

**Oregon
Solar Installation
Specialty Code**

Draft Document

**July
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CHAPTER 1
ADMINISTRATION
SECTION 101
GENERAL

101.1 Title. These regulations shall be known as the **Oregon Solar Installation Specialty Code**, hereinafter referred to as “this code.”

101.2 Scope.

101.2.1 General. The provisions of this code shall apply to all aspects of the structural requirements for the installation, alteration, replacement and repair of solar Photovoltaic (PV) systems.

Exceptions:

1. This code shall not apply to the installation, alteration, re-placement, repair of PV systems in a public way.
2. This code shall not apply to the installation of structural components on exempt agricultural buildings as defined in Oregon Revised Statute (ORS) 455.315.
3. Electrical installation, alteration and repair as defined in ORS 479.510-895 are controlled by **Oregon Electrical Specialty Code (OESC) chapter 690**, replicated in Appendix A.
4. Existing PV installations that complied with minimum safety standards in effect at time of installation shall not be considered in violation of the current minimum PV installation standards unless the use or occupancy changed, requiring different methods, alterations or additions or the International Fire Code (IFC) or Building Official requires updates to protect the safety of the occupants and public.

455.020 Purpose; scope of application; exceptions; scope of rules; fees by rule. (1) This chapter is enacted to enable the Director of the Department of Consumer and Business Services to promulgate a state building code to govern the construction, reconstruction, alteration and repair of buildings and other structures and the installation of mechanical devices and equipment therein, and to require the correction of unsafe conditions caused by earthquakes in existing buildings. The state building code shall establish uniform performance standards providing reasonable safeguards for health, safety, welfare, comfort and security of the residents of this state who are occupants and users of buildings, and will provide for the use of modern methods, devices, materials, techniques and practicable maximum energy conservation.

(2) The rules adopted pursuant to this chapter shall include

structural standards; standards for the installation and use of mechanical, heating and ventilating devices and equipment; and standards for prefabricated structures; and shall, subject to ORS 455.210, prescribe reasonable fees for the issuance of building permits and similar documents, inspections and plan review services by the Department of Consumer and Business Services. The department may also establish, by rule, the amount of any fee pertaining to the state building code or any specialty code that is authorized by statute, but for which an amount is not specified by statute.

(3) This chapter does not affect the statutory jurisdiction and authority of the Workers' Compensation Board, under ORS chapter 654, to promulgate occupational safety and health standards relating to places of employment, and to administer and enforce all state laws, regulations, rules, standards and lawful orders requiring places of employment to be safe and healthful.

(4) This chapter and any specialty code does not limit the authority of a municipality to enact regulations providing for local administration of the state building code; local appeal boards; fees and other charges; abatement of nuisances and dangerous buildings; enforcement through penalties, stop-work orders or other means; or minimum health, sanitation and safety standards for governing the use of structures for housing, except where the power of municipalities to enact any such regulations is expressly withheld or otherwise provided for by statute. Pursuant to the regulation of dangerous buildings, a municipality may adopt seismic rehabilitation plans that provide for phased completion of repairs that are designed to provide improved life safety but that may be less than the standards for new buildings.

101.3 Intent. The purpose of this code is to establish the minimum requirements for the installation of PV components and support systems to safeguard the public health, safety and general welfare through structural strength and safety to life and property from fire and other hazards associated with the installation of PV systems, and to provide safety to fire fighters and emergency responders during emergency operations.

It is not the purpose of this code to create or otherwise establish or designate any particular class or group of persons who will or should be especially protected or benefited by the terms of this code. It does not affect the requirements contained in ORS 479.620-479.630 or the rules thereunder.

101.4 Statutory References. This code is adopted pursuant to the ORS. Where in any specific case this code and the statutes specify different requirements, the statute shall govern. Statutes related to this code are ORS 455.010 through 455.895.

101.5 Severability. In the event that any part or provision of this code is held to be illegal or void, this shall not have the effect of making void or illegal any of the other parts or provisions.

SECTION 102 APPLICABILITY

102.1 General. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable. Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern.

102.2 Other laws. The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

102.3 Application of references. References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

102.4 Referenced codes and standards. The codes and standards referenced in this code shall be considered part of the requirements of this code to the prescribed extent of each such reference. Where differences occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

102.4.1 Structural. Where not specifically addressed in this code, the provisions of the **Oregon Structural Specialty Code (OSSC)**, shall apply to the design and installation of structural support systems for PV installations.

SECTION 103

DUTIES AND POWERS OF THE BUILDING OFFICIAL

103.1 General. The building official is hereby authorized and directed to enforce the provisions of this code under ORS 455.148 or 455.150. The building official shall have the authority to render interpretations of this code and to adopt policies and procedures in order to clarify the application of its provisions. Such interpretations, policies and procedures shall be in compliance with the intent and purpose of this code. Such policies and procedures shall not have the effect of waiving requirements specifically provided for in this code.

103.2 Applications and permits. The building official shall receive applications, review construction documents, issue permits for the installation, alteration, replacement, repair of PV systems including the electrical and structural requirements, inspect the premises for which such permits have been issued, and enforce compliance with the provisions of this code.

Separate electrical permits are required under the **OESC** and Oregon Administrative Rule (OAR) 918-309.

103.3 Notices and orders. The building official shall issue all necessary notices or orders to ensure compliance with this code.

103.4 Inspections. The building official shall make all of the required inspections, or the building official shall have the authority to accept reports of inspection by approved agencies or individuals. Reports of such inspections shall be in writing and be certified by a responsible officer of such approved agency or by the responsible individual.

103.5 Reserved.

103.6 Right of entry. Where it is necessary to make an inspection to enforce the provisions of this code, or where the building official has reasonable cause to believe that there exists in a structure or upon a premises a condition which is contrary to or in violation of this code which makes the structure or premises unsafe, dangerous or hazardous, the building official is authorized to enter the structure or premises at reasonable times to inspect or to perform the duties imposed by this code, provided that if such structure or premises be occupied that credentials be presented to the occupant and entry requested. If such structure or premises is unoccupied, the building official shall first make a reasonable effort to locate the owner or other person having charge or control of the structure or premises and request entry. If entry is refused, the building official shall have recourse to the remedies provided by law to secure entry.

103.7 Department records. The building official shall keep official records as dictated by OAR 166-150-0020 where a county has jurisdiction; OAR 166-200-0025 where a city has jurisdiction; and OAR Chapter 166 Division 300 et al for the cities and counties where the State of Oregon has jurisdiction. Such records shall be retained in the official records for the period indicated in the respective OARs noted above. The

building official shall maintain a permanent record of all permits issued in flood hazard areas, including copies of inspection reports and certifications required in Section 1612.

103.8 Liability. See ORS 30.265 for regulations relating to liability.

30.265 Scope of liability of public body, officers, employees and agents; liability in nuclear incident. (1) Subject to the limitations of ORS 30.260 to 30.300, every public body is subject to action or suit for its torts and those of its officers, employees and agents acting within the scope of their employment or duties, whether arising out of a governmental or proprietary function or while operating a motor vehicle in a ridesharing arrangement authorized under ORS 276.598. The sole cause of action for any tort of officers, employees or agents of a public body acting within the scope of their employment or duties and eligible for representation and indemnification under ORS 30.285 or 30.287 shall be an action against the public body only. The remedy provided by ORS 30.260 to 30.300 is exclusive of any other action or suit against any such officer, employee or agent of a public body whose act or omission within the scope of the officer's, employee's or agent's employment or duties gives rise to the action or suit. No other form of civil action or suit shall be permitted. If an action or suit is filed against an officer, employee or agent of a public body, on appropriate motion the public body shall be substituted as the only defendant. Substitution of the public body as the defendant does not exempt the public body from making any report required under ORS 742.400.

(2) Every public body is immune from liability for any claim for injury to or death of any person or injury to property resulting from an act or omission of an officer, employee or agent of a public body when such officer, employee or agent is immune from liability.

(3) Every public body and its officers, employees and agents acting within the scope of their employment or duties, or while operating a motor vehicle in a ridesharing arrangement authorized under ORS 276.598, are immune from liability for:

- (a) Any claim for injury to or death of any person covered by any workers' compensation law.
- (b) Any claim in connection with the assessment and collection of taxes.
- (c) Any claim based upon the performance of or the failure to exercise or perform a discretionary function or duty, whether or not the discretion is abused.
- (d) Any claim that is limited or barred by the provisions of any other statute, including but not limited to any statute of ultimate repose.

(e) Any claim arising out of riot, civil commotion or mob action or

out of any act or omission in connection with the prevention of any of the foregoing.

(f) Any claim arising out of an act done or omitted under apparent authority of a law, resolution, rule or regulation that is unconstitutional, invalid or inapplicable except to the extent that they would have been liable had the law, resolution, rule or regulation been constitutional, valid and applicable, unless such act was done or omitted in bad faith or with malice.

(4) Subsection (1) of this section applies to any action of any officer, employee or agent of the state relating to a nuclear incident, whether or not the officer, employee or agent is acting within the scope of employment, and provided the nuclear incident is covered by an insurance or indemnity agreement under 42 U.S.C. 2210.

(5) Subsection (3)(c) of this section does not apply to any discretionary act that is found to be the cause or partial cause of a nuclear incident covered by an insurance or indemnity agreement under the provisions of 42 U.S.C. 2210, including but not limited to road design and route selection.

103.9 Approved materials and equipment. Materials, equipment and devices approved by the building official shall be constructed and installed in accordance with such approval.

103.9.1 Used materials and equipment. The use of used materials which meet the requirements of this code for new materials is permitted.

103.10 Modifications. Wherever there are practical difficulties involved in carrying out the provisions of this code, the building official shall have the authority to grant modifications for individual cases, upon application of the owner or owner's representative, provided the building official shall first find that special individual reason makes the strict letter of this code impractical and the modification is in compliance with the intent and purpose of this code and that such modification does not lessen health, accessibility, life and fire safety, or structural requirements. The details of action granting modifications shall be recorded and entered in the files of the department of building safety.

103.11 Alternative materials, design and methods of construction and equipment. The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, design or method of construction shall be approved where the building official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

103.11.1 Tests. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the building official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the building official shall approve the testing procedures. Tests shall be performed by an approved agency. Reports of such tests shall be retained by the building official for the period required for retention of public records.

SECTION 104 PERMITS

104.1 Required. Any owner or authorized agent who intends to construct, enlarge, alter, repair, move, or change the installation of a PV system or the installation of which is regulated by this code, or to cause any such work to be done, shall first make application to the building official and obtain the required permit.

104.2 Work exempt from permit. Exemptions from permit requirements of this code shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other laws or ordinances of this jurisdiction. Permits shall not be required for the following:

Temporary testing systems: A permit shall not be required for the installation of any temporary testing system.

104.2.1 Emergency repairs. Where equipment replacements and repairs must be performed in an emergency situation, the permit application shall be submitted within the next working business day to the building official.

104.2.2 Public service agencies. A permit shall not be required for the installation, alteration or repair of generation, transmission, distribution or metering or other related equipment that is under the ownership and control of public service agencies by established right.

104.2.3 Electrical Permits. Additional exemptions from permitting requirements for electrical installations are found in Oregon Administrative Rule 918-309-0000.

104.3 Application for permit. To obtain a permit, the applicant shall first file an application therefor in writing on a form furnished by the building department for that purpose.

Such application shall:

1. Identify and describe the work to be covered by the permit for which application is made.

2. Describe the land on which the proposed work is to be done by legal description, street address or similar description that will readily identify and definitely locate the proposed work.
3. Be accompanied by construction documents and other information as required in **Section 105**.
4. State the valuation of the proposed work.
5. Be signed by the applicant, or the applicant's authorized agent.
6. Give such other data and information as required by the building official.

104.3.1 Action on application. The building official shall examine or cause to be examined applications for permits and amendments thereto within a reasonable time after filing. If the application or the construction documents do not conform to the requirements of pertinent laws, the building official shall reject such application in writing, stating the reasons therefor. If the building official is satisfied that the proposed work conforms to the requirements of this code and laws and ordinances applicable thereto, the building official shall issue a permit therefor as soon as practicable.

104.3.2 Time limitation of application. An application for a permit for any proposed work shall be deemed to have been abandoned 180 days after the date of filing, unless such application has been pursued in good faith or a permit has been issued; except that the building official is authorized to grant one or more extensions of time for additional periods not exceeding 90 days each. The extension shall be requested in writing and justifiable cause demonstrated.

104.4 Validity of permit. The issuance or granting of a permit shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code or of any other ordinance of the jurisdiction. Permits presuming to give authority to violate or cancel the provisions of this code or other ordinances of the jurisdiction shall not be valid. The issuance of a permit based on construction documents and other data shall not prevent the building official from requiring the correction of errors in the construction documents and other data. The building official is also authorized to prevent occupancy or use of a structure where in violation of this code or of any other ordinances of the jurisdiction.

104.5 Expiration. Every permit issued shall become invalid unless the work on the site authorized by such permit is commenced within 180 days after its issuance, or if the work authorized on the site by such permit is suspended or abandoned for a period of 180 days after the time the work is commenced. The building official is authorized to grant, in writing, one or more extensions of time, for periods not more than 180 days each. The extension shall be requested in writing and justifiable cause demonstrated.

104.6 Suspension or revocation. The building official is authorized to suspend or revoke a permit issued under the provisions of this code wherever the permit is issued in error or on the basis of incorrect, inaccurate or incomplete information, or in violation of any ordinance or regulation or any of the provisions of this code.

104.7 Placement of permit. The building permit or copy shall be kept on the site of the work until the completion of the project.

SECTION 105

SUBMITTAL DOCUMENTS

105.1 General. Submittal documents consisting of construction documents, statement of special inspections, geotechnical report and other data shall be submitted in two or more sets with each permit application. The construction documents shall be prepared by a registered design professional where required by the building codes. Where special conditions exist, the building official is authorized to require additional construction documents to be prepared by a registered design professional.

Exceptions:

1. The building official is authorized to waive the submission of construction documents and other data not required to be prepared by a registered design professional if it is found that the nature of the work applied for is such that review of construction documents is not necessary to obtain compliance with this code.
2. Plans, calculations and specifications, diagrams and other data prepared and designed by an architect or an engineer licensed by the state to practice as such are not required for the following work, provided the building official determines that the work is not of a highly technical nature or there is unreasonable potential risk to life and/or the safety of the structure:
 - 2.1 The erection, enlargement or alteration of any structure, or any appurtenance thereto, where the resulting structure has a ground area of 4,000 square feet (372m²) or less and is not more than 20 feet (6096 mm) in height from the top surface of the lowest floor to the highest interior finish (See ORS 671.030).
 - 2.2 A single family dwelling, a farm agricultural building, non-farm agricultural building, or accessory building to a single-family dwelling.
 - 2.3 Alterations or repairs that do not involve structural parts of the building.
3. Plans, calculations and specifications, diagrams and other data prepared and designed by an architect or an engineer, licensed by the state to practice as such, are not required where the applicant has demonstrated on a form approved by the division that the proposed installation complies with the requirements of sections 304.9 [Fire Fighter Access] and 305.4 [Prescriptive Path].

105.2 Construction documents. Construction documents shall be in accordance with **Sections 105.2.1** through **105.2.5**.

Exception: Exception: Construction documents shall not be required when applicant has demonstrated on a form approved by the division that proposed installation complies with the requirements of sections **304.9** and **305.4**

105.2.1. Construction Documents. The following construction documents shall be provided to the Authority Having Jurisdiction at the time of permit application.

105.2.2 Support Structure. The construction documents shall describe, with sufficient clarity, the structure required to support the components and to resist the applicable snow, seismic, wind and uplift forces as defined in the **Oregon Structural Specialty Code (OSSC)**. The construction documents, including calculations, shall be prepared by an Architect or Engineer licensed to practice in the state of Oregon and shall be designed in accordance with the requirements of the **OSSC**.

105.2.3 Component Attachment. The construction documents shall be in sufficient clarity to show attachments are designed to resist the applicable snow, seismic, wind and uplift forces on the PV components as defined in the **OSSC**. The construction documents, including calculations, shall be prepared by an Architect or Engineer licensed to practice in the state of Oregon and shall be designed in accordance with the requirements of the **OSSC**.

Exception: Construction documents showing component attachment shall not be required to be prepared by an Architect or Engineer licensed in the State of Oregon when the manufacturers installation instructions provide designs sufficient for the applicable snow, seismic, wind and uplift loads.

