INFRASTRUCTURE TECHNOLOGIES
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Fire safety guideline for external walls

A guide for high-rise construction in Australia

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CSIRO's infrastructure technologies team provide independent testing, consulting and certification services to support product development and enhance public confidence in products and systems used in Australia's built infrastructure.

Contents

Executive summary

There are a wide range of building materials and systems on the market which are used for external walls, or façades in buildings in Australia. This range is increasing as new and innovative products come onto the market. These products can be installed as complete or portions of building façades.

In June 2014 CSIRO, in conjunction with University of Ulster, completed a research report for the National Fire Protection Association on combustible façades[1]. The report covers typical combustible façade construction systems and methods, fire incidents, fire test methods and regulation around the world.

In November 2014 there was a large combustible façade fire at a building in Docklands, Melbourne. Subsequently the Metropolitan Fire Brigade released an investigation report on their findings of the fire and the possible causes[2]. The fire was unusual as it spread up the exterior cladding of the building due to the use of a combustible aluminium composite panel (ACP) façade.

This document is intended to aid building practitioners in understanding the fire hazards of combustible external wall materials and pathways to demonstrate compliance in relation to façade fire safety under the requirements of the current National Construction Code, Volume 1, Building Code of Australia (BCA) [3]. In particular it focuses on the requirements for multi-storey buildings in Australia requiring Type A and Type B construction for Class 2 to 9 buildings. This is not relevant to domestic low-rise buildings.

The document draws on the National Fire Protection Association (NFPA) research report, Building Code of Australia deemed to satisfy provisions and CSIRO fire testing expertise.

The elements discussed include the façade, exterior wall, lining, cladding, wall systems, system parts and components and attachments to the walls. Many of these terms are used within the BCA but not all are defined in the BCA.

While industry and regulatory attention has largely focused on ACP materials used as exterior wall claddings on residential buildings, CSIRO's research identifies many other systems with combustible elements being installed across a range of building types and classes. Systems such as polymer core metal faced sandwich panel, timber feature walls and rendered faced polymer core (such as polystyrene foam) and others must also comply with building regulations and codes.

1 Compliance in Australia

In order to show compliance in Australia, any building product or system must satisfy the performance requirements by either:

- meeting the *Deemed to Satisfy* provisions of the Building Code of Australia (BCA); or
- being the subject of an appropriately formulated *Alternative Solution* in accordance with Clauses A0.9 and A0.10.

Evidence of Suitability will be required in accordance with A2.2 of Volume One of the BCA.

This guide primarily considers the compliance pathways available under the Deemed to Satisfy provisions of the 2015 revision to the BCA. Limited guidance is also provided regarding *Alternative Solutions*.

2 External wall or attachment?

For buildings requiring Type A and B construction the BCA Deemed to Satisfy provisions addresses two common cases relating to fire performance of external walls:

- The cladding is the exterior wall or part of the wall. (BCA Specification C1.1, Sections 3.1(b) &4.1 (b) apply)
- The cladding is an *attachment* to an exterior wall having the required FRL. (BCA Specification C1.1 Clause 2.4 applies)

The term "*external wall*" is defined in the BCA as "... an outer wall of a building which is not a common wall".

The term "attachment" or the difference between an attachment and an external wall is not defined in the BCA.

When a term is not specifically defined in the code, the common usage governs. The following definitions are from Macquarie's dictionary:

- Wall - An upright work or structure of stone, brick, or similar material, serving for enclosure, division, support, protection, etc., as one of the upright enclosing sides of a building; Or, Anything which resembles or suggests a wall
- Attachment - An adjunct or supplementary device

While not intended as a general approach to building code interpretation, CSIRO has applied the following reasoning to determine when a building element should be assessed as an external wall (or integral part of external wall) or an attachment:

- If the cladding/lining/other item is removed and the remaining structure no longer functions suitably as an external wall (for example, the remaining structure has no fire resistance level, is unable to prevent the penetration of water, is unable to resist wind loads, or in certain applications cannot meet acoustic requirements), then it is considered an integral part of the external wall, and BCA Specification C1.1, Sections 3.1(b) &4.1 (b) applies.
- If the cladding/lining/other item is removed and the remaining wall system still functions as an external wall then Spec C1.1 Clause 2.4 applies.

