CONTRACT

THIS CONTRACT is between the CITY OF ANN ARBOR, a Michigan municipal corporation, 301 East Huron Street, Ann Arbor, Michigan 48104 ("City") and FERNDALE ELECTRIC COMPANY, INC. ("Contractor"), a Michigan corporation, located at 31750 Sherman Avenue, Madison Heights, MI 48071.

Based upon the mutual promises below, the Contractor and the City agree as follows:

ARTICLE I - Scope of Work

The Contractor agrees to furnish all of the materials, equipment and labor necessary; and to abide by all the duties and responsibilities applicable to it for the project titled **Solar and Battery Storage Installation at City Facilities, ITB No. 4766** in accordance with the requirements and provisions of the following documents, including all written modifications incorporated into any of the documents, all of which are incorporated as part of this Contract:

Non-discrimination and Living Wage
Declaration of Compliance Forms (if applicable)
Vendor Conflict of Interest Form
Prevailing Wage Declaration of Compliance Form (if applicable)
Bid Forms
Contract and Exhibits
Bonds
General Conditions
Standard Specifications
Detailed Specifications
Plans
Addenda

ARTICLE II - Definitions

Administering Service Area/Unit means Office of Sustainability and Innovations

Project means Solar and Battery Storage Installation at City Facilities, ITB No. 4766

Supervising Professional means the person acting under the authorization of the manager of the Administering Service Area/Unit. At the time this Contract is executed, the Supervising Professional is: Simi Barr, whose job title is Senior Analyst, Municipal Operations. If there is any question concerning who the Supervising Professional is, Contractor shall confirm with the manager of the Administering Service Area/Unit.

Contractor's Representative means John Hillock whose title is Chief Executive Officer.

ARTICLE III - Time of Completion

(A) The work to be completed under this Contract shall begin immediately on the date specified in the Notice to Proceed issued by the City.

(B) The entire work for this Contract shall be completed within 24 months, from contract execution.

(C) Failure to complete all the work within the time specified above, including any extension granted in writing by the Supervising Professional, shall obligate the Contractor to pay the City, as liquidated damages and not as a penalty, an amount

equal to $500 for each calendar day of delay in the completion of all the work. If any liquidated damages are unpaid by the Contractor, the City shall be entitled to deduct these unpaid liquidated damages from the monies due the Contractor.

The liquidated damages are for the non-quantifiable aspects of any of the previously identified events and do not cover actual damages that can be shown or quantified nor are they intended to preclude recovery of actual damages in addition to the recovery of liquidated damages.

ARTICLE IV - The Contract Sum

(A) The City shall pay to the Contractor for the performance of the Contract, the lump sum price as given in the Bid Form in the amount of:
One Million, twenty two thousand, three hundred ninety three dollars and sixty-seven cents ($1,022,393.67)

(B) The amount paid shall be equitably adjusted to cover changes in the work ordered by the Supervising Professional but not required by the Contract Documents. Increases or decreases shall be determined only by written agreement between the City and Contractor.

ARTICLE V - Assignment

This Contract, and any portion or any right or obligation thereunder, may not be assigned or subcontracted without the written consent of the City. Notwithstanding any consent by the City to any assignment, Contractor shall at all times remain bound to all warranties, certifications, indemnifications, promises and performances, however described, as are required of it under this Contract unless specifically released from the requirement, in writing, by the City.

ARTICLE VI - Choice of Law

This Contract shall be construed, governed, and enforced in accordance with the laws of the State of Michigan. By executing this Contract, the Contractor and the City agree to venue in a court of appropriate jurisdiction sitting within Washtenaw County for purposes of any action arising under this Contract. The parties stipulate that the venue referenced in this Contract is for convenience and waive any claim of non-convenience.

Whenever possible, each provision of the Contract will be interpreted in a manner as to be effective and valid under applicable law. The prohibition or invalidity, under applicable law, of any provision will not invalidate the remainder of the Contract.

ARTICLE VII - Relationship of the Parties

The parties of the Contract agree that it is not a Contract of employment but is a Contract to accomplish a specific result. Contractor is an independent Contractor performing services for the City. Nothing contained in this Contract shall be deemed to constitute any other relationship between the City and the Contractor.

Contractor certifies that it has no personal or financial interest in the project other than the compensation it is to receive under the Contract. Contractor certifies that it is not, and shall not become, overdue or in default to the City for any Contract, debt, or any other obligation to the City including real or personal property taxes. City shall have the right to set off any such debt against compensation awarded for services under this Contract.

ARTICLE VIII - Notice

All notices given under this Contract shall be in writing, and shall be by personal delivery or by certified mail with return receipt requested to the parties at their respective addresses as specified in the Contract Documents or other address the Contractor may specify in writing. Notice will be deemed given on the date when one of the following first occur: (1) the date of actual receipt; or (2) three days after mailing certified U.S. mail.

ARTICLE IX - Indemnification

To the fullest extent permitted by law, Contractor shall indemnify, defend and hold the City, its officers, employees and agents harmless from all suits, claims, judgments and expenses including attorney's fees resulting or alleged to result, in whole or in part, from any act or omission, which is in any way connected or associated with this Contract, by the Contractor or anyone acting on the Contractor's behalf under this Contract. Contractor shall not be responsible to indemnify the City for losses or damages caused by or resulting from the City's sole negligence. The provisions of this Article shall survive the expiration or earlier termination of this contract for any reason.

ARTICLE X - Entire Agreement

This Contract represents the entire understanding between the City and the Contractor and it supersedes all prior representations, negotiations, agreements, or understandings whether written or oral. Neither party has relied on any prior representations in entering into this Contract. No terms or conditions of either party's invoice, purchase order or other administrative document shall modify the terms and conditions of this Contract, regardless of the other party's failure to object to such form. This Contract shall be binding on and shall inure to the benefit of the parties to this Contract and their permitted successors and permitted assigns and nothing in this Contract, express or implied, is intended to or shall confer on any other person or entity any legal or equitable right, benefit, or remedy of any nature whatsoever under or by reason of this Contract. This Contract may be altered, amended or modified only by written amendment signed by the City and the Contractor.

ARTICLE XI – Electronic Transactions

The City and Contractor agree that signatures on this Contract may be delivered electronically in lieu of an original signature and agree to treat electronic signatures as original signatures that bind them to this Contract. This Contract may be executed and delivered by facsimile and upon such delivery, the facsimile signature will be deemed to have the same effect as if the original signature had been delivered to the other party.

[Signatures on next page]

FERNDALE ELECTRIC COMPANY, INC.

By_____
Name:
Title:

Date:_____

CITY OF ANN ARBOR

By_____
Christopher Taylor, Mayor

By_____
Jacqueline Beaudry, City Clerk

Dated:_____

Approved

By_____
Milton Dohoney Jr., City Administrator

By_____
Missy Stults, Sustainability and Innovations Director

Approved

By_____
Atleen Kaur, City Attorney

PERFORMANCE BOND

(1) Ferndale Electric Company, Inc. of 31750 Sherman Ave., Madison Heights, MI, 48071 (referred to as "Principal"), and _____, a corporation duly authorized to do business in the State of Michigan (referred to as "Surety"), are bound to the City of Ann Arbor, Michigan (referred to as "City"), for $1,022,393.67, the payment of which Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by this bond.

(2) The Principal has entered a written Contract with the City entitled Solar and Battery Storage Installation at City Facilities, ITB No. 4766 and this bond is given for that Contract in compliance with Act No. 213 of the Michigan Public Acts of 1963, as amended, being MCL 129.201 et seq.

(3) Whenever the Principal is declared by the City to be in default under the Contract, the Surety may promptly remedy the default or shall promptly:

(a) complete the Contract in accordance with its terms and conditions; or

(b) obtain a bid or bids for submission to the City for completing the Contract in accordance with its terms and conditions, and upon determination by Surety of the lowest responsible bidder, arrange for a Contract between such bidder and the City, and make available, as work progresses, sufficient funds to pay the cost of completion less the balance of the Contract price; but not exceeding, including other costs and damages for which Surety may be liable hereunder, the amount set forth in paragraph 1.

(4) Surety shall have no obligation to the City if the Principal fully and promptly performs under the Contract.

(5) Surety agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder, or the specifications accompanying it shall in any way affect its obligations on this bond, and waives notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work, or to the specifications.

(6) Principal, Surety, and the City agree that signatures on this bond may be delivered electronically in lieu of an original signature and agree to treat electronic signatures as original signatures that bind them to this bond. This bond may be executed and delivered by facsimile and upon such delivery, the facsimile signature will be deemed to have the same effect as if the original signature had been delivered to the other party.

SIGNED AND SEALED this _____ day of _____, 202_.

_____	_____
(Name of Surety Company)	(Name of Principal)
By _____	By _____
(Signature)	(Signature)
Its _____	Its _____
(Title of Office)	(Title of Office)
Approved as to form:	Name and address of agent:
_____	_____
Atleen Kaur, City Attorney	_____
	_____

LABOR AND MATERIAL BOND

(1) Ferndale Electric Company, Inc. of 31750 Sherman Ave., Madison Heights, MI, 48071 (referred to as "Principal"), and _____, a corporation duly authorized to do business in the State of Michigan, (referred to as "Surety"), are bound to the City of Ann Arbor, Michigan (referred to as "City"), for the use and benefit of claimants as defined in Act 213 of Michigan Public Acts of 1963, as amended, being MCL 129.201 et seq., in the amount of $1,022,393.67, for the payment of which Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by this bond.

(2 The Principal has entered a written Contract with the City entitled Solar and Battery Storage Installation at City Facilities, ITB No. 4766; and this bond is given for that Contract in compliance with Act No. 213 of the Michigan Public Acts of 1963 as amended.

(3) If the Principal fails to promptly and fully repay claimants for labor and material reasonably required under the Contract, the Surety shall pay those claimants.

(4) Surety's obligations shall not exceed the amount stated in paragraph 1, and Surety shall have no obligation if the Principal promptly and fully pays the claimants.

(5) Principal, Surety, and the City agree that signatures on this bond may be delivered electronically in lieu of an original signature and agree to treat electronic signatures as original signatures that bind them to this bond. This bond may be executed and delivered by facsimile and upon such delivery, the facsimile signature will be deemed to have the same effect as if the original signature had been delivered to the other party.

SIGNED AND SEALED this _____ day of _____, 202_

_____	_____
(Name of Surety Company)	(Name of Principal)
By _____	By _____
(Signature)	(Signature)
Its _____	Its _____
(Title of Office)	(Title of Office)
Approved as to form:	Name and address of agent:
_____	_____
Atleen Kaur, City Attorney	_____
	_____

GENERAL CONDITIONS

Section 1 - Execution, Correlation and Intent of Documents

The contract documents are complementary and what is called for by any one document shall be binding. The intention of the documents is to include all labor and materials, equipment and transportation necessary for the proper execution of the work. Materials or work described in words which so applied have a well-known technical or trade meaning have the meaning of those recognized standards.

In case of a conflict among the contract documents listed below in any requirement(s), the requirement(s) of the document listed first shall prevail over any conflicting requirement(s) of a document listed later.

(1) Addenda in reverse chronological order; (2) Detailed Specifications; (3) Standard Specifications; (4) Plans; (5) General Conditions; (6) Contract; (7) Bid Forms; (8) Bond Forms; (9) Bid.

Section 2 - Order of Completion

The Contractor shall submit with each invoice, and at other times reasonably requested by the Supervising Professional, schedules showing the order in which the Contractor proposes to carry on the work. They shall include the dates at which the Contractor will start the several parts of the work, the estimated dates of completion of the several parts, and important milestones within the several parts.

Section 3 - Familiarity with Site and Work

The Contractor or its representative shall make personal investigations of the site of the work and of existing structures and shall determine to its own satisfaction the conditions to be encountered, the nature of the ground, the difficulties involved, and all other factors affecting the work proposed under this Contract. The Contractor will not be entitled to any additional compensation unless conditions are clearly different from those which could reasonably have been anticipated by a person making diligent and thorough investigation of the site.

The Contractor will not be allowed the benefit of extra compensation or time to complete the work under this Contract for extra expenses or time spent as a result of the error or omission which Contractor was aware of and did not bring to the City’s attention before commencing work.

Section 4 - Wage Requirements

Under this Contract, the Contractor shall conform to Chapter 14 of Title I of the Code of the City of Ann Arbor as amended; which in part states "...that all craftsmen, mechanics and laborers employed directly on the site in connection with said improvements, including said employees of subcontractors, shall receive the prevailing wage for the corresponding classes of craftsmen, mechanics and laborers, as determined by statistics for the Ann Arbor area compiled by the United States Department of Labor. At the request of the City, any contractor or subcontractor shall provide satisfactory proof of compliance with the contract provisions required by the Section.

Pursuant to Resolution R-16-469 all public improvement contractors are subject to prevailing wage and will be required to provide to the City payroll records sufficient to demonstrate compliance with the prevailing wage requirements. A sample Prevailing Wage Form is provided in the Appendix herein for reference as to what will be expected from contractors. Use of the Prevailing Wage Form provided in the Appendix section or a City-approved equivalent will be required along with wage rate interviews.

Where the Contract and the Ann Arbor City Ordinance are silent as to definitions of terms required in determining contract compliance with regard to prevailing wages, the definitions provided in the Davis-Bacon Act as amended (40 U.S.C. 278-a to 276-a-7) for the terms shall be used.

If the Contractor is a “covered employer” as defined in Chapter 23 of the Ann Arbor City Code, the Contractor agrees to comply with the living wage provisions of Chapter 23 of the Ann Arbor City Code. The Contractor agrees to pay those employees providing Services to the City under this Contract a “living wage,” as defined in Section 1:815 of the Ann Arbor City Code, as adjusted in accordance with Section 1:815(3); to post a notice approved by the City of the applicability of Chapter 23 in every location in which regular or contract employees providing services under this Contract are working; to maintain records of compliance; if requested by the City, to provide documentation to verify compliance; to take no action that would reduce the compensation, wages, fringe benefits, or leave available to any employee or person contracted for employment in order to pay the living wage required by Section 1:815; and otherwise to comply with the requirements of Chapter 23.

Contractor agrees that all subcontracts entered into by the Contractor shall contain similar wage provision covering subcontractor’s employees who perform work on this contract.

Section 5 - Non-Discrimination

The Contractor agrees to comply, and to require its subcontractor(s) to comply, with the nondiscrimination provisions of MCL 37.2209. The Contractor further agrees to comply with the provisions of Section 9:158 of Chapter 112 of Title IX of the Ann Arbor City Code, and to assure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity.

Section 6 - Materials, Appliances, Employees

Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light, power, transportation, and other facilities necessary or used for the execution and completion of the work. Unless otherwise specified, all materials incorporated in the permanent work shall be new, and both workmanship and materials shall be of the highest quality. The Contractor shall, if required, furnish satisfactory evidence as to the kind and quality of materials.

The Contractor shall at all times enforce strict discipline and good order among its employees and shall seek to avoid employing on the work any unfit person or anyone not skilled in the work assigned.

Adequate sanitary facilities shall be provided by the Contractor.

Section 7 - Qualifications for Employment

The Contractor shall employ competent laborers and mechanics for the work under this Contract. For work performed under this Contract, employment preference shall be given to qualified local residents.

Section 8 - Royalties and Patents

The Contractor shall pay all royalties and license fees. It shall defend all suits or claims for infringements of any patent rights and shall hold the City harmless from loss on account of infringement except that the City shall be responsible for all infringement loss when a particular process or the product of a particular manufacturer or manufacturers is specified, unless the City has notified the Contractor prior to the signing of the Contract that the particular process or product is patented or is believed to be patented.

Section 9 - Permits and Regulations

The Contractor must secure and pay for all permits, permit or plan review fees and licenses necessary for the prosecution of the work. These include but are not limited to City building permits, right-of-way permits, lane closure permits, right-of-way occupancy permits, and the like. The City shall secure and pay for easements shown on the plans unless otherwise specified.

The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the contract documents are at variance with those requirements, it shall promptly notify the Supervising Professional in writing, and any necessary changes shall be adjusted as provided in the Contract for changes in the work.

Section 10 - Protection of the Public and of Work and Property

The Contractor is responsible for the means, methods, sequences, techniques and procedures of construction and safety programs associated with the work contemplated by this contract. The Contractor, its agents or sub-contractors, shall comply with the "General Rules and Regulations for the Construction Industry" as published by the Construction Safety Commission of the State of Michigan and to all other local, State and National laws, ordinances, rules and regulations pertaining to safety of persons and property.

The Contractor shall take all necessary and reasonable precautions to protect the safety of the public. It shall continuously maintain adequate protection of all work from damage, and shall take all necessary and reasonable precautions to adequately protect all public and private property from injury or loss arising in connection with this Contract. It shall make good any damage, injury or loss to its work and to public and private property resulting from lack of reasonable protective precautions, except as may be due to errors in the contract documents, or caused by agents or employees of the City. The Contractor shall obtain and maintain sufficient insurance to cover damage to any City property at the site by any cause.

In an emergency affecting the safety of life, or the work, or of adjoining property, the Contractor is, without special instructions or authorization from the Supervising Professional, permitted to act at its discretion to prevent the threatened loss or injury. It shall also so act, without appeal, if authorized or instructed by the Supervising Professional.

Any compensation claimed by the Contractor for emergency work shall be determined by agreement or in accordance with the terms of Claims for Extra Cost - Section 15.

Section 11 - Inspection of Work

The City shall provide sufficient competent personnel for the inspection of the work.

The Supervising Professional shall at all times have access to the work whenever it is in preparation or progress, and the Contractor shall provide proper facilities for access and for inspection.

If the specifications, the Supervising Professional's instructions, laws, ordinances, or any public authority require any work to be specially tested or approved, the Contractor shall give the Supervising Professional timely notice of its readiness for inspection, and if the inspection is by an authority other than the Supervising Professional, of the date fixed for the inspection. Inspections by the Supervising Professional shall be made promptly, and where practicable at the source of supply. If any work should be covered up without approval or consent of the Supervising Professional, it must, if required by the Supervising Professional, be uncovered for examination and properly restored at the Contractor's expense.

Re-examination of any work may be ordered by the Supervising Professional, and, if so ordered, the work must be uncovered by the Contractor. If the work is found to be in accordance with the contract documents, the City shall pay the cost of re-examination and replacement. If the work is not in accordance with the contract documents, the Contractor shall pay the cost.

Section 12 - Superintendence

The Contractor shall keep on the work site, during its progress, a competent superintendent and any necessary assistants, all satisfactory to the Supervising Professional. The superintendent will be responsible to perform all on-site project management for the Contractor. The superintendent shall be experienced in the work required for this Contract. The superintendent shall represent the Contractor and all direction given to the superintendent shall be binding as if given to the Contractor. Important directions shall immediately be confirmed in writing to the Contractor. Other directions will be confirmed on written request. The Contractor shall give efficient superintendence to the work, using its best skill and attention.

Section 13 - Changes in the Work

The City may make changes to the quantities of work within the general scope of the Contract at any time by a written order and without notice to the sureties. If the changes add to or deduct from the extent of the work, the Contract Sum shall be adjusted accordingly. All the changes shall be executed under the conditions of the original Contract except that any claim for extension of time caused by the change shall be adjusted at the time of ordering the change.

In giving instructions, the Supervising Professional shall have authority to make minor changes in the work not involving extra cost and not inconsistent with the purposes of the work, but otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a written order by the Supervising Professional, and no claim for an addition to the Contract Sum shall be valid unless the additional work was ordered in writing.

The Contractor shall proceed with the work as changed and the value of the work shall be determined as provided in Claims for Extra Cost - Section 15.

Section 14 - Extension of Time

Extension of time stipulated in the Contract for completion of the work will be made if and as the Supervising Professional may deem proper under any of the following circumstances:

(1) When work under an extra work order is added to the work under this Contract;

(2) When the work is suspended as provided in Section 20;

(3) When the work of the Contractor is delayed on account of conditions which could not have been foreseen, or which were beyond the control of the Contractor, and which were not the result of its fault or negligence;

(4) Delays in the progress of the work caused by any act or neglect of the City or of its employees or by other Contractors employed by the City;

(5) Delay due to an act of Government;

(6) Delay by the Supervising Professional in the furnishing of plans and necessary information;

(7) Other cause which in the opinion of the Supervising Professional entitles the Contractor to an extension of time.

The Contractor shall notify the Supervising Professional within 7 days of an occurrence or conditions which, in the Contractor's opinion, entitle it to an extension of time. The notice shall be in writing and submitted in ample time to permit full investigation and evaluation of the Contractor's claim. The Supervising Professional shall acknowledge receipt of the Contractor's notice within 7 days of its receipt. Failure to timely provide the written notice shall constitute a waiver by the Contractor of any claim.

In situations where an extension of time in contract completion is appropriate under this or any other section of the contract, the Contractor understands and agrees that the only available adjustment for events that cause any delays in contract completion shall be extension of the required time for contract completion and that there shall be no adjustments in the money due the Contractor on account of the delay.

Section 15 - Claims for Extra Cost

If the Contractor claims that any instructions by drawings or other media issued after the date of the Contract involved extra cost under this Contract, it shall give the Supervising Professional written notice within 7 days after the receipt of the instructions, and in any event before proceeding to execute the work, except in emergency endangering life or property. The procedure shall then be as provided for Changes in the Work - Section 13. No claim shall be valid unless so made.

If the Supervising Professional orders, in writing, the performance of any work not covered by the contract documents, and for which no item of work is provided in the Contract, and for which no unit price or lump sum basis can be agreed upon, then the extra work shall be done on a Cost-Plus-Percentage basis of payment as follows:

(1) The Contractor shall be reimbursed for all reasonable costs incurred in doing the work, and shall receive an additional payment of 15% of all the reasonable costs to cover both its indirect overhead costs and profit;

(2) The term "Cost" shall cover all payroll charges for employees and supervision required under the specific order, together with all worker's compensation, Social Security, pension and retirement allowances and social insurance, or other regular payroll charges on same; the cost of all material and supplies required of either temporary or permanent character; rental of all power-driven equipment at agreed upon rates, together with cost of fuel and supply charges for the equipment; and any costs incurred by the Contractor as a direct result of executing the order, if approved by the Supervising Professional;

(3) If the extra is performed under subcontract, the subcontractor shall be allowed to compute its charges as described above. The Contractor shall be permitted to add an additional charge of 5% percent to that of the subcontractor for the Contractor's supervision and contractual responsibility;

(4) The quantities and items of work done each day shall be submitted to the Supervising Professional in a satisfactory form on the succeeding day, and shall be approved by the Supervising Professional and the Contractor or adjusted at once;

(5) Payments of all charges for work under this Section in any one month shall be made along with normal progress payments. Retainage shall be in accordance with Progress Payments-Section 16.

No additional compensation will be provided for additional equipment, materials, personnel, overtime or special charges required to perform the work within the time requirements of the Contract.

When extra work is required and no suitable price for machinery and equipment can be determined in accordance with this Section, the hourly rate paid shall be 1/40 of the basic weekly rate listed in the Rental Rate Blue Book published by Dataquest Incorporated and applicable to the time period the equipment was first used for the extra work. The hourly rate will be deemed to include all costs of operation such as bucket or blade, fuel, maintenance, "regional factors", insurance, taxes, and the like, but not the costs of the operator.

Section 16 - Progress Payments

The Contractor shall submit each month, or at longer intervals, if it so desires, an invoice covering work performed for which it believes payment, under the Contract terms, is due. The submission shall be to the City's Finance Department - Accounting Division. The Supervising Professional will, within 10 days following submission of the invoice, prepare a certificate for payment for the work in an amount to be determined by the Supervising Professional as fairly representing the acceptable work performed during the period covered by the Contractor's invoice. To insure the proper performance of this Contract, the City will retain a percentage of the estimate in accordance with Act 524, Public Acts of 1980. The City will then, following the receipt of the Supervising Professional's Certificate, make payment to the Contractor as soon as feasible, which is anticipated will be within 15 days.

An allowance may be made in progress payments if substantial quantities of permanent material have been delivered to the site but not incorporated in the completed work if the Contractor, in the opinion of the Supervising Professional, is diligently pursuing the work under this Contract. Such materials shall be properly stored and adequately protected. Allowance in the estimate shall be at the invoice price value of the items. Notwithstanding any payment of any allowance, all risk of loss due to vandalism or any damages to the stored materials remains with the Contractor.

In the case of Contracts which include only the Furnishing and Delivering of Equipment, the payments shall be; 60% of the Contract Sum upon the delivery of all equipment to be furnished, or in the case of delivery of a usable portion of the equipment in advance of the total equipment delivery, 60% of the estimated value of the portion of the equipment may be paid upon its delivery in advance of the time of the remainder of the equipment to be furnished; 30% of the Contract Sum upon completion of erection of all equipment furnished, but not later than 60 days after the date of delivery of all of the equipment to be furnished; and payment of the final 10% on final completion of erection, testing and acceptance of all the equipment to be furnished; but not later than l80 days after the date of delivery of all of the equipment to be furnished, unless testing has been completed and shows the equipment to be unacceptable.

With each invoice for periodic payment, the Contractor shall enclose a Contractor's Declaration - Section 43, and an updated project schedule per Order of Completion - Section 2.

Section 17 - Deductions for Uncorrected Work

If the Supervising Professional decides it is inexpedient to correct work that has been damaged or that was not done in accordance with the Contract, an equitable deduction from the Contract price shall be made.

Section 18 - Correction of Work Before Final Payment

The Contractor shall promptly remove from the premises all materials condemned by the Supervising Professional as failing to meet Contract requirements, whether incorporated in the work or not, and the Contractor shall promptly replace and re-execute the work in accordance with the Contract and without expense to the City and shall bear the expense of making good all work of other contractors destroyed or damaged by the removal or replacement.

If the Contractor does not remove the condemned work and materials within l0 days after written notice, the City may remove them and, if the removed material has value, may store the material

at the expense of the Contractor. If the Contractor does not pay the expense of the removal within 10 days thereafter, the City may, upon 10 days written notice, sell the removed materials at auction or private sale and shall pay to the Contractor the net proceeds, after deducting all costs and expenses that should have been borne by the Contractor. If the removed material has no value, the Contractor must pay the City the expenses for disposal within 10 days of invoice for the disposal costs.

The inspection or lack of inspection of any material or work pertaining to this Contract shall not relieve the Contractor of its obligation to fulfill this Contract and defective work shall be made good. Unsuitable materials may be rejected by the Supervising Professional notwithstanding that the work and materials have been previously overlooked by the Supervising Professional and accepted or estimated for payment or paid for. If the work or any part shall be found defective at any time before the final acceptance of the whole work, the Contractor shall forthwith make good the defect in a manner satisfactory to the Supervising Professional. The judgment and the decision of the Supervising Professional as to whether the materials supplied and the work done under this Contract comply with the requirements of the Contract shall be conclusive and final.

Section 19 - Acceptance and Final Payment

Upon receipt of written notice that the work is ready for final inspection and acceptance, the Supervising Professional will promptly make the inspection. When the Supervising Professional finds the work acceptable under the Contract and the Contract fully performed, the Supervising Professional will promptly sign and issue a final certificate stating that the work required by this Contract has been completed and is accepted by the City under the terms and conditions of the Contract. The entire balance found to be due the Contractor, including the retained percentage, shall be paid to the Contractor by the City within 30 days after the date of the final certificate.

Before issuance of final certificates, the Contractor shall file with the City:

(1) The consent of the surety to payment of the final estimate;
(2) The Contractor's Affidavit in the form required by Section 44.

In case the Affidavit or consent is not furnished, the City may retain out of any amount due the Contractor, sums sufficient to cover all lienable claims.

The making and acceptance of the final payment shall constitute a waiver of all claims by the City except those arising from:

(1) unsettled liens;
(2) faulty work appearing within 12 months after final payment;
(3) hidden defects in meeting the requirements of the plans and specifications;
(4) manufacturer's guarantees.

It shall also constitute a waiver of all claims by the Contractor, except those previously made and still unsettled.

Section 20 - Suspension of Work

The City may at any time suspend the work, or any part by giving 5 days notice to the Contractor in writing. The work shall be resumed by the Contractor within 10 days after the date fixed in the

written notice from the City to the Contractor to do so. The City shall reimburse the Contractor for expense incurred by the Contractor in connection with the work under this Contract as a result of the suspension.

If the work, or any part, shall be stopped by the notice in writing, and if the City does not give notice in writing to the Contractor to resume work at a date within 90 days of the date fixed in the written notice to suspend, then the Contractor may abandon that portion of the work suspended and will be entitled to the estimates and payments for all work done on the portions abandoned, if any, plus 10% of the value of the work abandoned, to compensate for loss of overhead, plant expense, and anticipated profit.

Section 21 - Delays and the City's Right to Terminate Contract

If the Contractor refuses or fails to prosecute the work, or any separate part of it, with the diligence required to insure completion, ready for operation, within the allowable number of consecutive calendar days specified plus extensions, or fails to complete the work within the required time, the City may, by written notice to the Contractor, terminate its right to proceed with the work or any part of the work as to which there has been delay. After providing the notice the City may take over the work and prosecute it to completion, by contract or otherwise, and the Contractor and its sureties shall be liable to the City for any excess cost to the City. If the Contractor's right to proceed is terminated, the City may take possession of and utilize in completing the work, any materials, appliances and plant as may be on the site of the work and useful for completing the work. The right of the Contractor to proceed shall not be terminated or the Contractor charged with liquidated damages where an extension of time is granted under Extension of Time - Section 14.

