Combustible Facades & AS 5113 Amendment 1 (Draft)

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Fire spread on facade

What is acceptable?
Outline

- Overview of current situation
- Engineering perspective of NCC requirements
- Definition of combustibility
- AS5113 fire propagation testing and classification of external walls revisited
- AS5113 Amendment 1
- AS5113 debris criterion
Combustible Facades

- Energy efficiency requires:
  - insulation on outside and thermal mass inside
  - Insulation, waterproofing membranes and vapor barriers are often combustible

- Composite panels extensively used for cladding
  - Core material can be EPS, XPS, PE, PP, PU, PIR and Phenolic
  - Aluminium - PE composite panel most common (sometimes with flame retardants/fillers)

- NCC 2016 Amendment 1
  - Clarified combustible external wall provisions
  - Introduced Verification Method CV3

- AS 5113 Amendment 1 out for public comment
Fire Hazard

- Window plumes from fires
  - Radiative and convective heat flux - Severe exposure sufficient to melt aluminium

- Fire spread via façade and external wall
  - Internal via cavities (both vertical and lateral)
  - External via combustible cladding (façade)

- Radiant heat flux from surrounding building
  - Radiant flux typically well resisted by low absorptivity aluminium

- Increased heat flux to surrounding buildings
  - Radiant source needs to consider façade contribution

- Fires outside building (ground and balconies)
  - External fires more likely to break into building
NCC Performance Requirements

- Fire spread **between** buildings; and
- Fire spread **within** buildings
- Fire spread on/in external walls controlled only to degree necessary
- Provision for safe evacuation
- Provision for fire brigade intervention

**CP2**
(a) A building must have elements which will, to the degree necessary, avoid the spread of fire—
(i) to exits; and
(ii) to sole-occupancy units and public corridors; and
   Application: CP2(a)(ii) only applies to a Class 2 or 3 building or Class 4 part.
(iii) between buildings; and
(iv) in a building.
Spandrels

- NCC spandrel provisions are marginal at best
  - Only just effective for traditional narrow windows
- Adding extra fuel (combustible façade) makes it worse
- Equivalence not possible, absolute assessment difficult
- Fire propagation via cavity between spandrel and cladding further reduces effectiveness
  - Flame length longer as there is very limited entrainment
  - Flames likely to impinge directly on window of storey above
  - Weakest point around window (opening trim)
- Cavity barriers are needed to limit fire spread
  - NCC is silent on cavity barriers except for protected timber
FCRC investigated the issue of non-combustible construction requirements in the BCA (Project 3)

Identified post-fire performance expectations

FCRC looked at the appropriate test method for assessment of combustible facades (Project 2)

The Vertical Channel Test was recommended

Identified limitations of AS1530.3 test and cone calorimeter for assessing fire behaviour of composites
Combustibility Test – AS1530.1

- Called up by NCC to define “Non-combustible”
- Based on ISO 1182
  - Measures even small exothermic reaction without flaming
  - Specimen 50mm high (number of layers if less)
  - 45mm dia. cylindrical specimens inserted into furnace at 750°C
  - Must not flame for > 5s
  - Must not cause temperature rise > 50K
- Number of attempts internationally to adopt less strict definition
- FCRC Project 2 recommended basing it on Heat Release Rate
AS1530.1 Issues

- Inconsistency between NCC use and Clause 1.4 of standard
- NCC call-up overrides intended application in standard
- Suitable to determine combustibility of product if representative specimen can be made
- Emphasis on representing:
  - average properties (proportions)
  - surfaces at top and bottom

1.4 APPLICATION TO FIRE HAZARD ASSESSMENT
The test results relate only to the behaviour of the test specimens of the material under the particular conditions of the test, and are not intended to be the sole criteria for assessing the potential fire hazard of the material in use. The test method is not applicable to products which are coated, faced or laminated. In such cases, tests may be carried out separately on the individual materials from which the product is formed.

