

TPIC Technical Bulletin #7
January 12, 2012

Solar Ready Truss Design Procedure

1. Introduction/Background

The Solar Ready Guidelines have been developed by Natural Resources Canada's (NRCan) CanmetENERGY and Office of Energy Efficiency New Housing Division in partnership with the Canadian Solar Industries Association (CanSIA). During the Stakeholder Review process of these Guidelines, recommendations were made to develop a Solar Ready Truss design procedure that would enable builders using truss systems to readily overcome potential structural design concerns related to additional loads associated with solar systems that may be installed on their Solar Ready homes. Section 2 of this document explains the building code compliance; Section 3 describes roles and responsibilities; Section 4 provides the required Solar Ready Truss Design Requirements and Procedures; Section 5 describes approved attachment methods and Section 6 provides the recommended load cases in the design of SR trusses.

2. Building codes and design standards

This technical bulletin has been developed to establish compliance with the National Building Code of Canada; the CSA O86, Engineering design in wood and the TPIC design procedures when Solar Ready Truss Design Procedures presented in this document are followed.

3. Roles and Responsibilities

A. Builders

- a. Builders must identify on the house plans a minimum 3.7 m (12 ft) x 3.1 m (10 ft) of unobstructed area for solar panels¹ to be installed. The entire roof plane in which this unobstructed area is allocated will be designed to accommodate the loads associated with the solar panels according to TPIC specifications.
- b. Ensure the truss designer/fabricator has been notified of the location of the identified area / roof plane which is to be designed Solar Ready.

B. Truss Designer

- a. The SR Truss Design Procedures are intended to be used by truss designers across Canada and by those truss fabricators exporting trusses to Canada when supplying trusses to builders that subscribe to Natural

¹ "Solar panels" collectively refers to solar collectors used for domestic hot water heating and/or space heating as well as solar photovoltaic modules used for electricity generation. The dead load limit of 0.24 kPa (5 psf) includes the mass of the panels themselves as well as mounting brackets, c-channel/mounting rails and any fluids contained in the panel.

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Resources Canada's (NRCan) Solar Ready initiative. The design procedures specified in this document are to be used to produce a truss design drawing that shows the trusses manufactured per the drawing have been designed Solar Ready in accordance with TPIC's SR Truss Design Procedures and in accordance with NRCan's Solar Ready Guidelines.

- b. The truss designer shall communicate to the solar panel installer the attachment method assumed in the design. See section 5 for the description of the attachment methods permitted.

C. Building Framers and/or Truss Fabricators

If the scab method of attachment is desired, Building Framers and/or Truss Fabricators are responsible for the following:

- a. Installation and attachment of the scab members to trusses occurring in the roof plane designed Solar Ready as shown in the truss design drawing. Installation of the scab members must be completed according to Section 5.
- b. Scab member ends (in the overhang / eave area of the roof) shall be clearly marked to identify the scab as Solar Ready scab. This can be done by painting the ends green or marked Solar Ready (SR) in some other fashion so as to indicate to a future solar installer that the scabs are intended for the attachment of solar panels.
- c. Scabs must be fastened to the same side of the truss chords under the solar panel roof plane.

D. Solar System Installers

- a. Solar system installers are required to abide by the design restrictions of Solar Ready homes built in accordance with this document, including selecting solar panels that fall within the design load limits and installing the solar panels according to the TPIC approved method of attachment presented in Section 5.
- b. Points of attachment must be spaced according to the maximum allowable spacing defined in Section 5.
- c. The solar panels are to be mounted in parallel with the roof deck at a height above the roof deck not exceeding 102 mm (4"). The TPIC SR

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Truss Design Procedure does not allow for rack mounting of solar panels.

- d. Solar system installers must confirm that the house has been designed solar ready. This can be done by checking under the eaves for the presence of scabs marked SR or by checking truss design drawing, which will indicate whether or not the house has been designed Solar Ready.