105.2.5 Building and Site Plan. The construction documents shall show and describe, with sufficient clarity, the location(s) of the PV components in relation to buildings, structures, property lines and, as applicable, flood hazard areas, floodways and shall show compliance with local zoning, planning, solar access requirements, etc, if applicable, as required by the Building Official. The building official is authorized to waive or modify the requirement for a site plan when the application for permit is for alteration or repair or when otherwise warranted.

Exception: Subject to the approval of the Building Official, construction documents showing the building and site plan shall not be required when, due to the nature of the project, it can be demonstrated that there are no significant impacts to the items in listed above.

105.2.5.1 Design flood elevations. Where design flood elevations are not specified, they shall be established in accordance with **OSSC Section 1612.3.1**.

105.2.6 Information on construction documents. Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when

approved by the building official. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations, as determined by the building official.

105.3 Examination of documents. The building official shall examine or cause to be examined the accompanying submittal documents and shall ascertain by such examinations whether the construction indicated and described is in accordance with the requirements of this code and other pertinent laws or ordinances.

105.3.1 Approval of construction documents. When the building official issues a permit, the construction documents shall be approved, in writing or by stamp, as “Reviewed for Code Compliance.” One set of construction documents so reviewed shall be retained by the building official. The other set shall be returned to the applicant, shall be kept at the site of work and shall be open to inspection by the building official or a duly authorized representative.

105.3.2 Previous approvals. This code shall not require changes in the construction documents or construction for which a lawful permit has been heretofore issued or otherwise lawfully authorized, and the construction of which has been pursued in good faith within 180 days after the effective date of this code and has not been abandoned.

105.3.3 Phased approval. The building official is authorized to issue a permit for the construction of PV support systems before the construction documents for the whole PV system has been submitted, provided that adequate information and detailed statements have been filed complying with pertinent requirements of this code. The holder of such permit for the PV support systems shall proceed at the holder’s own risk without assurance that a permit for the entire PV system will be granted.

105.3.4 Design professional in responsible charge.

105.3.4.1 General. When it is required that documents be prepared by a registered design professional, the building official shall be authorized to require the owner, or installer to engage and designate on the building permit application a registered design professional who shall act as the registered design professional in responsible charge. If the circumstances require, the owner, or installer shall designate a substitute registered design professional in responsible charge who shall perform the duties required of the original registered design professional in responsible charge. The building official shall be notified in writing by the owner or installer if the registered design professional in responsible charge is changed or is unable to continue to perform the duties. The registered design professional in responsible charge shall be responsible for reviewing and coordinating submittal documents prepared by others, including phased and deferred submittal items, for compatibility with the design of the PV system.

105.3.4.2 Deferred submittals. For the purposes of this section, deferred submittals are defined as those portions of the design that are not submitted at the time of the application and that are to be submitted to the building official within a specified period.

Deferral of any submittal items shall have the prior approval of the building official. The registered design professional in responsible charge shall list the deferred submittals on the construction documents for review by the building official.

Documents for deferred submittal items shall be submitted to the registered design professional in responsible charge who shall review them and forward them to the building official with a notation indicating that the deferred submittal documents have been reviewed and found to be in general conformance to the design of the PV system. The deferred submittal items shall not be installed until the deferred submittal documents have been approved by the building official.

105.4 Amended construction documents. Work shall be installed in accordance with the approved construction documents, and any changes made during installation that are not in compliance with the approved construction documents shall be resubmitted for approval as an amended set of construction documents.

105.5 Retention of construction documents. One set of approved construction documents shall be retained by the building official for a period of not less than that dictated by OAR 166-150-0020 where a county has jurisdiction, OAR 166-200-0025 where a city has jurisdiction and OAR 166-300 et al for the jurisdictions where the State of Oregon has jurisdiction. One set of approved plans and specifications shall be returned to the applicant, and said set shall be kept on the site of the work at all times during which the work authorized thereby is in progress. The building official shall maintain a permanent record of all permits issued in flood hazard areas, including copies of inspection reports and certifications required in Section 1612.

SECTION 106

TEMPORARY STRUCTURES AND USES

106.1 General. The building official is authorized to issue a permit for temporary structures and temporary uses. Such permits shall be limited as to time of service, but shall not be permitted for more than 180 days. The building official is authorized to grant extensions for demonstrated cause.

106.2 Conformance. Temporary structures and uses shall conform to the structural strength, and fire safety requirements of this code as necessary to ensure public health, safety and general welfare.

106.3 Termination of approval. The building official is authorized to terminate such permit for a temporary structure or use and to order the temporary structure or use to be discontinued.

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SECTION 107

FEES

Note: Unless amended locally by a municipality under the authority of ORS 455.040 and 455-210, the requirements of Section 107 apply.

107.1 Payment of fees. A permit shall not be valid until the fees prescribed by law have been paid, nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

107.2 Schedule of permit fees. A fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority under authority of ORS 455.020 and 455.210.

455.210. (1) Fees shall be prescribed as required by ORS 455.020 for plan review and permits issued by the Department of Consumer and Business Services for the construction, reconstruction, alteration and repair of prefabricated structures and of buildings and other structures and the installation of mechanical heating and ventilating devices and equipment. The fees may not exceed 130 percent of the fee schedule printed in the "Uniform Building Code," 1979 Edition, and in the "Uniform Mechanical Code," 1979 Edition, both published by the International Conference of Building Officials. Fees are not effective until approved by the Oregon Department of Administrative Services.

(2) Notwithstanding subsection (1) of this section, the maximum fee the Director of the Department of Consumer and Business Services may prescribe for a limited plan review for fire and life safety as required under ORS 479.155 shall be 40 percent of the prescribed permit fee.

(3)(a) A municipality may adopt by ordinance or regulation such fees as may be necessary and reasonable to provide for the administration and enforcement of any specialty code or codes for which the municipality has assumed responsibility under ORS 455.148 or 455.150. A municipality shall give the director notice of the proposed adoption of a new or increased fee under this subsection. The municipality shall give the notice to the director at the time the municipality provides the opportunity for public comment under ORS 294.160 regarding the fee or, if the proposed fee is contained in an estimate of municipal budget resources, at the time notice of the last budget meeting is published in a newspaper under ORS 294.401.

(b) Ten or more persons or an association with 10 or more members may appeal the adoption of a fee described in this

subsection to the Director of the Department of Consumer and Business Services. The persons or association must file the appeal no later than 60 days after the director receives notice of the proposed adoption of the fee from the municipality under paragraph (a) of this subsection. However, if the municipality failed to give notice to the director, an appeal may be filed with the director within one year after adoption of the new or increased fee. Upon receiving a timely appeal, the director shall, after notice to affected parties and hearing, review the municipality's fee adoption process and the costs of administering and enforcing the specialty code or codes referred to in paragraph (a) of this subsection. The director shall approve the fee if the director feels the fee is necessary and reasonable. If the director does not approve the fee upon appeal, the fee is not effective. The appeal process provided in this paragraph does not apply to fees that have been submitted for a vote and approved by a majority of the electors voting on the question.

(c) Fees collected by a municipality under this subsection shall be used for the administration and enforcement of a building inspection program for which the municipality has assumed responsibility under ORS 455.148 or 455.150.

(d) For purposes of paragraph (b) of this subsection, in determining whether a fee is reasonable the director shall consider whether:

(A) The fee is the same amount as or closely approximates the amount of the fee charged by other municipalities of a similar size and geographic location for the same level of service;

(B) The fee is calculated with the same or a similar calculation method as the fee charged by other municipalities for the same service;

(C) The fee is the same type as the fee charged by other municipalities for the same level of service; and

(D) The municipality, in adopting the fee, complied with ORS 294.160, 294.361 and 294.401 and this section and standards adopted by the director under ORS 455.148 (11) or 455.150 (11).

(4) Notwithstanding any other provision of this chapter:

(a) For the purpose of partially defraying state administrative costs, there is imposed a surcharge in the amount of four percent of the total permit fees or, if the applicant chooses to pay an hourly rate instead of purchasing a permit, four percent of the total hourly charges collected.

(b) For the purpose of partially defraying state inspection costs, there is imposed a surcharge in the amount of two percent of the total permit fees or, if the applicant chooses to pay an hourly rate instead of purchasing a permit, two percent of the total hourly charges collected.

(c) For the purpose of defraying the cost of administering and enforcing the state building code, there is imposed a surcharge on permit fees and on hourly charges collected instead of permit fees. The surcharge may not exceed one percent of the total permit fees or, if the applicant chooses to pay an hourly rate instead of purchasing a permit, one percent of the total hourly charges collected.

(5) Municipalities shall collect and remit surcharges imposed under subsection (4) of this section to the director as provided in ORS 455.220.

(6) The director shall adopt administrative rules to allow reduced fees for review of plans that have been previously reviewed.

107.3 Plan review fees

107.3.1 Building permit valuations.

1. Permits issued for installations that comply with **304.9** and **305.4**, will be charged a flat fee that includes permit review in accordance with OAR 918-050-0180.
2. All other installations shall be based on the value of the system following the methodology set out in OAR 918-050-0180.

107.4 Work commencing before permit issuance. Any person who commences any work on a PV system before obtaining the necessary permits shall be subject to an investigation fee equal to the permit fee that shall be in addition to the required permit fees.

Exception: Work as permitted in Section **104.2.1**

107.5 Related fees. The payment of the fee for the construction, or alteration, for work done in connection to or concurrently with the work authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.

107.6 Refunds. The building official is authorized to establish a refund policy.

SECTION 108

INSPECTIONS

108.1 General. Construction or work for which a permit is required shall be subject to inspection by the building official and such construction or work shall remain accessible and exposed for inspection purposes until approved. Approval as a result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or of other laws or ordinances of the jurisdiction. Inspections

presuming to give authority to violate or cancel the provisions of this code or of other laws or ordinances of the jurisdiction shall not be valid. It shall be the duty of the permit applicant to cause the work to remain accessible and exposed for inspection purposes. Neither the building official nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material required to allow inspection.

108.2 Preliminary Inspection. Before issuing a permit, the building official is authorized to examine or cause to be examined structures and sites for which an application has been filed.

108.3 Required Inspections. The building official, upon notification, shall make the inspections set forth in Sections

108.3.1 through 108.3.10.

108.3.1 Ground Mounted Footing and Foundation Inspection. Footing and foundation inspections shall be made after excavations for footings are complete and any required reinforcing steel is in place. It shall be noted in the inspection report if the structural metal and reinforcing steel comply with the OESC requirements for a grounding electrode. For concrete foundations, any required forms shall be in place prior to inspection. Materials for the foundation shall be on the job, except where concrete is ready mixed in accordance with ASTM C 94, the concrete need not be on the job.

108.3.2 Mounting Inspection. Inspection shall be made of the attachment of modules to racking or structural supports and the attachment of components to the structure.

108.3.3 Electrical Inspection. Inspection of electrical components of a PV system shall be conducted in accordance with the requirements of OAR 918-271. Where structural components, such as rebar, are used as grounding elements they shall be included as part of the electrical inspection.

108.3.4 Lowest Equipment Elevation. In flood hazard areas, the elevation certification required in OSSC Section 1612.5 shall be submitted to the building official.

108.3.5 Other Inspections. In addition to the inspections specified above, the building official is authorized to make or require other inspections of any construction work to ascertain compliance with the provisions of this code and other laws that are enforced by the department of building safety.

108.3.6 Special Inspections. For special inspections, see Section OSSC 1704.

108.3.7 Final Inspection. The final inspection shall be made after all work required by the building permit is completed.

108.4 Inspection Agencies. The building official is authorized to accept reports of approved inspection agencies, provided such agencies satisfy the requirements as to qualifications and reliability.

108.5 Inspection Requests. It shall be the duty of the holder of the building permit or their duly authorized agent to notify the building official when work is ready for inspection. It shall be the duty of the permit holder to provide access to and means for inspections of such work that are required by this code.

108.6 Approval Required. Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the building official. The building official, upon notification, shall make the requested inspections and shall either indicate the portion of the construction that is satisfactory as completed, or notify the permit holder or his or her agent wherein the same fails to comply with this code. Any portions that do not comply shall be corrected and such portion shall not be covered or concealed until authorized by the building official.

SECTION 109 BOARD OF APPEALS

109.1 General. In order to hear and decide appeals of orders, decisions or determinations made by the building official relative to the application and interpretation of this code the local jurisdiction shall establish an appeals procedure.

109.2 Limitations on Authority. An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equally good or better form of construction is proposed. An appeals board, when appointed, shall have no authority to waive requirements of this code.

109.4 Appeal of Decisions of Building Official. ORS 455.475 provides an alternative appeals process to that set forth by the local municipality.

455.475 Appeal of decision of building official. A person aggrieved by a decision made by a building official under authority established pursuant to ORS 455.148, 455.150 or 455.467 may appeal the decision. The following apply to an appeal under this section:

(1) An appeal under this section shall be made first to the appropriate specialty code chief inspector of the Department of Consumer and Business Services. The decision of the department chief inspector may be appealed to the appropriate advisory board. The decision of the advisory board may only be appealed to the Director of the Department of Consumer and Business Services if codes in addition to the applicable specialty code are at issue.

(2) If the appropriate advisory board determines that a decision by the department chief inspector is a major code interpretation, then the inspector shall distribute the decision in writing to all applicable specialty code public and private inspection authorities in the state. The decision shall be distributed within 60 days after the board's determination, and there shall be no charge for the distribution of the decision. As used in this subsection, a "major code interpretation" means a code interpretation decision that affects or may affect more than one job site or more than one inspection jurisdiction.

(3) If an appeal is made under this section, an inspection authority shall extend the plan review deadline by the number of days it takes for a final decision to be issued for the appeal.

SECTION 110 VIOLATIONS

110.1 Prohibited Acts. Prohibited acts are as described in ORS 455.450.

455.450 Prohibited acts. A person may not:

(1) Violate, or procure or assist in the violation of, any final order of the Director of the Department of Consumer and Business Services, an advisory board, a state administrative officer or any local appeals board, building official or inspector, concerning the application of the state building code in a particular case or concerning a license, certificate, registration or other authorization.

(2) Engage in, or procure or assist any other person to engage in, any conduct or activity for which a permit, label, license, certificate, registration or other formal authorization is required by any specialty code, any provision of ORS 446.003 to 446.200, 446.225 to 446.285, 446.395 to 446.420, 446.566 to 446.646, 446.666 to 446.746, 479.510 to 479.945, 479.950 and 480.510 to 480.670, this chapter or ORS chapter 447, 460 or 693, or any rule adopted or order issued for the administration and enforcement of those provisions, without first having obtained such permit, label, license, certificate, registration or other formal authorization.

(3) Violate, or procure or assist in the violation of, any standard, specification, requirement, prohibition or other technical provision set forth in the state building code or an applicable local building code or in any rule or order of the Department of Consumer and Business Services, an advisory board, a local governing body or local building official.

110.2 Notice of Violation. The building official is authorized to serve a notice of violation or order on the person responsible for the erection, construction, alteration, extension, or repair of a PV system in violation of the provisions of this code, or in violation of a permit or certificate issued under the provisions of this code. Such order shall direct the discontinuance of the illegal action or condition and the abatement of the violation.

110.3 Prosecution of Violation. If the notice of violation is not complied with promptly, the building official is authorized to request the legal counsel of the jurisdiction to institute the appropriate proceeding at law or in equity to restrain, correct or abate such violation, or to require the removal of the PV system in violation of the provisions of this code or of the order or direction made pursuant thereto.

110.4 Violation Penalties. Any person who violates a provision of this code or fails to comply with any of the requirements thereof or who erects, constructs, alters or repairs a PV system in violation of the approved construction documents or directive of the building official, or of a permit or certificate issued under the provisions of this code, shall be subject to penalties as prescribed by law.

110.5 Penalties. Penalties for violations are prescribed in ORS 455.895 or as adopted by the municipality having authority. Local authority to levy penalties is limited to violations of code application only.

455.895 Civil penalties. (1)(a) The State Plumbing Board may impose a civil penalty against a person as provided under ORS 447.992 and 693.992. Amounts recovered under this paragraph are subject to ORS 693.165.

(b) The Electrical and Elevator Board may impose a civil penalty against a person as provided under ORS 479.995. Amounts recovered under this paragraph are subject to ORS 479.850.

(c) The Board of Boiler Rules may impose a civil penalty against a person as provided under ORS 480.670. Amounts recovered under this paragraph are subject to ORS 480.670.

