

ELECTRICAL SPECIFICATIONS

A. GENERAL

- a) CONTRACTOR SHALL REFER TO ALL RELATED DOCUMENTS, ARCHITECTURAL, STRUCTURAL, CIVIL AND MEP DRAWINGS, AND FULLY UNDERSTAND THE SCOPE OF WORK AND CONDITION OF CONSTRUCTION.
- b) THE WORK UNDER THIS SPECIFICATIONS AND DRAWINGS SHALL INCLUDE ALL LABOR.
- c) ALL INSTALLATION OF DEVICES AND CONNECTION OF CONDUCTORS SHALL BE PERFORMED BY LICENSED AND SKILLED ELECTRICIAN OR JOURNEYMAN.
- d) THE WORK INCLUDES, BUT NOT LIMITED TO:
1. THE COMPLETE ELECTRICAL DISTRIBUTION SYSTEM.
 2. ROUGH-IN AND FINAL CONNECTIONS TO ALL DEVICES REQUIRING ELECTRICAL POWER, INCLUDING OWNER PROVIDED EQUIPMENT.
- e) EACH CONTRACTOR SHALL OBTAIN ALL PERMITS AND INSPECTIONS REQUIRED BY THE REGULATORY AUTHORITIES. ALL FEES RELATED TO OBTAINING PERMITS AND INSPECTION SHALL BE PAID FOR BY EACH CONTRACTOR IN HIS TRADE.
- f) ALL MATERIALS AND WORKMANSHIP SHALL COMPLY WITH LOCAL, COUNTY, STATE, AND NATIONAL CODES, SPECIFICATIONS, UTILITY COMPANY REQUIREMENTS AND ALL INDUSTRY STANDARDS.
- g) ANY DIFFERENCES IN ABOVE MENTIONED REQUIREMENTS; THE MOST STERN SHALL OVERRULE ALL OTHERS.
- h) THE MANUFACTURERS PUBLISHED DIRECTIONS SHALL BE FOLLOWED IN THE DELIVERY, STORAGE, PROTECTION, INSTALLATION AND WIRING OF ALL EQUIPMENT AND MATERIAL.
- j) THE DRAWINGS SHOW DIAGRAMMATICALLY THE LOCATIONS OF THE VARIOUS LINES, CONDUITS, AND EQUIPMENT AND THE METHOD OF CONNECTING AND CONTROLLING THEM. IT IS NOT INTENDED TO SHOW EVERY CONNECTION IN DETAIL AND ALL FITTINGS REQUIRED FOR A COMPLETE SYSTEM. THE SYSTEMS SHALL INCLUDE BUT ARE NOT LIMITED TO THE ITEMS SHOWN ON THE DRAWINGS. EXACT LOCATIONS OF THESE ITEMS SHALL BE DETERMINED BY REFERENCE TO THE GENERAL PLANS AND MEASUREMENTS AT THE BUILDING AND IN COOPERATION WITH THE OTHER SUBCONTRACTORS, AND IN ALL CASES, SHALL BE SUBJECT TO THE APPROVAL OF THE OWNER. THE OWNER RESERVES THE RIGHT TO MAKE ANY REASONABLE CHANGE IN THE LOCATION OF ANY PART OF THIS WORK WITHOUT ADDITIONAL COST TO THE OWNER.
- k) CONTRACTOR SHALL COORDINATE AND VERIFY THE WORK WITH EXISTING CONDITIONS AND THE WORK OF OTHER TRADE PRIOR TO ANY FABRICATIONS OR INSTALLATION. IF THE LAYOUT OF THE EQUIPMENT ON DRAWINGS ARE IMPRACTICAL TO THE CONDITION IN FIELD, CONTRACTOR SHALL NOTIFY THE OWNER IMMEDIATELY PRIOR TO ANY FABRICATION OR INSTALLATION.
- l) THE LINES INDICATING BRANCH CIRCUITS DO NOT REPRESENT THE ROUTING OF ELECTRICAL CONDUITS. THEY INDICATE THE LAYOUT AND CONTROL OF CIRCUITS.

