Department of Building and Housing
Te Tari Kaupapa Whare

Solar water heaters – Guidance for suppliers, installers and building consent authorities

This Guidance is intended to be read in conjunction with Acceptable Solution G12/AS2

December 2009

Contents

Foreword

In December 2007, a new Acceptable Solution for solar water heating (G12/AS2) came into effect which brought together the requirements of the relevant Building Code performance criteria into a single document.

To facilitate the installation of solar water heaters beyond the scope of G12/AS2, the Department of Building and Housing has worked with the Energy Efficiency and Conservation Authority (EECA), industry and building consent authorities (BCAs) to develop this Guidance. The aim of this Guidance is to streamline and simplify the consenting process for solar water heaters through improving the understanding of the Building Code performance criteria related to solar water heaters, and providing a framework for preparing and assessing alternative solutions.

The Department has committed to monitor the effectiveness of this Guidance, to determine how useful it is for industry and building consent authorities. After a suitable evaluation period, several options will be considered including replacing the current Acceptable Solution for Solar Water Heaters with appropriate guidance material.

Purpose of this document

This Guidance aims to help suppliers, installers and building consent authorities to better understand the Building Code performance criteria for solar water heaters. It provides a range of options as possible performance-based solutions and helps readers to design and evaluate specific 'performance-based' solutions (alternative solutions) for themselves.

This Guidance has been prepared in consultation with building consent authorities and industry. It aims to offer potential ways to resolve issues identified by solar water heater suppliers and installers.

This Guidance is issued as guidance information under section 175 of the Building Act 2004. It is not a Compliance Document and it is not mandatory for BCAs to accept the methods described in this Guidance as a way of establishing compliance with the relevant clauses of the Building Code. This document may be updated from time-to-time and the latest version is available from the Department's website at www.dbh.govt.nz.

Introduction

Background

In December 2007, an Acceptable Solution for solar water heaters (G12/AS2) came into effect. G12/AS2 provides a non-mandatory way for solar water heater installations to comply with the New Zealand Building Code. It also resolved some problems with solar water heating installations identified in a 2007 BRANZ report titled *An Inspection of Solar Water Heating Installations*.

Industry feedback

The Department has received feedback from the solar water heating industry and other stakeholders about the Acceptable Solution for solar water heaters (G12/AS2). Suppliers and industry groups have provided the following feedback on G12/AS2:

- The scope is not broad enough because it excludes solar water heaters with solar collectors larger than $4m^2$.
- The materials specified for solar collector frames show one non-mandatory way to demonstrate compliance with the New Zealand Building Code. Solar water heater suppliers often use other materials and designs which may also achieve the New Zealand Building Code performance criteria for Structure (B1) and Durability (B2).
- The inclination requirements (angle of the solar collector) are challenging for installations on low pitched roofs in the southern parts of New Zealand (higher latitudes). The complexity of changing the inclination angle of the solar collector outweighs the benefit of increased performance in some cases.
- The additional retesting of solar water heaters to Australian/New Zealand Standards that have previously been tested to European Standards, adds unnecessary compliance cost.

Response to the feedback

The Department considered stakeholder feedback and as a result has published this Guidance to suggest a way forward to resolve these issues. The aim of this Guidance is to provide guidance on how the relevant Building Code performance criteria can be achieved for solar water heater installations that are outside the scope of G12/AS2. This Guidance aims to demonstrate and explain ways for building consent authorities (BCAs) to assess alternative solution proposals. This is shown diagrammatically in Figure 1 below.

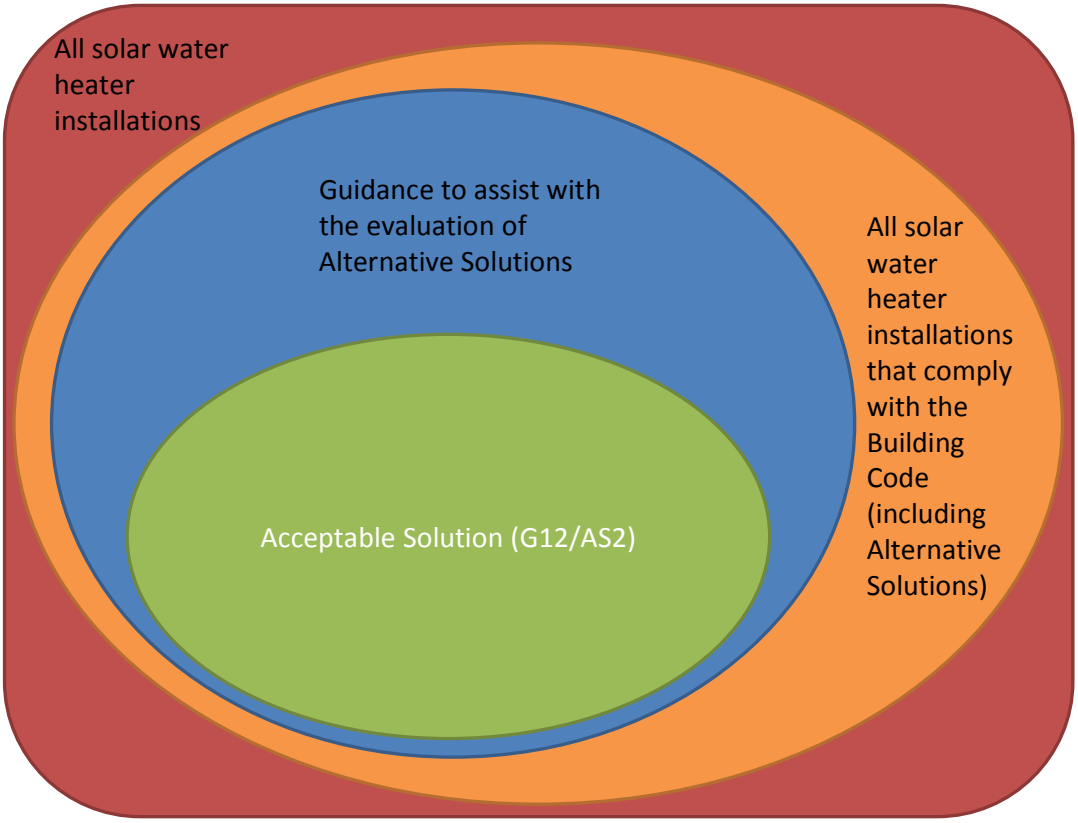

Figure 1: The aim of this Guidance

The Department will work with industry and other stakeholders to provide practical education on how to apply the guidance for maximum effect.

The Department is interested in hearing from all stakeholders about the effectiveness of this Guidance. Please contact the Department on 0800 242 243 to provide any feedback.

The building controls regime

Overview

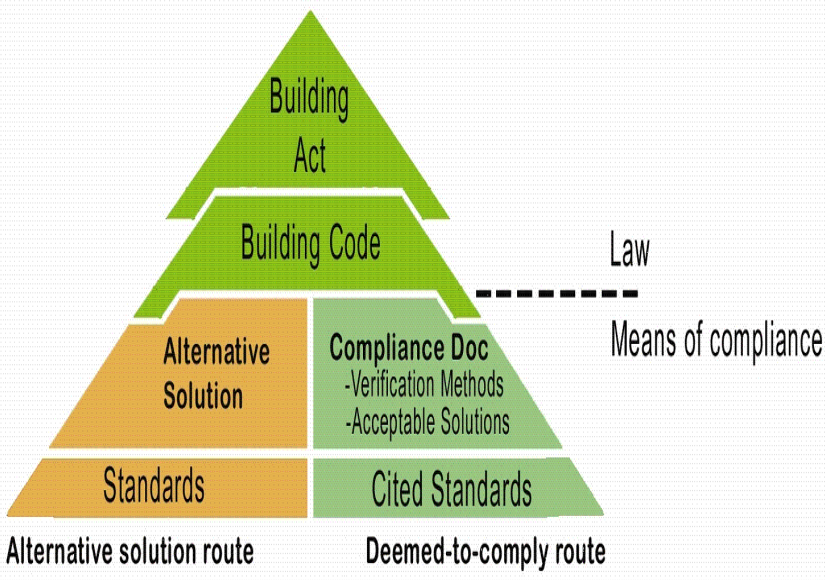

Figure 2: The building controls regime

Figure 2 shows the structure of the building controls regime. It is a hierarchical structure, therefore the Building Act 2004 takes precedence over the Building Code. The Building Act and the Building Code form the mandatory parts of the building controls regime.

Compliance Documents describe one way to comply with the performance criteria in the Building Code. Using Compliance Documents is not the only way to demonstrate compliance with the Building Code, however, the Building Act states that methods described in Compliance Documents must be accepted by building consent authorities as achieving the performance criteria described in the Building Code.

Building Act - Purpose and Principles

Section 3 of the Building Act describes the purpose of the Building Act. This includes criteria to ensure that: “buildings are designed, constructed, and able to be used in ways that promote sustainable development.” Installing solar water heaters is one way to contribute to this criteria.

In achieving the purpose of the Building Act, 16 principles must be taken into account. These principles are described in section 4 of the Building Act. The principle most relevant to solar water heating is “the need to facilitate the efficient use of energy and energy conservation and the use of renewable sources of energy in buildings”.

Another principle also important when considering innovative solutions like solar water heating is: “the importance of allowing for continuing innovation in methods of building design and construction”. This principle is important in terms of the Building Act recognising that not every solution will be described in Compliance Documents, however, Alternative Solutions should be considered and evaluated in terms of the performance criteria in the Building Code.

How to comply with the Building Code

Compliance with the Building Code can be established in the following ways:

- Acceptable Solutions
- Verification Methods
- Product Certification
- alternative solutions
- determinations.

The Building Act and Compliance Documents

The Building Act states that by following a Compliance Document users are deemed to comply with the Building Code. Section 22(2) of the Building Act states: “A person who complies with a compliance document must, for the purposes of this Act, be treated as having complied with the provisions of the building code to which the document relates”.

