MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HIKINA WHAKATUTUKI

Determination 2017/088

Regarding the code-compliance of a façade system proposed for remediation work to an apartment building at 12 Selwyn Road, Howick, Auckland

Summary

This determination considers the compliance of a replacement façade system to an existing 5-storey building. The façade system incorporates high-pressure laminate panels fixed to an aluminium frame creating a 50mm wide cavity between the panels and the lined timber-framed wall behind. The authority has concerns about the façade system's ability to perform with respect to preventing the spread of fire over the external cladding. The determination considers the compliance of the original façade system, and as modified in response to the determination's initial findings.

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1. The matter to be determined

1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004[1] ("the Act") made under due authorisation by me, Katie Gordon, Manager Determinations, Ministry of Business, Innovation and Employment ("the Ministry"), for and on behalf of the Chief Executive of the Ministry.

1.2 The decisions to make this determination under section 184 of the Act and engage a person to assist under section 187 of the Act were made by the previous Manager Determinations.

[1] The Building Act, Building Code, compliance documents, past determinations and guidance documents issued by the Ministry are all available at www.building.govt.nz or by contacting the Ministry on 0800 242 243.

1.3 The parties to the determination are:

- the architect for the proposed remediation ("the architect") who is deemed to be a licensed building practitioner under the Act[2] and is the applicant
- Auckland City Council ("the authority"), carrying out its duties as a territorial authority or building consent authority
- Body Corporate BC 340942 as owner of common areas and representing the owners of the apartments in the building ("the owners").

1.4 I have provided Fire and Emergency New Zealand[3] ("FENZ") with the determination documentation for comment by way of consultation under section 170 of the Act.

1.5 The application for this determination arises from the decision of the authority to refuse to accept a proposed façade system ("the original façade system"). The original facade system is described in paragraph 2.3. The authority is of the view it had received insufficient information on the original façade system to be satisfied that it would comply with certain fire safety clauses[4] of the Building Code (Schedule 1, Building Regulations 1992).

1.6 The façade system was modified in response to the first draft determination ("the modified façade system") and its compliance was considered in the second draft determination.

1.7 The matters to be determined[5] are therefore:

- whether the authority was correct to refuse to grant the building consent based on the information provided for the original façade system, and
- whether the modified façade system, if properly installed on the building in accordance with the plans and specifications, will comply with Building Code Clause C3 Fire affecting areas beyond the source.

The façade systems include the associated components of the external building envelope (such as the timber framing, the rigid air barrier, the façade panels, the joints and the support brackets) as well as the way the components have been installed and work together.

1.8 Matters outside this determination

1.8.1 The architect's submission is restricted to the façade systems' compliance with Clause C3. Other matters raised by the authority during the processing of the building consent are left to the parties to resolve and this determination is limited to the matter outlined above.

1.8.2 Although the architect asked for the determination to consider other similar cladding systems, this dispute concerns a specific building consent application for a specific cladding system on a specific building, and this determination is therefore limited to the façade system proposed for this particular apartment building. Notwithstanding that, I consider the evaluation process and analysis in this determination provides guidance for similar cladding systems in similar situations, subject to the same evaluation process being used in each of such cases.

[2] Registered Architects are treated as if they were licensed in the building work licensing class Design 3 under the Building (Designation of Building Work Licensing Classes) Order 2010.
[3] Previously the New Zealand Fire Service
[4] In this determination, unless otherwise stated, references to sections and clauses are to sections of the Act and clauses of the Building Code.
[5] Under section 177(1)(a) of the Act

1.9 The evidence

1.9.1 Evidence considered in this determination includes reports provided to the architect and the Ministry by a variety of specialist fire advisors. In making my decision, I have considered:

- relevant parts of submissions from the parties
- the following reports provided by the cladding supplier to the architect and forwarded to the authority:
  - April 2009: the fire test report on NFPA 285[6] testing of sample façade systems by the US fire laboratory ("the US test facility")
  - February 2014: analysis/extension of NFPA 285 test results to similar systems by a fire protection US consultancy ("the US fire consultant")
  - May 2017: compliance of the original façade system with the Building Code by a local fire consultant ("the fire consultant")
- the report by the fire engineer engaged by the authority ("the authority's engineer")
- the reports of the expert commissioned by the Ministry to advise on this dispute ("the fire scientist")
- the other evidence in this matter.

1.9.2 Within this determination, the relevant reports and their authors are given the following titles:

Table 1: The relevant reports

Date	Report provided by:	Report for:	Reference used in the determination
29 April 2009	the US test facility	the US manufacturer	"US test report"
14 Feb 2014	the US fire consultant		"US opinion"
30 May 2017	the fire consultant	the supplier	"fire consultant's report"
19 Sept 2017	the authority's engineer	the authority	"the authority's report"
22 Sept 2017	the fire scientist	the Ministry	"fire scientist's report"
25 Oct 2017	the fire consultant	the supplier	"the amended proposal"
31 Oct 2017	the fire scientist	the Ministry	"the fire scientist's addendum report"

2. The building work and background

2.1 The building work consists of an exterior wall cladding system proposed to replace damaged monolithic wall cladding to an existing 5-storey high apartment building on an excavated sloping site in a high wind zone. The building is rectangular in plan and is sited on a north-south axis, with the street to the south and a driveway to the west providing access to basement parking.

2.2 The original building

2.2.1 The original building was constructed in 2004, and consists of four levels of

[6] NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies. The National Fire Protection Association of America (NFPA) develops and maintains fire standards and codes.

apartments over a basement car park. The apartments are stepped back on the east (coastal) side to provide roof decks to each level. Access to each apartment is via a stairwell lift and corridors along the west (rear) of the building. The building currently has plastered EIFS[7] cladding which has failed in places, allowing water ingress and giving rise to the need to re-clad the building.

2.2.2 The building has a steel structural frame with concrete suspended floors and timber infill framing. The basement car park level has a reinforced block perimeter and slab on grade, and the top level is largely timber framed with some steel structural elements. Wall construction above the basement level is timber framing, specifically designed to suit the height of the building and high wind conditions of the site.

2.3 The original façade system

2.3.1 The original façade system comprised a high-pressure laminate panels (the HPL panels") riveted to an aluminium rail system which provides a 50mm cavity behind the HPL panels as indicated in Figure 1.

