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MINNESOTA DEPARTMENT OF LABOR & INDUSTRY

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Solar Photovoltaic (PV) Systems
Questions and Answers

The following frequently asked questions and answers are a compendium of existing statutes, rules and National Electrical Code (NEC) provisions that are applicable to all electrical installations, with a special emphasis related to the installation of solar photovoltaic systems

Electrical Licensing

EL-1) Are solar PV systems, including photovoltaic modules, panels and arrays, and their associated components, considered to be electrical equipment under the State Electrical Code?

Answer: Yes. The State Electrical Code adopts by reference the 2014 edition of the National Electrical Code (NEC). Solar photovoltaic systems fall within the definition of "equipment" as it is defined in the NEC. See NEC Article 100 and Article 690 for all pertinent definitions. Accordingly, solar PV systems, including photovoltaic modules, panels and arrays, and their associated components, are electrical equipment under the State Electrical Code.

(Reference the Board of Electricity Final Interpretation dated July 8, 2009 available at http://www.dli.mn.gov/PDF/boe/Interp/SPS.pdf)

EL-2) How is the term "electrical work" defined in state law?

Answer: Minnesota Statute 326B.31, Subdivision 17, defines "electrical work" as follows:

> *Electrical work. "Electrical work" means the installing, altering, repairing, planning, or laying out of electrical wiring, apparatus, or equipment for electrical light, heat, power, technology circuits or systems, or other purposes. The installing, altering, repairing, planning, or laying out of electrical wiring, apparatus, or equipment for electrical light, heat, power, technology circuits or systems, or other purposes includes, but is not limited to, the performance of any work regulated by the standards referred to in section 326B.35.*

EL-3) Are the solar PV systems that are regulated by the National Electrical Code considered "electrical work", as the term is defined in Minnesota Statute 326B.31, Subdivision 17?

Answer: Yes. Unless specifically exempt in Minnesota Statute Chapter 326B, all electrical work installed in Minnesota is required to be installed in accordance with all applicable electrical licensing and inspection requirements.

EL-4) Solar PV systems are generally installed on some form of structural support system (racking) on building roofs, on poles, on the ground and on a wide variety of structures. Are the non-electrical structural support systems considered to be “electrical work”, as the term is defined in Minnesota Statute 326B.31, Subdivision 17?

Answer: No. Non-electrical equipment and non-electrical structural support elements that consist of brackets, racking, purlins, blocking, frames, poles, concrete, roofing ballast, skids, anchors and similar are not considered electrical work. Such structural support systems usually require professional design by a registered structural engineer; this type of professional design work is not within the scope or authority of any classification of Minnesota electrical license.

EL-5) Some solar PV systems use a support system that incorporates enclosed electrical wireways (channels) and interconnecting electrical conduits that are used to provide structural support for the individual solar PV modules and they also serve as raceways for electrical circuit conductors. Is this type of support system, or portions thereof, considered to be “electrical work”, as the term is defined in Minnesota Statute 326B.31, Subdivision 17?

Answer: Yes. This type of support system, or the applicable portions thereof, is considered to be “electrical work”, as the term is defined in Minnesota Statute 326B.31, Subdivision 17. Portions of the support system that includes wireways, conduits, raceways or other enclosed channels expressly intended for electrical circuit conductors or the extension of electrical circuitry is considered electrical work.

EL-6) Some solar PV support systems provide structural support for the solar PV modules and the metallic support system (structure) is identified or listed as an equipment grounding conductor. Is this type of support system or structure, or portions thereof, considered to be “electrical work”, as the term is defined in Minnesota Statute 326B.31, Subdivision 17?

Answer: Yes. NEC Article 690 has specific requirements for such support systems or structures.

EL-7) Some solar PV support systems provide structural support for the solar PV modules and the metallic support system may also be bonded to a grounding electrode and a grounding electrode conductor, where the metallic support system may serve as a path for electrical ground-faults (See the definition of “ground-fault current path” in the NEC). Is this type of support system, or portions thereof, considered to be “electrical work”, as the term is defined in Minnesota Statute 326B.31, Subdivision 17?