The Building Act also states that there are ways other than following a Compliance Document to establish compliance with the Building Code. Section 23 of the Building Act states: “A person may comply with a compliance document in order to comply with the provisions of the building code to which the document relates, but doing so is not the only means of complying with those provisions”.

The Building Code

The Building Code is in Schedule 1 of the Building Regulations 1992. Copies of each Building Code clause are included in the front of the Compliance Document that directly relate to specific Building Code clauses.

The Building Code clauses relevant to solar water heaters are listed on page 11 of this Guidance.

Each Building Code clause includes an objective, a functional requirement and performance criteria.

Acceptable Solutions

Acceptable Solutions:

- are not mandatory
- must be used within their scope and limits
- are generic solutions and do not include proprietary systems, products or company names
- are often conservative because they are deemed to comply with the Building Code
- describe only one way to demonstrate compliance with the Building Code

Alternative solutions

An alternative solution is: a design (of all or part of a building) that complies with one or more requirements of the Building Code, but does not follow the solutions provided by the Compliance Documents. It can include a material, component or construction method that differs completely or partially from those described in the Compliance Documents. It can be a minor variation from a Compliance Document, or a radically different design and construction approach.

Not everyone wants a 'one size fits all' building solution. A building owner may want something that looks different or performs better, is more cost effective, or overcomes a specific site problem. There may not be a Compliance Document for the proposed construction. Whatever the reason, a non-generic approach to building design and construction is often desired or required.

The Building Code is performance-based, and says how a building must perform once built instead of prescribing how it must be built. It therefore allows for innovation and unique situations. This enables designers the freedom to come up with proposals for innovative solutions that provide the best outcome for each project but still meet the requirements of the Building Code.

Designers and BCAs have important roles to play in the use of alternative solutions. Discussion early in the design process will clarify expectations. The designer needs to know what information and evidence the BCA will expect, and the BCA needs a clear understanding of what the building consent applicant is trying to achieve. The designer must provide documented evidence demonstrating that the proposed building work, when built, will comply with the Building Code.

For more information on alternative solution proposals go to: www.dbh.govt.nz/blc-alternative-solutions

Options to satisfy the performance requirements of the Building Code

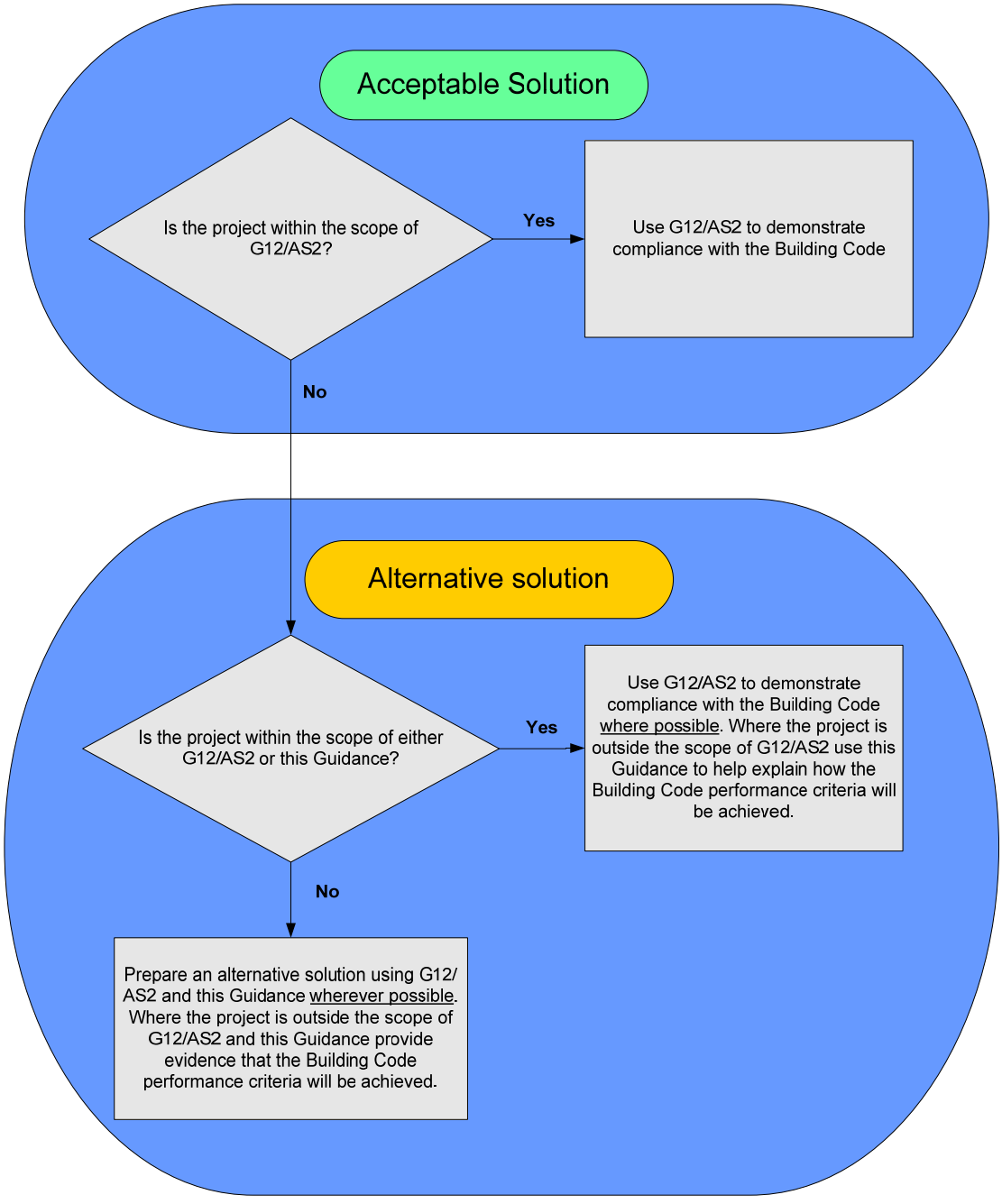

Figure 3: Ways to demonstrate that the Building Code performance criteria are met

Building Code clauses related to solar water heaters

Relevant Building Code clauses

Solar water heaters installations are required to meet the performance criteria described in the Building Code. The relevant Building Code clauses are:

- B1 Structure
- B2 Durability
- E2 External moisture
- F2 Hazardous substances and processes
- G9 Electricity
- G12 Water supplies
- H1 Energy efficiency

Some of these clauses may not apply for all installations. For example, F2 Hazardous substances and processes may not always apply because some solar water heater installations will not involve the use of hazardous materials.

The objectives, functional requirements and performance criteria for each of these Building Code clauses are included in the relevant Compliance Documents for each of these clauses. The objectives of each of these Building Code clauses are summarised in Table 1 below:

Table 1: Building Code clauses and objectives relevant to solar water heaters

Building Code clause		Summarised objectives
B1	Structure	Protect people from injury or loss of amenity and protect other property from damage caused by structural failure.
B2	Durability	Ensure that throughout a building's life it will satisfy the other objectives of the Building Code i.e. continue to work.
E2	External moisture	Protect people from illness or injury caused by external moisture entering the building.
F2	Hazardous substances and processes	Protect people from illness or injury and other property from damage caused by exposure to hazardous building materials.
G9	Electricity	Protect people from fire and injury caused by electrical installations.
G12	Water supplies	Protect people from illness or injury or loss of amenity caused by water systems.
H1	Energy efficiency	Facilitate the efficient use of energy (sourced from a network utility operator or a depletable energy resource).

1. Structure (B1)

a) Background

The Acceptable Solution for solar water heaters (G12/AS2) is limited to solar collectors with an area no larger than $4m^2$. Many consumers want higher capacity solar water heaters and this often means that larger solar collectors are required. In response to this issue the Department has developed this Guidance describing how solar collectors larger than $4m^2$ can be installed safely on roofs.

The ability of a building to support a solar collector depends on the system characteristics and the building design. This Guidance provides information on how solar collectors can be installed on buildings built to a wider range of structural Standards, than those included in G12/AS2.

b) Principles

The Building Code clause B1 objectives for structure aim to:

1. *Protect people from injury as a result of structural failure.* For solar water heating this means: protecting against the building or roof collapsing as a result of a solar collector being installed and causing injury to the occupants, and protecting against solar collectors (or parts) blowing from a roof and causing injury.
2. *Protect people from loss of amenity as a result of deformation of the structure*. For solar water heaters this means protecting against the roof of a building deflecting (beyond reasonable limits) as a consequence of a solar collector being installed. This deformation could have an impact on the weathertightness of the building either by causing gaps in the roof cladding or changing the way water runs off the cladding. If deformations like this caused leaks this could result in loss of amenity or use of the building.
3. *Protect other property from damage caused by structural failure.* For solar water heaters this means: protecting against solar collectors blowing from a roof and causing damage to another building, and projecting against the collapse of the roof and damaging other property.

c) Guidance

Scope and limitations

The scope of this Guidance is limited to the installation of solar collectors on timber framed roofs, which meet the criteria in Table 2 below and the site and installation conditions listed. It is important that the roof structure is examined to determine the most appropriate solution for installing a solar collector.

Table 2: Structural requirements of this Guidance for roofs supporting solar collectors

Structural design Standard for roof	**Maximum member span (see Figure 4) for a range of rafter or top chord of truss sizes**		**Maximum weight per support point**	**Maximum weight of solar collector (including fluid) divided by area of supporting roof (see Figure 5)**
NZS 1900 Chapter 6.1:1964 (including amendments 1 to 5) NZS 3604:1978 NZS 3604:1981 NZS 3604:1984 NZS 3604:1990 NZS 3604:1999	Rafter or top chord of truss sizes (mm)	Maximum member span (mm)	30 kg	15 kg/m^2
	70 x 35	1200		
	90 x 35	1400		
	75 x 40	1400		
	70 x 45	1400		
	75 x 50	1800		
	90 x 45	1800		
	100 x 40	1800		
	Larger Rafters	2000		
NZS 4203:1984 NZS 4203:1992 AS/NZS 1170 Parts 0, 1 & 2:2002, Part 3:2003 and NZS 1170 Part 5:2004	See size and span requirements for various fixing options		50 kg	15 kg/m^2

The member span is the distance between the centres of the supporting members, as shown in Figure 4.