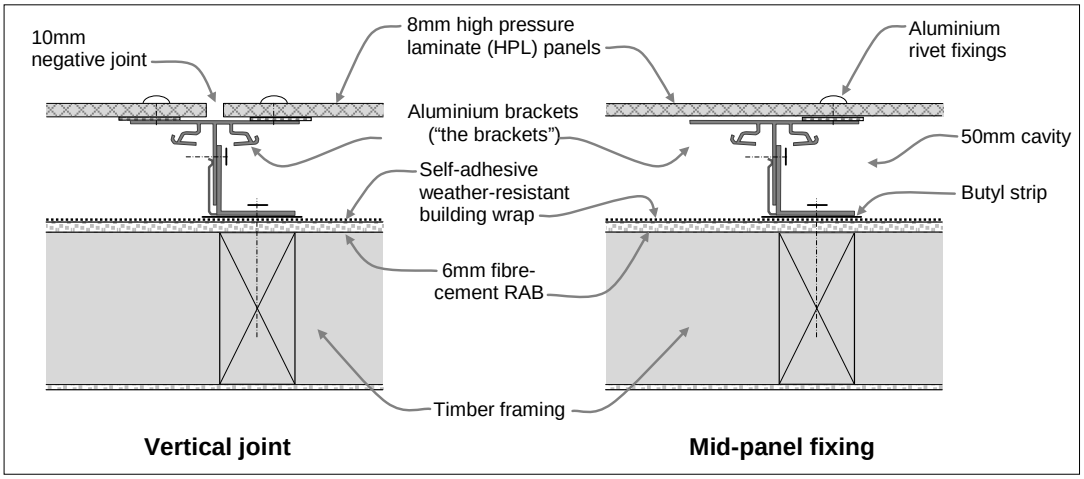


Figure 1: Typical construction of the original façade system (not to scale)

2.3.2 The HPL panels are made of a fire-retardant high-pressure laminate phenolic-impregnated kraft paper with a decorative finish. A transparent topcoat is added to the surface layer(s) and cured, with coloured pigments added to the surface during curing to provide a variety of colours.

2.3.3 The brackets are fixed through building wrap and 6mm fibre-cement rigid air barrier ("RAB") into the framing.

2.3.4 The HLP panels are manufactured by a company founded in the Netherlands more than 50 years ago that supplies panels under various brand names, with different qualities for indoor and outdoor applications.

2.3.5 There are different formulations of the HPL panels; a standard panel and a fire-retardant panel. The US test report (refer paragraph 2.4) considered the performance of the fire-retardant panel which is the panel discussed in this determination.

2.3.6 The fire-retardant HPL panels are marketed by the NZ supplier ("the supplier") for outdoor applications such as façade cladding.

[7] Exterior insulation and finish system

2.3.7 The manufacturer's information includes performance data on various properties of the panels, including strength and impact resistance, water resistance/absorption, thermal resistance/conductivity, and fire performance, which is tested to European and North American standards.

2.4 The US test report

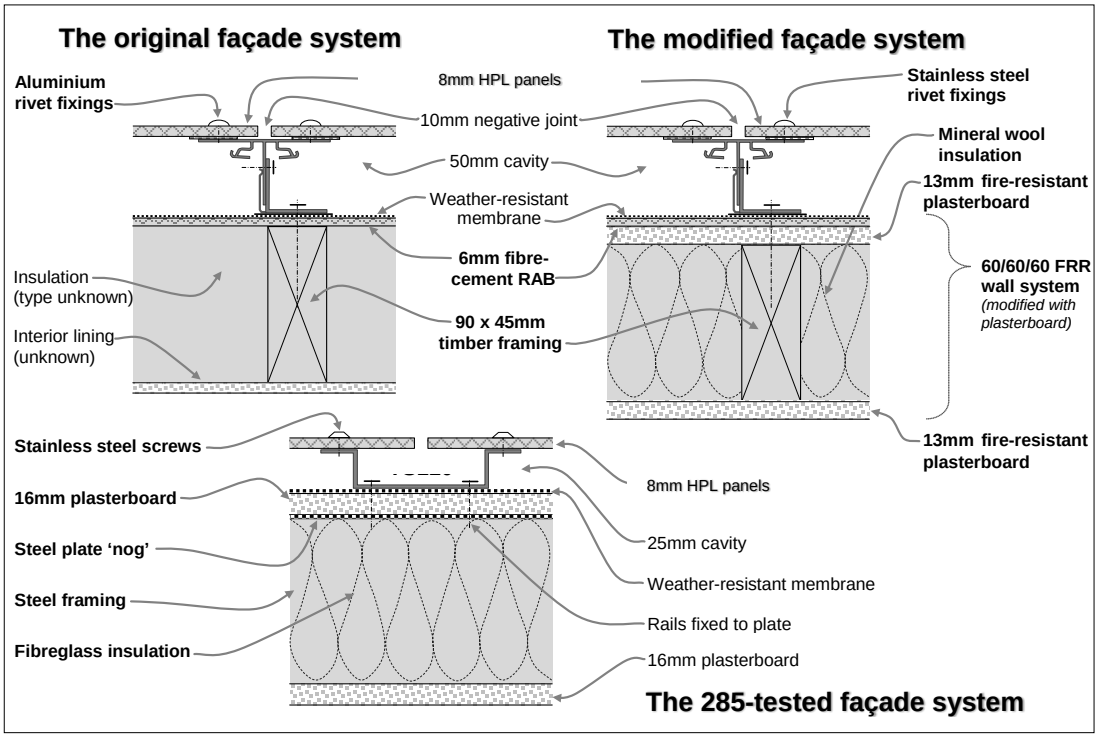
2.4.1 Fire tests conducted on a similar panel system were conducted for the manufacturer by a multinational inspection, product testing and certification company at its US test facility in 2009. The test results have been used by the fire consultant to support the original façade system's compliance with fire safety clauses (Paragraph 5.8.2 (b) of C/AS2 – see Appendix A1.2).

2.4.2 The report dated 29 April 2009 recorded a fire test carried out in November 2008 in accordance with NFPA 285:2006 using the test rig shown in Figure 3. The test wall ("the 285-tested system") used TS110 brackets and the report concluded the system "met the requirements of the 30 minute test".

2.5 The original and modified façade systems

2.5.1 Following the issue of the first draft determination the original façade system was amended to the modified façade system. The original facade system, the modified façade system and the 285-tested system are shown in Figure 2, with significant component differences shown in bold.

Figure 2: The original, modified, and 285-tested façade systems (not to scale)



2.5.2 Components of the façade systems shown in Figure 2 are compared in Table 2:

Table 2: Components of the façade systems

Components	Original façade system	Modified façade system	The 285-tested system
Interior lining	Unknown	13mm fire-resistant plasterboard *	16mm Gypsum plasterboard
Framing	Timber wall framing	Timber wall framing *	Steel wall framing
Frame Insulation	Unknown	Mineral wool insulation (60 kg/m^3) *	R-19 thermal insulation batts (probably fibreglass)
Fire-stopping Insulation	Fire barriers at each floor level	Fire barriers at each floor level	Mineral wool insulation at floor level (as fire stopping)
Exterior lining(s)	6mm fibre-cement RAB	13mm fire-resistant plasterboard, 6mm fibre-cement RAB *	16mm Gypsum plasterboard
Building wrap	'Weather resistant' membrane	'Weather resistant' membrane	'Weather resistant' membrane
Façade support frame	Aluminium support angles and 'T' sections	Aluminium support angles and 'T' sections	Aluminium support 'top hat' channels
Façade panels	8mm fire-retardant HPL	8mm fire-retardant HPL	8mm fire-retardant HPL
* **NOTE:** Components of base wall assembly which make up a fire rated system which provides Fire Resistance Rating of 60/60/60 FRR (based on manufacturer's Design Manual August 2017)			

2.6 The US opinion

2.6.1 In an opinion dated 14 February 2014, a US fire consultant provided:

> ...an analysis and extension of NFPA 285 fire tests that incorporated various exterior [sample wall panels from the same manufacturer] and certain fixing systems used to install these panels.

