings Part 1: Determination of the burning behavior using a radiant heat source, Standards Australia
8. AS /NZS 1530.3:1999 Methods for fire tests on building materials, components and structures Part 3: Simultaneous determination of ignitability, flame propagation, heat release and smoke release, Standards Australia
9. ISO 5660-1:2002 Reaction-to-fire tests – Heat release, smoke production and mass loss rate - Part 1: Heat release rate (cone calorimeter method)
10. EN 13501-1:2007 Fire Classification Of Construction Products And Building Elements – Part 1: Classification Using Data From Reaction To Fire Tests, Comite Europeen de Normalisation
11. EN ISO 1182:2010 Reaction To Fire Tests For Products, Comite Europeen de Normalisation
12. AS 1530.1 – 1994 Methods for fire tests on building materials, components and structures Part 1: Combustibility test for materials
13. EN ISO 1716:2010 Reaction To Fire Tests For Products – Determination Of The Gross Heat Of Combustion (Calorific Value), Comite Europeen de Normalisation

14. EN 13823:2010 Reaction To Fire Tests For Building Products – Building Products Excluding Floorings Exposed To The Thermal Attack By A Single Burning Item, Comite Europeen de Normalisation

15. EN ISO 11925-2:2010 Reaction To Fire Tests – Ignitability Of Products Subjected To Direct Impingement Of Flame - Part 2: Single-Flame Source Test, Comite Europeen de Normalisation

16. AS 1530.2-1993 Methods for fire tests on building materials, components and structures – Test for flammability of materials, Standards Australia

17. ASTM E84-12 Standard Test Method for Surface Burning Characteristics of Building Materials, American Society for Testing and Materials

18. ASTM D2898-10 Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing, American Society for Testing and Materials

19. EN ISO 9239-1:2010 Reaction To Fire Tests For Floorings – Part 1: Determination Of The Burning Behaviour Using A Radiant Heat Source, Comite Europeen de Normalisation

20. ASTM E648-10e1 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems

A

# Appendix A – Glossary of Terms

**Combustible**

Defined in Clause A1.1: "Combustible means – (a) Applied to a material – combustible as determined by AS 1530.1. (b) Applied to construction of part of building – constructed wholly or in part of combustible material".

**Fire Engineering Brief or Fire Safety Engineering Brief (FEB)**

Defined in the International Fire Engineering Guidelines as "A documented process that defines the scope of work for the fire engineering analysis and the basis for analysis as agreed by stakeholders".

**Fire Resistance Level (FRL)**

Defined in Clause A1.1: "FRL means the grading periods in minutes determined in accordance with Specification A2.3, for the following criteria –

a) structural adequacy
b) integrity
c) insulation
and expressed in that order".

**Fire-resisting**

Defined in Clause A1.1: "Fire-resisting, applied to a building element, means having an FRL appropriate for that element".

**Fire wall**

Defined in Clause A1.1: "Fire wall means a wall with an appropriate resistance to the spread of fire that divides a storey or building into fire compartments".

**Load-bearing**

Defined in Clause A1.1: "Load-bearing means intended to resist vertical forces additional to those due to its own weight".

**Non-combustible**

Defined in Clause A1.1:"Non-combustible means –

a) Applied to a material – not deemed combustible as determined by AS 1530.1 – Combustibility Tests for Material.

b) Applied to construction or part of a building – constructed wholly of materials that are not deemed combustible."

**Rise in storeys**

Defined in Clause A1.1: "Rise in storeys means the greatest number of storeys calculated in accordance with C1.2".


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