(2) The Director of the Department of Consumer and Business Services, in consultation with the appropriate board, if any, may impose a civil penalty against any person who violates any provision of ORS 446.003 to 446.200, 446.225 to 446.285, 446.395 to 446.420, 446.566 to 446.646, 446.666 to 446.746, 479.510 to 479.945, 479.950 and 480.510 to 480.670 and this chapter and ORS chapters 447, 460 and 693, or any rule adopted or order issued for the administration and enforcement of those provisions. Except as provided in subsections (3), (4) and (9) of this section or ORS 446.995, a civil penalty imposed under this section must be in an amount determined by the appropriate board or the director of not more than \$5,000 for each offense or, in the case of a continuing offense, not more than \$1,000 for each day of the offense.

(3) Each violation of ORS 446.003 to 446.200 or 446.225 to 446.285, or any rule or order issued thereunder, constitutes a separate violation with respect to each manufactured structure or with respect to each failure or refusal to allow or perform an act required thereby, except that the maximum civil penalty may not exceed \$1 million for any related series of violations occurring within one year from the date of the first violation.

(4) The director may impose a civil penalty of not more than \$25,000 against a public body responsible for administering and enforcing a building inspection program. As used in this subsection, “public body” has the meaning given that term in ORS 174.109.

(5) The maximum penalty established by this section for a violation may be imposed only upon a finding that the person has engaged in a pattern of violations. The Department of Consumer and Business Services, by rule, shall define what constitutes a pattern of violations. Except as provided in subsections (1) and (10) of this section, moneys received from any civil penalty under this section are appropriated continuously for and shall be used by the director for enforcement and administration of provisions and rules described in subsection (2) of this section.

(6) Civil penalties under this section shall be imposed as provided in ORS 183.745.

(7) A civil penalty imposed under this section may be remitted or reduced upon such terms and conditions as the director or the appropriate board considers proper and consistent with the public health and safety. In any judicial review of a civil penalty imposed under this section, the court may, in its discretion, reduce the penalty.

(8) Any officer, director, shareholder or agent of a corporation, or member or agent of a partnership or association, who personally participates in or is an accessory to any violation by the partnership, association or corporation of a provision or rule described in subsection (2) of this section is subject to the penalties prescribed in this section.

(9) In addition to the civil penalty set forth in subsection (1) or (2) of this section, any person who violates a provision or rule described in subsection (2) of this section may be required by the director or the appropriate board to forfeit and pay to the General Fund of the State Treasury a civil penalty in an amount determined by the director or board that shall not exceed five times the amount by which such person profited in any transaction that violates a provision or rule described in subsection (2) of this section.

(10) If a civil penalty is imposed for a violation of a provision of ORS 446.566 to 446.646 and the violation relates to a

filing or failure to file with a county assessor functioning as agent of the department, the department, after deducting an amount equal to the department's procedural, collection and other related costs and expenses, shall forward one-half of the remaining civil penalty amount to the county in which the manufactured structure is located at the time of the violation.

SECTION 111 STOP WORK ORDER

111.1 Authority. Whenever the building official finds any work regulated by this code being performed in a manner either contrary to the provisions of this code or dangerous or unsafe, the building official is authorized to issue a stop work order.

111.2 Issuance. The stop work order shall be in writing and shall be given to the owner of the property involved, or to the owner's agent, or to the person doing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order, and the conditions under which the cited work will be permitted to resume.

111.3 Unlawful Continuance. Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be subject to penalty.

CHAPTER 2 DEFINITIONS

201.1 Scope. Unless otherwise expressly stated, the following words and terms shall, for the purposes of this code, have the meanings indicated in this chapter.

201.2 Interchangeability. Words used in the present tense include the future; the singular number includes the plural and the plural, the singular

201.3 Terms Defined in Other Codes. Where terms are not defined in this code such terms shall have the meanings ascribed to them as in other code publications adopted by the State of Oregon.

201.4 Terms Not Defined. Where terms are not defined through the methods authorized by this section, such terms shall have ordinarily accepted meanings such as the context implies.

SECTION 202 DEFINITIONS

– A –

Approved. Acceptable to the authority having jurisdiction.

Approved Field Evaluation Firm– An organization primarily established for purposes of testing to approved standards and approved by the Authority Having Jurisdiction.

Array. A mechanically integrated assembly of modules or panels with a support structure and foundation, tracker, and other components, as required, to form a power-producing unit.

Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

– B –

Building Code. As defined in ORS 455.020.

Building Integrated Photovoltaics. Photovoltaic cells, devices, modules, or modular materials that are integrated into the outer surface or structure of a building and serve as the outer protective surface of that building.

– D –

Dead Load. The weight of materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding and other similarly incorporated architectural and structural items, and the weight of fixed service equipment, such as cranes, plumbing stacks and risers, electrical feeders, HVAC systems and fire sprinkler systems.

– E –

Electrical Code, (OESC). For the purpose of this code, any reference to the Electrical Code shall mean the **Oregon Electrical Specialty Code**.

Existing Work. Existing work is a PV system or any part thereof which has been installed prior to the effective date of this Code.

– L –

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Live loads (roof). Those loads produced (1) during maintenance by workers, equipment and materials; and (2) during the life of the structure by movable objects such as planters and by people.

– M –

Mechanical Code (OMSC). For the purpose of this code, any reference to the Mechanical Code shall mean the **Oregon Mechanical Specialty Code**.

Module. A complete, environmentally protected unit consisting of solar cells, optics, and other components, exclusive of tracker, designed to generate power when exposed to sunlight.

– N –

NRTL. A Nationally Registered Testing Laboratory.

– P –

Photovoltaic (PV). Relating to electricity produced by the action of solar radiation on a solar cell.

Photovoltaic (PV) System. The total components and subsystems that, in combination, convert solar energy into electric energy suitable for connection to a utilization load.

– R –

Racking. A system of components that directly supports the PV modules and transfers the applied loads to the building structure or ground-supported structure.

Residential Code, (ORSC). For the purpose of this code, any reference to the Residential Code shall mean the Oregon Residential Specialty Code.

– S –

Structural Code, (OSSC). For the purpose of this code, any reference to the Structural Code shall mean the Oregon Structural Specialty Code.

Supports. Supports, hangers, and anchors are devices for properly supporting and securing pipe, appurtenances, fixtures, and equipment.

– T –

Townhouse. Means a single family dwelling unit constructed in a group of three or more attached units in which each unit extends from foundation to roof and with open space on at least two sides. For the purposes of this code, row house, and zero lot line dwellings shall be considered to be townhouses.

CHAPTER 3
INSTALLATION REQUIREMENTS
SECTION 301
GENERAL

301.1 Scope. The provisions of this chapter shall govern the installation of photovoltaic (PV) components including location, materials and structural support. Where the installation of PV systems is not covered by this chapter the installation shall be in compliance with the applicable provisions of the Oregon Building Code as defined in ORS 455.020.

Exception: Where applicable provisions are specified, compliance with the **Oregon Residential Specialty Code (ORSC)** shall satisfy the requirements of this section when the PV system is installed on;

1. Detached one and two family dwellings and townhouses classified as Group R-3, and Group U Occupancies; and
2. Residences used for family daycare or foster care in accordance with ORS Chapters 418, 443 and 657A; and
3. Detached Congregate residences (each accommodating 10 persons or less) and detached lodging houses containing not more than five guest rooms.

SECTION 302
DEFINITIONS

302.1 General. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

Conventional Light-Frame Wood Construction. A type of construction whose primary structural elements are formed by a system of repetitive wood-framing members in accordance with **OSSC Section 2308** or the **ORSC** as applicable.

Cutout. An area adjacent to a pathway for use by firefighters to cut a vent if needed. Cutouts shall not be less than 30 inches (762 mm) in any dimension.

Non-Occupied Accessory Structure. A structure normally not occupied such as a garage, carport, shed, or agricultural building.

Pathway. Unobstructed route provided within or around the PV array to provide unimpeded access and egress for firefighting purposes.

Racking. A system of components that directly supports the PV modules and transfers the applied loads to the building structure or ground-supported structure

Solar Roof. A roof on which a solar array is installed.

SECTION 303

MINIMUM STANDARDS AND QUALITY

303.1 General. Photovoltaic (PV) components, racking, support structures and attachments shall be in accordance with the provisions of this chapter. PV systems shall be designed and installed in accordance with this code and the manufacturer's installation instructions.

303.2 Type of Construction. PV systems, including supporting structure, shall comply with the requirements of **OSSC Chapter 6** for the structures required to be of non-combustible type of construction or the **ORSC** as applicable.

303.3 Material Standards. PV modules shall be certified in accordance with UL1703 and shall be installed in accordance with the manufacturer's installation instructions.

303.4 Certification Requirements. PV racking and attachments shall comply with one of the following:

1. Certified to UL 1703 by a Nationally Recognized Testing Laboratory and installed in accordance with the manufacturers installation instructions.
2. Designed by an Oregon Licensed Engineer or Architect.
3. Field evaluation by an Approved Field Evaluation Firm.
4. Approval by the Authority Having Jurisdiction.

303.5 Fire Classification. Rooftop mounted PV systems shall have a fire classification that is equal to or greater than the roof assembly required by **OSSC Section 1505.1**.

303.6 Weather Protection. All components of the PV system exposed to the weather shall be constructed of materials approved for exterior locations and protected from corrosion or deterioration.

SECTION 304

LOCATION

304.1 General. The location of Photovoltaic (PV) components, racking, support structures and attachments shall be in accordance with the provisions of this chapter.

304.2 Zoning Requirements. The installation of PV systems shall comply with the requirements of the zoning requirements of the Authority Having Jurisdiction (AHJ).

304.3 Flood Hazard Areas. Installation of PV systems within flood hazard areas, as defined by the AHJ, shall comply with the **OSSC** or **ORSC Section R324** as applicable.

304.4 Building Egress. PV systems shall not be installed in locations that would restrict, or otherwise prevent the use of, the required means of egress and emergency escape and rescue. The means of egress shall comply with **Chapter 10** of the **OSSC** or **ORSC Section R310** and **R311** as applicable.

304.5 Light and Ventilation. PV systems shall not be installed in locations that would restrict the required light and ventilation. Light and ventilation shall comply with **OSSC Chapter 12** or **ORSC Section R303** as applicable.

304.6 Rooftop Vent and Drain Clearances. PV systems shall not be installed in locations that would restrict the function of plumbing or mechanical vents, skylights, drains or other rooftop features.

Exception: Non-operable skylights in one- and two-family dwellings.

304.7 Mechanical Equipment Clearances. PV systems shall be installed with not less than a 30 inch (762 mm) clearance around mechanical equipment requiring service or maintenance. The specific provisions of the **Oregon Mechanical Specialty Code (OMSC)** and **OESC** apply to installations of PV systems.

304.8 Roof Drainage. PV systems shall not be installed in a manner that would obstruct roof drainage. No vertical supports or roof penetrations shall be allowed within 12 inches (305 mm) of each side of the low point of the valley. The PV modules or racking may extend into the valley no more than 6 inches (152 mm) from the valley low point provided that a minimum 3 inch (76 mm) clearance above the surface of the roof is maintained.

304.9 Fire Fighter Access and Escape. To provide access and escape for Fire Fighters the location of roof-mounted PV modules shall comply with the requirements of this section.

304.9.1 General Pathway Requirements. All PV installations shall include a 36 inch wide (914mm) pathway maintained along three sides of the solar roof. The bottom edge of a roof with a slope that exceeds 2:12 shall not be used as a pathway. All pathways shall be located over a structurally supported area and measured from edge of the roof and horizontal ridge to the solar array or any portion thereof.

Exception:

1. On structures with a PV array area of 1,000 square feet (92.90m²) or less installed on a roof with a slope that exceeds 2:12 and with an intersecting adjacent roof and where no section is larger than 150 feet (45720 mm) measured in length or width:

A. Where the PV array does not exceed 25% as measured in plan view of total roof area of the structure, a minimum 12 inch (305mm) unobstructed pathway, shall be maintained along each side of any horizontal ridge.

B. Where the solar array area exceeds 25% as measured in plan view of total roof area of the structure, a minimum of one 36 inch (914 mm) unobstructed pathway from ridge to eave, over a structurally supported area, must be provided in addition to a minimum 12 inch (305mm) unobstructed pathway along each side of any horizontal ridge.

2. Pathways are not required on *non-occupied accessory structures* provided they are separated from occupied structures by a 6 feet (3048 mm) minimum separation distance or by a minimum two-hour fire rated assembly.

3. Townhouses providing fire separation as required by the applicable code at the time of construction may be considered one structure and comply with the provisions of 304.9.1(A).

Where townhouses are separated by real property lines and pathways cross real property lines, the building official shall review, approve and maintain a record of all easements for access related to the PV system installation. Easements may be general in nature or they may describe specific locations. The applicant shall provide a copy of the recorded easement to the building official prior to issuance of the building permit. Easements shall be recorded for each affected dwelling unit and the book and page number provided to the jurisdiction having authority.

NOTE: See section 304.10 for alternate installations.

304.9.2 Intermediate Pathway Locations. Systems that include a solar array section that is larger than 150 feet (mm) measured in length or width shall have additional intermediate pathways. An intermediate pathway not less than 36" (914mm) wide separating the array shall be provided for every 150 feet (45720 mm) of array including offset modules or angled installations. The maximum square footage of an array shall not exceed 22,500 ft². (2090 m²) without the installation of an intermediate pathway.

304.9.2.1. Where a system is required to have intermediate pathways, all pathways shall have one or more cutouts located adjacent to the pathway. No point on the pathway shall be more than 25 feet (7620) from a cutout.

304.9.3 Prohibited Locations. Pathways shall not be located within 12 inches of the low point of a valley.

304.9.4 Smoke and Heat Vents. In structures where smoke and heat vents have been installed to comply with the requirements of the **International Fire Code Chapter 9** Smoke and Heat Vents and **Chapter 23** High Piled Storage, a 36 inch wide pathway to and around each vent shall be provided for fire department access, maintenance and testing of these vents.

304.9.5 Electrical Component Location.

304.9.5.1 Disconnects, j-boxes, combiner boxes or gutters shall not be located in any required pathway or cutout.

304.9.5.2 Raceways on flat roofs that cross a required pathway shall be bridged to avoid tripping hazards. Raceways shall not be permitted in required pathways on roofs with a slope that exceeds 2:12.

304.10 Alternate Installations. In accordance with section **103.11**, an alternative material, design, location, method of construction, or means of safe fire fighter access and egress may be approved by the building official.

SECTION 305 STRUCTURAL

305.1 General. Photovoltaic (PV) components, racking, support structures and attachments shall be in accordance with the provisions of this section.

305.2 Module Attachment. PV modules shall be attached in accordance with the manufacturer's installation instructions and to account for all loads, including dead loads, snow loads, wind loads and seismic loads, as prescribed by the **OSSC**.

305.3 Racking. Racking shall comply with this section.

305.3.1 Building Penetrations. All penetrations shall be flashed or sealed in a manner that prevents moisture from entering the wall and roof.

305.3.2 Structural Support and Attachment. Racking and racking supports shall be positively attached to the structural components or blocking in accordance with *Figure 2* through the use of screws, bolts, j-bolts, or other approved means. Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. Racking and racking supports shall be mounted to structural components and shall not be attached to wall or roof coverings, trim or structural sheathing as a means of structural support. Racking and racking supports installed in accordance

with manufacturer's specifications or be designed in accordance with the OSSC and shall be mounted in accordance with one of the following:

1. Installed in accordance with manufacturer's specifications and be designed in accordance with the OSSC.
2. Installed in accordance with section **305.4**.
3. Positively attached to the structural components or blocking in accordance with *Figure 2* through the use of screws, bolts, j-bolts, or other approved means. Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. Racking and racking supports shall be mounted to structural components and shall not be attached to wall or roof coverings, trim or structural sheathing as a means of structural support.
4. Attached to standing seam metal roofs with connectors in accordance with manufacturer's installation instructions.
5. Certified non-penetrating or minimally penetrating systems installed in accordance with the manufacturer's installation instructions.

305.3.3 Roof Mounted Racking. Roof-mounted supporting structures shall be certified in accordance with section **303.4**, and shall be designed in accordance with accepted engineering practice, constructed and installed to safely support all loads, including dead loads, snow loads, wind loads and seismic loads as prescribed by the **OSSC** or in accordance with section **305.4**.

305.3.4 Ground Mounted Racking. Ground-mounted supporting structures, and all parts thereof, shall be designed, constructed and installed to safely support all loads, including dead loads, flood loads, snow loads, wind loads and seismic loads as prescribed by the **OSSC**.

The bottom of modules shall be at least 18 inches (457 mm) clear from ground level.