If the Contractor is adjudged a bankrupt, or if it makes a general assignment for the benefit of creditors, or if a receiver is appointed on account of its insolvency, or if it persistently or repeatedly refuses or fails except in cases for which extension of time is provided, to supply enough properly skilled workers or proper materials, or if it fails to make prompt payments to subcontractors or for material or labor, or persistently disregards laws, ordinances or the instructions of the Supervising Professional, or otherwise is guilty of a substantial violation of any provision of the Contract, then the City, upon the certificate of the Supervising Professional that sufficient cause exists to justify such action, may, without prejudice to any other right or remedy and after giving the Contractor 3 days written notice, terminate this Contract. The City may then take possession of the premises and of all materials, tools and appliances thereon and without prejudice to any other remedy it may have, make good the deficiencies or finish the work by whatever method it may deem expedient, and deduct the cost from the payment due the Contractor. The Contractor shall not be entitled to receive any further payment until the work is finished. If the expense of finishing the work, including compensation for additional managerial and administrative services exceeds the unpaid balance of the Contract Sum, the Contractor and its surety are liable to the City for any excess cost incurred. The expense incurred by the City, and the damage incurred through the Contractor's default, shall be certified by the Supervising Professional.

Section 22 - Contractor's Right to Terminate Contract

If the work should be stopped under an order of any court, or other public authority, for a period of 3 months, through no act or fault of the Contractor or of anyone employed by it, then the Contractor may, upon 7 days written notice to the City, terminate this Contract and recover from the City payment for all acceptable work executed plus reasonable profit.

Section 23 - City's Right To Do Work

If the Contractor should neglect to prosecute the work properly or fail to perform any provision of this Contract, the City, 3 days after giving written notice to the Contractor and its surety may, without prejudice to any other remedy the City may have, make good the deficiencies and may deduct the cost from the payment due to the Contractor.

Section 24 - Removal of Equipment and Supplies

In case of termination of this Contract before completion, from any or no cause, the Contractor, if notified to do so by the City, shall promptly remove any part or all of its equipment and supplies from the property of the City, failing which the City shall have the right to remove the equipment and supplies at the expense of the Contractor.

The removed equipment and supplies may be stored by the City and, if all costs of removal and storage are not paid by the Contractor within 10 days of invoicing, the City upon 10 days written notice may sell the equipment and supplies at auction or private sale, and shall pay the Contractor the net proceeds after deducting all costs and expenses that should have been borne by the Contractor and after deducting all amounts claimed due by any lien holder of the equipment or supplies.

Section 25 - Responsibility for Work and Warranties

The Contractor assumes full responsibility for any and all materials and equipment used in the construction of the work and may not make claims against the City for damages to materials and equipment from any cause except negligence or willful act of the City. Until its final acceptance, the Contractor shall be responsible for damage to or destruction of the project (except for any part covered by Partial Completion and Acceptance - Section 26). The Contractor shall make good all work damaged or destroyed before acceptance. All risk of loss remains with the Contractor until final acceptance of the work (Section 19) or partial acceptance (Section 26). The Contractor is advised to investigate obtaining its own builders risk insurance.

The Contractor shall guarantee the quality of the work for a period of one year. The Contractor shall also unconditionally guarantee the quality of all equipment and materials that are furnished and installed under the contract for a period of one year. At the end of one year after the Contractor's receipt of final payment, the complete work, including equipment and materials furnished and installed under the contract, shall be inspected by the Contractor and the Supervising Professional. Any defects shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days. Any defects that are identified prior to the end of one year shall also be inspected by the Contractor and the Supervising Professional and shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days. The Contractor shall assign all manufacturer or material supplier warranties to the City prior to final payment. The assignment shall not relieve the Contractor of its obligations under this paragraph to correct defects.

Section 26 - Partial Completion and Acceptance

If at any time prior to the issuance of the final certificate referred to in Acceptance and Final Payment - Section 19, any portion of the permanent construction has been satisfactorily completed, and if the Supervising Professional determines that portion of the permanent construction is not required for the operations of the Contractor but is needed by the City, the Supervising Professional shall issue to the Contractor a certificate of partial completion, and immediately the City may take over and use the portion of the permanent construction described in the certificate, and exclude the Contractor from that portion.

The issuance of a certificate of partial completion shall not constitute an extension of the Contractor's time to complete the portion of the permanent construction to which it relates if the Contractor has failed to complete it in accordance with the terms of this Contract. The issuance of the certificate shall not release the Contractor or its sureties from any obligations under this Contract including bonds.

If prior use increases the cost of, or delays the work, the Contractor shall be entitled to extra compensation, or extension of time, or both, as the Supervising Professional may determine.

Section 27 - Payments Withheld Prior to Final Acceptance of Work

The City may withhold or, on account of subsequently discovered evidence, nullify the whole or part of any certificate to the extent reasonably appropriate to protect the City from loss on account of:

(1) Defective work not remedied;

(2) Claims filed or reasonable evidence indicating probable filing of claims by other parties against the Contractor;

(3) Failure of the Contractor to make payments properly to subcontractors or for material or labor;

(4) Damage to another Contractor.

When the above grounds are removed or the Contractor provides a Surety Bond satisfactory to the City which will protect the City in the amount withheld, payment shall be made for amounts withheld under this section.

Section 28 - Contractor's Insurance

(1) The Contractor shall procure and maintain during the life of this Contract, including the guarantee period and during any warranty work, such insurance policies, including those set forth below, as will protect itself and the City from all claims for bodily injuries, death or property damage that may arise under this Contract; whether the act(s) or omission(s) giving rise to the claim were made by the Contractor, any subcontractor, or anyone employed by them directly or indirectly. Prior to commencement of any work under this contract, Contractor shall provide to the City documentation satisfactory to the City, through City-approved means (currently myCOI), demonstrating it has obtained the required policies and endorsements. The certificates of insurance endorsements and/or copies of

policy language shall document that the Contractor satisfies the following minimum requirements. Contractor shall add registration@mycoitracking.com to its safe sender's list so that it will receive necessary communication from myCOI. When requested, Contractor shall provide the same documentation for its subcontractor(s) (if any).

Required insurance policies include:

(a) Worker's Compensation Insurance in accordance with all applicable state and federal statutes. Further, Employers Liability Coverage shall be obtained in the following minimum amounts:

Bodily Injury by Accident - $500,000 each accident
Bodily Injury by Disease - $500,000 each employee
Bodily Injury by Disease - $500,000 each policy limit

(b) Commercial General Liability Insurance equivalent to, as a minimum, Insurance Services Office form CG 00 01 04 13 or current equivalent. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements specifically for the following coverages: Products and Completed Operations, Explosion, Collapse and Underground coverage or Pollution. Further there shall be no added exclusions or limiting endorsements that diminish the City's protections as an additional insured under the policy. The following minimum limits of liability are required:

$1,000,000	Each occurrence as respect Bodily Injury Liability or Property Damage Liability, or both combined.
$2,000,000	Per Project General Aggregate
$1,000,000	Personal and Advertising Injury
$2,000,000	Products and Completed Operations Aggregate, which, notwithstanding anything to the contrary herein, shall be maintained for three years from the date the Project is completed.

(c) Motor Vehicle Liability Insurance, including Michigan No-Fault Coverages, equivalent to, as a minimum, Insurance Services Office form CA 00 01 10 13 or current equivalent. Coverage shall include all owned vehicles, all non-owned vehicles and all hired vehicles. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements that diminish the City's protections as an additional insured under the policy. Further, the limits of liability shall be $1,000,000 for each occurrence as respects Bodily Injury Liability or Property Damage Liability, or both combined.

(d) Umbrella/Excess Liability Insurance shall be provided to apply excess of the Commercial General Liability, Employers Liability and the Motor Vehicle coverage enumerated above, for each occurrence and for aggregate in the amount of $1,000,000.

(2) Insurance required under subsection (1)(b) and (1)(c) above shall be considered primary as respects any other valid or collectible insurance that the City may possess, including any self-insured retentions the City may have; and any other insurance the City does possess shall be considered excess insurance only and shall not be required to contribute

with this insurance. Further, the Contractor agrees to waive any right of recovery by its insurer against the City for any insurance listed herein.

(3) Insurance companies and policy forms are subject to approval of the City Attorney, which approval shall not be unreasonably withheld. Documentation must provide and demonstrate an unconditional and un-qualified 30-day written notice of cancellation in favor of the City of Ann Arbor. Further, the documentation must explicitly state the following: (a) the policy number(s); name of insurance company(s); name and address of the agent(s) or authorized representative(s); name(s), email address(es), and address of insured; project name; policy expiration date; and specific coverage amounts; (b) any deductibles or self-insured retentions which may be approved by the City, in its sole discretion; (c) that the policy conforms to the requirements specified Contractor shall furnish the City with satisfactory certificates of insurance and endorsements prior to commencement of any work. Upon request, the Contractor shall provide within 30 days a copy of the policy(ies) and all required endorsements to the City. If any of the above coverages expire by their terms during the term of this Contract, the Contractor shall deliver proof of renewal and/or new policies and endorsements to the Administering Service Area/Unit at least ten days prior to the expiration date.

(4) Any Insurance provider of Contractor shall be authorized to do business in the State of Michigan and shall carry and maintain a minimum rating assigned by A.M. Best & Company's Key Rating Guide of "A-" Overall and a minimum Financial Size Category of "V". Insurance policies and certificates issued by non-authorized insurance companies are not acceptable unless approved in writing by the City.

(5) City reserves the right to require additional coverage and/or coverage amounts as may be included from time to time in the Detailed Specifications for the Project.

(6) The provisions of General Condition 28 shall survive the expiration or earlier termination of this contract for any reason.

Section 29 - Surety Bonds

Bonds will be required from the Contractor as follows:

(1) A Performance Bond to the City of Ann Arbor for the amount of the proposals/bid(s) accepted;
(2) A Labor and Material Bond to the City of Ann Arbor for the amount of the proposals/bid(s) accepted.

Bonds shall be executed on forms supplied by the City in a manner and by a Surety Company authorized to transact business in Michigan and satisfactory to the City Attorney.

Section 30 - Damage Claims

The Contractor shall be held responsible for all damages to property of the City or others, caused by or resulting from the negligence of the Contractor, its employees, or agents during the progress of or connected with the prosecution of the work, whether within the limits of the work or elsewhere. The Contractor must restore all property injured including sidewalks, curbing, sodding, pipes, conduit, sewers or other public or private property to not less than its original condition with new work.

Section 31 - Refusal to Obey Instructions

If the Contractor refuses to obey the instructions of the Supervising Professional, the Supervising Professional shall withdraw inspection from the work, and no payments will be made for work performed thereafter nor may work be performed thereafter until the Supervising Professional shall have again authorized the work to proceed.

Section 32 - Assignment

Neither party to the Contract shall assign the Contract without the written consent of the other. The Contractor may assign any monies due to it to a third party acceptable to the City.

Section 33 - Rights of Various Interests

Whenever work being done by the City's forces or by other contractors is contiguous to work covered by this Contract, the respective rights of the various interests involved shall be established by the Supervising Professional, to secure the completion of the various portions of the work in general harmony.

The Contractor is responsible to coordinate all aspects of the work, including coordination of, and with, utility companies and other contractors whose work impacts this project.

Section 34 - Subcontracts

The Contractor shall not award any work to any subcontractor without prior written approval of the City. The approval will not be given until the Contractor submits to the City a written statement concerning the proposed award to the subcontractor. The statement shall contain all information the City may require.

The Contractor shall be as fully responsible to the City for the acts and omissions of its subcontractors, and of persons either directly or indirectly employed by them, as it is for the acts and omissions of persons directly employed by it.

The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind subcontractors to the Contractor by the terms of the General Conditions and all other contract documents applicable to the work of the subcontractors and to give the Contractor the same power to terminate any subcontract that the City may exercise over the Contractor under any provision of the contract documents.

Nothing contained in the contract documents shall create any contractual relation between any subcontractor and the City.

Section 35 - Supervising Professional's Status

The Supervising Professional has the right to inspect any or all work. The Supervising Professional has authority to stop the work whenever stoppage may be appropriate to insure the proper execution of the Contract. The Supervising Professional has the authority to reject all work and materials which do not conform to the Contract and to decide questions which arise in the execution of the work.

The Supervising Professional shall make all measurements and determinations of quantities. Those measurements and determinations are final and conclusive between the parties.

Section 36 - Supervising Professional's Decisions

The Supervising Professional shall, within a reasonable time after their presentation to the Supervising Professional, make decisions in writing on all claims of the City or the Contractor and on all other matters relating to the execution and progress of the work or the interpretation of the contract documents.

Section 37 - Storing Materials and Supplies

Materials and supplies may be stored at the site of the work at locations agreeable to the City unless specific exception is listed elsewhere in these documents. Ample way for foot traffic and drainage must be provided, and gutters must, at all times, be kept free from obstruction. Traffic on streets shall be interfered with as little as possible. The Contractor may not enter or occupy with agents, employees, tools, or material any private property without first obtaining written permission from its owner. A copy of the permission shall be furnished to the Supervising Professional.

Section 38 - Lands for Work

The Contractor shall provide, at its own expense and without liability to the City, any additional land and access that may be required for temporary construction facilities or for storage of materials.

Section 39 - Cleaning Up

The Contractor shall, as directed by the Supervising Professional, remove at its own expense from the City's property and from all public and private property all temporary structures, rubbish and waste materials resulting from its operations unless otherwise specifically approved, in writing, by the Supervising Professional.

Section 40 - Salvage

The Supervising Professional may designate for salvage any materials from existing structures or underground services. Materials so designated remain City property and shall be transported or stored at a location as the Supervising Professional may direct.

Section 41 - Night, Saturday or Sunday Work

No night or Sunday work (without prior written City approval) will be permitted except in the case of an emergency and then only to the extent absolutely necessary. The City may allow night work which, in the opinion of the Supervising Professional, can be satisfactorily performed at night. Night work is any work between 8:00 p.m. and 7:00 a.m. No Saturday work will be permitted unless the Contractor gives the Supervising Professional at least 48 hours but not more than 5 days notice of the Contractor's intention to work the upcoming Saturday.

Section 42 - Sales Taxes

Under State law the City is exempt from the assessment of State Sales Tax on its direct purchases. Contractors who acquire materials, equipment, supplies, etc. for incorporation in City projects are not likewise exempt. State Law shall prevail. The Contractor is presumed to know and understand the law and to have prepared its bid accordingly. No extra payment will be allowed under this Contract for failure of the Contractor to make proper allowance for taxes it must pay.

Section 43

CONTRACTOR'S DECLARATION

I hereby declare that I have not, during the period _____, 20___, to _____, 20__, performed any work, furnished any materials, sustained any loss, damage or delay, or otherwise done anything in addition to the regular items (or executed change orders) set forth in the Contract titled Solar and Battery Storage Installation at City Facilities, for which I shall ask, demand, sue for, or claim compensation or extension of time from the City, except as I hereby make claim for additional compensation or extension of time as set forth on the attached itemized statement. I further declare that I have paid all payroll obligations related to this Contract that have become due during the above period and that all invoices related to this Contract received more than 30 days prior to this declaration have been paid in full except as listed below.

There is/is not (Contractor please circle one and strike one as appropriate) an itemized statement attached regarding a request for additional compensation or extension of time.

_____ _____

Contractor Date

By _____
(Signature)

Its _____
(Title of Office)

Past due invoices, if any, are listed below.

Section 44

CONTRACTOR'S AFFIDAVIT

The undersigned Contractor,_____, represents that on _____, 20___, it was awarded a contract by the City of Ann Arbor, Michigan to_____ under the terms and conditions of a Contract titled _____. The Contractor represents that all work has now been accomplished and the Contract is complete.

The Contractor warrants and certifies that all of its indebtedness arising by reason of the Contract has been fully paid or satisfactorily secured; and that all claims from subcontractors and others for labor and material used in accomplishing the project, as well as all other claims arising from the performance of the Contract, have been fully paid or satisfactorily settled. The Contractor agrees that, if any claim should hereafter arise, it shall assume responsibility for it immediately upon request to do so by the City of Ann Arbor.

The Contractor, for valuable consideration received, does further waive, release and relinquish any and all claims or right of lien which the Contractor now has or may acquire upon the subject premises for labor and material used in the project owned by the City of Ann Arbor.

This affidavit is freely and voluntarily given with full knowledge of the facts.

_____ _____
Contractor Date

By _____
(Signature)

Its _____
(Title of Office)

Subscribed and sworn to before me, on this _____ day of _____, 20__
_____ , _____ County, Michigan
Notary Public
_____ County, MI
My commission expires on:

STANDARD SPECIFICATIONS

All work under this contract shall be performed in accordance with the Public Services Standard Specifications in effect at the date of availability of the contract documents stipulated in the RFP. All work under this Contract which is not included in these Standard Specifications, or which is performed using modifications to these Standard Specifications, shall be performed in accordance with the Detailed Specifications included in these contract documents.

Standard Specifications are available online:

http://www.a2gov.org/departments/engineering/Pages/Engineering-and-Contractor-Resources.aspx

DETAILED SPECIFICATIONS

Minimum technical specifications

General

- All power generation and transmission equipment must be UL listed and installed for its designed use.
- Construction must comply with most recent currently adopted State Building Code, which encompasses:
    - International Building Code
    - National Electric Code (NEC)
    - All other relevant state and national codes
- Contractor must transfer all manufacturer warranties for key equipment.
- System Contractor is responsible for conducting all required building, utility, and rebate inspections, and must complete all construction and documentation in a manner necessary to pass such inspections, and in accordance with industry standard best practices.
- System Contractor must possess current state electric and contractor's license from State's Contractors Licensing Board to perform work being proposed.

Solar PV Modules

- System modules shall be UL1703 listed, and CEC-listed.
- Module manufacturer must provide a 10-year warranty on minimum of 90% nameplate energy production and 25-year warranty on minimum of 80% nameplate energy production.
- All warranties must be documented in advance and be fully transferable to City.
- Solar module providers must have a strong track record of performance with a long-term ability to provide service and warranties.

Rooftop Mounted Systems

- All roofing penetrations must be performed in such a way (including sealing) to prevent leakage and maintain the existing rooftop warranty.
- All solar panels must be at least 6 inches above the roofing materials.
- Any newly exposed steel must be protected with marine-grade sealants for corrosion resistance.
- All components must be secured to reduce the potential for damage, vandalism, or theft.
- All City policies regarding installation of solar must be followed.

Carport Structures

- All carport structures shall be designed to have a minimum clearance height of ten (10) feet (although this may need to be higher depending on if the proposed locations need to accommodate buses).
- Structures located in parking lots shall be designed to minimize loss or encumbrance of parking spaces and ADA paths of travel.
- If necessary, painted concrete bollards shall be installed on support posts. The bollards shall extend up to a minimum elevation of 36" above finished grade.

- All structures shall be installed with a fascia surrounding the exposed edge of the structure's purlins with columns, beams, and fascia painted to a color of the Client's approval.
- All carport structures shall include the installation of high efficiency LED lighting with motion sensors and must conform to applicable local and state requirements.
- Carports should be wired with at least one power outlet per array.

Inverters

- Inverters must be located on a concrete pad with proper enclosures to prevent damage or theft.
- Inverters shall be UL1741 listed and IEEE 1547 compliant and must be CEC-listed with an CEC efficiency of 96% or higher.
- The inverter shall be capable of continuous operation with voltage variation of +/- 10% of nominal AC voltage. The inverter shall operate in an ambient temperature range of -20°C to +50°C.
- PV array design shall maintain DC input voltage within the inverter's specified MPPT window for all expected operating temperatures.
- Inverters shall include all necessary self-protective features and self-diagnostic features to protect the inverter from damage (in the event of component failure or from parameters beyond normal operating range due to internal or external causes).
- Inverters must carry minimum 10-year manufacturer warranty.
- All manufacturer warranties must be documented, in advance, and be fully transferable to City.

Balance of System Equipment

- Each proposed PV system shall include, at a minimum, one fused DC disconnect, and one fused AC disconnect for safety and maintenance concerns.
- String combiner boxes must include properly-sized fusing, and all metal equipment and components must be bonded and grounded as required by NEC.
- All system wiring and conduit must comply with NEC stipulations, and all indoor and outdoor wiring, outdoor-rated or otherwise, must be enclosed in EMT or RIGID conduit or covered raceway, except adjacent panel connections and under-array home run wiring.
- Wall penetrations must be sealed in compliance with NEC and NFPA regulations.
- All wiring materials and methods must adhere to industry-standard best practices, and all inter-module connections must require the use of a specialized tool for disconnecting.
- Lightning arrestors must be used to protect appropriate equipment from lightning strikes.
- Material requirements:
    - Fasteners and hardware throughout system shall be stainless steel or material of equivalent corrosion resistance.
    - Racking components shall be anodized aluminum, hot-dipped galvanized steel, or material of equivalent corrosion resistance.
    - Unprotected steel is not to be used in any components**.**

Interconnection

- The system must comply with all applicable utility interconnection requirements.
- System interconnection must comply with NEC and Utility regulations and must be approved by the applicable utility and the Ann Arbor Building Inspector before any PV system construction begins.

- Emergency back-up generation may exist on-site and must be factored into proposed PV system electrical plans according to building and electrical codes.
- All placards required by Client, the Building Inspector, the Utility, and/or State programs must be provided and installed according to Client and NEC guidelines.

Monitoring and Reporting Systems

- System monitoring and reporting must comply with State solar program requirements and must be provided at no additional cost for a minimum of five years.
- Monitoring shall include revenue-grade metering of PV system production and building consumption; pyranometer; and ambient air temperature sensor.
- Proposals must include Internet hosting of monitoring with on-line access for Client personnel and public display of data.
- Offeror must work with the City to determine best location and technique for monitoring communications interconnection.
- Offeror will be responsible for providing all required monitoring communications and power wiring and conduit, with City guidance on approved locations.

Battery Installations

- Contractor must include an integrated Battery Storage System (BSS) into the proposed Solar PV system that provides, at a minimum, resiliency during grid outages, and potentially other valuable services including load management and grid services. All pertinent details must be provided for the design, construction and interconnection of the BSS that are fully integrated into the Solar PV system and site electrical systems. The BSS must also integrate with any existing systems located on site.

Balance of System Equipment - Battery

Energy Storage Systems must meet the following requirements:

- The maximum sound level generated from the battery system and any associated equipment under any output level shall be limited to 65 dBA at 50 feet in any direction.
- Minimum 80% AC round trip efficiency.
- Chemistry must be lithium-ion; alternative proposals using batteries with lead-acid chemistry will be considered. No other types of energy storage will be considered.
- All components must operate at safe rated sustainable operating temperatures over the required ambient temperature range.
- Monitoring requirements must include: voltage, current, power, system performance alerts, remote and on-site access to data.
- Operation and Maintenance Manual, including recommended corrective action and maintenance procedures for each alert or observed condition.
- The BSS control system shall be designed to provide for automatic, unattended operation and for local manual operation or remote operation.
- Any existing emergency back-up generation connected to the site's electrical systems must be factored into proposed solar PV and BSS electrical plans.
- Interconnection designs and applications must fully document and comply with all utility and local requirements for operation during a grid outage and the safe process for power restoration from the grid.

System Design and Permitting

- Within 30 days of contract being signed, successful offeror shall create a construction plan set which includes at a minimum:
    - Site overview

    - Detailed array layout with stringing configuration
    - Geotechnical site preparation plans and footing details, as needed
    - Mounting and racking details
    - Details of electrical transmission showing conduit routing and location of electrical enclosures, conduit support details, and enclosure mounting details
    - Electrical single-line diagram
    - Monitoring system and recommended monitoring plan
    - Documentation regarding how the system design enables efficient repair and maintenance of the arrays
    - Construction project plan with timeline
- All proposed system designs and construction techniques must be approved by the City and utility.
- Offeror shall obtain structural PE stamp verifying the integrity of the existing facility to handle the additional weight load of the proposed PV system, if applicable.
- Offeror shall obtain electrical PE stamp verifying the integrity and code compliance of proposed PV system and interconnection with facility.
- Final array layouts shall be designed to minimize or avoid shading. If shading will occur, offeror shall specify the predicted solar access and performance losses.
- Wire loss in DC circuits to be < 1.5% based on STC values.
- Wire loss in AC circuits to be < 1.5% based on nominal voltages.

Construction

- Contractor shall prepare, maintain, and abide by a Site Safety Plan that will include, at a minimum, all applicable OSHA and MIOSHA workplace safety and Personal Protective Equipment (PPE) requirements
- Construction work shall be designed to minimize impact to facility operations. Contractor shall develop a construction plan for site access, staging, and equipment storage and obtain approval from the City prior to beginning construction.
- All asphalt, concrete, landscaping, and other areas that are disturbed during construction shall be remediated and returned to their original condition, or an equivalent condition approved by the City
- After completion of the work, the site shall be left clean and free of any dirt or debris that may have accumulated during construction. All construction equipment, spoils, and other construction byproducts shall be removed from the site.
- All electrical enclosures and equipment shall be installed to be readily accessible to qualified personnel only. Fences or other protection may be required per City specifications both during installation and as part of final design.
- All visible conduits and electrical equipment shall be painted or aesthetically dressed per City specifications.
- Location of existing underground utilities must be marked by MISSDIG and equivalent private service prior to any underground work.
- A goal for construction is zero waste and all recyclable materials must be sorted for proper handling.

Documentation and Process Control

In addition to construction requirements listed above, Contractor is required to:

- Coordinate with and receive appropriate approval from the local DTE Electric for proposed PV systems.
- Obtain Solar rebates and/or Renewable Energy Credits.
- Prepare press releases and a ribbon-cutting ceremony at City request.

- Provide As-Built drawings of PV system, which must include finalized module layout, single line diagram, and stringing chart, ideally in GIS.

Acceptance Testing

Contractor shall perform a complete acceptance test at the system and component level for safety, quality and performance. All testing and commissioning shall be conducted in accordance with the manufacturer's specifications. These tests shall include (but not be limited to) the following:

- Full system performance tests.
- Testing of all sensors of the monitoring system and the on-line presentation of performance.

The City (or City's representative) shall be informed, in advance, of testing times and have the opportunity to join in testing procedures. A report of all tests shall document the results of the testing activities and be presented to the City. The report shall include the date and time each test was performed and descriptions of all problems and deficiencies found during testing. Contractor shall be responsible for providing the labor and equipment necessary to conduct these tests and any required troubleshooting.

Owner Training

The Contractor must provide on-site training with accompanying training materials for City personnel in all aspects of operation, routine maintenance, and safety of the systems, and monitoring including:

- PV system safety, including shut-down procedures.
- PV module maintenance and troubleshooting.
- Structural elements maintenance and repair guidelines.
- Inverter overview and maintenance procedures.
- Calibration and adjustment procedures for the inverters and tracking systems (if any).
- Solar panel replacement.
- Monitoring system troubleshooting and reporting.

APPENDIX

LIST OF DRAWINGS

NUM	TITLE	REV	DATE: 6-27-2024 (INTERCONNECT)	6-29-2024 (BID REVIEW)	7-16-2024 (INTERCONNECT REV 1)	1-27-2025 (ADDENDUM-2)
	GENERAL					
G001	COVER SHEET		●	●	●	●
G002	GENERAL NOTATION			●		
	CIVIL					
C101	SITE PLAN			●		
C102	CONSTRUCTION PLAN			●		
C103	DEMOLITION PLAN			●		
	ELECTRICAL					
E101	ELECTRICAL SITE PLAN		●	●	●	
E102	AC POWER PLAN			●		
E103	DC POWER PLAN			●		
E104	GROUNDING PLAN			●		●
E105	PV STRING WIRING PLAN			●		●
E401	EQUIPMENT RACK ON ROOF			●		
E501	ELECTRICAL DETAILS			●		●
E601	ONE-LINE DIAGRAM		●	●	●	●
E701	LABELS AND PLACARDS			●		
E702	ELECTRICAL SPECIFICATIONS			●		
E801	DATA SHEETS			●		
E802	DATA SHEETS			●		
E803	DATA SHEETS			●		
E804	DATA SHEETS			●		
E805	DATA SHEETS			●		
	STRUCTURAL					
S-1.0	UNIRAC - ROOF BALLAST LAYOUT(S)			●		
EF2+	UNIRAC - ECOLIBRIUM-ECOFOOT2; MULTI-PAGE REPORT(S)			●		

PROJECT TO BE SUBMITTED AND REVIEWED UNDER THE 2015 MICHIGAN REHABILITATION CODE FOR EXISTING BUILDINGS (MRCEB) SECTION 301.1.2 “WORK AREA COMPLIANCE METHOD” PER SECTION 504.1 LEVEL-2 ALTERATIONS (CH 5-13).