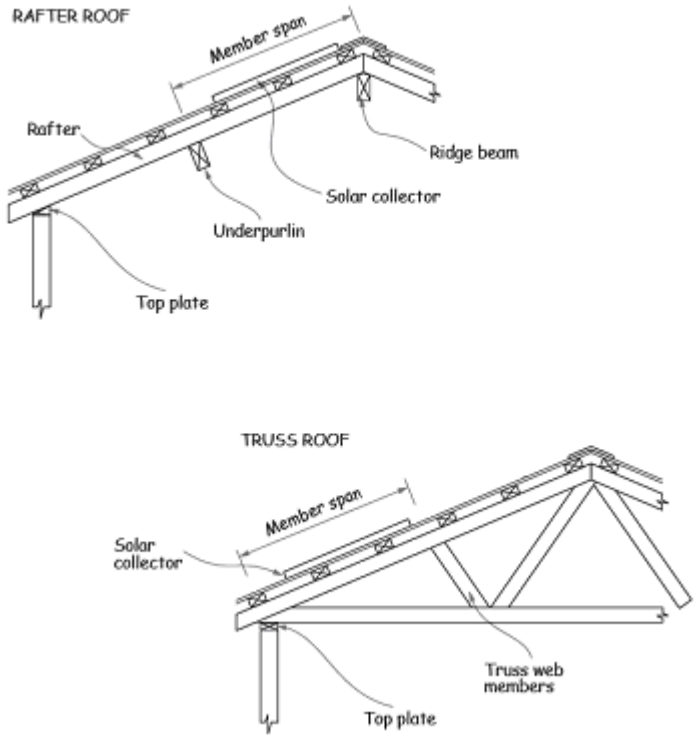

Figure 4: Member spans

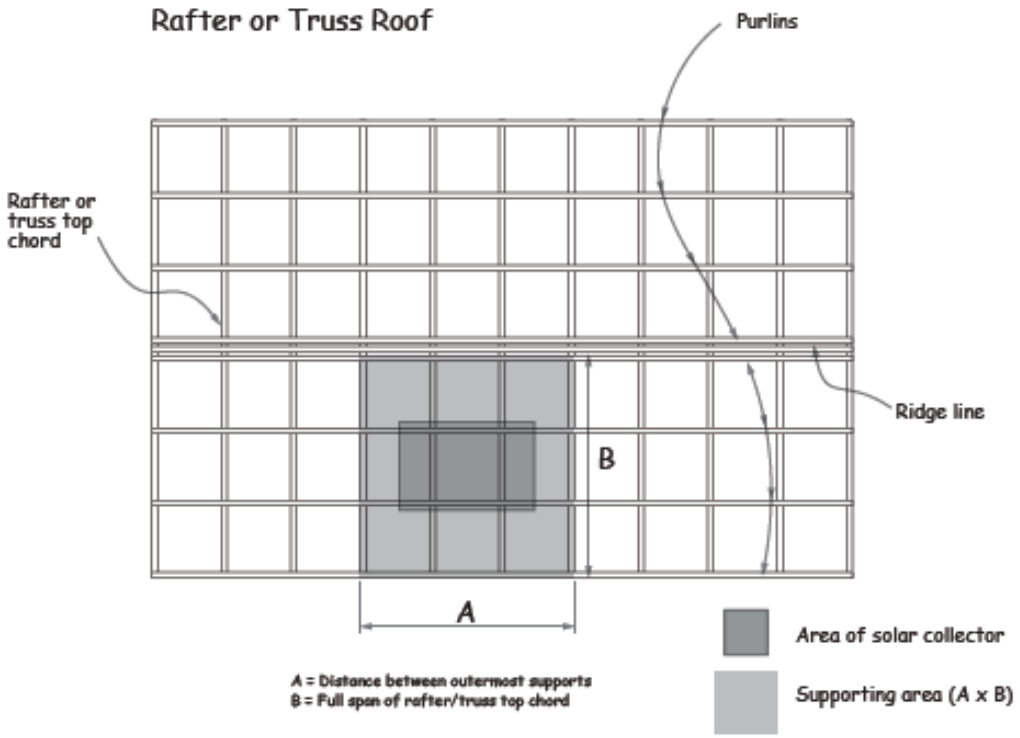

Figure 5: Solar collector supporting area

Note:

1. The total weight of the solar collector (including fittings and working fluid) divided by the roof area supporting the solar collector should not exceed 15 kg/m^2.

2. The roof area supporting the solar collector is the full span of the supporting rafters or truss top chords, multiplied by the distance across the roof between the two outermost rafters or truss top chords supporting the solar collector.

3. The following information is required to demonstrate that this loading requirement is achieved:

    - a simple sketch showing: the location and size of the solar collector; the size and spacing of the rafters; and the size and spacing of the purlins, and
    - a calculation showing the weight of the solar collector divided by the support area.

Site and installation conditions

The hot water storage tank should not be installed on or above the roof.

If the hot water storage tank is installed in the attic space, it should have a maximum size of either: 200 litres if installed according to NZS 3604:1999 Section 13.4; or 450 litres if installed according to AS/NZS 3500 Part 4:2003 Section 5.

The roof should have a pitch no steeper than 45°.

The building should not be in a wind zone where the ultimate limit state design wind speed exceeds 50 m/s (VH Building Wind Zone defined in NZS 3604:1999).

The design snow loading for the building should be less than 0.5 kPa as determined by NZS 3604:1999.

If the solar collector is installed at a different pitch to the pitch of the roof cladding then the solar collector should:

- face in the same compass direction as the section of the roof that it is fixed to, and
- be installed at a pitch no steeper than 45°.

General requirements

Solar collectors should have at least four fixing points connecting the solar collector to the building. The outermost fixings should be within 200 mm of the outside edge of the solar collector.

The solar collector should ideally be positioned centrally on a roof plane. The solar collector should not be located adjacent to eaves, ridge lines or roof edges.

The roof framing should not be reduced in strength except as a result of drilling for bolts or screws to fix the solar collector to the roof.

All fixings into timber roof framing should have minimum distances from the centre of the fixing to the edge of the timber roof framing of:

- 20 mm for 8 gauge screws
- 25 mm for 14 gauge screws
- 40 mm for 10 mm bolts.

Options for fixing solar collectors to roofs

There are two decisions that must be made which influence how the solar collector can be fixed to the roof of a house:

1. *Will the solar collector be installed parallel to the roof cladding or will the solar collector be installed at a different pitch from the roof cladding?*

   This decision is influenced by the orientation of the roof and the desired trade-off between optimal performance and installation costs. See section 7 of this Guidance for information about the relationship between solar collector performance and orientation and inclination.

   Installations where the solar collectors are parallel to the roof cladding are described in sections i, ii and iii. Installations where the solar collectors are installed at a different angle from the roof cladding are described in sections iv and v of this Guidance.

2. *Will the solar collector be installed adjacent to the roof cladding or will it be elevated above the cladding?*

   This decision is influenced by the cladding material installed and to some extent the age of the cladding material. Some cladding materials need regular washing and require solar collectors to be elevated above the cladding to allow washing of the cladding material with a brush. Not meeting this requirement may have an impact on the warranty of the roof cladding material. Contact the roof cladding manufacturer for specific advice.

   Installations where the solar collectors are fixed adjacent to the roof cladding are described in section i. of this Guidance. Installations where solar collectors are elevated above the roof cladding are described in sections ii. and iii.

i. Direct fixed (adjacent) solar collectors parallel to the roof

Flat plate solar collectors may be fixed directly to roofs as shown in Figures 6 and 7. Evacuated tube solar collectors may be fixed directly to roofs as shown in Figures 8 and 9. Note that spacers are often required to separate incompatible materials (see Tables 1, 2 and 3 in G12/AS2).

Solar collectors fixed directly to the roof should be fixed into purlins 70 x 45 mm or larger with no fewer than 4, 8 gauge (4 mm) screws.

Some roof cladding materials need regular washing. Roof cladding suppliers can provide specific advice. If the roof cladding material needs regular washing the solar collectors may need to be elevated above the roof cladding.

