

Simplified Solar Permitting Guidelines

Improving Permit Review and
Inspection for Small Solar Systems

Delaware Valley Regional Planning
Commission Training

Bill Brooks, Principal, Brooks Engineering

SIMPLIFIED PV PERMIT GUIDELINES



- The information in these guidelines are intended to provide a format whereby local jurisdictions and contractors can permit simple PV system installations where only a basic review is necessary.
- It is likely that most residential and some small commercial PV systems will comply with these simple criteria that address the requirements for PV systems in the building, electrical, and fire codes.

Guideline Contents



- 1. Eligibility List** – Defines the size, electrical, structural, and fire safety requirements for solar installations to qualify for simplified permitting.
- 2. Structural Review**– Enable applicants to “fill in the blanks” to explain the structural details of a rooftop solar PV system.
- 3. Electrical Review**– Enable applicants to “fill in the blanks” to explain the electrical configuration of a solar PV system.

CURRENT LAWS, REGS & CODES



This Guideline is not intended to create, explicitly or implicitly, any new requirements.

- NEC Article 690, 705, and chapters 1-4
- IRC R331, R902, R905, R908
- IBC 1505, 1509, 1511
- IFC 605.11
- ASCE 7-10, 7-16

SIMPLIFIED PV PERMIT GUIDELINES



Required Information for Permit:

1. Permit application required by the local jurisdiction. Permit applications normally include information about the project scope, project location, and the installer.
2. Site plan showing location of major components on the property. This drawing need not be exactly to scale, but it should represent relative location of components at site (see supplied example site plan). PV arrays in compliance with IRC fire setback requirements need no separate fire service review (with Fire Service MOU).

SIMPLIFIED PV PERMIT GUIDELINES



Required Information for Permit (cont.):

3. Electrical worksheets showing PV array configuration, wiring system, overcurrent protection, inverter, disconnects, required signs, and ac connection to building (see supplied standard electrical diagram).
4. Specification sheets and installation manuals (if available) for all major PV system components such as, PV modules, dc-to-dc converters, inverters, and mounting systems.

Purposes of Simplified Permitting



- A simplified, expedited permit process for small solar PV systems simplifies and consolidates the structural, electrical and fire review of the PV system
- It can eliminate the need for detailed engineering studies and often avoids unnecessary delays
- It is not the intent of an expedited process to circumvent the engineering process
- It is to recognize the similarities among these smaller systems and establish guidelines to determine when a PV project is within the boundaries of typical, well-engineered systems that are clearly compliant with electrical and building codes.

The “Box” to Qualify Simple Permits

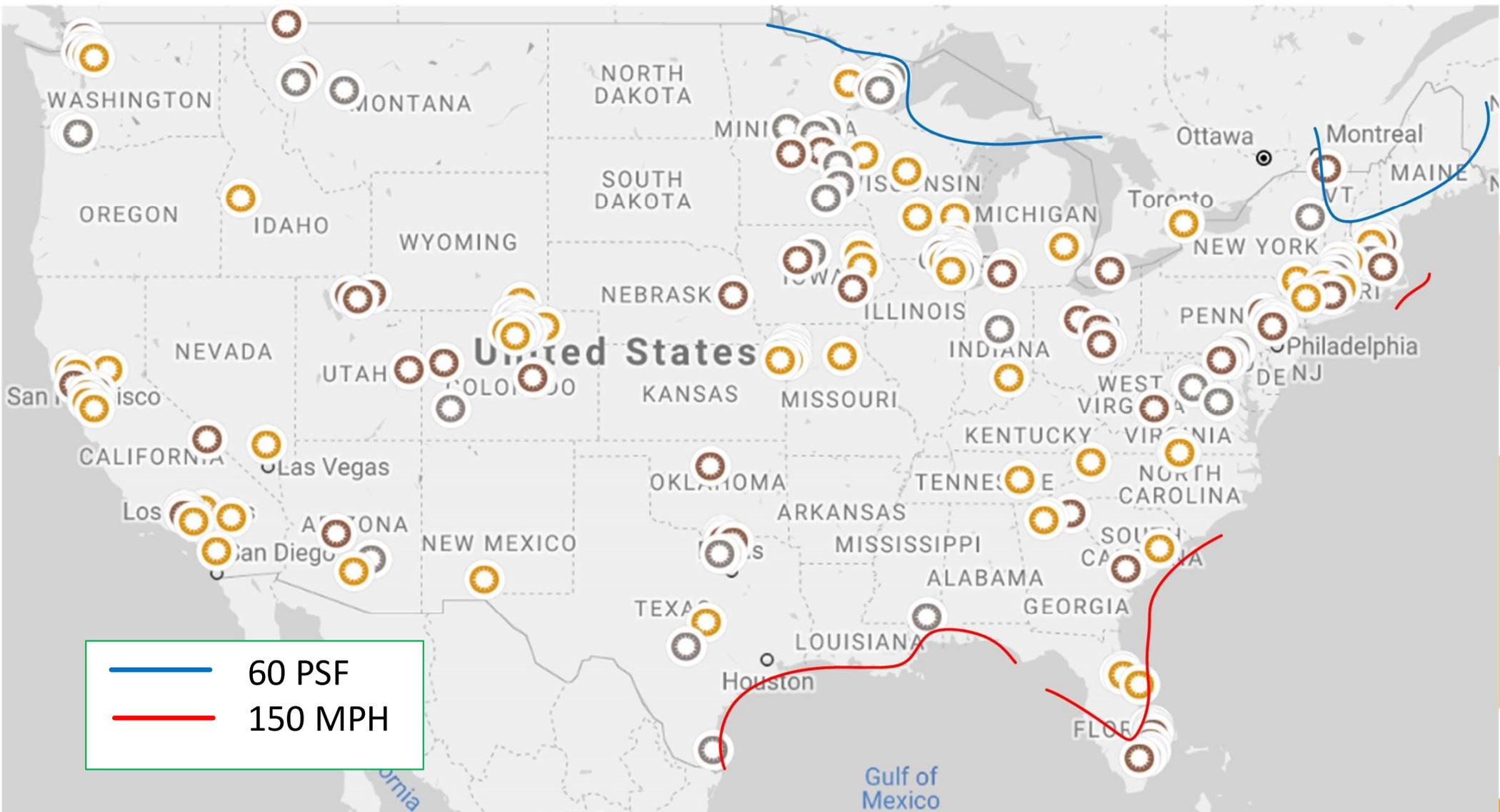
- PV system no larger than 15.36kW
- One- and two-family rooftop installations or structure of same construction.
- String inverter, dc converter, or microinverter
- Complies with eligibility checklist