E. Building Code Inspector

- a. It is intended that the identification of the home as being built Solar Ready according to NRCan's Solar Ready Guidelines and the TPIC SR Truss Design Procedure will assure building code inspectors that the roof has indeed been designed ready for solar system installation on the roof plane designated. It is recognized, however, that it is the purview of the building codes inspector to further inspect the roof to ensure this has been accomplished in a satisfactory manner if deemed appropriate by the builder inspector.
- b. Ensure that the attachment method used is in accordance with this document.

4. Solar Ready Truss Design Procedures

Solar Ready (SR) roofs must be designed with the assumption that the roof may or may not have a solar system installed at some point throughout their life time. Therefore, SR roofs must be designed using standard load cases as well as load cases that can be expected when solar panels are installed. Trusses supporting roof areas designated for the installation of solar panels shall be designed in accordance with the design requirements and procedures in this document.

A. Qualifying Roofs, Solar Panels and Installation Requirements

- I. The SR truss design applies only to roof trusses designed in compliance with Part 9 of NBCC. All other trusses not meeting this requirement are not considered SR and must be custom designed according to the specific loads imposed on the trusses affected.
- II. The SR truss design has made no allowance for solar panels with a total system dead load greater than 0.24 kPa (5 psf). Solar panels weighing more than 0.24 kPa (5 psf) may not be installed on SR roofs. Trusses may be designed SR only if the solar panel system can be mounted in parallel with the roof deck at a height above the roof deck not exceeding 102 mm (4").

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- III. The spacing between attachment points of the solar panel system to the roof shall be:
- a. No greater than every second roof truss to a maximum of 1.2 m (4 ft.), perpendicular to the roof trusses (i.e., horizontally).
 - b. No greater than 1.2 m (4 ft.) along the top chord of the roof trusses.
- IV. Solar panels shall not be installed on overhang areas of the SR roof.

B. Design Requirements

- I. In addition to the standard uniform load cases, SR trusses shall be designed for the following:
- a. For the surface of the roof trusses designated to carry solar panels per 3.A.a, the snow load and solar panel dead loads shall be applied as concentrated moving loads spaced at 1.2 m (4 ft) o/c along the top chord of the trusses, starting at the heel and ending at the peak. All concentrated loads shall move 1.2 m (4 ft) simultaneously, in 305 mm (1 ft) increments, from the heel towards the peak (along the rake).
 - b. Each concentrated load shall be calculated using a tributary area (m^2 , ft^2) of:
 - i. metric - 2.4 x truss spacing (m)
 - ii. imperial – 8 x truss spacing (ft)
 - c. As an alternative to 4.B.I.a. , for the surface of the roof trusses designated to carry solar panels per 3.A.a, the snow load and solar panel dead load may be applied to the top chord of the trusses as uniform distributed loads using a tributary width of 2 x the truss spacing with the maximum following stress indexes:
 - i. Top chord – $CSI \leq 0.70$
 - ii. Bottom chord – $CSI \leq 0.80$
 - iii. Webs - $CSI \leq 0.90$
 - iv. Moment connections (Except heels) – $JSI \leq 0.63$

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- II. SR roof trusses shall have maximum panel lengths, along the rake, not exceeding 2.4 m (8 ft) in the roof plane of the area designated to carry solar panels per 3.A.a.
- III. The load sharing factor, K_H , shall not be used in the design of SR roof trusses since the point loads applied through the points of attachment are derived from tributary spacing exceeding 0.61 m (2 ft) contrary to CSA O86 section 5.4.4.1.
- IV. Truss members subject to both bending and axial compression shall not be proportioned using a modified compression-bending column formula because SR trusses do not satisfy the requirements of CSA O86 Section 5.5.13.1.

C. Truss Design Drawings

The SR truss design drawings shall output the following on the drawing:

- a. Text containing the wording “Solar Ready” to indicate the truss has been designed SR.
- b. Truss chord label under the SR plane. Example “Chord A-E supports solar panels”.
- c. The SR truss design drawing shall output a maximum factored point load at each point of attachment (up and down). Example “Point load = XXX at each connection point”.
- d. Indicate the connection method assumed in design: (1) Scab method or (2) Blocking method or J & U bolts.