305.4 Prescriptive Installations. Roof installations on conventional light-frame construction which complies with this section shall qualify as prescriptive and shall not require an engineered design if all of the following criteria are met:

1. Roof structure: The supporting roof framing shall be conventional light framed wood construction with pre-engineered trusses or roof framing members at a spacing of 24 (610 mm) inch on center maximum that comply with the applicable allowable span in *Table 305.4.1* (See Appendix B) for the specific loads including ground snow loads not exceeding 50 psf and wind loads that do not exceed 100 MPH in exposure C or 110 MPH in exposures A or B.

Exception: Roof framing in compliance with the applicable allowable span in *Table 305.4.2* (See Appendix B) for the specific loads including ground snow loads not exceeding

70 psf and wind exposure is limited to exposure A, B or C shall satisfy the requirements of this section when the PV system is installed on;

1. Detached one and two family dwellings and townhouses classified as Group R-3, and Group U Occupancies; and
2. Residences used for family daycare or foster care in accordance with ORS Chapters 418, 443 and 657A; and
3. Detached Congregate residences (each accommodating 10 persons or less) and detached lodging houses containing not more than five guest rooms.

2. Roof materials. Roofing material shall be metal, single layer wood shingle or shake, or not more than two layers of composition shingle.

3. Loading: Installation shall comply with *Figure 305.4(1)*. The combined weight of the PV modules and racking shall not exceed 4.5 pounds per square foot (xxx kPa). PV modules or racking shall be directly attached to the roof framing or blocking installed in accordance with *Alternate 1, 2 or 3*. These attachments must be spaced no greater than 48 inches (1219 mm) on center in any direction. Attachments shall be spaced no greater than 24 inches on center in any direction where:

- A. Ground snow loads exceed 25 psf;
- B. Located within 3 feet of a roof edge, hip, eave or ridge; or
- C. Wind exposure is B or less and wind speed 100 MPH or less or wind exposure is exposure C and wind speed is 85 MPH or less.

Exception: PV modules or racking may be attached directly to standing seam metal panels using clamps and roofing materials which meet the following:

The allowable uplift capacity of clamps shall not be less than 115 pounds for clamps spaced at 60 inches on center or less as measured along the seam or not be less than 75 pounds for clamps spaced at less than 48 inches on center. Clamp spacing between seams shall not be less than 24-inches. Spacing of clamps along a seam shall not exceed 60-inches. See attached Figures.

Roofing panels shall comply with all of the following:

1. Shall be a minimum of 26 gage steel,
2. Shall be a maximum of 18-inches in width,
3. Shall be attached with a minimum of #10 screws at 24-inches on center,
4. Shall be installed over minimum ½-inch nominal wood structural panels attached to framing with 8d nails at 6-inches on center at panel edges and 12-inches on center field nailing.

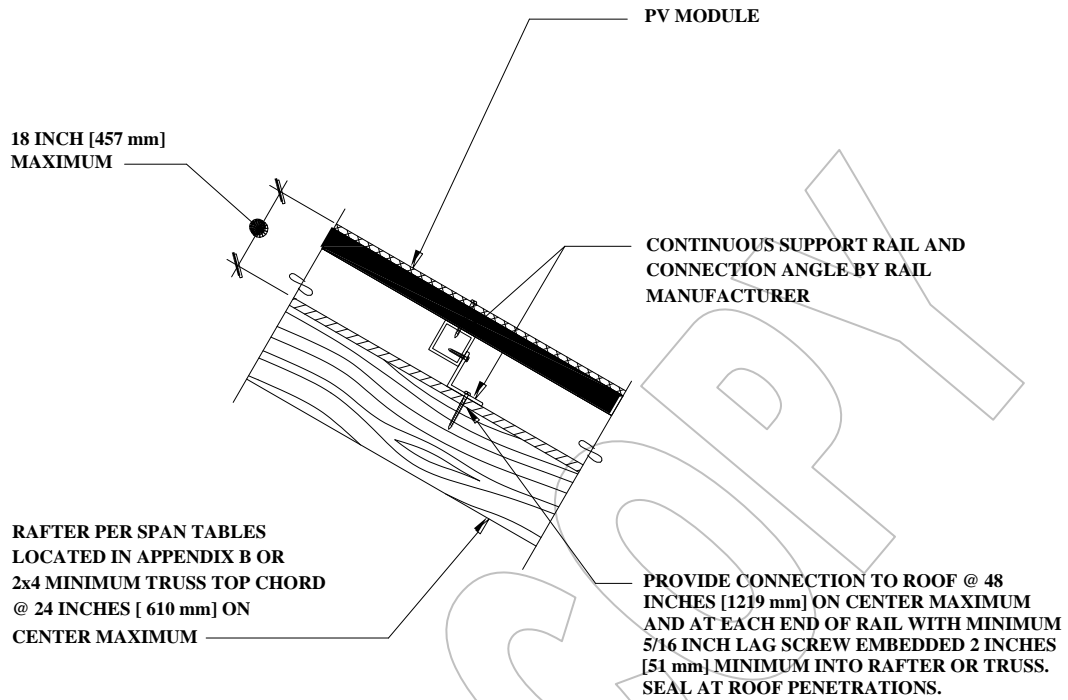


Figure 305.4(1)

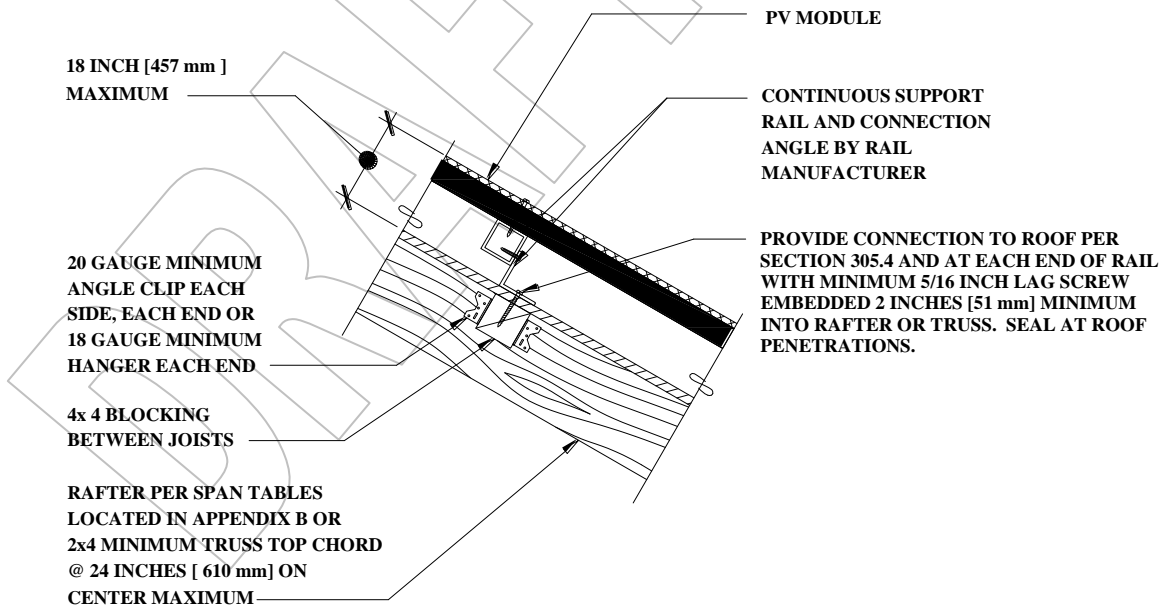


Figure 305.4(2)

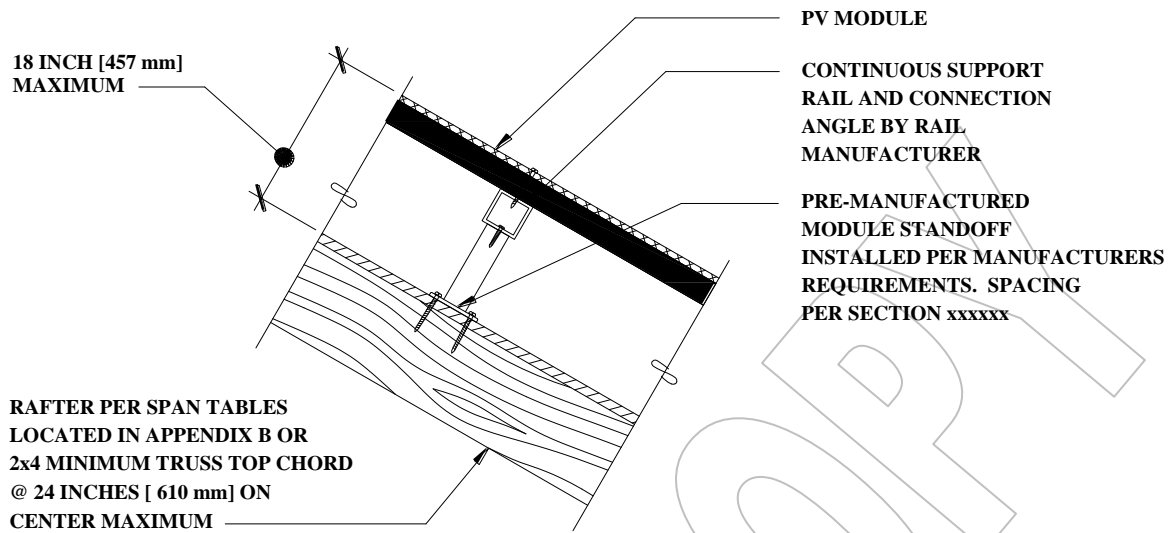


Figure 305.4(3)

4. Height: Maximum module height above roof shall be 18" from top of module to roof surface and in accordance with Figure 305.

5. Submittal Requirement. (Include a fill-in-the-blank form to be submitted stating rafter size/spacing/span, panel weight (psf), etc.

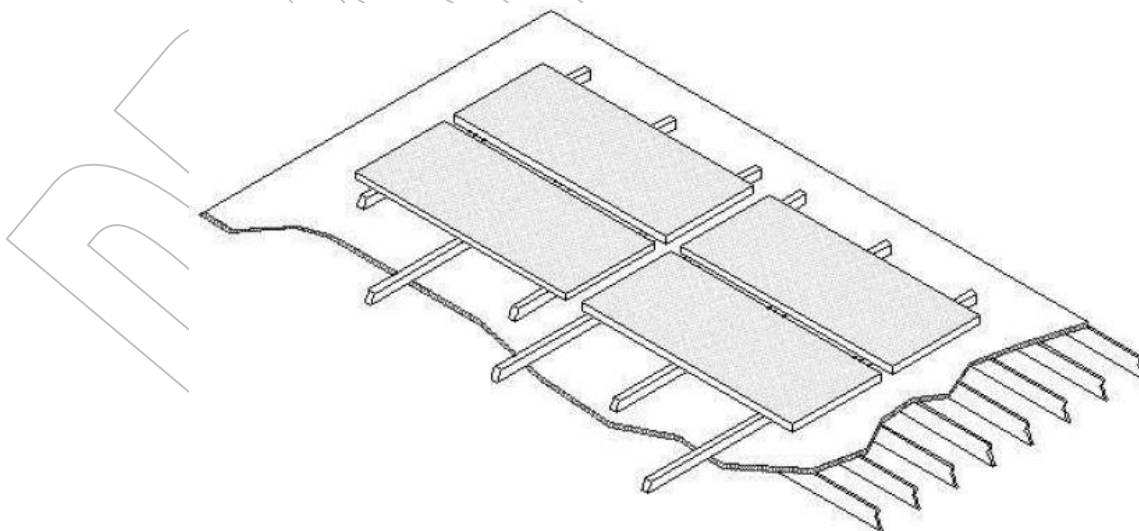


Figure 305.3.3.1.1(1) Installation – Rails perpendicular to framing members

APPENDIX

A

ELECTRICAL REQUIREMENTS

Note: The following electrical requirements apply to PV installations. Electrical requirements are contained in OESC Chapter 690. They are reproduced here for convenience.

APPENDIX A

ELECTRICAL REQUIREMENTS FOR PV INSTALLATIONS

Electrical wiring and equipment shall comply with the requirements of the Oregon Electrical Specialty Code (OESC) as modified by this document. In the event of conflict, the requirements found in the OESC shall prevail.

General

690.1 Scope. The provisions of this article apply to solar photovoltaic (**PV**), electrical energy systems, including the array circuit(s), inverter(s), and controller(s) for such systems. **PV** systems covered by this article may be interactive with other electrical power production sources or stand-alone, with or without electrical energy storage such as batteries. These systems may have ac or dc output for utilization.

See 2008 NEC for article 690.2 Definitions.

690.3 Other Codes. If the **PV** system is operated in parallel with a primary source(s) of electricity, **such as utility supply or on-site electric power sources**, the requirements in 705.14, 705.16, 705.32, and 705.143 shall apply.

The installation of conduits or other raceway systems shall comply with the appropriate requirements of the adopted OESC. Raceways and conduit systems shall be installed with special attention to ambient temperature, expansion characteristics of the conduit or raceway system and any required ambient temperature adjustment from Table 310.15(B)(2)(c).

PV systems, equipment, or wiring installed in a hazardous (classified) location shall also comply with the applicable portions of Articles 500 through 516.

690.4 Installation.

(A) PV System. A **PV** system shall be permitted to supply a building or other structure in addition to any service(s) of another electricity supply system(s).

(B) Conductors of Different Systems. **PV** source circuits and **PV** output circuits shall not be contained in the same raceway, cable tray, cable, outlet box, junction box, or similar fitting as feeders or branch circuits of other systems, unless the conductors of the different systems are separated by a partition or are connected together.

(C) Module Connection Arrangement. The connections to a module or panel shall be arranged so that removal of a module or panel from a PV source circuit does not interrupt a grounded conductor to another PV source circuit. Sets of modules interconnected as systems rated at 50 volts or less, with or without blocking diodes, and having a single over-current device shall be considered as a single-source circuit.

Supplementary over-current devices used for the exclusive protection of the PV modules are not considered as over-current devices for the purpose of this section.

(D) Equipment. Inverters, motor generators, **PV** modules, **PV** panels, ac **PV** modules, source-circuit combiners, and charge controllers intended for use in **PV** power systems shall be identified and certified for the application.

(E) Circuit routing. PV source and output circuits shall not be embedded in the roof covering.

Exception: Embedment shall be permitted in areas directly below PV modules and associated equipment or where passing perpendicularly through the roof assembly.

690.5 Ground-Fault Protection. Grounded dc **PV** arrays shall be provided with dc ground-fault protection meeting the requirements of 690.5 (A) through (C) to reduce fire hazards. Ungrounded dc PV arrays shall comply with 690.35.

*Exception No. 1: Ground-mounted or pole-mounted **PV** arrays with not more than two paralleled source circuits and with all dc source and dc output circuits isolated from buildings shall be permitted without ground-fault protection.*

*Exception No. 2: **PV** arrays installed at other than dwelling units shall be permitted without ground-fault protection where the equipment grounding conductors are sized in accordance with 690.45.*

(A) Ground-Fault Detection and Interruption. The ground-fault protection device or system shall be capable of detecting a ground-fault current, interrupting the flow of fault current, and providing an indication of the fault.

Automatically opening the grounded conductor of the faulted circuit to interrupt the ground-fault current path shall be permitted. If a grounded conductor is opened to interrupt the ground-fault current path, all conductors of the faulted circuit shall be automatically and simultaneously opened.

Manual operation of the main PV dc disconnect shall not activate the ground-fault protection device or result in grounded conductors becoming ungrounded.

(B) Isolating Faulted Circuits. The faulted circuits shall be isolated by one of the two following methods:

- (1) The ungrounded conductors of the faulted circuit shall be automatically disconnected.
- (2) The inverter or charge controller fed by the faulted circuit shall automatically cease to supply power to output circuits.

(C) Labels and Markings. A warning label shall appear on the utility-interactive inverter or be applied by the installer near the ground-fault indicator at a visible location, stating the following:

WARNING
ELECTRIC SHOCK HAZARD IF A GROUND FAULT IS INDICATED, NORMALLY
GROUNDED CONDUCTORS MAY BE UNGROUNDED AND ENERGIZED

When the **PV** system also has batteries, the same warning shall also be applied by the installer in a visible location at the batteries.

690.6 Alternating-Current (AC) Modules.

(A) PV Source Circuits. The requirements of Section 690 pertaining to **PV** source circuits shall not apply to ac modules. The **PV** source circuit, conductors, and inverters shall be considered as internal wiring of an ac module.

(B) Inverter Output Circuit. The output of an ac module shall be considered an inverter output circuit.

(C) Disconnecting Means. A single disconnecting means, in accordance with 690.15 and 690.17, shall be permitted for the combined ac output of one or more ac modules. Additionally, each ac module in a multiple ac module system shall be provided with a connector, bolted, or terminal-type disconnecting means.

