



Determination 2019/002

Regarding the issue of a notice to fix for a house with foam insulation at 76 Gatehouse Lane, Woodend, Waimakariri

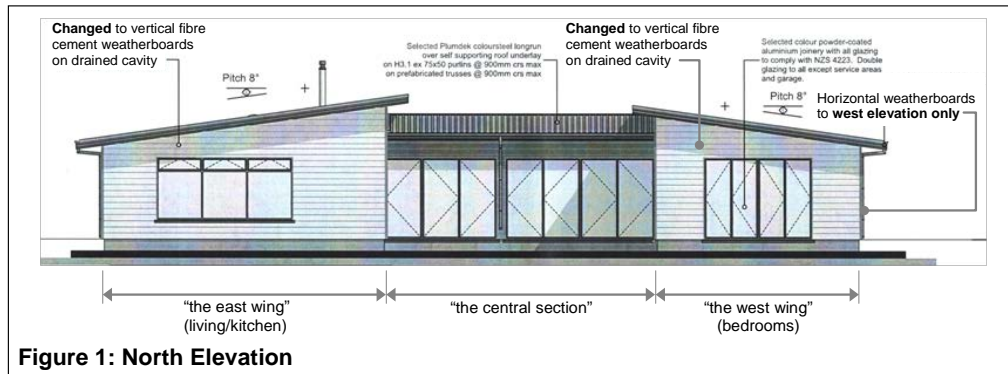


Figure 1: North Elevation

Summary

This determination considers the compliance of foam insulation installed to the walls and the underside of a roof in a house that has a low to moderate weathertightness risk.

1. The matter to be determined

1.1 This is a determination under Part 3 Subpart 1 of the Building Act 2004¹ (“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 parties to the determination

1.2.1 The parties to the determination are:

- the owners L Murray and O Hendriks (“the applicants”)
- Waimakariri District Council (“the authority”), carrying out its duties as a territorial authority or building consent authority.

1.2.2 The application for determination arises from the authority’s issue of a notice to fix about foam insulation installed into a house that was under construction. The approved building consent detailed fibreglass batts and the work to install the foam had been completed before a consent amendment was sought. The refusal arose because the authority was not satisfied that foam insulation would result in the building work complying with certain clauses² of the Building Code (First Schedule, Building Regulations 1992). The authority’s concerns relate to the thermal performance and weathertightness of the insulated walls and roof.

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.

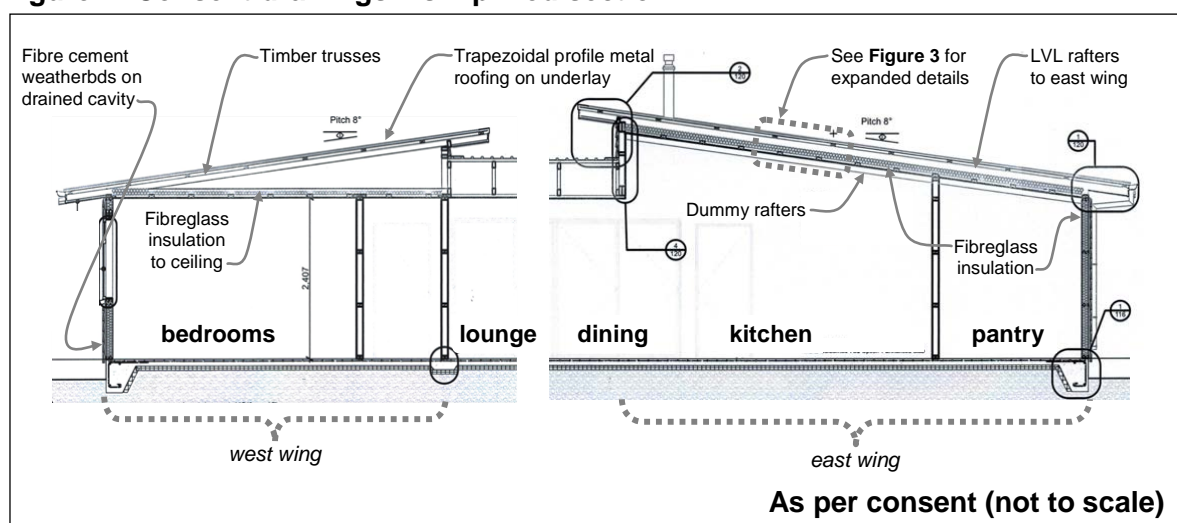
² In this determination, references to sections are to sections of the Act and references to clauses are to clauses of the Building Code.

