



External moisture – a guide to using the risk matrix



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Purpose of this document

This document has been prepared by the Department of Building and Housing (the Department) as guidance information in accordance with section 175 of the Building Act 2004. It provides guidance to building consent authorities (BCAs), designers and builders on the assessment of risk, as required by the Acceptable Solution E2/AS1 for Clause E2 External Moisture of the New Zealand Building Code.

Although reference is made to relevant sections of E2/AS1, information contained in the Acceptable Solution is not repeated. It is expected that readers will be broadly familiar with the new risk assessment process, and will use this booklet in conjunction with E2/AS1 in order to improve their understanding of the concepts involved in risk assessment. For defined terms, refer to the Definitions in E2/AS1.

The document includes more explanation and examples than are provided in the E2/AS1 Acceptable Solution, and covers:

- a summary of the background to risk assessment
- background to key risk factors used in risk assessment
- discussion and examples of risk factors
- discussion and expanded examples of risk assessment
- exercise examples to be used as training tools.

Designers are required to assess the weathertightness risk of their building proposals and to select appropriate wall cladding systems. Each BCA is responsible for assessing, on a case-by-case basis, what actions they must take to be 'satisfied on reasonable grounds' that the relevant requirements of the Building Code have been met. BCAs and building officials are also responsible for deciding whether to take their own legal or other professional advice to assist them with that assessment. This document is not a substitute for that professional advice.

This document is intended as guidance only, and is not specific to any particular project. While the Department has taken care in preparing this document, it should not be relied upon as establishing compliance with all the relevant requirements of the Building Act or Building Code in all cases that may arise. This document is not a Compliance Document and may be updated from time to time. The latest version is available from the Department's website at www.dbh.govt.nz

1.0 Introduction

It is clear that buildings containing certain design features are at risk of leaking and require extra protection.

Paragraph 3.1 of E2/AS1

There has been considerable discussion and concern over the suitability of certain types of cladding for leak-prone situations. The approach taken in E2/AS1 is to assess the level of risk for a proposed design, and to set exterior wall requirements according to that level.

Table 3 of E2/AS1

This approach allows a wide range of wall claddings to be used directly over framing for low-risk situations. As the assessed risk increases, the number of wall claddings requiring a drained cavity to provide additional moisture protection for the wall framing also increases. When the assessed risk reaches beyond a very high level, the proposed building (or part of the building) is no longer covered by the Acceptable Solution. It must be specifically designed and detailed to handle the weathertightness risk.

As well as helping with risk assessment for cladding systems that are included in E2/AS1, this guidance document may provide building consent authorities (BCAs) with assistance in considering the weathertightness risk involved when assessing alternative solutions. Many materials and claddings are not included in E2/AS1, but a familiarity with the principles behind risk assessment can still be applied to such situations.

The guide is primarily associated with Acceptable Solution E2/AS1. It is acknowledged that using the risk matrix, with the associated inclusion of a drained cavity in higher risk situations, is only one means of achieving weathertightness.

Designers and builders may also find this information useful in identifying individual features that will require particular care and attention during design and construction. It may assist in discussions with clients to be able to outline potential risks and ways to manage them, or to reduce risk by incorporating other compensating features. It may also help BCAs identify where and when inspections are required.

PHILOSOPHY OF RISK ASSESSMENT

The development of the risk assessment approach taken in E2/AS1 is based on work undertaken by two Canadians, Don Hazeldon and Paul Morris. They developed a simple concept called 'the 4Ds' to describe the basic principles of water management in buildings. The 4Ds as used in E2/AS1 are:

Deflection:

Keeping water away from potential entry points.

Drainage:

Providing means of removing water that does enter.

Drying:

Allowing any remaining moisture to be removed by ventilation or diffusion.

Durability:

Providing materials with appropriate durability.

Ideally, a design incorporates and balances all 4Ds. Keeping these basic principles in mind will assist when assessing designs or preparing and evaluating alternative solutions.

2.0 The risk assessment process

Section 3 of E2/AS1 covers the process of evaluating levels of weathertightness risk for a proposed design.

ESTABLISHING THE RISK

The E2/AS1 approach to assessing weathertightness risk uses a simple process that allows risks associated with various features to be added together, resulting in a risk score that is used to determine whether a drained cavity is required for a particular building design.

Table 1 of E2/AS1

Table 1 of E2/AS1 'Definitions of risk' sets out the risk factors and the levels of risk associated with each factor. A copy of this table is provided in Appendix 2 of this guide.

Figure 1 of E2/AS1

Figure A: Figure 1 of E2/AS1

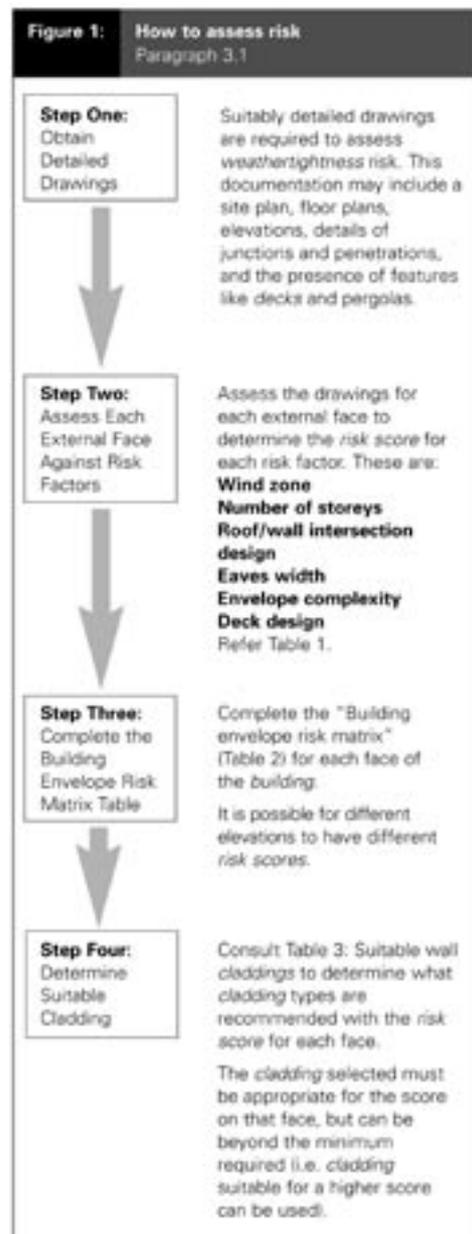


Figure 1 of E2/AS1 'How to assess risk' shows the process to be followed, as shown in Figure A.

Each external wall face or elevation of the building must be evaluated, which means that some designs may need more than four assessments. Scores may differ for each individual face due to differing risk features, as shown in the worked examples in Appendix 1.

The risk matrix

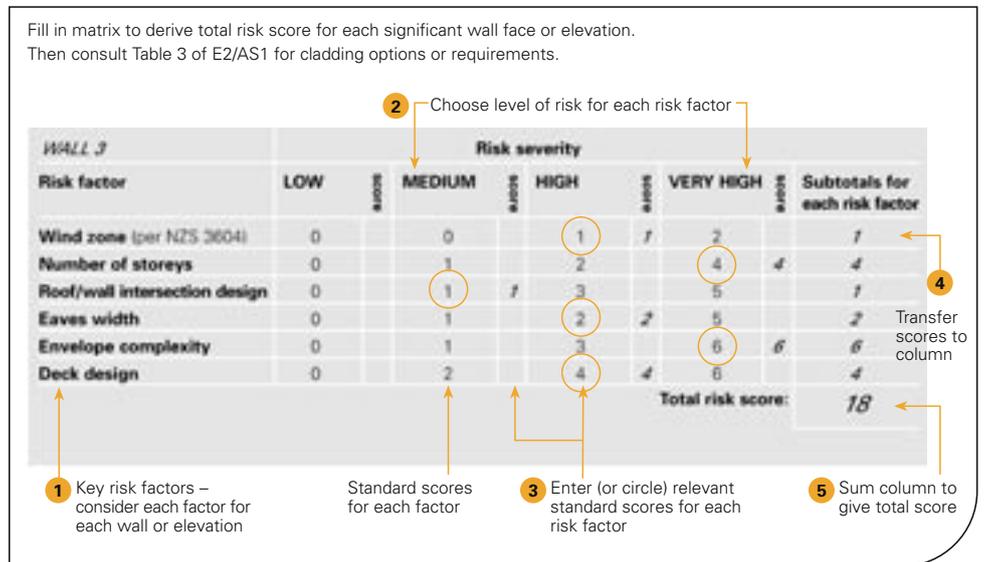
E2/AS1 Table 2

The risk matrix in Table 2 of E2/AS1 is completed for each significant wall.

The assessed risk scores for six key risk factors are added together in order to arrive at an overall risk score for the wall face or elevation.

That score is then used to determine suitable wall claddings from Table 3 of E2/AS1. This table effectively determines the need for a drained cavity behind those wall claddings that are included within the scope of the Acceptable Solution. Figure B shows the use of the risk matrix.

Figure B: Using the risk matrix



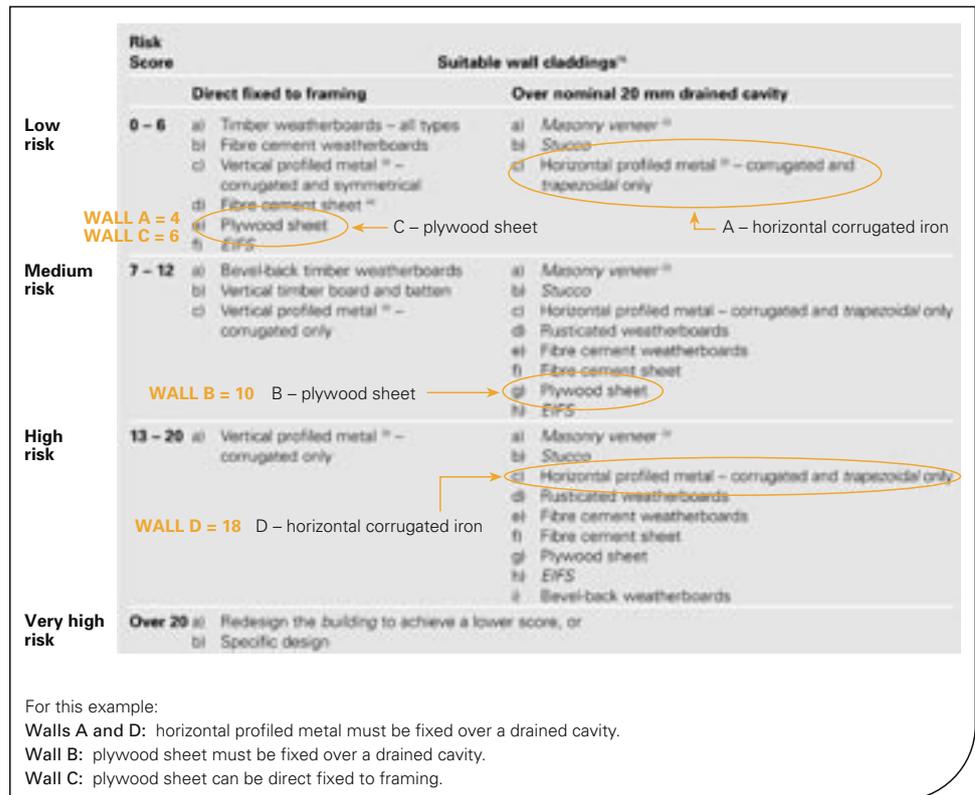
Some designers may choose to simplify documentation by taking the wall with the highest risk level and using that to set requirements for all other walls. This would also simplify construction and compliance checking, but does mean that cavities would be used in lower-risk situations in some instances.

E2/AS1 Table 3

The claddings table

Once total risk scores are derived for each relevant wall or elevation, Table 3 of E2/AS1 indicates those claddings that will require a drained cavity. An example of using the claddings table is shown in Figure C.