(D) Ground-Fault Detection. Alternating-current module systems shall be permitted to use a single detection device to detect only ac ground faults and to disable the array by removing ac power to the ac module(s).

(E) Overcurrent Protection. The output circuits of ac modules shall be permitted to have overcurrent protection and conductors sized in accordance with 240.5(B)(2).

II. Circuit Requirements

690.7 Maximum Voltage.

(A) Maximum PV System Voltage. In a dc **PV** source circuit or output circuit, the maximum **PV** system voltage for that circuit shall be calculated as the sum of the rated open-circuit voltage of the series-connected **PV** modules corrected for the lowest expected ambient temperature. For crystalline and multicrystalline silicon modules, the rated open-circuit voltage shall be multiplied by the correction factor provided in Table 690.7. This voltage shall be used to determine the voltage rating of cables, disconnects, overcurrent devices, and other equipment. Where the lowest expected ambient temperature is below -40°C (-40°F), or where other than crystalline or multicrystalline silicon **PV** modules are used, the system voltage adjustment shall be made in accordance with the manufacturer’s instructions.

When open-circuit voltage temperature coefficients are supplied in the instructions for **certified PV** modules, they shall be used to calculate the maximum PV system voltage as required by **manufacturer’s instructions instead of using** Table 690.7, **110.3(B)**.

**Table 690.7 Voltage Correction Factors for Crystalline and Multicrystalline Silicon Modules
Correction Factors for Ambient Temperatures below 25°C (77°F).**

(Multiply the rated open circuit voltage by the appropriate correction factor shown below.)

Ambient Temperature (°C)	Factor	Ambient Temperature (°F)
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24 to 20	1.02	76 to 68
19 to 15	1.04	67 to 59
14 to 10	1.06	58 to 50
9 to 5	1.08	49 to 41
4 to 0	1.10	40 to 32
-1 to -5	1.12	31 to 23
-6 to -10	1.14	22 to 14
-11 to -15	1.16	13 to 5
-16 to -20	1.18	4 to -4
-21 to -25	1.20	-5 to -13
-26 to -30	1.21	-14 to -22
-31 to -35	1.23	-23 to -31
-36 to -40	1.25	-32 to -40

(B) Direct-Current Utilization Circuits. The voltage of dc utilization circuits shall conform to 210.6.

(C) PV Source and Output Circuits. In one- and two-family dwellings, **PV** source circuits and **PV** output circuits that do not include lampholders, fixtures, or receptacles shall be permitted to have a maximum **PV** system voltage up to 600 volts. Other installations with a maximum **PV** system voltage over 600 volts shall comply with Article 690, Part **IX**.

(D) Circuits over 150 Volts to Ground. In one- and two-family dwellings, live parts in **PV** source circuits and **PV** output circuits over 150 volts to ground shall not be accessible to other than qualified persons while energized.

FPN: See 110.27 for guarding of live parts, and 210.6 for voltage to ground and between conductors.

(E) Bipolar Source and Output Circuits. For 2-wire circuits connected to bipolar systems, the maximum system voltage shall be the highest voltage between the conductors of the 2-wire circuit if all of the following conditions apply:

- (1) One conductor of each circuit is solidly grounded.
- (2) Each circuit is connected to a separate subarray.
- (3) The equipment is clearly marked with a label as follows:

WARNING
BIPOLAR PHOTOVOLTAIC ARRAY. DISCONNECTION
OF NEUTRAL OR GROUNDED CONDUCTORS MAY RESULT IN
OVERVOLTAGE ON ARRAY OR INVERTER.

690.8 Circuit Sizing and Current.

(A) Calculation of Maximum Circuit Current. The maximum current for the specific circuit shall be calculated in accordance with 690.8(A)(1) through (A)(4).

FPN: Where the requirements of 690.8(A)(1) and (B)(1) are both applied, the resulting multiplication factor is 156 percent.

(1) PV Source Circuit Currents. The maximum current shall be the sum of parallel module rated short-circuit currents multiplied by 125 percent.

(2) PV Output Circuit Currents. The maximum current shall be the sum of parallel source circuit maximum currents as calculated in 690.8(A)(1).

(3) Inverter Output Circuit Current. The maximum current shall be the inverter continuous output current rating.

(4) Stand-Alone Inverter Input Circuit Current. The maximum current shall be the stand-alone continuous inverter input current rating when the inverter is producing rated power at the lowest input voltage.

(B) Ampacity and Overcurrent Device Ratings. PV system currents shall be considered to be continuous.

(1) Sizing of Conductors and Overcurrent Devices. The circuit conductors and overcurrent devices shall be sized to carry not less than 125 percent of the maximum currents as calculated in 690.8(A). The rating or setting of overcurrent devices shall be permitted in accordance with 240.4(B) and (C).

Exception: Circuits containing an assembly, together with its overcurrent device(s), that is certified for continuous operation at 100 percent of its rating shall be permitted to be utilized at 100 percent of its rating.

(2) Internal Current Limitation. Overcurrent protection for PV output circuits with devices that internally limit the current from the PV output circuit shall be permitted to be rated at less than the value calculated in 690.8(B)(1). This reduced rating shall be at least 125 percent of the limited current value. PV output circuit conductors shall be sized in accordance with 690.8(B)(1).

Exception: An overcurrent device in an assembly certified for continuous operation at 100 percent of its rating shall be permitted to be utilized at 100 percent of its rating.

(C) Systems with Multiple Direct-Current Voltages. For a PV power source that has multiple output circuit voltages and employs a common-return conductor, the ampacity of the common-return conductor

shall not be less than the sum of the ampere ratings of the overcurrent devices of the individual output circuits.

(D) Sizing of Module Interconnection Conductors. Where a single overcurrent device is used to protect a set of two or more parallel-connected module circuits, the ampacity of each of the module interconnection conductors shall not be less than the sum of the rating of the single fuse plus 125 percent of the short-circuit current from the other parallel-connected modules.

(E) DC Current-Carrying Conductors. Conductors used for PV source and output circuits shall be considered current-carrying conductors. The provisions of Table 310.15(B)(2)(a) shall apply to PV circuits contained in raceways and appropriate de-rating of conductors as required by T310.15(B)(2)(c) shall be part of any design or installation of PV conductors.

690.9 Overcurrent Protection.

(A) Circuits and Equipment. **PV** source circuit, **PV** output circuit, inverter output circuit, and storage battery circuit conductors and equipment shall be protected in accordance with the requirements of Article 240. Circuits connected to more than one electrical source shall have overcurrent devices located so as to provide overcurrent protection from all sources.

Exception: An overcurrent device shall not be required for circuit conductors sized in accordance with 690.8(B) and located where one of the following apply:

- (a) *There are no external sources such as parallel-connected source circuits, batteries, or back-feed from inverters.*
- (b) *The short-circuit currents from all sources do not exceed the ampacity of the conductors.*

*FPN: Possible back-feed of current from any source of supply, including a supply through an inverter into the **PV** output circuit and **PV** source circuits, is a consideration in determining whether adequate overcurrent protection from all sources is provided for conductors and modules.*

(B) Power Transformers. Overcurrent protection for a transformer with a source(s) on each side shall be provided in accordance with 450.3, by considering first one side of the transformer, then the other side of the transformer, as the primary.

*Exception: A power transformer with a current rating on the side connected toward the **PV** power source, not less than the short-circuit output current rating of the inverter, shall be permitted without overcurrent protection from that source.*

(C) **PV Source Circuits.** Branch-circuit or supplementary-type overcurrent devices shall be permitted to provide overcurrent protection in **PV** source circuits. The overcurrent devices shall be accessible but shall not be required to be readily accessible. Standard values of supplementary overcurrent devices allowed by this section shall be in one ampere size increments, starting at one ampere up to and including 15 amperes. Higher standard values above 15 amperes for supplementary overcurrent devices shall be based on the standard sizes provided in 240.6(A).

(D) Direct-Current Rating. Overcurrent devices, either fuses or circuit breakers, used in any dc portion of a **PV** power system shall be **certified** for use in dc circuits and shall have the appropriate voltage, current, and interrupt ratings.

(E) Series Overcurrent Protection. In series-connected strings of two or more modules, a single overcurrent protection device shall be permitted.

690.10 Stand-Alone Systems. The premises wiring system shall be adequate to meet the requirements of this Code for a similar installation connected to a service. The wiring on the supply side of the building or structure disconnecting means shall comply with this Code except as modified by 690.10(A) through (D).

(A) Inverter Output. The ac output from a stand-alone inverter(s) shall be permitted to supply ac power to the building or structure disconnecting means at current levels less than the calculated load connected to that disconnect. The inverter output rating or the rating of an alternate energy source shall be equal to or greater than the load posed by the largest single utilization equipment connected to the system. Calculated general lighting loads shall not be considered as a single load.

(B) Sizing and Protection. The circuit conductors between the inverter output and the building or structure disconnecting means shall be sized based on the output rating of the inverter. These conductors shall be protected from overcurrents in accordance with Article 240. The overcurrent protection shall be located at the output of the inverter.

(C) Single 120-Volt Supply. The inverter output of a stand-alone solar **PV** system shall be permitted to supply 120 volts to single-phase, 3-wire, 120/240-volt service equipment or distribution panels where there are no 240-volt outlets and where there are no multiwire branch circuits. In all installations, the rating of the overcurrent device connected to the output of the inverter shall be less than the rating of the neutral bus in the service equipment. This equipment shall be marked with the following words or equivalent:

WARNING
SINGLE 120-VOLT SUPPLY. DO NOT CONNECT
MULTIWIRE BRANCH CIRCUITS!

(D) Energy Storage or Backup Power System Requirements. Energy storage or backup power supplies are not required.

III. Disconnecting Means

690.13 All Conductors. Means shall be provided to disconnect all current-carrying conductors of a **PV** power source from all other conductors in a building or other structure. A switch, circuit breaker, or other device, either ac or dc, shall not be installed in a grounded conductor if operation of that switch, circuit breaker, or other device leaves the marked, grounded conductor in an ungrounded and energized state.

Exception: A switch or circuit breaker that is part of a ground-fault detection system required by OSEC 690.5 shall be permitted to open the grounded conductor when that switch or circuit breaker is

automatically opened as a normal function of the device in responding to ground faults. The switch or circuit breaker shall indicate the presence of a ground fault.

FPN: The grounded conductor may have a bolted or terminal disconnecting means to allow maintenance or troubleshooting by qualified personnel.

690.14 Additional Provisions. PV disconnecting means shall comply with 690.14(A) through (D).

(A) Disconnecting Means. The disconnecting means shall not be required to be suitable as service equipment and shall comply with 690.17.

(B) Equipment. Equipment such as **PV** source circuit isolating switches, overcurrent devices, and blocking diodes shall be permitted on the **PV** side of the **PV** disconnecting means.

(C) Requirements for Disconnecting Means. Means shall be provided to disconnect all conductors in a building or other structure from the **PV** system conductors.

(1) Location. The **PV** disconnecting means shall be installed at a readily accessible location either on the outside of a building or structure or inside nearest the point of entrance of the system conductors.

Exception: Installations that comply with 690.31(E) shall be permitted to have the disconnecting means located remote from the point of entry of the system conductors.

The **PV** system disconnecting means shall not be installed in bathrooms.

(2) Marking. Each **PV** system disconnecting means shall be permanently marked to identify it as a **PV** system disconnect.

(3) Suitable for Use. Each **PV** system disconnecting means shall be suitable for the prevailing conditions. Equipment installed in hazardous (classified) locations shall comply with the requirements of Articles 500 through 517.

(4) Maximum Number of Disconnects. The **PV** system disconnecting means shall consist of not more than six switches or six circuit breakers mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard.

(5) Grouping. The **PV** system disconnecting means shall be grouped with other disconnecting means for the system to comply with 690.14(C)(4). A **PV** disconnecting means shall not be required at the **PV** module or array location.

(D) Utility-Interactive Inverters Mounted in Not-Readily-Accessible Locations. Utility-interactive inverters shall be permitted to be mounted on roofs or other exterior areas that are not readily accessible. These installations shall comply with (1) through (4):

(1) A direct-current **PV** disconnecting means shall be mounted within sight of or in the inverter.

(2) An alternating-current disconnecting means shall be mounted within sight of or in the inverter.

(3) The alternating-current output conductors from the inverter and an additional alternating-current disconnecting means for the inverter shall comply with 690.14(C)(1).

(4) A plaque shall be installed in accordance with 705.10.

690.15 Disconnection of PV Equipment. Means shall be provided to disconnect equipment, such as inverters, batteries, charge controllers, and the like, from all ungrounded conductors of all sources. If the equipment is energized from more than one source, the disconnecting means shall be grouped and identified.

A single disconnecting means in accordance with 690.17 shall be permitted for the combined ac output of one or more inverters or ac modules in an interactive system.

690.16 Fuses. Disconnecting means shall be provided to disconnect a fuse from all sources of supply if the fuse is energized from both directions and is accessible to other than qualified persons. Such a fuse in a PV source circuit shall be capable of being disconnected independently of fuses in other PV source circuits.

690.17 Switch or Circuit Breaker. The disconnecting means for ungrounded conductors shall consist of a manually operable switch(es) or circuit breaker(s) complying with all of the following requirements:

- (1) Located where readily accessible
- (2) Externally operable without exposing the operator to contact with live parts
- (3) Plainly indicating whether in the open or closed position
- (4) Having an interrupting rating sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment.

Where all terminals of the disconnecting means may be energized in the open position, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall be clearly legible and have the following words or equivalent:

WARNING
ELECTRIC SHOCK HAZARD. DO NOT TOUCH TERMINALS.
TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED
IN THE OPEN POSITION.

Exception: A connector shall be permitted to be used as an ac or a dc disconnecting means, provided that it complies with the requirements of 690.33 and is certified and identified for the use.

690.18 Installation and Service of an Array. Open circuiting, short circuiting, or opaque covering shall be used to disable an array or portions of an array for installation and service.

FPN: PV modules are energized while exposed to light. Installation, replacement, or servicing of array components while a module(s) is irradiated may expose persons to electric shock.

IV. Wiring Methods

690.31 Methods Permitted.

(A) Wiring Systems. All raceway and cable wiring methods included in this Code and other wiring systems and fittings specifically intended and identified for use on **PV** arrays shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

Where **PV** source and output circuits operating at maximum system voltages greater than 30 volts are installed in readily accessible locations, circuit conductors shall be installed in a raceway.

*FPN: **PV** modules operate at elevated temperatures when exposed to high ambient temperatures and to bright sunlight. These temperatures may routinely exceed 70°C (158°F) in many locations. Module interconnection conductors are available with insulation rated for wet locations and a temperature rating of 90°C (194°F) or greater.*

(B) Single-Conductor Cable. Single-conductor cable type USE-2, and single-conductor cable **certified** as **PV** wire shall be permitted in exposed outdoor locations in **PV** source circuits for **PV** module interconnections within the **PV** array.

Exception: Raceways shall be used when required by 690.31(A).

(C) Flexible Cords and Cables. Flexible cords and cables, where used to connect the moving parts of tracking **PV** modules, shall comply with Article 400 and shall be of a type identified as a hard service cord or portable power cable; they shall be suitable for extra-hard usage, **certified** for outdoor use, water resistant, and sunlight resistant. Allowable ampacities shall be in accordance with 400.5. For ambient temperatures exceeding 30°C (86°F), the ampacities shall be de-rated by the appropriate factors given in Table 690.31(C).

**Table 690.31(C) Correction Factors
Temperature Rating of Conductor**

Ambient Temperature (°C)	60°C (140°F)	75°C (167°F)	90°C (194°F)	105°C (221°F)	Ambient Temperature (°F)
30	1.00	1.00	1.00	1.00	86
31-35	0.91	0.94	0.96	0.97	87-95
36-40	0.82	0.88	0.91	0.93	96-104
41-45	0.71	0.82	0.87	0.89	105-113
46-50	0.58	0.75	0.82	0.86	114-122
51-55	0.41	0.67	0.76	0.82	123-131

56-60	-	0.58	0.71	0.77	132-140
61-70	-	0.33	0.58	0.68	141-158
71-80	-	-	0.41	0.58	159-176

(D) Small-Conductor Cables. Single-conductor cables certified for outdoor use that are sunlight resistant and moisture resistant in sizes 16 AWG and 18 AWG shall be permitted for module interconnections where such cables meet the ampacity requirements of 690.8. Section 310.15 shall be used to determine the cable ampacity and temperature de-rating factors.

