Department of Building and Housing
Te Tari Kaupapa Whare

Determination 2011/050

The code compliance of a vapour-control membrane system to a house at 12 Mystery Grove, Queenstown

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, John Gardiner, Manager Determinations, Department of Building and Housing ("the Department"), for and on behalf of the Chief Executive of that Department. The applicants are the owners of the proposed house, M and J Burston ("the applicants") acting through Pro Clima NZ Limited as the supplier of the product ("the supplier") and the other party is the Queenstown Lakes District Council ("the authority"), carrying out its duties as a territorial authority or building consent authority.

1.2 The reasons for the application

1.2.1 The application for this determination arises from the initial decision of the authority to refuse to issue a building consent, because it had received insufficient information in the documentation accompanying the consent application to be satisfied that the house would comply with Clause E3 Internal Moisture[2] and Clause B2 Durability of the Building Code (Schedule 1, Building Regulations 1992). The authority's concerns related to the potential for moisture problems to arise from the vapour-control membrane system specified for the proposed house ("the vapour-control membrane"). I also believe compliance with Clause E2 External Moisture is a relevant consideration.

1.2.2 Following the provision of further information, the authority approved the building consent on the condition that changes to the building work would be made, if necessary, based on the findings of this determination on the code compliance of the of the house incorporating the proposed vapour-control membrane.

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

[2] In this determination, unless otherwise stated, references to sections and clauses are to sections of the Act and clauses of the Building Code.

1.2.3 The matters to be determined[3] are therefore:

- whether the authority's initial refusal to issue a building consent was correct
- whether the vapour-control membrane proposed for use within the exterior walls and ceilings of this house will comply with Clause E2 External Moisture, Clause E3 Internal Moisture and Clause B2 Durability of the Building Code.

By the "vapour-control membrane" I mean the components of the system (the membrane and its accessories, and the construction of the external envelope) as well as the way the components have been installed and work together.

1.3 There is no evidence of dispute about any other matters related to the proposed house, and this determination is therefore limited to the vapour-control membrane. Building Code requirements related to the proposed membrane are provided in the Appendix.

1.4 In making my decision, I have considered the submissions of the parties and the other evidence in this matter, using a framework that I outline in paragraph 6.2.

2. The building work

2.1 The proposed building work is a single-storey detached house on a flat site in a high wind zone for the purposes of NZS 3604[4]. The house accommodates three bedrooms in a simple U-shaped plan, with a 3° monopitched roof and 600mm eaves. Construction is conventional timber frame, with a concrete slab and foundations, fibre-cement weatherboards with fibre-cement sheet cladding below the eaves, aluminium windows and profiled metal roofing.

2.2 The exterior walls and ceilings

2.2.1 A vapour-control membrane is proposed for within walls and ceilings to improve thermal efficiency by reducing air leakage during cold periods when the interior is warmer than the exterior. The location of the membrane is indicated in Figure 1 below.

2.2.2 In walls, the membrane system is installed to the inside face of the insulated framing, with 45mm x 45mm horizontal battens fixed through the membrane to form a 'service cavity' that is partially insulated with fibreglass. The vapour-control membrane is sealed to joinery openings and penetrations using proprietary tapes and accessories.

2.2.3 In ceilings, the membrane is installed to the underside of the insulated ceiling framing, with 50mm x 50mm x 200mm long horizontal battens fixed through the membrane to the bottom of the timber trusses. Proprietary metal battens and clips are fixed to the battens, providing a cavity for wiring and light fitting installation.

2.2.4 The vapour-control membrane is a 'humidity variable moisture control layer' with vapour diffusion resistance characteristics which vary according to relative humidity. The effect of this is that the membrane is more diffusion-tight in colder periods while

[3] Under sections 177(1)(a), 177(1)(b) and 177(2)(a) of the Act
[4] New Zealand Standard NZS 3604:1999 Timber Framed Buildings

resistance decreases significantly in warmer conditions. The vapour-control membrane is also airtight under all climatic conditions.