Note: For Type C fire resisting construction external walls are not required to be non-combustible but BCA Clause C1.10 fire hazard property provisions still apply.

3 External wall Deemed to Satisfy provisions

There are three groups of requirements in the BCA Volume One Deemed to Satisfy provisions related to reducing the impact of fire on external walls (or elements which are an integral part of an external wall).

1. A tested Fire-Resistance Level (FRL)

2. Requirements for building elements to be non-combustible,

3. Requirements to meet certain fire hazard properties for linings, materials and assemblies.

These requirements are independent of each other and must all be considered.

For example, a load bearing external wall more than 3 meters from a fire source feature (e.g. allotment boundary) in a Class 2 building of Type A construction must achieve a 90/60/30 FRL *and* be non-combustible, these two requirements are not equivalent. We note that a non-combustible material would normally comply with any fire hazard property requirements.

The following BCA Deemed to Satisfy provisions apply for combustibility of external walls

- BCA Specification C1.1, Section 3.1(b) and 4.1(b) state that for buildings required to have Type A or Type B Fire resisting construction, external walls must be non-combustible.
- For Type C fire resisting construction external walls are not required to be non-combustible but BCA Clause C1.10 fire hazard property provisions still apply.

So all external walls are required to be non-combustible for buildings greater than two or three storeys in height (depending on Classification), or deemed non-combustible in accordance with BCA Clause C1.12. The BCA defines combustible as:

- applied to a material – combustible as determined by AS 1530.1; or
- applied to construction or part of a building – constructed wholly or in part of combustible materials.

So if any part or component of an external wall is combustible, the entire wall is considered to be combustible.

The BCA Specification C1.1 Clause 2.4 does provide one alternative to the above (See Section 4).

3.1 Fire Resistance Level

Fire Resistance Level (FRL) means the grading periods in minutes determined in accordance with Specification A2.3, for the following criteria:

- structural adequacy
- integrity
- insulation

and expressed in that order.

> Note: A dash means that there is no requirement for that criterion. For example, 90/–/– means there is no requirement for an FRL for integrity and insulation, and –/–/– means there is no requirement for an FRL.

The FRL required for an external wall is dependent upon both:

- Separation distance from fire source features such as allotment boundaries
- Whether the wall is load bearing or not.

"Required" means required to satisfy a Performance Requirement or a Deemed to Satisfy provision of the BCA as appropriate.

As per the BCA, *"Loadbearing"* means 'intended to resist vertical forces additional to those due to its own weight'.

Therefore an external wall that transfers the weight of building elements other than its self-weight to the foundation structure is loadbearing. For example, if signs, awnings, facings or other attachments are supported by an external wall, the wall is loadbearing. If such items are attached to other building elements and not the wall, and the wall supports no other elements, the wall may be non-loadbearing. An example of how FRL requirements differ for load bearing and nonloadbearing walls is given in Table 1.

Table 1. Class 2, Type A construction – Required Fire Resistance Level

Building element distance to fire-source feature	Fire Resistance Level for loadbearing	Fire Resistance Level for non-loadbearing
Less than 1.5 meters	90/90/90	-/90/90
1.5 to less than 3 meters	90/60/60	-/60/60
3 meters or more	90/60/30	-/-/-

Source: Building Code of Australia – Table 3 (Specification C1.1, Clause 3.1(f))

3.2 Combustibility

Non- combustible is a defined term in the BCA. The compliance of a material to the BCA non-combustibility definition can be determined by conducting an AS1530.1 standard combustibility test. If the material satisfies the criteria outlined in the test method the material is not deemed combustible.

Alternatively, BCA Clause C1.12 lists materials which, though combustible or containing combustible fibres, may be used wherever a non-combustible material is required.

The following subsections give further guidance on assessment of non-combustibility.