Overall Limitations of Location



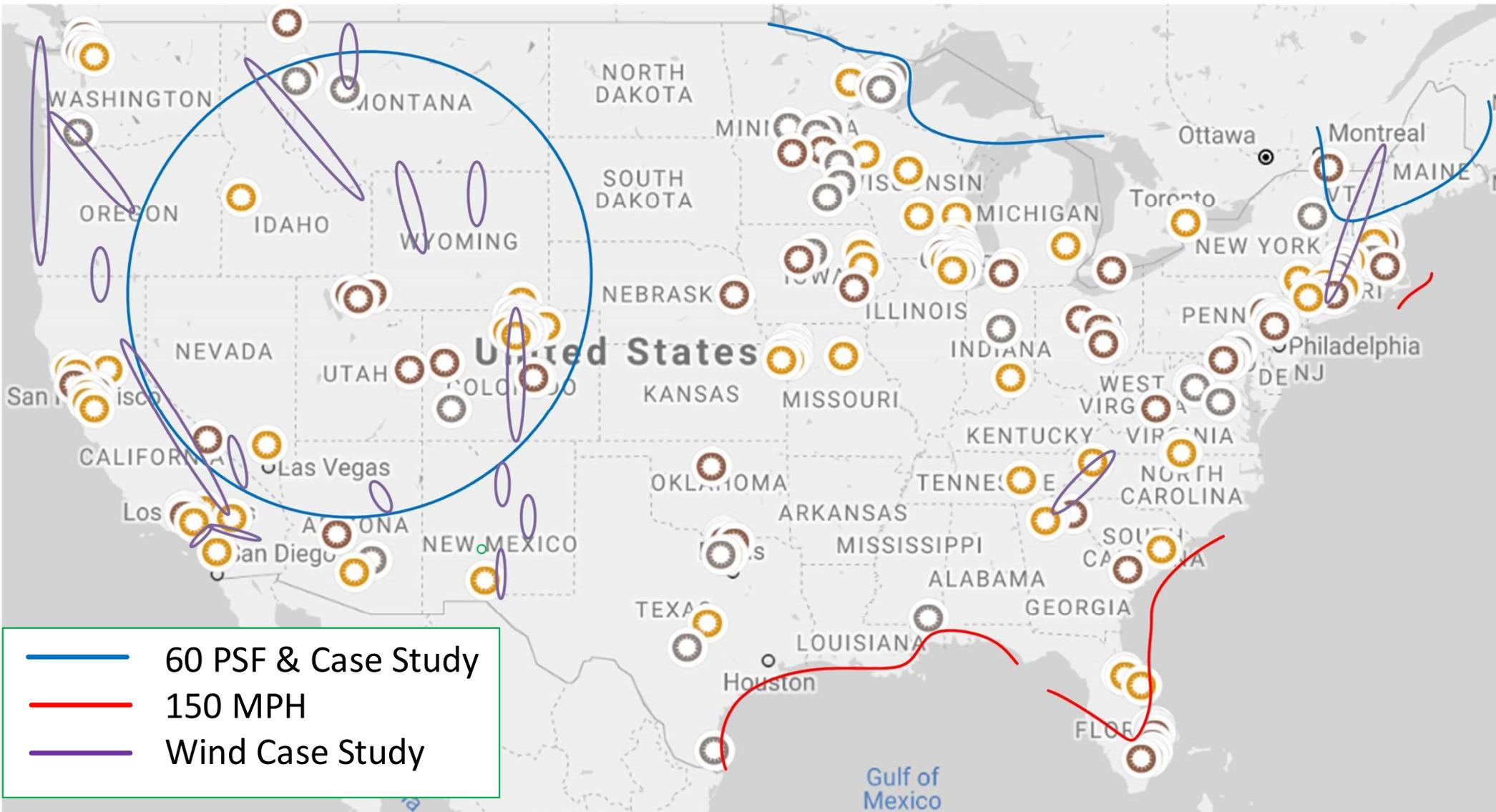
- Snow load no greater than 60 PSF (pounds per square foot).
- Wind load no greater than 150 MPH

Guidelines Cover Most of 48 States



— 60 PSF
— 150 MPH

Guidelines Cover Most of 48 States



Member Attached Limitations



- Snow load no greater than 60 PSF (pounds per square foot).
- Wind load no greater than 150 MPH
- Not Exposure D (waterfront)
- Not on steep hill (5% grade)
- Roof mean height 40' or less
- Roof structure meets IRC
- No structural damage

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



Member-Attached PV Array Requirements:

- 1. Array is set back from all roof edges and ridge by at least twice the gap under the modules (or more, where fire access pathways are required).
- 2. Array does not cantilever over the perimeter anchors more than 19”.
- 3. Gap under modules (roof surface to underside of module) is no greater than 10”.
- 4. Gaps between modules are (select one below):
 - a. *at least 0.25” on both short and long sides of modules, or*
 - b. *0” on short side, and at least 0.50” on long sides.*

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



Member-Attached PV Array Requirements (cont):

- 5. Mounting rail orientation or rail-less module long edges:
 - a. *run perpendicular to rafters or trusses, and attached to them*

- 6. The anchor/mount/stand-off spacing perpendicular to rafters or trusses:
 - a. *does not exceed 4'-0", and anchors in adjacent rows are staggered where rafters or trusses are at 24" or less on center*

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



Member-Attached PV Array Requirements (cont):

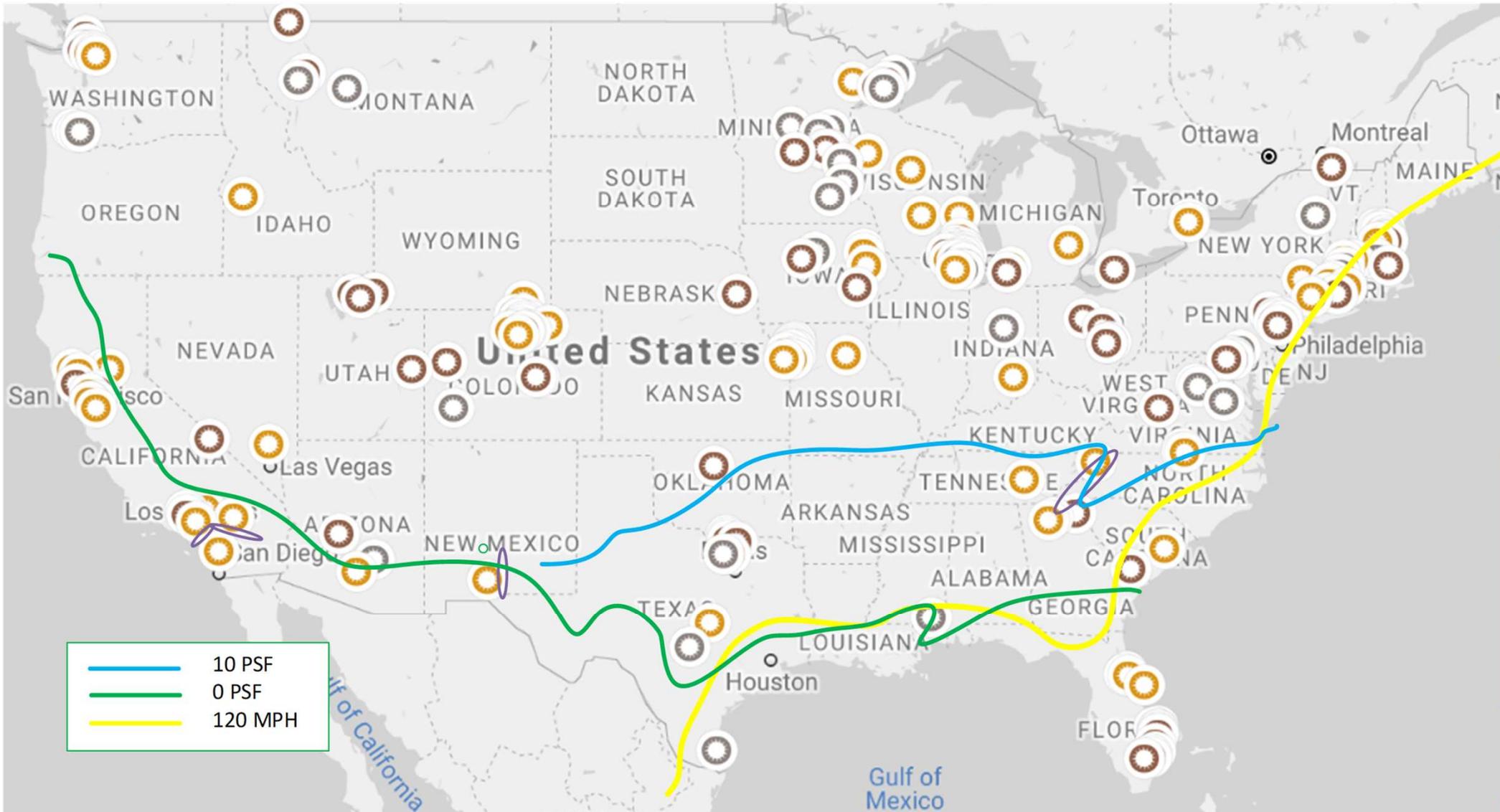
- 7. Upslope/downslope anchor spacing follows manufacturer's instructions.
- 8. Anchor fastener is (select one below):
 - a. *5/16" diameter lag screw with 2.5" embedment into structural member, or*
 - b. *fastener other than (a.) embedded in structural members in accordance with manufacturer's structural attachment details. Manufacturer's anchor layout requirements must not exceed the anchor spacing requirements shown in Items 5 and 6 above.*