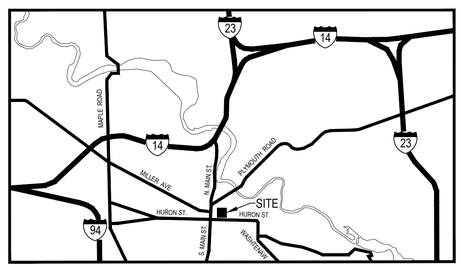
NOVA PROJECT #23-11-1168
110 kW AC, 1000 V DC (MAX.), 135 kW DC SOLAR PHOTOVOLTAIC SYSTEM

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL & JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

NOVA PROJECT MANAGER: JEFF ECKHOUT



N
SITE LOCATION MAP
NO SCALE

NOVA Consultants, Inc.
21580 Novi Road
Suite 300
Novi, MI 48375

Phone: (248) 347-3512
Fax: (248) 347-4152

www.novaconsultants.com

ISSUED

	DATE	DESCRIPTION	APPVD.
	6-27-2024	INTERCONNECT	
	6-29-2024	BID REVIEW	
1	7-16-2024	INTERCONNECT REV 1	
2	1-27-2025	ADDENDUM-2	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

COVER SHEET

PROJECT NUMBER	
23-11-1168-CH	
DRAWN BY: GAK	SHEET NUMBER: G001
SCALE: NONE	
SHEET SIZE: 22x34	

STANDARD METHODS OF NOTATION

- SHEET KEY NOTES □TAGS□
- ITEM DESIGNATION □E601 WIRE AND CONDUIT SCHEDULE□
- REVISION □ADDENDUM TAG
- DETAIL NUMBER (ELEVATION TAG) SHEET WHERE FOUND
- DETAIL NUMBER (SECTION CUT TAG) SHEET WHERE FOUND
- DETAIL NUMBER SHEET WHERE FOUND (BUBBLE DETAIL) ENLARGEMENT AREA
- DETAIL NUMBER / NAME (DRAWING TITLE & IDENTIFICATION) SHEET WHERE FOUND / SCALE
- SPOT ELEVATION
- MATCH LINE
- CENTER LINE
- LIGHT LINE INDICATES E□ISTING WORK
- HEAVY LINE INDICATES NEW WORK
- DASHED LINE INDICATES DEMOLITION
- UNDERGROUND CONDUIT AND WIRING

SITE, ROOF & FLOOR PLAN SYMBOLS

- PV STRING DESIGNATION
- MODULE □SITE & ROOF PLAN□
- SWITCHGEAR
- INVERTER
- PANEL BOARD
- DISCONNECT
- METER
- TRANSFORMER
- CT CABINET
- COMBINER
- DUPLE□ RECEPTACLE
- EV CHARGING STATION
- EV CHARGING ONLY □PARKING SPACE□
- COPPER CLAD GROUND ROD
- SILT FENCE
- CHAIN LINK FENCE
- GRAPHIC SCALE
- NORTH ARROW

ELECTRICAL DETAIL SYMBOLS

- PV STRING DESIGNATION
- MODULE □PV WIRING PLAN□
- SWITCHGEAR
- INVERTER
- PANEL BOARD
- DISCONNECT
- METER
- TRANSFORMER
- CT CABINET
- COMBINER
- DUPLE□ RECEPTACLE
- EV CHARGING STATION
- EV CHARGING ONLY □PARKING SPACE□
- COPPER CLAD GROUND ROD

ONE LINE DIAGRAM SYMBOLS □SHEET E601□

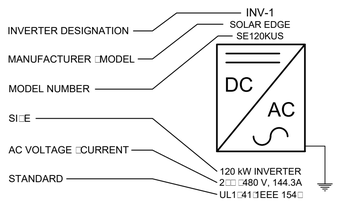
- PV STRING DESIGNATION
- MODULE □ONE - LINE DIAGRAM□
- OPTIMI□ER
- RAPID SHUTDOWN
- PANELBOARD □PB□W□MAIN BREAKER
- DISCONNECT
- FUSED DISCONNECT
- DISCONNECT SWITCH
- TRANSFORMER
- FUSE
- CIRCUIT BREAKER
- CURRENT TRANSFORMER □CTs□
- POTENTIAL TRANSFORMER □PTs□
- BUS BAR
- WYE TRANSFORMER CIRCUIT CONNECTION
- DELTA TRANSFORMER CIRCUIT CONNECTION
- GROUND
- INVERTER
- DISCONNECT
- METER
- COMBINER
- SURGE PROTECTIVE DEVICE □SPD□
- DUPLE□ RECEPTACLE
- GFCI DUPLE□ RECEPTACLE
- GFCI WITH IN USE COVER OUTDOOR RATED WEATHER RESISTANT
- EV CHARGING STATION
- UTILITY POLE TO GRID
- CIRCUIT HOMERUN W□STRING IDENTIFIER
- AREA DIVIDER LINE □E601 ONE-LINE DIAGRAM□

ELECTRICAL ABBREVIATION LIST

ABBREVIATION	DESCRIPTION
A	AMPERES
A.F.F.	ABOVE FINISH FLOOR
AU□	AU□ILIARY
AWG	AMERICAN WIRE GAUGE
BKR	BREAKER
CB	CIRCUIT BREAKER
CKT	CIRCUIT
CT	CURRENT TRANSFORMER
DEMO	DEMOLITION
DIM	DIMENSION
DISC	DISCONNECT
DP	DISTRIBUTION PANEL
DWG	DRAWING
ELEC	ELECTRICAL
EM □EMER	EMERGENCY
EMT	ELECTRICAL METALLIC TUBING
EVCS	ELECTRIC VEHICLE CHARGING STATION
E□ □E□IST	E□ISTING
FLR	FLOOR
G □GRD □EG	GROUND
GFCI □GFI	GROUND FAULT CIRCUIT INTERRUPTER
HP	HORSEPOWER
HV	HIGH VOLTAGE
H□	HERT□
INV	INVERTER
IG	ISOLATED GROUND
JB	JUNCTION BO□
kV	KILOVOLT
kVA	KILOVOLT- AMPERES
kW	KILOWATT
kWH	KILOWATT - HOURS
MA□	MA□IMUM
MPPT	MA□IMUM POWER POINT TRACKING
MDP	MAIN DISTRIBUTION PANEL
MIN	MINIMUM
MISC	MISCELLANEOUS
MTD	MOUNTED
NEC	NATIONAL ELECTRICAL CODE
N□A	NOT APPLICABLE
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
OC	ON CENTER
OCPD	OVER CURRENT PROTECTION DEVICE
PNL	PANEL
P	POLE
PH	PHASE
PV	PHOTOVOLTAIC
PT	POTENTIAL TRANSFORMER
PDP	POWER DISTRIBUTION PANEL
RSD	RAPID SHUTDOWN DEVICE
RECEPT	RECEPTACLE
RE□ □D	RE□UIRED
RSC	RIGID STEEL CONDUIT
SW	SWITCH
SWBD	SWITCH BOARD
SWGR	SWITCH GEAR
TELCOM	TELECOMMUNICATIONS
TP	TAMPERPROOF
TYP	TYPICAL
U.O.N.	UNLESS OTHERWISE NOTED
V	VOLTS
V.I.F.	VERIFY IN FIELD
W	WIRE
WP	WEATHERPROOF
□FMR	TRANSFORMER

NOTE: SOME SYMBOLS AND ABBREVIATIONS SHOWN MAY NOT APPLY TO THIS PROJECT.

INVERTER ANNOTATION



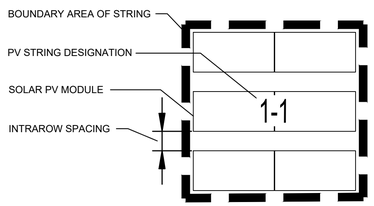
STANDARD MOUNTING HEIGHTS

DESCRIPTION	HEIGHT
PANELBOARD	6□0" A.F.F. TO TOP OF BO□
RECEPTACLE OUTLET	16" A.F.F. TO BOTTOM OF BO□. □MIN.□ 48" A.F.F. TO TOP OF BO□ □MA□.□
CONDUIT IN TRENCH	18" BELOW GRADE - TO TOP OF CONDIUT □MIN.□

LINES & WIRES

- GAS LINE
- AC WIRING
- AC WIRING UNDERGROUND
- DC WIRING
- STRING WIRING
- GROUND WIRE
- CONDUIT DOWN
- CONDUIT UP

PV ARRAY ANNOTATION PLAN



NOVA Cons□ltants, Inc.
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DATE	DESCRIPTION	APPVD.
6-2□-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

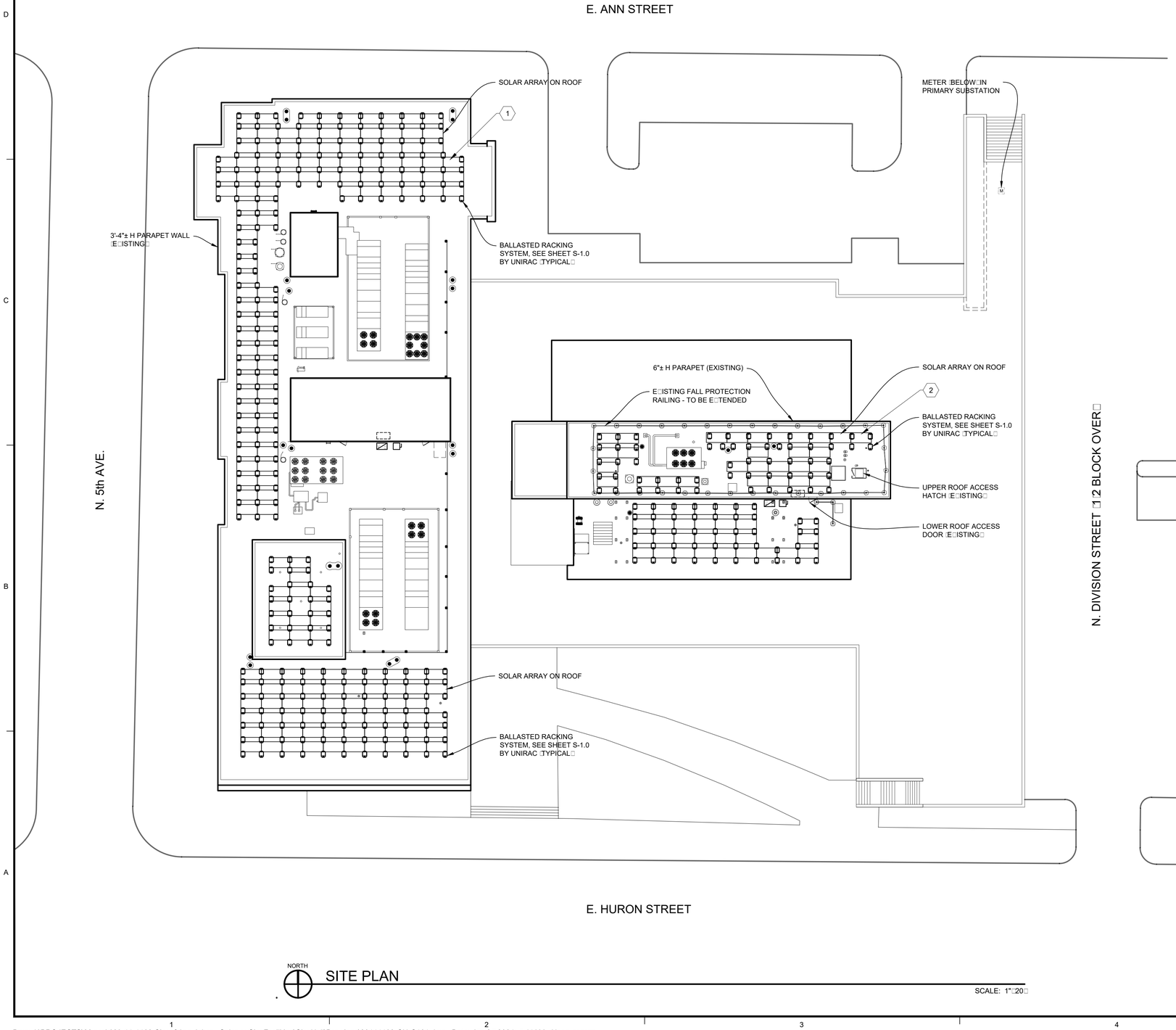
GENERAL NOTATION

PROJECT NUMBER 23-11-1168-CH

DRAWN BY | SHEET NUMBER G002

SCALE

SHEET SI□E 22□34



NORTH

SITE PLAN

SCALE: 1"=20'

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.

SHEET KEY NOTES

1. 80 kW AC, 101.5 kW DC - PV ARRAY (INV-1)
2. 30 kW AC, 33.64 kW DC - PV ARRAY (INV-2)

PV SYSTEM DESCRIPTION

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
AZIMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

LEGEND

	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER

0 5' 10' 20' 40'

SCALE: 1"=20'

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ISSUED

DATE	DESCRIPTION	APPVD.
6-20-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

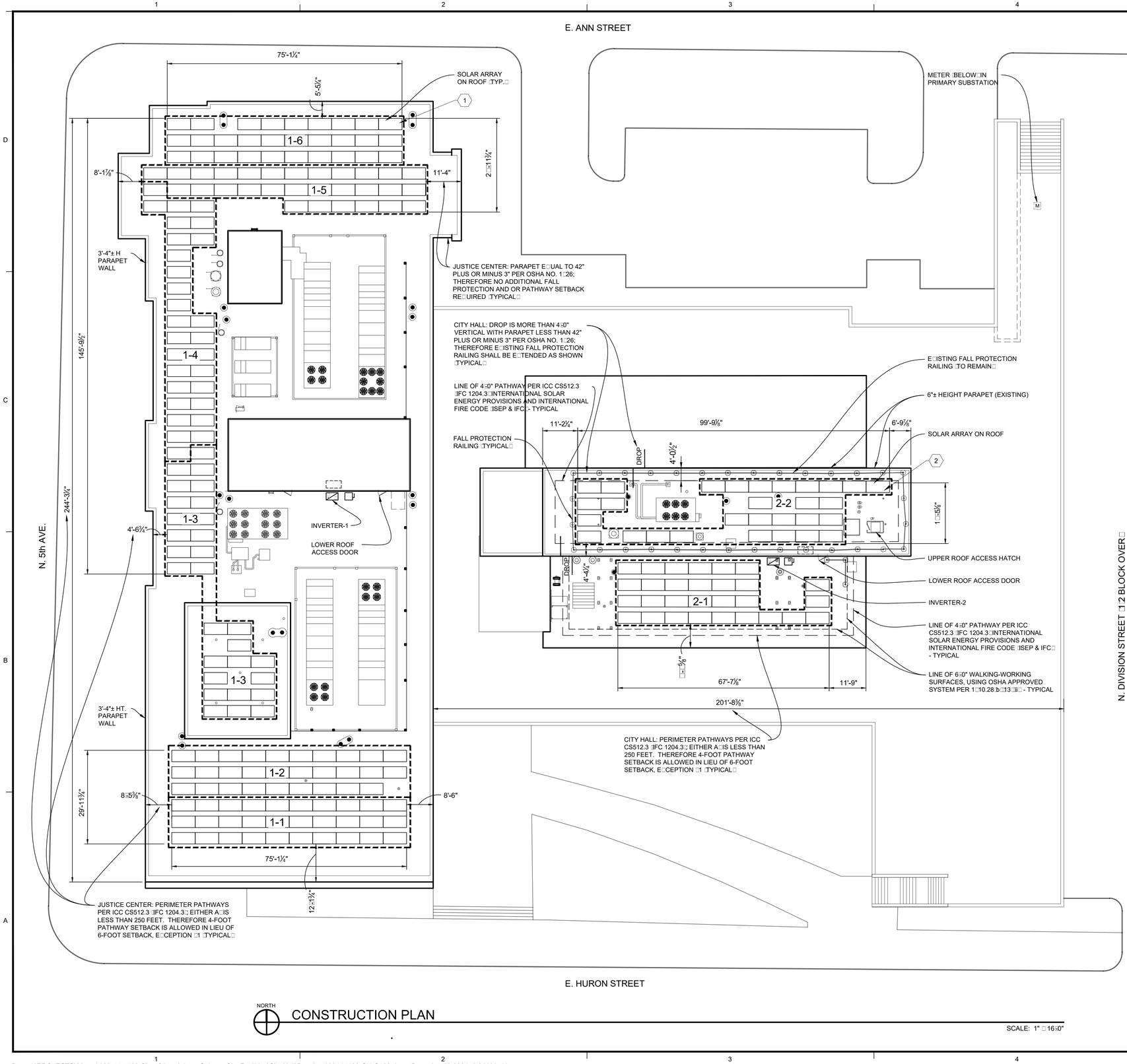
301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

SITE PLAN

PROJECT NUMBER	23-11-1168-CH
DRAWN BY	RGM, GAK
SCALE	AS NOTED
SHEET SIZE	22x34
SHEET NUMBER	C101

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\City Hall\Drawings\23111168-CH-C101.dwg Date: Jun 20, 2024; 9:41AM User: george



CONSTRUCTION PLAN

SCALE: 1" = 16'-0"

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC) 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
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SHEET KEY NOTES

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2. 30 kW AC, 33.64 kW DC - PV ARRAY (INV-2)

PV SYSTEM DESCRIPTION

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
A)IMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER

SCALE: 1" = 16'

NOVA Cons)tants, Inc.
21580 No) Road
S)te 300
No), MI 483)5
Phone: (248)34)-3512
Fa): (248)34)-4152
www.no)acons)tants.co)

ISSUED

DATE	DESCRIPTION	APPVD.
6-2)-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

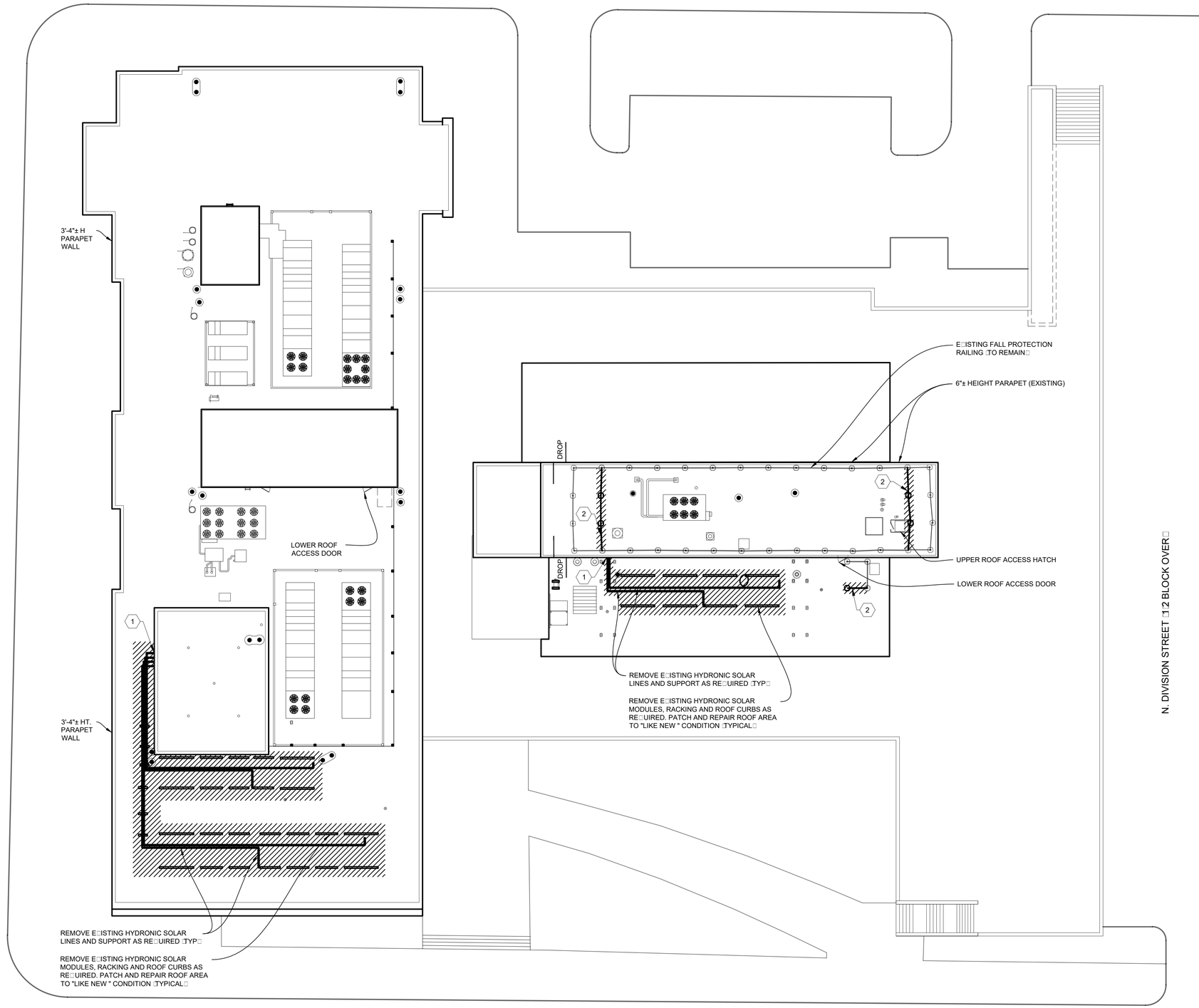
301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

CONSTRUCTION PLAN

PROJECT NUMBER: 23-11-1168-CH

DRAWN BY	SHEET NUMBER
RGM, GAK	C102
SCALE: AS NOTED	
SHEET SI)E: 22)34	



NORTH

DEMOLITION PLAN

SCALE: 1" □16□0"

SHEET GENERAL NOTES

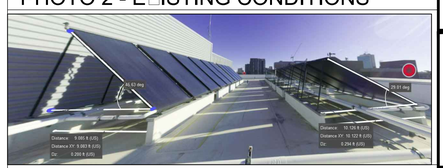
1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE □NEC□ 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.

SHEET KEY NOTES

1. DRAIN, CUT TO STUB AND CAP E□ISTING HYDRONIC SOLAR LINES AS RE□UIRED AND PER CODE □TYPICAL□
2. REMOVE AND RELOCATE E□ISTING FALL PROTECTION AS RE□UIRED

PHOTO 1 - E□ISTING CONDITIONS

PHOTO 2 - E□ISTING CONDITIONS



0 8□ 16□ 32□

SCALE: 1" □16□

NOVA Cons□ltants, Inc.
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No□i, MI 483□5

Phone: □248□34□-3512
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ISSUED

DATE	DESCRIPTION	APPVD.
6-2□-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

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RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
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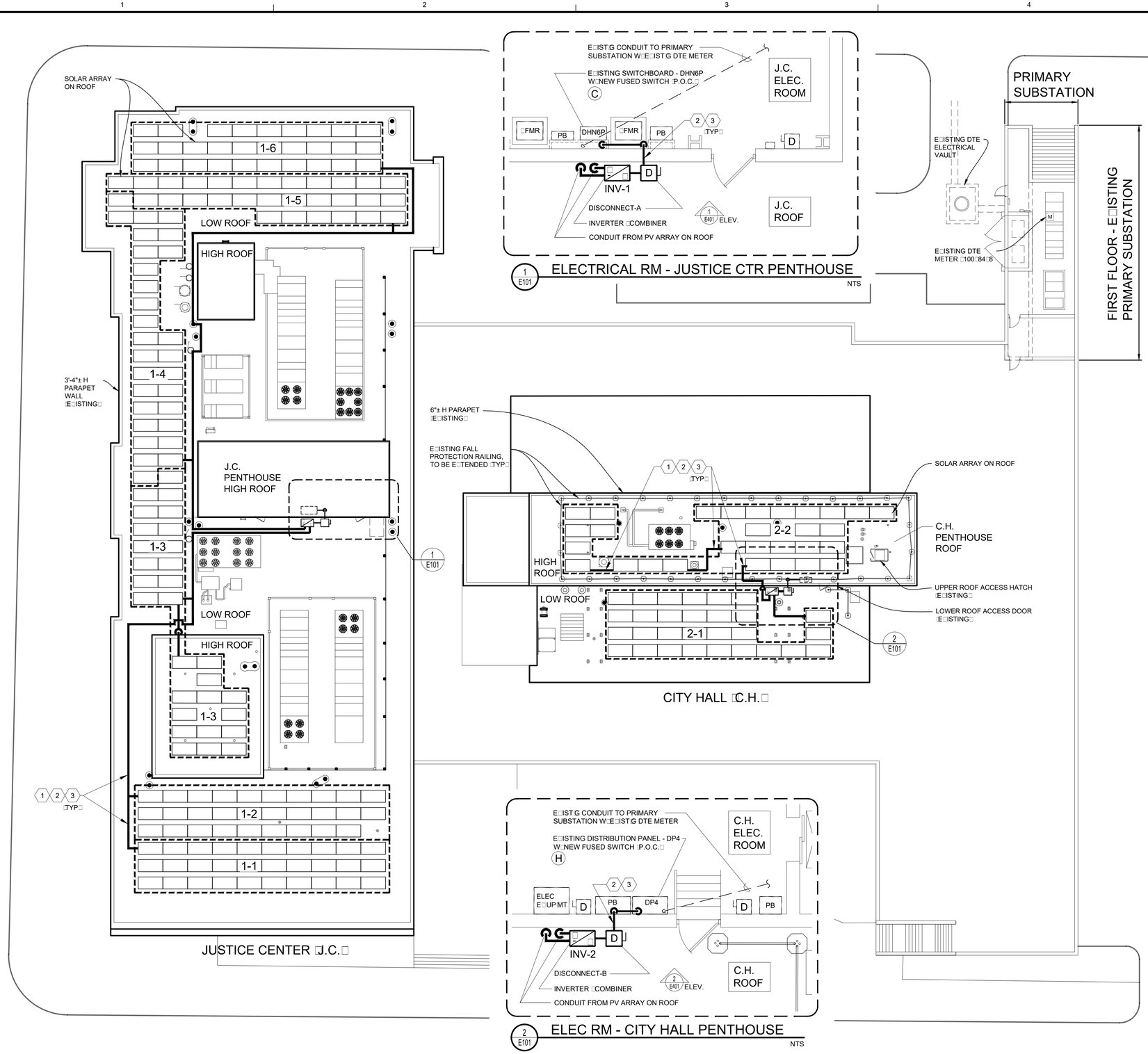
301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

DEMONLITION PLAN

PROJECT NUMBER
23-11-1168-CH

DRAWN BY	SHEET NUMBER
RGM, GAK	C103
SCALE: AS NOTED	
SHEET SI□E: 22□34	



SHEET GENERAL NOTES

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2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.

SHEET KEY NOTES

1. DC HOME RUNS UNDER MODULES: PV WIRING SHALL BE SECURED VIA HEYCO CABLE CLIPS OR EQUAL.
2. DC HOME RUNS NOT UNDER MODULES, AND AC WIRING: WIRING SHALL BE IN CONDUIT PER CODE, SEE VERTICAL CONDUIT SUPPORT (WALL) AND CONDUIT SUPPORT DETAILS (ROOF) ON SHEET E501.
3. SEE CONDUIT AND WIRE SIZE CHART ON SHEET E601.

PV SYSTEM DESCRIPTION - GENERAL (1)

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
AZIMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

PV SYSTEM DESCRIPTION - SUMMARY

FOR TOTAL SYSTEM:

PV MODULE MODEL:	JINKO SOLAR, JKM580N-72HL4-BDV
PV MODULE SIZE:	87.6" L x 44.65" W x 1.18" D
NUMBER OF MODULES:	233
PV MODULE PMAX:	580 W
OPTIMIZERS: S1200 DUAL OPTIMIZER	SOLAR EDGE S1201 DUAL OPTIMIZER
INVERTERS : 2	1. SOLAR EDGE SE80KUS 80 kW 2. SOLAR EDGE SE 30 US 30 kW
NO. OF STRINGS PER INVERTER:	INV 1: 6 STRINGS
NO. OF STRINGS PER INVERTER:	INV 2: 2 STRINGS
DC TO AC RATIO:	1.23
NUMBER OF STRINGS:	8
TOTAL NAMEPLATE SIZE:	135.14 kW DC 110.0 kW AC

NOTE: PV SYSTEM IS 1000 V DC IMAX

PV SYSTEM DESCRIPTION - SECTION (1)

JUSTICE CENTER : INV-1 80 kW AC	15 MODULES WITH 0 OPTIMIZERS DC 101.5 kW DC INV-1 DC TO AC RATIO 1.2
CITY HALL : INV-2 30 kW AC	58 MODULES WITH 30 OPTIMIZERS DC 33.64 kW DC INV-2 DC TO AC RATIO 1.12

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER
XFMR	TRANSFORMER
	AC WIRING CONDUIT
	DC WIRING CONDUIT
(P.O.C.)	POINT OF CONNECTION

0 8' 16' 32'
SCALE: 1" = 16'

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ISSUED

DATE	DESCRIPTION	APPVD.
6-2-2024	INTERCONNECT	
2-2-2024	BID REVIEW	
-16-2024	INTERCONNECT REV 1	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

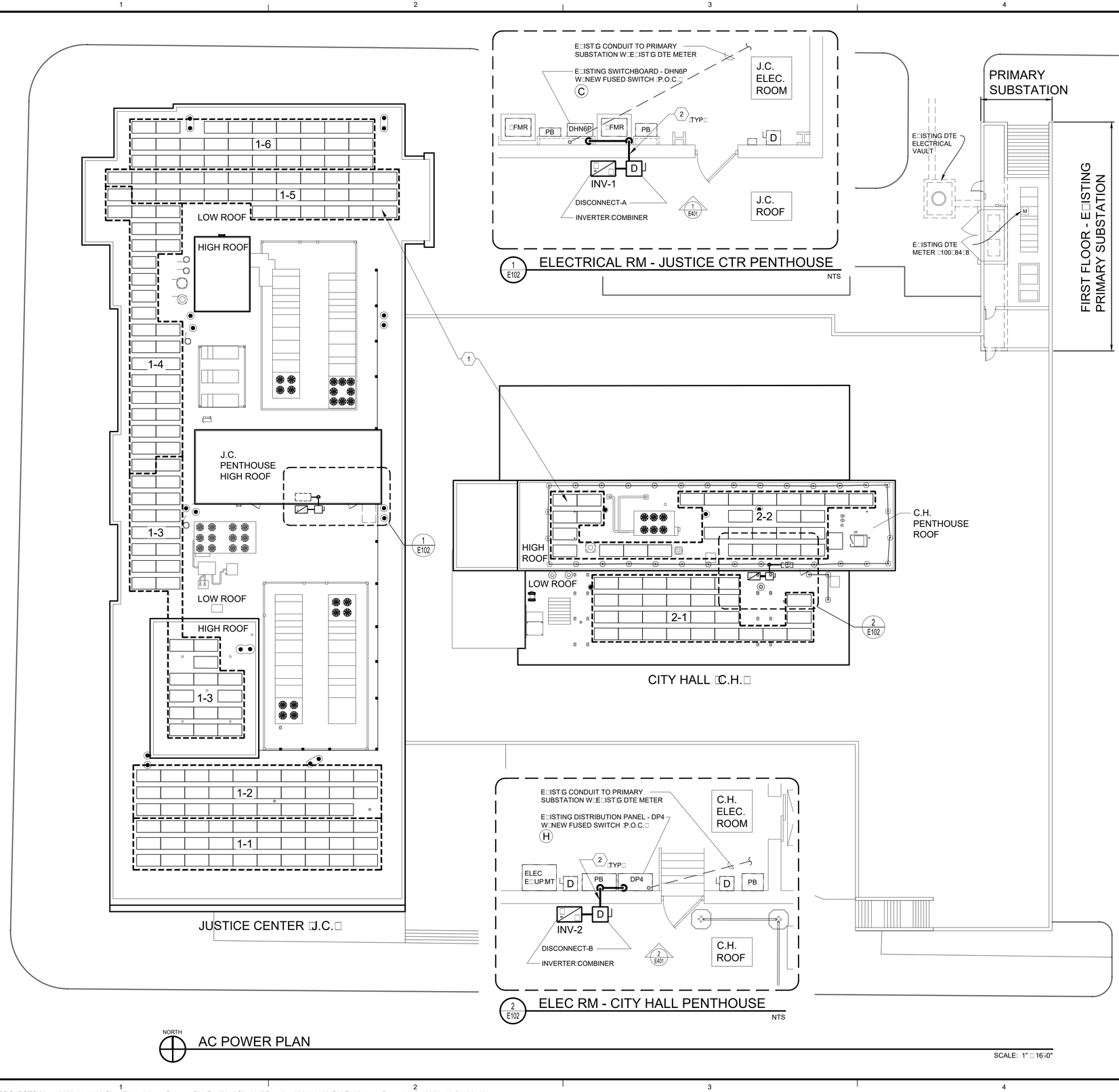
301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

ELECTRICAL PLAN

PROJECT NUMBER
23-11-1168-CH

DRAWN BY	SHEET NUMBER
RGM, GAK	E101
SCALE: AS NOTED	
SHEET SIZE: 22x34	



SHEET GENERAL NOTES

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2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN E□UIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.