3.2.1 Assessment of non-combustibility by testing to AS 1530.1

AS 1530.1 is a small-scale material fire test involving immersing a small sample of the material in a furnace held steady at 750°C.

There are three criteria in AS 1530.1 where a material is deemed combustible:

1. The mean duration of sustained flaming, as determined in accordance with AS 1530.1 Clause 3.2, is other than zero. In summary, the material is combustible if flaming sustained for a period of 5 seconds or longer occurs at any time during the test for any of the five samples tested.
2. The mean furnace thermocouple temperature rise, as determined in accordance with AS 1530.1 Clause 3.1, exceeds 50°C.
3. The mean specimen surface thermocouple temperature rise, as determined in accordance with AS 1530,1 Clause 3.1, exceeds 50°C.

The test method is intended to provide material property data on individual materials, not systems or composites. However if any one layer or element of a system or product is combustible then the whole system or product is considered combustible.

CSIRO is aware of some claims that the AS 1530.1 test is invalid or inappropriate for certain product types. The following addresses some of these frequently asked questions:

What if the product is less than 50mm thick?

AS 1530.1 Clause 2.2.2 requires the test specimen to be cut into a 50-mm x 45-mm diameter cylinder. Clause 2.2.3 of AS 1530.1 addresses how to prepare specimens for a material that is less than the required height by stacking discs of the material into a cylinder for the required height. The specimen is held together firmly by two fine steel wires.

Conversely products thicker than 50mm are cut to the required specimen size.

Is the test method applicable to products which are coated, faced or laminated?

AS 1530.1 Clause 1.4 states: “The test method is not applicable to products which are coated, faced or laminated.” However it continues “In such cases, tests may be carried out separately on the individual materials from which the product is formed…” Accordingly, this clause does not eliminate the assessment of any multi-layered assemblies, but states that each layer should be

tested separately to AS 1530.1. A system or product that has one layer or component that is combustible therefore could not be deemed non-combustible.

AS 1530.1 Appendix A further discusses the limitations of laminated materials. CSIRO has performed tests on laminated composite materials using following two different approaches:

- Separate tests on each material layer as required by AS 1530.1. These are reported as formal test reports in full compliance with AS1530.1.
- A single test on the laminate/material with all layers included as one specimen. These tests do not comply with Clause 1.4 so the reports are issued as indicative results only or a formal test report and stating the departure from the standard. The results however can be viewed with the following guidance.
  - Where an indicative test on a laminate has concluded the material is combustible it is reasonable to conclude that at least one of the materials of the laminate would be combustible if tested in isolation, therefore as a composite the material cannot be considered non-combustible.
  - Where an indicative test on a laminate has indicated the laminate material has not exceeded the criteria that deems a material as non-combustible, it is not reasonable to conclude that all of the materials of the laminate would be non-combustible if tested in isolation. Therefore, as a composite the material cannot be considered non-combustible. See AS1530.1 Appendix A1 for further guidance on this test limitation.

The test method is not a real world simulation of a fire so how can you tell how the product will react in a real fire?

It is true that the test does not simulate the broad range of fire exposure scenarios that may occur in the real world. However this is not the purpose of this test. The purpose is to provide a consistent and standardised test which conservatively categorises materials (primarily for the construction industry) which, although not completely inert, produce only a limited amount of heat and flame when exposed to temperatures of approximately 750°C and are expected not to burn substantially even when exposed to severe fire conditions.

Where data on flammability and fire spread under specific real-world fire scenarios is needed, different test methods which appropriately represent the specific scenario should be selected.

What happens if the test was not run for the full 30 minutes?

AS 1530.1 requires 5 samples to be tested and the minimum test time is 30 minutes.

If a sample fails by means of sustained flaming early in the testing process, the test is terminated to prevent damage to equipment. In this case, the intended 30 minute test exposure requirement of the standard has not been satisfied for number of samples and test duration, hence calculations for criteria related to furnace temperature rise and specimen temperature rise cannot be carried out. However, in these instances CSIRO will issue a formal test report stating the material to be of a clear fail on criteria (a) and that the material is deemed to be combustible. Any variations from the standard test method such as a test period of less than 30 seconds or less than 5 samples tested should be clearly stated on the test report.