Structural Summary Takeaway



1. Houses that were built in compliance with building structural codes, can support PV.
2. Single layer of roofing (no second layer of comp).
3. PV modules mounted within 2" and 10" of roof deck.
4. PV array distributed weight less than 4 lb/ft²
5. Typical rafter with supports 48" apart or closer (each anchor row mounted on alternating trusses) meet structural code requirements (represents most of housing stock).

Options for Low Snow and Wind



ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



Member-Attached PV Array Requirements (cont):

- 5. Mounting rail orientation or rail-less module long edges:
 - b. run parallel to rafters and are spaced no more than 4'-0" apart, Ground Snow Load is no greater than 10 psf, and Design Wind Speed does not exceed 120 mph.*

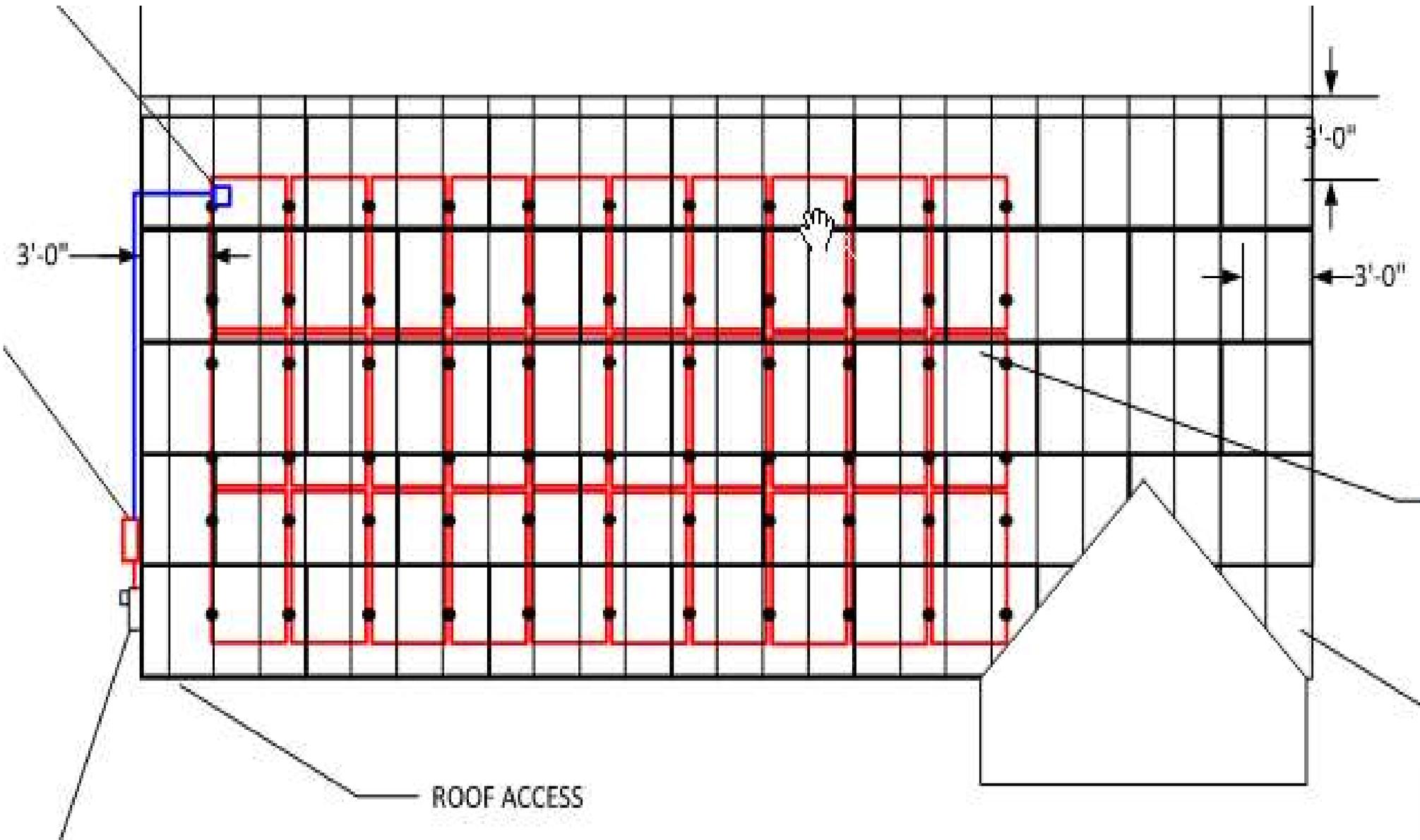
- 6. The anchor/mount/stand-off spacing perpendicular to rafters or trusses (select one below):
 - a. does not exceed 4'-0", and anchors in adjacent rows are staggered where rafters or trusses are at 24" or less on center (see Figure), or*
 - b. does not exceed 4'-0", anchor layout is orthogonal, roof slope is 6:12 or less, Ground Snow Load is no greater than 10 psf, and Design Wind Speed does not exceed 120 mph, or*
 - c. does not exceed 6'-0", anchor layout is orthogonal, roof slope is 6:12 or less, Ground Snow Load is zero, and Design Wind Speed does not exceed 120 mph.*

Sheathing Attached Limitations



- Snow load no greater than 60 PSF
- Wind load no greater than 140 MPH
- Not Exposure D (waterfront)
- Not on steep hill (5% grade)
- Roof mean height 30' or less
- Roof structure meets IRC
- Mfg Truss or Kiln Dry Rafters
- No structural damage
- Tributary area matters

BANDS OF STRENGTH—Middle 16" of Sheet



ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING—Sheathing—No Bands of Strength



- a. Some anchors are not within bands of strength, and all the following (i., ii. & iii.) apply:
 - i. Edge of array is more than 3 feet from any roof edge (Wind Zone 1), and
 - ii. Tributary area is 9 ft² or less (up to half the area of a 60 cell PV module), and
 - iii. Wind Exposure B only, and design wind speed does not exceed 120 mph.