- 1.2.3 The matter to be determined³ is therefore whether the as-built exterior walls and the roof with foam insulation installed comply with Clause E2 External moisture insofar as it relates to the foam insulation, and whether the building as a whole will comply with Clause H1 Energy efficiency.
- 1.2.4 This determination is limited to the matter outlined above in paragraph 1.2.3. This determination does not consider other parts of the house or compliance with other Clauses of the Building Code.
- 1.2.5 In making my decisions, I have considered the submissions of the parties, the report of the building surveyor engaged by the applicants (“the building surveyor”), the report of the expert commissioned by the Ministry to advise on this case (“the expert”), and other evidence in this matter. The relevant clauses of the building Code are provided in Appendix A.

2. The building work

- 2.1 The building work consists of a partly completed single-storey detached house situated on a large ‘near level’ rural site in a high wind zone for the purposes of NZS 3604⁴. The drawings take the garage door and entry as facing south and this determination follows that convention.
- 2.2 The floor plan of the house is ‘H-shaped’; with bedrooms in the west wing, kitchen, living, laundry and garage areas in the east wing, and lounge/dining areas and the main entry in the central section. The house is fairly simple in plan and form and is assessed as having a low to moderate weathertightness risk⁵.
- 2.3 Construction is generally light timber frame, with reinforced concrete foundations and floor slab, fibre cement weatherboards fixed over drained cavities, aluminium joinery and asymmetrical trapezoidal profiled metal roofing. The east and west wings have 8° mono-pitched roofs, and the central link section has a 5° gable roof. The east wing roof structure incorporates specifically designed proprietary 200x63mm LVL⁶ rafters at 600mm centres as shown in Figure 2, with timber roof trusses installed elsewhere.

Figure 2: Consent drawings – simplified section



³ Under section 177(1)(a) of the Act

⁴ New Zealand Standard NZS 3604:2011 Timber Framed Buildings

⁵ When assessed via Acceptable Solution E2/AS1 External Moisture

⁶ Laminated Veneer Lumber

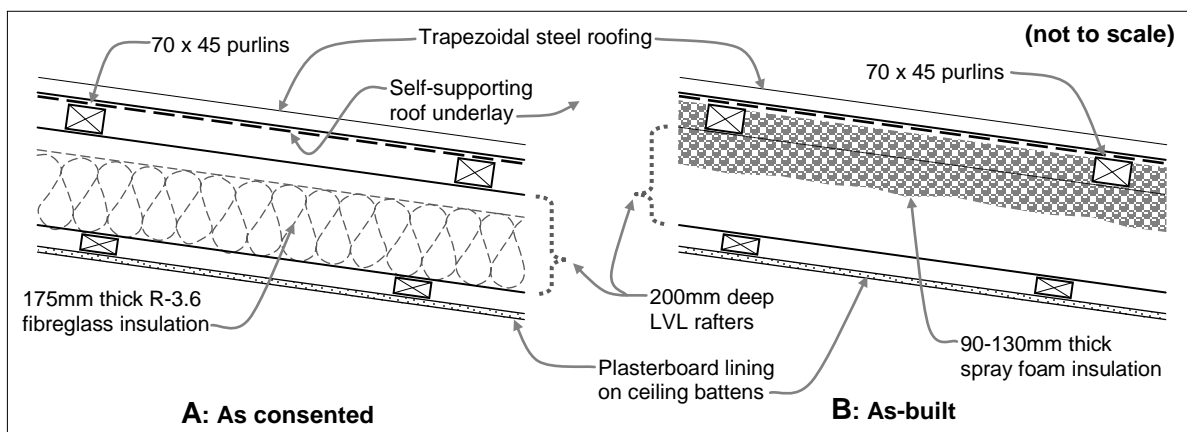
2.4 The wall claddings

- 2.4.1 Building consent drawings stated weatherboards were to be installed horizontally to the building, with vertical installation to the central section of the building on the south elevation. However, during construction the weatherboards were installed vertically to all elevations except the west elevation as noted on Figure 1. The weatherboard cladding is a proprietary system designed to allow horizontal or vertical installation of boards (with construction amended accordingly for each installation, for example, the use of horizontal battens for vertical installation).
- 2.4.2 The cladding comprises 16mm thick fibre cement rusticated weatherboards fixed through battens and the building wrap to the framing timbers. The 20mm battens form a cavity between the weather boards and the building wrap. The cladding system includes purpose-made flashings, notched horizontal timber battens for vertical installation, and other accessories.

2.5 The foam insulation

- 2.5.1 The approved building consent documents stated walls and roofs were to incorporate fibreglass batt insulation. However, during construction, the insulation was changed to sprayed polyurethane foam (“the foam insulation”). The foam insulation has been applied against the building wrap to the full depth of walls and to the underside of the roofing underlay at varying thickness.
- 2.5.2 The foam insulation is a thermoset cellular plastic insulating material that forms an insulation and air sealing barrier on walls and roofs. It is made by mixing two liquid components during the on-site application, which react very quickly when mixed and expand on contact with the wall and roof elements.
- 2.5.3 Figure 3 shows the roof construction; with ‘A’ showing the consented detail (fibreglass batts insulation) and ‘B’ showing the as-built detail (foam insulation).