Figure C: Using the claddings table



RISK BANDS AND BORDERS

Some designers may aim to avoid the use of drained cavities, where required by Table 3 of E2/AS1, by changing claddings between faces with differing risk scores or by using compensatory design features (such as wider eaves) to reduce the risk score. Because of this type of 'mix and match' between elevations, users of the risk matrix should have a clear understanding of the processes and principles of risk assessment and consider appropriate design solutions accordingly.

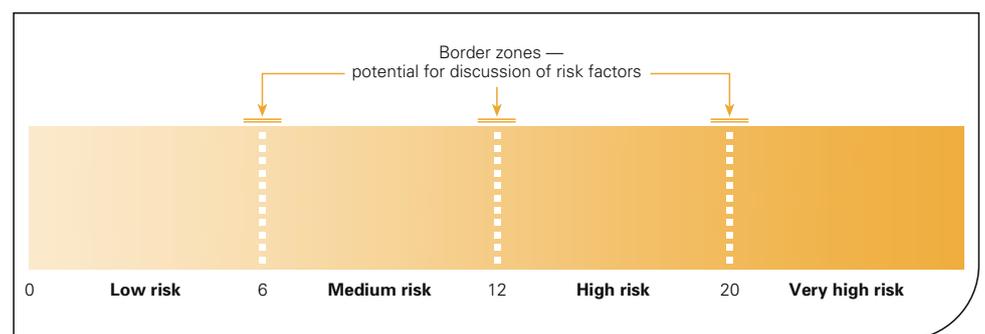
Table 3 of E2/AS1 gives four bands of risk that walls may fall within.

- Low risk: 0 up to 6**
- Medium risk: 7 up to 12**
- High risk: 13 up to 20**
- Very high risk: over 20**

Wall faces or elevations that fall in the centre of these bands can be clearly assessed at compliance stage, and any variation in assessment of relevant risk factors is unlikely to move a wall into a different risk band. Similarly, the requirement or not for a cavity of some wall cladding systems may not change even if the score moves into a new band. For example, bevel-back weatherboards may be direct fixed in both the low-risk and medium-risk bands.

Wall scores that fall close to borders where fixing requirements change from direct fixed to requiring a cavity, or to where a proposal will require specific design, are those that require the most care when assessing subjective risk factors. These risk factors will require careful judgement, and will be explored in the following section.

Figure D: Risk bands and borders



Assessment of the more interpretive risk factors may vary between parties. With envelope complexity, by way of example, the effect of a difference in judgement could be a score discrepancy of 3 (between high and very high complexity). This could have the potential to move a proposed wall into a higher risk band.

The next section discusses the risk factors, and focuses on those that require judgement of the underlying weathertightness risks.

3.0 Summary of key risk factors

Six key leak risk factors have been identified and will need assessment for every design.

Table 1 of E2/AS1

Table 1 of E2/AS1 gives the following key risk factors to be assessed.

- A Wind zone**
- B Number of storeys**
- C Roof/wall intersection design**
- D Eaves width**
- E Envelope complexity**
- F Deck design**

RISK FACTOR A – WIND ZONE

Table 1: Risk factor A

While wind has commonly been considered a contributor to water penetration, it has not yet been shown that the proportion of leaky houses has been markedly influenced by the wind zone of a particular building site. Scores assigned in the risk matrix are therefore limited to the following.

Low = 0	Medium = 0	High = 1	Very high = 2
(NZS 3604 limit 32 m/s)	(NZS 3604 limit 37 m/s)	(NZS 3604 limit 44 m/s)	(NZS 3604 limit 50 m/s)

The risk matrix wind zones are taken from those used in section 5 of NZS 3604: 1999 Timber Framed Buildings. For example, if the wind zone for a building is high according to NZS 3604, then the wind zone risk factor used in the matrix will also be high. If the wind zone is beyond the NZS 3604 upper limit of 50 m/sec, the building will require specific design.

Table 1: Risk factor B

RISK FACTOR B – NUMBER OF STOREYS

Increasing the number of storeys results in an effective increase in the catchment area of a wall exposed to wind-driven rain. It means more water will be running over any vulnerable areas associated with window and door openings, penetrations and other junctions on lower levels. The upper levels will also be more exposed to wind and rain with less shelter from surrounding landscape, vegetation or other buildings. Scores assigned in the risk matrix are as follows.

Low = 0	Medium = 1	High = 2	Very high = 4
(1 storey)	(2 storeys in part)	(2 storeys)	(more than 2 storeys)

Further information

Variations in storey height, including part storeys, are explored further in section 4 Risk factor B – Number of storeys (page 10).

RISK FACTOR C – ROOF/WALL INTERSECTION DESIGN

Table 1: Risk factor C

Roof design is not included in the risk matrix, as leaks within the body of the roof have no relationship to the selection of exterior wall cladding. However, junctions of roofs with walls do create potential risks, and these intersections are assigned varying risk scores as follows.

Low = 0	Medium = 1	High = 3	Very high = 5
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Further information

Examples of roof/wall intersection designs and risks are given in section 5 Risk factor C – Roof/wall intersection design (page 11).

RISK FACTOR D – EAVES WIDTH

Table 1: Risk factor D

Eaves shelter walls from rainfall. However, as rain is often wind-driven, effective shelter decreases as eaves width decreases. Upper storeys will also be more exposed to wind and rain, so effective shelter from eaves will decrease as the roof height increases. Varying risk level scores in the risk matrix are therefore assigned as follows.

Low = 0	Medium = 1	High = 2	Very high = 5
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Table A shows the relationship between eaves width and risk levels.

Table A: Eaves width

	 One storey	 Two storey	 Three storey
Low risk	> 600 mm		
Medium risk	451 to 600 mm	> 600 mm	
High risk	101 to 450 mm	451 to 600 mm	> 600 mm
Very high risk	≤100 mm	101 to 450 mm	451 to 600 mm

– Eaves width is to the outer limit of overhang, including gutters or fascias.
– Solid balustrades and parapets count as 0 mm eaves width.

RISK FACTOR E – ENVELOPE COMPLEXITY

Table 1: Risk factor E

As envelope complexity increases, the number of wall junctions increases. Junctions or penetrations associated with windows, doors, pipe or cable entry points and attachments such as pergolas are areas commonly vulnerable to water penetration, implying that increased complexity will tend to lead to increased risk of leaking. The risk matrix assigns increasing risk level scores to increasing envelope complexity as follows.

Low = 0	Medium = 1	High = 3	Very high = 6
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Further information

As discussed in section 2 The risk assessment process (page 3), this risk factor is likely to cause the most debate, as assessment of complexity will be subjective. Complexity is therefore explored further in section 6 Risk factor E – Envelope complexity (page 15).

RISK FACTOR F – DECK DESIGN

Table 1: Risk factor F

E2/AS1 Definitions

The level of risk depends on the type and the design of the deck.

‘Enclosed decks’ are considered to be higher risk as these provide a catchment area for rain. The risk is lower if the deck is protected by a roof overhang, while risk increases if the deck is cantilevered and/or located on higher storeys where exposure is greater. The risk matrix assigns risk levels as follows.

Low = 0	Medium = 2	High = 4	Very high = 6
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Further information

Examples of deck design and appropriate risk levels are given in section 7 Risk factor F – Deck design (page 20).

4.0 Risk factor B – Number of storeys

A correlation exists between the increasing number of storeys and an increasing incidence of leaks.

Low = 0	Medium = 1	High = 2	Very high = 4
(1 storey)	(2 storeys in part)	(2 storeys)	(more than 2 storeys)

Table 1: Risk factor B

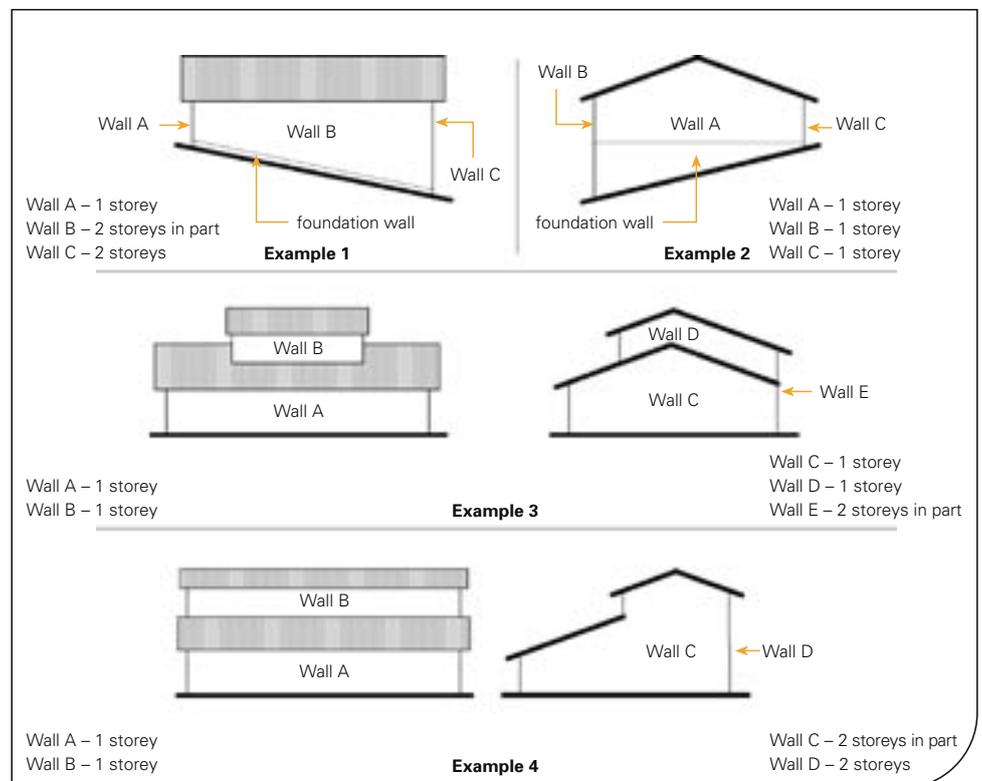
A building may have external walls that differ in storey height. The effective catchment area of a wall, together with the exposure of the upper wall area, must be considered when assessing the appropriate risk to be assigned.

Storey height is taken as being the unbroken height of the wall cladding being assessed, excluding foundation or basement walls. Junctions with the wall below will require specific detailing to suit the particular circumstances of the design.

STOREY HEIGHT

Many houses may have a partial upper storey. Depending on the type of upper storey, a particular wall may be classified as 'one storey', 'two storeys in part' or 'two storeys'. Figure E gives examples of appropriate classifications for different walls.

Figure E: Storey height



As shown, the storey height of the particular wall face being assessed is used for the risk matrix. In Example 2, walls above foundation walls do not include the foundation wall within the storey height. In Examples 3 and 4, clerestory walls are classified as one storey.

5.0 Risk factor C – Roof/wall intersection design

Junctions of roofs with walls create potential risks and are therefore assigned varying risk levels.

Low = 0	Medium = 1	High = 3	Very high = 5
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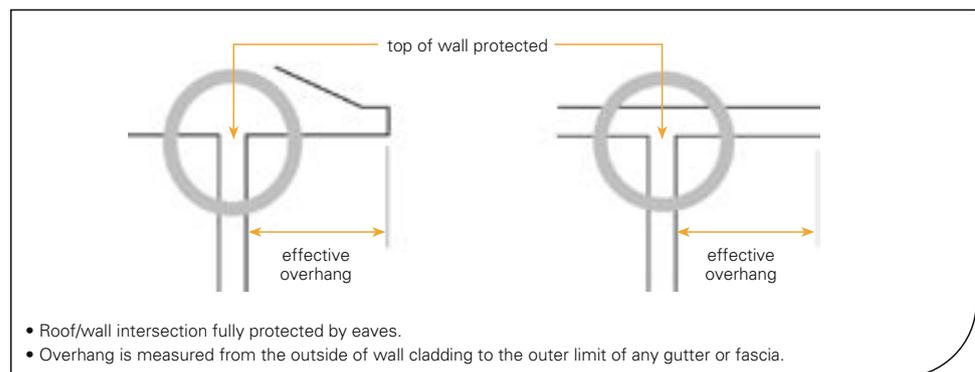
Table 1: Risk factor C

Although roof design is not a key risk factor for the selection of wall claddings, the risk level of the intersection of the roof with exterior walls is assessed as these junctions are potential leak points.