2.1 SAMPLING
The sample shall be selected to be representative of the average properties of the material.

2.2.3 Preparation
If the thickness of the material is less than the required height, specimens of the height specified in Clause 2.2.2 shall be made by using a sufficient number of layers of the material and by adjustment of the material thickness if required.
AS 5113:2016

- Classification standard
- Provides guidance on testing and interpretation of test data
- Draws upon the ISO and British façade test standards for classification of External Wall Fire Performance
- Uses a 3 m x 3 m radiant heat source (vertical furnace) for classification for building-to-building fire spread
- Specifies criteria for classification
- Includes criteria for debris
- Temperature used to assess risk of fire spread
- Temperature criteria applied 2 storeys above fire
## AS 5113:2016 – Classification External Wall Wall

<table>
<thead>
<tr>
<th>Provision</th>
<th>External Wall Performance (EW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Test Methods</td>
<td>ISO13785-2 or BS8414</td>
</tr>
<tr>
<td>Classification</td>
<td>EW</td>
</tr>
<tr>
<td></td>
<td>External wall system shall satisfy Classification Criteria in Clause 5.4.3 for ISO13785-2 or</td>
</tr>
<tr>
<td></td>
<td>Clause 5.4.5 for BS8414</td>
</tr>
<tr>
<td>Modifications to Procedures</td>
<td>YES. Refer to Clauses 5.4.2 to 5.4.5</td>
</tr>
</tbody>
</table>
### AS 5113:2016 – Classification Building-to-Building

<table>
<thead>
<tr>
<th>Provision</th>
<th>Building-to-Building Performance (BB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable Test Methods</td>
<td>Appendix C</td>
</tr>
<tr>
<td>Classification</td>
<td>BBnn</td>
</tr>
<tr>
<td></td>
<td>External wall system shall satisfy Classification Criteria in Clause 5.4.6 when exposed to nn kW/m² incident flux for 30 minutes.</td>
</tr>
<tr>
<td>Modifications to Procedures</td>
<td>No</td>
</tr>
</tbody>
</table>


AS 5113:2016 – Test Requirements EW

- Test to ISO 13785-2:2002 with timber crib specified in standard
- Alternatively, Test to BS 8414:2015 with pinus radiate crib
- Test assembly simulates room with window adjacent to wing wall to create re-entrant cavity
- Temperature measurement location specified in standard
AS 5113:2016 – Test Requirements EW

- Test on external wall system (wall or “attachment”)
- Test specimen >4.3 m (ISO) or 5.0 m (BS) above opening
- Simulates two storeys at 0.3 m and 3.0 m above window
- Includes cavity barrier where part of system
- Classification based on temperatures 4 m (ISO) or 5.0 m (BS) above opening (2 storey above!)
- No flame spread beyond edge of specimen to occur
- No flaming on ground (debris or molten material) >20 s
- Not more than 2kg of fallen debris
Comparison Test Configurations

ISO TEST

4m

Note Spandrel Panel

BS TEST

5m
## AS 5113:2016 – Classification Criteria EW

<table>
<thead>
<tr>
<th>Classification indices</th>
<th>Test method</th>
<th>Classification criteria</th>
<th>Related classification measure</th>
<th>Result in test</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>EW</td>
<td>ISO 13785-2</td>
<td>5.4.3(a) T&lt;sub&gt;W4m&lt;/sub&gt;</td>
<td>&lt;600°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.3(b) T&lt;sub&gt;cavity4m&lt;/sub&gt;</td>
<td>&lt;250°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.3(b) T&lt;sub&gt;layer4m&lt;/sub&gt;</td>
<td>&lt;250°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.3(c) T&lt;sub&gt;Unexposedside0.9m&lt;/sub&gt;</td>
<td>&lt;180°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.3(d) flaming</td>
<td>No flaming</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.3(d) openings</td>
<td>No openings</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.3(e) flame spread</td>
<td>No spread beyond specimen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.3(f) debris flaming</td>
<td>&lt;20 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.3(g) debris mass</td>
<td>&lt;2 kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## AS 5113:2016 – Classification Criteria EW