Figure 3: Roof insulation for east wing sloping ceilings



3. Background

3.1 The consent documentation

- 3.1.1 On 21 December 2017, the builder applied for a building consent as the authorised agent for the applicants. Although the applicants apparently expected the drawings and specification to call for foam insulation; the consent documentation stated

fibreglass insulation to the walls and roof, with calculations demonstrating compliance with Clause H1 based on fibreglass insulation.

- 3.1.2 On 26 February 2018, the authority issued a building consent (No. BC172140) for a ‘dwelling with attached garage and log burner’ based on the documentation submitted with the application.

3.2 Construction

- 3.2.1 The authority carried out various inspections⁷, including a ‘preline’ inspection on 22 June 2018, during which the authority’s inspector noted that foam insulation was installed when the building consent documents specified fibreglass batt insulation, and therefore an amendment to the building consent was required. It appears installation of the foam insulation continued without specific approval, with photographs taken during the process.

3.3 The refusal to issue an amendment

- 3.3.1 On 2 July 2018, the authority received an application for an amendment to the building consent ‘to change from Fibreglass insulation to Polyurethane Spray Foam insulation’ and requested further information from the applicants on the same day.
- 3.3.2 Some additional information and photographs were provided, and in an email dated 11 July 2018, the applicants explained that they needed to move into the house and asked whether there was ‘any way we can keep moving forward on our build’. An officer of the authority responded on 12 July 2018, noting “I can appreciate your time frame but if work continues it will be at your own risk”.
- 3.3.3 Work proceeded and linings were installed to most wall and roof areas. On 17 July 2018, the authority visited the site and several sheets of wall lining were removed to allow inspection of the framing cavity.
- 3.3.4 In a letter to the applicants dated 25 July 2018, the authority refused to issue an amendment to the building consent because it was:
- ...not satisfied on reasonable grounds that the provisions of the building code would be met if the building work were completed in accordance with the plans and specifications that accompanied the application.
- 3.3.5 The authority noted that conflicting product information had been provided leading to doubt as to what product had been installed, queried whether the foam insulation was suitable for residential use, and noted the installation of the foam insulation does not provide a suitable gap between the insulation and the roof underlay. The authority advised the amendment did not comply with Building Code Clauses E2.3.2, E2.3.5 and H1.3.1(a).
- 3.3.6 The authority also stated:
- During inspection on 17/7/2018, variations to thickness and gaps were noted of a very limited exposed sample, as lining of the walls and ceiling had been completed. The lining has been carried out after expressly noted in an email sent 12/7/2018, this was at the owner’s risk.

3.4 The notice to fix

- 3.4.1 The authority issued the applicants with a notice to fix dated 26 July 2018 under Sections 164 and 165 of the Act, which stated:

⁷ Including inspections for the foundations, superstructure and parts of the wall and roof claddings

Building work was carried out not in accordance with the building consent, which contravenes Section 40(1) of the [Act];

- Installation of a non-approved insulation material, which is not approved for residential construction.

Failure to assist inspections by lining without approval, which contravenes Section 223 (1) & (2) of the [Act];

- Installation of wall and ceiling linings before the required remedial work and re-inspection approval was granted by the building inspector (the pre-line inspection had failed).

3.4.2 The notice required the applicants to remedy the contravention as follows:

Complete the building work in accordance with the approved building consent (BC172140).

3.4.3 The notice to fix required the applicants to comply with the above by 2 November 2018; referring to the ‘letter dated 25 July for further clarity’ and noting:

All building work must cease immediately until the authority that issued this notice is satisfied that you are able and willing to resume operations in compliance with [the Act] and regulations under the Act, and other directions specified on this notice.

3.5 Response to notice to fix

3.5.1 On receipt of the above notice, work on the house ceased and the applicants sought advice from ‘an independent builder’, a roofing company, and consulted a building surveyor.

3.5.2 On 14 August 2018, the applicants emailed the authority to propose a way forward as follows (in summary):

- the building surveyor to check the ‘airflow gap [drainage cavity] in the external walls’
- if the gap acceptable, submit a foam sample to BRANZ ‘for testing’
- if foam was not acceptable, commence full removal of the foam from walls
- for the roof areas:
 - if foam insulation was not acceptable, remove and replace with fibreglass insulation, or
 - if foam insulation was acceptable, install battens to provide 25mm air gap above the foam.

3.5.3 The authority responded on the same day, accepting the options, however, the authority quantified this by stating the foam insulation still needed to be “approved” for it to remain.

3.6 The building surveyor’s report

3.6.1 The building surveyor visited the site on 16 August 2018 to inspect the drainage cavities of the external walls using a cavity camera; providing a report to the applicants dated 24 August 2018, which noted the investigation’s scope was to:

Carry out an inspection to the external walls of the dwelling and investigate the wall cavity to determine the likely extent of insulation within the 20mm drained and vented cavity. The purpose of the investigation is to determine if spray foam insulation has breached the 20mm cavity.