2.6.2 The US consultant noted that the manufacturer had 'performed several NFPA 285 fire tests on various exterior wall systems' incorporating the façade panels, which had met the 285 fire test performance requirements. The tested systems had combined the manufacturer's components with other components.

2.6.3 The US consultant analysed and extended the 285 test results to cover wall system configurations using various combinations of panel thicknesses, bracket fixing systems[8] and weather-resistant barriers over 16mm gypsum plasterboard sheathing – providing three tables that showed the permitted combinations required to meet NFPA 285.

2.6.4 The US consultant concluded:

> Based on the results of these tests, additional small-scale tests of the weather-resistive barriers and my experience with the NFPA 285 fire test, it is my judgment that the various configurations of exterior walls described in Tables I, II and III will meet the performance requirements of NFPA 285. These exterior wall configurations are a combination of [the proprietary] wall panels … panel cladding system components supplied by [the manufacturer] … and other base wall assembly components not part of panel cladding system

[8] The tested system - see Figure 2

2.6.5 I note that the fire scientist has reported that the US consultant is a recognised authority who has 'extensive first-hand experience with the NFPA 285 fire test method and he is a long-standing member and past-chair of the NFPA 285 technical committee'. The fire scientist considered the US consultant to be 'qualified to provide technical assessment on the potential effect of a variation to a specimen tested to NFPA 285'.

2.6.6 It is noted that the US opinion was not prepared for and did not consider the variations proposed for the proposed NZ installation. While the US opinion stated; "The support wall construction is beyond the scope of the [proprietary] exterior cladding assembly", it would have been a reasonable assumption by the US consultant that the support wall would have been constructed using non-combustible or limited-combustible materials as required under US building codes. This is unlike the proposed application where combustible timber framing will be used.

2.7 The fire consultant's report

2.7.1 The supplier engaged the fire consultant to compare the US test report results with the likely performance of locally-provided façade systems (including the original façade system for the subject building). The fire consultant provided a report dated 30 May 2017 which considered whether the locally-provided façade systems would pass the NFPA 285 fire test and thus satisfy the Building Code in relation to spread of fire.

2.7.2 The report considered three local alternatives to two of the manufacturer's proprietary systems approved as complying with the NFPA 258 test. The fire consultant described the components of the alternative systems, commenting on the effects of changes (if any) on the fire performance assessed for the systems. In respect of the original façade system, the fire consultant's opinion is considered in the fire scientist's report as summarised in Table 3 (see paragraph 5.4.2).

2.7.3 The fire consultant concluded that the three local systems would 'pass the NFPA 258 test' and would therefore comply with Clauses C3.5 and C3.6 of the Building Code, providing the following guidelines were followed:

1. If the cladding is fixed to a steel stud or timber framed wall, the exterior of the framing must be lined with a non combustible cladding system such as fibre cement sheet to protect the framing from the effects of fire.
2. The fixing method of the support structure and the panels to the support structure must not deviate from the [manufacturer's] Technical literature…
3. Fixings at closer spacings are acceptable when required to meet structural requirements.

2.8 The authority's refusal to accept the original façade system

2.8.1 The fire consultant's report was provided to the authority as part of the documentation supporting an application for a building consent (No. BCO 10251571) for the remediation work and the authority responded in a letter to the architect dated 21 August 2017.

2.8.2 The authority considered that the fire consultant's report was not sufficient to establish code-compliance and that 'a higher standard of evidence of compliance is therefore warranted, particularly in the light of recent overseas fires involving cladding systems.' The authority outlined its concerns and considered that a more authoritative opinion should be sought from a recognised testing laboratory.

2.8.3 The authority noted that the Acceptable Solutions to Clause C required cladding systems:

> ...to be either non-combustible or have met defined test criteria. The defined test is ISO 5660 Part 1 as modified by Clause 7.1.2 of Appendix C to the New Zealand Building Code Clauses C1-C6 Protection from Fire. An alternative fire test is the full scale NFPA 285:1998 test.

The authority concluded that:

> ...the application, in its current state, does not demonstrate that the [original façade system's] performance is equivalent to an NFPA 285 tested system. On that basis your Building consent application is declined...

2.9 The Ministry received the application for a determination from the architect on 23 August 2017. The body corporate (representing the owners of the apartment building) was added as a party to the determination, and the application was accepted on 30 August 2017.

3. The initial submissions

3.1 The architect described the building and its background. The architect noted that the apartment building was about 11.5m high, which put it within the requirement of the recent Amendment 4 to C/AS2-7 for cladding systems to sprinklered buildings over 7m high to have a fire test (see Appendix A1.3). Although the original façade system had not undergone a full fire test, the architect noted (in summary):

- The fire consultant compared the original façade system to the 258-tested system, and considered that the systems are sufficiently similar to conclude that proposed work would satisfy the amendment.
- The US fire consultant confirmed that in other countries compliance with fire regulations can be demonstrated by means of an expert comparison of an un-tested system with similar tested systems.
- The authority maintains that although many fire test standards specify the extent of acceptable variations from a tested specimen on the basis of a formal opinion by a suitably qualified organisation, NFPA 285 does not extend to opinions beyond the tested specimen.

3.2 The architect forwarded copies of:

- drawings of the original façade system dated 21 November 2014
- the US test report dated 29 April 2009
- the US fire consultant's letter of opinion dated 14 February 2014
- the fire consultant's report dated 30 May 2017
- the authority's letter to the architect dated 21 August 2017.

3.3 The authority's engineer provided an initial report dated 18 September 2017. This report made reference to ACP[9] panels, though this was largely removed in a revised report received on 19 September 2017 (see paragraph 4.2.1). (I note that the engineer's revised report still refers to molten and burning plastic.)

[9] Aluminium Composite Panel, which typically has a core of polyethylene with aluminium facing panels. The core may comprise mineral fibre and some polyethylene.

3.4 In regard to relevant performance criteria of Clause C (see Appendix A1.1), the authority's engineer (in summary):

- Noted a cladding system that has passed NFPA 285 testing does not necessarily meet the performance criteria of the Building Code.
- Provided specific comments on fire clauses 3.5, 3.7, and 3.9, relative to the results of a NFPA 285 test.
- Observed that the authority can require further details of the tested specimen and additional information on the testing of materials and components.
- Provided specific comments in relation to the 285-tested system which the engineer contended did not show compliance with the Building Code.
- Noted the differences between the 285-tested system and the original façade system and that 'the effect of numerous changes cannot reasonably be assessed by opinion'.

3.5 The authority's engineer concluded that the fire consultant's report 'fails to demonstrate comparable performance of the [original façade] systems to the NFPA 285 tested systems'.

4. The draft determinations and the responses received

4.1 The first draft determination

4.1.1 The first draft of this determination was issued to the parties for comment on 27 September 2017. The draft determination said that there were insufficient grounds for the authority to be satisfied that the original façade system would comply with Clause C3 of the Building Code.

