

Re-cladding of Holiday Cabins

1 BACKGROUND

- 1.1 The matter before the Authority is the adequacy of a re-cladding proposal (“the re-cladding proposal”).
- 1.2 The Authority takes the view that it is being asked in effect to determine whether the re-cladding proposal complies with clause E2 “External moisture” (and consequentially clauses B1 “Structure” and B2 “Durability”) of the building code (the First Schedule to the Building Regulations 1992).
- 1.3 The applicant is the building owner acting through the firm of building consultants and the only other party is the territorial authority. The construction company (“the builder”), who holds the New Zealand franchise for and specialises in the construction of a particular building type which includes the cladding system at issue in this Determination, was treated as being an "appropriate person" under section 19(1)(b) of the Building Act. Accordingly, the builder was sent the application and accompanying documents and was able to make submissions to the Authority.
- 1.4 The Authority engaged the services of an independent expert ("the expert") to give advice as to whether the re-cladding proposal would comply with the relevant requirements of the building code.
- 1.5 In making its determination, the Authority has not considered any other aspects of the building code.

2 THE BUILDING WORK

- 2.1 The building work in question relates to a number of holiday cabins (“the cabins”), which are clad with horizontal cedar weatherboards (“the sidings”) over an untreated plywood substrate, which is also a structural bracing panel (“the untreated plywood diaphragm”). The sidings are 138 mm high and vary in thickness from 3.5 mm to 10.5 mm. The sidings appear to overlap each other by 30 mm. The cabins have a 1600 mm wide veranda around half of their perimeter, with 450 mm wide eaves around the remainder.
- 2.2 The cabins were issued with a code compliance certificate by the territorial authority in April 2000.
- 2.3 In March 2003 the territorial authority withdrew the code compliance certificate and issued a notice to rectify. Among other things, that notice to rectify noted “The cladding is not

weatherproof and leaking is widespread”.

- 2.4 The matter of the adequacy of the cladding also went to arbitration. The settlement reached being that the builder was to negotiate with the territorial authority as to the method of re-cladding the cabins. The matter was to be considered resolved on receipt of advice from the territorial authority that it accepted that the builder’s proposals would comply with the requirements of the building code.
- 2.5 The builder subsequently proposed the re-cladding proposal which the territorial authority indicated it would accept as being code compliant. The applicant disagreed that the re-cladding proposal would comply with the building code and referred the matter to the Authority for determination.
- 2.6 That re-cladding proposal included the following steps:

Step 1. The current [sidings are] to be removed completely.

Step 2. The existing [untreated plywood diaphragm] and timber framing is to be checked for moisture ...

Step 3. Any plywood or timber found to have excessive moisture contents will be dried to an acceptable level ... Any plywood showing signs of mould is to be treated [with site applied treatments] to kill existing mould spores as well as prevent the possibility of future mould occurring.

Step 4. The [cabins] are subsequently to be reclad in 12 mm H3 treated plywood

Step 5. ... New building paper will be fixed over the new plywood

Step 6. The [sidings are] to be re fixed using good trade practice specifically using scribes to windows and doors ...

Step 7. Longitudinal joints and corners are to be protected against the moisture ingress by the use of scribes, corners boxes or soakers.

The re-cladding proposal also included specific details for weatherproofing at the doors and windows, however, those particular details were not disputed in any of the submissions received and are not discussed further in this Determination.

3 THE LEGISLATION

- 3.1 The relevant provisions of the building code include:

Clause B1 Structure

B1.3.1 Buildings, building elements and sitework shall have a low probability of rupturing, becoming unstable, losing equilibrium, or collapsing during construction or alteration and throughout their lives.

Clause B2 Durability

B2.3.1 Building elements must, with only normal maintenance, continue to satisfy the performance requirements of this code for the lesser of the specified intended life of the building, if stated, or:

- (a) The life of the building, being not less than 50 years, if:
 - (i) Those building elements (including floors, walls, and fixings) provide structural stability to the building, or
 - (ii) Those building elements are difficult to access or replace, or
 - (iii) Failure of those building elements to comply with the building code would go undetected during both normal use and maintenance of the building.
- (b) 15 years if:
 - (i) Those building elements (including the building envelope, exposed plumbing in the subfloor space, and in-built chimneys and flues) are moderately difficult to access or replace, or
 - (ii) Failure of those building elements to comply with the building code would go undetected during normal use of the building, but would be easily detected during normal maintenance.