B. PRODUCTS AND WORK

- a) MATERIALS FURNISHED SHALL BE NEW AND BY STANDARD MANUFACTURERS AND MUST CONFORM TO THE NATIONAL BOARD OF FIRE UNDERWRITERS REQUIREMENTS AND BEAR THE UNDERWRITER'S LABORATORIES' SEAL OF APPROVAL.
- b) LISTED MANUFACTURERS, MODELS, OR CATALOGUE NUMBERS IN PART OR ALL SHALL ENTAIL TO INCLUDE THE PUBLISHED MANUFACTURER'S DESCRIPTION AND SPECIFICATION.
- c) CONTRACTOR SHALL NOT INTERPRET THAT THE LISTED MANUFACTURERS IN SPECIFICATIONS OR DRAWINGS TO EXCLUDE ALL OTHER MANUFACTURERS
- d) CONTRACTOR SHALL MAKE CERTAIN THAT ALL EQUIPMENT FIT IN THE SPACE DESIGNATED AND DESIGNED FOR THE SURROUNDINGS IT OCCUPIES.
- e) ALL HORIZONTAL RUNS OF CONDUITS SHALL BE SUPPORTED BY MEANS OF APPROVED HANGER FROM THE STRUCTURAL CEILING.
- f) COORDINATE THE WORK UNDER THIS SECTION WITH ALL OTHER TRADES.
- g) VERIFY ELECTRICAL RESISTANCE MEETS MANUFACTURER'S REQUIREMENTS.

C. EQUIPMENT GROUNDING CONDUCTOR

- a) PER THE PROVISIONS OF NEC ARTICLE 690.45 AND 250.120(C), #6AWG GROUNDING CONDUCTORS ARE USED ON PV ARRAY INSTALLATIONS AS THE CONDUCTOR IS NOT PROTECTED FROM PHYSICAL DAMAGE IN THESE LOCATIONS. A SIZE #8AWG GROUNDING CONDUCTOR WOULD BE SUITABLE IF THE CONDUCTOR WAS SUITABLY PROTECTED.

D. FIRE PENETRATIONS

- a) EACH PENETRATION OF A FIRE RESISTANT RATED ASSEMBLY BY A PIPE, TUBE WIRE OR CONDUIT SHALL BE PROTECTED BY A THROUGH PENETRATION FIRE STOP SYSTEM THAT HAS BEEN TESTED ACCORDING TO ASTM E814 OR E199.

APPLICABLE CODES FOR COMPLIANCE

THIS PROJECT HAS BEEN DESIGNED TO AND SHALL BE INSTALLED TO THE FOLLOWING SPECIFIC PHOTOVOLTAIC CODE REQUIREMENTS:

APPLICABLE PHOTOVOLTAIC IBC 2012 CODES

IBC 1505.1 GENERAL.
IBC 1505.6 PHOTOVOLTAIC SYSTEMS.
IBC 1507.17 PHOTOVOLTAIC MODULES/SHINGLES AND MODULES.
IBC 1507.17.1 MATERIAL STANDARDS.
IBC 1509.7 PHOTOVOLTAIC PANELS AND MODULES.
1509.7.1 WIND RESISTANCE.
IBC 1509.7.2 FIRE CLASSIFICATION.
IBC 1509.7.3 INSTALLATION.
IBC [BG] 1509.7.4 PHOTOVOLTAIC PANELS AND MODULES.
IBC 1509.8.1 AERIAL SUPPORTS.
IBC 1511.1 PHOTOVOLTAIC PANELS AND MODULES.
IBC 1511.1.1 PHOTOVOLTAIC PANELS AND MODULES.
IBC 1607 LIVE ROOF LOADS
IBC 1607.12 ROOF LOADS.
IBC 1609 DEAD LOADS
IBC 1609 WIND LOADS
IBC 1609.11 APPLICATIONS;

APPLICABLE PHOTOVOLTAIC IFC 2012 CODES

IFC SECTION 317: ROOFTOP GARDENS AND LANDSCAPED ROOFS
IFC 317.1 GENERAL.
IFC 317.2 THROUGH 317.5 AND SECTIONS 1505.0 AND 1507.16 OF THE INTERNATIONAL BUILDING CODE.

