TPIC Technical Bulletin No. 7

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Solar Ready (SR) / Photovoltaic Ready (PVR) Truss Design Procedure

1. Introduction/Background

The Solar Ready Guidelines were developed in 2012 by Natural Resources Canada's (NRCan) CanmetENERGY and the Office of Energy Efficiency New Housing Division, in collaboration with the Canadian Solar Industries Association (CanSIA). The Solar Ready Guidelines specify a number of design considerations and modifications builders can make to new attached and detached homes in preparation for the installation of a future solar thermal system or small array solar photovoltaic system.

The Photovoltaic (PV) Ready Guidelines were developed in 2018 by Natural Resources Canada's (NRCan) CanmetENERGY in collaboration with the Canadian Home Builders Association (CHBA) Net Zero Home program and the Canadian Solar Industries Association (CanSIA). The PV Ready Guidelines specify a number of design considerations and modifications builders can make to new attached and detached homes in preparation for the installation of a future large array photovoltaic system.

The Solar Ready (SR) / PV Ready (PVR) Truss Design Procedure includes design elements common to both approaches. There are also three key elements that differ between the Solar Ready and PV Ready Guidelines from a truss design perspective, and as such, there is a need for Solar Ready (SR) trusses to be identified distinctly from PV Ready (PVR) trusses. The main differences are summarized in Table 1 below:

Design Element	Solar Ready	PV Ready
Unobstructed roof area to accommodate solar panels	Minimum 3.1m (10') x 3.7m (12')	Sufficiently large to offset a significant portion of the annual energy budget of the house (large arrays, intended to be applicable to net zero homes)
Dead load	0.24 kPa (5 psf)	0.17 kPa (3.5 psf)

Table 1. Differences between Solar Ready and PV Ready Guidelines

During the Stakeholder Review process of these Guidelines, recommendations were made to develop a Solar Ready / PV 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 or PV 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 / PV 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/PVR 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 / PV Truss Design Procedures presented in this document are followed.

3. Roles and Responsibilities

A. Builders

a. Builders must indicate whether they are following the Solar Ready Guidelines or Photovoltaic Ready Guidelines, so that the allocated roof areas and dead loads can be designed accordingly.

b. Builders must identify on the house plans the unobstructed roof area allocated according to the Solar Ready Guidelines or PV Ready Guidelines for solar panels[1] to be installed. For Solar Ready and PV Ready, 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.

c. Ensure the truss designer/fabricator has been notified of the location of the identified area / roof plane which is to be designed Solar Ready or PV ready.

B. Truss Designer

a. The Solar Ready / PV Ready 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 Resources Canada's (NRCan) Solar Ready or PV 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 or PV Ready in accordance with TPIC's Solar Ready / PV Ready Truss Design Procedures and in accordance with NRCan's Solar Ready or PV Ready Guidelines.

[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) for Solar Ready or 0.17 kPa (3.5 psf) for PV Ready includes the mass of the panels themselves as well as mounting brackets, c-channel/mounting rails and any fluids contained in the panel.

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 or PV 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 or PV Ready scab. This can be done by painting the ends green or marked Solar Ready (SR) or PV Ready (PVR) 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 or PV 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 Solar Ready / PV Ready 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 or PV Ready. This can be done by checking under the eaves for the presence of scabs marked SR or PVR or by checking the truss design drawing, which will indicate whether or not the house has been designed Solar Ready or PV Ready.

E. Building Code Inspector

a. It is intended that the identification of the home as being built Solar Ready or PV Ready according to NRCan's Solar Ready or PV Ready Guidelines and the TPIC Solar Ready / PV Ready 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 Panel Truss Design Procedures

Solar Ready / PV Ready roofs must be designed with the assumption that the roof may or may not have a solar system installed at some point throughout their lifetime. Therefore, SR / PVR 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 Solar Ready / PV Ready 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/PVR and must be custom designed according to the specific loads imposed on the trusses affected.

II. For Solar Ready, the truss design has made no allowance for solar panels with a total system dead load greater than 0.24 kPa (5 psf). For PV Ready, the truss design has made no allowance for solar panels with a total system dead load greater than 0.17 kPa (3.5 psf). Solar panels weighing more than 0.24 kPa (5 psf) for Solar Ready and 0.17 kPa (3.5 psf) for PV Ready may not be installed on SR / PVR roofs. Trusses may be designed SR / PVR 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").

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 / PVR roof.

B. Design Requirements

I. In addition to the standard uniform load cases, Solar Read / PV Ready 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 305mm (1.0 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 ≤ 0.70
   ii. Bottom chord – CSI ≤ 0.80
   iii. Webs - CSI ≤ 0.90
   iv. Moment Connections (except heels) – JSI ≤ 0.63

II. Solar Ready / PV Ready 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/PVR 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 O86-14 section 6.4.4

IV. Truss members subject to both bending and axial compression shall not be proportioned using a modified compression-bending column formula because SR / PVR trusses do not satisfy the requirements of CSA O86-14 Section 6.5.13.1.

C. Truss Design Drawings

The Solar Ready / PV Ready truss design drawings shall output the following on the drawing:

a. Text containing the wording "Solar Ready" or "PV Ready" to indicate the truss has been designed Solar Ready or "PV Ready".

b. Truss chord label under the SR/PVR plane.
Example "Chord A-E supports solar panels"

c. The Solar Ready / PV Ready 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

(2) Blocking method or J & U bolts

(3) Direct to Top Chord Method

5. Attachment Methods

Once the home has been verified as being built Solar Ready or PV 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 2.