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5. Attachment Methods.

Once the home has been verified as being built Solar Ready, installers may install solar panels according to the attachment methods described in this section. Solar panels shall be attached at spacing equal to two times the truss spacing perpendicular to the roof trusses (i.e., horizontally) but not directly on trusses. In no case shall the maximum spacing of connection points exceed 1.2 m (4 ft.) perpendicular to the roof trusses (i.e., horizontally) or exceed 1.2 m (4 ft.) parallel to the roof trusses (i.e., vertically).

A. **Scab Method.** This method allows rigid rails (e.g., c-channels), designed to carry the loads associated with the solar panels, to be attached to the scab members using lag screws. This must be accomplished using hardware and practices as recommended by the rigid rail manufacturers and/or solar system manufacturer. The scabs must be fastened to the adjacent truss chord using the nailing pattern in Table 1.

ROWS	VALID CHORD SIZE	SPACING (IN)	Nail diameter 0.120" 0.131" 0.148"		
			MAXIMUM POINT LOAD		
1	2X4 OR 2X6 OR 2X8	12	226	266	318
		8	339	399	477
		6	452	532	636
		4	678	798	954
2	2X4 OR 2X6 OR 2X8	12	452	532	636
		8	678	798	954
		6	904	1064	1272
		4	1356	1596	1908
3	2X6 OR 2X8	12	678	798	954
		8	1017	1197	1431
		6	1356	1596	1908
		4	2034	2394	2862
4	2X8	12	904	1064	1272
		8	1356	1596	1908
		6	1808	2128	2544
		4	2712	3192	3816

Table 1. Scab Nailing Pattern



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NOTES:

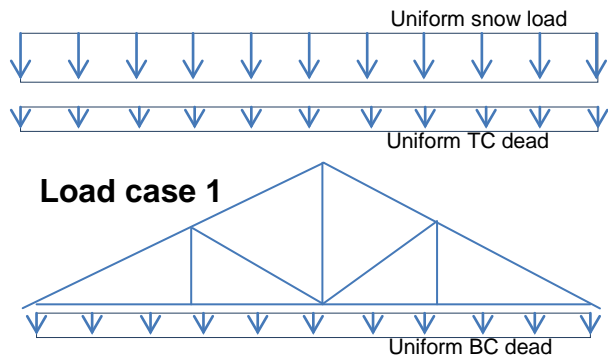
- 1) Dry SPF#2 or better scab member of same size as top chord is required.
- 2) Attach the required scab using 3" long nails with one of the diameters shown in table.
- 3) For nailing pattern, select # of rows, and spacing that has maximum point load higher than the solar panel point load shown on truss design drawing.
- 4) Nails shall be installed not closer than 3" to end of scab.
- 5) Maximum point load may be increased 15% for uplift loading due to wind (when required).
- 6) The maximum number of splices in scab member shall be two (2).

B. Other Methods. By using other methods of attachment that do not directly penetrate the truss top chord including the use of blocking, j-bolt or u-bolts as well as roof integrated systems of attachment. These methods must be accomplished using hardware and practices as recommended by the solar system manufacturer. In no case shall fasteners be used to reduce the truss chord cross-section.

Note that TPIC SR trusses are not designed to accommodate lagging directly into truss top chords. This method of attachment is therefore not permitted.

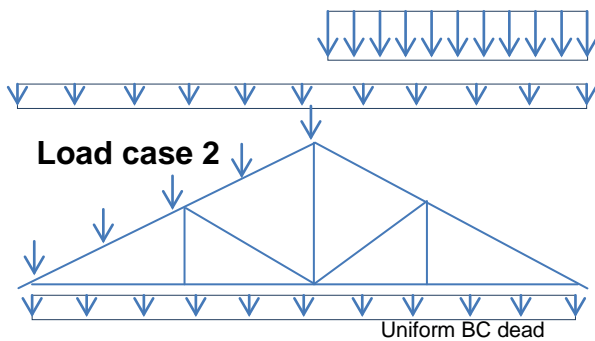
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6. Load Cases required by Section 4.B.1.a. & b.
 The following load cases are required for SR truss design.