To determine any material to be non-combustible requires full testing of 5 samples to be tested over the minimum test time of 30 minutes.

Is brand X panel non-combustible?

Many manufacturers of wall systems usually have a range of systems. A statement that a particular brand is compliant can be misleading. For example, many manufacturers will have 3 or 4 versions of ACP all with aluminium facing but with differing core material. The basic version may have a polyethylene core with no additives. The next better fire performance system may have fire retardant added to the core and may be designated fire resistant. A third may have substantial fire retardant and mineral filler in the core polymer. This may have an "A2" designation which indicates compliance to a level similar to that specified in a European jurisdiction. A further system may comply with the BCA requirements for non-combustibility but will be unlikely to have a polymer core.

3.2.2 Materials complying with Building Code of Australia Clause C1.12

Where non-combustible materials are required, an alternative BCA Deemed to Satisfy pathway is to comply with BCA Clause C1.12. This clause lists materials which, although combustible or containing combustible fibres, may be used wherever a non-combustible material is required.

It specifically includes:

1. Plasterboard
2. Perforated gypsum lath with a normal paper finish
3. Fibrous-plaster sheet
4. Fibre-reinforced cement sheeting
5. Pre-finished metal sheeting having a *combustible* surface finish not exceeding 1 mm thickness and where the *Spread-of-Flame Index* of the product is not greater than 0.
6. Bonded laminated materials where:
   - each laminate is *non-combustible*;
   - each adhesive layer does not exceed 1 mm in thickness;
   - the total thickness of the adhesive layers does not exceed 2 mm; and
   - the *Spread-of-Flame Index* and the *Smoke-Developed Index* of the laminated material as a whole does not exceed 0 and 3 respectively.

CSIRO notes that some materials complying with BCA Clause C1.12 may, in some scenarios, contribute more to fire growth and spread than materials complying with AS 1530.1. However the guide to the BCA states that the intent of this clause is to permit use of certain materials which are known to provide acceptable levels of fire safety.

In the case of item 6, the terms laminate and adhesive layer are not defined in the BCA. CSIRO applies the following interpretations:

- Laminate – a layer of material included to provide desired property such as structural rigidity, thermal or acoustic insulation or fire performance, etc. The layer may consist of any material (eg metal, ceramic etc), but excludes the material performing the role of the adhesive.
- Adhesive – a layer of material within the bonded laminated material which has the main purpose of adhering the other layers together. Adhesive is typically a combustible polymer.

CSIRO recommends that Items 5 and 6 should be tested and assessed by a Registered Testing Authority (as defined in the BCA) . CSIRO provides this service and delivers reports assessing compliance with BCA Clause C1.12.

3.3 Material fire hazard properties

There are many terms to describe how a material responds when involved in fire. Words used in the construction industry, often defined in test standards and regulation, may differ from common use by the general public. Combustibility is one such term used in the building code to classify materials. Combustible materials can be further categorised based on parameters such as ease of ignition, propensity to spread flame, flammability and smoke produced. A range of tests to determine fire hazard properties of materials are prescribed in BCA Specification C1.10.

4 Attachment to an external wall – Deemed to Satisfy provisions

The overarching BCA Deemed to Satisfy requirement for external walls for buildings of type A and B requirements is that the external walls must be non-combustible. However BCA Specification C1.1 Clause 2.4 does permit combustible materials to be used as an attachment under the following conditions:

- A combustible material may be used as a finish or lining to a wall or roof, or in a sign, sunscreen or blind, awning, or other attachment to a building element which has the required FRL if—
  - the material is exempted under C1.10 or complies with the fire hazard properties prescribed in Specification C1.10
  - it is not located near or directly above a required exit so as to make the exit unusable in a fire
  - it does not otherwise constitute an undue risk of fire spread via the facade of the building.
- The attachment of a facing or finish, or the installation of ducting or any other service, to a part of a building required to have an FRL must not impair the required FRL of that part.