Clause E2 External moisture

E2.3.2 Roofs and exterior walls shall prevent the penetration of water that could cause undue dampness, or damage to building elements.

4 SUBMISSIONS FROM THE PARTIES AND THE EXPERT'S REPORT

4.1 General

- 4.1.1 The Authority received submissions, in the form of written reports, from the applicant and the builder. The builder's submission included reports from two consultants. The territorial authority advised that it did not intend to make a submission.
- 4.1.2 The expert furnished a written report which was circulated to the parties and the builder for their information.
- 4.1.3 Both the applicant and the builder provided written responses in respect of each other's submissions and the builder responded to the expert's report.
- 4.1.4 The submissions are noted below in the order they were received.

4.2 Submission from the applicant

- 4.2.1 The applicant's submission included the following reasons for considering the re-cladding proposal would not comply with the building code:

- 4.2.2 The sidings cannot be considered as a cladding because of their “narrow and thin dimensions making them unstable” and their lack of weather grooves.
- 4.2.3 The 12 mm plywood must be considered as the building's "outer layer" and, despite the building wrap between the plywood and the sidings, which was a second line of defence, the plywood would become wet. This theory is borne out by the water damage sustained by the existing untreated plywood diaphragm. As the plywood is under the sidings, this would hinder the drying out process and there would be interstitial moisture soaking into the plywood where in contact with the sidings.
- 4.2.4 There was uncertainty as to how wet, and for what duration, the plywood would become and even H3 treated plywood would decay if it were above 20% moisture content for long periods of time. If it were assumed that the plywood would be wet for long periods, the moisture would permeate through to the layer of the existing untreated plywood diaphragm. However, the extent of this ingress would not be discovered until there was significant decaying in progress.
- 4.2.5 The re-cladding proposal needs to be considered as a composite construction, and as such, the consideration of its individual elements did not lead “into understanding the likely performance of the wall system”. There was no research to support the use of such a cladding system and the principles of the re-cladding proposal mirrored present wall systems that had turned out to be faulty. In any case, the re-cladding proposal could not be considered to be similar to other cladding types as it had several layers and its "sandwich effect" would inhibit the drying of water.
- 4.2.6 There was no evidence to support that the plywood, which has a structural function, or the timber framing, will be durable for at least 50 years as required by the building code.
- 4.2.7 An additional area of concern is that the wind zone had been underestimated. The territorial authority considered the site to be in a “High Wind” zone as determined from NZS 3604: 1999 “Timber Framed Buildings”. The applicant considered the site, at a minimum, to be in a “Very High” wind zone and because of its altitude and proximity to the coast considered that it may even be outside of the scope of NZS 3604 and require specific design.

4.3 Submissions from the builder

- 4.3.1 The builder produced reports from two consultants as well as forwarding a submission itself (see 4.5 below).

Consultant One expressed the following views:

- 4.3.2 The siding material, cladding underlay, and the 12 mm plywood and their installation complied with the relevant New Zealand Standards.
- 4.3.3 As regards the sidings, their profile had been proven through its service history with the builder since 1996 and a similar profile was found to be acceptable in principle in the Authority's Determination 99/014. The consultant also attached a test report from a building certifier who had carried out site testing on a show home using a similar system to the one in question. The report described this building as being four years old and situated in a “high

wind” zone. The report concluded that the system complied with the building code.

- 4.3.4 There was a generic requirement to carefully select the quality of the sidings to prevent bowing and cupping and the proposed nail fixing would reduce board movement. The joints needed to be staggered relative to the plywood beneath to eliminate a potential weak point for any moisture transfer. The durability of the wind barrier [12 mm thick] plywood is expected to be maintained if the sidings were fixed as described.
- 4.3.5 The transfer of moisture from the exterior into the wall was not expected to compromise the integrity of the untreated plywood diaphragm.
- 4.3.6 “The protection of the eaves and especially the veranda will reduce the impact of the elements on the [re-cladding proposal]”.
- 4.3.7 The relationship of all components was very important when considering moisture transfer into the wall. There could be no definitive judgement on the degree of moisture transfer, as the system was not “common building practice”, however, from experience of the individual components it was highly unlikely that the “degree of any moisture transfer will compromise the structural integrity of the untreated plywood diaphragm”.