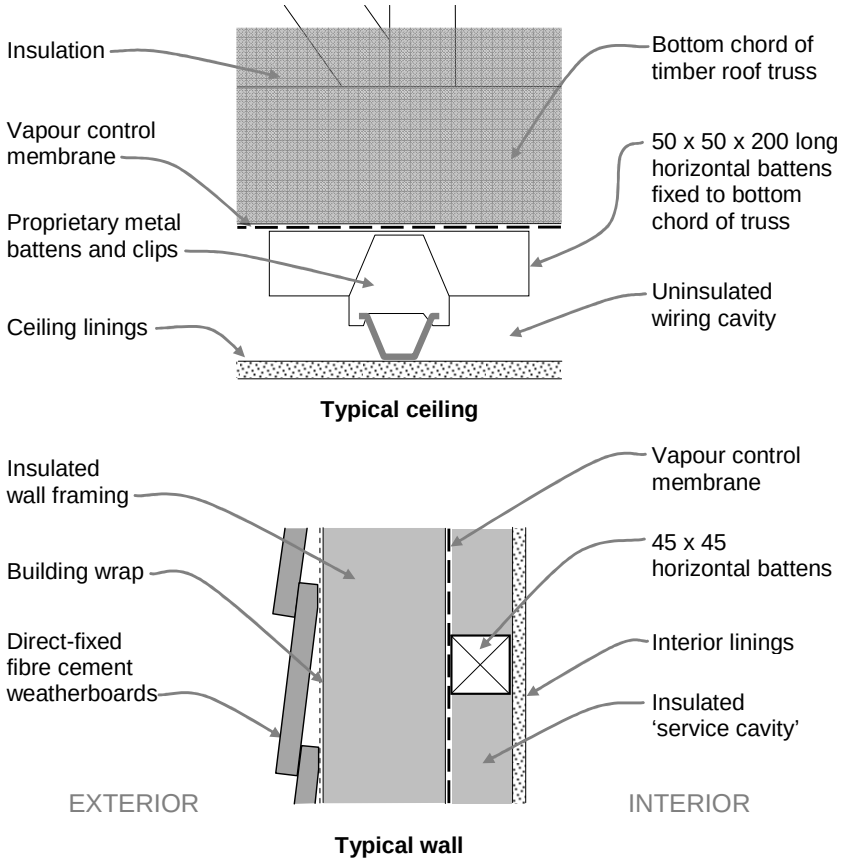

Figure 1: Location of membrane within walls and ceilings

2.2.5 During cold periods such as in winter, relative humidity adjusts the water vapour resistance of the membrane to limit diffusion and in doing so retards moisture vapour movement from the inside. During warmer periods, such as in summer, membrane properties adjust to allow water vapour to diffuse through the wall to the outside. When limiting vapour diffusion, condensation is avoided as the membrane temperature remains above the level where air is saturated and above the dewpoint.

2.3 The vapour-control membrane

2.3.1 The vapour-control membrane is a 0.2mm thick polyethylene copolymer membrane with a polypropylene fleece, which was developed for use on the interior sides of walls and ceilings. The membrane itself is called Pro Clima INTELLO and is part of a system called the Pro Clima Intelligent Airtightness System. The system is manufactured by a German company ("the manufacturer"), and includes sealing tape for joints, adhesives and other components.

2.3.2 The vapour-control membrane has been evaluated by the National Standards Authority of Ireland ("NSAI "), which provides a product certification service that is accredited by bodies in Ireland, the USA, UK and Canada[5]. The certificate

[5] NSAI Certification is recognized worldwide through a network of Mutual Recognition Agreements with other major certification bodies.

(No.07/0297) dated December 2007 evaluates the membrane system for materials and workmanship, durability, condensation resistance, ventilation, thermal performance and fire resistance.