- 3.6.2 The surveyor noted that only the west elevation could be investigated due to horizontal battens, used for the installation of vertical weatherboards, obstructing the view of the cavity on all other elevations (refer paragraph 2.4.1).
- 3.6.3 On the west elevation, the surveyor drilled holes through the cavity closer at the base of the horizontal weatherboards, extending the camera lens to about 800mm above the base. The cavity camera lens was moved in a 'sweeping motion' to identify any areas contacting the back of the cladding, with photographs taken of the cavity.
- 3.6.4 The surveyor assessed seven locations along the west elevation and found 'no evidence of excessive cavity intrusion' from the foam. No area was revealed where the building wrap contacted the back of the weatherboards, although photographs showed one small area of foam insulation towards the centre of the west elevation where the cavity was reduced to about 10mm.
- 3.6.5 The applicants applied for a determination on 29 August 2018, which was accepted on 5 September 2018. The Ministry sought further information from the parties, which was received by 13 September 2018.

4. The submissions

4.1 The initial submissions

- 4.1.1 The applicants set out a 'summary of events' leading to the current situation, which outlined (in summary):
- The inclusion of fibreglass insulation in the building consent documents had been an oversight which had not been picked up before applying for the building consent.
 - An application for an amendment to the consent was submitted and additional information was provided, with confusion as to the type of foam used. Because all inspections had passed and the work had been booked in sequence, the linings proceeded in order to avoid unnecessary delays.
 - There was confusion about the suitability of the installed foam and further information was submitted before the refusal to issue the amendment and the subsequent issue of the notice to fix.
 - Work onsite ceased and advice was sought from a building surveyor, who recommended that the drained cavity to the walls should be investigated and suggested that the roof could be raised to allow for a 25mm air gap above the foam to the roof.
 - the applicants felt that work on the house could have continued 'while waiting for verdict on the roof'.
- 4.1.2 The applicants forwarded copies of:
- the consent drawings
 - correspondence with the authority
 - various construction photographs taken during June 2018, including photographs of roof foam measurements of thickness
 - inspection records dated 15 and 22 June 2018

- various statements and technical information from the foam supplier and applicator
- the authority's refusal to issue a consent amendment dated 25 July 2018
- the notice to fix dated 26 July 2018
- the building surveyor's report dated 24 August 2018.

4.1.3 The authority made no submission but provided additional documents pertinent to this determination, including:

- the building consent application documentation dated 21 December 2017
- the building consent dated 26 February 2018 and the consent specifications
- the application for an amendment to the building consent dated 2 July 2018
- correspondence with the applicants.

4.2 The first draft determination and submissions received in response

4.2.1 The first draft determination was issued to the parties for comment on 30 November 2018.

4.2.2 The authority responded on 5 December 2018 accepting the draft with no further comment.

4.2.3 The applicants responded on 6 December 2018 accepting the draft subject to non-contentious amendments. The applicants also:

- clarified the extent of the change in weatherboard orientation installation (see paragraph 2.4.1)
- provided revised 'Calculation Method' calculations for the insulation (see paragraphs 6.6.1 to 6.6.3)
- provided architectural drawings showing a proposed revised roof design (including the removal of the roof cladding and underlay).

4.2.4 In regard to the architectural drawings of the revised roof design, and the revised 'Calculation Method' calculations, I leave these to the parties as per paragraph 7.1 of this determination, to be submitted to the authority as part of an application for an amendment to the building consent. In regards to the revised 'Calculation Method' calculations, the calculation should take note of the expert's assessment of the thickness and R-values of the foam insulation in paragraph 5.3.2 and 5.3.3. I also note that the R-value for the 90mm-framed walls is noted as 2.8 in the revised drawings and 3.6 in the revised Calculation Method (compared with R-value of 3.0 considered by the expert).

4.3 The second draft determination and submissions received in response

4.3.1 The second draft determination was issued to the parties for comment on 21 December 2018.

4.3.2 The authority responded on 24 December 2018 accepting the draft with no further comment.

4.3.3 The applicants responded on 7 January 2019 accepting the draft subject to non-contentious amendments. The applicants also:

- provided further revised ‘Calculation Method’ calculations for the insulation (see paragraphs 6.6.1 to 6.6.3)
- provided further revised architectural drawings showing a proposed revised roof design (including the removal of the roof cladding and underlay).

4.3.4 Further to paragraph 4.2.4, in regard to the architectural drawings of the revised roof design, and the revised ‘Calculation Method’ calculations provided in the paragraph above, I leave these to the parties as per paragraph 7.1 of this determination, to be submitted to the authority as part of an application for an amendment to the building consent.