Answer: Generally no. Metallic structural support systems (not otherwise used as electrical wireways, raceways or electrical conductors, such as equipment grounding conductors) that may serve as a path for ground-fault current does not automatically mean that the installation of such structural support system is considered electrical work. There are numerous metallic systems and elements in the built environment that serve as paths for ground-fault current or that may also serve as a means for other forms of electrical grounding and bonding, yet they are not considered to be electrical work. They could include, but not be limited to, structural

steel, reinforcing steel, metal building components, water piping, gas piping, ductwork, electrical shielding and the earth itself.

EL-8) Is the installation of any of the following items considered to be "electrical work", as the term is defined in Minnesota Statute 326B.31, Subdivision 17?; Grounding and bonding adapters, bushings, clamps, clips, conductors, couplings, devices, electrodes, fittings, grids, hubs, jumpers, locknuts, lugs, mesh, plates, rods, shunts, straps, wedges, wires and similar.

Answer: Yes. The installation of electrical grounding and bonding conductors, apparatus, components and similar is considered to be "electrical work", as the term is defined in Minnesota Statute 326B.31, Subdivision 17. All such electrical grounding and bonding conductors, apparatus, components and similar are required to be identified and listed for the purpose and installed in accordance with the manufacturer's installation instructions.

EL-9) With respect to electrical or structural systems, are there other statutes and rules that may be applicable to solar PV installations?

Answer: Yes. Minnesota Statutes 326.02, Subdivision 1 contains provisions that require licensure of persons who practice or offer to practice professional engineering. The practice of professional engineering is further defined in Minnesota Statute 326.02, Subdivision 2.

EL-10) Are licensed electrical contractors allowed to plan and layout their own electrical work?

Answer: Yes. Minnesota Statutes 326.02, Subdivision 5 states in pertinent part:

> *"Subd. 5. Limitation. The provisions of sections 326.02 to 326.15 shall not apply to…the planning for and supervision of the construction and installation of work by an electrical…contractor…as defined in and licensed pursuant to chapter 326B, where such work is within the scope of such licensed activity and not within the practice of professional engineering..."*

EL-11) If someone has additional questions related to professional design and licensure, to whom should they address their questions?

Answer: Please contact the Minnesota Board of Architecture and Engineering at http://mn.gov/aelslag/ or 651-296-2388.

EL-12) Do individuals handling, unloading and transporting electrical materials on a jobsite, need to be licensed or registered by the department?

Answer: No. Minnesota Statute 326B.31, Subdivision 17, defines "electrical work" as follows:

> *Electrical work. "Electrical work" means the installing, altering, repairing, planning, or laying out of electrical wiring, apparatus, or equipment for electrical light, heat, power, technology circuits or systems, or other purposes. The installing, altering, repairing, planning, or laying out of electrical wiring,*

apparatus, or equipment for electrical light, heat, power, technology circuits or systems, or other purposes includes, but is not limited to, the performance of any work regulated by the standards referred to in section 326B.35.

When electrical materials are being managed on the site (i.e. moving, stacking or storing), no "electrical work" as defined by Minnesota Statute is being done therefore no licensing and registration for individuals would be required.

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Electrical Code and Technical

EC-1) National Electrical Code (NEC) Section 690.9(D) requires overcurrent devices for PV source and PV output conductors to be accessible, but does not require them to be readily accessible. What does the NEC require or allow when the PV system is on a rooftop or an elevated structure?

Answer: NEC Article 100 definitions:

> **Accessible (as applied to equipment)** *Admitting close approach; not guarded by locked doors, elevation, or other effective means.*
>
> **Accessible (as applied to wiring methods)** *Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in by the structure or finish of the building.*
>
> **Accessible, Readily (Readily Accessible)** *Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom access is requisite to actions such as to use tools, to climb over or remove obstacles, or to resort to portable ladders, and so forth.*

The definitions are not intended to mean that equipment may not be elevated where it can be reached with a portable ladder or located behind locked doors, when qualified persons who need access have the necessary means to do so. The requirement states only that locked doors, elevation or other effective means must not "guard" against access.