(E) Direct-Current Photovoltaic Source and Output Circuits Inside a Building. Where direct-current PV source or output circuits of a utility-interactive inverter from a building-integrated or other PV system are run inside a building or structure, they shall be contained in metal raceways, or metal enclosures, from the point of penetration of the surface of the building or structure to the first readily accessible disconnecting means. The disconnecting means shall comply with 690.14(A) through (D).

(F) Flexible, Fine-Stranded Cables. Flexible, fine-stranded cables shall be terminated only with terminals, lugs, devices, or connectors that are certified for such use.

690.32 Component Interconnections. Fittings and connectors that are intended to be concealed at the time of on-site assembly, where certified for such use, shall be permitted for on-site interconnection of modules or other array components. Such fittings and connectors shall be equal to the wiring method employed in insulation, temperature rise, and fault-current withstand, and shall be capable of resisting the effects of the environment in which they are used.

690.33 Connectors. The connectors permitted by Article 690 shall comply with 690.33(A) through (E).

(A) Configuration. The connectors shall be polarized and shall have a configuration that is non-interchangeable with receptacles in other electrical systems on the premises.

(B) Guarding. The connectors shall be constructed and installed so as to guard against inadvertent contact with live parts by persons.

(C) Type. The connectors shall be of the latching or locking type. Connectors that are readily accessible and that are used in circuits operating at over 30 volts, nominal, maximum system voltage for dc circuits, or 30 volts for ac circuits, shall require a tool for opening.

(D) Grounding Member. The grounding member shall be the first to make and the last to break contact with the mating connector.

(E) Interruption of Circuit. Connectors shall be either (1) or (2):

(1) Be rated for interrupting current without hazard to the operator.

(2) Be a type that requires the use of a tool to open and marked “Do Not Disconnect Under Load” or “Not for Current Interrupting.”

690.34 Access to Boxes. Junction, pull, and outlet boxes located behind modules or panels shall be so installed that the wiring contained in them can be rendered accessible directly or by displacement of a module(s) or panel(s) secured by removable fasteners and connected by a flexible wiring system.

690.35 Ungrounded PV Power Systems. PV power systems shall be permitted to operate with ungrounded PV source and output circuits where the system complies with 690.35(A) through (G), and 690.47(A) through (D).

(A) Disconnects. All PV source and output circuit conductors shall have disconnects complying with 690, Part III.

(B) Overcurrent Protection. All PV source and output circuit conductors shall have overcurrent protection complying with 690.9.

(C) Ground-Fault Protection. All PV source and output circuits shall be provided with a ground-fault protection device or system that complies with (1) through (3):

- (1) Detects a ground fault
- (2) Indicates that a ground fault has occurred
- (3) Automatically disconnects all conductors or causes the inverter or charge controller connected to the faulted circuit to automatically cease supplying power to output circuits.

(D) The PV source conductors shall consist of the following:

- (1) Nonmetallic jacketed multi-conductor cables
- (2) Conductors installed in raceways, or
- (3) Conductors certified as PV Wire installed as exposed, single conductors

(E) The PV power system direct-current circuits shall be permitted to be used with ungrounded battery systems complying with 690.71(G).

(F) The PV power source shall be labeled with the following warning at each junction box, combiner box, disconnect, and device where energized, ungrounded circuits may be exposed during service:

**WARNING
ELECTRIC SHOCK HAZARD. THE DC CONDUCTORS
OF THIS PHOTOVOLTAIC SYSTEM ARE
UNGROUNDING AND MAY BE ENERGIZED**

(G) The inverters or charge controllers used in systems with ungrounded PV source and output circuits shall be certified for the purpose.

V. Grounding

690.41 System Grounding. For a **PV** power source, one conductor of a 2-wire system with a **PV** system voltage over 50 volts and the reference (center tap) conductor of a bipolar system shall be solidly grounded or shall use other methods that accomplish equivalent system protection in accordance with 250.4(A) and that utilize equipment certified for the use.

Exception: Systems complying with 690.35.

690.42 Point of System Grounding Connection. The dc circuit grounding connection shall be made at any single point on the **PV** output circuit.

*FPN: Locating the grounding connection point as close as practicable to the **PV** source better protects the system from voltage surges due to lightning.*

Exception: Systems with a 690.5 required ground-fault protection device shall be permitted to have the required grounded conductor-to-ground bond made by the ground-fault protection device. This bond, where internal to the ground-fault equipment, shall not be duplicated with an external connection.

690.43 Equipment Grounding. Exposed non-current-carrying metal parts of module frames, equipment, and conductor enclosures shall be grounded in accordance with 250.134 or 250.136(A) regardless of voltage. An equipment grounding conductor between a **PV** array and other equipment shall be required in accordance with 250.110.

Devices certified for grounding the metallic frames of **PV** modules shall be permitted to bond the exposed metallic frames of **PV** modules to grounded mounting structures. Devices certified for bonding the metallic frames of **PV** modules shall be permitted to bond the exposed metallic frames of **PV** modules to the metallic frames of adjacent **PV** modules.

Equipment grounding conductors for the **PV** array and structure (where installed) shall be contained within the same raceway or cable, or otherwise run with the **PV** array circuit conductors when those circuit conductors leave the vicinity of the **PV** array.

690.45 Size of Equipment Grounding Conductors.

Equipment grounding conductors for **PV** source and **PV** output circuits shall be sized in accordance with 690.45(A) or (B).

(A) General. Equipment grounding conductors in **PV** source and **PV** output circuits shall be sized in accordance with Table **690.45**. Where no overcurrent protective device is used in the circuit, an assumed overcurrent device rated at the **PV** rated short-circuit current shall be used in **Table 690.45**. Increases in equipment grounding conductor size to address voltage drop considerations shall not be required. The equipment grounding conductors shall be no smaller than 14 AWG.

Table 690.45 Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

**Rating or Setting of Overcurrent Device on individual strings or combined ampacity of
combiner box.**

Not exceeding (Amperes)	Size (AWG or kcmil)	
	Copper	Aluminum or Copper-clad Aluminum*
15	14	12
20	12	10
30	10	8
40	10	8
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250
1600	4/0	350
2000	250	400
2500	350	600
3000	400	600
4000	500	800
5000	700	1200

6000	800	1200
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(B) Ground-Fault Protection Not Provided. For other than dwelling units where ground-fault protection is not provided in accordance with 690.5(A) through (C), each equipment grounding conductor shall have an ampacity of at least two (2) times the temperature and conduit fill corrected circuit conductor ampacity.

*FPN: The short-circuit current of **PV** modules and **PV** sources is just slightly above the full-load normal output rating. In ground-fault conditions, these sources are not able to supply the high levels of short-circuit or ground-fault currents necessary to quickly activate overcurrent devices as in typical ac systems. Protection for equipment grounding conductors in **PV** systems that are not provided with ground-fault protection is related to size and withstand capability of the equipment grounding conductor, rather than overcurrent device operation.*

690.46 Array Equipment Grounding Conductors. Equipment grounding conductors for **PV** modules smaller than 6 AWG shall **be provided with physical protection.**

690.47 Grounding Electrode System.

(A) Alternating-Current Systems. A grounding electrode system shall be provided in accordance with 250.50 through 250.60. The grounding electrode conductor shall be installed in accordance with 250.64.

(B) Direct-Current Systems. a grounding electrode system shall be provided in accordance with 690.47(B)(1) through (B)(5) for grounded systems or ungrounded systems. The grounding electrode conductor shall be installed in accordance with 250.64.

(1) Not Smaller Than the Neutral Conductor. Where the dc system consists of a 3-wire balancer set or a balancer winding with overcurrent protection as provided in 445.12(D), the grounding electrode conductor shall not be smaller than the neutral conductor and not smaller than 6 AWG copper or 4 AWG aluminum.

(2) Not Smaller Than the Largest Conductor. Where the dc system is other than as in 690.47(B)(1), the grounding electrode conductor shall not be smaller than the largest conductor supplied by the system, and not smaller than 6 AWG copper or 4 AWG aluminum.

(3) Connected to Rod, Pipe, or Plate Electrodes. Where connected to rod, pipe, or plate electrodes as in 250.52(A)(5) or (A)(7), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.

(4) Connected to a Concrete-Encased Electrode. Where connected to a concrete-encased electrode as in 250.52(A)(3), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than 4 AWG copper wire.

(5) Connected to a Ground Ring- Where connected to a ground ring as in 250.52(A)(4), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than the conductor used for the ground ring.

(C) Systems with Alternating-Current and Direct-Current Grounding Requirements. Systems with alternating-current and direct-current grounding requirements shall comply with items (C)(1) through (C)(8):

- (1) Where **PV** power systems have both alternating-current (ac) and direct-current (dc) grounding requirements, the dc grounding system shall be bonded to the ac grounding system.
- (2) A bonding conductor between these systems shall be sized as the larger of the dc requirement in accordance with 690.45, the ac requirements based on the inverter alternating current overcurrent device rating and **Table 690.45, and shall not be smaller than # 6 AWG.**
- (3) A conductor that serves as both an equipment grounding conductor and as part of the bond between ac and dc systems for an inverter incorporating dc ground-fault protection shall meet the requirements for equipment bonding jumpers in accordance with Table 690.47. A single conductor shall be permitted to be used to perform the multiple functions of dc grounding, ac grounding, and bonding between ac and dc systems.
- (4) A bonding conductor or equipment grounding conductor that serves multiple inverters shall be sized based on the sum of applicable maximum currents used in item (2).
- (5) A common ground bus shall be permitted to be used for both systems.
- (6) A common grounding electrode shall be permitted to be used for both systems, in which case the grounding electrode conductor shall be connected to the ac ground system bonding point.
- (7) Grounding electrode conductor(s) shall be sized to meet the requirements of 250.66 (ac system) and 690.47(B) (dc system).
- (8) For systems with utility-interactive inverters, the premises grounding system serves as the ac grounding system.

Table 690.47 Grounding Electrode Conductor for Direct-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors		Size of Grounding Electrode Conductor	
(AWG/kcmil)		(AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
1/0 or smaller	3/0 or smaller	4	6
4	4/0 or 250	2	2
2/0 or 3/0	Over 250 through 500	1/0	1/0

Over 3/0 through 350	Over 500 through 900	2/0	3/0
Over 350 through 600	Over 900 through 1750	3/0	4/0
Over 600 through 1100	Over 1750		250
Over 1100			

Notes: Where multiple sets of conductors are used the equivalent size of the largest conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.

(D) Additional Electrodes for Array Grounding. Grounding electrodes shall be installed at the location of all ground- and pole-mounted **PV** arrays and as close as practicable to the location of roof-mounted photovoltaic arrays. The electrodes shall be connected directly to the array frame(s) or structure. The dc grounding electrode conductor shall be sized according to **690.47(B)**. Additional electrodes are not permitted to be used as a substitute for equipment bonding or equipment grounding conductor requirements.

The structure of a ground- or pole-mounted **PV** array shall be permitted to be considered a grounding electrode if it meets the requirements of 250.52. Roof-mounted **PV** arrays shall be permitted to use the metal frame of a building or structure if the requirements of 250.52(A)(2) are met.

Exception No. 1: Array grounding electrode(s) shall not be required where the load served by the array is integral with the array.

Exception No. 2: Additional array grounding electrode(s) shall not be required if located within 6 ft of the premises wiring electrode.

690.48 Continuity of Equipment Grounding Systems. Where the removal of equipment disconnects the bonding connection between the grounding electrode conductor and exposed conducting surfaces in the **PV** source or output circuit equipment, a bonding jumper shall be installed while the equipment is removed.

690.49 Continuity of **PV Source and Output Circuit Grounded Conductors.** Where the removal of the utility-interactive inverter or other equipment disconnects the bonding connection between the grounding electrode conductor and the **PV** source and/or **PV** output circuit grounded conductor, a bonding jumper shall be installed to maintain the system grounding while the inverter or other equipment is removed.

690.50 Equipment Bonding Jumpers. Equipment bonding jumpers, if used, **smaller than # 6 AWG, shall be provided with physical protection.**

VI. Marking

690.51 Modules. Modules shall be marked with identification of terminals or leads as to polarity, maximum overcurrent device rating for module protection, and with the following ratings:

- (1) Open-circuit voltage
- (2) Operating voltage
- (3) Maximum permissible system voltage
- (4) Operating current
- (5) Short-circuit current
- (6) Maximum power

690.52 Alternating-Current Photovoltaic Modules. Alternating-current modules shall be marked with identification of terminals or leads and with identification of the following ratings:

- (1) Nominal operating ac voltage
- (2) Nominal operating ac frequency
- (3) Maximum ac power
- (4) Maximum ac current
- (5) Maximum overcurrent device rating for ac module protection

690.53 Direct-Current PV Power Source. A permanent label for the direct-current PV power source indicating items (1) through (5) shall be provided by the installer at the PV disconnecting means:

- (1) Rated maximum power-point current
- (2) Rated maximum power-point voltage
- (3) Maximum system voltage

FPN to (3): See 690.7(A) for maximum PV system voltage.

- (4) Short-circuit current

FPN to (4): See 690.8(A) for calculation of maximum circuit current.

- (5) Maximum rated output current of the charge controller (if installed)

FPN: Reflecting systems used for irradiance enhancement may result in increased levels of output current and power.

690.54 Interactive System Point of Interconnection. All interactive system(s) points of interconnection with other sources shall be marked at an accessible location at the disconnecting means as a power source and with the rated ac output current and the nominal operating ac voltage.

690.55 PV Power Systems Employing Energy Storage. PV power systems employing energy storage shall also be marked with the maximum operating voltage, including any equalization voltage and the polarity of the grounded circuit conductor.

690.56 Identification of Power Sources.

(A) Facilities with Stand-Alone Systems. Any structure or building with a PV power system that is not connected to a utility service source and is a stand-alone system shall have a permanent plaque or directory

installed on the exterior of the building or structure at a readily visible location acceptable to the authority having jurisdiction. The plaque or directory shall indicate the location of system disconnecting means and that the structure contains a stand-alone electrical power system.

(B) Facilities with Utility Services and PV Systems. Buildings or structures with both utility service and a PV system shall have a permanent plaque or directory providing the location of the service disconnecting means and the PV system disconnecting means if not located at the same location.

VII. Connection to Other Sources

690.57 Load Disconnect. A load disconnect that has multiple sources of power shall disconnect all sources when in the off position.

690.60 Identified Interactive Equipment. Only inverters and ac modules certified as interactive shall be permitted in interactive systems.

690.61 Loss of Interactive System Power. An inverter or an ac module in an interactive PV system shall automatically de-energize its output to the connected electrical production and distribution network upon loss of voltage in that system and shall remain in that state until the electrical production and distribution network voltage has been restored.

A normally interactive PV system shall be permitted to operate as a stand-alone system to supply loads that have been disconnected from electrical production and distribution network sources.

690.62 Ampacity of Neutral Conductor. If a single-phase, 2-wire inverter output is connected to the neutral conductor and one ungrounded conductor (only) of a 3-wire system or of a 3-phase, 4-wire, wye-connected system, the maximum load connected between the neutral conductor and any one ungrounded conductor plus the inverter output rating shall not exceed the ampacity of the neutral conductor. A conductor used solely for instrumentation, voltage detection, or phase detection, and connected to a single-phase or 3-phase utility-interactive inverter, shall be permitted to be sized at less than the ampacity of the other current-carrying conductors and shall be sized equal to or larger than the equipment grounding conductor.

690.63 Unbalanced Interconnections.

(A) Single-Phase. Single-phase inverters for PV systems and ac modules in interactive PV systems shall not be connected to 3-phase power systems unless the interconnected system is designed so that significant unbalanced voltages cannot result.

(B) Three-Phase. Three-phase inverters and 3-phase ac modules in interactive systems shall have all phases automatically de-energized upon loss of, or unbalanced, voltage in one or more phases unless the interconnected system is designed so that significant unbalanced voltages will not result.

690.64 Point of Connection. The output of a utility-interactive inverter shall be connected as specified in 690.64(A) or (B).

(A) Supply Side. The output of a utility-interactive inverter shall be permitted to be connected to the supply side of the service disconnecting means.

(B) Load Side. The output of a utility-interactive inverter shall be permitted to be connected to the load side of the service disconnecting means of the other source(s) at any distribution equipment on the premises. Where distribution equipment, including switchboards and panelboards, is fed simultaneously by a primary source(s) of electricity and one or more utility-interactive inverters, and where this distribution equipment is capable of supplying multiple branch circuits or feeders, or both, the interconnecting provisions for the utility-interactive inverter(s) shall comply with (B)(1) through (B)(7).