5. The expert’s report

5.1 General

5.1.1 As mentioned in paragraph 1.2.5, I engaged an independent expert to assist me. The expert is a member of the New Zealand Institute of Architects and reviewed the amendment documentation and other evidence; providing a report dated 17 October 2018, which was forwarded to the parties on the same day.

5.1.2 The expert noted that the scope of his investigation was to review the documentation available in order to form a view on the ‘compliance of sprayed polyurethane foam insulation with ... clauses E2 and H1’. Relevant industry standards were considered and telephone discussions took place with the applicants, BRANZ, the building surveyor and the foam spray applicator.

5.1.3 The expert noted the following departures from the consent drawings:

- Fibre cement weatherboards are fitted horizontally to the west elevation only, with weatherboards to other elevations fitted vertically, which prevented the photographing of drained cavities in those areas (due to the need for horizontal battens for a vertical installation of weatherboards).
- Wall insulation was changed to the foam. Fibreglass batts to ceilings were omitted and foam insulation was sprayed on the underside of the roof underlay.

5.2 The foam product

5.2.1 In its refusal to issue an amendment to the building consent (see paragraph 3.3.5), the authority noted that conflicting product information had been provided leading to doubt as to what product had been installed, and further queried whether the foam insulation was suitable for residential use.

5.2.2 The expert discussed the confusion with the owner and the applicator and noted:

- There is no confusion as to what product was used for the roof of the central section of the house.
- The applicator believes the first product was simply rebranded by the manufacturer as the second product, however, the expert was unable to verify this with the manufacturer. Despite this, the expert noted the product literature for both products show the same thermal performance (R values), but other test properties varying slightly.

5.2.3 Taking the evidence into account, the expert considered that:

- It is likely that paperwork errors occurred and references to one product compared to the second product are ‘probably erroneous’.
- The thermal performance for both products is identical, and both are closed cell polyurethane foams, therefore in this case compliance issues are the same.
- Although foam product literature refers to ‘industrial/commercial’ applications, this appears to be a ‘marketing issue’ because no evidence could be found that the spray foam is not suitable for residential use.

5.3 Clause H1 Energy Efficiency

5.3.1 The expert noted that the authority is not satisfied that the insulation complies with Clause H1.3.1(a) which requires the building envelope to ‘provide adequate thermal resistance’.

5.3.2 In regard to the exterior walls, the expert noted that:

- The ‘H1 Compliance Report’ in the original consent documentation is based on external walls including fibreglass batts with an R-value of 2.8.
- The foam insulation has an R-value of 3.6 for a thickness of 100mm – and a thickness of 90mm is expected to have an R-value greater than 3.0 and therefore better than that provided by the fibreglass batts.
- Precise R-values for a thickness of 90mm can be derived from the thermal resistance K factor 0.025 – 0.030W/m.K stated in the spray foam manufacturer’s ‘Product Information Bulletin’.

5.3.3 In regard to the roof, the expert noted that:

- The ‘H1 Compliance Report’ in the original consent documentation is based on ceilings including a 175mm thick fibreglass blanket with an R-value of 3.6.
- The foam insulation requires a thickness of 100mm to achieve the R-value of 3.6 called for in the calculation. The roof foam thickness was measured as varying from 90mm to about 130mm, so the average may be greater than 100mm. (I note that the applied foam surrounds the 45mm deep roof purlins as shown in Figure 3B, so some lower thicknesses are likely to relate to measurements to the underside of purlins rather than the underside of the roofing underlay.)

5.4 Clause E2 External Moisture

5.4.1 The expert noted that the authority is not satisfied that the insulation complies with Clause E2 External moisture; in particular Clauses E2.3.2 and E2.3.5, which require roof and exterior walls to prevent the penetration of water, and that concealed spaces and cavities in buildings must be constructed in a way that prevents external moisture being accumulated or transferred.

5.4.2 In regard to the exterior walls, the expert noted that:

- A 20mm drained cavity separates the wall cladding from the building wrap and wall framing within which the foam insulation has been applied.
- The building surveyor reported ‘no evidence of excessive spray foam’, with one small area found to be within 10mm from the back of the weatherboards.

- Other elevations could not be inspected due to the horizontal battens obscuring camera views of the cavities from the base. However, the same foam and spray equipment was used so the cavities are expected to be in similar condition.
- The east and west elevations have a risk score⁸ of 2, so, in accordance with the Acceptable Solution E2/AS1, could have been constructed without a cavity (I note that the north and south wall faces of the east and west wings are also low risk so also did not require a drained cavity to comply with E2/AS1).
- The combination of low risk and lack of evidence of cavities being bridged leads to the conclusion that the performance of the drained cavities will meet the requirements of Clause E2 of the Building Code.