Careful assessment must be made to determine if the building element under consideration is in fact an attachment or an integral part of the external wall prior to applying BCA Specification C1.1 Clause 2.4. Guidance on the approach for this assessment is provided in Section **Error! Reference source not found.** of this document.

The requirements of BCA Specification C1.1 Clause 2.4 are discussed in more detail in the following sections.

4.1 Fire hazard properties

Any wall lining or facing attachments to an external wall must either:

- Be exempted by BCA Clause C1.10 (or C1.12)
- Meet the Fire hazard properties requirement prescribed in BCA Specification C1.10.

Exemptions listed in BCA Clause C1.10(c) include items like plaster, timber-framed windows, paint, or C1.10(c)(xiv) “any other material that does not significantly increase the hazards of fire.” The determination of C1.10(c)(xiv) requires expert judgement by a suitably qualified person and is therefore not allowed as an exemption in Victoria.

BCA Specification C1.1 Clause 2.4 does not explicitly state which fire hazard properties requirement prescribed in BCA Specification C1.10 are to be applied. However based on the wording in BCA Specification C1.10 clause 4(c), CSIRO interprets that the relevant requirement for attachments used as a finish, surface or lining to an external wall is that the material must be minimum Group 1, 2 or 3 based on AS ISO 9705 or AS/NZS 3837.

CSIRO considers that BCA Specification C1.10 clause 7 which specifies AS/NZS 1530.3 test requirements for other materials is not relevant or applicable for attachments used as external wall finish, lining or cladding.

4.2 Proximity to exits

BCA Specification C1.1 Clause 2.4 restricts attachments to limited locations "not located near or directly above a *required exit* as to make the *exit* unusable in a fire." From a practical viewpoint, the determination whether or not an exit will be rendered unusable usually requires the expert judgement of a suitably qualified and experienced person such as a fire safety engineer.

4.3 Risk of fire spread

The attachment location and contribution to fire spread on the façade must be considered.

Attachments must not "constitute an undue risk of fire spread via the façade of the building". Generally this may be viewed as spread beyond the floor of origin; but the precise definition of 'undue risk' will vary case-by-case. For example, hospitals would require stricter controls on spread via the façade compared to apartment buildings.

The determination of "an undue risk of fire spread via the façade" usually requires the expert judgement of a suitably qualified and experienced person such as a fire safety engineer, and dependent on the nature of the building design and materials, may require evidence from large-scale fire testing.

CSIRO considers that a full-scale façade test provides the clearest and most reliable basis for assessment of risk of fire spread. We recommend this (in addition to meeting fire hazard property requirements) as the preferred method of assessment. However the full-scale façade test must suitably represent the specific façade design and materials.

Compliance with the fire hazard property requirements does not automatically limit the risk of fire spread. In some cases a Group 1 rating may provide some indication that the "undue risk of fire spread" requirement is met. However because the arrangement and installation of materials and also the fire exposure is significantly different for an AS ISO 9705 test or an AS/NZS 3837 test compared to a full-scale façade fire, there may be cases where a Group 1 material would still support fire spread between levels in a full scale façade test. The risk that a material will support fire spread between levels is likely to increase for Group 2 and Group 3 materials.

We reiterate that the wall the attachment is connected to must be non-combustible as per Section **Error! Reference source not found.** of this document.

The installation of the attachment must be such that it does not compromise the FRL of the wall.

4.4 Impairment of fire resistance level

Typically, attachments to the wall which are supported by the wall would make the wall loadbearing and this would impact the FRL required for the wall.

In all cases the attachment must not impair the FRL of the wall. Attachments could possibly impair the FRL of the wall in the following ways:

- Any fixings or penetrations into the wall to support the attachment may influence the integrity or insulation of the wall system
- Any significant force loads beyond that of the originally fire tested wall system may influence the structural adequacy or integrity of the wall system
- Significant increased heat release near the surface of the wall may influence the structural adequacy, integrity or insulation of the wall system.

It is recommended that any impairment of FRL should be determined by AS 1530.4 testing by a Registered Testing Authority or, where reasonable, assessment by a suitably qualified and experienced person.