(1) Dedicated Overcurrent and Disconnect. Each source interconnection shall be made at a dedicated circuit breaker or fusible disconnecting means.

(2) Bus or Conductor Rating. The sum of the ampere ratings of overcurrent devices in circuits supplying power to a busbar or conductor shall not exceed 120 percent of the rating of the busbar or conductor. In systems with panelboards connected in series, the rating of the first overcurrent device directly connected to the output of a utility-interactive inverter(s) shall be used in the calculations for all busbars and conductors.

(3) Ground-Fault Protection. The interconnection point shall be on the line side of all ground-fault protection equipment.

*Exception: Connection shall be permitted to be made to the load side of ground-fault protection, provided that there is ground-fault protection for equipment from all ground-fault current sources. Ground-fault protection devices used with supplies connected to the load-side terminals shall be identified and **certified** as suitable for back-feeding.*

(4) Marking. Equipment containing overcurrent devices in circuits supplying power to a busbar or conductor supplied from multiple sources shall be marked to indicate the presence of all sources.

(5) Suitable for Back-feed. Circuit breakers, if back-fed, shall be suitable for such operation.

*FPN: Circuit breakers that are marked "Line" and "Load" have been evaluated only in the direction marked. Circuit breakers without "Line" and "Load" have been evaluated in both directions. **Circuit breakers not marked "Line" and "Load" are considered to be identified as suitable for back-feeding.***

(6) Fastening. Certified plug-in-type circuit breakers back-fed from utility-interactive inverters complying with 690.60 shall be permitted to omit the additional fastener normally required for service equipment.

(7) Inverter Output Connection. Unless the panelboard is rated not less than the sum of the ampere ratings of all overcurrent devices supplying it, a connection in a panelboard shall be positioned at the opposite (load) end from the input feeder location or main circuit location. The bus or conductor rating shall be sized for the loads connected in accordance with Article 220. A permanent warning label shall be applied to the distribution equipment with the following or equivalent marking:

WARNING
INVERTER OUTPUT CONNECTION
DO NOT RELOCATE THIS OVERCURRENT DEVICE

VIII. Storage Batteries

690.71 Installation.

(A) **General.** Storage batteries in a **PV** system shall be installed in accordance with the provisions of Article 480. The interconnected battery cells shall be considered grounded where the **PV** power source is installed in accordance with 690.41.

(B) Dwellings.

(1) **Operating Voltage.** Storage batteries for dwellings shall have the cells connected so as to operate at less than 50 volts nominal. Lead-acid storage batteries for dwellings shall have no more than twenty-four 2-volt cells connected in series (48-volts nominal).

Exception: Where live parts are not accessible during routine battery maintenance, a battery system voltage in accordance with 690.7 shall be permitted.

(2) **Guarding of Live Parts.** Live parts of battery systems for dwellings shall be guarded to prevent accidental contact by persons or objects, regardless of voltage or battery type.

*FPN: Batteries in **PV** systems are subject to extensive charge–discharge cycles and typically require frequent maintenance, such as checking electrolyte and cleaning connections.*

(C) **Current Limiting.** A certified, current-limiting, overcurrent device shall be installed in each circuit adjacent to the batteries where the available short-circuit current from a battery or battery bank exceeds the interrupting or withstand ratings of other equipment in that circuit. The installation of current-limiting fuses shall comply with 690.16.

(D) **Battery Nonconductive Cases and Conductive Racks.** Flooded, vented, lead-acid batteries with more than twenty-four 2-volt cells connected in series (48 volts, nominal) shall not use conductive cases or shall not be installed in conductive cases. Conductive racks used to support the nonconductive cases shall be permitted where no rack material is located within 150 mm (6 in.) of the tops of the nonconductive cases.

This requirement shall not apply to any type of valve-regulated lead-acid (VRLA) battery or any other types of sealed batteries that may require steel cases for proper operation.

(E) **Disconnection of Series Battery Circuits.** Battery circuits subject to field servicing, where more than twenty-four 2-volt cells are connected in series (48 volts, nominal), shall have provisions to disconnect the series-connected strings into segments of 24 cells or less for maintenance by qualified persons. Non–load-break bolted or plug-in disconnects shall be permitted.

(F) Battery Maintenance Disconnecting Means. Battery installations, where there are more than twenty-four 2-volt cells connected in series (48 volts, nominal), shall have a disconnecting means, accessible only to qualified persons, that disconnects the grounded circuit conductor(s) in the battery electrical system for maintenance. This disconnecting means shall not disconnect the grounded circuit conductor(s) for the remainder of the **PV** electrical system. A non-load-break-rated switch shall be permitted to be used as the disconnecting means.

(G) Battery Systems of More Than 48 Volts. On **PV** systems where the battery system consists of more than twenty-four 2-volt cells connected in series (more than 48 volts, nominal), the battery system shall be permitted to operate with ungrounded conductors, provided the following conditions are met:

- (1) The **PV** array source and output circuits shall comply with 690.41.
- (2) The dc and ac load circuits shall be solidly grounded.
- (3) All main ungrounded battery input/output circuit conductors shall be provided with switched disconnects and overcurrent protection.
- (4) A ground-fault detector and indicator shall be installed to monitor for ground faults in the battery bank.

690.72 Charge Control.

(A) General. Equipment shall be provided to control the charging process of the battery. Charge control shall not be required where the design of the **PV** source circuit is matched to the voltage rating and charge current requirements of the interconnected battery cells and the maximum charging current multiplied by 1 hour is less than 3 percent of the rated battery capacity expressed in ampere-hours or as recommended by the battery manufacturer. All adjusting means for control of the charging process shall be accessible only to qualified persons.

FPN: Certain battery types such as valve-regulated lead acid or nickel cadmium can experience thermal failure when overcharged.

(B) Diversion Charge Controller.

(1) Sole Means of Regulating Charging. A **PV** power system employing a diversion charge controller as the sole means of regulating the charging of a battery shall be equipped with a second independent means to prevent overcharging of the battery.

(2) Circuits with Direct-Current Diversion Charge Controller and Diversion Load. Circuits containing a dc diversion charge controller and a dc diversion load shall comply with the following:

- (1) The current rating of the diversion load shall be less than or equal to the current rating of the diversion load charge controller. The voltage rating of the diversion load shall be greater than the maximum battery voltage. The power rating of the diversion load shall be at least 150 percent of the power rating of the **PV** array.

(2) The conductor ampacity and the rating of the overcurrent device for this circuit shall be at least 150 percent of the maximum current rating of the diversion charge controller.

(3) **PV Systems Using Utility-Interactive Inverters.** **PV** power systems using utility-interactive inverters to control battery state-of-charge by diverting excess power into the utility system shall comply with (A) and (B):

(1) These systems shall not be required to comply with 690.72(B)(2). The charge regulation circuits used shall comply with the requirements of 690.8.

(2) These systems shall have a second, independent means of controlling the battery charging process for use when the utility is not present or when the primary charge controller fails or is disabled.

690.74 Battery Interconnections. Flexible cables in sizes 2/0 AWG and larger shall be permitted within the battery enclosure from battery terminals to a nearby junction box where they shall be connected to an approved wiring method. Flexible battery cables shall also be permitted between batteries and cells within the battery enclosure. Such cables shall be **certified** for hard-service use and identified as moisture resistant.

Flexible, fine-stranded cables shall only be used with terminals, lugs, devices, and connectors that are **certified** and marked for such use.

IX. Systems over 600 Volts

690.80 General. **PV** systems with a maximum system voltage over 600 volts dc shall comply with Article 490 and other requirements applicable to installations rated over 600 volts.

690.85 Definitions. For the purposes of Part IX of this article, the voltages used to determine cable and equipment ratings are as follows:

Battery Circuits. In battery circuits, the highest voltage experienced under charging or equalizing conditions.

PV Circuits. In dc photovoltaic source circuits and **PV** output circuits, the maximum system voltage.

APPENDIX

B

Span Tables

*Note: Appendix B references the Span Tables contained in the **Oregon Residential Specialty Code**. The Tables have been renumbered for inclusion in the **OSISC**.*

Please refer to the following information when using the tables:

Allowable rafter spans. Spans for rafters shall be in accordance with Tables 802.5. 1(1) through 802.5. 1(8). For other grades and species and for other loading conditions, refer to the AF&PA Span Tables for Joists and Rafters. The span of each rafter shall be measured along the horizontal projection of the rafter.

Purlins. Installation of purlins to reduce the span of rafters is permitted, as shown in Figure R802.5. 1. Purlins shall be sized no less than the required size of the rafters that they support. Purlins shall be continuous and shall be supported by 2-inch by 4-inch (51 mm by 102 mm) braces installed to bearing walls at a slope not less than 45 degrees from the horizontal. The braces shall be spaced not more than 4 feet (1219 mm) on center and the un braced length of braces shall not exceed 8 feet (2438 mm).

Bearing. The ends of each rafter or ceiling joist shall have not less than 1¹/₂ inches (38 mm) of bearing on wood or metal and not less than 3 inches (76 mm) on masonry or concrete.

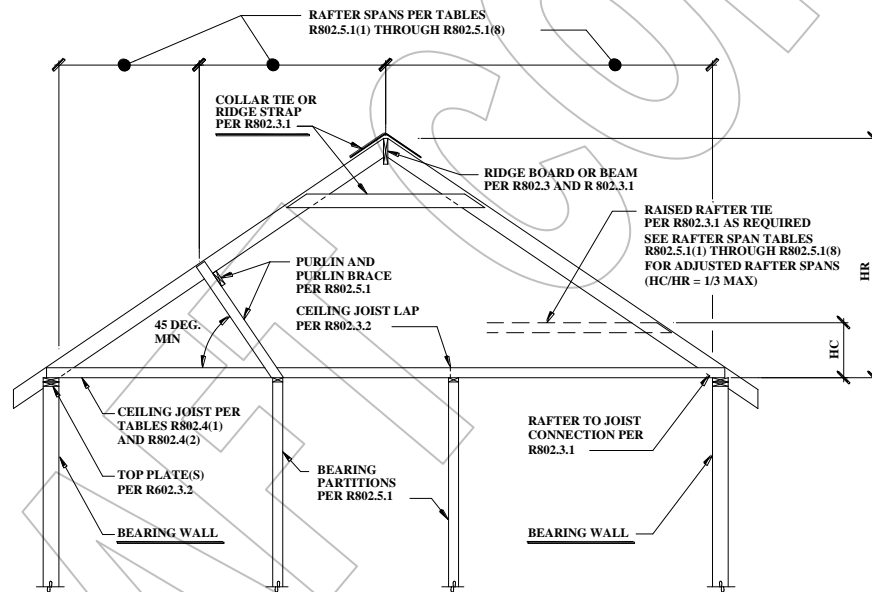


FIGURE R802.5.1
BRACED RAFTER CONNECTION

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 degree = 0.018 rad.

Note: Where ceiling joists run perpendicular to the rafter, rafter ties shall be installed per R802.3.1

HC = Height of ceiling joists or rafter ties measured vertically above the top of rafter support walls

HR = Height of roof ridge measured vertically above the top of the rafter support walls.

Table 305.4.1

(ORSC TABLE 802.5.1(3))
RAFTER SPANS FOR COMMON LUMBER SPECIES)
 (Ground snow load=30 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE	DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
		2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
		Maximum rafter spans ^a									
		(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
12	Douglas fir-larch SS	10-0	15-9	20-9	Note b	Note b	10-0	15-9	20-1	24-6	Note b
	Douglas fir-larch #1	9-8	14-9	18-8	22-9	Note b	9-0	13-2	16-8	20-4	23-7
	Douglas fir-larch #2	9-5	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Douglas fir-larch #3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Hem-fir SS	9-6	14-10	19-7	25-0	Note b	9-6	14-10	19-7	24-1	Note b
	Hem-fir #1	9-3	14-4	18-2	22-2	25-9	8-9	12-10	16-3	19-10	23-0
	Hem-fir #2	8-10	13-7	17-2	21-0	24-4	8-4	12-2	15-4	18-9	21-9
	Hem-fir #3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Southern pine SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	20-5	Note b	Note b
	Southern pine #1	9-8	15-2	20-0	24-9	Note b	9-8	14-10	18-8	22-2	Note b
	Southern pine #2	9-6	14-5	18-8	22-3	Note b	9-0	12-11	16-8	19-11	23-4
	Southern pine #3	7-7	11-2	14-3	16-10	20-0	6-9	10-0	12-9	15-1	17-11
	Spruce-pine-fir SS	9-3	14-7	19-2	24-6	Note b	9-3	14-7	18-8	22-9	Note b
	Spruce-pine-fir #1	9-1	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Spruce-pine-fir #2	9-1	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Spruce-pine-fir #3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
16	Douglas fir-larch SS	9-1	14-4	18-10	23-9	Note b	9-1	13-9	17-5	21-3	24-8
	Douglas fir-larch #1	8-9	12-9	16-2	19-9	22-10	7-10	11-5	14-5	17-8	20-5
	Douglas fir-larch #2	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Douglas fir-larch #3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Hem-fir SS	8-7	13-6	17-10	22-9	Note b	8-7	13-6	17-1	20-10	24-2
	Hem-fir #1	8-5	12-5	15-9	19-3	22-3	7-7	11-1	14-1	17-2	19-11
	Hem-fir #2	8-0	11-9	14-11	18-2	21-1	7-2	10-6	13-4	16-3	18-10
	Hem-fir #3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Southern pine SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-6	23-8	Note b
	Southern pine #1	8-9	13-9	18-1	21-5	25-7	8-8	12-10	16-2	19-2	22-10
	Southern pine #2	8-7	12-6	16-2	19-3	22-7	7-10	11-2	14-5	17-3	20-2
	Southern pine #3	6-7	9-8	12-4	14-7	17-4	5-10	8-8	11-0	13-0	15-6
	Spruce-pine-fir SS	8-5	13-3	17-5	22-1	25-7	8-5	12-9	16-2	19-9	22-10
	Spruce-pine-fir #1	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir #2	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir #3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
19.2	Douglas fir-larch SS	8-7	13-6	17-9	21-8	25-2	8-7	12-6	15-10	19-5	22-6
	Douglas fir-larch #1	7-11	11-8	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Douglas fir-larch #2	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Douglas fir-larch #3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
	Hem-fir SS	8-1	12-9	16-9	21-4	24-8	8-1	12-4	15-7	19-1	22-1
	Hem-fir #1	7-9	11-4	14-4	17-7	20-4	6-11	10-2	12-10	15-8	18-2
	Hem-fir #2	7-4	10-9	13-7	16-7	19-3	6-7	9-7	12-2	14-10	17-3
	Hem-fir #3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
	Southern pine SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	17-5	22-0	25-9
	Southern pine #1	8-3	13-0	16-6	19-7	23-4	7-11	11-9	14-9	17-6	20-11
	Southern pine #2	7-11	11-5	14-9	17-7	20-7	7-1	10-2	13-2	15-9	18-5
	Southern pine #3	6-0	8-10	11-3	13-4	15-10	5-4	7-11	10-1	11-11	14-2
Spruce-pine-fir SS	7-11	12-5	16-5	20-2	23-4	7-11	11-8	14-9	18-0	20-11	

Spruce-pine-fir	#1	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
Spruce-pine-fir	#2	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
Spruce-pine-fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2

Continued

TABLE 802.5.1(3)—continued
RAFTER SPANS FOR COMMON LUMBER SPECIES
(Ground snow load=30 psf, ceiling not attached to rafters, $L/\Delta = 180$)

RAFTER SPACING (inches)	SPECIES AND GRADE	DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
		2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
		Maximum rafter spans ^a									
		(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
24	Douglas fir-larch	7-11	12-6	15-10	19-5	22-6	7-8	11-3	14-2	17-4	20-1
	Douglas fir-larch	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Douglas fir-larch	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Hem-fir	7-6	11-10	15-7	19-1	22-1	7-6	11-0	13-11	17-0	19-9
	Hem-fir	6-11	10-2	12-10	15-8	18-2	6-2	9-1	11-6	14-0	16-3
	Hem-fir	6-7	9-7	12-2	14-10	17-3	5-10	8-7	10-10	13-3	15-5
	Hem-fir	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Southern pine	7-10	12-3	16-2	20-8	25-1	7-10	12-3	16-2	19-8	23-0
	Southern pine	7-8	11-9	14-9	17-6	20-11	7-1	10-6	13-2	15-8	18-8
	Southern pine	7-1	10-2	13-2	15-9	18-5	6-4	9-2	11-9	14-1	16-6
	Southern pine	5-4	7-11	10-1	11-11	14-2	4-9	7-1	9-0	10-8	12-8
	Spruce-pine-fir	7-4	11-7	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Spruce-pine-fir	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479kPa.