5.4.3 In regard to the roof, the expert noted that:

- The authority's concerns arise from the foam insulation applied directly against the underside of the roof underlay, with no air gap or roof void.
- From photos provided show kraft paper-based roofing underlay is used; these underlays dispose of condensation by a combination of:
 - via the top of the underlay, by draining moisture to the gutters
 - absorption by the underlay then subsequent re-evaporation via a void or gap above and beneath the underlay
- For the roofs, risks arise from:
 - Drainage from the top surface is limited by the asymmetrical trapezoidal profile of the metal roofing, where metal 'clamps' against the underlay for about 130 out of 190mm (almost 70% of the underlay surface).
 - Air borne moisture that condenses on the cold underside of the metal roofing will accumulate rather than evaporate, with the only opportunity for drying limited to narrow roofing crests (28mm at 191mm centres).
 - Absorption required by the underlay will therefore be increased and the moisture will be unable to be re-evaporate due to the lack of an air gap beneath the underlay, and the limited gap above the underlay.
- This risk may be mitigated by the very small volume of airspace between the roofing crest and underlay and therefore a small volume of air containing water vapour. However, the risk may increase by the specification of downlights which are not sealed, and the texture of the foam (which appears to have a texture like 'popcorn' rather than a continuous layer); both of which lead to the potential for warm moist internal air to diffuse to the underside of the roof cladding.

5.4.4 The expert informally discussed the situation with a BRANZ technical officer, who advised 'that a detailed evaluation would be required to quantify the risk of omitting the gap and referred to standard advice⁹ that there should be a 25mm minimum air gap between the roof underlay and the insulation'.

5.4.5 The expert concluded that, in conjunction with the absence of a 'detailed evaluation', the foam insulation installed to the roof (see Figure 3B) may not comply with clause E2.3.5 of the Building Code, noting:

⁸ Paragraph 3 of the Acceptable Solution for Clause E2, E2/AS1, provides a method of assessing the weathertightness risk of a building's envelope based on environmental factors, and building features and complexity.

⁹ BRANZ House Insulation Guide (July 2014)

- Installation instructions from foam insulation suppliers refer to preparation procedures for a variety of substrates, none of which include flexible roof underlays. No published information can be found that indicates a flexible underlay is a suitable substrate for sprayed insulation.
- Flexible underlays are not designed to support other materials and this risks damage to the underlay such as splits after some years when softened by absorbed water or flexing under earthquake or wind loads.

5.5 Summary

5.5.1 The expert concluded that there was sufficient evidence to show that:

... the sprayed foam wall insulation will comply with clauses H1.3.1 (a), E2.3.2 and E2.3.5 of the [Building Code],

... the sprayed foam roof insulation will comply with clause H1.3.1 (a) of the [Building Code] where 100mm thick or more,

However, the expert considered there was:

reasonable doubt ... that the sprayed foam roof insulation will comply with clause E2.3.5 of the [Building Code].

5.5.2 The expert said that revised calculations should be provided by the applicant in respect of Clause H1 identifying the substitution of fibreglass batts for the foam insulation, the R-values for the substituted insulation, and allowing for the variable or minimum thickness of the foam insulation under the roof.

6. Discussion

6.1 General

6.1.1 The parties do not dispute that foam insulation was applied to the walls and roof of the house before obtaining an amendment to the building consent. The applicants retrospectively applied for a building consent amendment, which the authority refused to issue due to concerns about compliance with Clauses E2 and H1. I am therefore satisfied that the authority was justified in issuing a notice to fix for work that was not in accordance with the building consent and requiring construction work to cease until the matter was satisfactorily resolved. The issue of the notice to fix is not disputed by the parties and I have not considered the notice any further than this.

6.1.2 The matter of dispute is whether the external building envelope, with the foam insulation installed as constructed, complies with Clauses E2 External moisture, and H1 Energy efficiency.

6.2 The legislation

6.2.1 The authority in its refusal (see paragraph 3.3.5) identified the relevant clauses of Clause E2 External moisture are E2.3.2 and E2.3.5. Clause E2.3.2 requires:

Roofs and exterior walls must prevent the penetration of water that could cause undue dampness, damage to *building elements*, or both.

Clause E2.3.5 requires:

Concealed spaces and cavities in *buildings* must be constructed in a way that prevents external moisture being accumulated or transferred and causing condensation, fungal growth, or the degradation of *building elements*.