5 Spandrels

Buildings of Type A construction without sprinkler protection would normally require non-combustible spandrels having an FRL of not less than 60/60/60 in accordance with BCA clause C2.6. This requirement will also impact the use of combustible materials on exterior walls.

6 Insulation and sarking

Insulation and sarking (reflective foil laminates, paper or polymer-based membranes or the like) are commonly used in external walls to achieve thermal and acoustic performance requirements. Insulation materials can take a number of forms such as:

- Non-woven flexible fibre blanket or board
- Rigid board
- Loose fill

Numerous types of combustible and non-combustible insulation products are commonly available.

Insulation material can contribute to the risk of façade fire spread. This risk is influenced by the following factors:

- The fire performance of the insulation materials
- Presence of ignition sources within the insulation or exposure to fire sources from the outside of the wall

- A façade cavity geometry can enhance fire spread via mechanisms such as re-radiation/reflection of heat and buoyancy driven 'chimney effect' air flows
- Presence of any continuous surfaces of insulation or cavity openings connecting levels. This can be eliminated by installing fire barriers which is a requirement of some building codes outside Australia.

CSIRO adopts the following conservative interpretation of BCA Deemed to Satisfy provisions regarding fire performance of insulation and sarking:

- Insulation or sarking which is present either within the cavity or on a surface of the external wall forms an integral part of the external wall system as its presence is required to achieve the thermal or acoustic performance of the wall.
- For buildings of Type A or B construction, such external wall insulation or sarking is required to be a non-combustible material in accordance with BCA Specification C1.1, Clauses 3.1(b) &4.1 (b).
- External wall insulation or sarking for buildings of Type C construction, or insulation or sarking used in other areas of Type A or B buildings (not otherwise required to be non-combustible by other parts of the BCA) may be combustible but must meet the fire hazard property requirements of BCA Specification C1.10.

CSIRO acknowledges that there is variance in the interpretation of BCA Deemed to Satisfy provisions for insulation and sarking for external walls that is currently applied in the building industry. For example, it is common for parts of the building industry to simply interpret that BCA Specification C1.10 clause 7 which specifies AS/NZS 1530.3 test requirements is the applicable requirement for insulation in external walls for Type A and Type B construction and AS 1530.2 for sarking. However adopting this approach may increase the risk of façade fire spread in some cases and therefore not meet the performance requirements of the BCA.

7 Evidence of suitability

The BCA requires evidence to support the use of materials that must be in the form of:

- A report issued by a Registered Testing Authority (Registered with or recognised by National Association of Testing Authorities
- A current Certificate of Conformity issued under the Australian Building Codes Board (ABCB) CodeMark scheme
- A Certificate of Accreditation issued by the Building Regulations Advisory Committee
- A certificate from a professional engineer or other appropriately qualified person which:
  - certifies that a material, design, or form of construction complies with the requirements of the BCA

  - sets out the basis on which it is given and the extent to which relevant specifications, rules, codes of practice or other publications have been relied upon
- A current certificate issued by a product certification body accredited by the Joint Accreditation System of Australia and New Zealand (JAS-ANZ)
- Any other form of documentary evidence that correctly describes the properties and performance of the material or form of construction, and adequately demonstrates its suitability or that a calculation method complies with an ABCB protocol.

7.1 Test reports or certificates

Test reports to AS 1530.1, or other relevant required fire test methods by a NATA accredited laboratory, are acceptable evidence. Another way of showing non-combustibility would be via a report by a *Registered Testing Authority* providing assessment that the product is non-combustible. This will most likely require an assessment against the requirements of AS 1530.1:1994 and likely would refer to a test report of a method equivalent or similar to AS 1530.1.

7.2 Certificate of conformity

A number of aluminium composite panels (ACPs) have been issued with Certificates of Conformity under the CodeMark scheme. These certificates identify specific requirements of the BCA the building material is certified to comply with. If there is any doubt about a certificate or other form of evidence of suitability, the body who issued the certificate should be contacted for clarification.