2.3.3 The certificate states that the vapour-control membrane is suitable for timber-framed construction and will minimise background air leakage as part of a system of controlled ventilation. Providing it is installed to the manufacturer's instructions and in accordance with the conditions of the appraisal, the certificate concludes that the vapour-control membrane:

> ...will significantly reduce the potential for interstitial condensation, reduce heat loss due to convection, and significantly reduce the possibility of structural degradation, dry rot and mould growth.

2.3.4 The New Zealand representative of the manufacturer provides a range of details adapted for local conditions and requirements. The supplier's information also notes that if occupants are unable to control ventilation via opening windows, a mechanical ventilation system is recommended. Correspondence with the authority initially confirmed that a mechanical ventilation system was intended for this house (see paragraph 3.2), but the supplier has now clarified that this was incorrect.

3. Background

3.1 The applicants lodged an application for a building consent for the building work. I have not seen a copy of the application, but I note that the drawings submitted with the application are dated 22 December 2010. I also note that the specification is general, with limited information specific to this particular house.

3.2 Various discussions took place between the supplier and the authority, with additional information provided during February 2011. In a letter to the authority dated 2 February 2011, the supplier stated that the proposed house 'has a balanced pressure heat recovery ventilation system' which is intended to replace inside stale air with outside fresh air. This has now been clarified by the supplier as an 'error in communication' (see paragraph 5.4) and is further addressed in paragraph 6.7.

3.3 Further discussions and email correspondence apparently followed during April. In an email to the supplier dated 11 April 2011, the authority confirmed that its main concern about the product was its 'compliance with E3' of the Building Code.

3.4 The supplier sought further clarification from the authority about its specific concerns. Responding via an email dated 12 April (copied to the Department), the authority expanded on its concerns in regard to 'air barriers' within wall and ceiling systems, noting that there were cases where these had caused moisture damage to components under some weather and use conditions. The authority concluded that:

> At the end of the day, we as the BCA are not absolute product technical experts. We are charged with making a decision based on the information put before us, and the responses to questions we ask. We would be very happy to have our queries answered to the standard required, and we look forward to the assistance of the Department or anything else you can provide...

3.5 The Department received a formal application for a determination from the supplier on 13 April 2011 and sought further information from the supplier and the authority. In a series of emails and telephone discussions, the supplier provided further information, including WUFI[6] results for the proposed house.

3.6 WUFI testing

3.6.1 Computer modelling of performance can be carried out using a WUFI program developed in Germany[7] and introduced in Europe in 1994. Using local 'partners' WUFI is now adapted for local conditions in a number of countries, including in New Zealand where BRANZ is the local partner.

3.6.2 WUFI is a program for analysis of heat and moisture changes over time in building envelopes. The results predict when condensation will occur and how much moisture will be in a wall or roof assembly over a period of time; identifying potential moisture problems caused by poor design, or inappropriate material use.

3.6.3 A WUFI analysis of moisture changes modelled over a three year period has been carried out for the proposed house on its particular site using the proposed wall construction and materials. The modelling with and without the vapour-control membrane, indicates that peak moisture content in the wall reduces significantly when the membrane is included as shown in the proposed construction details.

3.6.4 It is noted that the internal relative humidity data used in the modelling is based on the following assumptions:

- the house will have six occupants
- the internal temperature range will be between 18 and 21^{o}C
- ventilation requirements generally are met via the openable area of windows and other openings being not less than 5% of the floor area as described in paragraph 1.2.2 of Acceptable Solution G4/AS1
- there will be mechanical extract ventilation to the kitchen, bathrooms and laundry.

3.7 The authority's clarification

3.7.1 In an email to the Department and supplier, the authority confirmed that its questions related to compliance with Clause E3 and also to B2 as it applies to E3. The authority noted that the same concerns would not have arisen if the vapour-control membrane was used directly behind the linings.

3.7.2 The authority's concerns related specifically to whether the vapour-control membrane 'buried in through the wall system' could allow condensation on its surface, with moisture affecting the insulation, battens and the back of the lining. Concerns about the ceiling were similar, except that the cavity behind the lining was not insulated.