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING—Sheathing—Bands of Strength



- *b. All anchors are within bands of strength, and all of the following (i., ii. & iii.) apply:*
 - *i. Edge of array is more than 3 feet from any roof edge (Wind Zone 1), and*
 - *ii. Tributary area is 14 ft² or less (40"×48").*
 - *iii. One of the two wind cases below (x. or y.) applies:*
 - *x. Exposure B, and design wind speed does not exceed 140 mph, or*
 - *y. Exposure C, and design wind speed does not exceed 120 mph.*

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



- 8. Anchor-to-sheathing connection has an allowable stress design (ASD) uplift capacity of at least 166 lbs. under short duration loading, which corresponds to a mean ultimate tested uplift capacity of at least 520 lbs.

GENERAL STATEMENT FOR CHECKLIST:

If any structural item cannot be checked off, the building official may require the installer to provide structural calculations and/or details, stamped and signed by a design professional, addressing the unchecked item.

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



Step 2: Electrical PV System Requirements Checklist

For a simplified PV permit, following are the electrical requirements:

1. Major electrical components including PV modules, dc-to-dc converters, and inverters, are identified for use in PV systems.
2. Array mounting system UL2703 certified for bonding and grounding. Alternatively, the array mounting system may incorporate UL2703 grounding devices to bond separate exposed metal parts together or to the equipment grounding conductor.
3. The PV array consists of no more than 2 series strings per inverter input and no more than 4 series strings in total per inverter.

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



- 4. Field Installed PV array wiring meets the following requirements (all boxes must be checked):
 - a. All exposed PV source circuit wiring is no smaller than 12 AWG PV Wire or MFG Cable.
 - b. All PV source circuit wiring in raceway is no smaller than 12 AWG THWN-2, XHHW-2, or RHW-2.
 - c. Any field-installed PV output circuit wiring is 6 AWG THWN-2, XHHW-2, or RHW-2.
 - d. PV system circuits on buildings meet requirements for controlled conductors in 690.12.
- 5. The total inverter capacity has a continuous ac power output 15,360 Watts or less and meets the requirements of 705.12(B) where installed on the load side of the service disconnecting means (complies with Table 705.12 in the Electrical Commentary). (choose one below)
 - Load-side connection complying with Table 705.12(B)
 - Supply-side connection complying with 705.12(A)

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



6. Equipment is rated for the maximum dc voltage applied to the equipment (put N/A in all blanks that do not apply to the specific installation):
- A. ASHRAE Extreme Annual Mean Minimum Design Dry Bulb Temperature (one source is www.solarabcs.org/permitting) = _____;
- Table 690.7 (NEC) value _____
- B. Max (temp adjusted) module Voc:
- Rated Voc _____ V x Table 690.7 value _____ = _____ V

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



- C. Dc-to-dc converter(s) or microinverter rated maximum input voltage: _____ V
(must be greater than Max module Voc in (B.))
- D. Maximum number of dc-to-dc converters allowed in series (up to 600Vdc): _____
- E. Maximum voltage of dc-to-dc converter circuit with maximum number in (C.): _____ V

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



F. Inverter(s) rated maximum input voltage: _____ V (must be greater than 1)-4) below)

1) Inverter 1 input 1: Max module Voc (B.) _____ V x # in series _____ =
_____ V

2) Inverter 1 input 2: Max module Voc (B.) _____ V x # in series _____ =
_____ V

3) Inverter 2 input 1: Max module Voc (B.) _____ V x # in series _____ =
_____ V

4) Inverter 2 input 2: Max module Voc (B.) _____ V x # in series _____ =
_____ V

ELIGIBILITY CHECKLIST FOR SIMPLIFIED PV PERMITTING



7. One of the standard electrical diagrams (E1.1a, E1.1b, E1.1c, or E1.1d) can be used to accurately represent the PV system.

Fill out the appropriate standard electrical diagram completely. If the electrical system is more complex than the standard electrical diagram can effectively communicate, the project does not meet the requirements for a simplified permit application and additional information may be necessary for the jurisdiction to process the permit application.

Central/String Inverter Standard Plans



- Use this plan ONLY for central/string inverter systems with or without dc converters not exceeding 15.36kW on the roof of a one- or two-family dwelling or similar structure.
- The photovoltaic system must interconnect to the load side of a 120/240Vac service panel rated 400A or less (80-amp PV breaker or less).
- Not intended for more than two inverters, or more than one dc combiner per inverter (non-inverter-integrated).

Example 1—7.5kW Central Inverter PV System



PV System Components

PV Modules

Qty. 30, 285W, American Solar AS285

Inverter

Qty. 1, 7.5 kW, American Inverter AI-7500

Mounting System

OmniRack ModMount 5.0; sheathing attached;

House

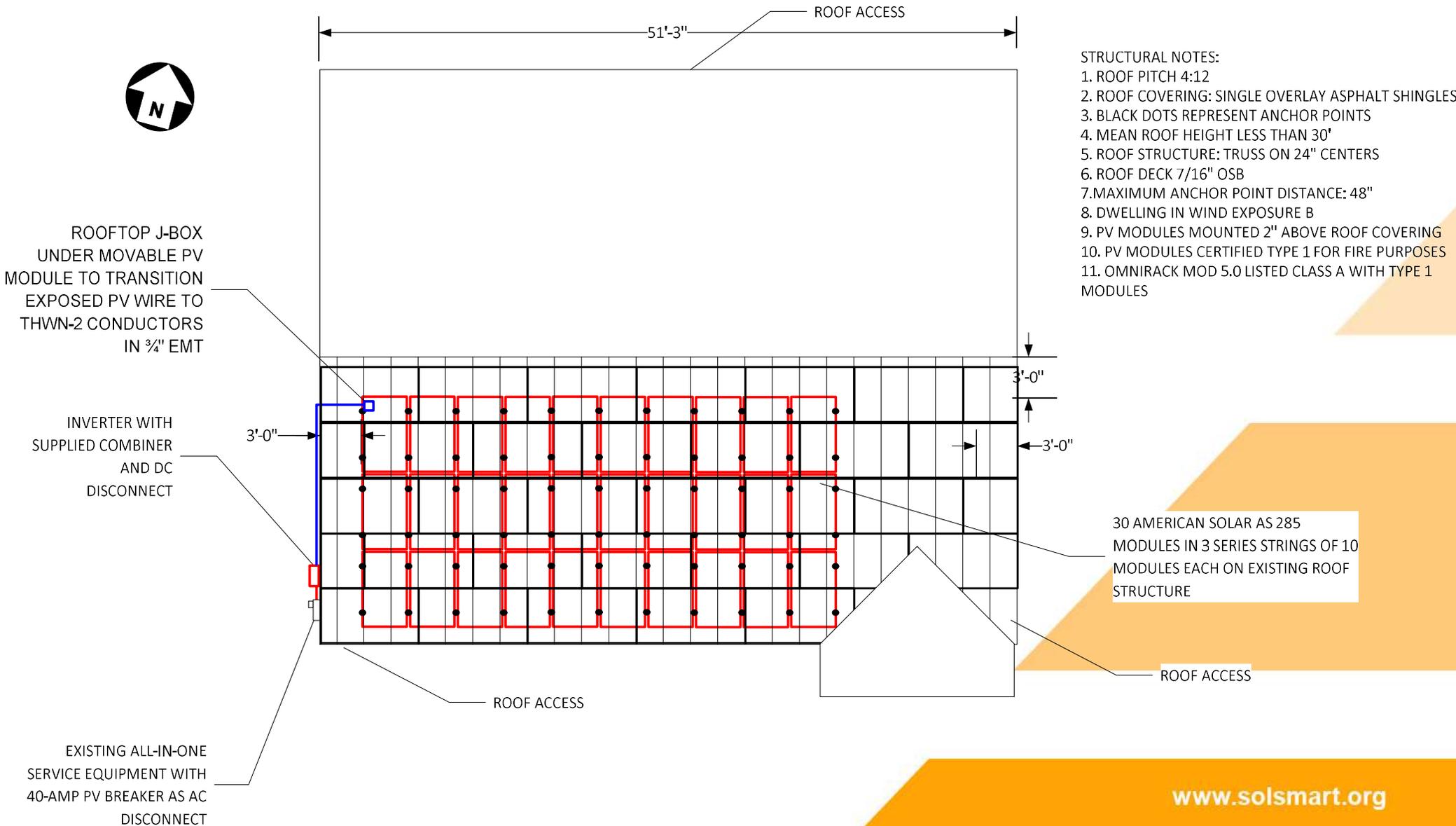
Roof Pitch 4:12; House built in 1988. Comp shingle roof. [structurally compliant]