The architect's responses

4.1.2 The architect initially responded to the authority's engineer's report in an email dated 18 September 2017, pointing out some incorrect references to the type of panel material, noting that HPL panel is a:

> homogenous high pressure laminate and therefore in no way the same product as ACP [referred to in the report. The proprietary system] is very different to an ACP panel. …[and] also has EN-13501 testing which shows limited smoke development and no dripping or flaming droplets.

The authority' engineer's report was amended as a result, and resubmitted (refer paragraph 3.3).

4.1.3 The architect responded to the draft determination on 10 October 2017 and included the following comments (in summary):

- The shortcomings identified in the first draft determination are acknowledged.
- Modifications to the façade system are proposed 'to more closely relate to the tested … system', which are supported by the supplier and the fire consultant.
- These modifications were discussed at a meeting with the authority and the architect was confident the modifications are sufficient to confirm compliance with Clause C3.

4.1.4 The architect also raised the following question regarding the fire scientist's report:

> Please advise whether a cladding system meets the external fire spread requirements of the Acceptable Solutions based on successful testing of the outer cladding only to [paragraph] 5.8.1, whether or not the cladding system incorporates combustible components or component configurations that may affect vertical fire spread.

4.1.5 The submission included a letter from the supplier, dated 4 October 2017, which noted (in summary):

- An email received from the US supplier about the performance of the HPL panels in the 285 test report noted no dripping burning plastic - pieces observed falling during the test were burn debris, and not a failure of the panel's fixing system.
- The subject "panel has been tested with two different systems to NFPA 285 four times and passed", with the test report of the system that most closely resembles the original façade system: reports for other of the manufacturer's systems were available on request.
- Because of the time and cost involved in NFPA 285 testing, it is accepted in the US that every system cannot be tested, and expert opinions are common to show compliance for variations of tested systems.
- NFPA 285 tests are intermediate-scale tests carried out in US test facilities, which provide a more realistic assessment of cladding systems. AS/NZ 3837[10] and ISO 5560[11] tests use a 90 x 90mm sample of the cladding, with no consideration of underlying substrate.

4.1.6 The submission included a letter from the fire consultant, dated 10 October 2017, which proposed the use of an established fire-rated wall assembly which has a 60/60/60 FRR[12] in place of the originally proposed wall assembly. The fire consultant also reviewed and commented on the authority's engineer's comments on the first draft determination.

4.1.7 The architect made a further response in a letter to the Ministry dated 25 October 2017, which explained that 'the specific performance of fibre-cement had been further reviewed', which had resulted in amendment to the façade system on the advice of the fire consultant.

4.1.8 The architect explained that a façade engineer and the fibre-cement manufacturer had also been consulted about the code compliance of the modified façade system and neither raised any maters of concern.

4.1.9 The submission included a letter from the fire consultant, dated 25 October 2017, which explained that the test results for the fire-rated wall assembly had shown that further modifications were needed for the modified façade system in regard to the test performance of the fibre-cement RAB. The fire consultant offered a number of options, the preferred option being the addition of one layer of 13mm fire-resistant plasterboard[13] under the 6mm fibre-cement RAB.

[10] AS/NZS 3837:1998 Method of test for heat and smoke release rates for materials and products using an oxygen consumption calorimeter
[11] ISO 5660:- Reaction-to-fire tests – Heat release, smoke production and mass loss rate Part 1: 2002 Heat release rate (cone calorimeter method)
[12] Fire Resistance Rating
[13] The 13mm fire-resistant plasterboard is proprietary product designed to provide passive fire protection

4.1.10 The fire consultant referred the matter to the manufacturer of the fire-resistant plasterboard who considered that:

> ...the combined system of 13mm [fire-resistant plasterboard] and 6mm RAB board will prevent the timber studs from being directly exposed to the ventilated cavity and contributing to the cavity temperature due to a flaming occurring for the 30 minute duration of the test.

4.1.11 The modified façade system is described in paragraph 2.5, Figure 2, and Table 4.

The authority's responses

4.1.12 The authority responded to the draft determination on 4 October 2017 accepting the draft determination subject to comment: the response included a letter from the authority's engineer dated 27 September 2017. The engineer noted the authority was interested to receive any comment from FENZ "in regard to the propensity of the proposed system to exfoliate, and in particular how this might impact on fire fighter safety and fire-fighting operations." The engineer noted the comment made by the fire scientist in relation to the expertise of the US fire consultant saying this advice should have been provided by the applicant.

4.1.13 The engineer also attached a copy of a test report[14] (the Australian test) as "other evidence" for the Ministry to consider and noted that:

> The test report describes an AS/NZS 3837:1998 cone calorimeter test of an 8 mm thick [HPL] panel.
>
> The test report identifies that the test methodology conforms to the specific requirements of Clause C7.1.2 of Annex C to C/ASx.
>
> Although this test pertains to cladding (and not a cladding system) the tested panel fails to meet the peak heat release rate and total released criteria of C/ASx Clause 5.8.1 under all boundary clearance circumstances.
>
> On the basis of these test results and the thermo-physical properties of phenolic resin it is reasonable to assume that this product would also be classified as combustible using the cited AS 1530 Part 1 test method for combustibility.

4.1.14 The authority made another submission on 20 October 2017 that said (in summary):

- None of the parties' submissions materially affected its view of the matter.
- It reiterated the view that the guidance sought by the architect in paragraph 4.1.4 be addressed.
- The authority requested the Ministry provide guidance on the "expected level of competency of individuals providing" opinions about "products subjected to fire testing that differ from the tested and approved system".

The owners' response

4.1.15 The owners' made no submission in response to the first determination.

4.2 The second draft determination

4.2.1 A second draft determination was issued to the parties for comment on 10 November 2017. The second determination found that that the modified façade system would, in principle, comply with Clause C3 of the Building Code.

[14] AWTA Product Testing Test Report 7-573875-CO, 22/07/2010 (Cone Calorimeter Single Run Data)

4.2.2 On 27 November 2017 the Ministry also sought clarification from the architects about the options for the decision in the final determination, namely; (1) the decision could remain as it was in the second draft; (2) that it could find the work was compliant with the exception of the fire stopping; or (3) it could await the completion of amended consent documentation and make a decision based on that. On 29 November 2017 the architect requested that the second option be adopted.

The authority's response

4.2.3 The authority responded to the draft determination on 20 October 2017 saying, in summary, that:

- It supported the question asked by the architect at paragraph 4.1.4. It requested guidance confirming "fire requirements … relate to cladding systems and not just components of those systems or simply the outer cladding."
- It sought guidance about the expected level of competency of individuals providing technical opinions the area of fire and material/system performance.
- It understood the fire scientist "has raised issues surrounding the fire performance of fibre-reinforced cement sheet products and supports the provision of guidance to its use". (This matter has been addressed by an additional layer of 13mm fire-resistant plasterboard under the fibre-cement RAB.)

4.2.4 On 14 December 2017 the authority advised it agreed with the submission made by FENZ, and would make no further comment.

The Architect's response

4.2.5 On 29 November 2017 the architect requested that the second option outlined in paragraph 4.2.2 be adopted as this was the most "time effective result for the client".

4.2.6 The architect left his response to the second draft determination until after receipt of the comment by FENZ. On 14 December 2017 the architect advised he had no further comment to make and also confirmed that the owners would not be making a submission in response to the second determination.