The overcurrent devices mounted on or behind modules or structural members of a PV system shall be accessible without damaging the PV modules or the structure in order to permit safe access for installers, maintenance personnel and the electrical inspector.

EC-2) The new requirements in NEC Section 690.12 address the requirement for a rapid shutdown function for all PV system circuits mounted in or on buildings. What type of equipment will be acceptable in order to comply with the Rapid Shutdown requirements?

Answer: Police, firefighters and other emergency persons must contend with elements of PV systems that remain energized after the utility service disconnect is opened. The rapid shutdown function provides the necessary means to mitigate the shock potential that poses a danger to first responders. NEC Section 690.12 outlines the shutdown time constraints, placement or location in the PV circuit and the level of energy that the rapid shutdown function will need to operate in order to achieve the protection. Designs and methods for achieving rapid system shutdown are not addressed in the NEC, other than 690.12(D) which requires the equipment (single function or multiple devices) performing the rapid shutdown to be listed and identified.

EC-3) NEC Section 690.31(A) requires readily accessible PV source and PV output conductors over 30 volts to be guarded or installed in a raceway. What methods will be

acceptable in order to comply with the requirements for guarding or protecting PV conductors that are installed in readily accessible locations?

Answer: NEC Article 100 defines guarded as covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger. Most PV systems do not have means for attaching raceways. The conductors would be considered "not readily accessible" by using any of the items mentioned in the NEC definition or by elevation or location, provided the conductors are high enough or located in such a manner to remove the likelihood that individuals could approach or come into contact with conductors. Installations will be considered guarded when access is limited to qualified persons.

EC-4) If listed alternating-current (ac) AFCI protection is not available to meet the rule of NEC 705.12(D)(6), how can installers provide the required protection for a utility-interactive inverter's wiring harness or cable output circuit?

Answer: The NEC rule states that a utility-interactive inverter with a wire harness or cable output circuit rated 240-volts, 30-amps or less that is not installed in a raceway shall be provided with listed ac AFCI protection.

At this time, products that meet the NEC requirement apparently are not available. NEC Section 90.4 specifically permits the authority having jurisdiction (AHJ) to accept installations and equipment that involves new technologies, products or materials that are not yet available at the time the Code is adopted to comply with the most recent previous edition of this Code adopted by the jurisdiction.

Unlike NEC Section (D)(6) in the 2014 NEC, the 2011 NEC has no requirement for AFCI protection of the wiring harness or cable output. Until at least one 240-volt 30-amp ac arc-fault circuit-interrupter device is made commercially available, the language in the 2011 NEC will be permitted.

EC-5) Does the 2014 NEC have specific color code requirements for the identification of PV conductors?

Answer: Yes. NEC Section 210.5(C)(2) and 215.12(C)(2) state that each ungrounded conductor of direct-current (dc) branch circuits and feeders operating over 50 volts shall be identified by polarity at all terminations, connections and splice points, and the identification method(s) must be posted at the branch circuit or feeder panelboard where the conductors originate.

Conductor identification is required by NEC Section 200.6 wherever positively or negatively grounded systems are encountered. NEC Sections 408.3(E)(2) and (F)(4 and 5) contain the provisions for labeling dc buses and properly identifying ungrounded dc systems and resistively grounded dc systems.

EC-6) When a PV source connection is made on the supply side of a service disconnect, is the PV disconnect treated as service equipment and required to meet all of the NEC requirements for a service disconnect?

Answer: Yes. Every disconnecting means that has a direct connection to the electrical grid shall be listed and identified as being suitable for use as service equipment and shall meet all of the required ratings.

The interconnected electric power production source (solar PV system) is permitted to be connected to the electrical grid as follows:

- NEC 230.2(A)(5); As a separate service (for interconnected parallel power production)
- NEC 230.40 Exception No. 5; As a separate set of service-entrance conductors
- NEC 705.12(A); As a separate connection to the supply side of an existing service disconnecting means (in effect, a separate set of service-entrance conductors)

NEC 230.70 has a basic rule that states that the disconnecting means for each service, or set of service-entrance conductors, shall not consist of not more than six switches or circuit breakers. Where there are two to six disconnecting means for a service, the disconnects shall be grouped. Where there are two separate services (Service A; normal power) (Service B; solar PV power production source), the disconnects for Service A shall be grouped, and the disconnects for Service B shall be grouped. However, the NEC does not require that the disconnects for both Service A and Service B be grouped together (Service A and Service B could be located on opposite ends of a building). Where a building or structure is supplied by more than one service, permanent plaques and directories are required.