Consultant Two expressed the following views:

- 4.3.8 The consultant considered the re-cladding proposal to be adequate and put forward arguments countering the applicant’s views. He noted:
- 4.3.9 The terms "narrow", "thin" and "unstable" used by the applicant to describe the sidings are not relative to the building code. When nailed in place their total horizontal thickness varies approximately from 6mm to 16mm and this could be compared with sheet materials currently available. The profiles cited by the applicant only applied to the Authority’s acceptable solution E2/AS1 and not to an alternative solution as proposed here.
- 4.3.10 As regards the lack of weather-grooves, wind-driven rain did not allow water to pass “through” the sidings. This would only occur either past the copper soakers to butt joints and through the butt joints, or up between the overlapping sidings. For this to occur, the wind would have to drive the water through 90 degrees at the rear of the soaker and only then where there was pressure differential between the outside and inside of the sidings. This would not occur where both building wrap and a plywood wind barrier have been installed. Tests carried out by the Window Association of NZ show that the use of building wrap alone is an effective means to maintain pressure equalisation outside the building wrap itself.
- 4.3.11 It was not accepted that any water gaining access between siding overlaps will gain access to the building wrap and plywood beneath it. Any wind-driven rain drawn by capillary action between overlapping sidings would encounter a “depressurisation air gap behind each board created by the shape of the angle of the back of each [siding] against the plumb line of the building wrap over the plywood wind barrier”. The ultimate result being that any water driven up between the overlapping sidings would be depressurised and distributed horizontally along the siding in the same manner as for a weather-grooved bevel backed or rusticated board. The siding performs the same functions as a cladding, albeit waterproofing

in a slightly different way, to that of the details contained in E2/AS1 for bevel backed and rusticated weatherboards.

- 4.3.12 The type of building wrap proposed to be used is a proprietary non woven spun polypropylene with a water absorbency of 113 grams per square metre and is, therefore, of a similar nature as that of the original bituminous based building paper that proved to be weathertight. Even if water were to gain access to the building wrap it did not follow that water would gain access to the plywood beneath it. This is because moisture can be removed from the re-cladding proposal by evaporation as well as drainage by gravity.
- 4.3.13 The inability of the plywood barrier to dry out was not accepted with the consultant considering the applicant's views here to be untested and "purely speculative".
- 4.3.14 The consultant noted that many houses in New Zealand had been constructed using bevel backed or rusticated weatherboard claddings and were shown to be weathertight. In addition, the Authority had approved the use of weatherboards similar to those used in this instance in Determination 99/014. Although the profiles may be different from the sidings the principles of drainage and de-pressurisation air gaps are the same. Further the re-cladding proposal should not be compared with those monolithic claddings that are currently causing problems nor can it be said to inhibit the drying out of water due to its composite or sandwich type construction.
- 4.3.15 The consultant considered that the re-cladding proposal could not be rejected simply because the composite nature of the proposed construction had not been tested. He noted his experience that weathertightness problems were more attributable to "faulty design, faulty workmanship and faulty maintenance" than to any "failure of the building system".
- 4.3.16 The proposed 12 mm plywood wind barrier was not a structural element, and as such, is only required to achieve a durability of at least 15 years under the building code.
- 4.3.17 Any comments made in relation to specific site-related wind readings were speculative, as no specific readings had been taken on the building site. Readings on the one NIWA weather station in the general area indicate average wind speeds equate to less than a light wind zone.

4.4 Applicant's responses to the reports of the builder's consultants.

In respect of Consultant One's report the applicant noted:

- 4.4.1 The type of building wrap that was now proposed had not been previously communicated to the applicant and the applicant's submission had been made without taking this into account. There were also additions to the specifications set out in this report compared with the details previously provided to the territorial authority.
- 4.4.2 The relevance of the site test information provided by the building certifier was questioned, as it was based on a building in a different location with a different wind exposure. The site exposure is key consideration which has been underestimated by the territorial authority.