4.3 Comment received from FENZ

4.3.1 FENZ was consulted on the matter under section 170 of the Act as noted in paragraph 1.4. FENZ responded on 13 December 2017, saying in summary, that:

- It accepted the fire scientist's conclusion that the modified façade system "will most likely pass the NFPA 285 fire test".
- Cladding fixings are important and play a vital role keeping a cladding in place. The amendments to the original facade system "demonstrate an appropriate response to potential vulnerabilities" for evacuees and firefighters.
- It did not consider small scale tests were "an appropriate means of assessing the performance or compliance of façade systems" and acknowledged the determination's reference to the "external wall cladding system" in this respect.
- It agreed that there was insufficient evidence to show that the original façade system would meet the Code, and the determination should express this view.

5. The fire scientist's reports

5.1 General

5.1.1 As mentioned in paragraph 1.9.1, I sought advice from a fire scientist experienced in the testing and assessment of products with the fire provisions of the Building Code. The fire scientist provided an initial report to the Ministry dated 22 September 2017. The scientist noted that the purpose of the report was to review the material provided in regard to the compliance of the proposed cladding with the fire safety provisions of the Building Code.

5.1.2 The fire scientist outlined the components of the original façade system and the components of the test wall used in the fire tests recorded in the US test report (see Table 2), and noted that the report:

> ...is limited to whether the proposed façade system would pass the NFPA 285 full scale façade fire test and therefore would comply with C/AS2 paragraph 5.8 and therefore with the relevant clause(s) of the NZBC. The supporting information provided by the applicant is examined to determine if it gives 'reasonable grounds' to be satisfied that the façade system would pass the NFPA 285 fire test.

5.1.3 The fire scientist noted the relevant code requirements of Clauses C3.5 and C3.7 (see Appendix A1.1) and explained that one way of complying is to satisfy the requirements of the Acceptable Solution C/AS2, which for the external walls is paragraphs 5.8.1 and 5.8.2 (see Appendix A1.2).

5.2 The NFPA 285 Fire Test

5.2.1 The fire scientist noted that C/AS2 Paragraph 5.8.2 cites NFPA 285:1998 but the fire test recorded in the US test report was conducted to the 2006 version. Despite editorial and technical changes, the performance criteria for passing the test remained generally largely unchanged and the scientist had 'no reason to dispute the conclusions made in the [US] test report' and expected the same result if the test had been to the 1998 standard.

5.2.2 The scientist described the NFPA 285 fire testing procedure ("285 test"), with the test rig used as shown in Figure 3.

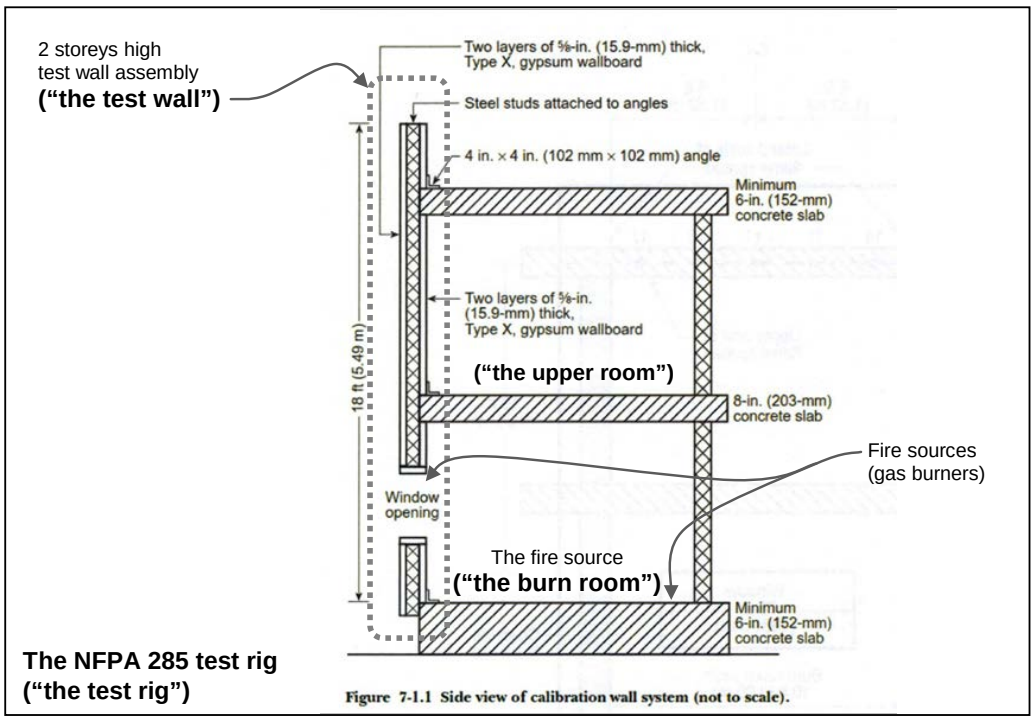
5.2.3 The standard set out conditions that would qualify as 'flame propagation' and the 285 test passed if there was no flame propagation[15] (in summary):

- on the exterior face of the test wall
- vertically or horizontally through core components of the test wall
- horizontally beyond the limits of the burn room.

5.2.4 The fire scientist noted that components of the base wall assembly used in the tested wall as shown in Table 2 would provide little fuel should an exterior fire breach the outer layer of gypsum board and reach the framing and cavity insulation (see Figure 2).

[15] With specified conditions determined to be the occurrence of 'flame propagation'

Figure 3: The NFPA 285 fire test rig[16]



5.3 Variations to a tested system

5.3.1 In regard to variations, the fire scientist noted the following (in summary):

- Variations to tested systems are commonly proposed for various reasons, with some standards specific about types of acceptable variations[17] while others (including NFPA 285) are silent.
- AS 1530.4[18] includes the permissible variations from tested specimens that do not require reference to the testing authority in each section, to facilitate greater direct application of test data[19].
- The Building Code permits expert testimony or opinions as evidence of compliance, and specifications of fire-rated systems are commonly based on a combination of test reports and assessments from test laboratories.
- In general, fire testing laboratories often assess variations made to previously tested construction, by:
  - considering the potential effect of each change on overall performance
  - applying scientific/engineering principles together with experience of fire testing similar construction
  - aiming to be satisfied that any proposed variation(s) would perform at least as well or better than the tested component or method.

[16] The figure shows a wall system used for calibration purposes. It differs slightly from the base wall assembly over which the tested system was installed.

[17] For example, NZS 4520 permits variations to fire-resistant doorsets only with a formal assessment by 'competent persons experienced in both testing and writing laboratory reports on fire-resistant doorsets, as appropriate, of similar construction to that proposed'.

[18] AS 1530:- Methods for fire tests on building materials, components and structures Part 4: 2005 Fire-resistance tests of elements of building construction

[19] For example, Section 10.11.2 d) says 'results obtained from framed wall systems may be applied to similar walls having studs of the same material with sizes greater than the tested prototype.'