Regardless of whether the solar PV system is connected to the utility electrical grid via a separate service, a separate set of service-entrance conductors or a supply side connection, there are numerous rules that need to be taken into consideration, including but not limited to rating, location, grouping, marking, etc. for disconnects, overcurrent protection, grounding, bonding, labeling and so on.

Contrary to conventional electrical distribution in which the premises electrical system is typically a consumer of electrical power, utility-interactive interconnected solar PV systems distribute excess electrical power onto the electrical grid. The bi-directional service disconnecting means serves a dual role as both the ac disconnecting means for the solar PV system and as the disconnecting means for the service or service-entrance conductors.

EC-7) Do the rules in NEC Article 225 for outside branch circuits and feeders apply to solar PV systems?

Answer: Yes. The scoping provisions in NEC 225.1 state that the article covers requirements for outside branch circuits and feeders run on or between buildings, structures or poles on the premises. It also covers electrical equipment and wiring for the supply of utilization equipment that is located on or attached to the outside of buildings, structures or poles. NEC 225.3 and the accompanying table also act as a reminder that Article 225 is specifically applicable to solar photovoltaic systems in Article 690.

See Article 100 for the definitions of *Building* and *Structure*. The definition of *Structure* has broad applicability as determined by the Authority Having Jurisdiction (AHJ). It might not be obvious to some solar PV installers, but a ground-mounted solar PV array, located away from

the building, is considered a structure for the purpose of Article 225. In addition to all of the rules in Article 690 for the solar PV system, all of the general rules in NEC Chapters 1 through 4 are applicable, including Article 225.

EC-8) Do PV string inverters need to meet the working space requirements of NEC 110.26?

Answer: Generally, YES. NEC 110.26 states: “Working space for equipment operating at 600 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized shall comply with the dimensions of 110.26(A)(1), (A)(2), and (A)(3) or as required or permitted elsewhere in this Code”. The code is very clear, if the equipment is likely to be examined, adjusted or serviced while energized, the requirements for height, depth and headroom would need to be met according to NEC 110.26.

However, if the inverter can be serviced while de-energized or if the inverter doesn’t have any exposed live parts as defined in Article 100, the distance requirements would not apply.

If you have a questionable installation in the field regarding string inverter working clearances, please check with your local AHJ prior to the installation.

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Inspection Fees and Procedures

EF-1) The inspection fee schedule in Minnesota Statutes 326B.37 does not contain any specific inspection fees that correlate with the typical solar PV system. Has the department established electrical inspection fees that directly correlate with solar PV systems?

Answer: Yes. When the inspection fee schedule is applied to a project and the calculated fee results in a total fee that is not reasonable (i.e. excessive), or the inspection fee schedule does not correlate with the electrical work associated with the project, Minnesota Statute 326B.37, Subdivision 12 authorizes the department to negotiate inspection fees that result in a total fee that is reasonable and more appropriately offsets the cost of providing the inspection service.

EF-2) What does the department's interim solar PV system inspection fee schedule look like?

Answer: The following inspection fees will be applicable to solar PV systems and installations:

(a) The inspection fee for the installation of solar PV systems, is

(1) 0 watts to and including 5,000 watts, $60; or
(2) 5,001 watts to and including 10,000 watts, $100 or
(3) 10,001 watts to and including 20,000 watts, $150 or
(4) 20,001 watts to and including 30,000 watts, $200 or
(5) 30,001 watts to and including 40,000 watts, $250 or
(6) 40,001 watts to and including 1,000,000 watts, $250, and $25 for each additional 10,000 watts over 40,000 watts or
(7) 1,000,000 watts to 5,000,000 watts, $2,650, and $15 for each additional 10,000 watts over 1,000,000 watts or
(8) 5,000,000 watts and larger, $8,650, and $10 for each additional 10,000 watts over 5,000,000 watts.