(Installations involving elevated solar collectors are described in sections ii and iii below)

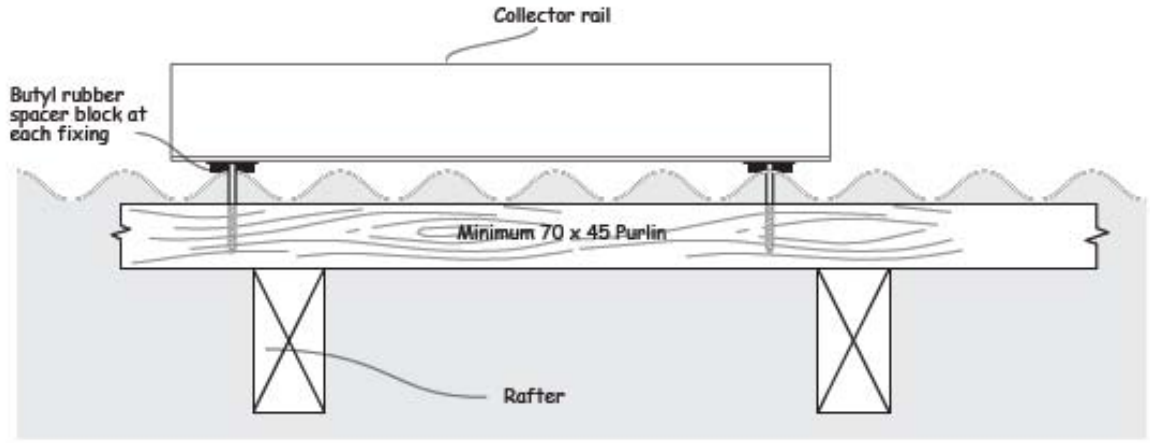

Figure 6: Direct fixed flat plate solar collector (section-view)

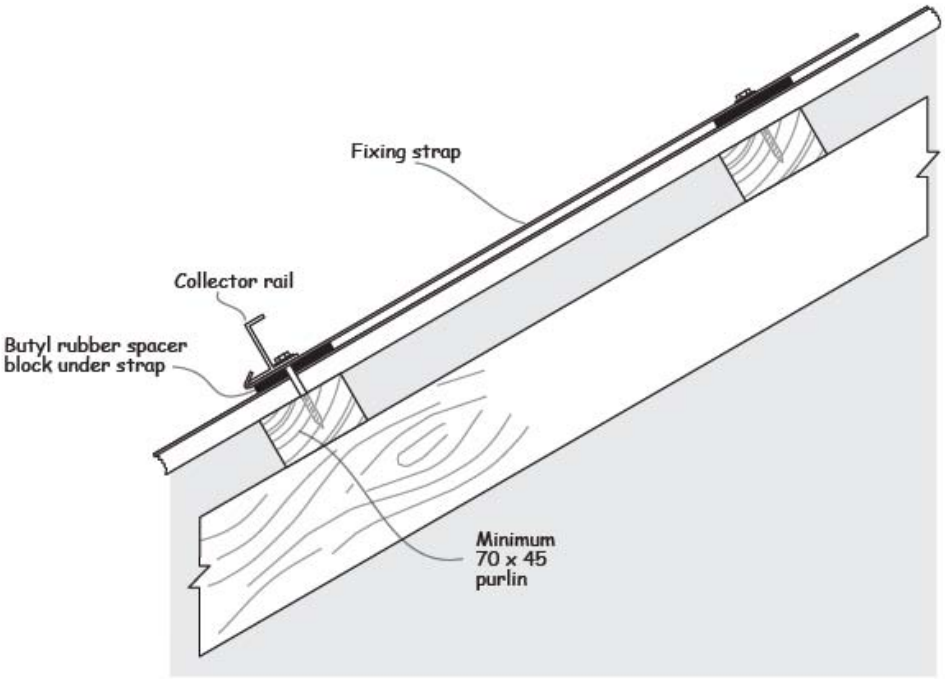

Figure 7: Direct fixed flat plate solar collector (elevation view).

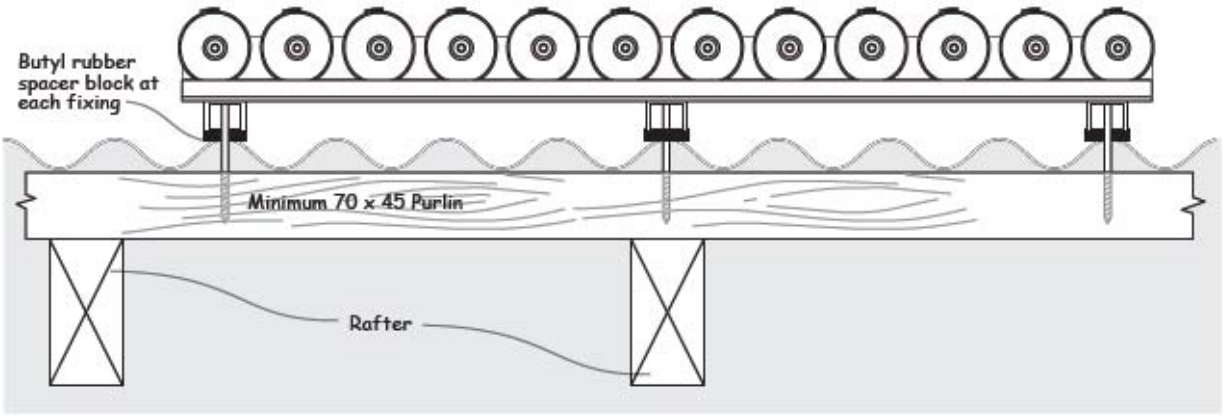

Figure 8: Direct fixed evacuated tube solar collector (section view)

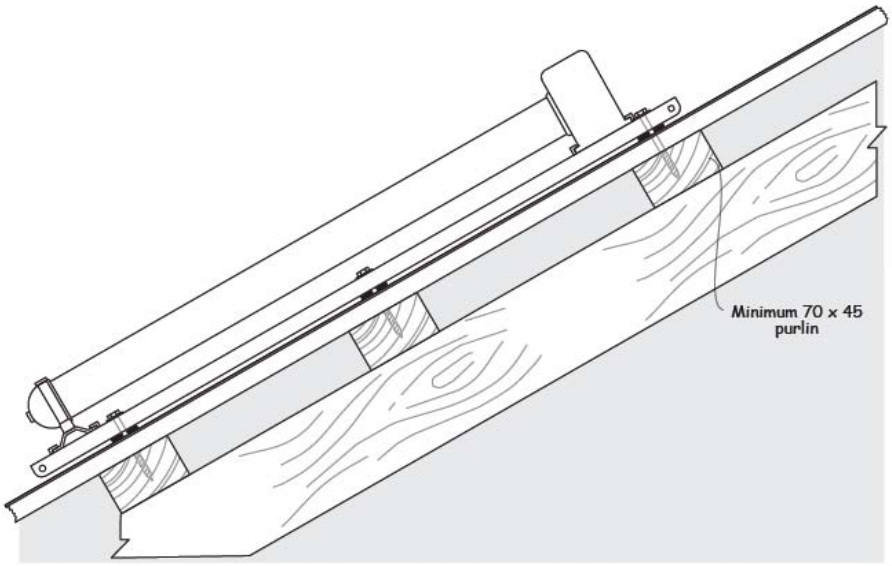

Figure 9: Direct fixed evacuated tube solar collector (elevation view)

ii. Elevated solar collector panels parallel to the roof

Solar collector panels mounted parallel to the roof that are elevated up to 50 mm above the roof cladding, may be fixed:

(a) as shown in Figure 10, with 14 gauge screws into:
  (i) purlins 70 x 45 mm or larger on their flat, that span no more than 900 mm, or
  (ii) rafters or truss top chords 90 x 45 mm or larger, or

(b) as shown in Figure 11, with 10 mm bolts to purlins 90 x 45 mm or larger on their flat spanning no more than 900 mm, or

(c) as shown in Figure 12, with 12 mm bolts welded to 3 mm plate, and screw fixed to rafters or truss top chords 90 x 45 mm or larger, or

(d) to collector support rails as described in section ii. below.