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<thead>
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<th>Related classification measure</th>
<th>Result in test</th>
<th>Pass/Fail</th>
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</thead>
<tbody>
<tr>
<td>EW</td>
<td>BS 8414-1 or BS 8414-2</td>
<td>5.4.5(a) $T_{w5m}$</td>
<td>&lt;600°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.5(b) $T_{cavity5m}$</td>
<td>&lt;250°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.5(b) $T_{layer5m}$</td>
<td>&lt;250°C</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>5.4.5(c) $T_{Unexposedside0.9m}$</td>
<td>&lt;180°C</td>
<td></td>
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<tr>
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<td></td>
<td>5.4.5(d) flaming</td>
<td>No flaming</td>
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<td>5.4.5(d) openings</td>
<td>No openings</td>
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<tr>
<td></td>
<td></td>
<td>5.4.5(e) spread</td>
<td>No spread beyond specimen</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>5.4.5(f) debris flaming</td>
<td>&lt;20 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.5(g) debris mass</td>
<td>&lt;2 kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## AS 5113:2016 – Classification Criteria BB

<table>
<thead>
<tr>
<th>Classification indices</th>
<th>Test method</th>
<th>Classification criteria</th>
<th>Related classification measure</th>
<th>Result in test</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>BB80</td>
<td>Appendix C</td>
<td>Prescribed level of exposure, in kW/m²</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>BB40</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>BB20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BB10</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

5.4.6(a) $T_{cavity}$  
<250°C

5.4.6(a) $T_{layer}$  
<250°C

5.4.6(b) $T_{unexposedside}$  
<180°C
## CLASSIFICATION OF EXTERNAL WALLS

<table>
<thead>
<tr>
<th>Class</th>
<th>Application</th>
<th>Combustible option</th>
<th>External wall fire spread requirement</th>
<th>Additional building requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>A100 plus</td>
<td>Type A construction, greater than 100 m effective height</td>
<td>No combustible option</td>
<td>EW</td>
<td>None</td>
</tr>
<tr>
<td>A100</td>
<td>Type A construction, greater than 25 m but less than or equal to 100 m effective height</td>
<td>EW</td>
<td>EW</td>
<td>Automatic sprinklers system with balcony protection</td>
</tr>
<tr>
<td>A25</td>
<td>Type A construction, less than or equal to effective height of 25 m</td>
<td>EW</td>
<td>EW</td>
<td>Automatic sprinklers system with balcony protection</td>
</tr>
<tr>
<td>B</td>
<td>Type B construction</td>
<td>EW</td>
<td>EW</td>
<td>Spandrels/horizontal projections</td>
</tr>
<tr>
<td>Minimum distance from boundary or adjacent building</td>
<td>Combustible option</td>
<td>Façade fire requirement</td>
<td>Additional building requirements</td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>--------------------</td>
<td>-------------------------</td>
<td>--------------------------------</td>
<td></td>
</tr>
<tr>
<td>On boundary or no distance between buildings</td>
<td>BB80</td>
<td></td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>1 m from boundary or 2 m between buildings</td>
<td>BB40</td>
<td></td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>3 m from boundary or 6 m between buildings</td>
<td>BB20</td>
<td></td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>6 m from boundary or 12 m between buildings</td>
<td>BB10</td>
<td></td>
<td>Nil</td>
<td></td>
</tr>
</tbody>
</table>
Appendix B provides Informative Commentary