(b) For the purpose of paragraph (a), the watt rating is the total estimated alternating current (ac) energy output of the solar system. The total dc energy output is not used.

(c) The solar PV inspection fees shall include inverters, modules, panels, combiners, converters, charge controllers, disconnecting means and electrical conductors between the inverter and the ac panelboard for stand-alone solar PV systems, or the conductors between the inverter and the service equipment or other power production, distribution and utilization system, such as a utility system and its connected loads, that is external to and not controlled by the solar PV power system.

(d) In addition to the inspection fees in (a), additional inspection fees may be applicable on large-scale projects for the inspection of additional electrical infrastructure between the inverter output circuit and the electrical production and distribution network. The inspection fees shall be calculated according to Minnesota Statutes 326B.37, subdivisions 2, 3, 4, and 6, paragraphs (d), (f), (j), and (k).

(e) When a plan review is required or performed the plan review fee is $80 per hour.

Minnesota Solar PV System
Electrical Inspection Fee Chart

Solar PV System Rating*	Inspection Fees
0 – 5,000 watts	$60
5,000 – 10,000 watts	$100
10,001 – 20,000 watts	$150
20,001 – 30,000 watts	$200
30,001 – 40,000 watts	$250
40,001 – 1,000,000 watts	$250, and $25 for each additional 10,000 watts over 40,000 watts
1,000,000 - 5,000,000 watts	$2,650 and $15 for each additional 10,000 watts over 1,000,000 watts
5,000,000 watts and larger	$8,650 and $10 for each additional 10,000 watts over 5,000,000 watts

*The watt rating is the total estimated alternating current (ac) energy output of the solar system. The total dc energy output is not used.

The solar PV inspection fees shall include inverters, modules, panels, combiners, converters, charge controllers, disconnecting means and electrical conductors between the inverter and the ac panelboard for stand-alone solar PV systems, or the conductors between the inverter and the service equipment or other power production, distribution and utilization system, such as a utility system and its connected loads, that is external to and not controlled by the solar PV power system.

In addition to the basic solar PV inspection fees, additional inspection fees may be applicable on large-scale projects for the inspection of additional electrical infrastructure between the inverter output circuit and the electrical production and distribution network. The inspection fees shall be calculated according to Minnesota Statute 326B.37, subdivisions 2, 3, 4, and 6, paragraphs (d), (f), (j), and (k).
When a plan review is required or performed the plan review fee is $80 per hour.

EF-3) Is a plan review required prior to the installation of a solar PV system?

Answer: Not at this time. However, installers of solar PV systems are expected to be able to answer any questions about the solar PV system posed by the Authority Having Jurisdiction (AHJ). The Solar America Board for Codes and Standards (Solar ABCs) has developed a set of standardized plan submittal and permit application documents that can be used to outline all of the plans, specifications and details for various types of solar PV systems. Solar PV installers are strongly encouraged to utilize these documents and make them available to the AHJ well in advance of the start of construction.

For large-scale solar PV projects, the department strongly encourages solar PV installers to contact the department well in advance of the start of construction in order to schedule one or more project review meetings. There is no plan review fee for these meetings. The purpose of the meetings is for the exchange of information and to help ensure the successful completion of the solar PV project. The department welcomes the opportunity to host these meetings.

EF-4) Upon request will the department perform a plan review prior to the installation of a solar PV system?

Answer: Yes. Please contact the department at dli.electricity@state.mn.us for more information. The department reserves the right to charge a plan review fee of $80 per hour when performing plan reviews.

Solar America Board for Codes and Standards Expedited Permitting
http://www.solarabcs.org/about/publications/reports/expedited-permit/forms/index.html

- Standard String System
- http://www.solarabcs.org/about/publications/reports/expedited-permit/pdfs/Example1-StandardStringSystem.pdf

- Micro-Inverter System

- http://www.solarabcs.org/about/publications/reports/expedited-permit/pdfs/Example2-Micro-Inverter.pdf

- AC-Module System
- http://www.solarabcs.org/about/publications/reports/expedited-permit/pdfs/Example3-ACModule.pdf

- Supply-Side Connection System
- http://www.solarabcs.org/about/publications/reports/expedited-permit/pdfs/Example4-Supply-SideConnection.pdf

Equipment Approval

EA-1) For electrical installations covered by the National Electrical Code (NEC), what is the difference between "*approved*" and "*listed*" when it comes to the acceptability of electrical equipment?