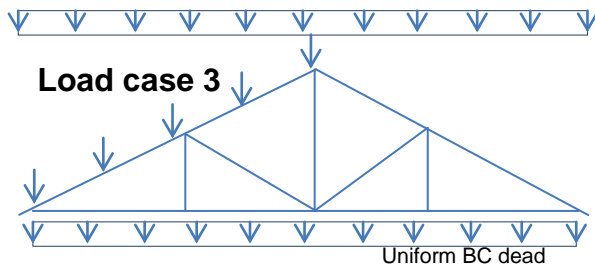
Load case 1

- Uniform snow load
- Uniform TC dead load
- Uniform BC dead load



Load case 2

- Uniform Snow Load – right only
- Uniform TC dead loads
- Conc. Moving Snow load @ 4 ft OC
- Conc. Solar panel moving dead load @ 4 ft OC
- Uniform BC dead load



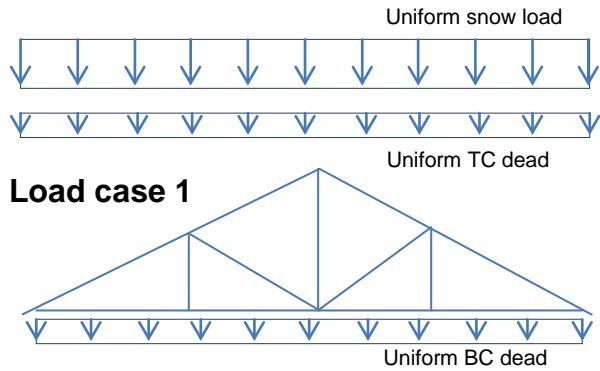
Load case 3

- Uniform TC dead loads
- Conc. Solar panel moving dead load @ 4 ft OC
- Uniform BC dead load

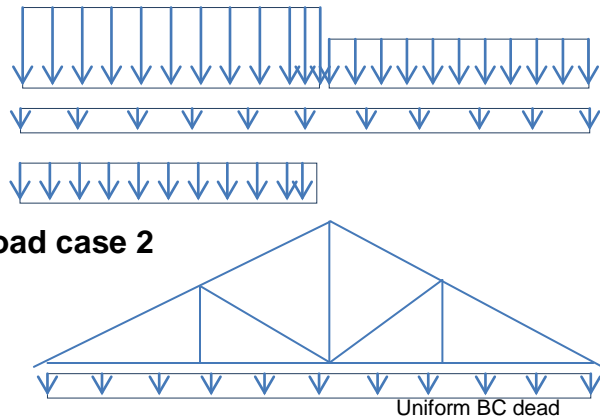
Other load cases may be required by authority having jurisdiction.

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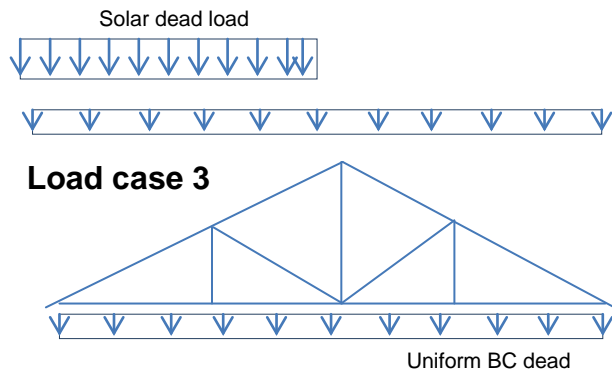
7. Load Cases required by Section 4.B.1.c.
The following load cases are required for SR truss design.



- Uniform snow load
- Uniform TC dead load
- Uniform BC dead load



- Uniform Snow Load – right only
- 2 x Uniform snow load – left only
- Uniform TC dead loads
- 2 x Uniform solar panel dead load
- Uniform BC dead load



- Uniform TC dead loads
- 2 x Uniform solar panel dead load
- Uniform BC dead load

Other load cases may be required by authority having jurisdiction.