5.3.2 In regard to the letter from the US fire consultant, the fire scientist noted that:

- the US fire consultant has extensive first-hand experience with the NFPA 285 fire test method and is a long-standing member of the NFPA 285 technical committee
- the US fire consultant is considered qualified to provide technical assessment on the potential effect of a variation to a NFPA 285-tested wall
- the opinion provided analysis and extension of NFPA 285 fire tests incorporating various exterior the HPL panels and fixing systems
- the exterior wall was a combination of the HPL panels and associated components and other base wall assembly components not part of façade system
- extension of the NFPA 285 fire test results did not significantly change or introduce new combustible components to the assembly, and changes were generally of a relatively minor nature.

5.4 The fire consultant's report

5.4.1 The fire scientist reviewed the report provided by the fire consultant, which had concluded that that the assessed systems would meet Building Code requirements providing certain guidelines were followed (see paragraph 2.8.2).

5.4.2 The fire scientist summarised the fire consultant's table, which I have further summarised in Table 3:

Table 3: The components of the 285-tested system and façade systems assessed by the fire consultant

Component	The 285-tested system USA	The HPL façade systems assessed	The fire consultant's comments
Wall substrate	• 150mm steel studs • R-19 batts, with mineral wool at each floor level • Horizontal steel backing plate for TS110 fixing. • Wall lined both sides with 16mm plasterboard. • Weather resistant barrier over plasterboard exterior	• Timber or steel studs • Fibre-cement RAB • Internal lining 10mm plasterboard[20] • Building wrap	• Framing should remain in place for 30-minute test and not contribute to fire growth. • RAB non-combustible so equivalent to plasterboard. • Wrap should not contribute any more to fire spread than original wrap used in test.
Bracket system	• 'Top hat' channel - overall width 146mm, depth of 25 mm	• Aluminium support angles and 'T' sections	• Similar concepts
Bracket material	• 6063 T5 aluminium.	• Aluminium	• Similar
Bracket spacing	• 300mm to 600mm centres	• 400mm to 600mm horizontally[21] and 800mm vertically.	• Similar

[20] Or thicker if fire rating required
[21] dependent on wind loading

Component	The 285-tested system USA	The HPL façade systems assessed	The fire consultant's comments
Bracket fixing	• Vertical rails connected to the underlying structure • Rail spacing and fixings to be specifically designed. • substructure channel anchorage to attach the channels to building to be stainless steel. • Vertical fixings at 610mm centres.	• One timber screw/ bracket	• Similar
Panel fixing	• Stainless steel screws. • Panel predrilled 50mm. minimum from edge.	• Aluminium rivets	• Rivets less robust in a fire as lower melting point. • Tests suggest that panel rather than fixing is weak link. • Temperature in cavity 3m above window peaked at 254°C – panels beyond fire area unlikely to fall off.
Fixings/sheet	• 584mm maximum spacing	• If two fixings in one direction then maximum spacing 600mm. • If three or more fixings in one direction then 750mm centres.	• Larger spacing for NZ system.
Panel thickness	8mm	8mm	• Same

5.5 The assessment of components

5.5.1 The fire scientist considered the components in Table 3 and assessed the fire consultant's conclusions about the acceptability of variations from the 285 test wall, which I summarise in the following.

5.5.2 Comments on the base wall assembly included (in summary):

- There needs to be justification as to why 6mm fibre-cement RAB is expected to remain in place during a fire, and prevent flames/gases penetrating into the cavity and spreading to combustible material such as timber framing.
- The 16mm thick gypsum plasterboard used in the 285 test has better fire resistant properties than 6mm fibre-cement board.
- Although some fibre-cement products can crack and fall away during fire exposure, others are used as part of a fire rated system – with a minimum thickness, fixing type and spacing requirements to achieve claimed performance. Detailed fire resistance references and specifications are needed.
- Using timber frame construction with 6mm fibre-cement board instead of steel frame with 16mm gypsum plasterboard needs justification, with evidence that the fibre-cement board will stay in place and protect framing during the period of exposure.
- Based solely on information provided, the variation proposed to the base wall assembly could perform more poorly than the tested assembly.

5.5.3 Comments on the panel fixing to brackets included (in summary):

- Fixing with aluminium rivets rather than steel screws would probably cause more panels to fall, or panels to fall sooner – so the change does not improve or maintain performance compared to that in the fire test.
- This might not result in increased flaming above the windows opening, but increases the hazard of falling materials onto fire fighters or others below and fire could spread from falling flaming panels depending on the panel's combustibility.
- Increasing fixing spacing is unlikely to improve performance compared to the fire tested system and whether performance would be maintained is unknown.

5.5.4 Comments on fibre insulation as fire stopping included (in summary) whether mineral fibre insulation is needed as fire stopping at each floor level is not addressed and should not be omitted from the specification unless justification is provided.

5.6 The fire scientist's conclusions on the original façade system

5.6.1 The fire scientist summarised the substantive differences between the originally proposed cladding and the testing system as follows:

- The base assembly is to be timber frame with unspecified cavity insulation instead of steel frame with (mostly likely) glass fibre insulation as tested.
- 6 mm fibre cement sheet is to be used on the outside of the framing instead of [16mm] gypsum plasterboard. The latter would be expected to have much better fire-resistant properties than the former.
- The aluminium support structure differs from that tested.
- The panels are fixed to the support structure with aluminium rivets instead of steel screws as tested.
- The panel fixings may have larger spacings compared to that tested.
- The mineral fibre insulation fire stopping at each level is possibly omitted but present in the test assembly.

5.6.2 Although variations to a tested system should be considered on their merit, the fire scientist concluded:

> I do not think the information provided to me contained sufficient justification to be satisfied that the proposed cladding system would pass the NFPA 285 acceptance criteria and therefore comply with the [Building Code].

5.7 The modified façade system

5.7.1 In response to the first draft determination, the fire consultant considered the six substantive differences between the 285-tested system and the original façade system identified by the fire scientist. The response was described in the amended proposal dated 25 October 2017 which formed the basis of the modified façade system; it is summarised in Table 4 (Figure 2 also refers).

Table 4: The amended proposal

	Component	Differences identified	Additional information provided / the modified façade system
1	**Base wall assembly**	Timber frame with unspecified cavity insulation instead of steel frame.	Base wall to be an established 60/60/60 FRR timber-framed wall, with additional layer of 13mm fire-resistant plasterboard beneath the fibre-cement RAB.
2		6mm fibre-cement RAB to outside of framing instead of 16mm gypsum plasterboard.	
3	**Aluminium support structure**	Aluminium support structure for the HPL panels differs from that tested.	• Proposed structure has same physical properties as tested product. • Dead load, seismic and wind loads drive the support structure sizing.
4	**Panel fixing method**	Panels fixed to support structure with aluminium rivets instead of steel screws.	Stainless steel rivets to be used.
5	**Spacing of fixings**	Fixings may have larger spacings compared to that tested.	Spacing to accord with NFPA 285 test.
6	**Insulation and cavity barriers**	Mineral fibre insulation fire stopping at each level is possibly omitted but present in the test assembly.	Cavity barriers are required and will be installed. There is no intention to delete these.