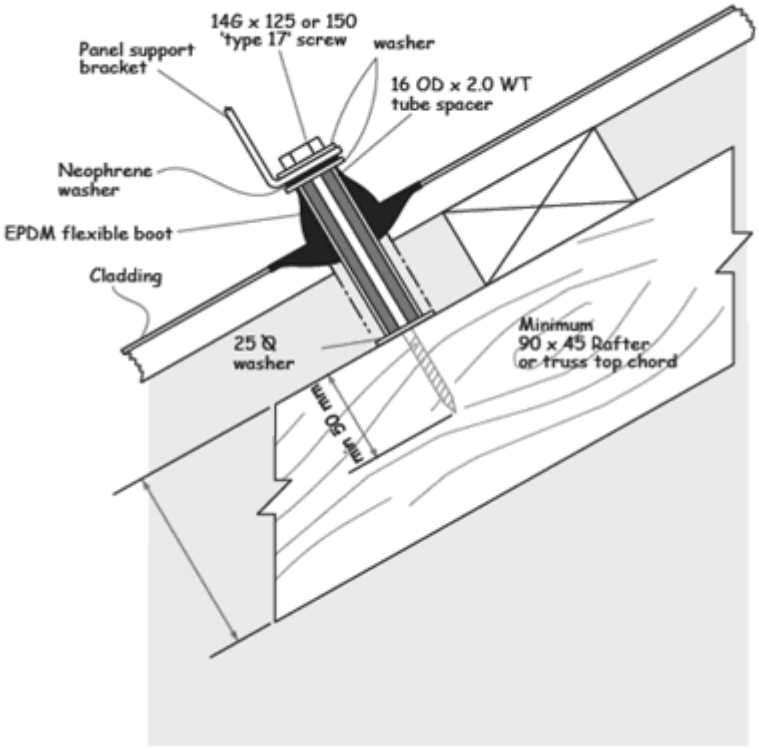

Figure 10: Screw fixing

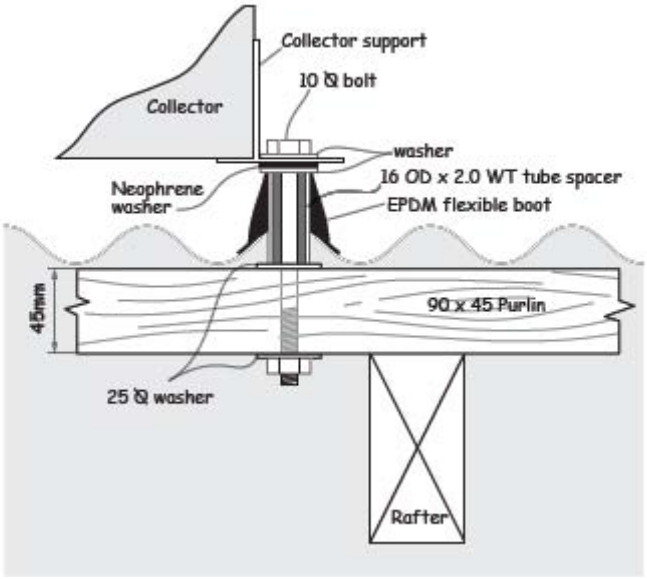

Figure 11: Bolt fixing

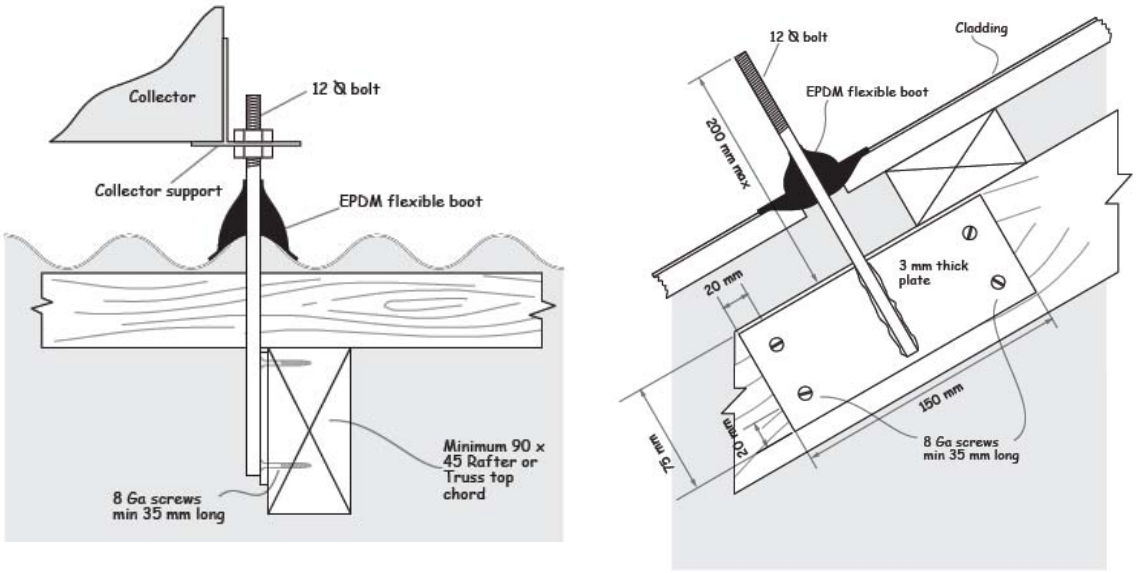

Figure 12: Stud fixing

iii. Collector support rails (elevated)

Collector support rails should be in one piece and may be mild steel angles with dimensions determined by either Table 3 or Table 4 (as appropriate), or other material with equivalent strength and stiffness.

Collector support rails running horizontally across the slope of the roof, as shown in Figure 13, should span the outermost rafters or trusses that support the solar collector.

Collector support rails running horizontally across the roof slope, as shown in Figure 13, should be fixed to either:

(a) each rafter or truss top chord that they cross using the details given in Figures 10 or 12, or

(b) purlins at not more than 1500 mm centres and within 300 mm of each end of the collector support rails using the connection details shown in Figures 10 or 11. The purlins must be a minimum size of 90 x 45 mm on their flat and span a maximum of 900 mm.

Collector support rails running vertically up the slope of the roof, as shown in Figure 14, should span the outermost purlins that support the solar collector.

Collector support rails running vertically up the slope of the roof should be supported as shown in Figure 14 by either:

(a) rafters or truss top chords at not more than 1500 mm centres and within 300 mm of each end of the collector support rails using the connection details shown in Figure 10 or 12, or

(b) each purlin crossed, using details shown in Figures 10 or 11. The purlins must be a minimum size of 90 x 45 mm on their flat and span a maximum of 900 mm.

Table 3: Support angle rails for panel collectors at a different pitch to roof cladding — up to 2.0 m slope length supported by rafters

Rafter or top chord spacing (m)	**ULS design wind speed** (m/s)	**Number of support points per rail**		**Support rail steel angle** (mm)	**Stud fixing detail**	**Roof slope limits**
		For up to 4 m^2	**For each added 2 m^2**			
up to 0.9	50	4	2	40 x 40 x 3	Fig 12	15° to 45°
		4	2	40 x 40 x 3	Fig 17	0° to 15°
	44	2	1	30 x 30 x 3	Fig 12	30° to 45°
		4	2	40 x 40 x 3	Fig 12	0° to 30°
	37	2	1	30 x 30 x 3	Fig 12	20° to 45°
		4	2	30 x 30 x 3	Fig 12	0° to 20°
	32	2	1	30 x 30 x 3	Fig 12	0° to 45°
0.9 to 1.2	50	4	2	40 x 40 x 5	Fig 12	15° to 45°
		4	2	40 x 40 x 5	Fig 17	0° to 15°
	44	2	1	30 x 30 x 3	Fig 12	30° to 45°
		4	2	40 x 40 x 3	Fig 12	0° to 30°
	37	2	1	30 x 30 x 3	Fig 12	20° to 45°
		4	2	40 x 40 x 3	Fig 12	0° to 20°
	32	2	1	30 x 30 x 3	Fig 12	0° to 45°

Notes:
1. ULS: ultimate load strength
2. The strut attachment to the rails for 4 m^2 solar collectors should be:
   - at the mid-point of the outer rail spans for four support points; or
   - at the support connections to the rail for two support points.

Table 4: Support angle rails for evacuated tube solar collectors at a different pitch to roof cladding — up to 2.0 m slope length supported by rafters

Rafter or top chord spacing (mm)	**ULS design wind speed** (m/s)	**Number of support points per rail**		**Support rail steel angle** (mm)	**Stud fixing detail**	**Roof slope limits**
		For up to 5 m^2	**For each added 2.5 m^2**			
up to 1200	up to 50	2	1	30 x 30 x 3	Fig. 12	0° to 45°

Notes:

1. This table applies only to evacuated tube solar collectors that have free air flow between the tubes i.e. no reflector or other infill behind the tubes.
2. The strut attachment to the rails should be at the support connections to the rail.
3. ULS: ultimate load strength.

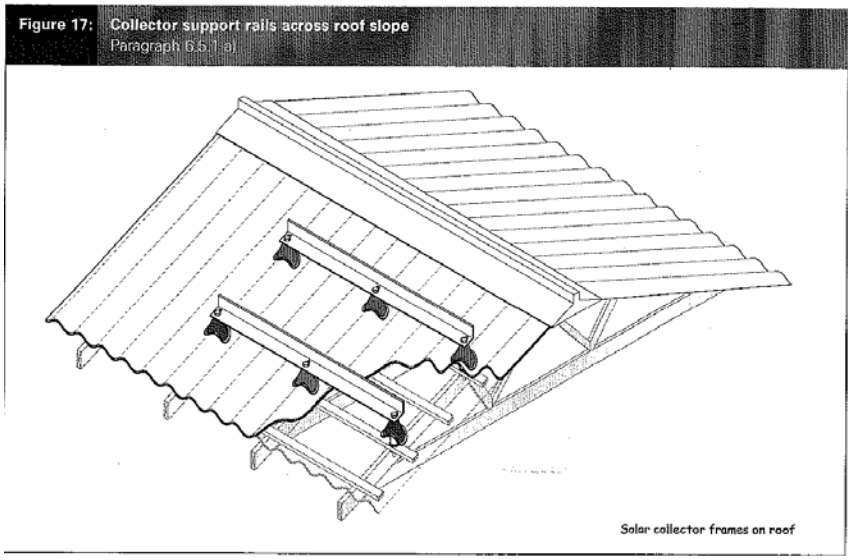

Figure 13: Collector support rails across roof slope

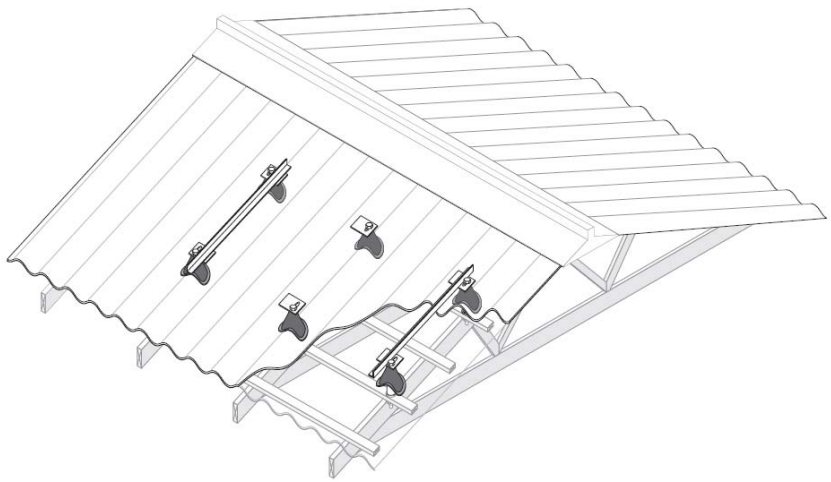

Figure 14: Collector frame up slope of roof

iv. Mounting collectors at a different pitch to the roof cladding (using horizontal support rails)

Solar collectors installed at a different pitch to the pitch of the roof and supported by horizontal rails running across the roof slope should be connected to rafters or truss top chords as specified in either Table 3 or Table 4, as appropriate.

Rails should be mild steel angles with dimensions determined by either Table 3 or Table 4 (as appropriate), or other material of equivalent strength and stiffness.

Rails should be separated by a distance up the roof slope of at least the slope length of the solar collector, see Figure 16.

The struts supporting the top edge of the solar collector and the diagonal brace should be mild steel angle complying with Table 5 or other material of equivalent strength and stiffness.