- a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. When ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the factors given below:

HC/HR	Rafter Span
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

HC = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

HR = Height of roof ridge measured vertically above the top of the rafter support walls.

b. Span exceeds 26 feet in length.

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**Table 305.4.1
(ORSC TABLE R802.5.1 (7))**

RAFTER SPANS FOR 70 PSF GROUND SNOW LOAD)(Ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACIN	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum Rafter Spans ^a									
			(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)
12	Douglas fir-larch	SS	7-7	11-10	15-8	19-5	22-6	7-7	11-10	15-0	18-3	21-2
	Douglas fir-larch	#1	7-1	10-5	13-2	16-1	18-8	6-8	9-10	12-5	15-2	17-7
	Douglas fir-larch	#2	6-8	9-9	12-4	15-1	17-6	6-3	9-2	11-8	14-2	16-6
	Douglas fir-larch	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Hem-fir	SS	7-2	11-3	14-9	18-10	22-1	7-2	11-3	14-8	18-0	20-10
	Hem-fir	#1	6-11	10-2	12-10	15-8	18-2	6-6	9-7	12-1	14-10	17-2
	Hem-fir	#2	6-7	9-7	12-2	14-10	17-3	6-2	9-1	11-5	14-0	16-3
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Southern pine	SS	7-5	11-8	15-4	19-7	23-10	7-5	11-8	15-4	19-7	23-10
	Southern pine	#1	7-3	11-5	14-9	17-6	20-11	7-3	11-1	13-11	16-6	19-8
	Southern pine	#2	7-1	10-2	13-2	15-9	18-5	6-8	9-7	12-5	14-10	17-5
	Southern pine	#3	5-4	7-11	10-1	11-11	14-2	5-1	7-5	9-6	11-3	13-4
	Spruce-pine-fir	SS	7-0	11-0	14-6	18-0	20-11	7-0	11-0	13-11	17-0	19-8
	Spruce-pine-fir	#1	6-8	9-9	12-4	15-1	17-6	6-3	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#2	6-8	9-9	12-4	15-1	17-6	6-3	9-2	11-8	14-2	16-6
Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5	
16	Douglas fir-larch	SS	6-10	10-9	13-9	16-10	19-6	6-10	10-3	13-0	15-10	18-4
	Douglas fir-larch	#1	6-2	9-0	11-5	13-11	16-2	5-10	8-6	10-9	13-2	15-3
	Douglas fir-larch	#2	5-9	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Douglas fir-larch	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
	Hem-fir	SS	6-6	10-2	13-5	16-6	19-2	6-6	10-1	12-9	15-7	18-0
	Hem-fir	#1	6-0	8-9	11-2	13-7	15-9	5-8	8-3	10-6	12-10	14-10
	Hem-fir	#2	5-8	8-4	10-6	12-10	14-11	5-4	7-10	9-11	12-1	14-1
	Hem-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
	Southern pine	SS	6-9	10-7	14-0	17-10	21-8	6-9	10-7	14-0	17-10	21-0
	Southern pine	#1	6-7	10-2	12-9	15-2	18-1	6-5	9-7	12-0	14-4	17-1
	Southern pine	#2	6-2	8-10	11-5	13-7	16-0	5-10	8-4	10-9	12-10	15-1
	Southern pine	#3	4-8	6-10	8-9	10-4	12-3	4-4	6-5	8-3	9-9	11-7
	Spruce-pine-fir	SS	6-4	10-0	12-9	15-7	18-1	6-4	9-6	12-0	14-8	17-1
	Spruce-pine-fir	#1	5-9	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#2	5-9	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
Spruce-pine-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9	
19.2	Douglas fir-larch	SS	6-5	9-11	12-7	15-4	17-9	6-5	9-4	11-10	14-5	16-9
	Douglas fir-larch	#1	5-7	8-3	10-5	12-9	14-9	5-4	7-9	9-10	12-0	13-11
	Douglas fir-larch	#2	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Douglas fir-larch	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
	Hem-fir	SS	6-1	9-7	12-4	15-1	17-4	6-1	9-2	11-8	14-2	15-5
	Hem-fir	#1	5-6	8-0	10-2	12-5	14-5	5-2	7-7	9-7	11-8	13-7
	Hem-fir	#2	5-2	7-7	9-7	11-9	13-7	4-11	7-2	9-1	11-1	12-10
	Hem-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
	Southern pine	SS	6-4	10-0	13-2	16-9	20-4	6-4	10-0	13-2	16-5	19-2
	Southern pine	#1	6-3	9-3	11-8	13-10	16-6	5-11	8-9	11-0	13-1	15-7
	Southern pine	#2	5-7	8-1	10-5	12-5	14-7	5-4	7-7	9-10	11-9	13-9
	Southern pine	#3	4-3	6-3	8-0	9-5	11-2	4-0	5-11	7-6	8-10	10-7
	Spruce-pine-fir	SS	6-0	9-2	11-8	14-3	16-6	5-11	8-8	11-0	13-5	15-7
	Spruce-pine-fir	#1	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#2	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
Spruce-pine-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10	

Continued

TABLE R802.5.1(7)—continued
RAFTER SPANS FOR 70 PSF GROUND SNOW LOAD
(Ceiling not attached to rafters, $L/\Delta = 180$)

RAFTER SPACING (inches)	SPECIES AND GRADE	DEAD LOAD = 10 psf					DEAD LOAD = 20 psf					
		2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	
		Maximum rafter spans ^a										
		(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	
24	Douglas fir-larch	SS	6-0	8-10	11-3	13-9	15-11	5-9	8-4	10-7	12-11	15-0
	Douglas fir-larch	#1	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Douglas fir-larch	#2	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Douglas fir-larch	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10
	Hem-fir	SS	5-8	8-8	11-0	13-6	13-11	5-7	8-3	10-5	12-4	12-4
	Hem-fir	#1	4-11	7-2	9-1	11-1	12-10	4-7	6-9	8-7	10-6	12-2
	Hem-fir	#2	4-8	6-9	8-7	10-6	12-2	4-4	6-5	8-1	9-11	11-6
	Hem-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10
	Southern pine	SS	5-11	9-3	12-2	15-7	18-2	5-11	9-3	12-2	14-8	17-2
	Southern pine	#1	5-7	8-3	10-5	12-5	14-9	5-3	7-10	9-10	11-8	13-11
	Southern pine	#2	5-0	7-3	9-4	11-1	13-0	4-9	6-10	8-9	10-6	12-4
	Southern pine	#3	3-9	5-7	7-1	8-5	10-0	3-7	5-3	6-9	7-11	9-5
	Spruce-pine-fir	SS	5-6	8-3	10-5	12-9	14-9	5-4	7-9	9-10	12-0	12-11
	Spruce-pine-fir	#1	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#2	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. When ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the factors given below:

<i>HC/HR</i>	Rafter Span Adjustment
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

HC = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

Table 305.4.1
(ORSC TABLE R802.5.1(8))
RAFTER SPANS FOR 70 PSF GROUND SNOW LOAD)
(Ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE	DEAD LOAD = 10 psf					DEAD LOAD = 20 psf					
		2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	
		Maximum rafter spans ^a										
		(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	
12	Douglas fir-larch	SS	6-10	10-9	14-3	18-2	22-1	6-10	10-9	14-3	18-2	21-2
	Douglas fir-larch	#1	6-7	10-5	13-2	16-1	18-8	6-7	9-10	12-5	15-2	17-7
	Douglas fir-larch	#2	6-6	9-9	12-4	15-1	17-6	6-3	9-2	11-8	14-2	16-6
	Douglas fir-larch	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Hem-fir	SS	6-6	10-2	13-5	17-2	20-10	6-6	10-2	13-5	17-2	20-10
	Hem-fir	#1	6-4	10-0	12-10	15-8	18-2	6-4	9-7	12-1	14-10	17-2
	Hem-fir	#2	6-1	9-6	12-2	14-10	17-3	6-1	9-1	11-5	14-0	16-3
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Southern pine	SS	6-9	10-7	14-0	17-10	21-8	6-9	10-7	14-0	17-10	21-8
	Southern pine	#1	6-7	10-5	13-8	17-6	20-11	6-7	10-5	13-8	16-6	19-8
	Southern pine	#2	6-6	10-2	13-2	15-9	18-5	6-6	9-7	12-5	14-10	17-5
	Southern pine	#3	5-4	7-11	10-1	11-11	14-2	5-1	7-5	9-6	11-3	13-4
	Spruce-pine-fir	SS	6-4	10-0	13-2	16-9	20-5	6-4	10-0	13-2	16-9	19-8
	Spruce-pine-fir	#1	6-2	9-9	12-4	15-1	17-6	6-2	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#2	6-2	9-9	12-4	15-1	17-6	6-2	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
16	Douglas fir-larch	SS	6-3	9-10	12-11	16-6	19-6	6-3	9-10	12-11	15-10	18-4
	Douglas fir-larch	#1	6-0	9-0	11-5	13-11	16-2	5-10	8-6	10-9	13-2	15-3
	Douglas fir-larch	#2	5-9	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Douglas fir-larch	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
	Hem-fir	SS	5-11	9-3	12-2	15-7	18-11	5-11	9-3	12-2	15-7	18-0
	Hem-fir	#1	5-9	8-9	11-2	13-7	15-9	5-8	8-3	10-6	12-10	14-10
	Hem-fir	#2	5-6	8-4	10-6	12-10	14-11	5-4	7-10	9-11	12-1	14-1
	Hem-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
	Southern pine	SS	6-1	9-7	12-8	16-2	19-8	6-1	9-7	12-8	16-2	19-8
	Southern pine	#1	6-0	9-5	12-5	15-2	18-1	6-0	9-5	12-0	14-4	17-1
	Southern pine	#2	5-11	8-10	11-5	13-7	16-0	5-10	8-4	10-9	12-10	15-1
	Southern pine	#3	4-8	6-10	8-9	10-4	12-3	4-4	6-5	8-3	9-9	11-7
	Spruce-pine-fir	SS	5-9	9-1	11-11	15-3	18-1	5-9	9-1	11-11	14-8	17-1
	Spruce-pine-fir	#1	5-8	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#2	5-8	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
19.2	Douglas fir-larch	SS	5-10	9-3	12-2	15-4	17-9	5-10	9-3	11-10	14-5	16-9
	Douglas fir-larch	#1	5-7	8-3	10-5	12-9	14-9	5-4	7-9	9-10	12-0	13-11
	Douglas fir-larch	#2	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Douglas fir-larch	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
	Hem-fir	SS	5-6	8-8	11-6	14-8	17-4	5-6	8-8	11-6	14-2	15-5
	Hem-fir	#1	5-5	8-0	10-2	12-5	14-5	5-2	7-7	9-7	11-8	13-7
	Hem-fir	#2	5-2	7-7	9-7	11-9	13-7	4-11	7-2	9-1	11-1	12-10
	Hem-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
	Southern pine	SS	5-9	9-1	11-11	15-3	18-6	5-9	9-1	11-11	15-3	18-6
	Southern pine	#1	5-8	8-11	11-8	13-10	16-6	5-8	8-9	11-0	13-1	15-7
	Southern pine	#2	5-6	8-1	10-5	12-5	14-7	5-4	7-7	9-10	11-9	13-9
	Southern pine	#3	4-3	6-3	8-0	9-5	11-2	4-0	5-11	7-6	8-10	10-7
	Spruce-pine-fir	SS	5-5	8-6	11-3	14-3	16-6	5-5	8-6	11-0	13-5	15-7
	Spruce-pine-fir	#1	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#2	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10

continued

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TABLE R802.5.1(8)—continued
RAFTER SPANS FOR 70 PSF GROUND SNOW LOAD ^a
(Ceiling attached to rafters, $L/\Delta = 240$)

RAFTER SPACING (inches)	SPECIES AND GRADE	DEAD LOAD = 10 psf					DEAD LOAD = 20 psf					
		2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	
		Maximum rafter spans ^a										
		(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)	(feet - inches)
24	Douglas fir-larch	SS	5-5	8-7	11-3	13-9	15-11	5-5	8-4	10-7	12-11	15-0
	Douglas fir-larch	#1	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Douglas fir-larch	#2	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Douglas fir-larch	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10
	Hem-fir	SS	5-2	8-1	10-8	13-6	13-11	5-2	8-1	10-5	12-4	12-4
	Hem-fir	#1	4-11	7-2	9-1	11-1	12-10	4-7	6-9	8-7	10-6	12-2
	Hem-fir	#2	4-8	6-9	8-7	10-6	12-2	4-4	6-5	8-1	9-11	11-6
	Hem-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10
	Southern pine	SS	5-4	8-5	11-1	14-2	17-2	5-4	8-5	11-1	14-2	17-2
	Southern pine	#1	5-3	8-3	10-5	12-5	14-9	5-3	7-10	9-10	11-8	13-11
	Southern pine	#2	5-0	7-3	9-4	11-1	13-0	4-9	6-10	8-9	10-6	12-4
	Southern pine	#3	3-9	5-7	7-1	8-5	10-0	3-7	5-3	6-9	7-11	9-5
	Spruce-pine-fir	SS	5-0	7-11	10-5	12-9	14-9	5-0	7-9	9-10	12-0	12-11
	Spruce-pine-fir	#1	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#2	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479kPa.

a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. When ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the factors given below:

<i>HC/HR</i>	Rafter Span Adjustment
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

where:

HC = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

HR = Height of roof ridge measured vertically above the top of the rafter support walls.

Table 305.4.1

(ORSC TABLE R802.5.1(9)
RAFTER/CEILING JOIST HEEL JOINT CONNECTIONS) ^{a,b,c,d,e,f,h}

RAFTER SLOPE	RAFTER SPACING (inches)	GROUND SNOW LOAD (psf)															
		20 ^g				30				50				70			
		Roof span (feet)															
		12	20	28	36	12	20	28	36	12	20	28	36	12	20	28	36
Required number of 16d common nails ^{a, b} per heel joint splices ^{c, d, e, f}																	
3:12	12	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	16	5	8	10	13	5	8	11	14	6	11	15	20	8	14	20	26
	24	7	11	15	19	7	11	16	21	9	16	23	30	12	21	30	39
4:12	12	3	5	6	8	3	5	6	8	4	6	9	11	5	8	12	15
	16	4	6	8	10	4	6	8	11	5	8	12	15	6	11	15	20
	24	5	8	12	15	5	9	12	16	7	12	17	22	9	16	23	29
5:12	12	3	4	5	6	3	4	5	7	3	5	7	9	4	7	9	12
	16	3	5	6	8	3	5	7	9	4	7	9	12	5	9	12	16
	24	4	7	9	12	4	7	10	13	6	10	14	18	7	13	18	23
7:12	12	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	16	3	4	5	6	3	4	5	6	3	5	7	9	4	6	9	11
	24	3	5	7	9	3	5	7	9	4	7	10	13	5	9	13	17
9:12	12	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	16	3	4	4	5	3	3	4	5	3	4	5	7	3	5	7	9
	24	3	4	6	7	3	4	6	7	3	6	8	10	4	7	10	13
12:12	12	3	3	3	3	3	3	3	3	3	3	3	4	3	3	4	5
	16	3	3	4	4	3	3	3	4	3	3	4	5	3	4	5	7
	24	3	4	4	5	3	3	4	6	3	4	6	8	3	6	8	10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479kPa.

- a. 40d box nails shall be permitted to be substituted for 16d common nails.
- b. Nailing requirements shall be permitted to be reduced 25 percent if nails are clinched.
- c. Heel joint connections are not required when the ridge is supported by a load-bearing wall, header or ridge beam.
- d. When intermediate support of the rafter is provided by vertical struts or purlins to a load bearing wall, the tabulated heel joint connection requirements shall be permitted to be reduced proportionally to the reduction in span.
- e. Equivalent nailing patterns are required for ceiling joist to ceiling joist lap splices.
- f. When rafter ties are substituted for ceiling joists, the heel joint connection requirement shall be taken as the tabulated heel joint connection requirement for two-thirds of the actual rafter-slope.
- g. Applies to roof live load of 20 psf or less.
- h. Tabulated heel joint connection requirements assume that ceiling joists or rafter ties are located at the bottom of the attic space. When ceiling joists or rafter ties are located higher in the attic, heel joint connection requirements shall be increased by the following factors:

HC/HR	Heel Joint Connection Adjustment Factor
1/3	1.5
1/4	1.33
1/5	1.25
1/6	1.2

1/10 or less



1.11

where:

H_C = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls.

H_R = Height of roof ridge measured vertically above the top of the rafter support walls.

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