5.7.2 In regard to the base wall assembly, the fire consultant included the following comments (in summary):

- The performance of the modified façade system will be similar to the tested assembly and not contribute to the temperature within the wall cavity, with:
  - 13mm fire-resistant plasterboard on the inside
  - 90x45mm framing, with studs at 600mm centres min, nogs at 800mm minimum
  - 13mm fire-resistant plasterboard on the outside
  - 6mm fibre-cement RAB on the outside
  - mineral insulation (60kg/m^3 density)
- The aluminium manufacturer's information shows that the proposed brackets have the same mechanical properties as the 285-tested brackets, and fixings to the structure are steel which will perform better than the aluminium.
- The modified façade system replaces the aluminium rivets with 5.0mm diameter stainless steel rivets spaced in accordance with the tested panels. The proposed steel rivets have a greater cross section than the tested screws, so should perform equally if not better than the tested wall.
- The NFPA 285 test did not have fire barriers in the ventilated cavity, so the proposed system will have lower temperatures above the barrier – so protecting aluminium brackets for longer and therefore improving fire performance.

5.8 The fire scientist's addendum report

5.8.1 The fire scientist provided an updated report dated 31 October 2017, which added an addendum to the first report. The addendum considered responses to the first draft determination together with additional information[22] provided after the issue of the first draft – in particular the modified façade system as outlined above.

[22] Including the BRANZ fire test report from which the specification for the established 60/60/60 FRR assembly was derived

5.8.2 The fire scientist reviewed the modified façade system taking into account fire test results for the proposed base wall. Some concerns were discussed with the fire consultant, who provided an amended proposal (see Table 4) that included an additional layer of 13mm fire-resistant plasterboard beneath the fibre-cement RAB.

5.8.3 In regard to the 25 October 2017 proposal, the fire scientist concluded:

> I have reviewed the proposed exterior wall assembly as described in the [architect's] letter of 25 October 2017 which now includes installing a layer of 13mm [fire-resistant] gypsum plasterboard between the timber framing and RAB of the base wall assembly. The [architect] also agrees to use 5.0mm stainless steel blind rivets with a 16mm head and 304 stainless steel mandrel with fixing centres as per the NFPA 285 tested system.
>
> With these changes, I am satisfied that the exterior wall system now proposed for installation at 12 Selwyn Road, Auckland would most likely pass the NFPA 285 fire test.

5.8.4 The fire scientist also addressed the question raised by the architect (also requested by the authority) regarding 'whether a cladding system meets the external fire spread requirements of the Acceptable Solutions based on successful testing of only the outer cladding to [paragraph] 5.8.1, whether or not the cladding system incorporates combustible components or component configurations that may affect vertical fire spread' (see paragraph 4.1.4) and included the following comments (in summary):

- The architect had provided one fire test result (ISO 5660 tests three samples minimum), indicating that the HPL panel narrowly fails to meet the Paragraph 5.8.1 criteria based on heat released per unit area over 15 minutes.
- Paragraph 5.8.1 is interpreted to apply to a depth of up to 50mm from cladding surface because bench-scale ISO 5660 tests use 100 mm^2 samples up to 50mm thick so base wall performance cannot be evaluated.
- Underlying combustible materials within wall cavity have not generally been required to meet minimum C/AS2 requirements – significantly limiting the value of ISO 5660 fire tests for evaluating risk of vertical fire spread.
- A larger scale NFPA 285 fire test of the entire external wall system is a comprehensive evaluation of vertical fire spread but testing is expensive and NZ test facilities are not available.
- A building's fire risk could be matched with the level and cost of the fire compliance testing required, with ISO 5660 testing suitable for low risk situations and NFPA 285 or similar for higher risk (or paragraph 5.8.1 could take into account combustible materials within the wall cavity).

6. Discussion

6.1 General

6.1.1 The determination considers the compliance of the original façade system and whether sufficient information was provided to the authority to enable it to grant the building consent.

6.1.2 During the determination process the façade system has been modified in response to the fire scientist's report, and the first draft determination, as described in the architect's submission dated 25 October 2017 (refer paragraph 4.1.9). The determination will therefore also consider the compliance of the modified façade system.

6.2 The relevant fire requirements

6.2.1 The relevant definitions and parts of Clause C3 are provided in Appendix A1. Clause C3.1 requires design and construction to provide a low probability of injury or illness to people not in close proximity to a fire source. Clauses C3.2 and C3.3 requires upper floors and other property to be protected from external fire spread including against fire spread to other property vertically or horizontally.

6.2.2 Clauses C3.5 and C3.7 specify criteria that must be met, for example, about preventing the spread of fire 'over the external cladding of multi-level buildings' and materials used as external claddings for external walls within 1m of a boundary. Clause 3.9 requires the consideration of the likelihood and consequences of failure.

6.2.3 Paragraph 5.8.1 (see Appendix A1.2) of the Acceptable Solution to Clause C (C/AS2) states that the 'external wall cladding system shall be tested in accordance with the relevant standard test' and meet specified requirements[23] unless 'the entire wall assembly has been tested at full scale in accordance with NFPA 285 and has passed the test criteria[24]'.

6.2.4 The Verification Method (see Appendix A1.4) to Clause C (C/VM2) states that for cladding:

> To demonstrate that NZBC C3.7 is achieved, it is expected that relevant fire test results for the selected cladding system will be provided. Engineers may also choose to comply with Paragraph 5.8 of the relevant Acceptable Solutions C/AS2... ...to satisfy the performance criteria of this clause.

6.2.5 I note that the NFPA 285 test is not about the fire rating of the façade assembly itself, but about preventing fire spreading vertically to upper levels of a building via the cladding.

6.3 The available technical information

6.3.1 The manufacturer's information about the HPL panels provides performance data on various properties of the product, including strength and impact resistance, water resistance/absorption, thermal resistance/conductivity, and fire performance, which is tested to European and North American standards. For the latter, fire test results are available for multi-storey applications.

6.3.2 The National Fire Protection Association of America (NFPA) develops and maintains fire standards and codes and NFPA 285 fire testing for a cladding system by the same manufacturer has been assessed by the fire consultant as sufficient to show the modified façade system's compliance with the relevant fire safety provisions (Paragraph 5.8.2 (b) of C/AS2 – see Appendix A1.2).

6.3.3 I have seen no site-specific drawings and specification for the work including modified façade system. There is also no evidence that the cladding installer will have experience with this particular product, however, the supplier has stated that approved installers are used for installation of the aluminium rail system and training is provided prior to cladding installation, with back up support provided to the installer on site.

[23] C/AS1 Paragraph 5.8.1
[24] C/AS1 Paragraph 5.8.2 (b)

6.4 The original façade system

6.4.1 The authority raised concerns about the applicability of the NFPA 285 test results in the US test report to the original façade system, and considered that the fire consultant's 30 May 2017 report was not sufficient to establish code compliance in that case. I accept the advice of the fire scientist that the original façade system as documented in the application for building consent did not provide sufficient evidence to show that compliance would be achieved. I therefore consider the authority was correct to refuse to grant the building consent for the original façade system.