Table 5: Dimensions of struts and diagonal braces

Strut and diagonal brace size (mm)	**Maximum length** (mm)
25 x 25 x 3	1200
30 x 30 x 3	1500
40 x 40 x 3	2400

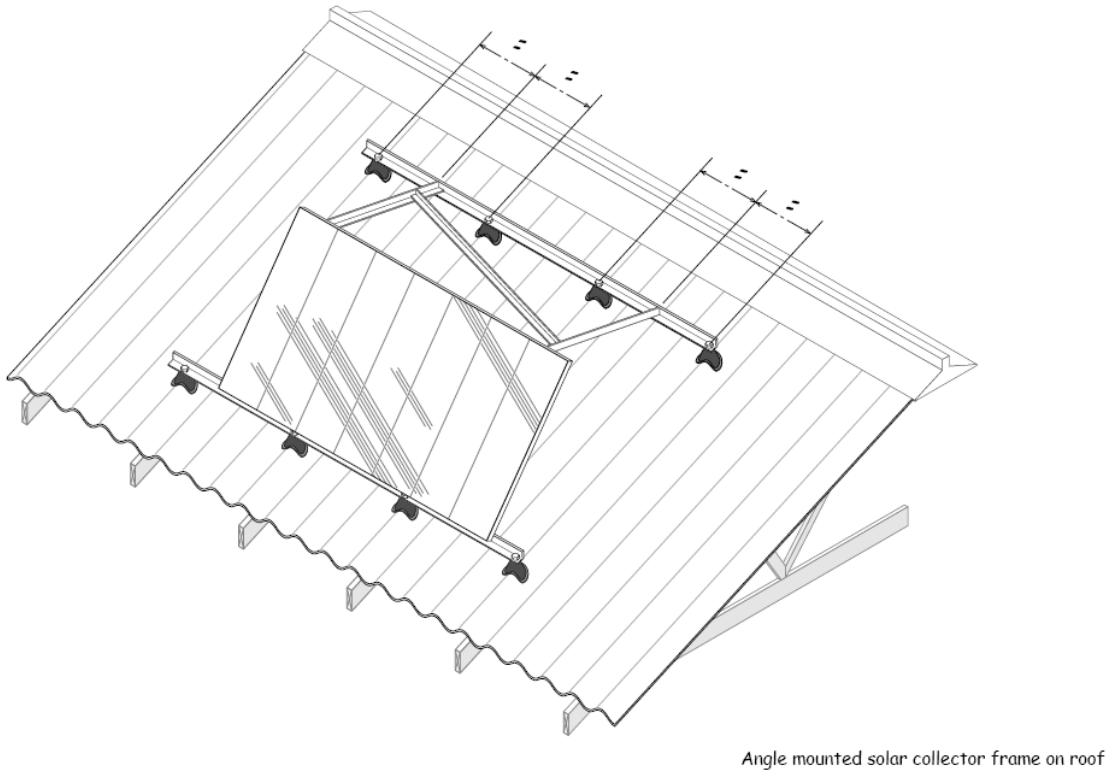

Figure 15: Collector at different pitch to roof

The struts should be connected by a diagonal brace connected within 50 mm of the top of one strut and within 50 mm of the bottom of the adjacent strut.

Connections between: struts and the diagonal brace; struts and support rails; support rails and the solar collector; and struts and the solar collector should use M8 class 4.6 bolts, nut and washers or another connection of equivalent strength.

Flat plate solar collectors (and evacuated tube solar collectors with a reflector that prevents air flow between the tubes) with a slope length no longer than 2 m, should be installed in accordance with Table 3 and Figure 12 or 17.

Evacuated tube solar collectors that allow air flow between the tubes, and have a slope length no longer than 2 m, should be installed in accordance with Table 4 and Figure 12.

v. Mounting collectors at a different pitch to the roof cladding (using frames)

Frames and diagonal braces should be specifically designed for the purpose.

The frame should be fixed to purlins by 14 gauge (6.3 mm) Type 17 screws.

The fixings of the frames to the purlins should be separated by a distance up the roof slope of at least the slope length of the solar collector (not the distance between the top edge of the collector and the roof cladding). See Figure 16.

The frames (in a line across the slope of the roof) should be separated by at least the distance between the rafters or truss top chords (see Figure 18).

For flat plate solar collectors:

- The slope length should not exceed 1600 mm.
- Frames are required at each end of the solar collector and at centres in between no further apart than 1200 mm.
- Where the slope length is up to 800 mm frames should be fixed in accordance with Table 7 and Figure 19.
- Where the slope length is between 800 mm and 1600 mm frames should be fixed in accordance with Table 6 and Figure 19.

Where the frame support requires three fixings (refer to Table 6 and Figures 18 and 19):

(a) Two of the fixings should be: at the higher end of the frame; fixed to purlins by a channel or top hat section running across the slope of the roof above a purlin; and

(b) The two top fixings should be spaced a minimum of 300 mm apart; and.

(c) Each supporting purlin should be fixed to the adjacent rafters or truss top chord with either 3 x 5mm diameter “Z” nails or a 25 x 1 mm steel strap and two 30 x 3.15 mm nails at each end.

For evacuated tube solar collectors:

- The slope length of evacuated tube solar collector should not exceed 2 m (see Figure 19).
- Frames are required at each end of the solar collector and at centres in between no further apart than 1600 mm
- Frame should be fixed in accordance with Table 8 and Figure 19.

Where alternative fixings are proposed these should distribute the load of the solar collectors over at least the number of fixing points required for the same size (and type) of solar collector following Table 3, 4, 6 or 7, as appropriate.

Table 6: Support channel rails for solar collectors at a different pitch to roof cladding – up to 1600 m slope length supported by purlins

ULS design wind speed (m/s)	**Minimum purlin size**	**Maximum purlin span** (mm)	**Minimum number of fixings per frame**
50	100 x 50, 90 x 45	1200	3
	75 x 50, 70 x 45	600	3
44	100 x 50, 90 x 45	1200	3
	75 x 50, 70 x 45	900	3
37	100 x 50, 90 x 45	1200	2
	75 x 50, 70 x 45	900	2
32	100 x 50, 90 x 45, 75 x 50, 70 x 45	1200	2

Table 7: Support channel rails for solar collectors at a different pitch to roof cladding – up to 800 mm slope length supported by purlins

ULS design wind speed (m/s)	**Minimum purlin size**	**Maximum purlin span** (mm)	**Minimum number of fixings per frame**
32 to 50	100 x 50, 90 x 45, 75 x 50, 70 x 45	1200	2

Table 8: Support channel rails for evacuated tube solar collectors at a different pitch to roof cladding – up to 2.0 m slope length supported by purlins

ULS design wind speed (m/s)	Minimum purlin size	Maximum purlin span (mm)	Minimum number of fixings per frame
32 to 50	100 x 50, 90 x 45, 75 x 50, 70 x 45	1200	2

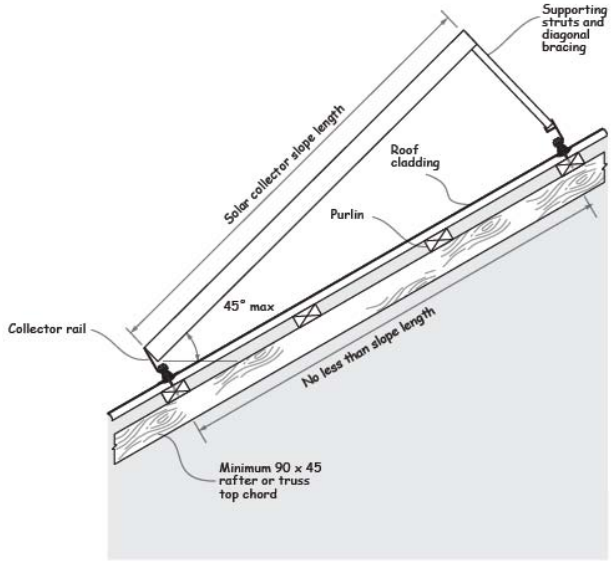

Figure 16: Collector at different pitch to roof

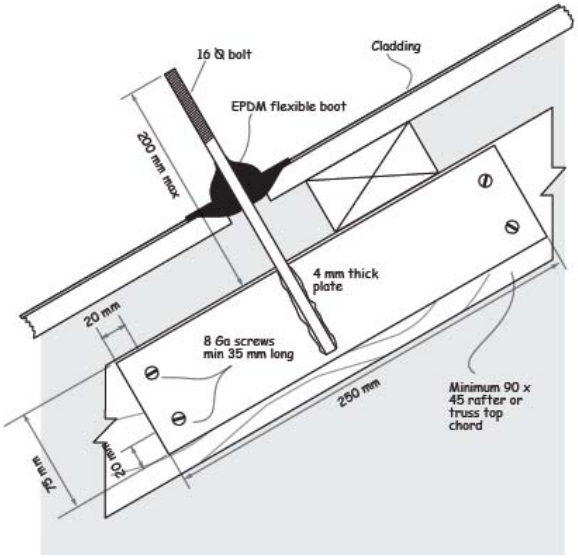

Figure 17: Stud fixing for panels at different pitch

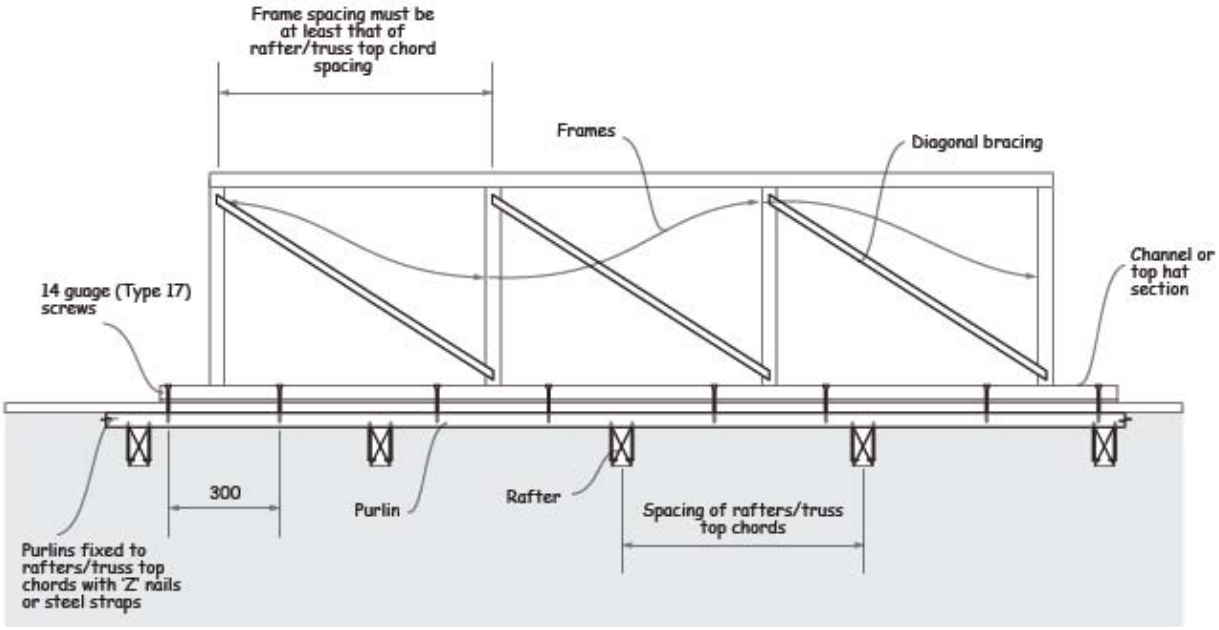

Figure 18: Solar collectors at a different pitch to the roof, supported using frames (elevation view)