- 6.2.2 The authority in its refusal (see paragraph 3.3.5) identified the relevant clauses of Clause H1 Energy Efficiency as H1.3.1(a), which requires:
- The *building* envelope enclosing spaces where the temperature or humidity (or both) are modified must be constructed to—
- (a) provide *adequate thermal resistance*...
- 6.2.3 In evaluating the construction of building elements, it is useful to make some comparisons with the relevant Acceptable Solutions and other authoritative sources, which will assist in determining whether features of the building work comply with the Building Code. In this case, the expert has also considered relevant industry standards and the other available evidence.
- 6.2.4 The Acceptable Solution H1/AS1 states:
- 1.2 Building performance index for housing**
- 1.2.1** Compliance with NZBC Clause H1.3.2E (Building Performance Index or BPI) satisfies NZBC Clause H1.3.1(a).
- 2.1 Housing and small buildings**
- 2.1.1** Construction in accordance with NZS 4218 section 3 and section 4.1 or 4.2 (as modified by Paragraphs 2.1.3 to 2.1.7) satisfies NZBC H1.3.1(a) for housing of any size and all buildings having a net lettable area no greater than 300 m².
- 2.1.2** Construction in accordance with NZS 4218 sections 3 and section 4.1 or 4.2 (as modified by Paragraphs 2.1.3 to 2.1.7) satisfies NZBC H1.3.2E for housing of any size, including multi-unit dwellings.
- 6.2.5 Acceptable Solution H1/AS1 references NZS 4218¹⁰ as a means of compliance with Clause H1.3.1(a). NZS 4218 provides for several methods in which to demonstrate compliance; in this case, the building consent documents show the building has used the ‘Calculation Method’ set out in that standard to demonstrate compliance with Clause H1.
- 6.3 The amendment to the consent for the foam insulation**
- 6.3.1 A minor variation can be made in cases, among other things, of substituting comparable products where there is a change from one known product to another similar known product and the use of the substituted product reflects common appropriate industry practice. Minor variations do not require the authority to issue an amended consent¹¹.
- 6.3.2 An amendment of a building consent under section 45(4)(b) is to be made as if it were an application for a building consent. Under section 49 a building consent authority, in considering a building consent or an amendment to be building consent, must carry out an assessment of the proposal and be satisfied on reasonable grounds that the building code would be met if the building work were properly completed in accordance with the plans and specifications that accompanied the application. I note a building consent amendment cannot be issued for building work that has already been completed; this has been considered in past determinations and by the Courts.¹²

¹⁰ New Zealand Standard NZS 4218:2009 Thermal Insulation – Housing and small buildings

¹¹ Under section 45A of the Act

¹² For example; Determination 2016/046 and 2017/020, and *Environment Waikato v Sutherland* District Court Wellington CIV-2010-085-629, 1 March 2011

6.4 The compliance of the external walls with respect to Clause E2

6.4.1 In regard to the external walls, I make the following observations:

- The expert has assessed the building envelope as having a low to medium weathertightness risk, although I note that the medium risk classification results from additional risks for clerestorey walls above the central section.
- If considered on a wall face approach¹³, walls not associated with the clerestoreys are assessed as having a low weathertightness risk and would not require a drained cavity to comply with the Acceptable Solution E2/AS1.
- Even if cavity depth were to be reduced in some areas, the low weathertightness risks to most walls makes it unlikely that this would result in moisture penetration through the building wrap and into the timber framing.
- The fibre cement weatherboard cladding to all walls is installed over a cavity, with the horizontal boards to the west elevation fixed through vertical battens and vertical weatherboards to other elevations fixed through notched horizontal timber battens. In both cases, battens are at 600mm centres maximum.
- Investigations of the west elevation have found no significant intrusion into the drained cavity and I concur with the expert that the cavities to external walls on the remaining elevations are unlikely to be worse than those investigated.
- A construction photo of the partly-clad garage west wall shows vertical battens with slotted horizontal battens cut to fit between; indicating that the decision to change to vertical boards was made after vertical battens were installed.
- The above suggests that the remaining external walls to west and east wings include vertical as well as horizontal cavity battens at 600mm centres, which provides increased support to the building wrap for those walls – indicating that these cavities are likely to be no worse than those investigated. I note both Acceptable Solution E2/AS1¹⁴ and the cladding manufacturer's installation manual requires flexible wall underlays to be restrained from bulging into the drained cavity if wall studs spacings are greater than 450mm. It is not clear from the building consent document or inspections whether restraint was proposed and installed, however, I consider vertical as well as horizontal cavity battens as constructed provide support to the underlay.

6.4.2 Taking the above circumstances into account, I conclude there are reasonable grounds to be satisfied that the performance of the drained cavities to the external walls will meet the requirements of Clause E2.3.2 to prevent 'prevent the penetration of water that could cause undue dampness, damage to building elements, or both'.

6.5 The compliance of the roof with respect to Clause E2

6.5.1 In regard to the roof, I make the following observations:

- The house is located in a region where clear winter nights are likely to provide a regular risk of significant condensation occurring on the underside of the cold metal roofing; so provision should be made to allow that moisture to dissipate.
- The roofing profile is asymmetrical trapezoidal, where about 70% of the underlay is in direct contact with flat metal; increasing the amount of

¹³ Refer to Ministry guidance document: *External moisture – a guide to using the risk matrix* (July 2013), available from www.building.govt.nz/assets/Uploads/building-code-compliance/e-moisture/e2-external-moisture/e2-riskmatrix.pdf

¹⁴ Acceptable Solution E2/AS1 External moisture, Paragraph 9.1.8.5 'Wall framing behind cavities'.

absorption required by the underlay and opportunities for evaporation limited to narrow strips provided by crests of the roofing.