6.5 The modified façade system

6.5.1 The original façade system has been revised to the modified façade system as described above.

6.5.2 The conclusions in the fire scientist's addendum report are that the modified façade system, in particular using the established 60/60/60 system with an additional 13mm fire-resistant plasterboard behind the fibre-cement RAB, would address the likelihood of flame entering the wall cavity, and that the façade system as a whole would "most likely" pass the NFPA 285 fire test.

6.5.3 Taking the fire scientist's report into account, I am satisfied that sufficient evidence has been provided to demonstrate that the modified façade system will, in this case, satisfy Clause C3 Fire affecting areas beyond the source. However, as noted by the fire scientist, a compliant system should incorporate fire stopping at each floor level in the building: this detail has not yet been provided.

6.5.4 The appropriate documentation should now be submitted to the authority for its approval detailing the modified façade system, as described herein, including the provision for fire stopping.

6.6 Advice sought by the authority and the architect

6.6.1 The authority has sought guidance in relation to the expected level of competency for those providing opinions about products in relation to tested systems. As with any person or entity providing specialist advice, the acceptance of otherwise of such advice will rest on a combination of qualifications, proven experience, and standing in their profession – coupled with the level of risk associated with the work on which the advice is being provided. Where doubt exists about specialist advice received, the authority can seek clarification about the author and/or the advice received: it can also seek to have the advice peer-reviewed.

6.6.2 The architect has requested the following guidance on the fire performance of an external cladding based on an assessment of the outer cladding only; this request has also been repeated by the authority:

> …whether a cladding system meets the external fire spread requirements of the Acceptable Solutions based on successful testing of the outer cladding only to [paragraph] 5.8.1, whether or not the cladding system incorporates combustible components or component configurations that may affect vertical fire spread"

(This has been commented on by the fire scientist at paragraph 5.8.4.)

6.6.3 The corresponding performance Clause of the Building Code is C3.5 which says:

> Buildings must be designed and constructed so that fire does not spread more than 3.5 m vertically from the fire source over the external cladding of multi-level buildings.

6.6.4 Cladding systems can vary considerably in terms of materials, configuration, complexity, the acceptable fire risk, and known fire performance of individual components and/or the complete cladding system. There will be situations where testing an outer cladding only would considered sufficient for a fire designer to be satisfied that Clause C3.5 will be met. Equally, there will be situations where the material properties of the outer cladding is but one part of a building's cladding system where the performance of the cladding system as the building's exterior envelope is less well understood. In my view individual cladding systems need to be assessed on their merits, and judgement made as to the appropriate test method(s) adopted to show compliance.

7. The decision

7.1 In accordance with section 188 of the Act, I hereby determine that the authority was correct to refuse the grant of the building consent in respect of the compliance of the original façade system with Building Code Clause C3 Fire affecting areas beyond the source.

7.2 I also determine the modified façade system as described herein will comply with Building Code Clause C3, with the exception of the fire stopping at each floor level.

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 22 December 2017.

Katie Gordon
Manager Determinations

APPENDIX

A.1 Relevant Building Code provisions

A1.1 The relevant parts of the Building Code discussed in this determination are:

Clause A2—Interpretation

In this building code unless the context otherwise requires, words shall have the meanings given under this clause.

fire the state of combustion during which flammable materials burn producing heat, toxic gases, or smoke or flame or any combination of these

fire source means the combination of the ignition source and the item first ignited within a room, space, or firecell, which combination is considered to be the origin of the fire for the purposes of design

Clause C1—Objectives of clauses C2 to C6 (protection from fire)

The objectives of clauses C2 to C6 are to:

(a) safeguard people from an unacceptable risk of injury or illness caused by fire,

(b) protect other property from damage caused by fire, and...

Clause C3— Fire affecting areas beyond the fire source

Functional requirement

C3.1 Buildings must be designed and constructed so that there is a low probability of injury or illness to persons not in close proximity to a fire source.

C3.2 Buildings with a building height greater than 10 m where upper floors contain sleeping uses or other property must be designed and constructed so that there is a low probability of external vertical fire spread to upper floors in the building.

C3.3 Buildings must be designed and constructed so that there is a low probability of fire spread to other property vertically or horizontally across a relevant boundary

C3.5 Buildings must be designed and constructed so that fire does not spread more than 3.5 m vertically from the fire source over the external cladding of multi-level buildings...

C3.7 External walls of buildings that are located closer than 1 m to the relevant boundary of the property on which the building stands must either:

(a) be constructed from materials which are not combustible building materials, or

(b) for buildings in importance levels 3 and 4, be constructed from materials that, when subjected to a radiant flux of 30 kW/m^2, do not ignite for 30 minutes, or

(c) for buildings in Importance Levels 1 and 2, be constructed from materials that, when subjected to a radiant flux of 30 kW/m^2, do not ignite for 15 minutes.

C3.9 buildings must be designed and constructed with regard to the likelihood and consequence of failure of any fire safety system intended to control fire spread.

A1.2 The relevant part of the current Acceptable Solution is:

C/AS2 Acceptable Solution for Buildings with Sleeping (non institutional)

5.8 Exterior surface finishes

External walls

5.8.1 The external wall cladding system shall be tested in accordance with the relevant standard test in Appendix C C7.1 and shall satisfy the following requirements:

a) If the distance to the relevant boundary is less than 1.0 m, the peak heat release rate shall not exceed 100 kW/m^2 and the total heat released shall not exceed 25 MJ/m^2, and

b) If the distance to the relevant boundary is 1.0 m or more and the building height is greater than 7.0 m the peak heat release rate shall not exceed 150 kW/m^2 and the total heat released shall not exceed 50 MJ/m^2.

5.8.2 The requirements in Paragraph 5.8.1 do not apply if:

a) Surface finishes are no more than 1 mm in thickness and applied directly to a non-combustible substrate, or

b) The entire wall assembly has been tested at full scale in accordance with NFPA 285 and has passed the test criteria.

A1.3 The relevant part of the former Acceptable Solution deleted for consent applications after 1 May 2017 was:

5.8.3 The requirements in Paragraph 5.8.1 b) do not apply if the building is sprinklered and has a building height of 25 m or less.

A1.4 The relevant part of the current Verification Method is:

Verification Method C/VM2

Cladding
To demonstrate that NZBC C3.7 is achieved, it is expected that relevant fire test results for the selected cladding system will be provided. Engineers may also choose to comply with Paragraph 5.8 of the relevant Acceptable Solutions C/AS2 to C/AS6 or with Table 4.1 to satisfy the performance criteria of this clause.

Table 4.1: Acceptable heat release rates for external wall cladding systems for control of horizontal fire spread

[Note] 4. Determined by testing to ISO 5660.1 or AS/NZS 3837 at an irradiance of 50 kW/m^2 for a duration of 15 minutes

Part A: External vertical fire spread over facade materials
This part applies to all multi-level buildings with a building height of more than 10 m where upper floors contain sleeping uses or other property...

Method
For Part A, either:

a) Comply with Table 4.2 in C/VM2, or...

Table 4.2: Acceptable heat release rates for external wall cladding systems for control of vertical fire spread

[Note] 3. Determined by testing to ISO 5660.1 or AS/NZS 3837 at an irradiance of 50 kW/m^2 for a duration of 15 minutes