[6] Wärme-und Feuchtetransport instationär translated as 'transient heat and moisture transport'.
[7] By the Fraunhofer Institute for Building Physics (FIBP)

3.8 The supplier's clarification

3.8.1 The supplier acknowledged the authority's clarification in an email dated 21 April 2011. The supplier clarified that the upper level of the vapour-control membrane's variable vapour resistance is such that it 'will never work as a vapour barrier'. At the highest level, it works as a 'vapour retarder' (see paragraph 4.3.1), which still allows some moisture to pass through.

3.8.2 The supplier also explained that condensation could only occur if the temperature around the vapour-control membrane was 'so low that the air is saturated and therefore beyond the dewpoint'. The supplier noted that WUFI results using local climate data confirmed that such conditions for condensation would not arise.

3.9 In an email to the supplier, copied to the Department, the authority acknowledged the supplier's explanations and agreed that construction could proceed. However, the authority also noted that the determination would decide on the compliance of the vapour-control membrane.

4. Meeting of the Department and the supplier

4.1 A meeting to seek further information about the product and the house was held at the Department's offices on 29 April 2011. With the agreement of the parties, the meeting was attended by officers of the Department, a Departmental contractor, and the supplier, but without attendance by the applicants or the authority. I generally described the function and limits of determinations in relation to this particular matter and explained the purpose of the meeting. The supplier noted that the manufacturer is currently seeking CodeMark certification[8] for New Zealand and Australia for the vapour-control membrane.

4.2 The supplier generally described how problems with air leakage reduce thermal performance in buildings. He also explained some of the background science and research that lead to the development of the vapour-control membrane in Germany, along with work done to introduce the system locally.

4.3 Water vapour transmission

4.3.1 The supplier described the terms he was familiar with from overseas for various materials with constant moisture vapour transmission resistance ("MVTR"):

- Vapour blocker: 5,000 MN.s/g or above
- Vapour barrier: between 250 and 5,000 MN.s/g
- Vapour retarder: between 50 and 250 MN.s/g.

[8] CodeMark certification is evidence of Building Code compliance, if the product is being used in accordance with the certificate and its instructions. However, while product certification is closely aligned in the two countries, products need to be certified separately for New Zealand and Australia because of differences in our respective building codes.

4.3.2 Current local classifications of vapour barriers were also discussed, with reference to AS/NZS 4200[9], in which vapour barriers are classified according to MVTR as:

- High: 450 MN.s/g or above
- Medium: between 7 and 450 MN.s/g
- Low: 7 MN.s/g or below.

4.3.3 The supplier explained that the above classifications are not appropriate for products developed to have humidity-variable resistance. The proposed vapour-control membrane has a MVTR that will vary from about 0.25 to 50 MN.s/g, which means that it acts like a vapour retarder only at the upper level.

4.4 The particular circumstances of the subject house were also discussed, including the local weather conditions, the generation and control of internal moisture and the WUFI analysis of the wall structure.

4.5 In response to questions about some of the proposed construction details, the supplier explained that:

- cavities at the inside of the walls and ceilings minimise penetrations through the membrane by providing access for wiring and other services
- the service cavity in the wall is insulated to provide additional insulation beyond that able to be installed within conventional wall framing
- the wall battens are horizontal and offset from the dwangs in order to minimise thermal bridging between the battens and the framing.

4.6 The discussions have enabled me to amplify or clarify various matters of fact and were of assistance to me in preparing this determination.

5. The submissions

5.1 The supplier's submissions were made in the correspondence, with further information provided in discussion at the meeting outlined in paragraph 4.

5.2 The supplier provided copies of:

- the drawings and specification
- the NSAI Certificate No. 07/0297
- some correspondence with the authority
- WUFI calculations dated 19 April 2011
- various installation details and other information.

5.3 A draft determination was issued to the parties for comment on 3 May 2011. The authority accepted the draft without comment on 4 May 2011. The supplier accepted the draft on behalf of the applicants on 4 May 2011, subject to some amendments which I have considered; I have amended the determination as I consider appropriate.