- 4.4.3 Disputed the protection afforded by eaves and verandas noting that inspections on site had revealed up to 40% moisture content in the plywood under one veranda at a height of 1.4 metres above deck level.
- 4.4.4 Considered the reference to Determination 99/014 was not relevant, as the weatherboard profile dimensions were significantly different. The weatherboards in Determination 99/014 were 190 mm wide with a thickness of 5 mm at the top and 20 mm at the bottom. In comparison the boards in question here are 138 mm wide with thicknesses varying from 3.5 mm to 10.5 mm. "As these differences ... are vast they cannot be compared on expected performance".
- 4.4.5 Considered that the claims made concerning the durability the system and the plywood components had not been substantiated.

In respect of Consultant Two's report the applicant noted:

- 4.4.6 In responding, the applicant stressed that the dimensions of the sidings are of "crucial importance", considering there are fundamentally different from, and unable to be compared to, the weatherboard profiles allowed in E2/AS1 or by Determination 99/014.
- 4.4.7 The applicant maintained that both wind-driven rain and capillary action were causing problems. These problems were exacerbated by the "thin and flimsy nature of the [sidings]" making them unsuitable for use especially in such an exposed location.
- 4.4.8 With respect to drying out of the composite cladding the applicant agreed there is no absolute data available in this area. The applicant however, reiterated that "The [sidings] have been tested on the subject buildings over the last few years and they have failed to perform adequately". The applicant further noted that "[t]he site is in a severe wind zone and ... there are presently areas of water ingress, including 1.4 m above deck level under a 1.7 metre wide overhang".

4.5 Builder's submission

- 4.5.1 In the course of determination, the builder forwarded dimensioned plans and a detailed cross section through the wall of the cabins. The type of building paper and the use of copper soakers at junctions were also confirmed. The builder also forwarded to the Authority samples of the sidings.
- 4.5.2 The builder noted:

"What we have proposed is effectively the recladding of these [cabins] with H3 12 mm ply. Strictly speaking ... the [sidings are] really a rainscreen. However used in conjunction with each other they form an exterior cladding"

We reject [the applicant's claim that] the "The [sidings] have failed". The arbitrator's findings were that the ... building paper had failed and there were some areas of faulty workmanship that had allowed some water ingress. For [the applicant] to claim 40% [moisture content] under the verandah and 1.400 up the wall would be virtually impossible unless there had been interference.

4.5.3 The particular type of siding has been widely used overseas for many years in a similar way that the builder has used them.

4.6 Applicant's responses to the builder's submission.

4.6.1 The applicant stated that its "original claims about water ingress and high moisture content levels are confirmed".

4.6.2 The applicant further contended that the arbitrator's assessment concerning the building paper was not correct noting that "The [sidings] could never form a rainscreen to the layers beneath as they are dimensionally unstable, have failed and will continue to fail. My previous statements in this regard are confirmed".

[The applicant's contentions in 4.6.1 and 4.6.2 above were immediately refuted by the builder who noted that there had been no information presented to show that water ingress had occurred where the building paper had remained intact nor that the sidings were dimensionally unstable.]

4.6.3 The applicant also noted that there had not been any connection made between the overseas product information and how it relates to New Zealand in general and the site in particular.

4.7 Report of the Authority's expert

4.7.1 The expert stated:

Performance of the Cedar cladding

A range of opinion on the weathertight performance of the [sidings] and [re-cladding proposal] is presented in the reports but we note that no experimental performance data is provided. This would have been useful in the context of the theoretical arguments advanced in many of the reports but we do not believe it is the central issue. We believe on this particular site, that some water leakage through weatherboard claddings has to be expected and managed appropriately.

[Consultant 2] discusses the physics of water entry through weatherboard claddings and while we agree with much of the theoretical argument, we want to point out that wind pressures will not always equalise across the cladding. To achieve pressure equalisation requires the cavity behind the cladding to be carefully partitioned to prevent lateral air flows between high and low pressures. There is no doubt that some pressure equalisation will occur ... but you have to expect air pressure gradients across this particular wall cladding in strong winds along with occasional water leakage.

In our experience there are important differences between theoretical and measured water leakage rates through weatherboard claddings. Measured leakage rates are often higher than expected because of gravity leakage paths through fixings, cracks and other defects in the cladding material. In [our] data on the water leakage performance of professionally constructed weatherboard claddings, half of the samples leaked before the application of an air pressure difference. Although the [sidings are] not represented in this data, and we appreciate that it is a quality product selected from clear timber, we maintain that weatherboard claddings in very high wind zones often leak and should be backed up with provisions to actively manage water.