SHEET KEY NOTES

1. 135.14 kW DC SOLAR ARRAY □101.5 kW DC □J.C.□□ 33.64 kW DC □C.H.□□
2. SEE CONDUIT AND WIRE SI□E CHART ON SHEET E601.

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
A□IMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
□ / □	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER
XFMR	TRANSFORMER
	AC WIRING CONDUIT
□P.O.C.□	POINT OF CONNECTION

0 8□ 16□ 32□
SCALE: 1" □ 16□

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ISSUED

DATE	DESCRIPTION	APPVD.
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CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL & JUSTICE CENTER

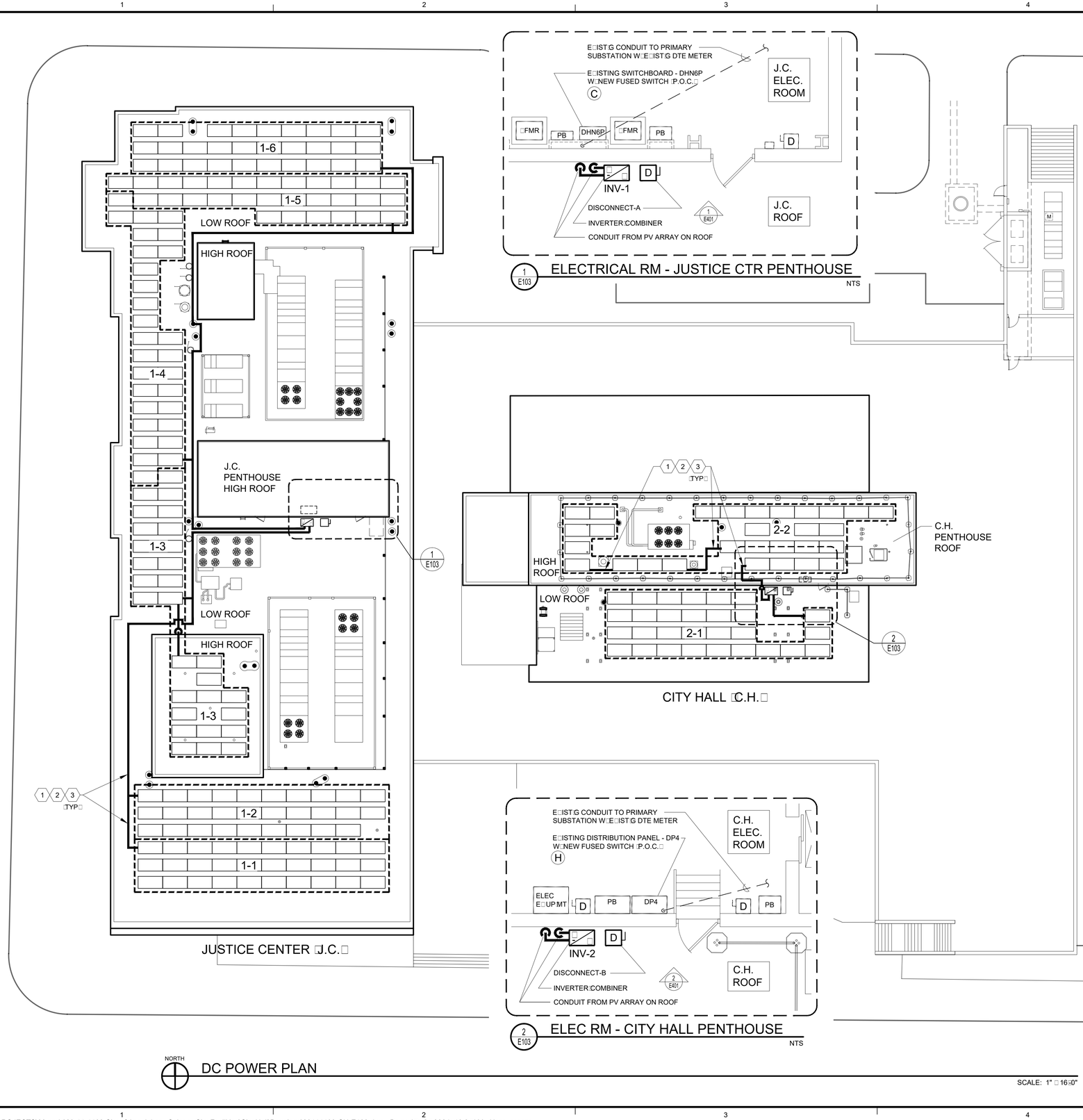
301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

AC POWER PLAN

PROJECT NUMBER: 23-11-1168-CH

DRAWN BY	SHEET NUMBER
RGM, GAK	E102
SCALE: AS NOTED	
SHEET SI□E: 22□34	



SHEET GENERAL NOTES

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SHEET KEY NOTES

1. DC HOME RUNS UNDER MODULES: PV WIRING SHALL BE SECURED VIA HEYCO CABLE CLIPS OR E(UAL.
2. DC HOME RUNS NOT UNDER MODULES, AND AC WIRING: WIRING SHALL BE IN CONDUIT PER CODE, SEE VERTICAL CONDUIT SUPPORT (WALL) AND CONDUIT SUPPORT DETAILS (ROOF) ON SHEET E501.
3. SEE CONDUIT AND WIRE SI(E CHART ON SHEET E601.

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
A(IMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
(/)	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER
XFMR	TRANSFORMER
———	DC WIRING CONDUIT
(P.O.C.)	POINT OF CONNECTION

0 8(16(32(
SCALE: 1" (16(

NOVA Cons(ltants, Inc.
21580 No(i Road
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No(i, MI 483(5
Phone: (248(34(-3512
Fa(: (248(34(-4152
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DATE	DESCRIPTION	APPVD.
6-2(-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL & JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

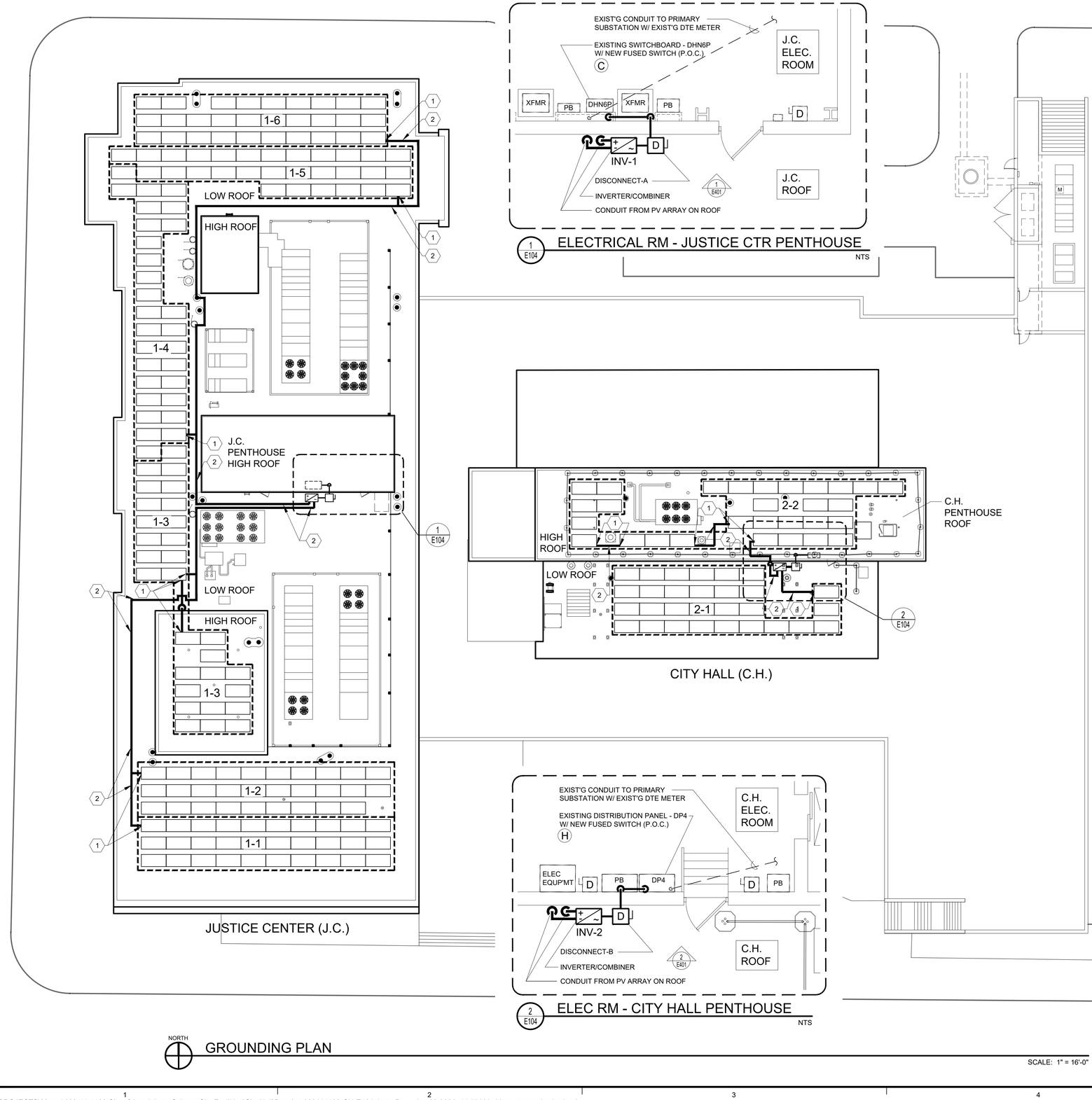
110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

DC POWER PLAN

PROJECT NUMBER: 23-11-1168-CH

DRAWN BY	SHEET NUMBER
RGM, GAK	E103
SCALE: AS NOTED	
SHEET SI(E: 22(34	

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\City Hall\Drawings\23111168-CH-E103.dwg Date: J(n 2(, 2024; 10:2(AM User: george



SHEET GENERAL NOTES

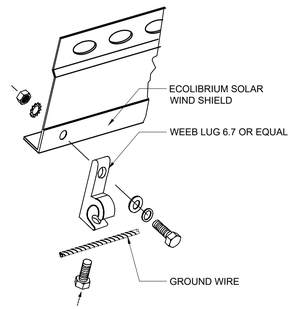
1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS..
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. CONDUIT FILL TO BE LESS THAN 40%.
4. CONTRACTOR TO VERIFY THAT MODULES ARE COMPATABLE WITH RACKING SYSTEM FOR ADEQUATE BONDING AND GROUNDING.
5. CONTRACTOR TO VERIFY WITH RACKING MANUFACTURER THE NUMBER OF GROUNDING LUGS REQUIRED. 1 LUG PER. CONTINUOUS ARRAY, NOT TO EXCEED 150' x 150'.
6. SOLAR PV WIRING METHODS AND WIRING SYSTEMS TO BE INSTALLED GROUNDING COMPLIANT WITH ARTICLE 250 PER NEC 690, PARTS IV AND V.
7. SEE SHEET E501 FOR GROUNDING DETAILS 2

SHEET KEY NOTES

1. INSTALL GROUND LUG PER MANUFACTURER SPECIFICATIONS
2. RACK TO RACK GROUNDING BARE #6 CU. RACK TO INVERTER GROUNDING USE GREEN USE-2 #6 CU

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
AZIMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS



3 E104 GROUNDING LUG DETAIL
SCALE: N.T.S.

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
± ~	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER
XFMR	TRANSFORMER
	GROUND WIRE
(P.O.C.)	POINT OF CONNECTION

0 8' 16' 32'
SCALE: 1" = 16'

NOVA Consultants, Inc.
21580 Novi Road
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Novi, MI 48375
Phone: (248) 347-3512
Fax: (248) 347-4152
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DATE	DESCRIPTION	APPVD.
6-29-2024	BID REVIEW	
1-27-2025	ADDENDUM-2 2	

REVISED

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CERTIFICATION

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SOLAR FACILITIES

CITY HALL & JUSTICE CENTER

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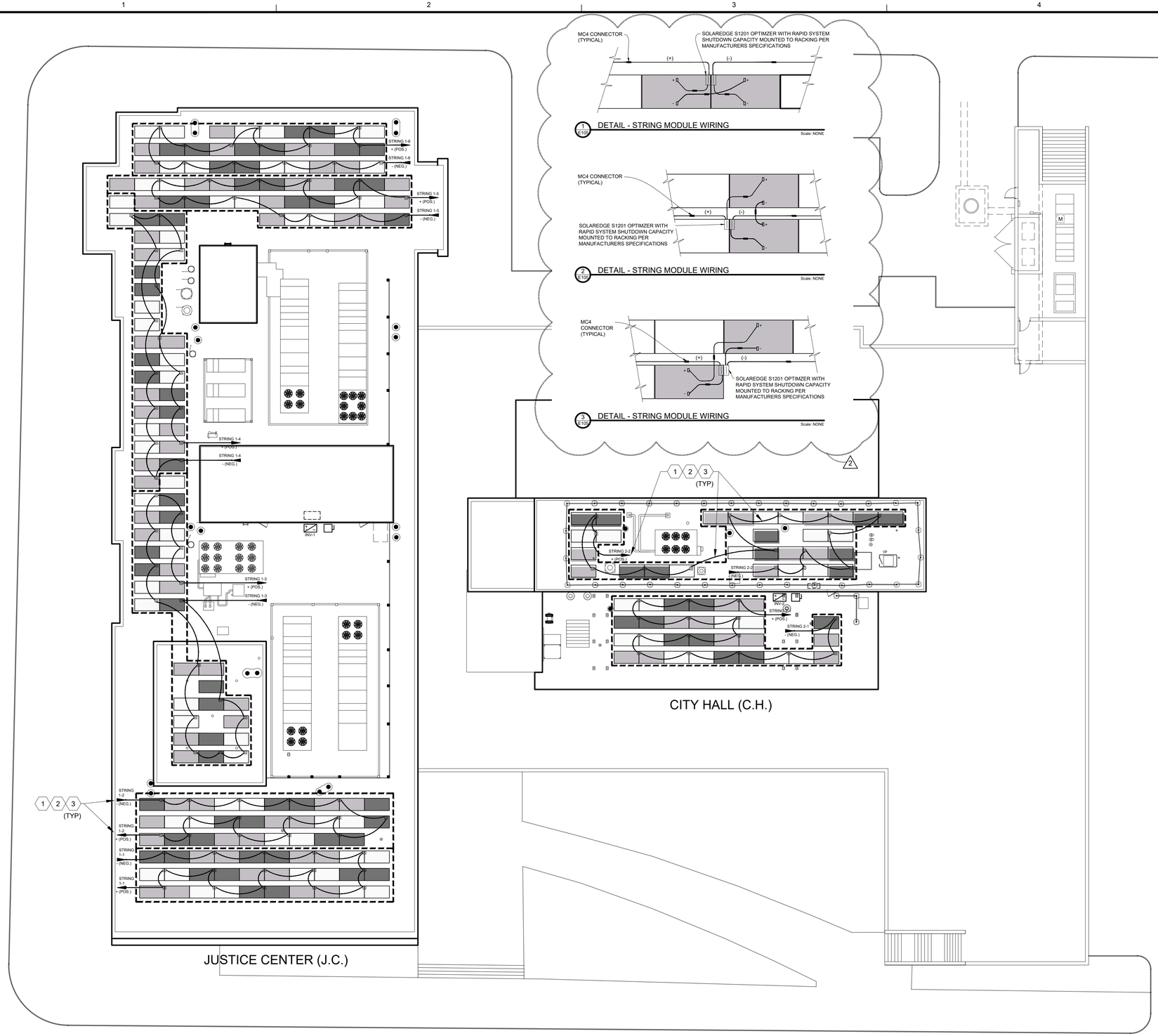
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

GROUNDING PLAN

PROJECT NUMBER	23-11-1168-CH
DRAWN BY	RGM, GAK
SCALE	AS NOTED
SHEET SIZE	22x34
SHEET NUMBER	E104



NORTH

PV WIRING PLAN

SCALE: 1" = 16'-0"

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.
4. PANEL MODULE PAIRS ARE WIRED IN SERIAL. POSITIVE OF FIRST PANEL TO NEGATIVE OF SECOND PANEL WITH REMAINING PANEL FEEDS CONNECTED TO S1201 OPTIMIZERS. 2

SHEET KEY NOTES

1. DC HOME RUNS UNDER MODULES: PV WIRING SHALL BE SECURED VIA HEYCO CABLE CLIPS OR EQUAL.
2. DC HOME RUNS NOT UNDER MODULES, AND AC WIRING: WIRING SHALL BE IN CONDUIT PER CODE, SEE VERTICAL CONDUIT SUPPORT (WALL) AND CONDUIT SUPPORT DETAILS (ROOF) ON SHEET E501.
3. SEE CONDUIT AND WIRE SIZE CHART ON SHEET E601.

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
AZIMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

PV SYSTEM DESCRIPTION - ANALYSIS

JUSTICE CENTER : INV-1 (80 kW AC)	175 MODULES WITH 90 OPTIMIZERS DC = 101.5 kW DC INV-1 DC TO AC RATIO = 1.27
CITY HALL : INV-2 (30 kW AC)	58 MODULES WITH 30 OPTIMIZERS DC = 33.64 kW DC INV-2 DC TO AC RATIO = 1.12

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
+ ~	INVERTER
D	DISCONNECT
M	METER
	STRING WIRING

0 8' 16' 32'
SCALE: 1" = 16'

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1-27-2025	ADDENDUM-2 2	

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CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

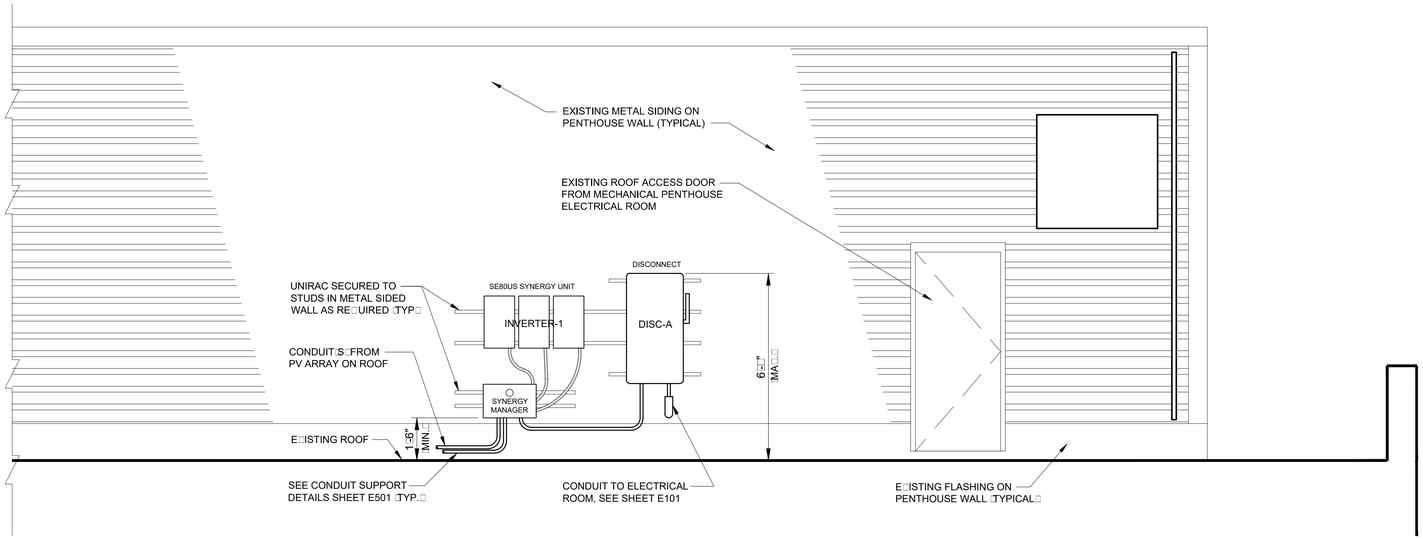
CITY HALL &
JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

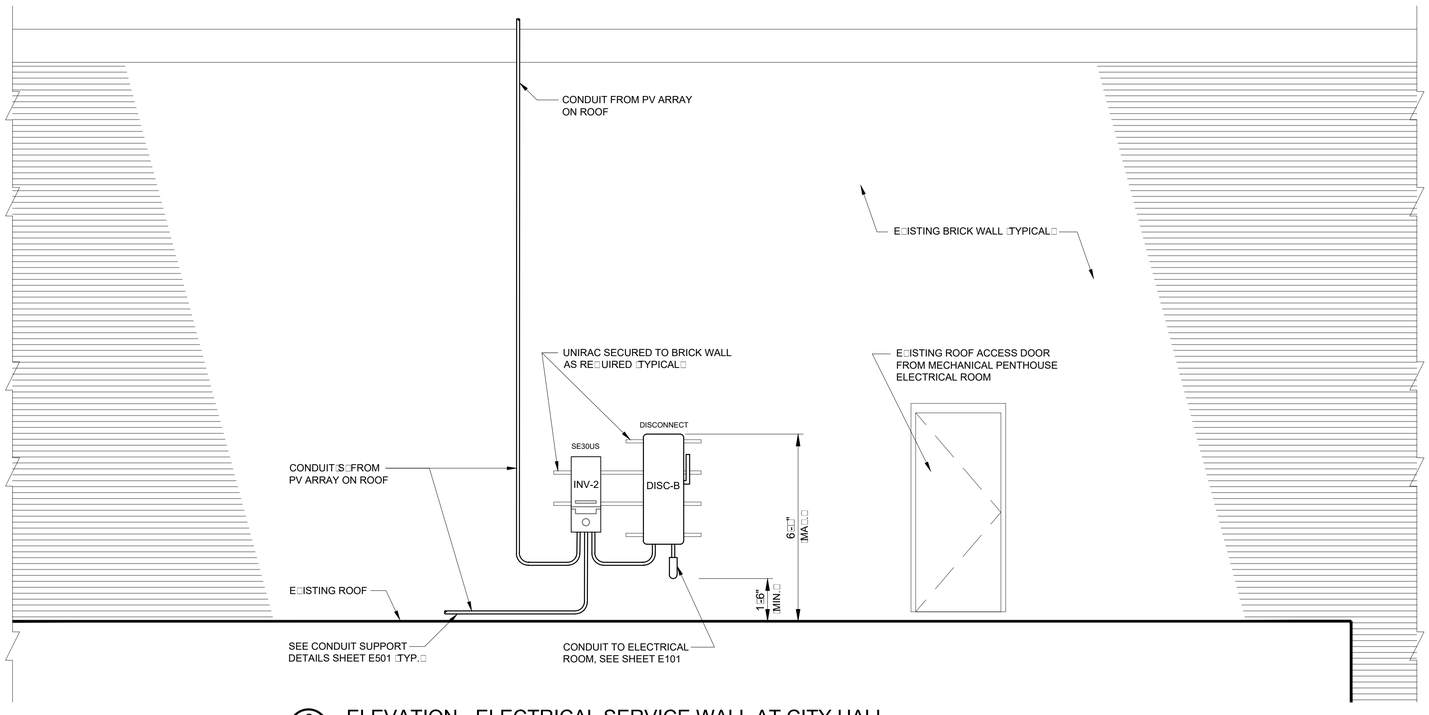
PV WIRING PLAN

PROJECT NUMBER	
23-11-1168-CH	
DRAWN BY: RGM, GAK	SHEET NUMBER: E105
SCALE: AS NOTED	
SHEET SIZE: 22x34	



1 / E401 ELEVATION - ELECTRICAL SERVICE WALL AT JUSTICE CENTER

SCALE: 3/8" = 1'-0"



2 / E401 ELEVATION - ELECTRICAL SERVICE WALL AT CITY HALL

SCALE: 3/8" = 1'-0"

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC) 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. FIELD ADJUST THE ARRAY LAYOUT BASED SITE OBSTRUCTIONS IF NECESSARY.
3. SITE PLAN BASED ON INFORMATION PROVIDED BY OWNER.

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RGM	JE

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SOLAR FACILITIES

CITY HALL & JUSTICE CENTER

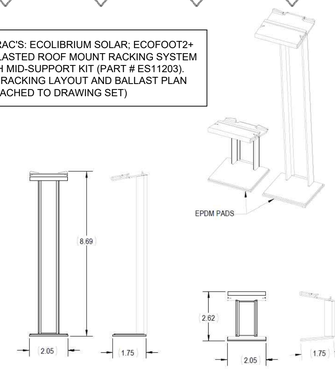
301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

EQUIPMENT RACK ON ROOF

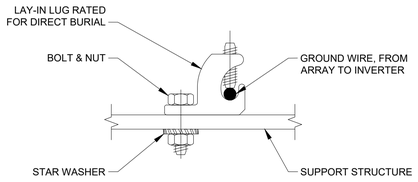
PROJECT NUMBER	
23-11-1168-CH	
DRAWN BY: GAK	SHEET NUMBER: E401
SCALE: AS NOTED	
SHEET SIZE: 22x34	

UNIRAC'S: ECOLIBRIUM SOLAR; ECOFOOT2+ BALLASTED ROOF MOUNT RACKING SYSTEM WITH MID-SUPPORT KIT (PART # ES11203). SEE RACKING LAYOUT AND BALLAST PLAN (ATTACHED TO DRAWING SET)



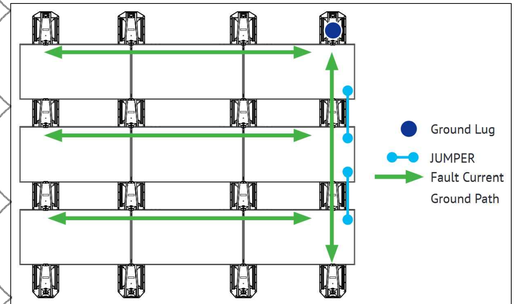
12 E501 MID-SUPPORT KIT

RACK	LUG	HARDWARE
GALVANIZED STEEL	COPPER	GALVANIZED STEEL
ALUMINUM	STAINLESS OR TIN-PLATED COPPER	STAINLESS STEEL
STAINLESS STEEL	COPPER, STAINLESS OR TIN-PLATED COPPER	STAINLESS STEEL



9 E501 GROUNDING DETAIL - MECH. / ELEC.

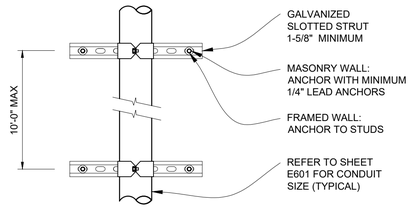
SCALE: NONE



Wind Deflectors carry module-to-module East/West ground bond. Bonding jumpers carry row-to-row North/South ground bond.

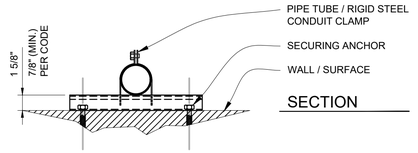
13 E501 MANUFACTURERS GROUNDING PLAN DET.

SCALE: N.T.S.



PLAN VIEW

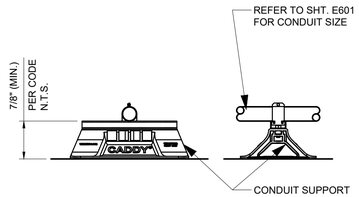
NOTE:
SUPPORT CONDUIT PER NEC 2023
MINIMUM EVERY 10'-0"



SECTION

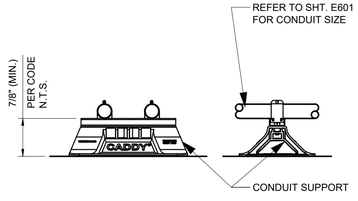
1 E501 VERTICAL CONDUIT SUPPORT - WALL

N.T.S.



2 E501 CONDUIT SUPPORT DETAIL - ROOF

N.T.S.



3 E501 CONDUIT SUPPORT DETAIL - ROOF

N.T.S.

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. CONDUIT FILL TO BE LESS THAN 40%.