Answer: In accordance with NEC 110.2, conductors and equipment required or permitted in the NEC shall be acceptable only if they are approved. The term *Approved* is defined in Article 100 simply as "Acceptable to the authority having jurisdiction" (AHJ). However, suitability of electrical equipment is commonly required to be evidenced by *Listing* and *Labeling*. See the definitions of *Listing* and *Labeling* in NEC Article 100. Listed and labeled equipment is required to be installed in accordance with any instructions that are included in the listing and labeling. In North America there are several testing laboratories that evaluate electrical equipment, list the equipment in published product directories and label the equipment as evidence that the equipment meets all applicable safety standards. In the U.S., the Department of Labor Occupational Safety & Health Administration (OSHA) administers the program that is responsible for accrediting the Nationally Recognized Testing Laboratories (NRTLs) (Examples of NRTLs include UL, ETL-ITSNA, MET, CSA, etc.)

EA-2) Does the NEC require solar PV equipment to be listed?

Answer: Yes. Simple approval of solar PV equipment by an AHJ is not permitted in the NEC. There are numerous examples in the NEC where electrical equipment is specifically required to be listed (e.g. luminaries, wiring methods, automatic transfer switches, service equipment, hazardous locations, etc.). NEC 690.4(B) specifically requires inverters, motor generators, PV modules, PV panels, ac PV modules, dc combiners, dc-to-dc converters and charge controllers to be listed for PV applications.

EA-3) Does the U.S. Department of Labor Occupational Safety & Health Administration (OSHA) require electrical equipment in the workplace to be listed and labeled?

Answer: Yes. More information is available in Standards – 29 CFR, part 1910.303, Occupational Safety and Health Standards.

EA-4) Does Minnesota have similar OSHA regulations requiring electrical equipment in the workplace to be listed and labeled?

Answer: Yes. The Minnesota Department of Labor and Industry also enforces the Minnesota Occupational Safety and Health Act (MNOSHA) and federal standards.

EA-5) In addition to the equipment approval requirements in the NEC, does Minnesota have overriding statutes or rules related to the approval of electrical equipment?

Answer: Yes. Minnesota Rules Chapter (MRC) 3801.3619 and 3800.3620 contain provisions for the approval of electrical equipment. MRC 3801.3619 contains definitions. MRC 3801.3620 contains the provisions for the approval of electrical equipment. MRC 3801.3620, Subpart 1 essentially requires all equipment used as part of or in connection with an electrical installation to be listed and labeled by a nationally recognized testing laboratory.

EA-6) Does MRC 3801.3620 contain any alternatives to listing and labeling?

Answer: Yes. MRC 3801.3620, Subpart 2 outlines the provisions that can be utilized to obtain the department's approval of certain types of electrical equipment. The two most common methods for third-party certification of non-listed equipment includes; 1) field evaluation by a nationally recognized testing laboratory, or 2) field evaluation by a registered electrical engineer.

EA-7) Does the department have more information online related to equipment approval?

Answer: Yes. Approval requirements for electrical equipment are online at http://www.dli.mn.gov/CCLD/ElectricalEquipment.asp

Building Code

BC-1) Does the Minnesota State Building Code contain provisions related to the installation of solar PV systems?

Answer: Yes. The 2015 Minnesota Building Code contains provisions for the installation of solar PV systems. The code provisions will include rules related to roof access, pathways and spacing requirements in an effort to mitigate hazards and to aid in firefighting operations. http://codes.iccsafe.org/app/book/content/2015_Minnesota/2015%20Minnesota%20Building%20Code/CHAPTER%2031.html
The code provisions are found in Minnesota Rules Section 1305.3113, which will be in the 2012 International Building Code (IBC), as amended and adopted.

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