LOW-RISK INTERSECTION DESIGNS

The least risky is the fully protected intersection provided by traditional eaves. The eaves direct roof water away from the wall framing and also protect the top of the wall from rain. Figure F illustrates these principles.

Figure F: Low-risk roof/wall intersection designs



E2/AS1 Paragraph 8.0

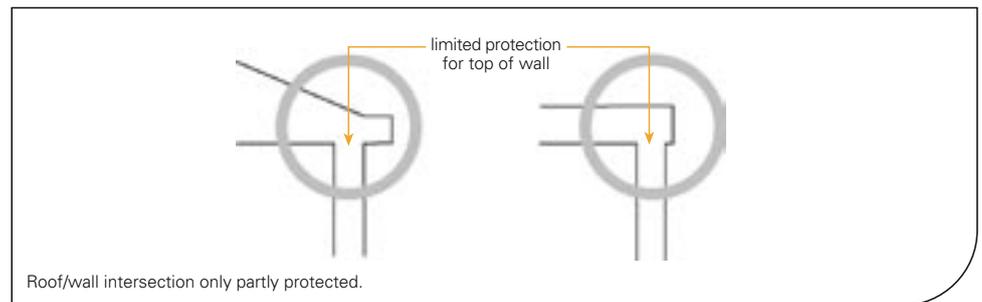
Examples of low-risk roof/wall intersections are shown by a number of E2/AS1 details. These include:

- Figure 25: Timber fascia eaves for masonry tile
- Figure 36: Eaves and barge for metal tile
- Figure 45 (a): Eaves for profiled metal.

MEDIUM-RISK INTERSECTION DESIGNS

Partly exposed intersections have no or minimal eaves to direct rain away from the wall framing, and provide limited protection for the top of the framing from wind-driven rain. Figure G illustrates these principles.

Figure G: Medium-risk roof/wall intersection designs



E2/AS1 Paragraph 8.0

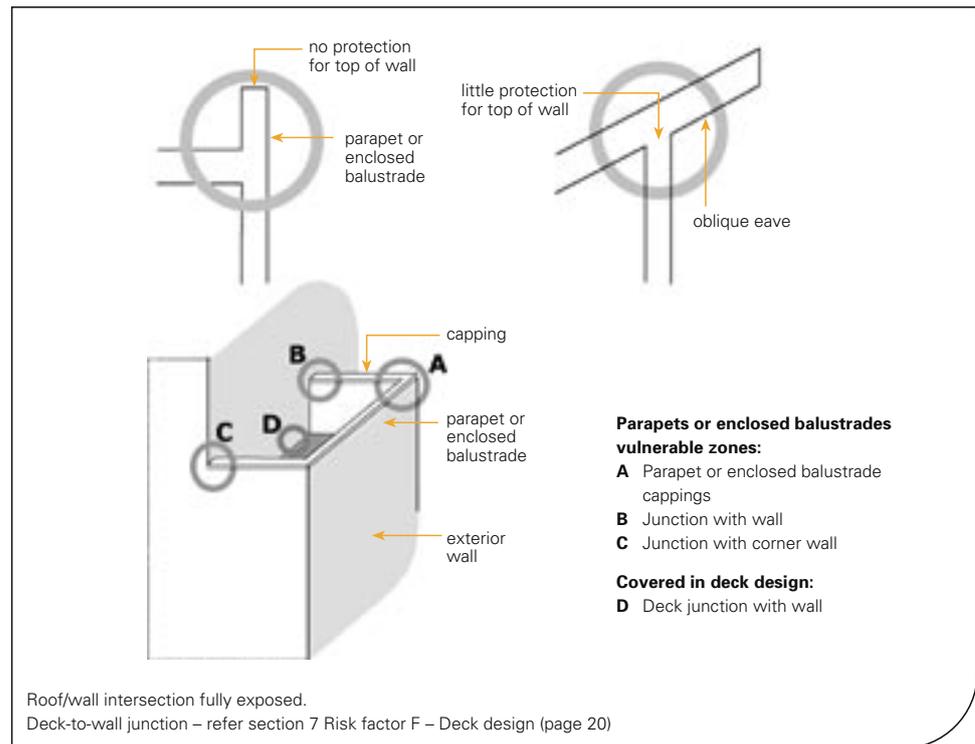
Examples of medium-risk roof/wall intersection designs are shown by a number of E2/AS1 details. These include:

- Figure 28: Roof/wall ridge for masonry tile
- Figure 45 (b): Roof/wall ridge for profiled metal
- Figure 61: Verges in membrane.

HIGH-RISK INTERSECTION DESIGNS

High-risk roof/wall intersections are those where exposure of the junction allows water to run over areas that are vulnerable to penetration, as shown in Figure H.

Figure H: High-risk roof/wall intersection designs



E2/AS1 Definitions

E2/AS1 uses the term ‘enclosed balustrade’ to describe framed and clad balustrades. As shown in Figure H, design features such as enclosed balustrades or parapets include potentially vulnerable junctions located directly above the wall framing. Water can run over these junctions, and a failure in this location poses a potential hazard for the wall framing below.

Another example of high-risk intersections is eaves that have a soffit at an angle of more than 90° to the exterior walls as shown in Figure H. This type of eave exposes the soffit/wall cladding intersection by allowing water to run over the vulnerable junction located at the top of the wall framing.

E2/AS1 Paragraph 6.0 and Paragraph 7.4

Examples of high-risk roof/wall intersection designs included in E2/AS1 details are:

- Figure 9: General capping joints for parapets and enclosed balustrades
- Figure 10: General construction of parapet and enclosed balustrade
- Figures 11 to 13: Parapet/balustrade junctions with walls
- Figure 18: Enclosed balustrade – bottom of cladding.

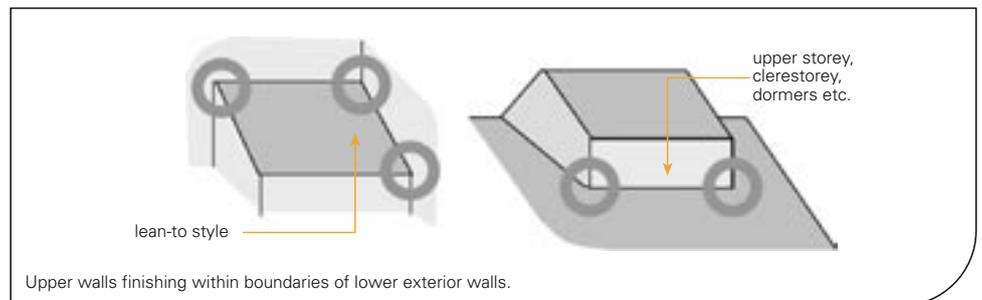
VERY HIGH-RISK INTERSECTION DESIGNS

This classification applies where upper walls terminate within the boundaries of the lower exterior walls, such as in multiple level roofs, clerestoreys, dormers, chimneys etc. These types of roof-to-wall intersections incorporate junctions that are exposed to water run-off and create opportunities for leaks to penetrate directly into interior wall framing below.

These are considered to be very high-risk intersections as the potential consequence of any failure is considered to be particularly serious. Any water that does penetrate this type of junction must be directed back to the outside. Any water that enters the exterior wall above the roof/wall junction, without draining back out to the outside, will penetrate down to the lower interior wall framing.

Figure I gives examples of very high-risk roof/wall intersection designs.

Figure I: Very high-risk roof/wall intersection designs



E2/AS1 and
Paragraph 5.0

Examples of very high-risk roof/wall intersection design included in E2/AS1 details are:

- Figure 7: Basic apron flashing
- Figure 8 (a): Gutter/wall junction
- Figure 30: Abutment at framed penetration for masonry tile
- Figure 37: Hidden gutter flashing for metal tiles
- Figure 48: Parallel apron flashings for profiled metal
- Figure 50: Parallel hidden gutter for profiled metal
- Figure 62: Junctions with walls for membrane.

6.0 Risk factor E – Envelope complexity

There is a strong relationship between the increasing complexity of a building's envelope and an increasing incidence of leaks.

Low = 0	Medium = 1	High = 3	Very high = 6
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Table 1: Risk factor E

The concept behind this risk factor is simple – the more complicated the building shape, the higher the weathertightness risk. As envelope complexity increases, the number of wall junctions also increases. The more complex the junctions are, the more difficult it will be to make the envelope weathertight. Increasing complexity will therefore tend to lead to increasing vulnerability to water penetration.

Assessment of complexity is somewhat subjective. What may be quite simple to designers may appear more complex to others. It is important to recognise there is no simple checklist system which can produce one right answer. Judgement must be based on an understanding of principles underlying increased vulnerability for complex envelopes, and the user of the risk matrix should be able to identify potential water entry points.

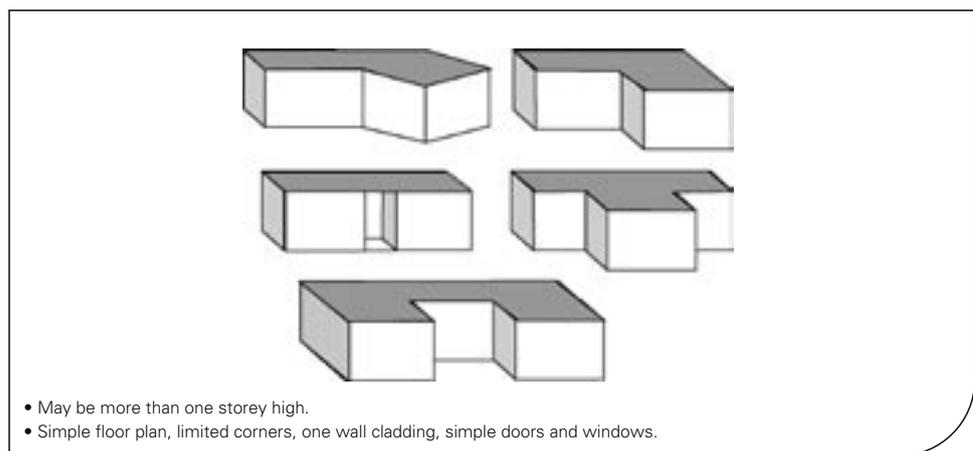
This section aims to expand on the descriptions given in Table 1 of E2/AS1 and to give illustrations of the various classifications.

LOW-RISK ENVELOPE COMPLEXITY

E2/AS1 Figure 2

E2/AS1 Figure 2 gives one example of a low-risk building envelope shape. Other examples of basic shapes are given in Figure J. For simplicity, roof shapes are not shown.

Figure J: Low-risk building envelopes



Simple building envelopes have limited corner junctions, together with few penetrations and junctions. With a single type of wall cladding, junctions between claddings are minimised. (Any difference in cladding over unlined subfloor spaces should not be considered as a change in cladding type when assessing envelope complexity.)

Low-risk building envelopes tend to have the following features.

Building shape

The floor plan is simple, with limited and straightforward corners. This limits the number and complexity of corner junctions, and hence the number of potentially vulnerable points.

Wall cladding

With a single wall cladding, there are no inter-cladding junctions vulnerable to water entry.

Windows

Window and door joinery is simple in design. There are no complex windows such as box, bay or conservatory-type glazing that may be difficult to weatherproof.