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1-27-2025	ADDENDUM-2	

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RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

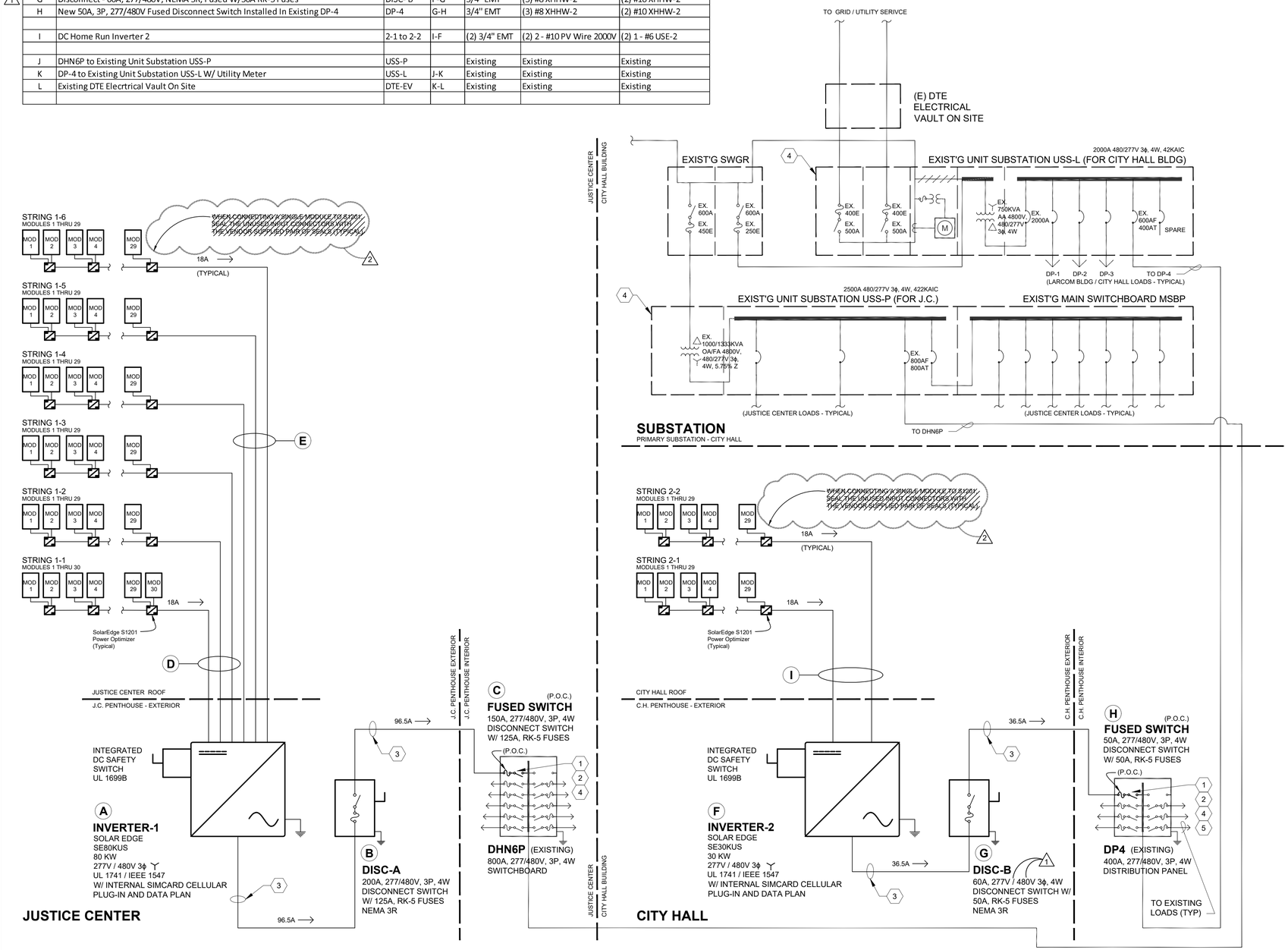
110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

ELECTRICAL DETAILS

PROJECT NUMBER	
23-11-1168-CH	
DRAWN BY: RGM, GAK	SHEET NUMBER: E501
SCALE: AS NOTED	
SHEET SIZE: 22x34	

CONDUIT AND WIRE SIZE CHART

Item	Description	Label	Route	Conduit	Wire (CU)	Neutral/Ground (CU)
	Justice Center					
A	Inverter - 80kW, 277/480V and DC Combiner Box	INV-1				
B	Disconnect - 200A, 3P, 277/480V, NEMA 3R, Fused W/125A RK-5 Fuses	DISC- A	A-B	1 1/4" EMT	(3) #1 XHHW-2	(2) #6 XHHW-2
C	New 277/480V, 3P, 150A Fused Switch Switch Installed In Existing DHN6P W/ 125A RK-	DHN6P	B-C	1 1/4" EMT	(3) #1 XHHW-2	(2) #6 XHHW-2
D	DC Home Runs Inverter 1	1-1 to 1-3	D-A	1 1/4" EMT	(6) - #10 PV Wire 2000V	(1) - #6 USE-2
E	DC Home Runs Inverter 1	1-4 to 1-6	E-A	1 1/4" EMT	(6) - #10 PV Wire 2000V	(1) - #6 USE-2
	City Hall					
F	Inverter - 30kW, 277/480V and DC Combiner Box	INV-2				
G	Disconnect - 60A, 277/480V, NEMA 3R, Fused W/50A RK-5 Fuses	DISC- B	F-G	3/4" EMT	(3) #8 XHHW-2	(2) #10 XHHW-2
H	New 50A, 3P, 277/480V Fused Disconnect Switch Installed In Existing DP-4	DP-4	G-H	3/4" EMT	(3) #8 XHHW-2	(2) #10 XHHW-2
I	DC Home Run Inverter 2	2-1 to 2-2	I-F	(2) 3/4" EMT	(2) 2 - #10 PV Wire 2000V	(2) 1 - #6 USE-2
J	DHN6P to Existing Unit Substation USS-P	USS-P		Existing	Existing	Existing
K	DP-4 to Existing Unit Substation USS-L W/ Utility Meter	USS-L	J-K	Existing	Existing	Existing
L	Existing DTE Elecrtrical Vault On Site	DTE-EV	K-L	Existing	Existing	Existing



A1 ONE LINE DIAGRAM

NO SCALE

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), AND ALL APPLICABLE LOCAL CODES AND STANDARDS.

2. THE INVERTERS INCLUDE RESIDUAL CURRENT DETECTION GFCI AS PART OF THE DC GROUND FAULT DETECTION METHOD REQUIRED BY UL 1741.

3. ARTICLE 310.15(B)(2) EXCEPTION: TYPE XHHW-2 INSULATED CONDUCTORS SHALL NOT BE SUBJECT TO THIS AMPACITY ADJUSTMENT PER 310.15

4. DC CONDUCTORS SHALL BE DERATED PER 310.15

5. SOLAREDGE INVERTERS ARE CERTIFIED UL 1699B FOR ARC FAULT PROTECTION PER SECTION 690.11

6. INVERTER INCLUDES ANTI-ISLANDING PROTECTION COMPLIANT WITH UL 1741 AND IEEE 1547 PER NEC 690.

7.CONTRACTOR TO FIELD VERIFY THAT ALL LISTED GROUNDING ELECTRODES ARE PRESENT AND PROPERLY TERMINATED ON SITE.

8. CONTRACTOR TO VERIFY THAT ALL CIRCUIT BREAKERS ARE SUITABLE FOR BACKFEED

SHEET KEY NOTES

1. AC GROUNDING CONNECTIONS TO DHN6P AND DP4 PROVIDES CONNECTION TO BUILDING GROUNDING ELECTRODE SYSTEM. GROUNDING CONDUCTORS AND BONDING JUMPERS TO BE INSTALLED TO COMPLY WITH ARTICLE 250.

2. NEW LOAD SIDE CONNECTION POWER PRODUCTION CONDUCTORS MUST MEET NEC 690, 705.12, AN UNGROUNDED CONDUCTOR SHALL BE INSTALLED AT THE POINT WHERE THE ELECTRIC POWER PRODUCTION CONDUCTORS ARE CONNECTED TO THE SERVICE.

3. REFER TO CHART ON E-601 FOR CONDUIT AND WIRE SIZES.

4. INSTALL PLACARD SHOWING LOCATIONS OF DISCONNECT AND SOLAR ARRAY.

5. CIRCUIT BREAKERS WITH A CURRENT RATING OF 125 A OR LESS MUST BE MARKED AS SUITABLE FOR 75°C OR 60°/75°C RATED CONDUCTORS. BREAKERS TO BE RATED FOR 25 KAIC OR GREATER.

6. PER NEC 705.28(C)(2), A CONDUCTOR USED SOLELY FOR INSTRUMENTATION, VOLTAGE, DETECTION, OR PHASE DETECTION AND CONNECTED TO A SINGLE-PHASE OR THREE-PHASE 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.

PV SYSTEM DESCRIPTION - COMBINED SUMMARY

FOR TOTAL SYSTEM:

PV MODULE MODEL:	JINKO SOLAR (EAGLE), JKM580N-72HL4-BDV
PV MODULE SIZE:	89.69" L X 44.65" W X 1.18" D
NUMBER OF MODULES:	233
PV MODULE P_{MAX}:	580 W
OPTIMIZERS: (120)	SOLAR EDGE S1201(DUAL OPTIMIZER)
INVERTERS : (2)	1. SOLAR EDGE SE80KUS (80 kW) 2. SOLAR EDGE SE30KUS (30 kW)
NO. OF STRINGS PER INVERTER:	INV #1 (6 STRINGS)
NO. OF STRINGS PER INVERTER:	INV #2 (2 STRINGS)
DC TO AC RATIO:	1.23
NUMBER OF STRINGS:	8
TOTAL NAMEPLATE SIZE:	135.14 kW DC 110.0 kW AC

NOTE: PV SYSTEM IS 1000 V DC (MAX.)

PV SYSTEM DESCRIPTION - SECTION 1

JUSTICE CENTER : INV-1 (80 kW AC)	175 MODULES W/ 90 OPTIMIZERS (101.5 kW DC) DC TO AC RATIO = 1.27
CITY HALL : INV-2 (30 kW AC)	58 MODULES W/ 30 OPTIMIZERS (33.64 kW DC) DC TO AC RATIO = 1.12

LEGEND

	DISCONNECT SWITCH
	TRANSFORMER
	FUSE
	GROUND
1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
(P.O.C.)	POINT OF CONNECTION

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Fax: (248) 347-4152

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ISSUED

DATE	DESCRIPTION	APPVD.
6-27-2024	INTERCONNECT	
6-29-2024	BID REVIEW	
7-16-2024	INTERCONNECT REV 1	
1-27-2025	ADDENDUM-2	

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SOLAR FACILITIES

CITY HALL & JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

ONE LINE DIAGRAM

PROJECT NUMBER
23-11-1168-CH

DRAWN BY: GAK
SCALE:
SHEET SIZE: 22x34
SHEET NUMBER: E601

PHOTOVOLTAIC SYSTEM DISCONNECT

LABEL 1

EACH PV STSTEM DISCONNECTING MEANS MUST BE LABELED WITH THIS PLACARD

WARNING

ELECTRIC SHOCK HA□ARD

DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND LOAD SIDES MAY BE ENERGI□ED IN THE OPEN POSITION

LABEL 2

THE UTILITY METERING CABINET, EACH INVERTER, EACH DC AND AC DISCONNECTING MEANS □SWITCHES AND BREAKERS□MUST BE LABELED WITH THIS PLACARD

WARNING

ELECTRIC SHOCK HA□ARD

IF GROUND FAULT IS INDICATED ALL NORMALLY GROUNDED CONDUCTORS MAY BE UNGROUNDED AND ENERGI□ED

LABEL 3

PHOTOVOLTAIC SYSTEM DC DISCONNECT

MA□ SYSTEM DC VOLTAGE		1000 V
SHORT CIRCUIT DC CURRENT	80kW INV-1	□6.5 A

LABEL 4A

INVERTER DC DISCONNECT MUST BE LABELED WITH THIS PLACARD
TOP OF LABEL IS WHITE ON BLACK, BOTTOM IS BLACK ON WHITE

PHOTOVOLTAIC SYSTEM DC DISCONNECT

MA□ SYSTEM DC VOLTAGE		1000 V
SHORT CIRCUIT DC CURRENT	30kW INV-2	45 A

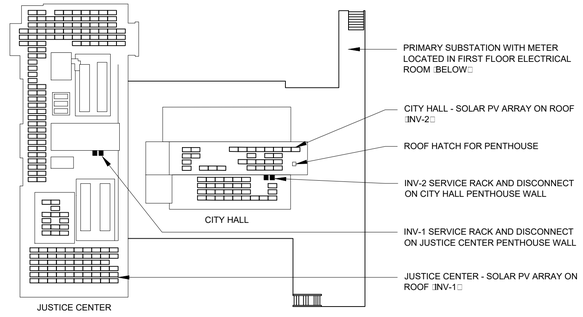
LABEL 4B

INVERTER DC DISCONNECT MUST BE LABELED WITH THIS PLACARD
TOP OF LABEL IS WHITE ON BLACK, BOTTOM IS BLACK ON WHITE

CAUTION

POWER TO THIS FACILITY IS ALSO SUPPLIED FROM THE FOLLOWING SOURCES WITH DISCONNECTS AS SHOWN:

NORTH



LABEL 6

INSTALL MAP PLACARD AS PER UTILITY RE□UIREMENTS, SIGNAGE SHALL BE RED BACKGROUND WITH WHITE ENGRAVED LETTERS: □CAUTION ¾", POWER TO...¾"□ CALL OUTS ⅜"□

THIS LABEL TO BE INSTALLED ON DISCONNECT DISC-MAIN□S□

WARNING

DUAL POWER SUPPLY

SOURCES UTILITY GRID AND PV SOLAR ELECTRIC SYSTEM

LABEL □

E□UIPMENT BACK FED FROM PHOTOVOLTAIC SYSTEMS MUST BE LABELED WITH THIS PLACARD INCLUDING BOTH 480 V. DISCONNECTS AND PRIMARY SWITCH AT SUBSTATION

PHOTOVOLTAIC SYSTEM AC POINT OF INTERCONNECTION

RATED AC OUTPUT CURRENT	□6.5 A
NOMINAL OPERATING AC VOLTAGE	480 VAC
80kW INV-1	

LABEL 5A

INTERACTIVE SYSTEM POINT OF INTERCONNECTION □DHN6P□ MUST BE LABELED WITH THIS PLACARD
TOP OF LABEL IS WHITE ON BLACK, BOTTOM IS BLACK ON WHITE

PHOTOVOLTAIC SYSTEM AC POINT OF INTERCONNECTION

RATED AC OUTPUT CURRENT	36.5 A
NOMINAL OPERATING AC VOLTAGE	480 VAC
30kW INV-2	

LABEL 5B

INTERACTIVE SYSTEM POINT OF INTERCONNECTION □DP4□ MUST BE LABELED WITH THIS PLACARD
TOP OF LABEL IS WHITE ON BLACK, BOTTOM IS BLACK ON WHITE

PHOTOVOLTAIC SOLAR BREAKER

DO NOT RELOCATETHIS OVERCURRENT DEVICE

LABEL 8

LABEL □

WARNING

THIS E□UIPMENT FED BY MULTIPLE SOURCES. TOTAL RATING OF ALL OVERCURRENT DEVICE SHALL NOT E□CEED AMPACITY OF BUSSBAR

LABEL 10

PHOTOVOLTAIC SYSTEM kWH METER

LABEL 11

AC DISCONNECT

LABEL 12

EACH AC DISCONNECTING MEANS MUST BE LABELED WITH THIS PLACARD

DC DISCONNECT

LABEL 13

EACH DC DISCONNECTING MEANS MUST BE LABELED WITH THIS PLACARD

CAUTION

PV OUTPUT CIRCUIT

LABEL 14

CAUTION

INVERTER OUTPUT CIRCUIT

LABEL 15

PHOTOVOLTAIC SYSTEM E□UIPPED WITH RAPID SHUTDOWN

LABEL 16

INVERTER AND P.O.I.

DC PHOTOVOLTAIC SOURCE CIRCUIT

LABEL 1□

CAUTION SOLAR CIRCUIT

LABEL 1□

NOVA Cons□ltants, Inc.
21580 No□ Road
S□ite 300
No□, MI 483□5
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www.no□acons□ltants.co□

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DATE	DESCRIPTION	APPVD.
6-2□-2024	BID REVIEW	

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CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

LABELS AND PLACARDS

PROJECT NUMBER 23-11-1168-CH

DRAWN BY GAK | SHEET NUMBER E□01

SCALE

SHEET SI□E 22□34

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\City Hall\Drawings\23111168-CH-E□01.dwg Date: J□n 2□2024; 11:14AM User: george

1. BASIC ELECTRICAL RE□UIREMENTS

A. FURNISH AND INSTALL THE MATERIAL, E□UIPMENT AND SYSTEMS COMPLETE AS SPECIFIED AND□OR INDICATED ON THE DRAWINGS.

B. COMPLY WITH THE 2023 NATIONAL ELECTRICAL CODE □NEC□AND ALL APPLICABLE MUNICIPAL, STATE, LOCAL CODES.

C. OBTAIN ALL APPLICABLE PERMITS INCLUDING BUILDING AND ELECTRICAL, LICENSES AND INSPECTIONS AS RE□UIRED.

D. ALL MATERIALS AND E□UIPMENT SHALL BE LISTED AND LABELED BY UL OR OTHER NATIONALLY RECOGNI□ED TESTING LABORATORY.

E. SUBMIT SHOP DRAWINGS, WIRING DIAGRAMS, SPECIFICATIONS, OPERATING DATA, AND□OR CATALOG CUTS FOR ALL E□UIPMENT.

F. FOLLOW □UALITY ASSURANCE PROJECT PLAN □APP□ STARTUP AND COMMISSIONING PROTOCOL.

G. UPON COMPLETION OF THE ELECTRICAL INSTALLATION, THE CONTRACTOR SHALL DELIVER TO NOVA ONE □1□ SET OF PRINTS OF AS-BUILT CONTRACT DRAWINGS SHOWING ALL ADDITIONS AND CHANGES DURING THE INSTALLATION. THESE DRAWINGS SHALL BE SUITABLE FOR USE IN PREPARATION OF RECORD DRAWINGS.

2. BASIC ELECTRICAL MATERIALS AND METHODS.

A. RACEWAYS

INSTALL ALL WIRING IN CONDUIT EXCEPT AS OTHERWISE INDICATED. MINIMUM CONDUIT SIZE TO BE ¾". CONDUIT SHALL BE RIGID GALVANI□ED STEEL ABOVE GROUND AND WHERE USED AS ELBOWS AND STUB-UPS UNDERGROUND. ELECTRICAL METALLIC TUBING □EMT□MAY BE INSTALLED ABOVE GROUND WHERE NOT SUBJECT TO DAMAGE. UNDERGROUND CONDUIT SHALL BE SCHEDULE 40 PVC. INSTALL CONDUITS PARALLEL AND PERPENDICULAR TO WALLS AND OTHER SURFACES. CLEAN, CAP, AND PROVIDE A PULL STRING IN EACH CONDUIT TO BE LEFT EMPTY.

B. BO□ES

JUNCTION BO□ES AND PULL BO□ES SHALL BE STAMPED STEEL OR CAST ALUMINUM, UL LISTED FOR THE APPLICATION.

C. DISCONNECT SWITCHES

UNLESS OTHERWISE INDICATED, DISCONNECT SWITCHES USED INDOORS SHALL HAVE A NEMA 12 ENCLOSURE AND DISCONNECT SWITCHES USED OUTDOORS SHALL HAVE A NEMA 3R ENCLOSURE. DISCONNECT SWITCHES SHALL BE PAD LOCKABLE IN THE OPEN POSITION.

D. GROUNDING

PROVIDE GROUNDING OF THE ENTIRE ELECTRICAL SYSTEM IN ACCORDANCE WITH NEC ARTICLE 250.

PROVIDE E□UIPMENT GROUNDING CONDUCTORS IN ALL BRANCH CIRCUITS AND ALL FEEDERS.

GROUNDING CONDUCTORS SHALL BE CLASS B STRANDED COPPER, GREEN INSULATED. TERMINATE EACH END USING A SUITABLE LISTED CONNECTOR.

BOND PV MODULES AS SHOWN ON THE DRAWINGS. CONNECT BONDING PIGTAILS TO MODULES PER MANUFACTURER'S INSTRUCTIONS. WHERE USED LUGS SHALL BE UL LISTED FOR DIRECT BURIAL.

GROUNDING ELECTRODES □GROUND RODS□SHALL BE COPPER-CLAD STEEL, MINIMUM 5/8" DIAMETER AND 8 FT. LONG.

BOND TOGETHER METAL STRUCTURES PER NEC 250.110.

E. WIRE AND CABLE

1□ WIRE FOR AC CIRCUITS SHALL BE RATED □0 DEGREES C WET OR DRY AND SHALL BE STRANDED COPPER WIRES, TYPE THHN□THWN-2 AND RATED 600V.

2□ WIRE FOR MEDIUM VOLTAGE SHALL BE 1C-15kV CLASS.

3□ WIRE FOR DC CIRCUITS SHALL BE RATED □0 DEGREES C WET OR DRY AND SHALL BE STRANDED COPPER. ALL DC WIRING NOT IN RACEWAY SHALL BE INSULATED TYPE USE-2 OR PV RATED TO 2000V.

4□ DC E□UIPMENT GROUNDING CONDUCTOR SHALL BE MINIMUM OF □6 AWG COPPER AND BE MECHANICALLY ATTACHED TO EACH PV RACKING STRUCTURE UNLESS OTHERWISE NOTED.

5□ NO SPLICES SHALL BE MADE E□CEPT WITHIN BO□ES UL LISTED FOR THE PURPOSE.

F. SENSORS AND SENSOR WIRING

1□ FURNISH AND INSTALL PYRANOMETERS, TEMPERATURE SENSORS, ETC. AS RE□UIRED AND AS SHOWN ON DRAWINGS. ALL WIRING USED FOR CONTROLS AND MONITORING SHALL BE APPROVED BY NOVA.

3. DATA AND COMMUNICATIONS SYSTEMS

A. ALL DATA AND COMMUNICATIONS WIRING □INCLUDING CELL MODEMS□SHALL BE COORDINATED WITH THE CITY OF ANN ARBOR AND INSTALLED BY ELECTRICAL CONTRACTOR OR AS DIRECTED BY NOVA.

4. IDENTIFICATION AND LABELS

A. ALL WIRES SHALL BE LABELED AT EACH END.

B. ALL E□UIPMENT MUST BE LABELED PER NEC ARTICLE 6□0 AND SHEET E-□01.

C. PROVIDE LABEL ON EACH PIECE OF E□UIPMENT, SUCH AS INVERTER, COMBINER BO□ES, DISCONNECT SWITCHES, ETC. THE LABEL SHALL IDENTIFY THE E□UIPMENT BY THE NAME USED ON THE DRAWINGS, SUCH AS INVERTERS, COMBINER BO□ES, DISCONNECT SWITCHES.

5. PV SYSTEM E□UIPMENT

A. PV MODULES:

1□ JINKO SOLAR □EAGLE□JKM580N-□2HL4-BDV □580W□

a. MA□ POWER OUTPUT: P□ a□□580W AT STC

b. VOLTAGE AT MA□ POWER: V□ p □42.5□V

c. OPEN CIRCUIT VOLTAGE: Voc □51.4□V

d. CURRENT AT MA□ POWER: I □pp □13.62A

e. SHORT CIRCUIT CURRENT: I sc □14.3□A

2□ MODULES PER STRING □ 2□ □TYPICAL□ E□CEPTION STRING 1-1 □30 MODULES

3□ STRINGS PER INVERTER □6 □INV. □1□□2 □INV. □2□

4□ NUMBER OF STRINGS □8

5□ No. OF MODULES □233

6□ NEG LEAD LENGTH □LANDSCAPE□□ 55.12"

□□ POS LEAD LENGTH □LANDSCAPE□□ 55.12"

B. POWER OPTIMI□ER

1□ SOLAREDGE S1201 □DUAL OPTIMI□ER□

2□ INPUT WIRE LENGTH IN FEET

INPUT 1	OUTPUT
5.25□	□□□ 1□38□□□0.32□

3□ RATED INPUT DC POWER □ 1200W

4□ USE WITH 2 MODULES CONNECTED IN PARALLEL

5□ PHOTOVOLTAIC RAPID SHUTDOWN SYSTEM, COMPLIANT WITH NEC 2014, 201□, 2023

C. TOTAL ARRAY:

1□ DC NAMEPLATE RATING: □233 □580□□ 135.14 kW

D. RACKING SYSTEM:

1□ UNIRAC'S ECOLIBRIUM SOLAR, ECOFOOT2□ WITH BALLAST

2□ MODULES TILTED 10 DEGREES

E. INVERTER

1□ SOLAREDGE SE 80K US □SE 30K US

2□ NUMBER OF INVERTERS □ 1 □1

3□ MEETS IEEE-154□, RULE 21, RULE 14 □HI□

4□ UL LISTED TO UL-1□41, UL-1□41 SA, UL-16□□B. CSA 2.22

5□ NOMINAL INPUT VOLTAGE DC□ TO DC- □ 850 VDC □INV-1□□850 VDC □INV-2□

6□ MA□IMUM INPUT VOLTAGE DC□ TO DC- □1000 VDC □EACH□

□□ MA□ INPUT CURRENT: □6.5A □INV-1□□36.25A □INV-2□

8□ NOMINAL OUTPUT VOLTAGE: 2□□480 VAC

□□ CONTINUOUS CURRENT OUTPUT: □6.5A □INV-1□□36.25A □INV-2□

10□MA□ CONTINUOUS OUTPUT POWER: 80kW □INV-1□□30kW □INV-2□

5. INSTALLATION

A.

1□ STORE MODULES IN MANUFACTURER'S PACKAGING UNTIL READY TO INSTALL.

2□ PREPARE SURFACE AND INSTALL PER MANUFACTURER'S RECOMMENDATIONS.

3□ ATTACH MODULE GROUNDING TERMINAL TO GROUNDING SYSTEM PER DRAWINGS.

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ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

ELECTRICAL
SPECIFICATIONS

PROJECT NUMBER
23-11-1168-CH

DRAWN BY
RGM, GAK

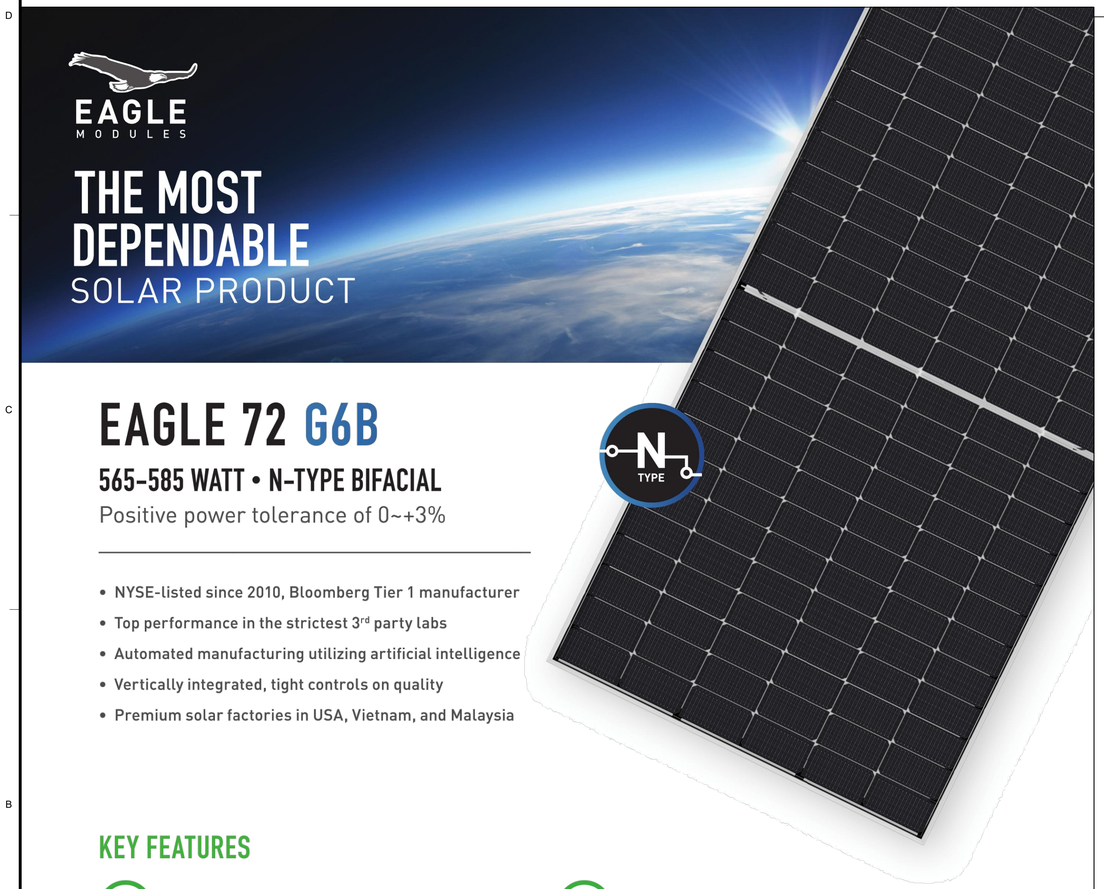
SCALE

SHEET SI□E
22□34

SHEET NUMBER
E□02

EAGLE MODULES

THE MOST DEPENDABLE SOLAR PRODUCT



EAGLE 72 G6B

565-585 WATT • N-TYPE BIFACIAL

Positive power tolerance of 0~+3%

- NYSE-listed since 2010, Bloomberg Tier 1 manufacturer
- Top performance in the strictest 3rd party labs
- Automated manufacturing utilizing artificial intelligence
- Vertically integrated, tight controls on quality
- Premium solar factories in USA, Vietnam, and Malaysia

KEY FEATURES

N-Type Technology
N-type cells offer Jinko's in-house TOPCon technology with better performance and improved reliability.

Multi Busbar Half Cell Technology
Better light trapping and current collection to improve module power output and reliability.

Bifacial Power Gain
N-Type architecture increases bifaciality for higher backside bonus and better lifetime yield.

Low Temperature Coefficient
Best in class temperature coefficient for highest lifetime energy yield in all climates.

Industrial Grade Construction
Fire Type 29 with optimized dual-glass construction and thick frame for highest mechanical load resistance.

Shade Tolerant
Twin array design allows continued performance even with shading by trees or debris.

Protected Against All Environments
Certified to withstand humidity, heat, rain, marine environments, wind, hailstorms, and packed snow.

Warranty
12-year product and 30-year linear power warranty.