- The lack of an air gap beneath the underlay (due to the installation of the foam insulation) will allow moisture absorbed by the underlay to accumulate against the foam insulation; risking long term timber damage to battens, and rafters/truss chords, which are encased by the foam insulation, effecting their durability.
- The expert could not find any published information that indicates a flexible underlay is a suitable substrate for sprayed insulation (see paragraph 5.4.5), nor has any such information been provided to me by the applicants. Flexible underlays are not designed to support other materials. The installation of the foam insulation directly to the underside of the underlay risks damage to the underlay, particularly if the underlay is softened by absorbed water or flexing under earthquake or wind loads. The underlay is a key part of the roof construction and the weathertightness performance of the roof, and any damage to the underlay will also impact the weathertightness performance of the roof.

6.5.2 Taking the above circumstances into account, I do not consider there are reasonable grounds to be satisfied that the anticipated performance of the roofs as constructed will meet the requirements of Clause E2.3.5 to prevent ‘moisture being accumulated or transferred and causing condensation, fungal growth, or the degradation of building elements’.

6.6 Compliance with Clause H1 Energy Efficiency

6.6.1 Taking the expert’s report into account, I consider the foam insulation applied to the walls and roofs of this house is likely to result in the house as a whole complying with Clause H1.3.1(a) of the Building Code.

6.6.2 Revised ‘Calculation Method’ calculations have been provided in response to the draft determination (refer paragraph 4.2.3 and paragraph 4.3.3). I note there are discrepancies between the R-values for the wall insulation stated in the revised drawings, in the ‘Calculation Method’ calculations, and in the R-value considered appropriate by the expert (refer paragraph 4.2.4 and paragraph 4.3.4).

6.6.3 The discrepancies should be addressed in order to confirm whether the foam insulation as installed will meet the requirements of NZS 4218, as the standard referenced in Acceptable Solution H1/AS1 as a means of compliance.

6.7 Conclusions

6.7.1 I have considered the expert’s report and the other available evidence, together with the particular circumstances described above. I am of the opinion that there are sufficient grounds for me to conclude that the foam-insulated external walls will achieve compliance with E2 External moisture. However as outlined in paragraph 6.5, that opinion does not apply to the roof areas of the house.

6.7.2 I am also of the opinion that the information provided to the authority to date on the foam insulation as installed is not sufficient to demonstrate its compliance with Clause H1 of the Building Code. Additional information as outlined in paragraph 6.6.2 therefore needs to be submitted for the authority’s approval.

6.7.3 I acknowledge and support the authority with respect to the need to properly assess alternative solutions, and how these should be adequately documented when seeking

consent for their use. It is the responsibility of the party seeking building consent to provide accurate details that properly show how compliance is to be achieved, together with adequate information supporting the use of any product or system.

- 6.7.4 I emphasise that each determination is conducted on a case-by-case basis. Accordingly, the fact that a particular insulation system has been established as being code compliant in relation to a particular building does not necessarily mean that the same system will be code compliant in another situation.

7. What happens next?

- 7.1 With respect to the foam insulation to the roof; the applicants should address the areas described in paragraphs 6.5.1 and the discrepancies noted in paragraph 6.6.2, including a detailed proposal for remediation of roof areas, to be submitted to the authority as part of a new application for an amendment to the building consent. Any outstanding items of disagreement can be referred to the Chief Executive for a further binding determination.
- 7.2 With respect to the foam insulation to the walls; I leave this to the parties to agree on how to formalise the acceptance of this work.

8. The decision

- 8.1 In accordance with section 188 of the Building Act 2004, I hereby determine that:
- the as-built external walls insulated with the foam insulation comply with Clause E2 External moisture insofar as it relates to the foam insulation.
 - the as-built roof insulated with the foam insulation does not comply with Clause E2 External moisture insofar as it relates to the foam insulation.
- 8.2 I have insufficient information on which to decide whether compliance has been achieved in respect of Clause H1.3.1(a).

Signed for and on behalf of the Chief Executive of the Ministry of Business, Innovation and Employment on 4 February 2019.

Katie Gordon
Manager Determinations

Appendix A

A.1 The relevant clauses of the Building Code include:

Clause E2 – External moisture

E2.3.2

Roofs and exterior walls must prevent the penetration of water that could cause undue dampness, damage to *building elements*, or both.

E2.3.5

Concealed spaces and cavities in *buildings* must be constructed in a way that prevents external moisture being accumulated or transferred and causing condensation, fungal growth, or the degradation of *building elements*.

Clause H1 – Energy efficiency provisions

H1.3.1

The *building* envelope enclosing spaces where the temperature or humidity (or both) are modified must be constructed to—

(a) provide *adequate thermal resistance*; and

....