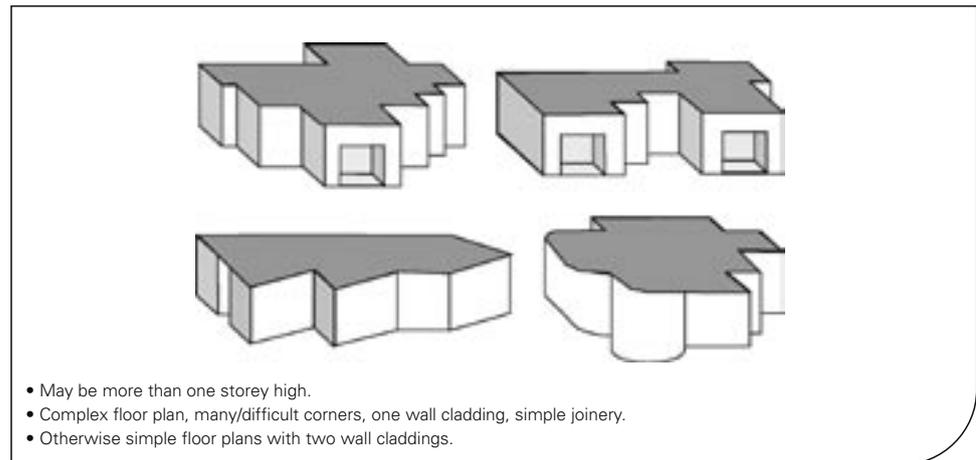
Attachments

There are no exposed attachments such as pergolas, with fixings that penetrate wall claddings.

MEDIUM-RISK ENVELOPE COMPLEXITY

E2/AS1 Figure 3 gives one example of a medium-risk building envelope shape. Other examples of basic shapes are given in Figure K. For simplicity, roof shapes are not shown.

Figure K: Medium-risk building envelopes



Simple envelopes with two wall claddings

If building envelopes meet all the criteria required for low-risk envelope complexity except they have two types of cladding, these will be classified as medium-risk.

Moderately complex envelopes with single wall cladding

Other medium-risk building envelopes have more complex shapes, with more corner junctions. They may have curved and/or acute angled corners, but will still have limited penetrations and junctions. With a single type of wall cladding, junctions between claddings are minimised.

These building envelopes tend to have the following features.

Building shape

The floor plan is complex, with more corner junctions, and possibly curved walls. Corners may be at acute angles. The number and complexity of corner junctions is increased, and hence the number of potentially vulnerable points.

Wall cladding

With no more than two different wall claddings, there are limited inter-cladding junctions vulnerable to water entry.

Windows

Window and door joinery is reasonably simple in design, without complex windows such as box, bay or conservatory-type glazing that may be difficult to weatherproof.

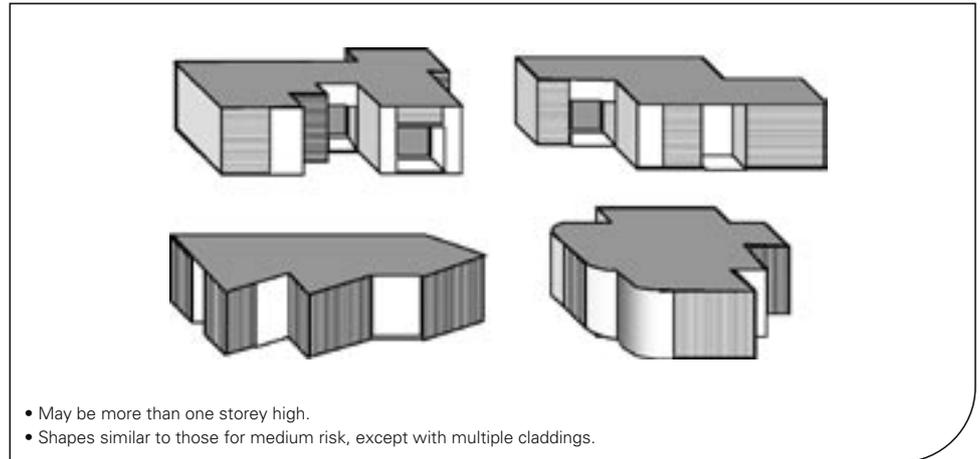
Attachments

There are no exposed attachments such as pergolas, with fixings that penetrate wall claddings.

HIGH-RISK ENVELOPE COMPLEXITY

Examples of high-risk building envelope shapes are given in Figure L. For simplicity, roof shapes are not shown.

Figure L: High-risk building envelopes



High-risk building envelopes have complex shapes, with many corner junctions. They may have curved and/or acute angled corners and/or multiple (three or more) cladding types, and will tend to have the following features.

Building shape

Complex floor plan, with many corner junctions, and possibly curved walls. Corners may be at acute angles. The number and complexity of vulnerable corner junctions is increased.

Wall cladding

With multiple wall claddings there are inter-cladding junctions vulnerable to water entry.

Windows

Window and door units are conventional in design, without specialised windows such as box, bay or conservatory-type glazing.

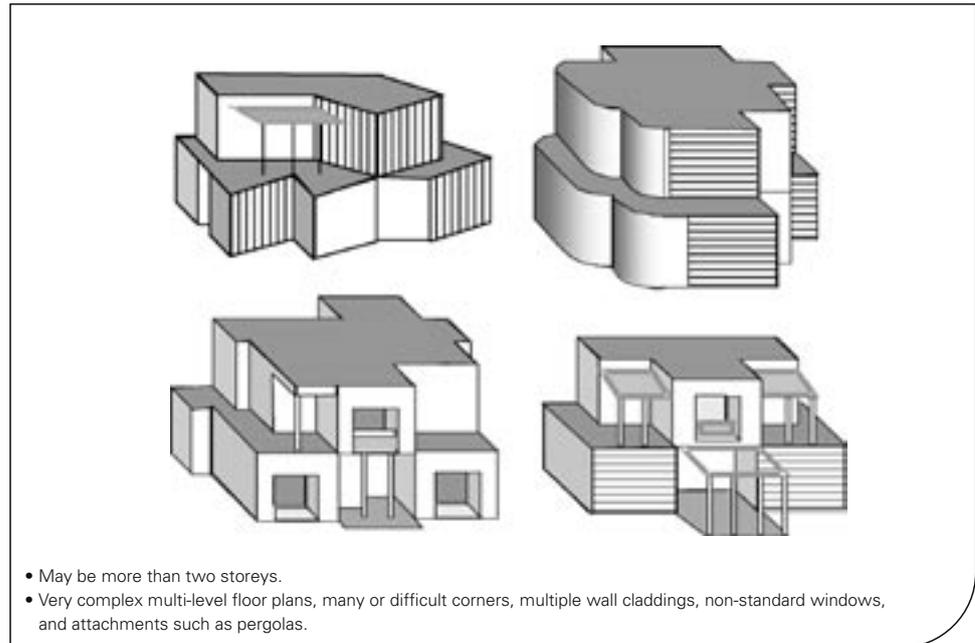
Attachments

There are no exposed attachments such as pergolas, with fixings that penetrate wall claddings.

VERY HIGH-RISK ENVELOPE COMPLEXITY

E2/AS1 Figure 4 gives one example of a very high-risk building envelope shape. Other examples of basic shapes are given in Figure M. For simplicity, roofs are not shown.

Figure M: Very high-risk building envelopes



Very high-risk envelopes are an extension of the factors covered for high-risk envelopes. Floor plans are very complex, walls may be curved and corner junctions may be at angles other than 90°. There may also be added risky features, such as pergolas, attachments, box windows and upper-level walls that finish within the boundaries of the floor below.

Very high-risk building envelopes tend to have the following features.

Building shape

The floor plan is very complex, with multi-levels, many corner junctions, and possibly curved walls. Corners may be at acute angles. The number and complexity of corner junctions is increased, hence the number of potentially vulnerable points.

Wall cladding

With multiple wall claddings there are inter-cladding junctions vulnerable to water entry.

Windows

Window and door joinery may be non-standard in design, with complex windows such as box, bay, dormer or specialised conservatory-type glazing that lead to complex window-to-wall junctions.

Attachments

There are exposed attachments such as pergolas, with fixings that penetrate wall claddings.

7.0 Risk factor F – Deck design

The presence of decks has shown the strongest correlation with the incidence of leaks.

Low = 0	Medium = 2	High = 4	Very high = 6
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Table 1: Risk factor F

Buildings with decks and/or balconies are over-represented in buildings experiencing leaks.

TYPES OF DECK

E2/AS1 Definitions

E2/AS1 uses the term 'decks' to include both decks and balconies. It divides decks into two categories: those with a free-draining surface, such as spaced timber slats; and 'enclosed decks'. The following considers these two types of deck and the different risks they present.

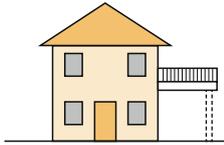
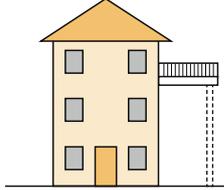
Timber slat decks

The level of risk depends on the design and location of the deck. Some are considered low risk if they do not lead to vulnerable penetrations of the external wall and are free-draining. For example, a traditional timber slat deck at ground level is unlikely to increase the danger of water penetration into a wall. However, one from an upper storey will lead to vulnerable penetrations of the wall cladding.

As the deck-to-wall junction is vulnerable to water penetration, the level of risk is related to the exposure of this junction. The risk will increase as the level of the deck is raised to upper storeys, or decrease with the shelter of a deep overhang.

Timber slat decks with cantilevered joists have added risks of water entry, as the joists penetrating the wall cladding are difficult to weatherproof. They are therefore given a higher risk classification, as shown in Table B.

Table B: Timber slat decks – risk levels

	 Ground floor	 First floor	 Second floor
Low risk	Timber slat deck – non-cantilevered	Timber slat deck – junction fully protected by roof	Timber slat deck – junction fully protected by roof
Medium risk		Timber slat deck – non-cantilevered	Timber slat deck – non-cantilevered
High risk		Timber slat deck – cantilevered	
Very high risk			Timber slat deck – cantilevered

E2/AS1 Paragraph 7.0

The most vulnerable areas for timber slat decks are the connections of the deck structure to the exterior wall. Deck connection details are covered in E2/AS1 by:

Figure 14 (b) and (c): Threshold separations

Figure 15: Junction with wall for non-cantilevered timber deck

Figure 16: Junction with wall for cantilevered timber deck.

Enclosed decks

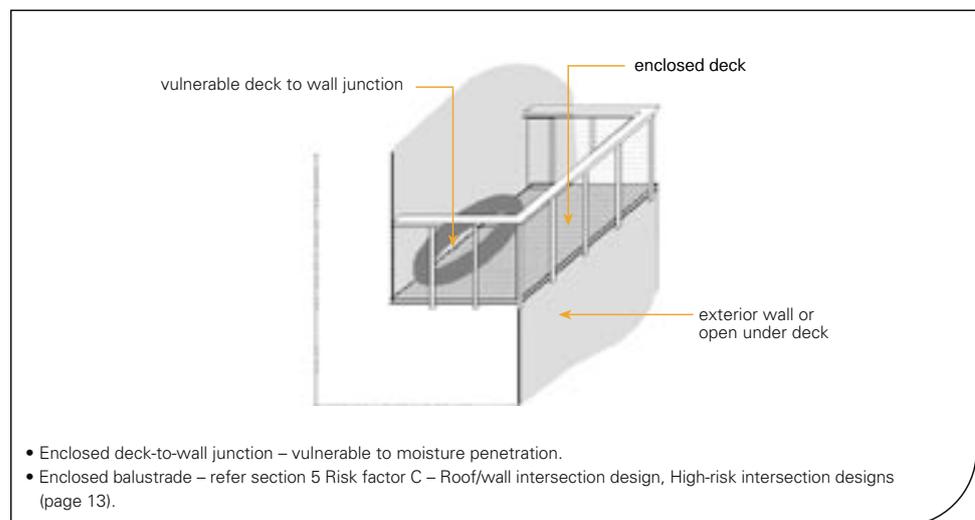
E2/AS1 Definitions

E2/AS1 defines an 'enclosed deck' as one that has an impermeable upper surface and is closed on the underside. This means any moisture penetration endangers the framing of the deck and adjoining walls and is difficult to detect. The areas most vulnerable to moisture penetration are solid balustrades and deck-to-wall junctions.