[9] AS/NZS 4200.1:1994 Pliable building membranes and underlays - Materials

5.4 In a letter to the Department, also dated 4 May 2011, the supplier added that he had mistakenly stated that the building would incorporate a mechanical ventilation system (see paragraph 3.2). The supplier also stated that such a system is not is not necessary to the operation of the vapour-control membrane. I address this in paragraph 6.7.

6. Code compliance of the vapour-control membrane

6.1 General

6.1.1 The authority's concerns about the use of this particular vapour-control membrane are associated with the potential accumulation of internal moisture within the building envelope, which is covered by Clause E3 Internal Moisture.

6.1.2 Although Clause E3 covers the accumulation of internal moisture, its Acceptable Solution E3/AS1 makes no specific reference to the requirements and characteristics of barriers to airflow within the concealed spaces in buildings, such as within the wall or ceiling structure as is the case for here.

6.1.3 As water vapour may also move from the exterior into the interior in certain conditions, I consider Clause E2 is relevant to this matter. There are provisions within the Clause E2 External Moisture, and its Acceptable Solution E2/AS1, which may be helpful when considering the circumstances in this particular case. The following therefore considers the associated requirements of both Clause E2 and E3.

6.1.4 Clause E2 includes provisions relating to the accumulation of moisture within the concealed spaces in buildings, such as within a wall structure. Notwithstanding that these provisions relate principally to external moisture, they are relevant when considering water vapour movement in both directions though the building envelope.

6.1.5 I note that the proposed house, in the absence of the vapour-control membrane, adopts the solutions provided in E2/AS1, and would be considered to comply fully with Clause E2.

6.2 The available evidence

6.2.1 In order to form a view as to code compliance of the vapour-control membrane system I need to consider the evidence that is available, which includes:

- the available test and technical information on the system
- the available technical information on the building envelope proposed for this particular house, including the detailed drawings
- the history of use of comparable wall systems.

6.3 The manufacturer's test information

6.3.1 NSAI provides internationally recognised certification of products and systems. The NSAI certificate dated December 2007 states that the vapour-control membrane system complies with applicable requirements for materials and workmanship, fire safety, durability, condensation resistance, ventilation and thermal performance.

6.3.2 The certificate states that the vapour-control membrane is suitable for timber framed construction and will minimise background air leakage as part of a system of controlled ventilation and will significantly reduce the potential for interstitial condensation.

6.4 The technical and other information

6.4.1 Other information available for this product includes:

- the manufacturer's detailed instructions for handling and fixing the membrane
- the NZ supplier's instructions and construction details
- the detailed drawings of the house
- the WUFI analysis on the vapour-control membrane as used in this particular house.

6.4.2 I accept that the NSAI certificate includes independent confirmation on qualities of the vapour-control membrane, and the WUFI analysis allows a link to the information to the applicable performance requirements of the New Zealand Building Code.

6.5 History of use

6.5.1 Although the vapour-control membrane has been used since about 1994 in Europe, UK, Ireland and North America, it was introduced more recently in New Zealand where it has apparently been installed in about 50 houses.

6.5.2 While it is accepted that this type of vapour-control membrane has been successfully used in other countries for some years, its use in New Zealand is relatively recent and the ability to predict its performance over an expected lifetime of 50 years or more is limited. However, I accept that this particular house is located in a climate zone which is very similar to some areas where the product is commonly used.

6.6 Use in this house

6.6.1 In regard to the use of the vapour-control membrane in this house, I also note the following:

- As representative of the manufacturer, the supplier will provide the components of the vapour-control membrane. The supplier has approved relevant construction details for this house, will oversee installation of the membrane, and will supply guarantees on completion.
- Using a WUFI analysis of moisture changes over a three year period, the supplier has modelled this house on its particular site. The modelling with and without the membrane, predicts that peak moisture content in the wall will reduce significantly when the membrane is included as proposed.