- ISO9001:2015 Quality Standards
- ISO14001:2015 Environmental Standards
- IEC61215, IEC61730 certified products
- ISO45001: 2018 Occupational Health & Safety Standards
- UL61730 certified products

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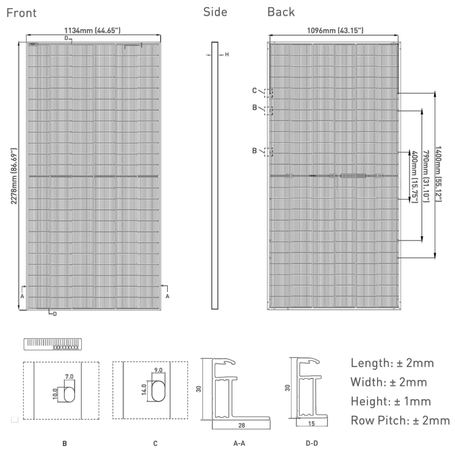
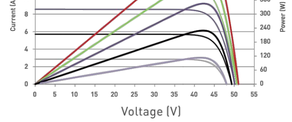
ENGINEERING DRAWINGS



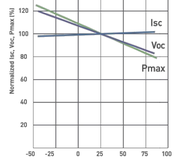
Length: ± 2mm
Width: ± 2mm
Height: ± 1mm
Row Pitch: ± 2mm

ELECTRICAL PERFORMANCE & TEMPERATURE DEPENDENCE

Current-Voltage & Power-Voltage Curves (585W)



Temperature Dependence of Isc, Voc, Pmax



MECHANICAL CHARACTERISTICS

No. of Half Cells	144 (2 x 72)
Dimensions	2278 x 1134 x 30mm (89.69 x 44.65 x 1.18in)
Weight	32kg (70.55lbs)
Front Glass	2.0mm, Anti-Reflection Coating
Back Glass	2.0mm, Heat Strengthened Glass
Frame	Anodized Aluminum Alloy
Junction Box	IP68 Rated
Output Cables	12 AWG, 1400mm (55.12in)
Fire Type	Type 29
Pressure Rating	5400Pa (Snow) & 2400Pa (Wind)

TEMPERATURE CHARACTERISTICS

Temperature Coefficients of Pmax	-0.29%/°C
Temperature Coefficients of Voc	-0.25%/°C
Temperature Coefficients of Isc	0.045%/°C
Nominal Operating Cell Temperature (NOCT)	45±2°C
Bifacial Factor	80±5%

MAXIMUM RATINGS

Operating Temperature (°C)	-40°C~+85°C
Maximum System Voltage	1500VDC
Maximum Series Fuse Rating	30A

PACKAGING CONFIGURATION

(Two pallets = One stack)

36pcs/pallets, 72pcs/stack, 720pcs/40 HQ Container

BIFACIAL OUTPUT-REARSIDE POWER GAIN

5%	Maximum Power (Pmax)	593Wp	599Wp	604Wp	609Wp	614Wp
	Module Efficiency (%)	22.97%	23.17%	23.37%	23.57%	23.78%
15%	Maximum Power (Pmax)	650Wp	656Wp	661Wp	667Wp	673Wp
	Module Efficiency (%)	25.15%	25.37%	25.60%	25.82%	26.05%
25%	Maximum Power (Pmax)	706Wp	713Wp	719Wp	725Wp	731Wp
	Module Efficiency (%)	27.34%	27.58%	27.82%	28.07%	28.31%

WARRANTY

12-year product and 30-year linear power warranty

1st year degradation not to exceed 1%, each subsequent year not to exceed 0.4%, minimum power at year 30 is 87.4% or greater.

ELECTRICAL CHARACTERISTICS

Module Type	JKM565N-72HL4-BDV		JKM570N-72HL4-BDV		JKM575N-72HL4-BDV		JKM580N-72HL4-BDV		JKM585N-72HL4-BDV	
	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax)	565Wp	425Wp	570Wp	429Wp	575Wp	432Wp	580Wp	436Wp	585Wp	440Wp
Maximum Power Voltage (Vmp)	42.14V	39.52V	42.29V	39.65V	42.44V	39.78V	42.59V	39.87V	42.74V	40.03V
Maximum Power Current (Imp)	13.41A	10.75A	13.48A	10.81A	13.55A	10.87A	13.62A	10.94A	13.69A	10.99A
Open-circuit Voltage (Voc)	50.87V	48.32V	51.07V	48.51V	51.27V	48.70V	51.47V	48.89V	51.67V	49.08V
Short-circuit Current (Isc)	14.19A	11.46A	14.25A	11.50A	14.31A	11.55A	14.37A	11.60A	14.43A	11.65A
Module Efficiency STC (%)	21.87%		22.07%		22.26%		22.45%		22.65%	

*STC: Irradiance 1000W/m² Cell Temperature 25°C AM = 1.5
NOCT: Irradiance 800W/m² Ambient Temperature 20°C AM = 1.5 Wind Speed 1m/s

*Power measurement tolerance: ±3%

The company reserves the final right for explanation on any of the information presented hereby. JKM565-585N-72HL4-BDV-F2-US

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110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

DATA SHEETS

PROJECT NUMBER 23-11-1168-CH
DRAWN BY GAK
SCALE
SHEET SI□E 22□34
SHEET NUMBER E801

Power Optimizer

For North America

S1201

POWER OPTIMIZER

SolarEdge's most advanced, cost-effective Power Optimizer for commercial and large field installations

- **Greater Energy Yields**
  - High efficiency (99.5%) with module-level MPPT, for maximized system energy production and revenue, and fast project ROI
  - Supports high power and bifacial PV modules, and high string current for more power per string.
- **Maximum Protection with Built-In Safety**
  - Designed to automatically reduce high DC voltage to touch-safe levels, upon grid/inverter shutdown, with SafeDC™
  - Includes SolarEdge Sense Connect, allowing continuous monitoring to detect overheating due to installation issues or connector-level wear and tear
- **Lower BoS Costs**
  - Flexible system design enables maximum space utilization and up to 2x longer string lengths, 50% less cables, fuses and combiner boxes
  - Supports connection of two PV modules in series with easy cable management and fast installation times
- **Simpler O&M**
  - Module-level system monitoring enabling pinpointed fault detection and remote, time-saving troubleshooting

solaredge.com

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Power Optimizer

For North America

S1201

	S1201	Units
INPUT		
Rated Input DC Power(1)	1200	W
Absolute Maximum Input Voltage (Voc)	125	Vdc
MPPT Operating Range	12.5 – 105	Vdc
Maximum Short Circuit Current (Isc) of Connected PV Module	15	Adc
Maximum Efficiency	99.5	%
Weighted Efficiency	98.8	%
Overvoltage Category	II	
OUTPUT DURING OPERATION		
Maximum Output Current	18	Adc
Maximum Output Voltage	80	Vdc
OUTPUT DURING STANDBY (POWER OPTIMIZER DISCONNECTED FROM INVERTER OR INVERTER OFF)		
Safety Output Voltage per Power Optimizer	1	Vdc
STANDARD COMPLIANCE		
Photovoltaic Rapid Shutdown System	Compliant with NEC 2014, 2017, 2020	
EMC	FCC Part15, IEC 61000-6-2, and IEC 61000-6-3	
Safety	IEC62109-1 (class II safety), UL1741, UL3741, CSA C22.2#107.1	
Material	UL94 V-0, UV Resistant	
RoHS	Yes	
Fire Safety	VDE-AR-E 2100-712:2013-05	
INSTALLATION SPECIFICATIONS		
Maximum Allowed System Voltage	1000	Vdc
Dimensions (W x L x H)	129 x 155 x 59 / 5.08 x 6.10 x 2.32	mm / in
Weight	1106 / 2.4	gr / lb
Input Connector	MC4(2)	
Input Wire Length	1.6 / 5.25(3)	m / ft
Output Connector	MC4	
Output Wire Length	(+) 5.3 (-) 0.10 / (+) 17.38, (-) 0.32	m / ft
Operating Temperature Range(4)	-40 to +85 / -40 to +185	°C / °F
Protection Rating	IP68 / NEMA6P	
Relative Humidity	0 – 100	%

(1) Rated power of the module at STC will not exceed the power optimizer Rated Input DC Power. Modules with up to +5% power tolerance are allowed.
(2) For other connector types please contact SolarEdge.
(3) The Sense Connect feature is only enabled on the output cable connectors.
(4) For ambient temperatures above +65°C / +149°F power de-rating is applied.

PV System Design Using a SolarEdge Inverter(5)(6)(7)		208V Grid SE10K	208V Grid SE17.3K*	277/480V Grid SE20K, SE30K	277/480V Grid SE40K*	
Compatible Power Optimizers				S1201		
Minimum String Length	Power Optimizers	8	10	15	15	
	PV Modules	15	19	29	29	
Maximum String Length	Power Optimizers	30	30	30	30	
	PV Modules	60	60	60	60	
Maximum Continuous Power per String		7200	8820	15300	15300	W
Maximum Allowed Connected Power per String(7)		1 string – 8400	1 string – 10020	1 string – 17550	2 strings or less – 17550	W
		2 strings or more – 10600	2 strings or more – 13000	2 strings or more – 23000	3 strings or more – 23000	
Parallel Strings of Different Lengths or Orientations		Yes				
Maximum Difference in Number of Power Optimizers Allowed Between the Shortest and Longest String Connected to the Same Inverter Unit		5 Power Optimizers				

*The same rules apply for Synergy units of equivalent power ratings, that are part of the modular Synergy Technology inverter.
(5) S1201 cannot be mixed with any other Power Optimizers models in the same string.
(6) For each string, a Power Optimizer may be connected to a single PV module if 1) each Power Optimizer is connected to a single PV module or 2) it is the only Power Optimizer connected to a single PV module in the string.
(7) To connect more STC power per string, design your project using SolarEdge Designer.

RoHS

Intertek

NOVA Cons□ltants, Inc.
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135 kW DC SOLAR ARRAY

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PROJECT NUMBER
23-11-1168-CH

DRAWN BY: GAK
SCALE:
SHEET SI□E: 22□34

SHEET NUMBER
E802

INVERTER - 1

Three Phase Inverter with Synergy Technology

For the 277/480V Grid for North America

SE80KUS / SE100KUS / SE110KUS / SE120KUS

INVERTER

Powered by unique pre-commissioning process for rapid system installation

- Pre-commissioning feature for automated validation of system components and wiring during the site installation process and prior to grid connection
- Easy 2-person installation with lightweight, modular design (each inverter consists of 2 or 3 Synergy units and 1 Synergy Manager)
- Independent operation of each Synergy unit enables higher uptime and easy serviceability
- Built-in thermal sensors detect faulty wiring, ensuring enhanced protection and safety
- Built-in arc fault protection and rapid shutdown
- Built-in PID mitigation for maximized system performance
- Monitored* and field-replaceable surge protection devices, to better withstand surges caused by lightning or other events
- Built-in module-level monitoring with Ethernet or cellular communication for full system visibility

W□INTERNAL SIMCARD CELLULAR PLUG-IN AND DATA PLAN

*Applicable only for DC and AC SPDs

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Three Phase Inverter with Synergy Technology

For the 277/480V Grid for North America

SE80KUS / ~~SE100KUS~~ / ~~SE110KUS~~ / ~~SE120KUS~~

INVERTER - 1

MODEL NUMBER	SE80KUS	SE100KUS	SE110KUS	SE120KUS	
APPLICABLE TO INVERTERS WITH PART NUMBER	SExxK-USx8Ixxxx				UNITS
OUTPUT					
Rated AC Active Output Power	80000	100000	110000	120000	W
Maximum AC Apparent Output Power	80000	100000	120000	120000	VA
AC Output Line Connections	3W + PE, 4W + PE				
Supported Grids	WYE: TN-C, TN-S, TN-C-S, TT, IT; Delta: IT				
AC Output Voltage Minimum-Nominal-Maximum(1) (L-N)	244 – 277 – 305				Vac
AC Output Voltage Minimum-Nominal-Maximum(1) (L-L)	422.5 – 480 – 529				Vac
AC Frequency Min-Nom-Max(1)	59.5 – 60 – 60.5				Hz
Maximum Continuous Output Current (per Phase, PF=1)	96.5	120	144.3		Aac
GFDI Threshold	1				A
Utility Monitoring, Islanding Protection, Configurable Power Factor, Country Configurable Thresholds	Yes				
Total Harmonic Distortion	≤ 3				%
Power Factor Range	+/-0.2 to 1				
INPUT					
Maximum DC Power (Module STC) Inverter / Synergy Unit	140000 / 70000	175000 / 58300	210000 / 70000		W
Transformer-less, Ungrounded	Yes				
Maximum Input Voltage DC+ to DC-	1000				Vdc
Operating Voltage Range	850 – 1000				Vdc
Maximum Input Current	2 x 48.25	3 x 40	3 x 48.25		Adc
Reverse-Polarity Protection	Yes				
Ground-Fault Isolation Detection	167kΩ sensitivity per Synergy Unit(2)				
CEC Weighted Efficiency	98.5				%
Nighttime Power Consumption	< 8	< 12			W
ADDITIONAL FEATURES					
Supported Communication Interfaces(3)	2 x RS485, Ethernet, Wi-Fi (optional), Cellular (optional)				
Smart Energy Management	Export Limitation				
Inverter Commissioning	With the SetApp mobile application using built-in Wi-Fi access point for local connection				
Arc Fault Protection	Built-in, User Configurable (According to UL1699B)				
Photovoltaic Rapid Shutdown System	EC 2014, 2017 and 2020, Built-in				
PID Rectifier	Nighttime, built-in				
RS485 Surge Protection (ports 1+2)	Type II, field replaceable, integrated				
AC, DC Surge Protection	Type II, field replaceable, integrated				
DC Fuses (Single Pole)	25A, integrated				
DC SAFETY SWITCH					
DC Disconnect	Built-in				
STANDARD COMPLIANCE					
Safety	UL1699B, UL1741, UL1741 SA, UL1741 SB, UL1998, CSA C22.2#107.1, Canadian AFCI according to T.I.L. M-07				
Grid Connection Standards	IEEE 1547-2018, Rule 21, Rule 14 (HI)				
Emissions	FCC part 15 class A				

(1) For other regional settings please contact SolarEdge support.
(2) Where permitted by local regulations.
(3) For specifications of the optional communication options, visit the Communication product page or the Resource Library to download the relevant product datasheet.

Three Phase Inverter with Synergy Technology

For the 277/480V Grid for North America

SE80KUS / ~~SE100KUS~~ / ~~SE110KUS~~ / ~~SE120KUS~~

INVERTER - 1

MODEL NUMBER	SE80KUS	SE100KUS	SE110KUS	SE120KUS	
APPLICABLE TO INVERTERS WITH PART NUMBER	SExxK-USx8Ixxxx				UNITS
INSTALLATION SPECIFICATIONS					
Number of Synergy Units per Inverter	2	3			
Ac Max Conduit Size	2 ½"				in
Max AWG Line / PE	4/0 / 1/0				
DC Max Conduit Size	1 x 3"; 2 x 2"				in
DC Input Inverter/ Synergy Unit	8 / 4 pairs; 6-12 AWG	12 / 4 pairs; 6-12 AWG			
	2 pairs / 1 pair, Max 2 AWG; copper or aluminum	3 pairs / 1 pair, Max 2 AWG; copper or aluminum			
Dimensions (H x W x D)	Synergy Unit: 22 x 12.9 x 10.75 / 558 x 328 x 273 Synergy Manager: 14.17 x 22.4 x 11.6 / 360 x 560 x 295				in / mm
Weight	Synergy Unit: 70.4 / 32 Synergy Manager: 39.6 / 18				lb / kg
Operating Temperature Range	-40 to +140 / -40 to +60(4)				°F / °C
Cooling	Fan (user replaceable)				
Noise	< 67				dBA
Protection Rating	NEMA 3R				
Mounting	Brackets provided				

(4) For power de-rating information refer to the Temperature De-rating - Technical Note (North America).

NOVA Cons□ltants, Inc.
21580 No□ Road
S□ite 300
No□, MI 483□5
Phone: □248□34□-3512
Fa□ □248□34□-4152
www.no□acons□ltants.co□

ISSUED

DATE	DESCRIPTION	APPVD.
6-2□-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

DATA SHEETS

PROJECT NUMBER 23-11-1168-CH
DRAWN BY GAK
SCALE
SHEET SI□E 22□34
SHEET NUMBER E803

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\City Hall\Drawings\23111168-CH-E803.dwg Date: J□n 2□2024; 11:38AM User: george

INVERTER - 2

Three Phase Inverters for the 277/480V Grid

for North America

SE20KUS / SE30KUS / SE33.3KUS

12-20 YEAR WARRANTY

INVERTERS

The best choice for SolarEdge enabled systems

- Quick and easy inverter commissioning directly from a smartphone using the SolarEdge SetApp
- Specifically designed to work with power optimizers
- Superior efficiency (98%)
- Fixed voltage inverter for longer strings
- Integrated Safety Switch
- UL1741 SA certified, for CPUC Rule 21 grid compliance
- Integrated arc fault protection and rapid shutdown for NEC 2014 and 2017, per article 690.11 and 690.12
- Built-in module-level monitoring
- Internet connection through Ethernet or Wireless
- Small, lightweight, and easy to install outdoors or indoors on provided bracket
- Supplied with RS485 Surge Protection Device, to better withstand lightning events

solaredge.com

W□INTERNAL SIMCARD CELLULAR PLUG-IN AND DATA PLAN

solaredge

Three Phase Inverters for the 277/480V Grid(1)

for North America

~~SE20KUS~~ / SE30KUS / ~~SE33.3KUS~~

INVERTER - 2

MODEL NUMBER	SE20KUS	SE30KUS	SE33.3KUS	
APPLICABLE TO INVERTERS WITH PART NUMBER		SEXXK-XXXXXBXX4		
OUTPUT				
Rated AC Power Output	20000	30000	33300	VA
Maximum AC Power Output	20000	30000	33300	VA
Output Line Connections	3 phase, 4-wire / PE (L1-L2-L3-N), TN, TT			
AC Output Voltage Minimum-Nominal-Maximum(2) (L-N)	244-277-305			Vac
AC Output Voltage Minimum-Nominal-Maximum(2) (L-L)	422.5-480-529			Vac
AC Frequency Min-Nom-Max(2)	59.3 - 60 - 60.5			Hz
Maximum Continuous Output Current (per Phase)	24	36.5	40	A
GFDI Threshold	1			A
Utility Monitoring, Islanding Protection, Country Configurable Set Points	Yes			
THD	≤ 3			%
INPUT				
Maximum DC Power (Module STC)	27000	40500	45000	W
Transformer-less, Ungrounded	Yes			
Maximum Input Voltage DC to Gnd	490			Vdc
Maximum Input Voltage DC+ to DC-	1000			Vdc
Nominal Input Voltage DC to Gnd	420			Vdc
Nominal Input Voltage DC+ to DC-	850			Vdc
Maximum Input Current	26.5	39	40	Adc
Maximum Input Short Circuit Current	45			Adc
Reverse-Polarity Protection	Yes			
Ground-Fault Isolation Detection	1MΩ Sensitivity	350kΩ Sensitivity(3)		
CEC Weighted Efficiency	98	98.5		%
Night-time Power Consumption	< 3	< 4		W
ADDITIONAL FEATURES				
Supported Communication Interfaces	RS485, Ethernet, Built-in Cellular (optional)			
Inverter Commissioning	With the SetApp mobile application using built-in access point for local connection			
Rapid Shutdown – NEC 2014 and 2017 690.12	Automatic Rapid Shutdown upon AC Grid Disconnect(4)			
RS485 Surge Protection Plug-in	Supplied with the inverter			
Smart Energy Management	Export Limitation			
STANDARD COMPLIANCE				
Safety	UL1741, UL1741 SA, UL1699B, CSA C22.2, Canadian AFCI according to T.I.L. M-07			
Grid Connection Standards	IEEE1547, Rule 21, Rule 14 (HI)			
Emissions	FCC part15 class B			
INSTALLATION SPECIFICATIONS				
AC output conduit size / AWG range	3/4" minimum / 12-6 AWG	3/4" minimum / 8-4 AWG		
DC input conduit size / AWG range	3/4" minimum / 12-6 AWG			
Number of DC inputs	2 pairs	3 pairs(4)		
Dimensions (H x W x D)	21 x 12.5 x 10.5 / 540 x 315 x 260			in / mm
Dimensions with Safety Switch (H x W x D)	30.5 x 12.5 x 10.5 / 775 x 315 x 260			in / mm
Weight	73.2 / 33.2	93.6 / 42.5		lb / kg
Weight with Safety Switch	79.7 / 36.2	100.3 / 45.5		lb / kg
Cooling	Fans (user replaceable)			
Noise	< 50	< 55		dBA
Operating Temperature Range	-40 to +140 / -40 to +60(5)			°F / °C
Protection Rating	NEMA 3R			

(1) For 120/208V inverters refer to: https://www.solaredge.com/sites/default/files/se-three-phase-us-inverter-208V-setapp-datasheet.pdf
(2) For other regional settings please contact SolarEdge support
(3) Where permitted by local regulations
(4) Field replacement kit for 1 pair of inputs P/N: DCD-3PH-1TBK; Field replacement kit for 3 pairs of fuses and holders P/N: DCD-3PH-6FHK-S1
(5) For power de-rating information refer to: https://www.solaredge.com/sites/default/files/se-temperature-derating-note-na.pdf

CE

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No□, MI 483□5
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CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

DATA SHEETS

PROJECT NUMBER 23-11-1168-CH
DRAWN BY GAK
SCALE
SHEET SI□E 22□34
SHEET NUMBER E804

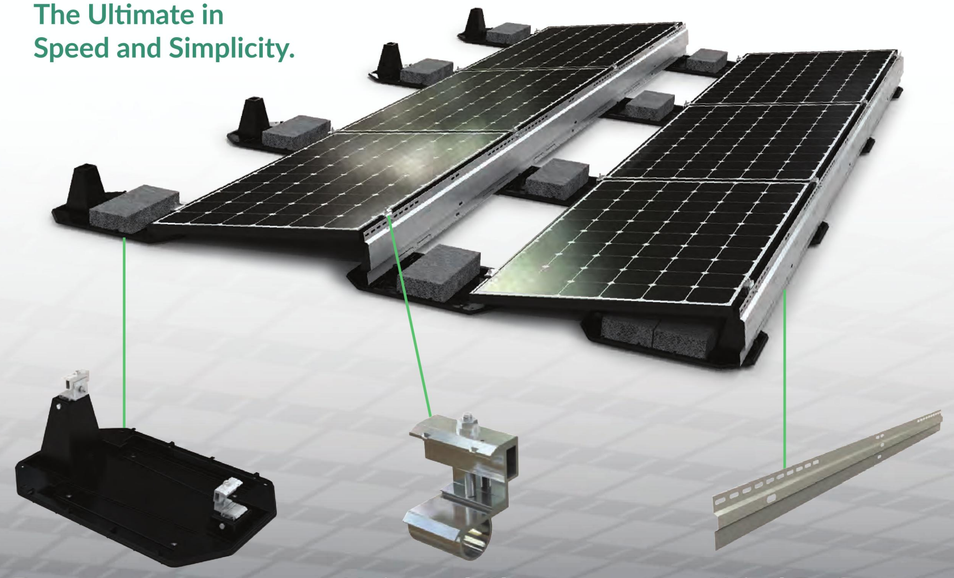
EcoFoot2+®

Ballasted Racking System

Installer-Preferred for Low-Slope Roofs

Three Main Components.

The Ultimate in Speed and Simplicity.



Base

UL-Listed ASA based resin is a durable material commonly used for automotive and construction products. Wire Clips are built-in for easy wire management. Class A fire rated and UL2703 Certified.

Universal Clamp

The preassembled Universal Clamp is ready to go right out of the box. Simply drop the Clamp into the Base. Integrated Bond Pin achieves integrated grounding without the use of grounding washers. Fits 30-50mm module frames with a single component.

Wind Deflector

Corrosion-resistant wind deflector on every module helps minimize uplift, reduce ballast requirements and carries UL2703 validated ground path from modules and racking components.

Ecolibrium Solar

Contact: 740.249.1877 | sales@ecolibriumsolar.com | www.ecolibriumsolar.com

Pure Performance

Unbeatable, Right Out of the Box.

No other racking products install flat roof arrays better than EcoFoot2+ Racking Solution. Installers prefer EcoFoot2+ because it's fast, simple, and durable. The line-up is unbeatable:

- Ready-to-go, preassembled components and simple installation
- No PV panel prep required: bases self-align
- Low-effort roof layout, just two chalk lines required
- No training required, 5-minute learning curve

Commercial

Residential

Design Flexibility

Wire Management Built-In

Master the Most Challenging Rooftop

Stackable Bases fit up to 50kW of Bases delivered on a standard pallet.

System Benefits

- Low part count
- Rapid system deployment
- Preassembled Universal Clamp
- Increased design flexibility
- More ballast capacity
- Simplified logistics
- Ship up to 50kW per pallet

Validation Summary

- Certified to UL2703 Fire Class A for Type I and II modules
- Certified to UL2703
- Grounding and Bonding
- Wind tunnel tested to 150mph
- SEAOC seismic compliant
- CFD and structurally tested
- DNV GL rated at 13.5 panels per installer-hour

Technical Specifications

Dimensions: 26.5"L x 18.25"W x 8.3"H
Typical System Weight: 3.5–6 lbs. per sq. ft.
Module orientation: Landscape/Portrait
Tilt angle: Landscape 10°/Portrait 5°
Module inter-row spacing: 18.9”
Roof pitch: 0° to 7°
Clamping range: 30-50mm
Ballast requirements: 4" x 8" x 16"
Warranty: 25 years
Slip sheets: not required by Ecolibrium Solar.
If required by roofer, use 20"x29" under Base.