IFC 317.2 ROOFTOP GARDEN OR LANDSCAPED ROOF SIZE.
IFC 317.3 ROOFTOP STRUCTURE AND EQUIPMENT CLEARANCE.
IFC 317.4 VEGETATION.
IFC [A] 105.7.13 SOLAR PHOTOVOLTAIC POWER SYSTEMS.

IFC 601.2 PERMITS.
IFC 605.11 SOLAR PHOTOVOLTAIC POWER SYSTEMS.
IFC 605.11.1 MARKING.
IFC 605.11.1.1 MATERIALS.
IFC 605.11.1.2 MARKING CONTENT.
IFC 605.11.1.3 MAIN SERVICE DISCONNECT.
IFC 605.11.1.4 LOCATION OF MARKING.
IFC 605.11.2 LOCATIONS OF DC CONDUCTORS.
IFC 605.11.3 ACCESS AND PATHWAYS.
IFC 605.11.3.1 ROOF ACCESS POINTS.
IFC 605.11.3.2 RESIDENTIAL SYSTEMS FOR ONE- AND TWO FAMILY DWELLINGS.
IFC 605.11.3.2.1 RESIDENTIAL BUILDINGS WITH HIP ROOF LAYOUTS. N/A
IFC 605.11.3.2.2 RESIDENTIAL BUILDINGS WITH A SINGLE RIDGE. N/A
IFC 605.11.3.2.3 RESIDENTIAL BUILDINGS WITH ROOF HIPS AND VALLEYS. : N/A
IFC 605.11.3.2.4 RESIDENTIAL BUILDING SMOKE VENTILATION. N/A
IFC 605.11.3.3 OTHER THAN RESIDENTIAL BUILDINGS.
IFC 605.11.3.3.1 ACCESS.
IFC 605.11.3.3.2 PATHWAYS.
IFC 605.11.3.3.3 SMOKE VENTILATION.
IFC 605.11.4 GROUND-MOUNTED PHOTOVOLTAIC ARRAYS.

APPLICABLE NFPA 70: NEC 2014 CODES

NEC 690.1 GENERAL (SCOPE)
NEC 690.2 DEFINITIONS
NEC 690.3 OTHER ARTICLES
NEC 690.4 GENERAL REQUIREMENTS
NEC 690.4 (B) EQUIPMENT.
NEC 690.4 (C) QUALIFIED PERSONS.
NEC 690.4 (D) MULTIPLE INVERTERS.
NEC 690.5 GROUND FAULT PROTECTION.
NEC 690.6 ALTERNATING CURRENT (AC) MODULES: N/A
NEC 690.7 MAXIMUM VOLTAGE.
NEC 690.8 CIRCUIT SIZING AND CURRENT
NEC 690.8 A. CALCULATION OF MAXIMUM CIRCUIT CURRENT
NEC 690.8 B. CONDUCTOR AMPACITY.
NEC 690.9 OVERCURRENT PROTECTION
NEC 690.9 (A) CIRCUITS AND EQUIPMENT