Moisture transfer paths

We note some discussion in the reports concerning the likelihood of moisture transfer paths to the [untreated plywood diaphragm]. The arguments offered against the [re-cladding proposal] ... accept that the quantity of water that will travel through to the [untreated plywood diaphragm] is uncertain. The case in favour of the re-cladding proposal ... argues that there is an established track record of successful weatherboard walls over a plywood wind barrier. We agree that weatherboard walls have an established track record on less windy sites and that in more exposed sites a treated plywood wind barrier is often specified. We believe, however, that the proposed re-cladding solution that leaves the [untreated plywood diaphragm] in place is largely experimental.

We note that the [untreated plywood diaphragm] has become wet and that the [re-cladding proposal] presents plans for drying and removing any areas of decay affected material. Experience with leaking houses with decayed framing suggests that specialist help may be needed to correctly identify areas needing replacement or treatment.

... we believe that a drained and vented cavity would more effectively decouple the [siding] from the sheathing than the [re-cladding proposal].

History of performance of untreated structural sheathing

[We are aware of several cases] where untreated plywood in contact with a leaking cladding has failed to meet the requirements of clauses E2 and B2. There are various claddings involved in these cases but the common element is the presence of uncontrolled water in wicking contact with untreated plywood sheathing. The subject of this determination is different in that the untreated layer is protected with a building wrap and an additional layer of treated plywood. Our concern is that the [untreated plywood diaphragm] is still in wicking contact with water trapped behind the cladding. Unfortunately there is no analytical way of confirming whether or not the moisture content of this panel will support further timber decay and we are therefore unable to confirm that the [untreated plywood diaphragm] will last the life of the building. As a result, we think that [untreated plywood diaphragm] is an unsuitable bracing component to have in wicking contact with a weatherboard cladding in very high wind exposures at [this site].

Wind exposure classification

A range of opinion on likely wind speeds at the building site is expressed in the reports. Tradition assessment methods following NZS 4203: 1992 suggest a classification of either Very High or Specific Design. [The applicant] provide[d] calculations in support of Specific Design ... and our own calculations suggest the wind exposure classification to be on the borderline of Very High and Specific Design. There may be specific features present that are not accounted for in a desk based assessment but the weathertightness opinion offered on the suitability of the [re-cladding proposal] is based on a wind exposure classification of Very High.

Conclusions

The site exposure is Very High by our calculations and we consider that water will leak through any weatherboard cladding in this situation and should be actively managed. The [re-cladding proposal] adds an additional layer of treated plywood to the wall system but the [untreated plywood diaphragm] may still remain in wicking contact with water trapped in the outer layers. Our view is that in this particular situation, the durability and bracing ability of the [untreated plywood diaphragm] can not be guaranteed for the intended life of the building.

5.0 Alternative re-cladding proposal

- 5.1 In response to the expert's report, the builder wrote to the Authority noting that it was clear that the expert favoured the provision of a cavity behind the sidings. While the builder did not necessarily agree and believed its re-cladding proposal would meet the requirements of the building code, it nevertheless wanted to resolve this longstanding matter. Accordingly, as an act of "good faith" it offered to amend its re-cladding proposal to include a cavity. The amended proposal essentially remained as noted in 2.6 above; however, the following step was to be added between Steps 5 and 6:

Fix new ex 50x25 H3 Battens @ 480 c max to form new 20 mm cavity. Vermin proof bottom of cavity.

- 5.2 In response the applicant stated that it believed the proposal "to be beyond the scope of the determination". Also "in the unlikely event of it being accepted within the determination we would argue against the proposal, as it does not meet the requirements of the building code". In this respect, the applicant questioned the fitness of the sidings, the untreated plywood diaphragm being left in place and the trapping of moisture between the plywood layers.
- 5.3 Finally, there was a response made on behalf of the builder disagreeing with the applicant's stance regarding the scope of the determination and stating that the Authority had a "positive obligation to consider all or any amendments to the [re-cladding proposal] submitted by the [builder]".