Ecolibrium Solar

740-249-1877 | www.ecolibriumsolar.com
507 Richland Avenue, Athens, OH 45701

EcoFoot2+ Sales Sheet v2.1 121919

NOVA Consultants, Inc.
21580 Novi Road
Suite 300
Novi, MI 48375
Phone: 248-347-3512
Fax: 248-347-4152
www.novaconsultants.com

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6-27-2024	BID REVIEW	

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NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

CITY HALL &
JUSTICE CENTER

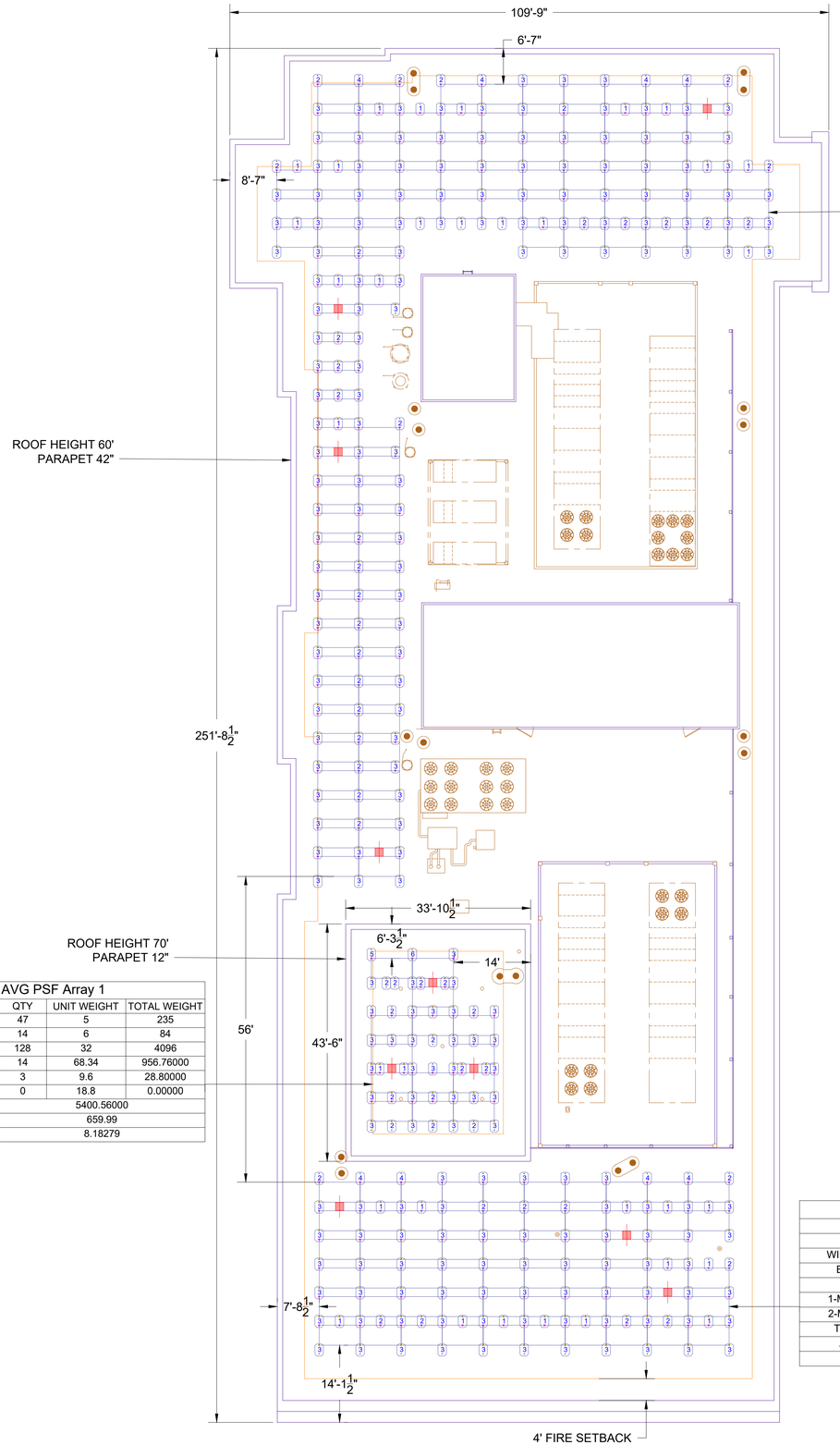
301 E. HURON STREET
ANN ARBOR, MI 48104

110 kW AC SOLAR ARRAY
135 kW DC SOLAR ARRAY

DATA SHEETS

PROJECT NUMBER 23-11-1168-CH
DRAWN BY GAK
SCALE
SHEET SIZE 22x34
SHEET NUMBER E805

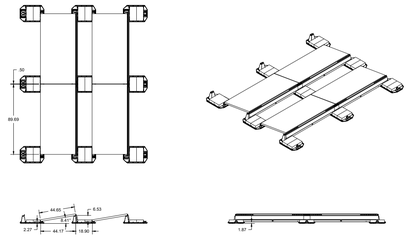
Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\City Hall\Drawings\23111168-CH-E805.dwg Date: Jun 27 2024; 12:11PM User: george



BOM and AVG PSF Array 2			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	172	5	860
WIND DEFLECTORS K	102	6	612
BALLAST BLOCKS	459	32	14688
PANELS	102	68.34	6970.68000
1-MOD ATTACHMENT	4	9.6	38.40000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)	23169.08000		
ARRAY AREA(sft)	4416.51		
AVG PSF	5.24602		

BOM and AVG PSF Array 1			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	47	5	235
WIND DEFLECTORS K	14	6	84
BALLAST BLOCKS	128	32	4096
PANELS	14	68.34	956.76000
1-MOD ATTACHMENT	3	9.6	28.80000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)	5400.56000		
ARRAY AREA(sft)	659.99		
AVG PSF	8.18279		

BOM and AVG PSF Array 1			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	94	5	470
WIND DEFLECTORS K	59	6	354
BALLAST BLOCKS	250	32	8000
PANELS	59	68.34	4032.06000
1-MOD ATTACHMENT	3	9.6	28.80000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)	12884.86000		
ARRAY AREA(sft)	2503.02		
AVG PSF	5.14773		



JINKO SOLAR JKM580N-72HL4-BDV 580W

ECOFOOT2+ LANDSCAPE ELEVATION/ISO VIEWS

SCALE: NTS UNITS: INCHES

MODULE NOTES

-PV MODULE SPECS (W): 580

-PV MODULE QUANTITY: 175

-SYSTEM POWER RATING (STC KWDC): 101.5

-ORIENTATION/TILT (DEGREE): LANDSCAPE/8.41°

BALLAST NOTES

-BALLAST BLOCK: 16"x8"x4" @ 32 LBS

ECOFOOT 2+ (BLOCK PER E2+):

N = BASE WITH NO OF BLOCKS

= 1 MODULE ATTACHMENT

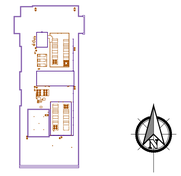
ARRAY OF GREATEST AVERAGE PSF = 8.18

BILL OF MATERIALS

PART NO	NAME	QTY
ES20207	ECOFOOT2+	313
ES10466	UNIVERSAL CLAMP KIT	273
ES20311K	WIND DEFLECTOR	175
ES10970	ECOFOOT MLPE BRACKET	175
ES10378	38" BONDING JUMPER	41
ES11203	MID-SUPPORT KIT	175
310999	FLASHLOC RM	10
ES10843	ROOF TO STRUT	10
ES10844	STRUT TO MODULE	10
ES20501	1 5/8" X 1 5/8" 12 GAUGE STRUT (10')	5
USER SUPPLIED	32 LBS BALLAST BLOCK (SOURCED LOCALLY OR SUPPLIED BY OTHERS)	837
008009P	ILSCO LAY IN LLUG	3

SITE NOTES

BASIC WIND SPEED (MPH)	120
EXPOSURE CATEGORY	B
GROUND SNOW LOAD (PSF)	20
OCCUPANCY CATEGORY	IV
SEISMIC (Ss)	0.094
ROOF HEIGHT (FT)	VARIES
PARAPET HEIGHT (IN)	VARIES
SETBACK TYP. (IN)	48
ROOF SLOPE (DEG)	1.20
ROOFING TYPE	TPO
ASCE7 VERSION	2010
BUILDING CODE	IBC 2015



NO.	REVISION	BY	DATE
0	INITIAL RELEASE	SG	2024-6-7

UNIRAC®
1411 BROADWAY BOULEVARD NE
ALBUQUERQUE, NEW MEXICO, USA, 87102
WWW.UNIRAC.COM

PRODUCED FOR: NOVA CONSULTANTS INC

PROJECT NAME:
JUSTICE CENTER 301 E
HURON ST
ANN ARBOR, MI 48104 48104

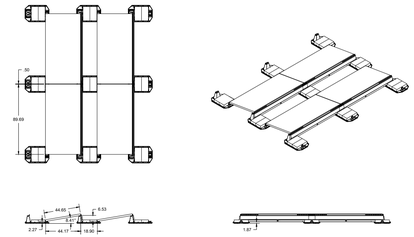
Date: 2024-06-07

Scale: CUSTOM

Drawn By: SG

Sheet: S-1.0

DRAWING INDICATES PLACEMENT OF EQUIPMENT AND BALLAST. PLEASE REFER TO INSTALLATION MANUAL FOR FULL PRODUCT DETAILS. INSTALLER IS RESPONSIBLE FOR VERIFICATION OF SITE AND PROJECT SPECIFICS. DESIGN IS FINALIZED WHEN ACCOMPANIED BY STAMPED ENGINEERING REPORT.



JINKO JKM 580N-72HL4-BDV 580W

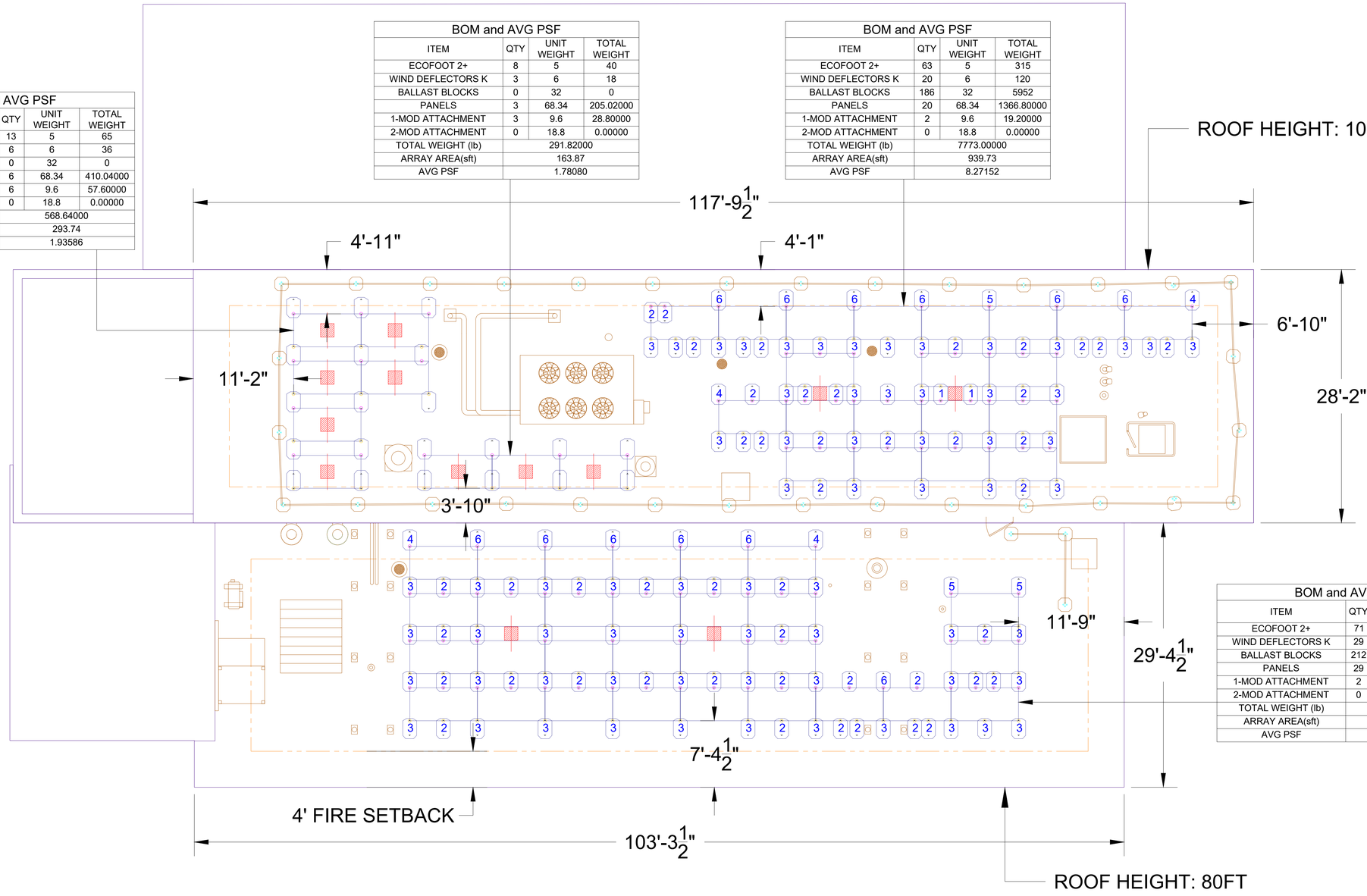
ECOFOOT2+ LANDSCAPE ELEVATION/ISO VIEWS

SCALE: NTS UNITS: INCHES

BOM and AVG PSF			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	13	5	65
WIND DEFLECTORS K	6	6	36
BALLAST BLOCKS	0	32	0
PANELS	6	68.34	410.04000
1-MOD ATTACHMENT	6	9.6	57.60000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)	568.64000		
ARRAY AREA(sft)	293.74		
AVG PSF	1.93586		

BOM and AVG PSF			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	8	5	40
WIND DEFLECTORS K	3	6	18
BALLAST BLOCKS	0	32	0
PANELS	3	68.34	205.02000
1-MOD ATTACHMENT	3	9.6	28.80000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)	291.82000		
ARRAY AREA(sft)	163.87		
AVG PSF	1.78080		

BOM and AVG PSF			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	63	5	315
WIND DEFLECTORS K	20	6	120
BALLAST BLOCKS	186	32	5952
PANELS	20	68.34	1366.80000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)	7773.00000		
ARRAY AREA(sft)	939.73		
AVG PSF	8.27152		



BOM and AVG PSF			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	71	5	355
WIND DEFLECTORS K	29	6	174
BALLAST BLOCKS	212	32	6784
PANELS	29	68.34	1981.86000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)	9314.06000		
ARRAY AREA(sft)	1305.96		
AVG PSF	7.13196		

MODULE NOTES

-PV MODULE SPECS (W): 580

-PV MODULE QUANTITY: 58

-SYSTEM POWER RATING (STC KWDC): 33.64

-ORIENTATION/TILT (DEGREE): LANDSCAPE/8.41°

BALLAST NOTES

-BALLAST BLOCK: 16"x8"x4" @ 32 LBS

ECOFOOT 2+ (BLOCK PER E2+):

= BASE WITH BLOCK COUNT

= 1 MODULE / SEISMIC ATTACHMENT

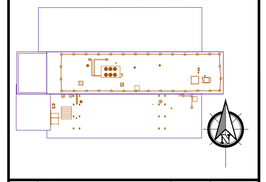
ARRAY OF GREATEST AVERAGE PSF = 8.27

BILL OF MATERIALS

PART NO	NAME	QTY
ES20207	ECOFOOT2+	155
ES10466	UNIVERSAL CLAMP KIT	116
ES20311K	WIND DEFLECTOR	58
ES10970	ECOFOOT MLPE BRACKET	58
ES10378	38" BONDING JUMPER	13
ES11203	MID-SUPPORT KIT	58
310999	FLASHLOC RM	13
ES10843	ROOF TO STRUT	13
ES10844	STRUT TO MODULE	13
ES20501	1 5/8" X 1 5/8" 12 GAUGE STRUT (10')	6
USER SUPPLIED	32 LBS BALLAST BLOCK (SOURCED LOCALLY OR SUPPLIED BY OTHERS)	398
008009P	ILSCO LAY IN LUG	4

SITE NOTES

BASIC WIND SPEED (MPH)	120
EXPOSURE CATEGORY	B
GROUND SNOW LOAD (PSF)	20
OCCUPANCY CATEGORY	IV
SEISMIC (Ss)	0.094
ROOF HEIGHT (FT)	VARIES
PARAPET HEIGHT (IN)	6
SETBACK TYP. (IN)	48
ROOF SLOPE (DEG)	1.20
ROOFING TYPE	OTHER
ASCE7 VERSION	2010
BUILDING CODE	IBC 2015



NO.	REVISION	BY	DATE
0	INITIAL RELEASE	PK	2024-6-4

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1411 BROADWAY BOULEVARD NE
ALBUQUERQUE, NEW MEXICO, USA, 87102
WWW.UNIRAC.COM

PRODUCED FOR: NOVA CONSULTANTS INC

PROJECT NAME: CITY HALL

301 EAST HURON STREET
ANN ARBOR, MI 48104

Date: 2024-06-05

Scale: CUSTOM

Drawn By: PK

Sheet: S-1.0

DRAWING INDICATES PLACEMENT OF EQUIPMENT AND BALLAST. PLEASE REFER TO INSTALLATION MANUAL FOR FULL PRODUCT DETAILS. INSTALLER IS RESPONSIBLE FOR VERIFICATION OF SITE AND PROJECT SPECIFICS. DESIGN IS FINALIZED WHEN ACCOMPANIED BY STAMPED ENGINEERING REPORT.

SOLAR PROJECT DESIGN

Prepared For: Nova Consultants Inc
Project Name: Justice Center
Project Address: 301 E Huron St, Ann Arbor, MI 48104
Date: June 7, 2024

SOLUTION OVERVIEW

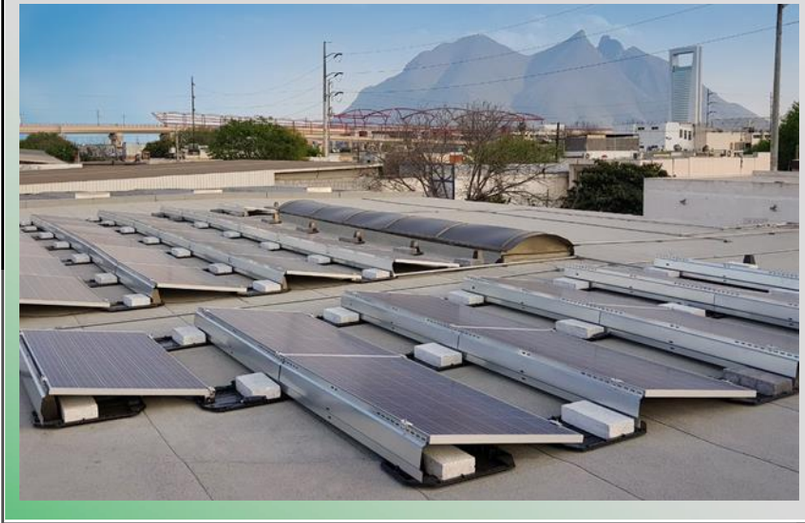
EcoFoot2+ Low-Slope Racking

With 500MW installed, EcoFoot Racking is preferred by installers for fast, simple installation and streamlined logistics. The enclosed provides the layout and system details for a complete solution for your project using this validated and reliable product.

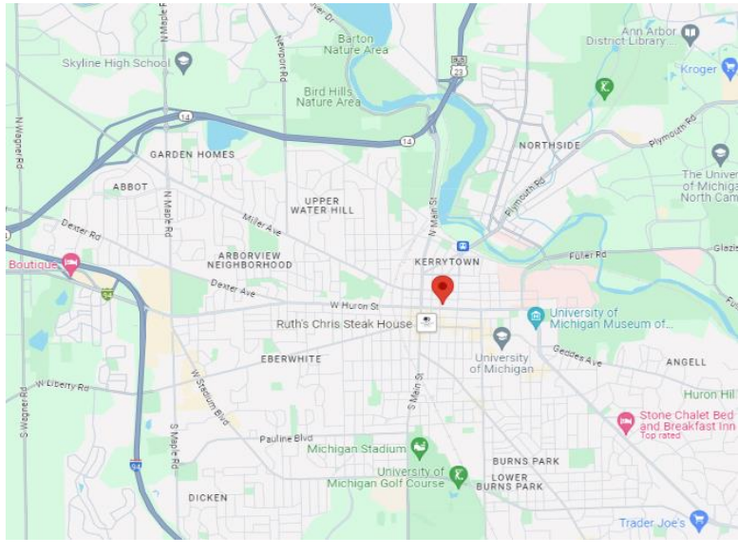
EcoFoot2+ delivers key advantages for a successful, efficient installation.
Faster Installation: Installers complete projects in less time with self-aligning Bases, simple pre-assembled components, five-minute learning curve, and one-tool installation. Install speed is rated at 13.5 modules/installer-hour by DNV-GL.

Low Part Count & Streamlined Logistics: EcoFoot2+ consists of three core components: roof friendly, durable Base with integrated north/south Wire Clips, pre-assembled Clamps, and Wind Deflector to reduce ballast and provide east/west bonding. Stackable Bases fit up to 50kW per pallet, meaning fewer crane lifts and less space used on the job site.

Dedicated Support: Experienced project managers and field technicians support your project from bid to inspection. Project managers ensure you have needed details to obtain a permit and pass inspection. Our field team offers a dedicated phone line and email. On-site training is available.



VICINTY MAP



PROJECT SPECIFICATIONS

SYSTEM INFORMATION	
Total System Size (KW)	93.38
Total Module Quantity	161
Module Orientation	Landscape
EQUIPMENT	
Module Manufacturer	JINKO SOLAR
Module Model	JKM580N-72HL4-BDV
Module Wattage	580
Module Length (in.)	89.69
Module Width (in.)	44.65
Module Weight (lbs)	68.34
BUILDING DATA	
Roof Type	Other
Parapet Height (in)	42
Setback (in)	48
Roof Height (ft)	60
Roof Slope (degrees)	1.20
DESIGN VALUES	
ASCE Version	2010
Basic Windspeed (mph)	120
Wind Exposure Category	B
Occupancy Category	IV
Ground Snow Load (lb/ft^2)	20

DESIGN IS FINALIZED WHEN ACCOMPANIED BY STAMPED ENGINEERING REPORT.

CONTRACTOR IS RESPONSIBLE FOR VERIFYING ROOF CAPACITY.
CONTRACTOR IS RESPONSIBLE FOR CONFIRMING ALL DESIGN CRITERIA ARE CORRECT AND APPROPRIATE FOR THE PROJECT SITE.
CONTRACTOR MUST CONFIRM DESIGN MEETS ALL UTILITY AND AHJ REQUIREMENTS.
CONTRACTOR IS RESPONSIBLE FOR VERIFYING THAT BUILDING STRUCTURE AND RELATED CONNECTIONS CAN SUPPORT ALL LOADS IMPOSED BY PV SYSTEM.
REFER TO INSTALLATION MANUAL FOR FULL PRODUCT DETAILS AND ADDITIONAL INFORMATION.

Uplift, Sliding and Seismic Calculations

Explanation of EcoFoot System Calculations and Design Procedure

Installer Name:	Nova Consultants Inc
Project Name:	Justice Center
Project Address:	301 E Huron St Ann Arbor, MI 48104
Date Prepared:	6/7/2024

Calculation Explanation Key Sections:

Table Of Figures:

3rd Party Engineering Resources

Rowan, Williams, Davies, & Irwin Inc (RWDI) -- Wind Tunnel Testing Per ASCE 7 / IBC
Maffei Structural Engineering -- Peer Review of Wind Tunnel Testing
Testing Engineers, Inc. -- Friction Testing per ASTM G115
CBC Engineers -- Professional Engineering Review and Certification

Introduction, Site Specifics and Variable Definition

In order to efficiently design EcoFoot2+ and EcoFoot5D ballasted photovoltaic systems, Unirac makes use of a proprietary solar array design aid called "EcoCalcs". Starting with a set of design criteria, shown here in Table 1 below, EcoCalcs utilizes methodologies laid out in the ASCE7 and SEAOC PV1/PV2 documents, and derivative building codes. Actual calculations for this project are included herein, and are accompanied by a step-by-step explanation of Unirac's design process.

The output of EcoCalcs is a comprehensive set of ballast prescriptions, including Image 3 found on Page 6. Ballast prescriptions are applied to a proposed system layout by the Unirac engineering team. Engineering Alliance, Unirac's professional engineering partner, has reviewed and verified EcoCalcs and reviews system designs to ensure that calculations and ballast prescriptions were correctly applied. Upon successful review, Engineering Alliance provides a stamped design review including relevant supporting documentation (this explanation included) and a stamped, approved ballast plan.

Please note: Unirac and Engineering Alliance are not conducting a structural review of the proposed site.

Below, Table 1 and Table 2 list the design criteria and project details for a proposed system in Ann Arbor, MI. These values will be used throughout the remainder of this explanation.

Table 1: System Design Criteria

Product Line	EcoFoot 2+
ASCE7 Version	2010
Ground Elevation (ft)	N/A
Roof Type	Other
Roof Height (ft.)	60
Roof Slope (deg)	1.20
Min Edge Setback (in)	48
Parapet Height (in.)	42
3 Sec. Gust (mph)	120
Occupancy Category	IV
Wind Exposure	B
Snow Load (psf)	20.0
Seismic Data (SS)	0.0940
Soil Site Class	D
Coeff. Of Friction (fn)*	0.37

**req's slip sheets*

Table 2: PV Module Specifics

Module Manufacturer	JINKO SOLAR
Module Model	JKM580N-72HL4-BDV
Module Orientation	Landscape
Module Power (w)	580
Module Length (in)	89.69
Module Width (in)	44.65
Module Weight (lbs.)	68.34

Utilizing the inputs from Tables 1 and 2, the factors in Table 3 are generated for the site. This list of factors is used in various ways to fully define a proposed system according to calculations laid out in the SEAOC and ASCE documents. In the scope of this explanation, factors are used to calculate velocity pressure, qh as defined in ASCE7-05, Section 6.5.10; ASCE7-10, Section 30.3.2; or ASCE7-16 and ASCE7-22, Section 26.10.2, and ultimately the amount of ballast required to offset uplift and drag forces.

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Table 3: Calculation Inputs, Constants, and Variables

Racking Component Weight per Module	15.19	lbs.
Ballast Block Weight	32	lbs.
Asymmetric lift load Ratio (North Row)	1.4	
Asymmetric lift load Ratio (South Row)	1.6	
Ala= Effective Lift Area of PV Module	27.511	ft^2
Ada= Effective Drag Area of PV Module	4.07	ft^2
dLF1= Dead Load of Module and Attributed Racking	83.528	lbs.
Roof Setback Minimum	48	in.
Load Combination Factor for Wind	0.6	
Load Combination Factor for Seismic	0.7	
α (from ASCE7 Table 6-2 or 26.9.1 or 26.11-1)=	7	
zg (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	1200	ft.
zmin (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	30	ft.
z selected (from zmin & inputs)=	60	ft.
Kz= Velocity pressure exposure coefficient at height	0.85	
Kzt= Topographic Factor	1	
Kd= Directionality Factor	0.85	
Ke= Ground Elevation Factor	1	
Wind design load factor	0.6	
Dead Load design load factor	0.6	
qh_wind= Velocity Pressure (0.00256*Kz*Kzt*Ke*Kd*V^2*I)	26.76	psf

An explanation of variables:

Asymmetric Lift Load Ratio: This is a ratio describing the leverage created by EcoFoot base dimensions, module attachment location and location of center of ballast mass. Assessed as a multiplier on top of ballast distribution scheme in Image 4.

dLF1= Dead Load of Module and Attributed Racking: the weight of one module and hardware attributed to that module, not including ballast.

Ala= Effective Lift Area of PV Module: The surface area of a module projected onto the horizontal plane for lift calculations.

Ada= Effective Drag Area of PV Module: The surface area of a module projected onto the horizontal plane for drag calculations.

qh= Velocity Pressure at height "h": Calculation prescribed by ASCE7-05, eq. 6-15, and ASCE7-10, eq. 30.3-1, or ASCE7-16 and ASCE 7-22, eq. 26.10-1 (subscript "h" used here for clarity, ASCE7 utilizes subscript "z").

Wind Tunnel Testing, Uplift and Drag Force Calculations

Wind tunnel testing of the EcoFoot product line to determine GCn values has been conducted by Rowan Williams Davies & Irwin Inc. (RWDI), a nationally recognized boundary-layer wind tunnel test firm. Testing was conducted in accordance with ASCE7-05, section 6.6; and ASCE7-10/16/22, section 31.2. Module-specific GCn data allows for precise application of ballast to prevent uplift. Deviation from prescriptive wind GCn values has been addressed according to SEAOC PV2 via a peer review of the wind tunnel testing and results by Maffei Structural Engineering.

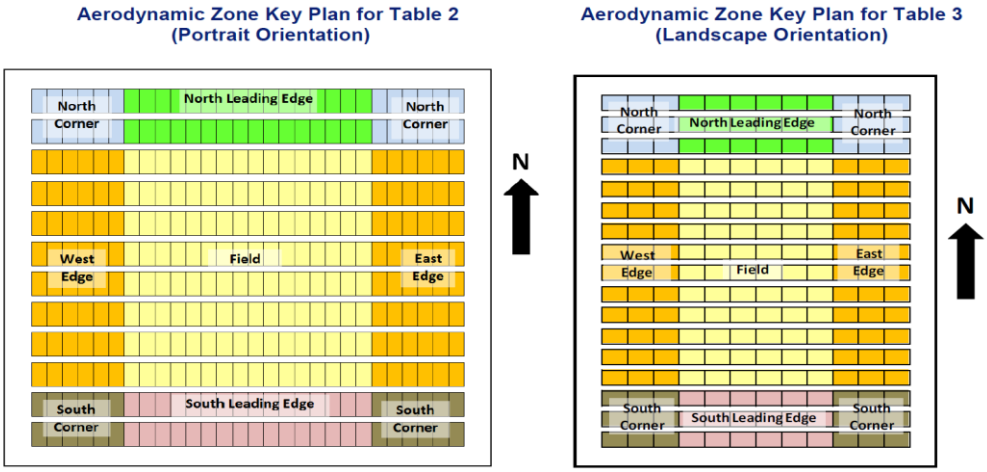
GCn and qh are used to calculate the pressure exerted on each module via the design wind pressure equations (ASCE7-05 – section 6.5.12.4, ASCE7-10 – section 30.4.2, ASCE7-16-30.5.2 and ASCE7-22 – section 30.3.2). Ballast required to offset uplift and drag forces (BWUz) is calculated in accordance with RWDI recoemndations. Detailed calculations for this project are found in Table 4. Resulting required ballast BWUz is displayed graphically in Image 3.

Table 4: Ballast to Resist Uplift Calculations for Project Proposed in Ann Arbor, MI 48104

			Load Sharing Area						
		#col x #rows	2x2	2x3			3x2	3x3	Down (1x1)
North Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.0	-7.9			-7.1	-6.6	17.0
	WLFUz=Uplift wind force =pUz*Ala	lbs.	-248.8	-218.6			-196.0	-180.9	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-99.2	-81.1			-67.5	-58.5	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	165.3	135.1			112.5	97.4	
North Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-7.1	-6.3			-6.0	-5.5	15.6
	WLFUz=Uplift wind force =pUz*Ala	lbs	-196.0	-173.4			-165.9	-150.8	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-67.5	-53.9			-49.4	-40.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	112.5	89.9			82.3	67.3	
E/W Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.0	-6.6			-7.1	-5.5	17.0
	WLFUz=Uplift wind force =pUz*Ala	lbs	-248.8	-180.9			-196.0	-150.8	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-99.2	-58.5			-67.5	-40.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	165.3	97.4			112.5	67.3	
Field	pUz=Uplift design wind pressure =qh*GCnUz	psf	-7.1	-6.3			-6.0	-5.5	15.6
	WLFUz=Uplift wind force =pUz*Ala	lbs	-196.0	-173.4			-165.9	-150.8	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-67.5	-53.9			-49.4	-40.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	112.5	89.9			82.3	67.3	
South Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.0	-6.6			-7.7	-5.5	17.0
	WLFUz=Uplift wind force =pUz*Ala	lbs	-248.8	-180.9			-211.1	-150.8	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-99.2	-58.5			-76.5	-40.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	165.3	97.4			127.6	67.3	
South Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-8.2	-6.3			-7.1	-5.5	15.6
	WLFUz=Uplift wind force =pUz*Ala	lbs	-226.2	-173.4			-196.0	-150.8	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-85.6	-53.9			-67.5	-40.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	142.7	89.9			112.5	67.3	

The aerodynamic differences among different sub-sections of a large array are handled by various calculation sections (North Corner, North Edge, E/W Edge...) and apply according to the excerpt from the RWDI report shown below in Image 1. The highlighted sections of Table 4 correspond to specific module locations, also shown in Image 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for expanded calculations pertaining to the highlighted sections.

Image 1: Aerodynamic Zones from RWDI Report



To check the amount of drag a given sub-array will experience, the equation in Image 2 is utilized - an excerpt from RWDI's test report. Each sub-array is checked for sliding, proceeding from the smallest to largest or until drag no longer governs total required ballast.

Table 5 lists the calculations used to identify the total required ballast to counteract drag forces and prevent sliding. Friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients. Unless detailed information is available pertaining to the location of the sub-array, the roof's worst case uplift GCp are utilized in calculating drag and required ballast.