Risks associated with solid balustrades (and parapets) are included in section 5 Risk factor C – Roof/wall intersection design (page 11).

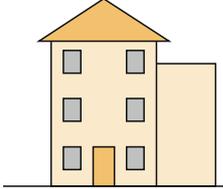
Risk factor F – Deck design covers the junction of the deck with the exterior wall as shown in Figure N.

Figure N: Enclosed decks



The weathertightness risks for enclosed decks increase as exposure increases with height from the ground. Table C indicates the variation in risk levels for enclosed decks.

Table C: Enclosed decks – risk levels

	 Ground floor	 First floor	 Second floor
Low risk	Enclosed deck – junction fully protected by roof		
Medium risk	Enclosed deck – exposed to rain	Enclosed deck – junction fully protected by roof	Enclosed deck – junction fully protected by roof
High risk	Enclosed deck – cantilevered	Enclosed deck – exposed to rain or cantilevered	
Very high risk		Enclosed deck – exposed to rain and cantilevered	Enclosed deck – exposed to rain and/or cantilevered

Covering the deck with a roof overhang helps to protect the junctions of the deck to the exterior walls and decreases the risk, while cantilevering the deck joists increases vulnerable penetrations and increases the risk.

E2/AS1 Paragraph 8.5

In E2/AS1, enclosed deck details are covered by:

- Figure 56: Fall in membrane roofs and decks
- Figure 62: Junctions with walls for membrane.

Appendix 1: Worked examples

Worked examples of the risk matrix.

The following examples provide floor plans and elevations of three varying house designs, together with completed risk matrices.

In the first two examples, a simple **elevation approach** has been taken which considers each elevation of the house as a whole, regardless of the number of wall faces that may be present within a single elevation.

The third example uses a more detailed **wall face approach** where each wall face of the house is assessed separately. This means complex designs will need more assessments completed in order to cover the whole design.

Both approaches are shown in order to illustrate the differences and similarities between them, as either may be used for assessment. However, as shown in the examples, the elevation approach tends to be better suited to simpler designs where there is little difference in the overall scores resulting from either approach. The more detailed wall face approach is likely to suit more complicated designs. The examples also show instances where a 'hybrid' approach is taken, which incorporates elements of both systems.

Drawings have been simplified for ease of presentation, with only relevant exterior walls and features illustrated. It should be noted that drawings are not to scale. It should also be noted that the plans and elevations indicate roof overhangs that exclude gutters and fascias. However, when eaves widths are considered for assessment, the total eave or verge projection will include gutters and fascias.

The examples

The three building examples illustrate a range of design complexity, and contain a variety of design features. Although they are based on real examples, a number of changes have been made in order to improve their usefulness as worked examples.

Example 1

This is a reasonably simple single-storey house in a low wind zone, with a lined basement garage. The design has a hip roof, one type of wall cladding and two decks (one at ground level and the other cantilevered above the basement garage).

Example 2

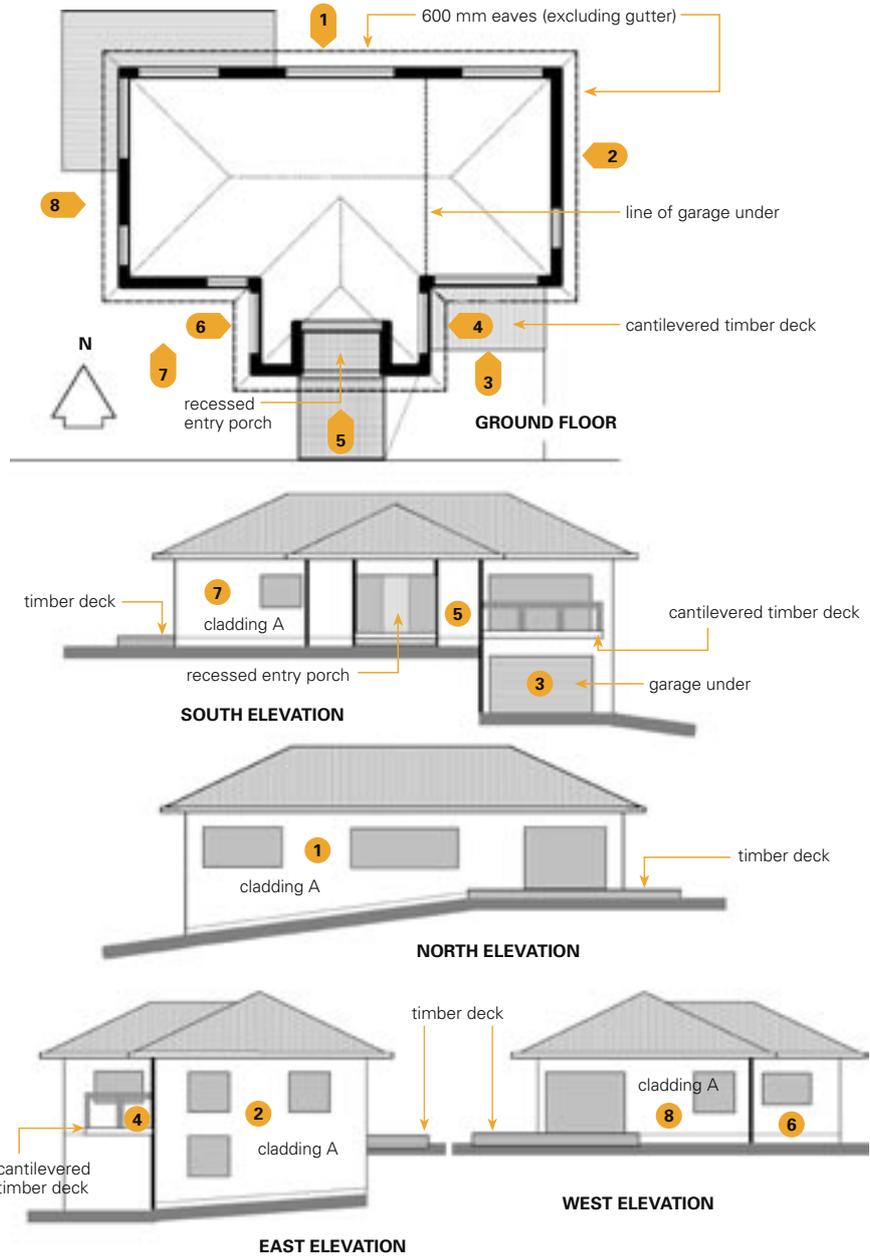
This is a more complex house in a medium wind zone, with monopitch roofs separated by a clerestory section of wall. It is two and a half storeys high, and uses two different types of wall cladding. The design has a corner box window and an enclosed deck, which is partially set back into the building envelope.

Example 3

This is a two-storey house in a high wind zone, with two single-storey areas extending from the ground floor. One of these is a garage that has an enclosed deck on the roof, while the other is a 'lean-to' extension. The design has a number of bay windows and an enclosed deck, which is partially set back into the building envelope.

EXAMPLE 1: PLAN AND ELEVATIONS

Wind zone per NZS 3604 = Low



Example 1: Completed risk matrix forms

(Elevation approach)

ELEVATION: WEST (WALL 8)		RISK SEVERITY							
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0	0	0		1		2		0
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0	0	1		3		5		0
Eaves width	0	0	1		2		5		0
Envelope complexity	0	0	1		3		6		0
Deck design	0	0	2		4		6		0
Total risk score:									0

Reasoning: The west elevation is **Wall 8** (as Wall 6 for this worked example is assessed as part of the south elevation), and is one storey in height. Eaves are wider than 600 mm, leading to low risk scores for the roof/wall junctions and eaves width (as the eave is at the first-storey level). Envelope complexity is considered to be low. Deck design is also low risk, as the timber deck is at ground-floor level.

The total risk score of 0 for this elevation falls at the bottom of the low risk band of 0 to 6. The combined total score of the factors could increase up to 6 without changing the overall risk classification.

ELEVATION: NORTH (WALL 1)		RISK SEVERITY							
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0	0	0		1		2		0
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0	0	1		3		5		0
Eaves width	0	0	1		2		5		0
Envelope complexity	0	0	1		3		6		0
Deck design	0	0	2		4		6		0
Total risk score:									0

Reasoning: The north elevation is **Wall 1** and is one storey in height for most of its length. Eaves are wider than 600 mm, leading to low risk scores for the roof/wall junctions and eaves width (as the eave is at the first-storey level). Envelope complexity is considered to be low. Deck design is also low risk, as the timber deck is at ground-floor level, while the cantilevered deck at the other end does not touch this wall.

The total risk score of 0 for this elevation falls at the bottom of the low risk band of 0 to 6. The combined total score of the factors could increase up to 6 without changing the overall risk classification.

ELEVATION: EAST (WALL 2)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0	0	0		1		2		0
Number of storeys	0		1		2	2	4		2
Roof/wall intersection design	0	0	1		3		5		0
Eaves width	0		1	1	2		5		1
Envelope complexity	0	0	1		3		6		0
Deck design	0	0	2		4		6		0
Total risk score:									3

Reasoning: The east elevation is **Wall 2** (as Wall 4 for this worked example is assessed as part of the south elevation), and is two storeys in height for most of its length. Eaves are wider than 600 mm, leading to low risk scores for the roof/wall junctions and medium risk scores for eaves width (as the eave is at the second-storey level). The envelope complexity is considered to be low, and there is no deck.

The total risk score of 3 for this wall falls within the low risk band of 0 to 6. The combined total score of the factors could increase up to 3 without changing the overall risk classification.

ELEVATION: SOUTH (WALLS 3, 4, 5, 6, 7)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0	0	0		1		2		0
Number of storeys	0		1	1	2		4		1
Roof/wall intersection design	0	0	1		3		5		0
Eaves width	0		1	1	2		5		1
Envelope complexity	0	0	1		3		6		0
Deck design	0		2		4	4	6		4
Total risk score:									6

Reasoning: The south elevation includes **Walls 3 to 7**, and is two storeys in part. Eaves are wider than 600 mm, and this protects the top of the wall framing, leading to low risk scores for the roof/wall junctions and medium risk scores for eaves width (as part is at the second-storey level). Envelope complexity is considered to be low, but the deck factor is high as there is a cantilevered deck at the first floor level.

The total risk score of 6 for this elevation falls just within the low risk band of 0 to 6. An increase in score on any of the risk factors will increase the overall risk classification and change cladding options accordingly. For example, if the deck were changed to an enclosed type this would increase the deck risk factor to very high and bring this elevation within the medium risk band of 7 to 12.

Summary:

For Example 1, wall scores and cladding options are as follows.