NEC 690.9 (B) OVERCURRENT DEVICE RATINGS
NEC 690.9 (C) DIRECT-CURRENT RATING.
NEC 690.9 (D) PHOTOVOLTAIC SOURCE AND OUTPUT CIRCUITS
NEC 690.9 (E) POWER TRANSFORMERS:
NEC 690.9 (F) SERIES OVERCURRENT PROTECTION.
NEC 690.10 STAND-ALONE SYSTEMS: N/A
NEC 690.11 ARC-FAULT CIRCUIT PROTECTION (DIRECT CURRENT)
NEC 1507.12 RAPID SHUTDOWN OF PV SYSTEMS ON BUILDINGS
NEC 690.13 BUILDING OR OTHER STRUCTURE SUPPLIED BY A PHOTOVOLTAIC SYSTEM. DC CONDUCTOR DISCONNECT
NEC 690.13 (A) LOCATION.
NEC 690.13 (B) MARKING.
NEC 690.13 (C) SUITABLE FOR USE.
NEC 690.13 (D) MAXIMUM NUMBER OF DISCONNECTS.
NEC 690.13 (E) GROUPING.
NEC 690.15(A) UTILITY INTERACTIVE INVERTERS MOUNTED IN NOT-READILY ACCESSIBLE LOCATIONS, N/A
NEC 690.15(B) EQUIPMENT
NEC 690.15(C) DIRECT CURRENT COMBINER DISCONNECTS. N/A
NEC 690.16 FUSES
NEC 690.17 DISCONNECT TYPE
NEC 690.17(A) MANUALLY OPERABLE
NEC 690.17(B) SIMULTANEOUS OPENING OF POLES
NEC 690.17(C) EXTERNALLY OPERABLE
NEC 690.17(D) DISCONNECTION OF GROUNDED CONDUCTOR.
NEC 690.17(E) INTERRUPTING RATING.
NEC 690.18 INSTALLATION AND SERVICE OF AN ARRAY
NEC 690.31 WIRING METHODS
NEC 690.32 COMPONENT INTERCONNECTIONS
NEC 690.33 CONNECTORS
NEC 690.33 (A) CONFIGURATION.
NEC 690.33 (B) GUARDING.
NEC 690.33 (C) TYPE.
NEC 690.33 (D) GROUNDING MEMBER.
NEC 690.33 (E) INTERRUPTION OF CIRCUIT.
NEC 690.34 ACCESS TO BOXES
NEC 690.35 UNGROUNDED PHOTOVOLTAIC SYSTEMS
NEC 690.35 (A) DISCONNECTS
NEC 690.35 (B) OVERCURRENT PROTECTION
NEC 690.35 (C) GROUND FAULT PROTECTION
NEC 690.35 (D) CONDUCTORS
NEC 690.35 (E) BATTERY SYSTEM: N/A
NEC 690.35 (F) MARKING.
NEC 690.35 (G) EQUIPMENT.
NEC 690.41 SYSTEM GROUNDING
NEC 690.42 POINT OF SYSTEM GROUNDING CONNECTION
NEC 690.43 EQUIPMENT GROUNDING
NEC 690.43 (A) EQUIPMENT GROUNDING
NEC 690.43 (B) EQUIPMENT GROUNDING CONDUCTOR REQUIRED.
NEC 690.43 (C) STRUCTURE AS EQUIPMENT GROUNDING CONDUCTOR.
NEC 690.43 (D) PHOTOVOLTAIC MOUNTING SYSTEMS AND DEVICES.
NEC 690.43 (E) PHOTOVOLTAIC MOUNTING SYSTEMS AND DEVICES.
NEC 690.43 (F) ALL CONDUCTORS TOGETHER.
NEC 690.45 SIZE OF EQUIPMENT GROUNDING CONDUCTORS.
NEC 690.46 ARRAY EQUIPMENT GROUNDING CONDUCTORS.
NEC 690.47 GROUNDING ELECTRODE SYSTEM.
NEC 690.48 CONTINUITY OF EQUIPMENT GROUNDING SYSTEM.
NEC 690.49 CONTINUITY OF PHOTOVOLTAIC SOURCE AND OUTPUT CIRCUIT GROUNDED CONDUCTORS.
NEC 690.50 EQUIPMENT BONDING JUMPERS.
NEC 690.51 MODULES.
NEC 690.52 ALTERNATING CURRENT PHOTOVOLTAIC
NEC 690.53 DIRECT-CURRENT PHOTOVOLTAIC POWER SOURCE:
NEC 690.54 INTERACTIVE SYSTEM POINT OF INTERCONNECTION
NEC 690.55 PHOTOVOLTAIC POWER SYSTEM EMPLOYING ENERGY STORAGE:
NEC 690.56 IDENTIFICATION OF POWER SOURCES.
NEC 690.56 (A) FACILITIES WITH STAND ALONE SYSTEM. N/A
NEC 690.56 (B) FACILITIES WITH UTILITY SERVICES AND PV SYSTEMS.
NEC 690.56 (C) FACILITIES WITH RAPID SHUTDOWN.
NEC 690.57 LOAD DISCONNECT. N/A
NEC 690.60 IDENTIFIED INTERACTIVE EQUIPMENT.

GENERAL NOTES

- 1) ALL INSTALLATIONS ARE TO BE IN STRICT ACCORDANCE WITH ARTICLE 690 OF THE LATEST ACCEPTED EDITION OF THE NATIONAL ELECTRICAL CODE (NFPA 70).
- 2) FOR KEYNOTES WITH LETTER DESIGNATIONS, SEE CONDUCTOR SIZING TABLES SHEET E-2.