Form Fill-Out Demonstration



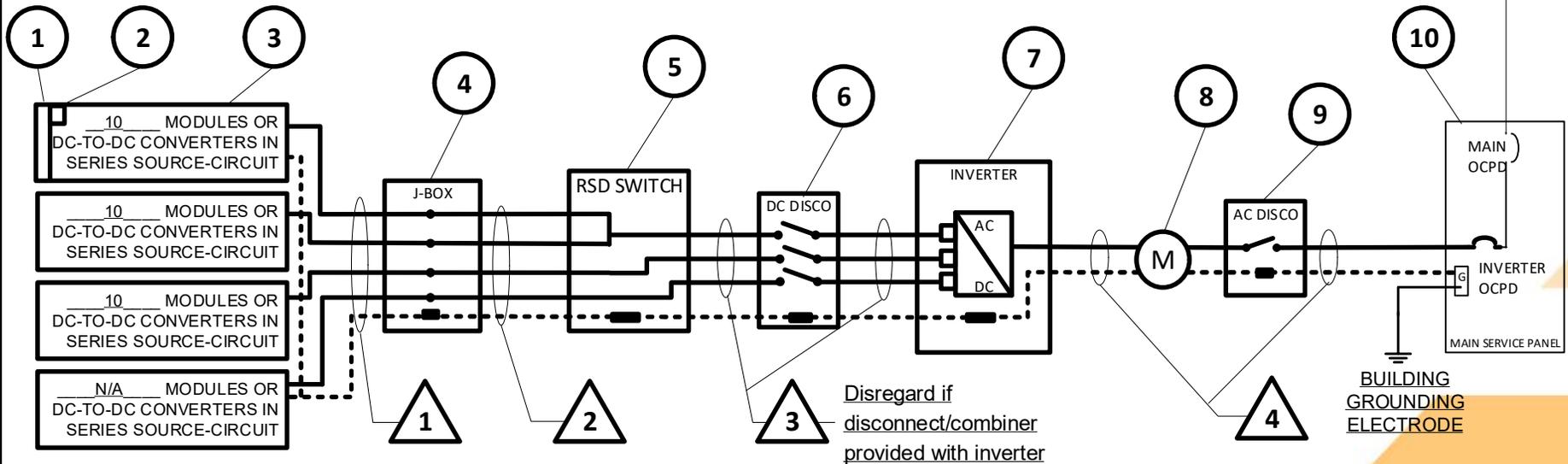
Compliance Document
Standard Plan—Simplified Central Inverter
Structural Criteria—compliant

Sheathing Attached System





EQUIPMENT SCHEDULE			
TAG	DESCRIPTION	PART NUMBER	NOTES (N/A IF NOT USED)
1	SOLAR PV MODULE	AS 285	AMERICAN SOLAR, QUANTITY - 30 (SEE NOTES SHEET FOR DETAILS)
2	DC-DC CONVERTER		N/A
3	PV ARRAY OUTPUT 1		2 STRINGS WITH 10 MODULES PER SERIES STRING
	PV ARRAY OUTPUT 2		1 STRING WITH 10 MODULES PER SERIES STRING
	PV ARRAY OUTPUT 3		N/A
4	J-BOX		6"x6"x4" NEMA 4, PVC JUNCTION BOX
5	ROOFTOP RSD SWITCH	AI-RSD-3	THREE STRING RAPID SHUTDOWN SWITCH FOR AI-7500
6	DC DISCONNECT	MFR-supplied	LISTED WITH INVERTER, 600VDC
7	DC/AC INVERTER	AI-7500	7500 WATT, SINGLE PHASE (SEE NOTES SHEET FOR DETAILS)
8	GEN METER	FORM 2S	4-JAW, 240V CYCLOMETER REGISTER KWH METER IN 100-A BASE
9	AC DISCONNECT		N/A
10	SERVICE PANEL	SQ.D 200D	240_VAC, _200_A MAIN, _200_A BUS, _40_A INVERTER OCPD



FOR UNUSED SERIES STRINGS
PUT "N/A" in BLANK ABOVE

CONDUIT AND CONDUCTOR SCHEDULE					
TAG	DESCRIPTION OR CONDUCTOR TYPE	COND. GAUGE	NUMBER OF CONDUCTORS	CONDUIT TYPE	CONDUIT SIZE
1	USE-2 <input type="checkbox"/> or PV WIRE <input type="checkbox"/>	10		N/A	N/A
	BARE COPPER EQ. GRD. COND. (EGC)	6		N/A	N/A
2	THWN-2 <input type="checkbox"/> or XHHW-2 <input type="checkbox"/> or RHW-2 <input type="checkbox"/>	10			
3	THWN-2 <input type="checkbox"/> or XHHW-2 <input type="checkbox"/> or RHW-2 <input type="checkbox"/>	6			
	INSULATED EGC	10			
4	THWN-2 <input type="checkbox"/> or XHHW-2 <input type="checkbox"/> or RHW-2 <input type="checkbox"/>				
	INSULATED EGC				

Contractor Name, Address and Phone: Bill and Ted's Solar 456 Excellent Drive San Dimas, CA 800-555-1212		One-Line Standard Electrical Diagram for Small-Scale, Single-Phase PV Systems Site Name: John and Jane Homeowner Site Address: 12 Sunnyside St, Philadelphia, PA System AC Size: 7.5 KW		
Drawn By:	SIZE	FSCM NO	DWG NO	REV
Checked By:	SCALE	NTS	Date:	SHEET
			E1.1a	