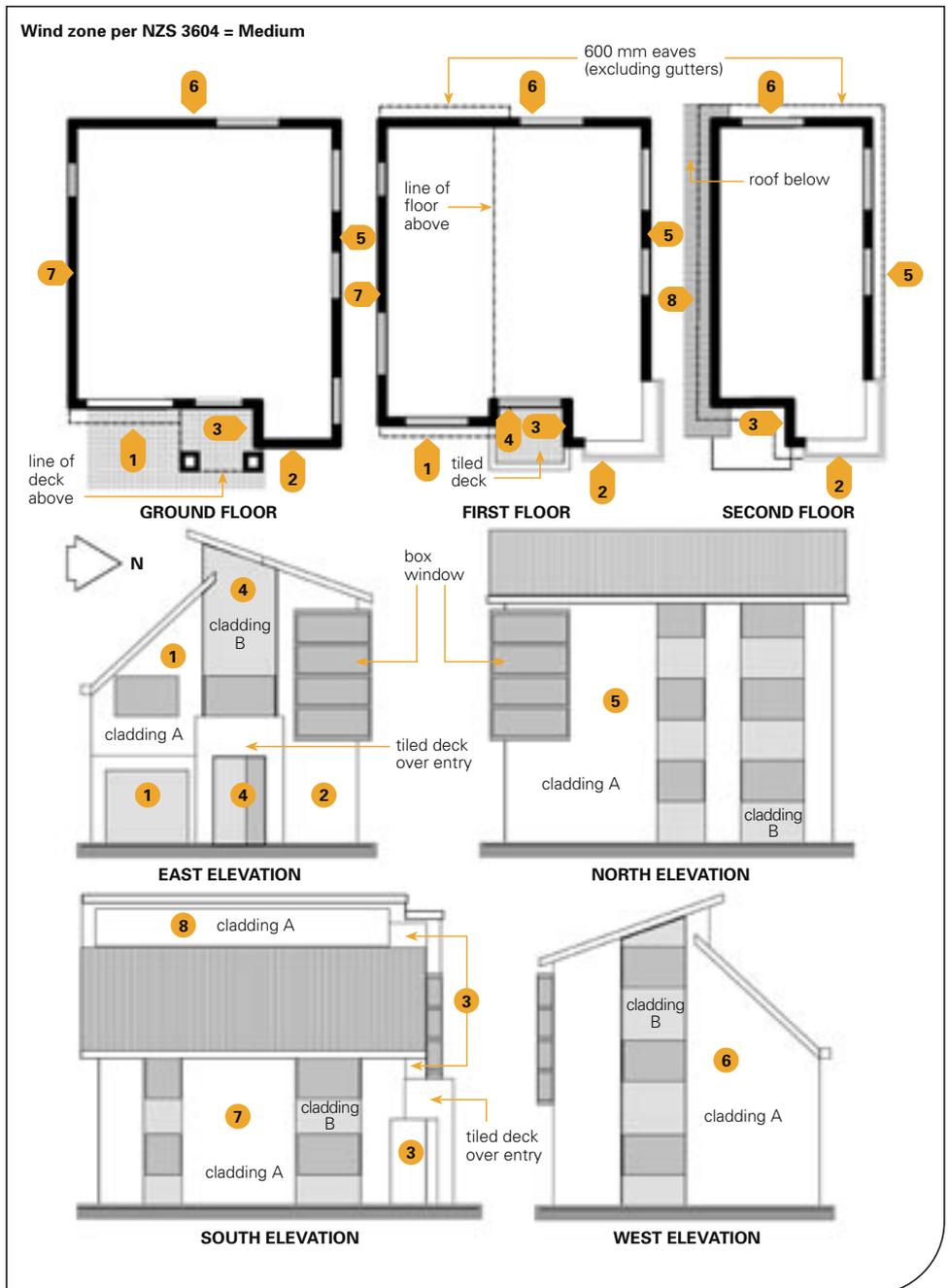
Elevation	Wall(s)	Score	Risk level	Suitable claddings (per E2/AS1 Table 3)	
				Direct fixed	Over cavity
WEST	8	0	Low risk	Timber weatherboards – all types	Masonry veneer
NORTH	1	0		Stucco	
EAST	2	3		Fibre-cement weatherboards	Horizontal profiled metal – corrugated and trapezoidal only
SOUTH	3, 4, 5, 6, 7	6		Vertical profiled metal – corrugated and symmetrical Fibre-cement sheet Plywood sheet EIFS	

All walls are assessed as low risk, which allows the greatest choice of direct-fixed claddings.

For this design, a wall face approach would change the risk scores of some individual walls, but would not alter the risk band they fall within. This is likely to be similar for many simple designs, with little effect on cladding choices.

However, as shown in the following two worked examples, differences between the two approaches tend to increase with more complex designs, with more likelihood of changes in the risk bands and cladding choices.

EXAMPLE 2: PLAN AND ELEVATIONS



Example 2: Completed risk matrix forms

(Elevation approach)

South elevation: This includes two walls on different planes, with one a clerestorey wall. An elevation approach is not suitable for this particular elevation, as it would lead to anomalies by aggregating different risks that would not affect the other wall. The south elevation has therefore been split into south 1 and south 2.

ELEVATION: SOUTH 1 (WALL 7)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0	0	1		2		0
Number of storeys	0		1		2	2	4		2
Roof/wall intersection design	0		1	1	3		5		1
Eaves width	0		1		2		5	5	5
Envelope complexity	0		1	1	3		6		1
Deck design	0	0	2		4		6		0
Total risk score:									9

Reasoning: The south 1 elevation is the two-storey **Wall 7**. It has two different claddings and no eaves. There is therefore a very high risk score for eaves width. The lack of eaves means that the roof/wall intersection is partly exposed, leading to a medium risk score for the roof/wall junction.

Envelope complexity is considered to be medium, due to the presence of additional inter-cladding junctions on an otherwise simple elevation. There is no deck on this wall, so this factor is low risk.

The total risk score of 9 falls within the medium risk band of 7 to 12. The combined total score of the factors could decrease by 2 or increase by up to 3 without changing the overall risk classification.

ELEVATION: SOUTH 2 (WALL 8)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0	0	1		2		0
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0		1		3		5	5	5
Eaves width	0		1		2		5	5	5
Envelope complexity	0		1		3	3	6		3
Deck design	0	0	2		4		6		0
Total risk score:									13

Reasoning: The south 2 elevation is the clerestorey **Wall 8**, which is less than one storey in height. It has a 600 mm oblique eave, with the soffit at an angle of more than 90° to the wall leaving the junction exposed. In addition, the clerestorey nature of the wall (finishing within the boundaries of the lower floor) leads to a risky junction at the apron flashing. These two features combine to give a very high risk score for roof/wall junctions.

Eaves width is also considered very high risk as, although the eave is just over 600 mm at the third-storey level, the oblique angle will provide less shelter than conventional eaves of the same width and position. The envelope complexity is considered to be high, due to the wall finishing within the boundaries of the floor beneath. There is no deck on this wall, so this factor is low risk.

The total risk score of 13 for this wall falls at the lower limit of the high risk band of 13 to 20. A decrease of 1 in the combined total score would lower the risk classification. Reconsidering the design features could reduce the combined total score and then bring this south wall 8 into a lower risk band.

ELEVATION: WEST (WALL 6)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0	0	1		2		0
Number of storeys	0		1		2		4	4	4
Roof/wall intersection design	0	0	1		3		5		0
Eaves width	0		1		2	2	5		2
Envelope complexity	0		1	1	3		6		1
Deck design	0	0	2		4		6		0
Total risk score:									7

Reasoning: The west elevation is the two and a half-storey **Wall 6**, which has two different claddings. Eaves are wider than 600 mm (including barge boards), and this protects the top of the wall framing, leading to a low risk score for the roof/wall junction. There is a high risk score for eaves width (as part of the eaves are at third-storey level). Envelope complexity is considered to be medium, due to the additional inter-cladding junctions on an otherwise simple elevation. There is no deck on this wall, so this factor is low risk.

The total risk score of 7 for this elevation falls within the medium risk band of 7 to 12. The combined total score of the factors could increase up to 5 without changing the overall risk classification.

ELEVATION: NORTH (WALL 5)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0	0	1		2		0
Number of storeys	0		1		2		4	4	4
Roof/wall intersection design	0	0	1		3		5		0
Eaves width	0		1		2	2	5		2
Envelope complexity	0		1		3		6	6	6
Deck design	0	0	2		4		6		0
Total risk score:									12

Reasoning: The north elevation is the three-storey **Wall 5**. It has two different claddings, and a box window. Eaves are wider than 600 mm, and this protects the top of the wall framing, leading to a low risk score for the roof/wall junction. There is a high risk score for eaves width (as eaves are at third-storey level). Envelope complexity is considered to be very high, due to the presence of the corner box window together with additional inter-cladding junctions. With no deck on this wall, this factor is low risk.

The total risk score of 12 for this elevation falls at the upper limit of the medium risk band of 7 to 12. An increase of 1 in the total combined score would raise the risk classification.

ELEVATION: EAST (WALLS 1,2,3,4)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0	0	1		2		0
Number of storeys	0		1		2		4	4	4
Roof/wall intersection design	0		1		3	3	5		3
Eaves width	0		1		2	2	5		2
Envelope complexity	0		1		3		6	6	6
Deck design	0		2		4	4	6		4
Total risk score:									19

Reasoning: The east elevation includes **Walls 1 to 4**, and is part two-storey and part three-storey in height. (In this example, wall 3 is assessed as part of the east elevation as it is on a different plane from the rest of the south elevation.) Eaves are wider than 600 mm, and this protects the top of the wall framing for most walls. However, this elevation includes oblique eaves (above wall 3), plus enclosed balustrades to the deck, leading to a high risk score for roof/wall junctions and a high risk score for eaves width (as part of the eave is at the third-storey level).

Envelope complexity is considered to be very high, due to the many corner junctions, the upper deck finishing within the boundaries of the lower floor and the corner box window. The deck risk factor is high, as the elevation includes an enclosed deck at the first-floor level.

The total risk score of 19 for the walls on this elevation falls at the upper end of the high risk band of 13 to 20. A total increase of 2 in the combined total score of the risk factors would move the overall risk classification above the very high risk category, therefore requiring specific design for this elevation.

Summary:

For Example 2, wall scores and cladding options (excluding masonry veneer) are as follows.

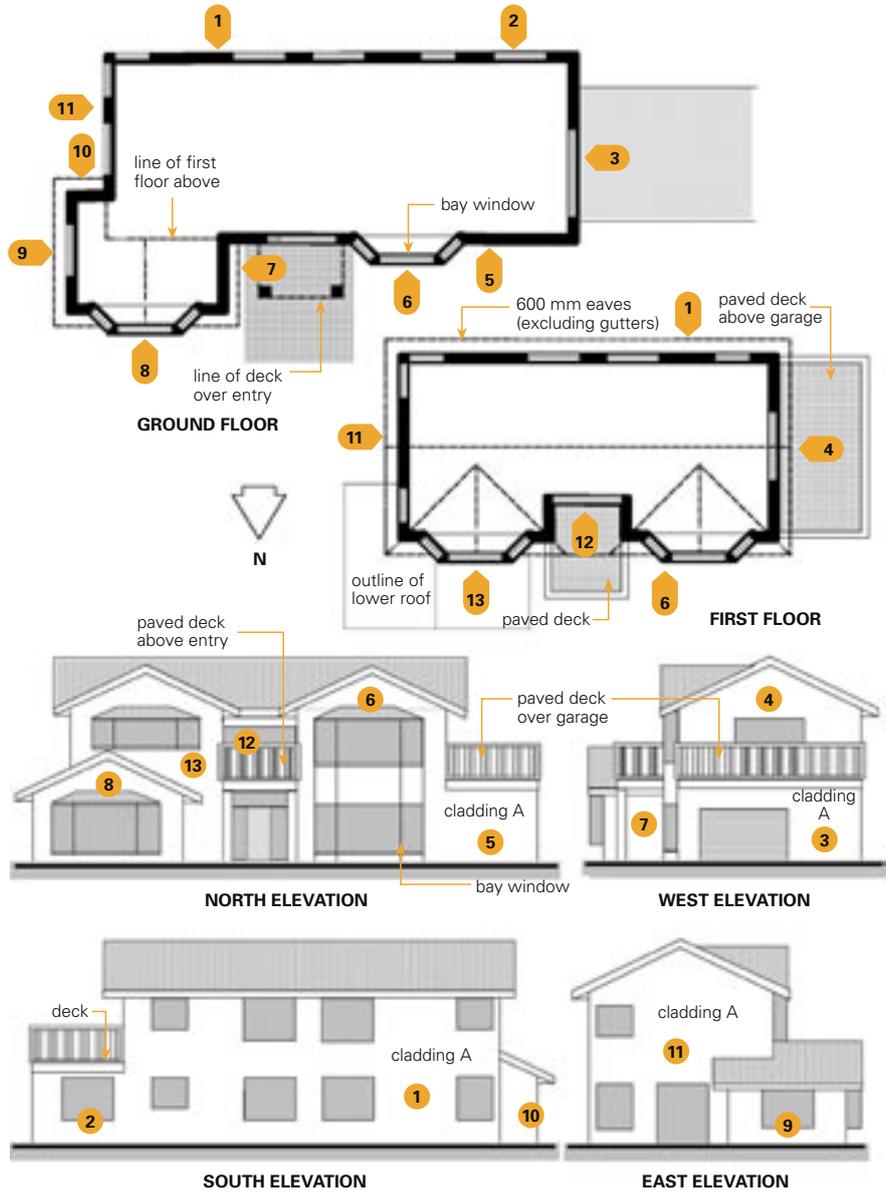
Elevation	Wall(s)	Score	Risk level	Suitable claddings (per E2/AS1 Table 3)	
				Direct fixed	Over cavity
WEST	6	7	Medium risk	Bevel-back timber weatherboards	Masonry veneer
SOUTH 1	7	9		Vertical timber board and batten	Stucco
NORTH	5	12		Vertical profiled metal – corrugated only	Horizontal profiled metal – corrugated and trapezoidal only Rusticated weatherboards Fibre-cement weatherboards Fibre-cement sheet Plywood sheet EIFS
SOUTH 2	8	13	High risk	Vertical profiled metal – corrugated only	Masonry veneer
EAST	1, 2, 3, 4	19			Horizontal profiled metal – corrugated and trapezoidal only Rusticated weatherboards Fibre-cement weatherboards Fibre-cement sheet Plywood sheet EIFS Bevel-back weatherboards