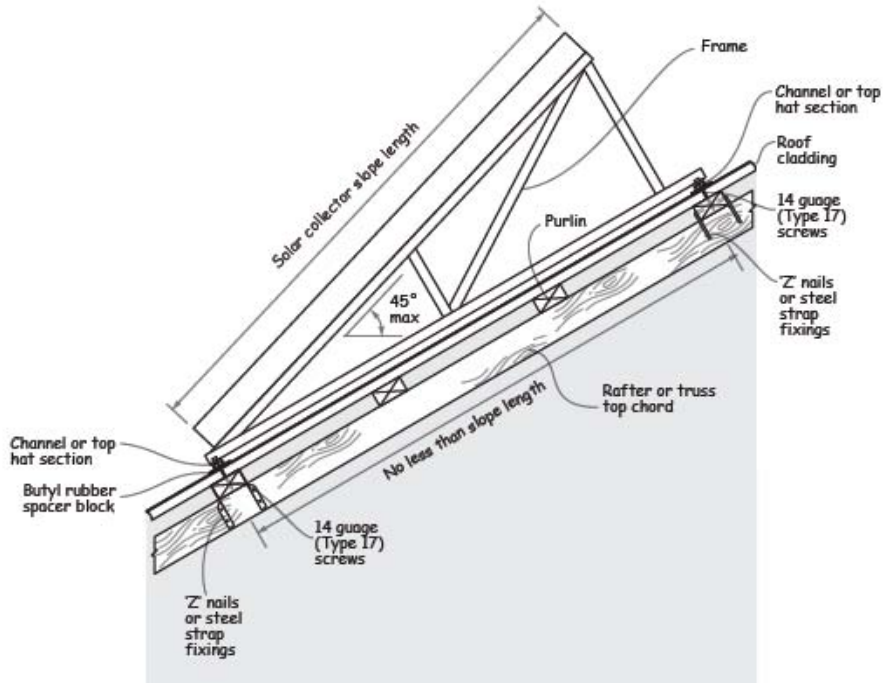

Figure 19: Solar collectors at a different pitch to the roof supported using frames (section view)

d) Installations beyond the scope of this Guidance

Solar water heater installations that include the installation of a hot water tank on the roof of a building add a significant additional load to the roof structure. In these cases it is expected that the roof structure will need to be strengthened to support the additional load. It is not possible to provide practical generic solutions for these installations. Therefore, a specific design will be required by a suitably qualified structural engineer, such as a Chartered Professional Engineer.

For solar water heater installations in wind zones that exceed Very High wind speeds (as defined in NZS3604) it is not possible to provide practical generic solutions. Therefore, a specific design will be required by a suitable qualified structural engineer, such as a Chartered Professional Engineer.

2. Durability (B2)

a) Background

Several of the drawings in the Acceptable Solution for solar water heaters (G12/AS2), include the term “hot dip galv”. The size and strength of these frames and supports was determined based on mild steel (which are usually required to be hot dip galvanised to achieve adequate durability). This has meant some solar water heater suppliers who use other durable materials cannot use G12/AS2, because the frames and supports are outside its scope. However, in many cases these frames and supports are durable and meet the durability performance requirement in the Building Code. Also these other materials may be made of a lighter material, which still achieves the strength and stiffness requirements.

b) Principle

The objective of Code clause B2 is to ensure that a building, throughout its life, will continue to satisfy the other objectives of the Building Code (see NZBC B2.1).

Solar water heaters are easy to access, moderately difficult to replace and failure to comply with the Building Code is unlikely to be detected during normal use, therefore, the Building Code performance criterion for durability is 15 years (see NZBC B2.3.1).

Some parts of the solar water heater may need to be replaced before this time. If that is the case these parts should be able to be replaced without removal of more durable parts of the solar water heater (see NZBC B2.3.2)

c) Guidance

There are many ways to achieve the Building Code performance requirements for durability. One way, described in G12/AS2 is to use hot dip galvanised mild steel, however, other materials that meet the New Zealand Building Code durability requirement and have equivalent stiffness and strength can also be used. These other materials are often lighter, resulting in reduced additional load on the building structure.

Designers will need to demonstrate how their proposed solution meets the durability requirements. Designers may choose to use the material selection Tables in G12/AS2 (Tables 1, 2 and 3) to do this or use similar Tables from E2/AS1 (Tables 20, 21 and 22).

Building consent authorities should be receptive to alternative solutions proposals that comply with the Building Code performance criteria because they often result in a better solution for the supplier and the customer.

Information about the difference between the New Zealand Building Code durability performance criteria and the warranty period of building products is included in Codewords 21 - July 2007 (http://www.dbh.govt.nz/codewords-21-article-7). The title of the article is "Durability vs warranty".

3. External moisture (E2)

a) Background

Penetrations in roofs for the installation of solar water heaters are adequately described in the Acceptable Solution (G12/AS2) to achieve the Building Code performance criteria for external moisture. There is one instance that the Department is aware of where a solar water heater was being installed on a roof with a lower pitch than the construction details in G12/AS2 provides. The weathertightness requirements for this situation are not included in G12/AS2, because it is not common, however, weathertightness details for these situations are available in E2/AS1.

b) Principle

The objective of this clause is to protect people from illness or injury caused by external moisture entering the building (see NZBC E2.1).

c) Guidance

If a design solution to a specific situation is not included in G12/AS2, in the first instance, refer to other Acceptable Solutions such as E2/AS1 for weathertightness. There may also be other ways to demonstrate that the performance criteria in the Building Code are achieved.

4. Hazardous substances and processes (F2)

a) Background

There are no known concerns with solar water heater installations achieving the hazardous building materials requirements of the Building Code.

b) Principle

The objective of this clause is to safeguard people from injury and illness caused by exposure to hazardous building materials (see NZBC F2.1).

c) Guidance

For solar water heaters, the most relevant of the three performance criteria relating to Building Code clause F2 is NZBC F.2.3.3. The most practical way to achieve these performance criteria is to ensure that it is unlikely for people to come into contact with any broken glass (or other brittle material). This can be achieved by installing the solar collector on the roof of a building. Installers should avoid installing evacuated tube or other glass solar collectors over an unprotected area such as a pergola, unless some other provisions have been made to achieve the performance criteria in the Building Code (see NZBC F2.3.3).

Refer to **Appendix 1** to see the relationship between Building Code performance criteria and relevant paragraphs of AS/NZS 2712:2007.

5. Electricity (G9)

a) Background

There are no known concerns with solar water heater installations achieving the electrical installation requirements of the Building Code.

b) Principle

The objective of this clause is to protect people from fire and injury caused by electrical installations (see NZBC G9.1).

c) Guidance

New electrical work associated with installing a solar water heater must be certified (that is, a Certificate of Compliance, CoC, is required in accordance with regulation 39 of the Electricity Regulations 1997) but does not require a building consent. However, an owner can choose to obtain a building consent for the electrical work, in which case details of the work must be included on the plans and specifications that are submitted for building consent.

When a building consent is sought for electrical work, the most straightforward way to show that the requirements of clause G9 are met is to comply with the Electricity Regulations 1997 and provide a copy of the CoC to the building consent authority.

6. Water supplies (G12) - system requirements

a) Background

The Acceptable Solution for solar water heaters (G12/AS2) requires solar water heating systems to comply with AS/NZS 2712:2007 from 1 July 2009. AS/NZS 2712:2007 was published in September 2007, however, some solar water heater suppliers are still completing the system tests required in this Standard. Complying with all parts of AS/NZS 2712:2007 may go beyond what is required to meet the performance criteria in the Building Code, in some cases. Complying with AS/NZS 2712:2007 is one way to demonstrate compliance with the Building Code. However, complying with AS/NZS 2712:2002 and EN 12975 Parts 1 & 2 may also be suitable ways to establishing Building Code compliance.

The Department wants to avoid the unnecessary retesting of products that have already been satisfactorily tested to a relevant international Standard, where the installation of these products achieves the performance requirements of the Building Code.

The Acceptable Solution for solar water heaters (G12/AS2) also requires solar water heaters to have a minimum of 50 litres of hot water storage per square metre of collector area. This is a prescriptive way to demonstrate that the relevant performance criteria is achieved. There are other performance-based ways to demonstrate that this performance criteria is achieved such as performance modelling and/or testing.

b) Principles

The objective of this clause is to protect people from illness or injuries caused by water systems and protect people from loss of amenity caused by failure of water supply systems (see NZBC G12.1).

c) Guidance

Solar water heating systems should comply with an appropriate product Standard to ensure that the system is safe. The Department considers that any of the following product Standards are suitable:

i. AS/NZS 2712:2007
ii. AS/NZS 2712:2002
iii. EN 12975 Parts 1 & 2

However, for the product Standards that do not include system tests (i.e. AS/NZS 2712:2002 and EN 12975 Part 1 & 2) further information may be required to demonstrate that the Building Code performance criteria are met. For example the relationship between solar collector area and hot water storage will need to be verified (see paragraph 3.3.1 of

G12/AS2) and the solar water heating system should also have fail-safe mechanisms to deal with excessive temperatures and pressures (see paragraphs 3.4.1 and 3.4.2 of G12/AS2).