6.6.2 Taking account of its recent introduction and unusual properties, I acknowledge the authority's concerns about the product. The authority assessed the information it had received with the building consent application and sought further information. Considering the further information that has been made available since has allowed me to conclude that the vapour-control membrane will not cause the house to become non-compliant with respect to Clauses B2, E2, and E3.

6.7 Compliance with Clause G4 Ventilation

6.7.1 The supplier initially stated that a mechanical ventilation system was intended for the house, but has since confirmed that this statement was incorrect (see paragraph 5.4). I note that the supplier's information recommends that a mechanical ventilation system be installed if occupants are unable to control ventilation via opening windows.

6.7.2 The ability and ease of manually controlling ventilation via opening windows depends on the circumstances of particular occupants of a building, and code compliance must consider both current and future occupants of this house. However, I note this is the case with most houses. Irrespective of what system is provided, by either natural or mechanical means, the house must comply with Clause G4.

6.7.3 I acknowledge the supplier's position that the benefits of the vapour-control membrane will be more fully realised if it is installed in conjunction with a controlled mechanical ventilation system. However, in my view the performance requirements of the remaining relevant Building Code Clauses will be achieved irrespective of whether natural or mechanical ventilation is to be relied upon to achieve compliance with Clause G4.

6.8 Conclusion

6.8.1 I have seen no evidence that suggests that the house as proposed with the inclusion vapour-control membrane will not comply with Building Code Clauses B2, E2 and E3, when the vapour-control membrane is installed in this house in accordance with manufacturer's and supplier's instructions and details.

6.8.2 It is emphasised that each determination is conducted on a case-by-case basis. Accordingly, the fact that this particular vapour-control membrane has been established as being code-compliant in relation to a particular building in a particular climate zone does not necessarily mean that the same system will be code-compliant in another situation.

7. The decision

7.1 In accordance with section 188 of the Act, I hereby determine that:

- the authority's initial decision to refuse to issue the building consent was correct, based on inadequate documentation to establish that the proposed wall and ceiling details would comply with Building Code Clauses B2, E2 and E3
- based on the additional information subsequently provided, the vapour-control membrane system proposed for use within the exterior walls and ceilings of this house will not lead to the house not complying with Building Code Clauses B2, E2 and E3.

Signed for and on behalf of the Chief Executive of the Department of Building and Housing on 24 May 2011.

John Gardiner
Manager Determinations

APPENDIX

The relevant Building Code requirements

Clause E3 Internal Moisture

The relevant provisions of Clause E3 are:

OBJECTIVE

E3.1 The objective of this provision is to–

(a) Safeguard people against illness, injury, or loss of *amenity* that could result from the accumulation of internal moisture

FUNCTIONAL REQUIREMENT

E3.2 Buildings must be constructed to avoid the likelihood of–

(a) Fungal growth or the accumulation of contaminants on linings and other building elements...

(c) Damage to building elements being caused by the presence of moisture.

Clause E2 External Moisture

The associated provisions of Clause E2 are:

PERFORMANCE

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.

E2.3.7 Building elements must be constructed in a way that makes due allowance for the following:

(a) the consequences of failure...

(c) variation in the properties of materials and in the characteristics of the site.

The Acceptable Solution E2/AS1

Associated sections of the Acceptable Solution E2/AS1 are:

9.1.4 Barriers to airflow

This Acceptable Solution requires that buildings have barriers to airflow, in the form of:

a) Interior linings with all joints stopped...

COMMENT:
The primary function of air barriers and air seals is to moderate airflows at junctions and inside the wall cavity. Airflows in certain weather conditions encourage significant amounts of water to move along their path, and it is therefore important to manage airflow in cavity walls with barriers and air seals. In the absence of internal linings, an air barrier is required to support wind pressures at locations such as gable ends and unlined garage spaces. Air pressure drop is not always across the internal lining, indicating the wrap or sheathing acts as an air barrier as well.