PV MODULE RATINGS @ STC (Guide Section 2)

MODULE MAKE	AMERICAN SOLAR		
MODULE MODEL	AS-285		
MAX POWER-POINT CURRENT (I _{MP})		9.20 A	
MAX POWER-POINT VOLTAGE (V _{MP})		31.3 V	
OPEN-CIRCUIT VOLTAGE (V _{OC})		39.7 V	
SHORT-CIRCUIT CURRENT (I _{SC})		9.84 A	
MAX SERIES FUSE (OCPD)		20 A	
MAXIMUM POWER (P _{MAX})		285 W	
MAX VOLTAGE (TYP 1000V _{DC})		1000 V	

NOTE FOR ARRAY CIRCUIT WIRING
(Guide Section 4 and Appendix E):

LOWEST EXPECTED AMBIENT TEMPERATURE BASED ON ASHRAE MINIMUM MEAN EXTREME DRY BULB TEMPERATURE FOR ASHRAE LOCATION MOST SIMILAR TO INSTALLATION LOCATION. LOWEST EXPECTED AMBIENT TEMP -12 °C

NOTES FOR INVERTER CIRCUITS (Section 42):

- 1) IF UTILITY REQUIRES A VISIBLE-BREAK SWITCH, DOES THIS SWITCH MEET THE REQUIREMENT? YES NO N/A
- 2) IF GENERATION METER REQUIRED, DOES THIS METER SOCKET MEET THE REQUIREMENT? YES NO N/A
- 3) SIZE INVERTER OUTPUT CIRCUIT (AC) CONDUCTORS ACCORDING TO INVERTER OCPD AMPERE RATING. (See Table xxx)
- 4) TOTAL OF 1 INVERTER OCPD(S), ONE FOR EACH INVERTER. DOES TOTAL SUPPLY BREAKERS COMPLY WITH 120% BUSBAR RULE IN 705.12(D)? YES NO

NOTES FOR ALL DRAWINGS:

OCPD = OVERCURRENT PROTECTION DEVICE
NATIONAL ELECTRICAL CODE® REFERENCES SHOWN AS (NEC XXX.XX)

DC-TO-DC CONVERTER RATINGS (if used)

CONVERTER MAKE			
CONVERTER MODEL			
MAX CURRENT			A
MAX VOLTAGE			V
MAXIMUM POWER			W
MAX OUTPUT CIRCUIT V (TYP 600V _{DC})			V

INVERTER RATINGS (Guide Section 4)

INVERTER MAKE	AMERICAN INVERTER		
INVERTER MODEL	AI-7500		
MAX DC VOLT RATING		600 V	
MAX POWER @ 40°C		7500 W	
NOMINAL AC VOLTAGE		240 V	
MAX AC CURRENT		31.25 A	
MAX OCPD RATING		40 A	

SIGNS—SEE GUIDE SECTION 7

***SIGN FOR DC DISCONNECT**

PHOTOVOLTAIC POWER SOURCE	
RATED MPP CURRENT	27.6 A
RATED MPP VOLTAGE	313 V
MAX SYSTEM VOLTAGE	461 V
MAX CIRCUIT CURRENT	36.9 A
WARNING: ELECTRICAL SHOCK HAZARD—LINE AND LOAD MAY BE ENERGIZED IN OPEN POSITION	

SIGN FOR PV SYSTEM DISCONNECT

SOLAR PV SYSTEM DISCONNECT	
AC OUTPUT CURRENT	31 A
NOMINAL AC VOLTAGE	240 V

SIGN FOR DISTRIBUTION PANELS

THIS PANEL FED BY MULTIPLE SOURCES (UTILITY AND SOLAR)

SIGN FOR NEC 705.12(D)(2)(3)(b) (if used)

WARNING:
INVERTER OUTPUT CONNECTION;
DO NOT RELOCATE THIS
OVERCURRENT DEVICE.

SIGN FOR NEC 690.12 (for roof-mounted systems)

PHOTOVOLTAIC SYSTEM
EQUIPPED WITH RAPID SHUTDOWN

*NOTE: MICROINVERTER AND AC MODULE SYSTEMS DO NOT NEED DC DISCONNECT SIGN SINCE 690.51 MARKING ON PV MODULE COVERS NEEDED INFORMATION

Contractor Name, Address and Phone: _____ _____ _____		Notes for One-Line Standard Electrical Diagram for Single-Phase PV Systems		
		Site Name: _____		
		Site Address: _____		
		System AC Size: _____		
Drawn By:	SIZE	FSCM NO	DWG NO	REV
			E1.2a	
Checked By:	SCALE	NTS	Date:	SHEET

Microinverter Standard Plans--Scope



- Use this plan ONLY for systems using microinverters or ac modules (ACM) not exceeding 15.36 kW, with no more than 4 output circuits, one PV module/microinverter, installed on the roof of a one- or two-family dwelling or similar structure.
- The PV system must interconnect to the load side of a 120/240Vac, service panel rated 400A or less (80-amp breaker or less).

Example 2— 7.5kW Microinverter PV System



- PV System Components

- PV Modules

- Qty. 30, 285W, American Solar AS285

- Inverters

- Qty. 30, 250W, American Inverter AI-250

- Mounting System

- OmniRack ModMount 4.0; Maximum span 72”;

- House

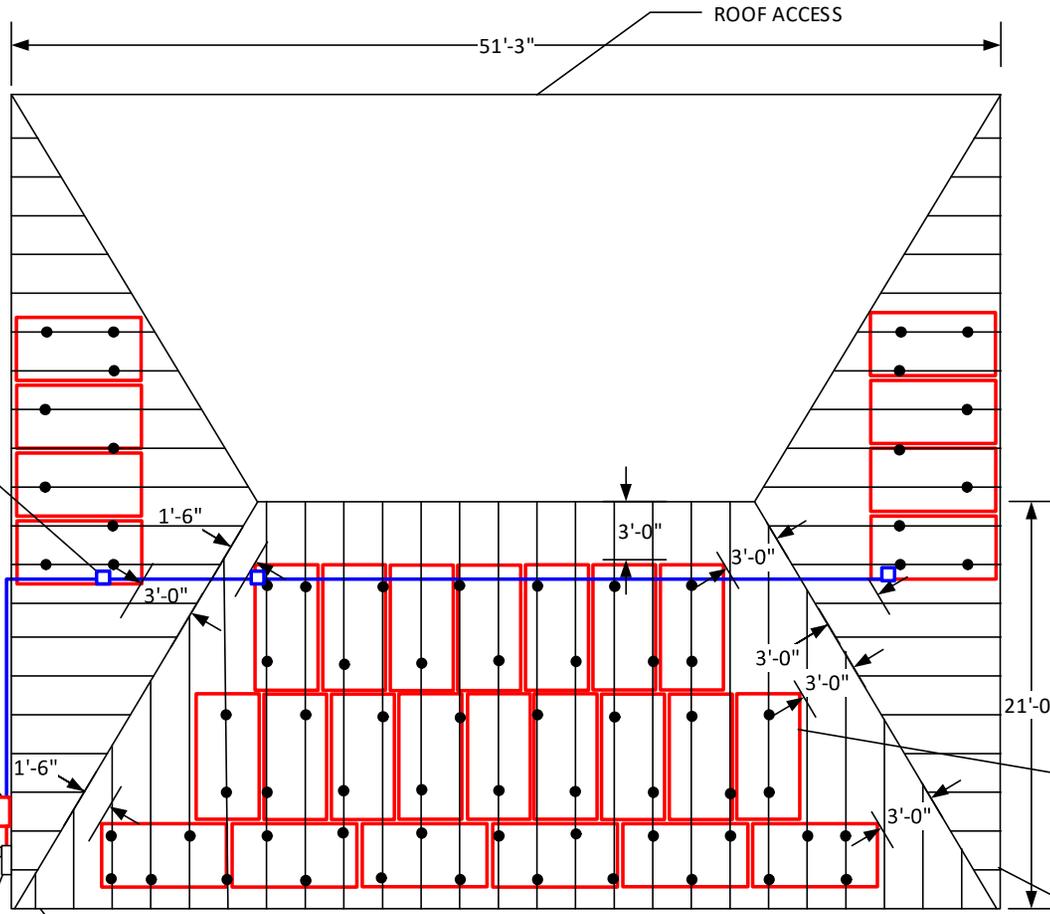
- Roof Pitch 4:12; House built in 1988. Comp shingle roof. [structurally compliant]