As a comparison, if a wall face approach is taken, walls are likely to be classified as follows:

Wall number	Score	Risk level
6	7	Medium risk
1	8	
7	9	
5	12	
4	13	High risk
8	13	
3	14	
2	16	

EXAMPLE 3: PLAN AND ELEVATIONS

Wind zone per NZS 3604 = High



Example 3: Completed risk matrix forms

(Wall face approach)

In this design, there are a number of areas where an elevation approach would lead to anomalies from transferring the higher risk score of one wall into another lower risk wall when the risk is not related. This can occur when an elevation contains walls at different planes, such as a single-storey lean-to and a two-storey wall with additional high risk factors. Some features will interact with a number of walls (such as the deck and balustrade above the garage in this example) and will need to be considered and scored in each.

(For this example, the assessments are completed generally in the order of the wall numbers.)

WALL NUMBER: 1 (SOUTH)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0		1		2	2	4		2
Roof/wall intersection design	0	0	1		3		5		0
Eaves width	0		1	1	2		5		1
Envelope complexity	0	0	1		3		6		0
Deck design	0		2	2	4		6		2
Total risk score:									6

Reasoning: Wall 1 is the two-storey portion of the south elevation. Eaves are wider than 600 mm, and this protects the top of the wall framing, leading to a low risk score for the roof/wall junction and a medium risk score for eaves width (as the eave is at the second-storey level).

The envelope complexity is considered to be low. The end of the wall adjoins an enclosed deck. As the deck affects only the end of the wall, it is considered that the deck risk factor should be medium (less than it would be if the deck projected from this wall).

The total risk score of 6 for this wall falls at the upper end of the low risk band of 0 to 6. Any increase in score will push the design into the medium risk band. This wall could include the garage wall 2; however, it is considered that a designer should have the option of splitting this elevation into 2 walls and treating the two walls in different ways if wished.

WALL NUMBER: 2, 3, 5 (SOUTH, WEST, NORTH)		RISK SEVERITY							
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0		1	1	3		5		1
Eaves width	0		1		2		5	5	5
Envelope complexity	0	0	1		3		6		0
Deck design	0	0	2		4	4	6		0
Total risk score:									7

Reasoning: Walls 2, 3 and 5 are the one-storey walls around the lined garage. They have a roof deck and no eaves, leading to medium risk scores for the partly exposed roof/wall junction and very high risk scores for eaves width.

Envelope complexity is considered to be low. The deck factor is low risk, as there is no deck attached to these walls (the roof deck has no effect if balustrades are side-fixed into walls).

The total risk score of 7 for this wall falls at the lower level of the medium risk band of 7 to 12. The total of the combined scores could increase by 5 without changing the overall risk classification. As discussed above, walls 2 and 5 may be considered together with wall 3 to allow the designer the option of treating these walls in a different manner from the neighbouring walls 1 and 6.

WALL NUMBER: 4 (WEST)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0		1		3	3	5		3
Eaves width	0		1	1	2		5		1
Envelope complexity	0		1		3	3	6		3
Deck design	0		2		4	4	6		4
Total risk score:									12

Reasoning: Wall 4 is the upper floor on the west elevation. Eaves are greater than 600 mm, which protects the top of the wall framing. However, the bottom of the wall intersects with the roof deck causing vulnerable junctions. This leads to a high risk score for the roof/wall junction and a medium risk score for eaves width (as the eave is at the second-storey level). Envelope complexity is considered to be high, due to the wall finishing within the boundaries of the lower floor. The roof deck makes the deck risk factor high.

The total risk score of 12 for this wall falls at the upper level of the medium risk band of 7 to 12. Any increase in the total combined scores will increase the overall risk classification.

WALL NUMBER: 6 (NORTH)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0		1		2	2	4		2
Roof/wall intersection design	0		1		3	3	5		3
Eaves width	0		1	1	2		5		1
Envelope complexity	0		1		3		6	6	6
Deck design	0		2		4	4	6		4
Total risk score:									17

Reasoning: Wall 6 is a two-storey portion of the north elevation. It is adjacent to paved decks at both ends, has a bay window and eaves greater than 600 mm, which protect the top of the wall framing. However, there are risky junctions with the roof over the bay window, so roof/wall junctions are classified as high risk. There is a medium risk score for eaves width (as the eave is at the second-storey level). The bay window is a risky feature and leads to a number of vulnerable junctions. Envelope complexity is therefore considered to be very high. The junctions with paved decks at first-floor level lead to deck design being classified as high risk.

The total risk score of 17 for this wall falls in the middle of the high risk band of 13 to 20. The total combined scores could decrease by 4 or increase by 3 without changing the overall risk classification.

WALL NUMBER: 7, 9, 10 (WEST, EAST, SOUTH)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0	0	1		3		5		0
Eaves width	0	0	1		2		5		0
Envelope complexity	0	0	1		3		6		0
Deck design	0	0	2		4		6		0
Total risk score:									1

Reasoning: Walls 7, 9 and 10 are the one-storey walls on the west, east and south elevations. Eaves are greater than 600 mm, which protects the top of the wall framing and leads to a low risk score for the roof/wall junction and a low risk score for eaves width (as the eave is at the first-storey level). Envelope complexity is considered to be low and there is no deck.

The total risk score of 1 for these walls falls well within the low risk band of 0 to 6. The combined total score of the factors could increase by up to 5 without changing the overall risk classification.

WALL NUMBER: 8 (NORTH)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0		1		3	3	5		3
Eaves width	0	0	1		2		5		0
Envelope complexity	0		1		3		6	6	6
Deck design	0	0	2		4		6		0
Total risk score:									10

Reasoning: Wall 8 is the one-storey portion of the north elevation. Eaves are greater than 600 mm, which protects the top of the wall framing. However, there are risky junctions with the roof over the bay window, so roof/wall junctions are classified as high risk. This leads to a high risk score for the roof/wall junction and a low risk score for eaves width (as the eave is at the first-storey level). Envelope complexity is considered to be very high, due to the bay window. There is no deck.

The total risk score of 10 for this wall falls within the medium risk band of 7 to 12. The combined total score of the factors could decrease by 3 or increase by 2 without changing the overall risk classification.

WALL NUMBER: 11 (EAST)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0		1		2	2	4		2
Roof/wall intersection design	0		1		3	3	5		3
Eaves width	0		1	1	2		5		1
Envelope complexity	0		1		3	3	6		3
Deck design	0	0	2		4		6		0
Total risk score:									10

Reasoning: Wall 11 is the two-storey wall on the east elevation. Eaves are greater than 600 mm, which protects the top of the wall framing. However, there is a risky junction with the lean-to roof, so roof/wall junctions are classified as high risk. This leads to a high risk score for the roof/wall junction and a medium risk score for eaves width (as the eave is at the second-storey level). Envelope complexity is considered to be high risk (due to the lean-to). There is no deck.

The total risk score of 10 for this wall falls within the medium risk band of 7 to 12. The combined total score of the factors could decrease by 3 or increase by 2 without changing the overall risk classification.

WALL NUMBER: 12 (NORTH)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0	0	1		3		5		0
Eaves width	0		1	1	2		5		1
Envelope complexity	0		1		3	3	6		3
Deck design	0		2	2	4		6		2
Total risk score:									7

Reasoning: Wall 12 is the single-storey recessed upper wall on the north elevation, along with the adjacent short walls. The deep roof overhang protects the wall framing. This leads to a low risk score for the roof/wall junction and a medium risk score for eaves width (as the eaves are at the second-storey level). Envelope complexity is considered to be high risk, due to the walls finishing within the boundaries of the floor below. The deck risk factor is considered to be medium, as the deck is protected by the roof.

The total risk score of 7 for this wall falls at the lower level of the medium risk band of 7 to 12. The combined total score of the factors could increase by 5 without changing the overall risk classification.

WALL NUMBER: 13 (NORTH)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0		1		2	2	4		2
Roof/wall intersection design	0		1		3		5	5	5
Eaves width	0		1	1	2		5		1
Envelope complexity	0		1		3		6	6	6
Deck design	0		2	2	4		6		2
Total risk score:									17

Reasoning: Wall 13 is the two-storey wall on the north elevation. Eaves are greater than 600 mm, which protects the top of the wall framing. However, there are risky junctions with the lower roof and with the roof of the bay window, leading to a very high risk score for the roof/wall junction and a medium risk score for eaves width (as the eave is at the second-storey level).

Envelope complexity is considered to be very high, due to the presence of a bay window and also the upper wall finishing within the boundaries of the lower floor. The presence of an adjacent paved deck at first-floor level leads to this factor being classified as medium risk, as the deck is protected by the roof.

The total risk score of 17 for this wall falls in the middle of the high risk band of 13 to 20. The combined total score of the factors could decrease by 4 or increase by 3 without changing the overall risk classification.

Summary (wall face approach):

For Example 3, wall scores and cladding options are as follows.

Wall number	Score	Risk level	Suitable claddings (per E2/AS1 Table 3)	
			Direct fixed	Over cavity
1 7 9 10	6 1 1 1	Low risk	Timber weatherboards – all types Fibre-cement weatherboards Vertical profiled metal – corrugated and symmetrical Fibre-cement sheet Plywood sheet EIFS	Masonry veneer Stucco Horizontal profiled metal – corrugated and trapezoidal only
2 3 5 4 8 11 12	7 7 7 12 10 10 7	Medium risk	Bevel-back timber weatherboards Vertical timber board and batten Vertical profiled metal – corrugated only	Masonry veneer Stucco Horizontal profiled metal – corrugated and trapezoidal only Rusticated weatherboards Fibre-cement weatherboards Fibre-cement sheet Plywood sheet EIFS
6 13	17 17	High risk	Vertical profiled metal – corrugated only	Masonry veneer Stucco Horizontal profiled metal – corrugated and trapezoidal only Rusticated weatherboards Fibre-cement weatherboards Fibre-cement sheet Plywood sheet EIFS Bevel-back weatherboards

Alternative elevation approach

ELEVATION: SOUTH (WALLS 1 AND 2)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0		1		2	2	4		2
Roof/wall intersection design	0		1	1	3		5		1
Eaves width	0		1		2		5	5	5
Envelope complexity	0	0	1		3		6		0
Deck design	0		2		4	4	6		4
Total risk score:									13

Reasoning: The south elevation is the mainly two-storey face including walls 1 and 2. Eaves above wall 1 are greater than 600 mm. Wall 2 is the one-storey wall of the garage, which has a roof deck and no eaves leading to a medium risk score for the partly exposed roof/wall junction and very high risk scores for eaves width.

The envelope complexity is considered to be low, but the exposed and enclosed roof deck at the first-floor level is considered high risk.

The total risk score of 13 falls just within the high risk band of 13 to 20. Any decrease in the total combined score would move the elevation into the low risk band.