Table 2. Scab Nailing Pattern

		Nail diameter →	0.120"	0.131"	0.148"
ROWS	VALID CHORD SIZE	SPACING (IN)	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

NOTES:
1) Dry SPF No. 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). The splices plates connecting scab members must match the top chord splice plates

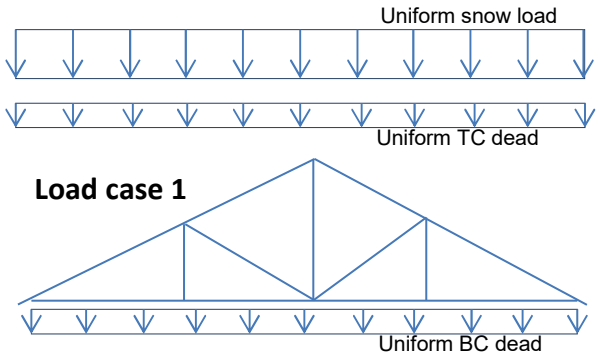
B. Other Methods

Other methods of attachment such as blocking, j-bolt or u-bolts as well as roof integrated systems of attachment may be used as recommended by the solar system manufacturer. In no case shall fasteners be used to reduce the truss chord cross-section.

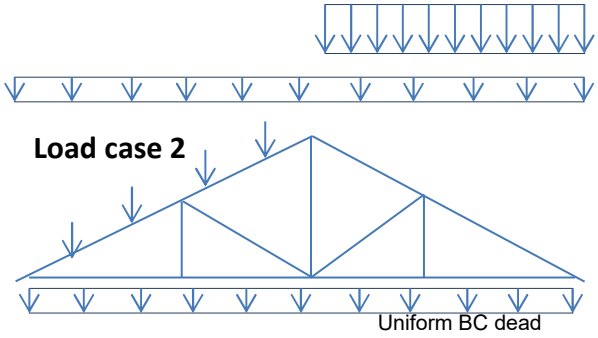
Note that TPIC SR Trusses are not designed to accommodate lagging directly into truss top chords. This method of attachment is therefore not permitted.

6. Load Cases Required by Section 4.B.I: a & b

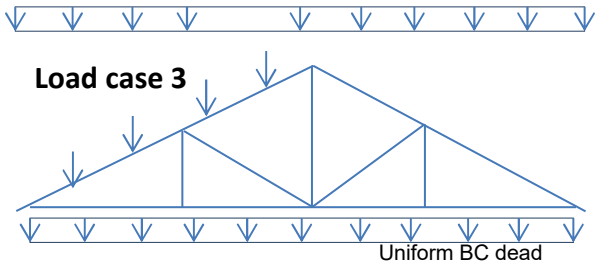
The following load cases are required for SR / PVR truss design:



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



- 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

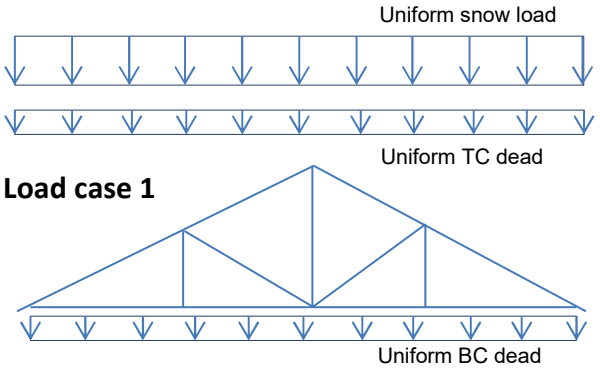


- Uniform TC dead loads
- Conc. Solar panel moving dead load @ 4 ft OC
- Uniform BC dead load

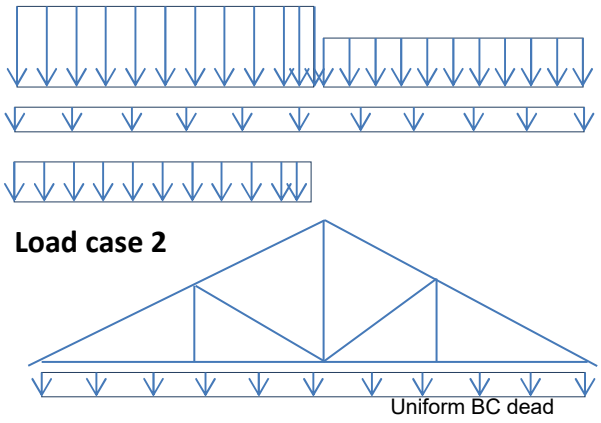
Other load cases may be required by authority having Jurisdiction

7. Load Cases Required by Section 4.B.I: c

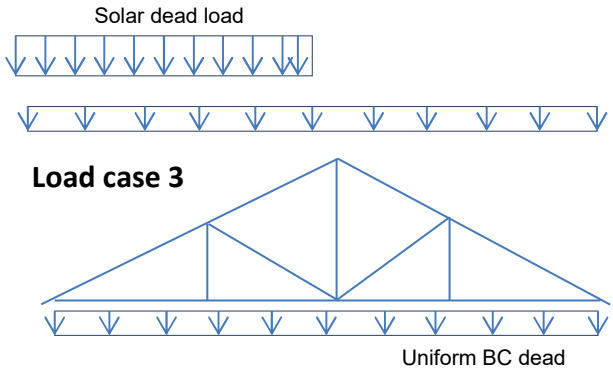
The following load cases are required for SR / PVR truss design:



- 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