As an alternative to having a minimum of 50 litres of hot water storage per square metre of collector area, systems could be tested to meet the No-Load System Operation Test described in Appendix F of AS/NZS 2712:2007.

Refer to **Appendix 1** to see the relationship between Building Code performance criteria and relevant paragraphs of AS/NZS 2712:2007.

7. Energy efficiency (H1) - orientation and inclination

a) Issue

The inclination requirements in G12/AS2 cannot be achieved when solar collectors are installed parallel to the roof cladding on low pitched roofs in some parts of the country (optimal inclination is a function of latitude and therefore location). The cost of changing the inclination may outweigh the benefits of increased performance from the solar water heater in some cases.

b) Principle

The objective of Clause H1 is to facilitate the efficient use of energy (see NZBC H1.1), however, this objective only applies to energy from a network utility operator or a depletable energy resource.

Solar energy does not come from a network utility operator and is not a depletable energy resource. Clause H1 includes no performance criteria related to the energy efficient use of renewable solar energy used in solar water heaters, but any supplementary heating from a network utility operator is covered by the Building Code.

For solar water heaters this becomes a little complex, because a system using energy from a network must meet the performance criteria in clause H1 of the Building Code, however, this clause excludes renewable energy not provided by a network utility operator.

The performance requirements in Code clause H1 that relate to hot water systems states that they must: limit the energy lost in the heating process, and be constructed to limit heat loss from hot water tanks and hot water pipes (see H1.3.4).

c) Guidance

G12/AS2 achieves the performance criteria required in clause H1.3.4 by ensuring that the solar collector is reasonably well orientated and assumes that the solar energy from the solar water heater will exceed any additional heat loss that may occur from a solar hot water storage tank which may not limit the heat loss from the tank to the same extent as other water heaters.

There are other ways to achieve these performance criteria such as using a tank that meets the heat loss requirements specified in AS/NZS 4692.2:2005, and using a controller that meets the requirements of AS/NZS 2712:2007 and insulating hot water pipes.

The following information on orientation and inclination is useful to satisfy customers' performance expectations. Customers will expect that their solar water heater works effectively and saves energy. In terms of the Building Code performance requirements, solar water heaters (like other water heaters) are required to limit heat loss from the hot water cylinder and limit heat loss from hot water pipes. An important part of achieving this is to ensure that network energy is not wasted – for example ensuring that a controller to control supplementary heating is installed and working effectively, and that the system is designed to avoid reverse thermo syphoning and the resultant heat loss from the solar collector.

The following guidance on orientation and inclination of solar collectors is provided to help suppliers and installers understand the effects on system performance from non-optimal orientation and inclination. Refer to **Appendix 1** to see the relationship between Building Code performance criteria and relevant paragraphs of AS/NZS 2712:2007.

Orientation and inclination of solar collectors

The ideal orientation of a solar collector is geographic north with an inclination angle from the horizontal the same as the angle of latitude for the location. Deviations from the ideal orientation and inclination will reduce the performance of the solar water heater.

Small deviations from the ideal orientation and inclination have minimal effect on system performance and are often more cost effective to install. Typically solar collectors should be installed at the same angle as the pitch of the roof as long as the performance is 75% or more of the maximum achievable performance.

A compass points towards magnetic north. Magnetic north varies from geographic north by $19^1/_2$ degrees in Auckland, 22 degrees in Wellington and $23^1/_2$ degrees in Christchurch. In New Zealand magnetic north is always east of geographic north. It is important that geographic north is considered with regards to orientation of solar collectors rather than magnetic north. The website http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp provides a calculation of the difference from magnetic north to geographic north (magnetic declination). The magnetic declination for some centres in New Zealand is shown in Table 9 below.

Shading of solar collectors should be minimised to ensure maximum performance of the system.

Table 9: Variation from magnetic north to geographic north (declination)

Town/City	Latitude (south)	Longitude (east)	Declination (east)
Whangarei	35° 43’	174° 20’	19° 00’
Auckland	36° 55’	174° 47’	19° 30’
Tauranga	37° 42’	176° 11’	20° 00’
Taupo	38° 42’	176° 06’	21° 30’
Wellington	40° 00’	175° 30’	22° 00’
Nelson	41° 18’	173° 17’	22° 00’
Christchurch	43° 33’	172° 40’	23° 30’
Dunedin	45° 52’	170° 30’	25° 00’
Invercargil	46° 26’	168° 21’	25° 00’

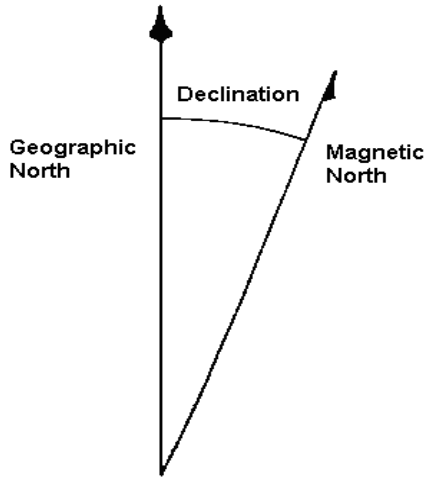

Figure 20: Geographic north vs. magnetic north

Table 10: Performance of flat plate solar collectors over a range of orientations and inclinations

Orientation (degrees)		Inclination angle (degrees)								
		0	10	20	30	40	50	60	70	80
	240	0.86	0.81	0.76	0.69	0.62				
West	270	0.86	0.86	0.84	0.81	0.78	0.72	0.66	0.59	0.50
	300	0.86	0.89	0.91	0.91	0.90	0.86	0.80	0.72	0.63
	330	0.86	0.92	0.96	0.97	0.97	0.93	0.88	0.79	0.68
North	0	0.86	0.93	0.98	1.00	1.00	0.96	0.90	0.81	0.69
	30	0.86	0.92	0.96	0.98	0.98	0.95	0.89	0.81	0.70
	60	0.86	0.90	0.92	0.92	0.91	0.88	0.82	0.75	0.67
East	90	0.86	0.86	0.85	0.83	0.80	0.75	0.69	0.62	0.55
	120	0.86	0.82	0.77	0.71	0.65				

The effect of slope and orientation on energy savings of a 3.3 m² flat plate solar collector.

Modelled using AS/NZS 4234 Zone 5.

The maximum energy savings are 2,398 kWh/year.

Table 11: Performance of evacuated tube solar collectors over a range of orientations and inclinations

Orientation (degrees)		Inclination angle (degrees)								
		0	10	20	30	40	50	60	70	80
	240									
West	270	0.80	0.79	0.77	0.74	0.70	0.64	0.58	0.52	0.44
	300	0.80	0.84	0.85	0.84	0.82	0.78	0.72	0.64	0.55
	330	0.82	0.87	0.91	0.92	0.91	0.87	0.81	0.72	0.62
North	0	0.87	0.94	0.98	1.00	1.00	0.96	0.90	0.80	0.67
	30	0.87	0.93	0.96	0.97	0.97	0.93	0.88	0.79	0.68
	60	0.88	0.91	0.92	0.91	0.89	0.85	0.79	0.71	0.62
East	90	0.88	0.88	0.86	0.83	0.79	0.74	0.67	0.60	0.51
	120									

The effect of slope and orientation on annual energy savings of a 2.4 m² evacuated tube solar collector.

Modelled using AS/NZS 4234 Zone 5.

The maximum energy savings are 2,388 kWh/year

Appendix 1

Building Code Clauses		Summarised Performance criteria	AS/NZS 2712:2007	Other
F2	Hazardous substances and processes	Hazardous substances used in the construction of buildings must not result in harmful concentrations at exposed material surfaces.	See paragraph 2.3	
		Brittle materials (including glass) that people are likely to come into contact with will either: break in a way unlikely to cause injury; or resist reasonable impact without breaking; or be protected from impact.	See paragraph 4.4.3.	
G12	Water supplies	Hot water for washing people must be at a temperature that avoids the likelihood of scalding.		Tempering value see G12/AS1 paragraph 6.14.2.
		Flow rate must be adequate.		This is a hot water system requirement, rather than a specific requirement of the solar water heater.
		leaks must be avoided	See paragraph 3.2 which references AS/NZS 4691.1 and clause 5.3 includes a water tightness requirement for tanks (this requirement will still need to be satisfied for the remainder of the solar hot water system).	
		Components likely to need maintenance should be reasonably accessible.	See paragraph 2.4.	
		The system should be able to be isolated for maintenance and testing.		This is a water system requirement rather than a specific solar water heater requirement.
		Hot water storage tanks must have safety devices that: relieve excessive pressure during normal and abnormal operation; and limit temperatures to avoid the likelihood of flash steam if the tank ruptures.	See paragraphs 2.6.1, 2.6.2 and 2.7.	
		Hot water systems must be capable of being controlled to avoid the growth of legionella bacteria.		G12/AS2 paragraph 3.5 list options to achieve this requirement.

Building Code Clauses		Summarised Performance criteria	AS/NZS 2712:2007	Other
H1	Energy efficiency	Systems for the heating, storage or distribution of hot water must (having regard to the energy source used): limit the energy lost in the heating process; and	See paragraph 6.3.1.	
		Limit heat losses from storage vessels; and	See paragraph 3.2.	
		Limit heat losses from hot water distribution pipes connected to storage vessels.		H1/AS1 paragraph 5.0.1 refers to NZS 4305:1996

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