Form Fill-Out Demonstration



Compliance Document
Standard Plan—Simplified Microinverter
Structural Criteria (compliant)

Member Attached System



STRUCTURAL NOTES:

1. ROOF PITCH 4:12
2. ROOF COVERING: SINGLE LAYER ASPHALT SHINGLES
3. BLACK DOTS REPRESENT ANCHOR POINTS
4. MEAN ROOF HEIGHT LESS THAN 30'
5. ROOF STRUCTURE: 2x6 RAFTERS ON 24" CENTERS WITH MIDSPAN SUPPORT—MAX SPAN 11'6".
6. ROOF DECK 7/16" OSB
7. MAXIMUM ANCHOR POINT HORIZONTAL DISTANCE: 72"
8. DWELLING IN WIND EXPOSURE B
9. ANCHORS ARE 5/16" LAG SCREWS WITH 2.5 EMBEDMENT IN STRUCTURE
10. EACH ANCHOR FLASHED WITH "ANCHOR-FLASH" ALUMINUM FLASHING
11. ALL MODULE RAILS RUN PERPENDICULAR TO RAFTERS
12. PV MODULES MOUNTED 5" ABOVE ROOF COVERING
13. PV MODULES CERTIFIED TYPE 1 FOR FIRE PURPOSES
14. OMNIRACK MOD 3.0 LISTED CLASS A WITH TYPE 1 MODULES

30 AMERICAN SOLAR AS 285
MODULES EACH CONNECTED TO AN
AMERICAN INVERTER AS-250
MICROINVERTER IN TWO CIRCUITS OF
15 MICROINVERTERS EACH
ON EXISTING ROOF STRUCTURE

ROOFTOP J-BOX
UNDER MOVABLE PV
MODULE TO TRANSITION
EXPOSED PV WIRE TO
THWN-2 CONDUCTORS IN
3/4" EMT (typical 3 places)

125-AMP AC
SUBPANEL WITH
TWO, 20-AMP PV
BREAKERS

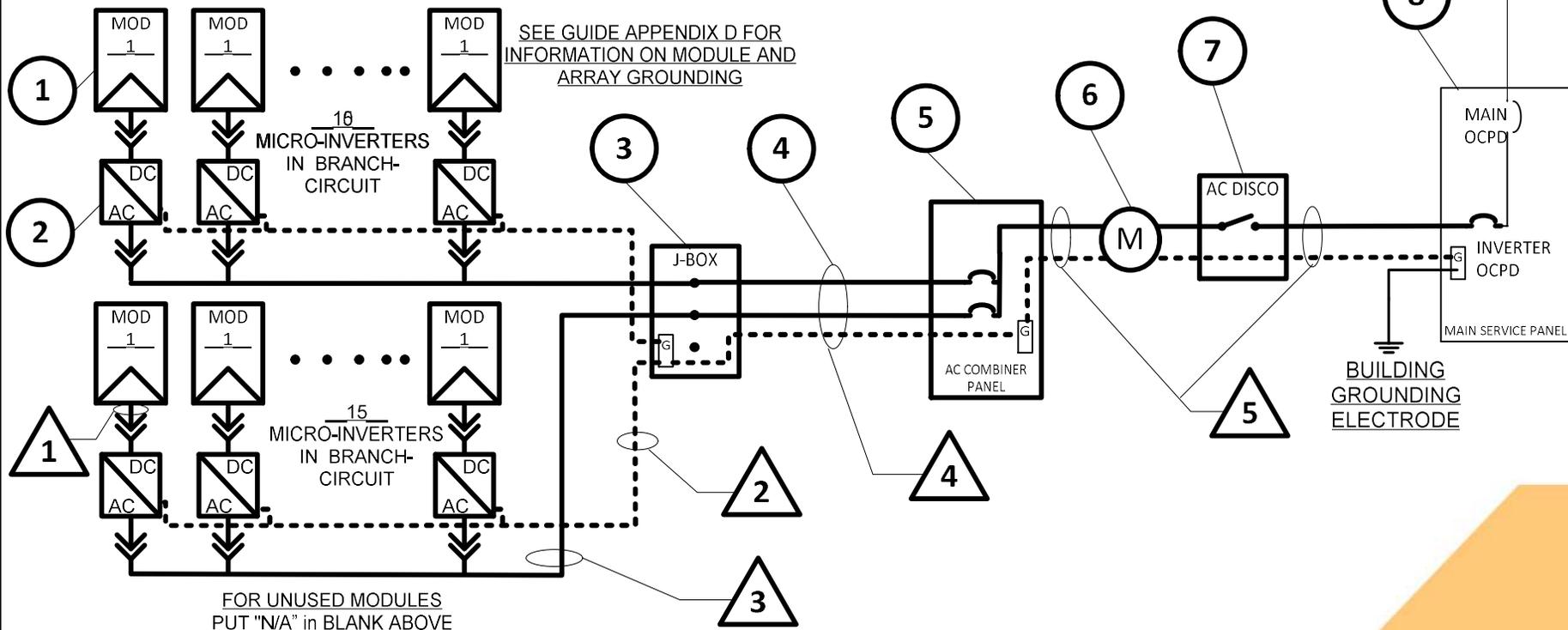
EXISTING ALL-IN-ONE
SERVICE EQUIPMENT WITH
40-AMP PV BREAKER AS AC
DISCONNECT

ROOF ACCESS

ROOF ACCESS

EQUIPMENT SCHEDULE

TAG	DESCRIPTION	PART NUMBER	NOTES
1	PV DC or AC MODULE	AS 285	AMERICAN SOLAR, QUANTITY - 20 (SEE NOTES SHEET FOR DETAILS)
2	DC/AC INVERTER (MICRO)	AI-250	250 WATT, SINGLE PHASE (SEE NOTES SHEET FOR DETAILS)
3	J-BOX (IF USED)		6"x6"x4" NEMA 4, PVC JUNCTION BOX
4	PV ARRAY	N/A	2,20-A AC CIRCUITS WITH 15 MICRO-INVERTERS PER CIRCUIT
5	AC COMB. PANEL (IF USED)	SD125SL	240VAC, 125-A MAIN LUG PANEL W/ 40-A BREAKER AS MAIN
6	GEN METER (IF USED)	FORM 2S	4-JAW, 240V CYCLOMETER REGISTER KWH METER IN 100-A BASE
7	AC DISCONNECT (IF USED)	D222NRB	240VAC, 30-AMP UNFUSED (SEE GUIDE APPENDIX C)
8	SERVICE PANEL	SD200SL	240VAC, 200-A MAIN, 200-A BUS, 30-A INVERTER OCPD (SEE NOTE 5 FOR INVERTER OCPDs, ALSO SEE GUIDE SECTION 9)