West elevation:

The west elevation contains two walls on different planes: the one-storey garage Wall 3 and the upper-level, one-storey Wall 4. If a single assessment of the elevation were made, the resulting total risk score of 21 would lead to a requirement for specific design. This illustrates the way that risky areas of one wall face can be transferred to another when the risk does not apply, so over-weighting certain risk factors.

It is therefore considered that an elevation approach is not suitable for this particular elevation, as it would lead to anomalies by aggregating different risks that would not affect the other wall. The west elevation has therefore been split into west 1 and west 2.

ELEVATION: WEST 1 (WALL 3)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0		1	1	3		5		1
Eaves width	0		1		2		5	5	5
Envelope complexity	0	0	1		3		6		0
Deck design	0	0	2		4		6		0
Total risk score:									7

Reasoning: This part of the west elevation is the one-storey **Wall 3** of the garage. It has a roof deck and no eaves, leading to medium risk scores for the partly exposed roof/wall junction and very high risk scores for eaves width.

Envelope complexity is considered to be low. The deck factor is low risk, as there is no deck attached to these walls (the roof deck has no effect if balustrades are side-fixed into walls).

The total risk score of 7 for this wall falls at the lower level of the medium risk band of 7 to 12. The total combined score could increase by 5 without changing the overall risk classification.

ELEVATION: WEST 2 (WALL 4)	RISK SEVERITY								
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0		1		3	3	5		3
Eaves width	0		1	1	2		5		1
Envelope complexity	0		1		3	3	6		3
Deck design	0		2		4	4	6		4
Total risk score:									12

Reasoning: Wall 4 is the upper floor on the west elevation. Eaves are greater than 600 mm, which protects the top of the wall framing. However, the bottom of the wall intersects with the roof deck causing vulnerable junctions. This leads to a high risk score for the roof/wall junction and a medium risk score for eaves width (as the eave is at the second-storey level). Envelope complexity is considered to be high, due to the wall finishing within the boundaries of the lower floor. The roof deck makes the deck risk factor high.

The total risk score of 12 for this wall falls at the upper level of the medium risk band of 7 to 12. Any increase in scores will increase the overall risk classification.

North elevation:

Like the west elevation, the north elevation also contains walls on different planes: the one-storey Wall 8 and the remaining Walls 5, 6, 12 and 13.

It is therefore considered that the elevation approach should be modified for this particular elevation, to avoid anomalies from aggregating unrelated risks. In this case, the single-storey wall on the north elevation has therefore been separated as North 2 as it is on a different plane from the rest of the elevation.

ELEVATION: NORTH 1 (WALLS 5, 6, 12, 13)		RISK SEVERITY							
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0		1		2	2	4		2
Roof/wall intersection design	0		1		3		5	5	5
Eaves width	0		1		2		5	5	5
Envelope complexity	0		1		3		6	6	6
Deck design	0		2		4	4	6		4
Total risk score:									23

Reasoning: The north 1 elevation is the mainly two-storey face including Walls 5, 6, 12 and 13. Eaves above Walls 6, 12 and 13 are greater than 600 mm. Wall 5 is the one-storey wall of the garage, which has a roof deck and no eaves leading to very high risk scores for eaves width.

There are risky junctions with roofs over the two bay windows and with the lower roof on wall 13, leading to a very high risk score for roof/wall junctions.

Envelope complexity is considered to be very high for this elevation due to the bay windows and the recessed deck on the upper level.

The deck risk factor is also considered to be high due to the latter deck along with the roof deck above the garage.

The total combined risk score of 23 would result in this elevation requiring specific design.

ELEVATION: NORTH 2 (WALLS 7 AND 8)		RISK SEVERITY							
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0	0	1		2		4		0
Roof/wall intersection design	0		1		3	3	5		3
Eaves width	0	0	1		2		5		0
Envelope complexity	0		1		3		6	6	6
Deck design	0	0	2		4		6		0
Total risk score:									10

Reasoning: The north 2 elevation includes the one-storey **Walls 7 and 8**. Eaves are greater than 600 mm, which protects the top of the wall framing and leads to a low risk score for eaves width (as the eave is at the first-storey level). However, there are risky junctions with the roof over the bay window leading to a high risk score for roof/wall intersections.

Envelope complexity is considered to be very high, due to the bay window, and there are no decks.

The total risk score of 10 falls within the medium risk band of 7 to 12. The total combined score of the factors could decrease by 3 or increase by 2 without changing the overall risk classification.

ELEVATION: EAST (WALLS 9, 10 AND 11)		RISK SEVERITY							
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1	1	2		1
Number of storeys	0		1		2	2	4		2
Roof/wall intersection design	0		1		3	3	5		3
Eaves width	0		1	1	2		5		1
Envelope complexity	0		1		3	3	6		3
Deck design	0	0	2		4		6		0
Total risk score:									10

Reasoning: The east elevation includes the two-storey **Wall 11** and the one-storey **Walls 9 and 10**. Eaves are greater than 600 mm, which protects the top of the wall framing. However, there is a risky junction with the lean-to roof, so roof/wall junctions are classified as high risk. This leads to a high risk score for the roof/wall junction and a medium risk score for eaves width (as most eaves are at the second-storey level). Envelope complexity is considered to be high risk (due to the lean-to) and there is no deck.

The total risk score of 10 for this elevation falls within the medium risk band of 7 to 12. The total combined score of the factors could decrease by 3 or increase by 2 without changing the overall risk classification.

Comparison of the approaches

The following shows the possible change in risk scores resulting from the different approaches.

Elevation	Wall number	ELEVATION FACE APPROACH		WALL FACE APPROACH		Change in risk level
		Risk scores	Risk levels	Risk scores	Risk levels	
SOUTH	1	13	High	6	Low	2 levels
	2		High	7	Medium	1 level
WEST						
West 1	3	7	Medium	7	Medium	
West 2	4	12	Medium	12	Medium	
NORTH						
North 1	5	23	Specific design	7	Medium	3 levels
	6		Specific design	17	High	2 levels
	12		Specific design	7	Medium	3 levels
	13		Specific design	17	High	2 levels
North 2	7	10	Medium	1	Low	1 level
	8		Medium	10	Medium	
EAST	9	10	Medium	1	Low	1 level
	10		Medium	1	Low	1 level
	11		Medium	10	Medium	

This comparison shows the effect of transferring risks relevant to one wall to another possibly unrelated wall for some types of design.

While the elevation approach may be suitable for many designs, care should be taken that it is not automatically applied to all designs.

Appendix 2: Reference tables

Reference tables and blank forms

E2/AS1 TABLE 1: DEFINITIONS OF RISK		
A: Wind zone	Low risk	Low wind zone as described by NZS 3604
	Medium risk	Medium wind zone as described by NZS 3604
	High risk	High wind zone as described by NZS 3604
	Very high risk	Very high wind zone as described by NZS 3604
B: Number of storeys	Low risk	One storey
	Medium risk	Two storeys in part
	High risk	Two storeys
	Very high risk	More than two storeys
C: Roof/wall intersection design	Low risk	Roof-to-wall intersection fully protected (eg, hip and gable roof with eaves)
	Medium risk	Roof-to-wall intersection partly exposed (eg, hip and gable roof with no eaves)
	High risk	Roof-to-wall intersection fully exposed (eg, parapets, enclosed balustrades or eaves at greater than 90° to vertical with soffit lining)
	Very high risk	Roof elements finishing within the boundaries formed by the exterior walls (eg, lower ends of aprons, chimneys, dormers etc.)
D: Eaves width ^{(1) (2)}	Low risk	Greater than 600 mm for single storey
	Medium risk	451-600 mm for single storey, or over 600 mm for two storey
	High risk	101-450 mm for single storey, or 451-600 mm for two storey, or greater than 600 mm above two storey
	Very high risk	0-100 mm for single storey, or 0-450 mm for two storey, or less than 600 mm above two storey
E: Envelope complexity	Low risk	Simple rectangular, L, T or boomerang shape, with single cladding type
	Medium risk	Moderately complex, angular or curved shapes (eg, Y or arrowhead) with no more than two cladding types
	High risk	Complex, angular or curved shapes (eg, Y or arrowhead) shapes with multiple cladding types
	Very high risk	As for High risk, but with junctions not covered in C or F (eg, box windows, pergolas, multi-storey re-entrant shapes etc)
F: Deck design ⁽³⁾	Low risk	None, timber slat deck or porch at ground-floor level
	Medium risk	Fully covered in plan by roof, or timber slat deck attached at first- or second-floor level
	High risk	Enclosed deck exposed in plan or cantilevered at first-floor level
	Very high risk	Enclosed deck exposed in plan or cantilevered at second-floor level or above
NOTES: (1) Eaves width measured horizontally from external face of wall cladding to outer edge of overhang, including gutters and fascias. (2) Balustrades and parapets count as 0 mm eaves. (3) The term deck includes balconies, as described in the Definitions for E2/AS1.		

RISK FACTORS A TO C AND E								
Risk levels	A: Wind zone	score	B: Number of storeys	score	C: Roof/wall intersection design	score	E: Envelope complexity	score
Low risk	Low wind zone	0	One storey	0	Fully protected	0	Simple	0
Medium risk	Medium wind zone	0	Two storeys in part	1	Partly exposed	1	Moderate	1
High risk	High wind zone	1	Two storeys	2	Fully exposed	3	Complex	3
Very high risk	Very high wind zone	2	More than two storeys	4	Within boundaries of lower walls	5	Very complex	6
	<i>(as per NZS 3604)</i>		<i>(refer to section 4, page 10)</i>		<i>(refer to section 5, page 11)</i>		<i>(refer to section 6, page 15)</i>	

D: EAVES WIDTH				
Risk levels	score	One storey	Two storeys	Three storeys
Low risk	0	> 600 mm		
Medium risk	1	451 to 600 mm	> 600 mm	
High risk	2	101 to 450 mm	451 to 600 mm	> 600 mm
Very high risk	5	≤100 mm	101 to 450 mm	451 to 600 mm

F: SPACED TIMBER DECKS				
Risk levels	score	Deck extends from or attached at:		
		Ground floor	First floor	Second floor
Low risk	0	Timber slat deck – non-cantilevered	Timber slat deck – junction fully protected by roof	Timber slat deck – junction fully protected by roof
Medium risk	2		Timber slat deck – non-cantilevered	Timber slat deck – non-cantilevered
High risk	4		Timber slat deck – cantilevered	
Very high risk	6			Timber slat deck – cantilevered

F: ENCLOSED DECKS				
Risk levels	score	Deck extends from or attached at:		
		Ground floor	First floor	Second floor
Low risk	0	Enclosed deck – junction fully protected by roof		
Medium risk	2	Enclosed deck – junction exposed to rain	Enclosed deck – junction fully protected by roof	Enclosed deck – junction fully protected by roof
High risk	4	Enclosed deck – cantilevered	Enclosed deck – junction exposed to rain or cantilevered	
Very high risk	6		Enclosed deck – junction exposed to rain and cantilevered	Enclosed deck – junction exposed to rain and/or cantilevered

Blank risk matrix forms

ELEVATION OR WALL:		RISK SEVERITY							
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1		2		
Number of storeys	0		1		2		4		
Roof/wall intersection design	0		1		3		5		
Eaves width	0		1		2		5		
Envelope complexity	0		1		3		6		
Deck design	0		2		4		6		
Total risk score:									

ELEVATION OR WALL:		RISK SEVERITY							
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1		2		
Number of storeys	0		1		2		4		
Roof/wall intersection design	0		1		3		5		
Eaves width	0		1		2		5		
Envelope complexity	0		1		3		6		
Deck design	0		2		4		6		
Total risk score:									

ELEVATION OR WALL:		RISK SEVERITY							
Risk factor	Low		Medium		High		Very high		Subtotals for each risk factor
Wind zone	0		0		1		2		
Number of storeys	0		1		2		4		
Roof/wall intersection design	0		1		3		5		
Eaves width	0		1		2		5		
Envelope complexity	0		1		3		6		
Deck design	0		2		4		6		
Total risk score:									



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