6 THE AUTHORITY'S VIEW

- 6.1 The Authority notes that it has not seen a specification (covering all relevant material properties including grading and allowable defects) for the sidings. As the material is essentially re-used from its previous application then the Authority assumes the previous specification applies and that none of the parties have an issue with it.
- 6.2 The Authority accepts the arguments put forward by the applicant that the recladding proposal cannot be considered as providing a weatherproof cladding for the cabins at the particular site in question. The sidings, due to a combination of factors but primarily their dimensions and the exposure of the site, are considered to be more in the nature of a rainscreen than a major contributing component of the weatherproofing system. As such it is considered that the sidings will allow water through in greater volumes than those associated with more conventional weatherboarding systems, such as those described in the Authority's acceptable solution E2/AS1. As a result the building paper will be wetter than normal and water will pass through to the plywood substrate, irrespective as to which type of building paper is used. The Authority also believes that the presence of the sidings also prevents the plywood from drying out due to a limited airflow.
- 6.3 Reference has been made to Determination 99/014, which relates to the acceptance of certain cedar weatherboards as complying with the building code. That Determination was specific to the particulars pertaining to that application and cannot simply be applied to this or any other case without extreme caution. In particular, the weatherboards were considered only for use over "a suitable flexible backing". The Authority also notes that the weatherboards that were the subject of that Determination were 190 mm wide and tapered

from 20 to 5 mm in thickness. This is significantly different from the sidings considered here (see 2.1 above) and on that point alone the Authority considers that the findings of Determination 99/014 are not relevant to this Determination.

- 6.4 The Authority does not necessarily accept that rot would ensue in the new plywood cladding as the result of exposure to moisture content of 20% as contended by the applicant. However, the fact that the plywood is wet and is not able to dry out would lead to a situation that is conducive to decay and allow for the transfer of moisture to other parts of the building, such as the existing untreated plywood diaphragm and adjacent framing, internal linings and trim. The Authority notes that water was transferred through the original cladding system of sidings and building wrap into the untreated plywood diaphragm and as the re-cladding proposal reuses the same sidings, is of the opinion that this will happen again. In this regard the Authority notes the differences of opinion as to the extent of the water penetration. However, it does not doubt its occurrence noting the territorial authority's advice in its notice to rectify that the original cladding is "not weatherproof and leaking is widespread".
- 6.5 The existing untreated plywood diaphragm is a bracing element and is required to be effective for the life of the building. The Authority accepts that there is doubt whether this element will meet its durability requirements even if it were to remain dry in the future. There is no certainty that all rot or potential rot will be discovered and removed. In addition, the Authority accepts the opinion of the expert that the untreated plywood diaphragm will be in wicking contact with the new plywood layer. As such, there is no certainty that the untreated plywood diaphragm will remain dry and be able to fulfil its bracing and durability functions for the intended life of the building.
- 6.6 The Authority notes that in the submissions there is some confusion as to the life of the cabins. In places the life is noted as a specified intended life of 20 years whereas in others it is referred to as being at least 50 years. Irrespective of which is correct, the Authority considers that Clause E2 has not been complied with and therefore considers that the durability of the building's structural components, in particular the untreated plywood bracing diaphragm, will be adversely affected.
- 6.7 There are conflicting opinions as to which wind zone applies to the building site. After considering these arguments, the Authority accepts that the site would be in the "Very High" (and bordering on the "Specific Design") wind zone classification as described in NZS 3604. The exposure of the site is considered a critical factor to this Determination.
- 6.8 The Authority notes the alternative re-cladding proposal put forward by the builder but takes the view that the Authority does not have jurisdiction to consider the alternative proposal, which was not part of the matter submitted by the applicant for determination. The Authority therefore accepts the applicant's contentions as noted in 5.2 above as being correct. Had the proposals satisfied the applicant then it was open for the applicant to withdraw its application for determination. As this has not occurred then the Authority cannot consider the matter any further. As stated in many previous Determinations it is not for the Authority to advise how the work shall be rectified. That is a matter for the applicant to propose and for the territorial authority to check for code compliance with any further disputes being able to be forwarded to the Authority for resolution.

7 THE AUTHORITY'S DECISION

- 7.1 In accordance with section 20(a) of the Building Act the Authority finds that the re-cladding proposal does not comply with the relevant requirements of the building code.

Signed for and on behalf of the Building Industry Authority on this 19th day of March 2004

J Ryan
Chief Executive