CONDUIT AND CONDUCTOR SCHEDULE

TAG	DESCRIPTION OR CONDUCTOR TYPE	COND. GAUGE	NUMBER OF CONDUCTORS	CONDUIT TYPE	CONDUIT SIZE
1	USE-2 <input type="checkbox"/> or PV WIRE <input type="checkbox"/>	MFG	MFG Cable	N/A	N/A
2	GEC <input checked="" type="checkbox"/> EGC <input checked="" type="checkbox"/> X ALL THAT APPLY	6 AWG	1 BARE CU	N/A	N/A
3	EXTERIOR CABLE LISTED W/ INV.	MFG	MFG Cable	N/A	N/A
4	THWN-2 <input checked="" type="checkbox"/> or XHHW-2 <input type="checkbox"/> or RHW-2 <input type="checkbox"/>	12 AWG	2-B, 2-R, 2-W	EMT	3/4"
	GEC <input checked="" type="checkbox"/> EGC <input checked="" type="checkbox"/> X ALL THAT APPLY	8 AWG	1 GREEN	SAME	SAME
	NO DC GEC IF 690.35 SYSTEM				
5	THWN-2 <input checked="" type="checkbox"/> or XHHW-2 <input type="checkbox"/> or RHW-2 <input type="checkbox"/>	10 AWG	1-R, 1-B, 1-W	EMT	3/4"
	GEC <input checked="" type="checkbox"/> EGC <input checked="" type="checkbox"/> X ALL THAT APPLY	8 AWG	1 GREEN	SAME	SAME

Contractor Name, Address and Phone: Bill and Ted's Solar 456 Excellent Drive San Dimas, CA 800-555-1212		One-Line Standard Electrical Diagram for Micro-Inverter or AC Module PV Systems			
		Site Name: John and Jane Homeowner Site Address: 123 Sunnyside St., Boston, MA System AC Size: 4.0 KW			
Drawn By: Bill	SIZE	FSCM NO	DWG NO E1.1a	REV 0	
Checked By: Ted	SCALE	NTS	Date:	SHEET	

PV MODULE RATINGS @ STC (Guide Section 2)

MODULE MAKE	AMERICAN SOLAR		
MODULE MODEL	AS-285		
MAX POWER-POINT CURRENT (I_{MP})	9.20 A		
MAX POWER-POINT VOLTAGE (V_{MP})	31.3 V		
OPEN-CIRCUIT VOLTAGE (V_{OC})	39.7 V		
SHORT-CIRCUIT CURRENT (I_{SC})	9.84 A		
MAX SERIES FUSE (OCPD)	20 A		
MAXIMUM POWER (P_{MAX})	285 W		
MAX VOLTAGE (TYP 1000V _{DC})	1000 V		

NOTES FOR ALL DRAWINGS:

OCPD = OVERCURRENT PROTECTION DEVICE
 NATIONAL ELECTRICAL CODE® REFERENCES SHOWN AS (NEC XXX.XX)

DC-TO-DC CONVERTER RATINGS (if used)

CONVERTER MAKE			
CONVERTER MODEL			
MAX CURRENT		A	
MAX VOLTAGE		V	
MAXIMUM POWER		W	
MAX OUTPUT CIRCUIT V (TYP 600V _{DC})		V	

INVERTER RATINGS (Guide Section 4)

INVERTER MAKE	AMERICAN INVERTER		
INVERTER MODEL	AI-250		
MAX DC VOLT RATING	60 V		
MAX POWER @ 40°C	250 W		
NOMINAL AC VOLTAGE	240 V		
MAX AC CURRENT	1.04 A		
MAX OCPD RATING	20 A		

LOWEST EXPECTED AMBIENT TEMPERATURE BASED ON ASHRAE MINIMUM MEAN EXTREME DRY BULB TEMPERATURE FOR ASHRAE LOCATION MOST SIMILAR TO INSTALLATION LOCATION. LOWEST EXPECTED AMBIENT TEMP -15 °C

- 1) IF UTILITY REQUIRES A VISIBLE-BREAK SWITCH, DOES THIS SWITCH MEET THE REQUIREMENT? YES NO N/A
- 2) IF GENERATION METER REQUIRED, DOES THIS METER SOCKET MEET THE REQUIREMENT? YES NO N/A
- 3) SIZE INVERTER OUTPUT CIRCUIT (AC) CONDUCTORS ACCORDING TO INVERTER OCPD AMPERE RATING. (See Table xxx)
- 4) TOTAL OF 1 INVERTER OCPD(s), ONE FOR EACH INVERTER. DOES TOTAL SUPPLY BREAKERS COMPLY WITH 120% BUSBAR RULE IN 705.12(D)? YES NO

SIGNS-SEE GUIDE SECTION 7

*SIGN FOR DC DISCONNECT

PHOTOVOLTAIC POWER SOURCE	
RATED MPP CURRENT	
RATED MPP VOLTAGE	
MAX SYSTEM VOLTAGE	
MAX CIRCUIT CURRENT	
WARNING: ELECTRICAL SHOCK HAZARD—LINE AND LOAD MAY BE ENERGIZED IN OPEN POSITION	

SIGN FOR PV SYSTEM DISCONNECT

SOLAR PV SYSTEM DISCONNECT	
AC OUTPUT CURRENT	31 A
NOMINAL AC VOLTAGE	240 V

SIGN FOR DISTRIBUTION PANELS

THIS PANEL FED BY MULTIPLE SOURCES (UTILITY AND SOLAR)

SIGN FOR NEC 705.12(D)(2)(3)(b) (if used)

WARNING:
 INVERTER OUTPUT CONNECTION;
 DO NOT RELOCATE THIS OVERCURRENT DEVICE.

SIGN FOR NEC 690.12 (for roof-mounted systems)

PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN

*NOTE: MICROINVERTER AND AC MODULE SYSTEMS DO NOT NEED DC DISCONNECT SIGN SINCE 690.51 MARKING ON PV MODULE COVERS NEEDED INFORMATION

Contractor Name, Address and Phone: _____ _____ _____		Notes for One-Line Standard Electrical Diagram for Single-Phase PV Systems			
		Site Name: _____			
		Site Address: _____			
		System AC Size: _____			
Drawn By:	SIZE	FSCM NO	DWG NO	REV	
			E1.2a		
Checked By:	SCALE	NTS	Date:	SHEET	