CodeMark certificates also commonly contain limitations or conditions for the installation and use of the building material. For instance, a common condition is a requirement that the building material or product must be installed in a particular manner or in accordance with a technical manual supplied by the manufacturer. If a certificate is accepted then all conditions or limitations listed on the certificate should be transferred to design documentation including construction drawings, specifications, and if relevant, to Fire Engineering Reports (FER).

Note: When relying on certified materials, it is critical to remain aware of fundamental BCA requirements. CodeMark approval of a product as an attachment does not overwrite BCA requirements that the wall it is attached to has an appropriate FRL.

8 Compliance as an Alternative Solution

As an *Alternative Solution*, a fire safety engineer might be able to develop requirements on the use of a particular combustible panel or element for a specific external wall in the building design. The method and format is similar to other parts of an *Alternative Solution* where the fire safety engineer, following the concepts in the International Fire Engineering Guidelines (IFEG), develops a design that meets the performance requirements of the BCA.

It is CSIRO's view that the material properties of a combustible system, determined from small-scale testing, are rarely sufficient to determine if a particular product can be used as part of a building's *Alternative Solution*. This is because small-scale tests typically do not reasonably represent full-scale façade fire scenarios and often only test individual materials rather than the system of materials and fixings as a whole.

Large-scale façade test data is recommended as the best basis for a complete analysis.

Using standard fire safety engineering strategies, a large number of combustible external wall systems are likely to be suitable for design of a Class 2 building using Type A construction. However, depending on the external wall system fire properties, as determined through appropriate testing, limitations may be required on the exact use of a given external wall system. Such design decisions will need to be made by a suitably accredited and experienced fire safety engineer on a case-by case basis.

The installation of sprinklers, fire barriers, limiting exposed areas of combustible materials or separation between combustible materials are all strategies that may be adopted as part of an *Alternative Solution*, and these may reduce the fire risk. However, previous façade fire incidents indicate that internal sprinklers alone may not prevent external fire spread.

An *Alternative Solution* for an external wall system would need to address the Performance Requirement CP2 as a minimum. CSIRO supports current industry views that "*CP2(a) A building must have elements which will, to the degree necessary, avoid the spread of fire— (iv) in a building"* includes fire spread on the façade.

An *Alternative Solution* would also need to address CP4. Depending on the location of the material and class of building CP3, CP6, CP7, CP8, CP9, EP2.2 and others may also need to be addressed (to ensure compliance with BCA Clause A0.10).

Review of such an *Alternative Solution* by an independent expert third party is recommend by the IFEG for complex fire safety issues. It is CSIRO's opinion that the use of a combustible façade in Type A or Type B construction often creates a complex fire safety issue.

9 Fire testing for fire hazard properties

9.1 Group number assessment

Fire hazard properties are covered in the BCA by Clause C1.10. Standards Australia has recently published AS 5637.1 to provide guidance on determining the fire hazard properties of walls and ceiling linings. This specifies a full-scale room test (AS ISO 9705) or, when appropriate, the small-scale test (AS/NZS 3837) for predicting the results of the room test. Small-scale testing is not appropriate in all cases.

Note: The AS ISO 9705 room fire test and group number prediction method are intended for fires in enclosures on internal wall and ceiling surfaces. The original Fire Code Reform Centre research[4], that supported adoption of the AS ISO 9705 room fire test and group number prediction method by the BCA, intended that it was only to be applied for internal wall and ceiling surfaces, not external wall surfaces. At the time, the Fire Code Reform Centre research did consider different intermediate and full-scale façade fire tests for adoption in the BCA.

The current BCA Deemed to Satisfy provisions do not differentiate between internal and external linings, and therefore the group number system is applied to both external and internal wall linings where non-combustible materials are not otherwise required.

Application of data and properties from enclosure fire tests and extension to façade fires requires the expert judgement of a suitably qualified and experienced person such as an appropriately accredited fire safety engineer.

9.2 Fire hazard properties from AS/NZS 1530.3

The BCA revised the regulation of wall and ceiling linings to AS ISO 9705 and AS/NZS 3837 in 2003. There is little data correlating AS/NZS 1530.3 to fire performance of façades. Therefore CSIRO advises AS/NZS 3837 data is unlikely to be appropriate for use as part of an *Alternative Solution*.