- Selection of test protocol
- Tests selected as they contain wing wall with re-entrant corner
- Crib fire more meaningful and less costly than other fire sources
- ISO preferred standard but BS commonly used and similar
- Fire severity such as to challenge façade without dominating performance
- Classification levels intended to be consistent with NCC
- BB levels consistent with Verification Methods CV1 and CV2
- BB assessment based on common AS 1530.4 test
Amendment 1 has just been released for public comment
“Debris” now defined as having individual mass >100g
Recommends debris weight distribution be reported
Intended to be compatible with CV3 of NCC 2019
Appendix A on possible regulatory framework replaced
Appendix B now enhanced with further clarification as to performance assessment of facades based on test data
  - Clarifies that CV3 is not mandatory and normal performance assessment remains an option
If debris criteria not satisfied: Recommends risk assessment
  - Risk assessment to consider height of building, proximity to egress routes, likely fire brigade intervention, sprinklers and nature of fallen debris
<table>
<thead>
<tr>
<th>Risk Mitigation</th>
<th>Measurement/Observation</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention of fire spread to two floor levels above fire</td>
<td>Temperature 50 mm from façade, 5 m above opening</td>
<td>&lt;= 600°C</td>
</tr>
<tr>
<td>Prevention of incipient fire spread to two floor levels above fire</td>
<td>Internal temperatures of materials and cavities 5 m above opening</td>
<td>&lt;= 250°C</td>
</tr>
<tr>
<td>Prevent fire spread to two floor levels above fire and lateral spread</td>
<td>Flame spread beyond confines of specimen</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Prevent fire spread to floors below</td>
<td>Continuous flaming on ground for more than 20 s from debris or molten material</td>
<td>Not permitted</td>
</tr>
<tr>
<td>Limit debris impact with fire fighters, occupants and passers-by</td>
<td>Total mass of debris</td>
<td>&lt;= 2 kg</td>
</tr>
<tr>
<td>Prevent fire spread to floor above if wall not fire resistant</td>
<td>Non-fire side temperature 900 mm above opening</td>
<td>&lt;= 180K rise</td>
</tr>
<tr>
<td>Prevent fire spread to floor above if wall not fire resistant</td>
<td>Flaming on non-fire side or the occurrence of openings in the unexposed face</td>
<td>Not permitted</td>
</tr>
</tbody>
</table>
AS 5113 Issues

- ISO 13785-2 and BS 8414 standards are not identical
  - Fire sizes are different
  - Specimen sizes are different
  - Temperature measurement locations are different
  - Opening dimensions are different (spandrel panel in ISO test)
- Tests have poor repeatability and reproducibility
- Specimens do not contain opening on next storey
  - Fire spread from opening to opening not assessed
- Heat flux from flames would cause fire spread with NCC spandrels
- Fire spread to next storey only assessed with fire-rated walls
- Fallen debris subject to high heat flux in BS8414 test
Debris Criteria

- Concern expressed about 2kg debris limit
  - Is total 2kg of charred flakes or dust really a hazard?
- Studies conducted on risk posed by drones
  - Objects falling from heights may reach terminal velocity
  - Terminal velocity for 4cm² 100g steel bolt is about 70m/s
  - Impact energy is 245J
  - 2kg limit based on survivability of blunt object impacts
  - 100g limit based on impact energy
  - 76J limit proposed for head
  - 200J limit proposed for body
- FB helmet impact energy criterion of 50J shock absorption

The impact into the thorax with a 2kg object at 10m/s (20kts) is survivable with serious injuries. The model predicts the absence of serious head injuries (skull fracture) for an RPA mass under 2kg and impact velocities below 7.5m/s (15kts).
Impact Energy of Debris

The graph illustrates the impact energy of debris as a function of velocity and mass. Different lines represent different masses (M=0.5kg, M=1.0kg, M=2kg, M=7kg, M=20kg). The y-axis represents kinetic energy (J), and the x-axis represents velocity in kts and m/s. The graph includes markers for different levels of damage: UDS (Underwater Detonation Shell), LCS & terminal velocity, and 90% fatality. The red dot indicates the energy level of a cricket ball.
Conclusions

- Combustible materials are often needed in external walls
- Combustible facades must meet community expectations for fire safety
- Require objective assessment of:
  - Fire performance – contribution to fire spread (compartment & building)
  - Impact on egress – risk of falling debris
  - Impact on fire brigade intervention – risk of falling and flaming debris

- NCC 2019 confirms:
  - Default non-combustible external walls
  - CV3 combustible external walls of proven performance with sprinklers

- AS 5113 provides:
  - classification and assists with interpretation of test data
  - guidance to fire engineers on test data