KEYNOTES

- 1 280W MODULES INCLUDES #10AWG (UL 600V). DO NOT REMOVE THE QUICK CONNECTS AS THE MODULE WARRANTY AND UL LISTING MAY BE INVALIDATED.
- 2 USE MODULE GROUNDING METHODS AND SPECIFIED GROUNDING LOCATIONS PER MANUFACTURER'S INSTALLATION MANUAL AND WARRANTY. THE MODULE EQUIPMENT GROUNDS SHALL GROUND ALL THE EQUIPMENT AND SHALL TERMINATE IN THE INVERTER CABINET.
- 3 SOLAR DISCONNECT, PROVIDE 30A, 600ADC RATED NEMA 3R NON-FUSED DISCONNECT. LABEL FRONT OF DISCONNECT WITH SIGNAGE STATING "SOLAR ARRAY DISCONNECT".
- 4 MANUAL TRANSFER SWITCH. 3-POLE, NON-FUSED, 600VDC RATED, NEMA 1, DOUBLE THROW DEVICE. SQUARE D MODEL DTU361 OR SIMILAR.
- 5 STRING INVERTER, ABB MODEL PVI-3.6-OUTD-US. INVERTER MEETS UL 1741 AND TO HAVE INTEGRAL ANTI-ISLANDING PROTECTION FEATURES AND CONNECTION UNIT WITH INTEGRATED DISCONNECT AND FUSES. PROVIDE (3) SETS OF 20A 600 VDC RATED FUSES AT DC POSITIVE AND DC NEGATIVE STRING INPUTS. HOUSING TO BE FULLY WEATHERPROOF.
- 6 EXISTING 600A MCB PANELBOARD NEMA 1 WITH (3) 20A 1-POLE BREAKERS RATED 277V. BREAKERS ARE TO BE BACK-FED RATED.

PV STRING SIZING EQUATIONS AND DATA

PV STRING SIZING

$I_{sc} \times 1.56 = 15.17 \text{ AMPS}$
CONDUCTOR DERATED FOR LOCAL STATISTICALLY HIGH TEMPERATURE OF 39°C = 0.88

$V_{oc}: 39.50 \text{ V DC}$
OF MODULES PER STRING: 8
RECORD LOW TEMP: -10°C
TEMP. COEFF. OF V_{oc} : -0.32% PER DEGREE CELSIUS
STC TEMP: 25°C
TEMP CORRECTED FOR RECORD LOW: -36°C
 $(-0.32\% \times -35) + 1 = 1.12$
 $39.50 \text{ VDC} \times 1.12 = 44.24 \text{ V DC @ RECORD LOW } -10^\circ\text{C}$
 $44.24 \text{ V}_{oc} \times 8 \text{ MODULES PER STRING} = 353.92 \text{ V}_{oc} \text{ @ RECORD LOW } -10^\circ\text{C}$

EQUIPMENT DATASHEETS AND PRODUCT CERTIFICATES

THE FOLLOWING LIST OF ENCLOSURES TO BE PROVIDED BY TRUE ENERGY, INC REPRESENTATIVE AS PART OF THIS PHOTOVOLTAIC PROJECT SUBMISSION:

CODE SUMMARY: TRUE ENERGY USA / IBC/IFC/NEC/IECC CODE COMPLIANCE SUMMARY

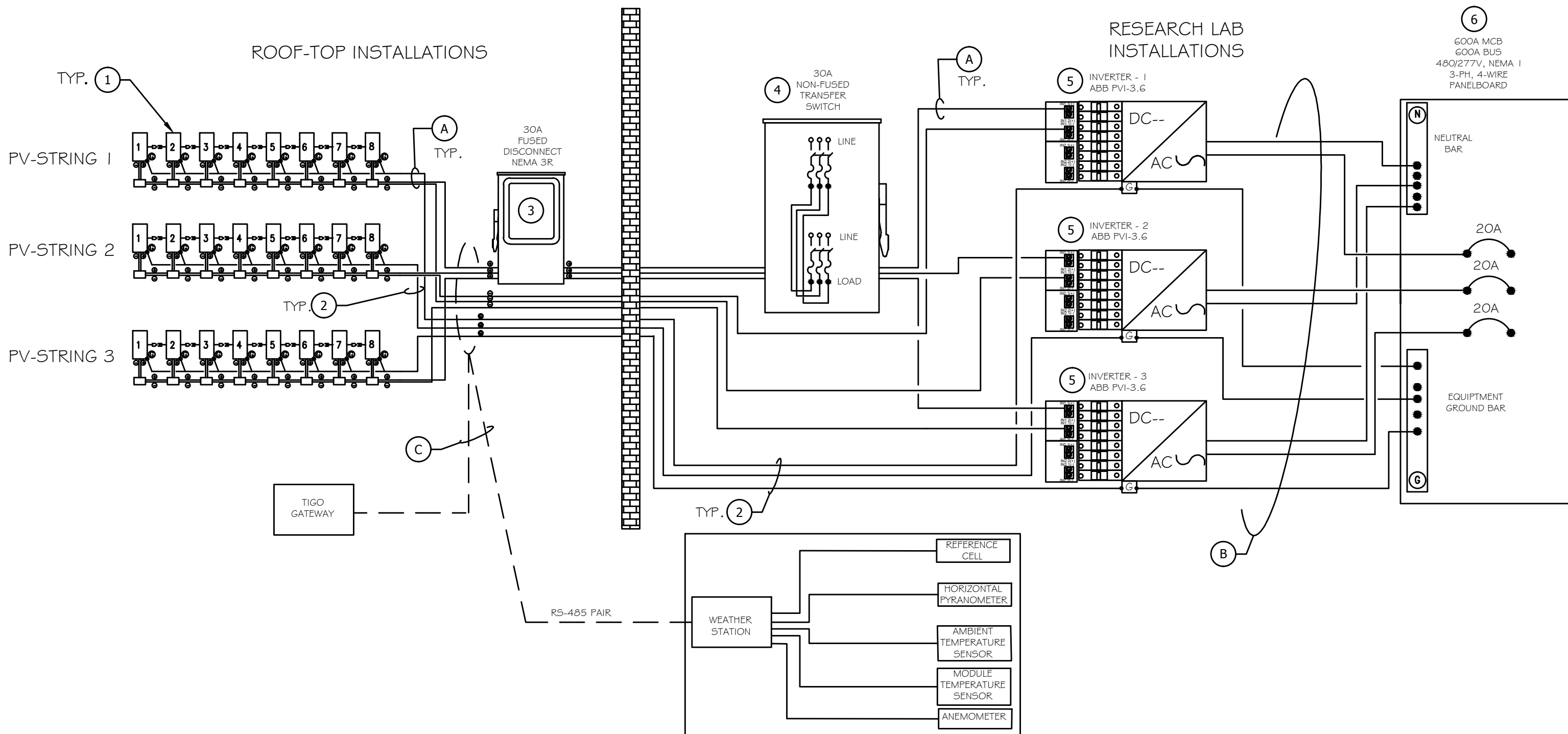
SOLARWORLD SW 280 MONO BLACK: DATA SHEET
SOLARWORLD SW 280 MONO BLACK: CSA GROUP / CERTIFICATE OF COMPLIANCE UL 1703

UNIRAC RM: DATA SHEET
UNIRAC RM 10: TUV / UL 2703 FIRE CERTIFICATION

ABB PVI-3.6: DATA SHEET
ABB PVI-3.6: CSA GROUP / UL 1741 CERTIFICATE OF COMPLIANCE

PE LETTER: STABILITY ENGINEERING / ROOF LOADS FOR BALLASTED ARRAY
PE LETTER: STABILITY ENGINEERING / WIND LOADS ON ARRAY

TIGO TS4-S: SAFETY/MONITORING DATA SHEET



1 ELECTRICAL THREE-LINE DIAGRAM – ROOF INSTALLATION
E-1 SCALE: NONE

FOR
CONSTRUCTION

DRAWN BY: HL/MM/DA

CHECKED BY: BA/RK

ISSUE / REVISIONS:

DATE DESCRIPTION

10/27/2016 PERMIT SET

SHEET NAME:

ELECTRICAL RISER,
SPECIFICATIONS &
GENERAL NOTES

SHEET NUMBER:

E-1

10/27/2016