Practitioners must take care interpreting 1530.3 test data. For example a *spread of flame index* of zero (0) does not indicate that the material will not spread flame in all fire situations. A group 3 material can achieve a *spread of flame index* of zero (0) in the AS/NZS 1530.3 and is highly likely to have flame spread the full extent of a vertical element once ignited.

9.3 Large-scale façade fire testing

There are a number of internationally-recognised full-scale façade test methods including National Fire Protection Association 285, BS 8414, and ISO 13785 that are currently used for regulation of façade fire performance in other countries.

These methods vary in terms of specimen arrangement, ignition-source size, measurements and the required pass/fail criteria. It is important to carefully consider applicability and limitations of any specific full-scale fire test results when applying such data for use as an *Alternative Solution*.

Standards Australia has recently released AS 5113:2016. This standard provides guidance regarding testing and classification of fire performance of external walls. It includes details of full-scale façade test methods proposed for Australia.

The work to develop this standard was in recognition of the need for an improved method of assessing combustible external walls in Australia. A full scale façade test has been specified due to its ability to assess complete façade system performance including the impact of the fixing methods, cut and exposed edges, thermal expansion of metals leading to delamination, etc.

10 Conclusion

This guideline is intended to aid building practitioners in understanding the fire hazards of combustible materials and pathways to demonstrate compliance in relation to façade fire safety under the requirements of the current BCA. Whether a cladding is part of a wall or an attachment, the restrictions on its use are quite stringent. Combustible materials can be used if the correct approach as set out in the BCA is followed to show compliance with the performance requirements. For cladding systems with combustible elements large-scale test data is likely to be required.

Regardless of whether a project implements *Alternative Solutions* that utilise combustible facades, Deemed to Satisfy cladding systems, or attachments, the documentation must clearly specify the *exact material type* assessed as being suitable and *approved* for use including fixing methods, joint treatments, limitations etc. Inspections of the combustible wall or attachment and confirmation in writing that the approved material has been installed in accordance with documentation or Fire Safety Engineering Report must also be conducted.

11 Services provided by CSIRO

CSIRO carries out testing certification and standardisation of reaction to fire and fire resistance of product and building. We also provide independent and objective fire safety engineering expertise and evaluation. We operate the most comprehensive fire research, consulting and testing facility in Australia, which combines our expertise and full-scale fire testing equipment to simulate a wide range of fire scenarios.

We provide an independent and objective fire safety engineering consultancy for innovative solutions that satisfy or exceed the required level of fire safety, while meeting the demand for cost efficiency and flexibility. These extend to independent 3rd part peer review services of designs and building installations.

Additional to fire safety we offer services to assess the weather performance of new facades, and analyse the weather performance of existing facades and windows.

This includes determining facade weather performance. We developed and run SIROWET, our own comprehensive and integrated facade performance test. Tests can be performed in our laboratory on prototypes or on existing buildings. We also can perform assessments on prototype building elements for product approval and/or quality assurance. We can conduct structural, weather performance and thermal cycling tests on full-scale facade test samples to meet Australian and a range of international Standards. Where required we can determine recommendations for cost-effective remediation.

For more information on our services, please visit www.csiro.au/do-business/services

References

1. White N, Delichatsios M. (2015) Fire hazards of exterior wall assemblies containing combustible components. New York: Springer-Verlag 2015
2. MFB. (2015) Post Incident Analysis Report: Lacrosse Docklands. Melbourne Australia: MFB, Report No.: Report No: 1403134A DocCentral # 1009072.
3. Australian Building Codes Board. (2015) National Construction Code Series Volume 1, Building Code of Australia 2015, Class 2 to 9 Buildings. Canberra: Australian Building Codes Board; 2015.
4. Dowling VP, Blackmore JB. (1998) Fire Performance of Wall and Ceiling Linings, FCRC Final Report, Project 2 Stage A. Sydney: Fire Code Reform Centre Ltd., 1998.

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