Image 2: Ballast to Resist Sliding Equation

Ballast (lb) to Resist Sliding

$$\alpha_D \cdot Ballast_{drag} = \alpha_W \cdot q_z \cdot \left[(GC_p)^*_{drag} \cdot A_{drag} \cdot \left(\frac{1}{f_n}\right) + |GC_p|^*_{uplift} \cdot A_{uplift} \right] - \alpha_D \cdot M \qquad (lb)$$

Table 5: Ballast to Resist Sliding Calculation

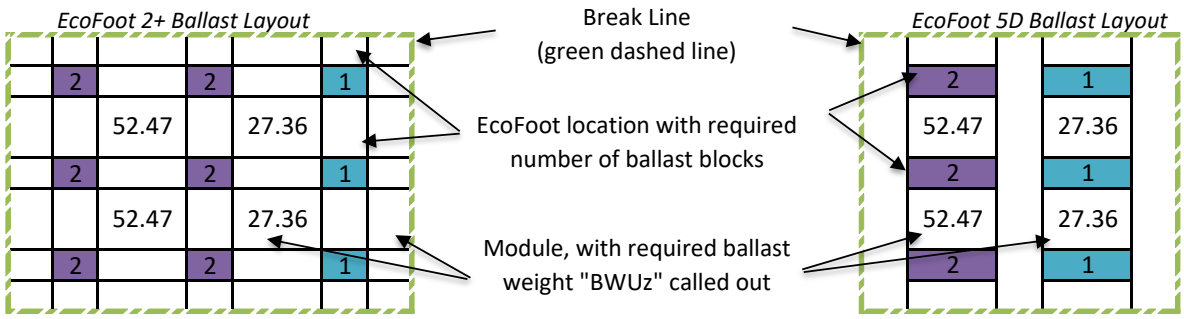
Sub-Array Module Count Total:	16
a_w = Wind Load Combination Factor =	0.6
a_d = Dead Load Combination Factor =	0.6
qz (qh in Table 3)	26.76
M = dLF1 from Table 3 =	83.53
f_n (also see Table 1) =	0.37
A_{uplift} = Ala in Table 3 =	27.51
A_{drag} = Ada in Table 3 =	4.07
$GC_{p\text{-}drag}$	1.42
$GC_{p\text{-}uplift}$	-0.62
Area Reduction Factor =	0.31
$(GCp)^*_{drag}$ =	0.44
$\lvert GCp \rvert^*_{uplift}$ =	0.19
Total Required Ballast Weight (Per Image 2)=	**2989.18**
$W_{ballastblock}$ =	32
Total Required Ballast Blocks:	**94**

Ballast Application to Sheet S-1.0

For easier interpretation, the results calculated in Table 4 are laid out in graphical representations of a solar array, shown in Image 4. Unirac engineers and drafters make use of this graphical layout when applying ballast to a given system design.

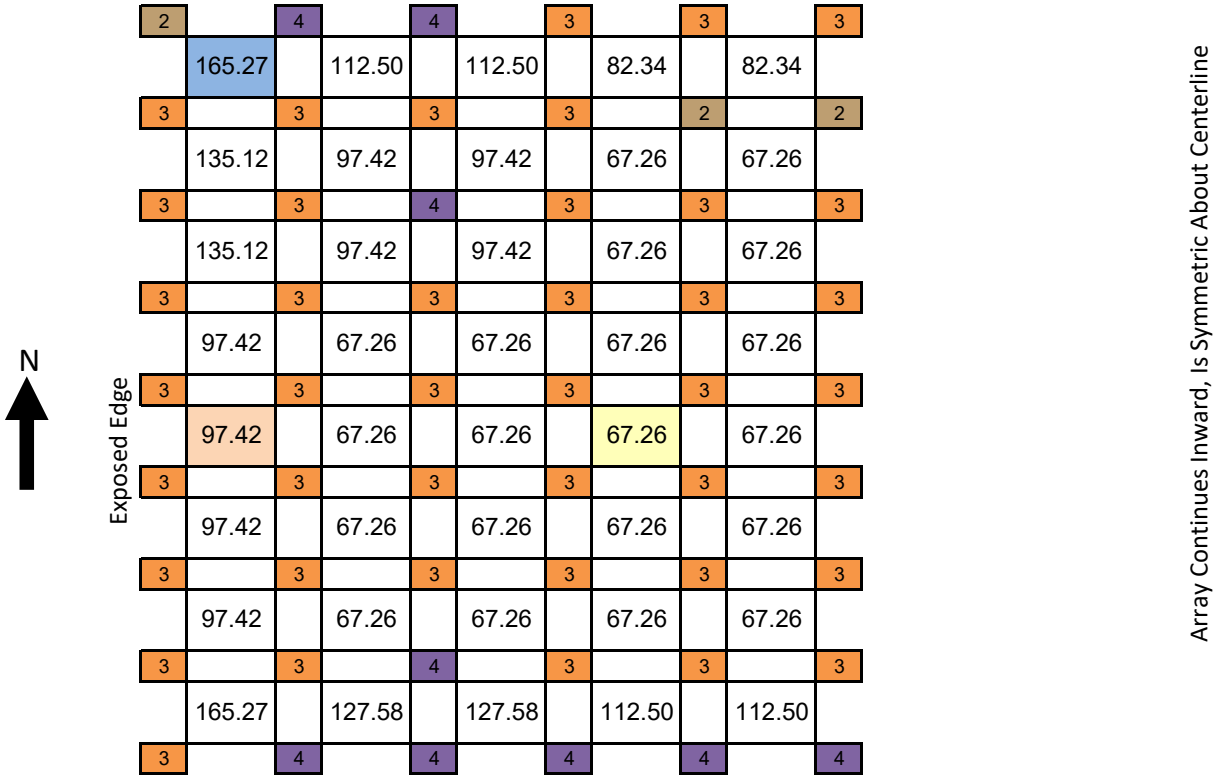
As shown in Image 3, the ballast required to resist lift - BWUz from Table 4 - is listed for each module location in Image 4. A portion of each BWUz value is distributed to each of the connected EcoFoot Bases, also detailed in Image 3 and included in Image 4. The total ballast required at each EcoFoot location is then calculated and rounded up to the next ballast block increment.

Image 3: Example of Module and Ballast Graphical Representation



The ballast prescription array shown in Image 4 is one of many similar arrays created automatically through EcoCalcs in order to address all possible array configurations. The data calculated in Table 4 was ultimately used to assign ballast to the system design in Sheet S-1.0 by Unirac. EcoCalcs and the resulting ballast plan S-1.0 are reviewed by CBC Engineers for correctness and completeness. Once approved, an engineering report including Sheet S-1.0 and any supporting material (this explanation included) are stamped and sealed by a professional engineer registered in the state where the project is proposed.

Image 4: Ballast Prescriptions Produced by Table 4



NOTE: The colored module locations in Image 4 correspond to the same colored areas in Table 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for more detailed calculations.

Detailed Calculations From Table 4

North Corner Module		
GCn Value from RWDI report:	-0.34	
qh value from Table 3:	26.76	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-9.04	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-248.80	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-99.16	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	165.27	lbf

East/West Edge Module		
GCn Value from RWDI report:	-0.25	
qh value from Table 3:	26.76	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-6.58	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-180.95	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-58.45	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	97.42	lbf

Interior Module		
GCn Value from RWDI report:	-0.20	
qh value from Table 3:	26.76	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-5.48	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-150.79	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-40.36	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	67.26	lbf

Max downpoint load calculations

No of Mid supports	1	
Tributary Area to support/bays/base	0.5	of module area
Wind force down (WL)	234 lbs	
Snow load Down (SL)	330.13 lbs	
Total Dead load per Bay (DL)	145.36 lbs	

Load Combinations

DL+ SL	475.49 lbs
DL+0.6WL	285.59 lbs
DL+0.75SL+0.45WL	**498.13 lbs**

SEAOC PV1 - 2012 - Section 4: attached Arrays

Unirac utilizes the unattached design approach to account for seismic force as provided for by Section 16 of the 2016 California Building Code, the Structural Engineering Association of California PV1 Requirements (SEAOC PV1-2012) and ASCE 7. Section 1613.5 defines “Ballasted Photovoltaic System” which also defines "partially attached" systems, and provides guidance for designing arrays that utilize physical anchors and friction to resist seismic forces. SEAOC PV1 or ASCE 7 Chapter 13 defines the calculations required design attached photovoltaic systems, including friction to partially offset seismic forces.

The following explanation walks through calculations outlined in Section 4 - Attached Arrays. The attached approach begins with the project specific design criteria outlined in Table 6. These values reflect site inputs as well as assumptions permitted in the SEAOC PV1-2012 document Section 4 and ASCE 7 chapter 13 .

Table 6: Seismic Design Inputs

Number of blocks per Ecofoot	6.00
Wp=Weight per unit	275.53
Site Class	D
Seismic Design Category	0.00
Ip	1.50
Rp	1.50
'Seismic Calcs (Attached)'!A9	1.00
Fa (Site Class D)	1.6
Sms = Fa x Ss	0.15
Sds = (2/3) x Sms	0.10

Table 7: ASCE7 Inputs

z=height of point of attachment (in.)	1.00
h=structure height compared to base (in.)	1.00
Fp=0.4*ap*Sds*Wp*(1+2*z/h)/(Rp/Ip)	33.15
Fp=1.6*Sds*Ip*Wp	66.30
Fp=0.3*Sds*Ip*Wp	12.43
Fp	33.15
Fp (ASD)	23.21

SEAOC PV1 specifies that “PV support systems that are attached to the roof structure shall be designed to resist the lateral seismic force *Fp* specified in ASCE 7-16/22 Chapter 13.” Although SEAOC PV1 was released prior to ASCE 7-16/22, *Fp* is defined the same way in Chapter 13 of both ASCE verions 7-10, 7-16 and 7-22. Therefore the lateral seismic force analysis applied is valid for both ASCE 7-10, 16 and 22. In utilizing the *Fp* calculations for nominal, minimum, and maximum values laid out in Section 13.3.1, the values in Table 7 are found.

The following is excerpted from SEAOC PV1-2012, Section 4 – Attached Arrays:

“For attached roof-bearing systems, friction is permitted to contribute in combination with the design lateral strength of attachments to resist the lateral force Fp when all of the following conditions are met:

- “The maximum roof slope at the location of the array is less than or equal to 7 degrees (12.3 percent);
- “The height above the roof surface to the center of mass of the solar array is less than the smaller of 36 inches and half the least plan dimension of the supporting base of the array
- “Rp shall not exceed 1.5 unless it is shown that the lateral displacement behavior of attachments is compatible with the simultaneous development of frictional resistance.”

The EcoFoot 2+ and EcoFoot 5D systems have been demonstrated to be in conformance with the above stated stipulations. As such, and in accordance with the remainder of Section 4 – Attached Arrays from SEAOC PV1-2012, the force required to resist movement due to seismic shifting is calculated. Based on the minimum ultimate shear strength of the roof mounting method prescribed for this job, the total lateral load that one attachment may offset is calculated, and by extension the number of modules allowed per attachment point. These values can be found in Table 8.

All friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients, methodology that is in agreement with SEAOC PV2 and Los Angeles, CA stipulations.

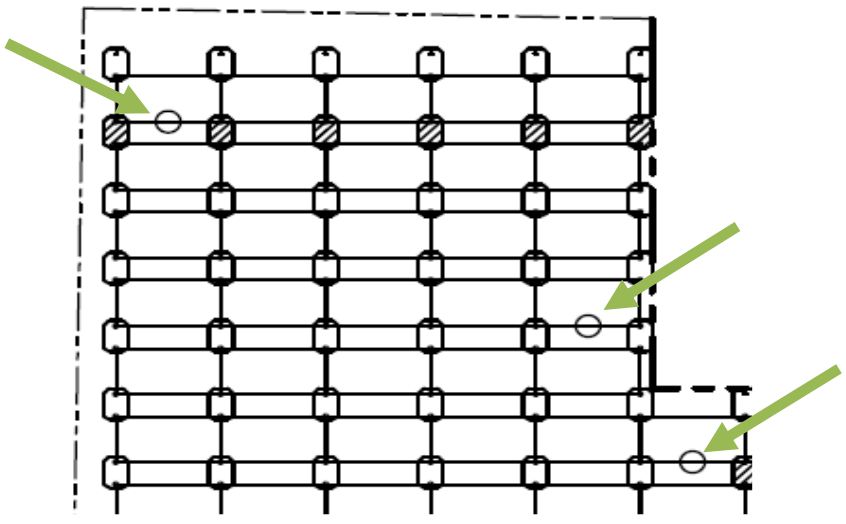
Table 8: Calculation of Physical Attachment Requirements

Friction Coefficient	0.37	*ASTM G115 Tested*
Ff (max friction) = (0.6-0.14*Sds)*(0.7*u)*Wp	41.93	*SEAOC section 4 (ASD), Friction Force*
Excess force per unit	-18.72	*Force to be offset by physical attachments*
Attachment system rating (allowable)	634.91	*ASD design load*
Number of panels per attachment	-33.91	*(if negative, no fasteners are needed)*

This final number of panels per attachment represents the maximum number of modules that any given attachment point may account for in terms of offsetting seismic force Fp. Physical attachments shall be installed per the manufacturer's instructions, and attached to the EcoFoot 2+ or EcoFoot 5D system per the installation instructions provided by Unirac.

On Sheet S-1.0 physical attachments are called out as shown below in Image 5:

Image 5: Example of ballast layout with seismic attachment callouts



SOLAR PROJECT DESIGN

Prepared For: Nova Consultants Inc
Project Name: Justice Center
Project Address: 301 E Huron St, Ann Arbor, MI 48104
Date: June 7, 2024

SOLUTION OVERVIEW

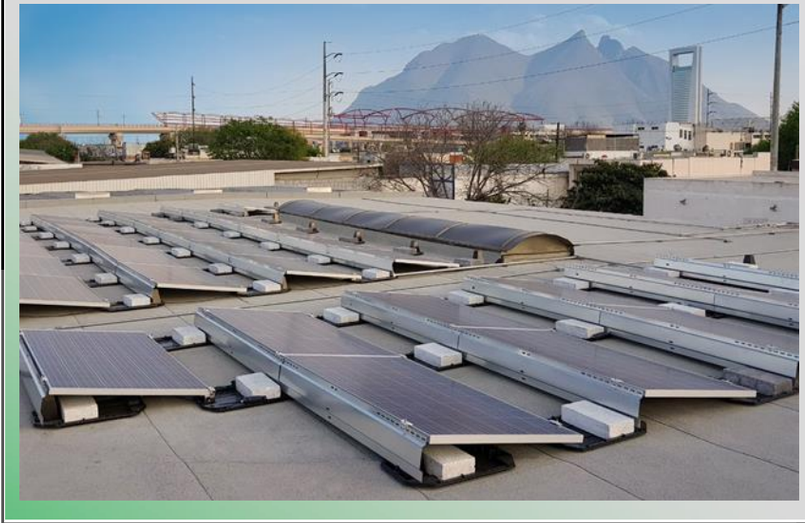
EcoFoot2+ Low-Slope Racking

With 500MW installed, EcoFoot Racking is preferred by installers for fast, simple installation and streamlined logistics. The enclosed provides the layout and system details for a complete solution for your project using this validated and reliable product.

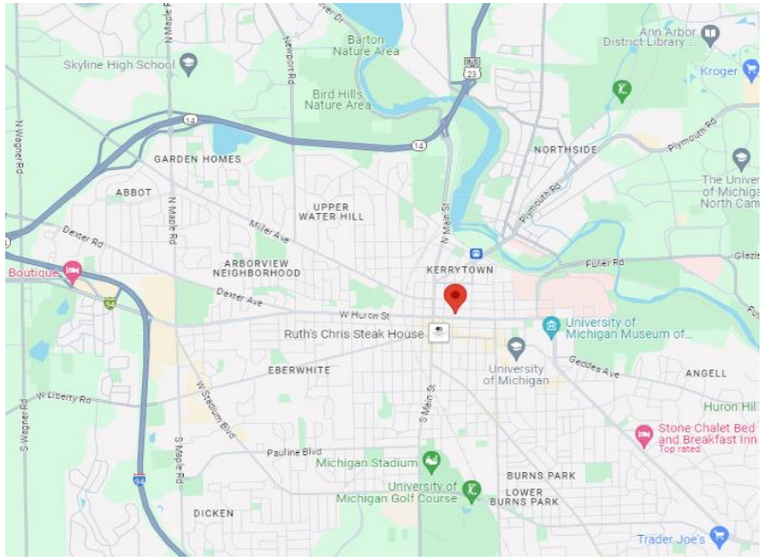
EcoFoot2+ delivers key advantages for a successful, efficient installation.
Faster Installation: Installers complete projects in less time with self-aligning Bases, simple pre-assembled components, five-minute learning curve, and one-tool installation. Install speed is rated at 13.5 modules/installer-hour by DNV-GL.

Low Part Count & Streamlined Logistics: EcoFoot2+ consists of three core components: roof friendly, durable Base with integrated north/south Wire Clips, pre-assembled Clamps, and Wind Deflector to reduce ballast and provide east/west bonding. Stackable Bases fit up to 50kW per pallet, meaning fewer crane lifts and less space used on the job site.

Dedicated Support: Experienced project managers and field technicians support your project from bid to inspection. Project managers ensure you have needed details to obtain a permit and pass inspection. Our field team offers a dedicated phone line and email. On-site training is available.



VICINTY MAP



PROJECT SPECIFICATIONS

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Uplift, Sliding and Seismic Calculations

Explanation of EcoFoot System Calculations and Design Procedure

Installer Name:	Nova Consultants Inc
Project Name:	Justice Center
Project Address:	301 E Huron St Ann Arbor, MI 48104
Date Prepared:	6/7/2024

Calculation Explanation Key Sections:

Table Of Figures:

3rd Party Engineering Resources

Rowan, Williams, Davies, & Irwin Inc (RWDI) -- Wind Tunnel Testing Per ASCE 7 / IBC
Maffei Structural Engineering -- Peer Review of Wind Tunnel Testing
Testing Engineers, Inc. -- Friction Testing per ASTM G115
CBC Engineers -- Professional Engineering Review and Certification

Introduction, Site Specifics and Variable Definition

In order to efficiently design EcoFoot2+ and EcoFoot5D ballasted photovoltaic systems, Unirac makes use of a proprietary solar array design aid called “EcoCalcs”. Starting with a set of design criteria, shown here in Table 1 below, EcoCalcs utilizes methodologies laid out in the ASCE7 and SEAOC PV1/PV2 documents, and derivative building codes. Actual calculations for this project are included herein, and are accompanied by a step-by-step explanation of Unirac's design process.

The output of EcoCalcs is a comprehensive set of ballast prescriptions, including Image 3 found on Page 6. Ballast prescriptions are applied to a proposed system layout by the Unirac engineering team. Engineering Alliance, Unirac's professional engineering partner, has reviewed and verified EcoCalcs and reviews system designs to ensure that calculations and ballast prescriptions were correctly applied. Upon successful review, Engineering Alliance provides a stamped design review including relevant supporting documentation (this explanation included) and a stamped, approved ballast plan.

Please note: Unirac and Engineering Alliance are not conducting a structural review of the proposed site.

Below, Table 1 and Table 2 list the design criteria and project details for a proposed system in Ann Arbor, MI. These values will be used throughout the remainder of this explanation.

Table 1: System Design Criteria

Product Line	EcoFoot 2+
ASCE7 Version	2010
Ground Elevation (ft)	N/A
Roof Type	Other
Roof Height (ft.)	70
Roof Slope (deg)	1.20
Min Edge Setback (in)	48
Parapet Height (in.)	12
3 Sec. Gust (mph)	120
Occupancy Category	IV
Wind Exposure	B
Snow Load (psf)	20.0
Seismic Data (SS)	0.0940
Soil Site Class	D
Coeff. Of Friction (fn)*	0.37

**req's slip sheets*

Table 2: PV Module Specifics

Module Manufacturer	JINKO SOLAR
Module Model	JKM580N-72HL4-BDV
Module Orientation	Landscape
Module Power (w)	580
Module Length (in)	89.69
Module Width (in)	44.65
Module Weight (lbs.)	68.34

Utilizing the inputs from Tables 1 and 2, the factors in Table 3 are generated for the site. This list of factors is used in various ways to fully define a proposed system according to calculations laid out in the SEAOC and ASCE documents. In the scope of this explanation, factors are used to calculate velocity pressure, qh as defined in ASCE7-05, Section 6.5.10; ASCE7-10, Section 30.3.2; or ASCE7-16 and ASCE7-22, Section 26.10.2, and ultimately the amount of ballast required to offset uplift and drag forces.

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Table 3: Calculation Inputs, Constants, and Variables

Racking Component Weight per Module	15.19	lbs.
Ballast Block Weight	32	lbs.
Asymmetric lift load Ratio (North Row)	1.4	
Asymmetric lift load Ratio (South Row)	1.6	
Ala= Effective Lift Area of PV Module	27.511	ft^2
Ada= Effective Drag Area of PV Module	4.07	ft^2
dLF1= Dead Load of Module and Attributed Racking	83.528	lbs.
Roof Setback Minimum	48	in.
Load Combination Factor for Wind	0.6	
Load Combination Factor for Seismic	0.7	
α (from ASCE7 Table 6-2 or 26.9.1 or 26.11-1)=	7	
zg (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	1200	ft.
zmin (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	30	ft.
z selected (from zmin & inputs)=	70	ft.
Kz= Velocity pressure exposure coefficient at height	0.89	
Kzt= Topographic Factor	1	
Kd= Directionality Factor	0.85	
Ke= Ground Elevation Factor	1	
Wind design load factor	0.6	
Dead Load design load factor	0.6	
qh_wind= Velocity Pressure (0.00256*Kz*Kzt*Ke*Kd*V^2*I)	27.97	psf

An explanation of variables:

Asymmetric Lift Load Ratio: This is a ratio describing the leverage created by EcoFoot base dimensions, module attachment location and location of center of ballast mass. Assessed as a multiplier on top of ballast distribution scheme in Image 4.

dLF1= Dead Load of Module and Attributed Racking: the weight of one module and hardware attributed to that module, not including ballast.

Ala= Effective Lift Area of PV Module: The surface area of a module projected onto the horizontal plane for lift calculations.

Ada= Effective Drag Area of PV Module: The surface area of a module projected onto the horizontal plane for drag calculations.

qh= Velocity Pressure at height "h": Calculation prescribed by ASCE7-05, eq. 6-15, and ASCE7-10, eq. 30.3-1, or ASCE7-16 and ASCE 7-22, eq. 26.10-1 (subscript "h" used here for clarity, ASCE7 utilizes subscript "z").

Wind Tunnel Testing, Uplift and Drag Force Calculations

Wind tunnel testing of the EcoFoot product line to determine GCn values has been conducted by Rowan Williams Davies & Irwin Inc. (RWDI), a nationally recognized boundary-layer wind tunnel test firm. Testing was conducted in accordance with ASCE7-05, section 6.6; and ASCE7-10/16/22, section 31.2. Module-specific GCn data allows for precise application of ballast to prevent uplift. Deviation from prescriptive wind GCn values has been addressed according to SEAOC PV2 via a peer review of the wind tunnel testing and results by Maffei Structural Engineering.

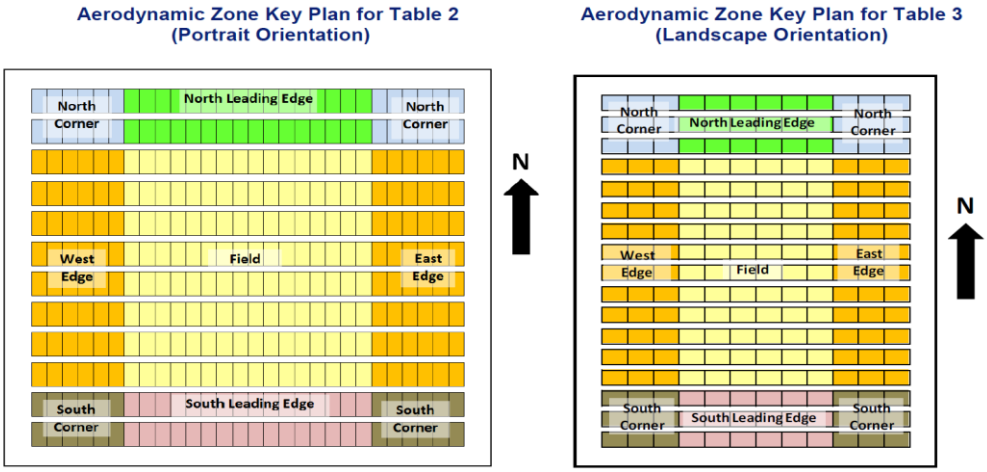
GCn and qh are used to calculate the pressure exerted on each module via the design wind pressure equations (ASCE7-05 – section 6.5.12.4, ASCE7-10 – section 30.4.2, ASCE7-16-30.5.2 and ASCE7-22 – section 30.3.2). Ballast required to offset uplift and drag forces (BWUz) is calculated in accordance with RWDI recoemndations. Detailed calculations for this project are found in Table 4. Resulting required ballast BWUz is displayed graphically in Image 3.

Table 4: Ballast to Resist Uplift Calculations for Project Proposed in Ann Arbor, MI 48104

			Load Sharing Area						
		#col x #rows	2x2	2x3			3x2	3x3	Down (1x1)
North Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.5	-8.3			-7.4	-6.9	17.8
	WLFUz=Uplift wind force =pUz*Ala	lbs.	-260.0	-228.5			-204.9	-189.1	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-105.9	-87.0			-72.8	-63.3	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	176.5	145.0			121.3	105.6	
North Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-7.4	-6.6			-6.3	-5.7	16.3
	WLFUz=Uplift wind force =pUz*Ala	lbs	-204.9	-181.2			-173.3	-157.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-72.8	-58.6			-53.9	-44.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	121.3	97.7			89.8	74.1	
E/W Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.5	-6.9			-7.4	-5.7	17.8
	WLFUz=Uplift wind force =pUz*Ala	lbs	-260.0	-189.1			-204.9	-157.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-105.9	-63.3			-72.8	-44.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	176.5	105.6			121.3	74.1	
Field	pUz=Uplift design wind pressure =qh*GCnUz	psf	-7.4	-6.6			-6.3	-5.7	16.3
	WLFUz=Uplift wind force =pUz*Ala	lbs	-204.9	-181.2			-173.3	-157.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-72.8	-58.6			-53.9	-44.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	121.3	97.7			89.8	74.1	
South Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.5	-6.9			-8.0	-5.7	17.8
	WLFUz=Uplift wind force =pUz*Ala	lbs	-260.0	-189.1			-220.6	-157.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-105.9	-63.3			-82.2	-44.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	176.5	105.6			137.1	74.1	
South Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-8.6	-6.6			-7.4	-5.7	16.3
	WLFUz=Uplift wind force =pUz*Ala	lbs	-236.4	-181.2			-204.9	-157.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-91.7	-58.6			-72.8	-44.4	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	152.8	97.7			121.3	74.1	

The aerodynamic differences among different sub-sections of a large array are handled by various calculation sections (North Corner, North Edge, E/W Edge...) and apply according to the excerpt from the RWDI report shown below in Image 1. The highlighted sections of Table 4 correspond to specific module locations, also shown in Image 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for expanded calculations pertaining to the highlighted sections.

Image 1: Aerodynamic Zones from RWDI Report



To check the amount of drag a given sub-array will experience, the equation in Image 2 is utilized - an excerpt from RWDI's test report. Each sub-array is checked for sliding, proceeding from the smallest to largest or until drag no longer governs total required ballast.

Table 5 lists the calculations used to identify the total required ballast to counteract drag forces and prevent sliding. Friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients. Unless detailed information is available pertaining to the location of the sub-array, the roof's worst case uplift GCp are utilized in calculating drag and required ballast.

Image 2: Ballast to Resist Sliding Equation

Ballast (lb) to Resist Sliding

$$\alpha_D \cdot Ballast_{drag} = \alpha_W \cdot q_z \cdot \left[(GC_p)^*_{drag} \cdot A_{drag} \cdot \left(\frac{1}{f_n}\right) + |GC_p|^*_{uplift} \cdot A_{uplift} \right] - \alpha_D \cdot M \qquad (lb)$$

Table 5: Ballast to Resist Sliding Calculation

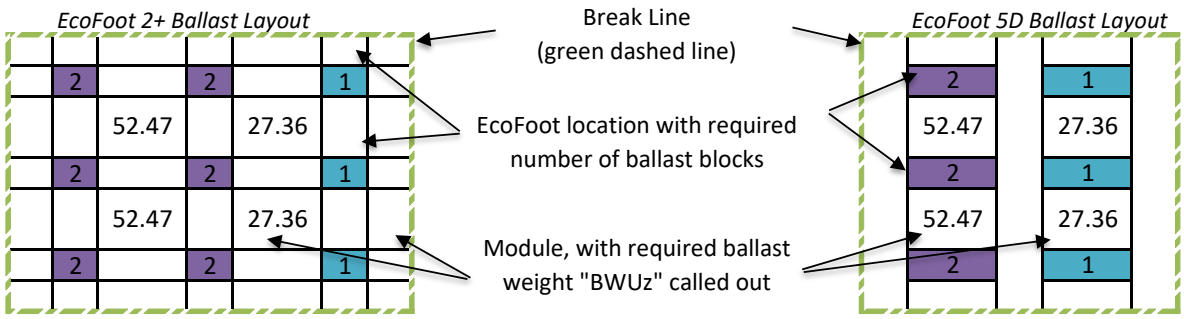
Sub-Array Module Count Total:	16
a_w = Wind Load Combination Factor =	0.6
a_d = Dead Load Combination Factor =	0.6
qz (qh in Table 3)	27.97
M = dLF1 from Table 3 =	83.53
f_n (also see Table 1) =	0.37
A_{uplift} = Ala in Table 3 =	27.51
A_{drag} = Ada in Table 3 =	4.07
$GC_{p\text{-drag}}$	1.42
$GC_{p\text{-uplift}}$	-0.62
Area Reduction Factor =	0.31
$(GCp)^*_{drag}$ =	0.44
$\lvert GCp \rvert^*_{uplift}$ =	0.19
Total Required Ballast Weight (Per Image 2)=	**3183.96**
$W_{ballastblock}$ =	32
Total Required Ballast Blocks:	**100**

Ballast Application to Sheet S-1.0

For easier interpretation, the results calculated in Table 4 are laid out in graphical representations of a solar array, shown in Image 4. Unirac engineers and drafters make use of this graphical layout when applying ballast to a given system design.

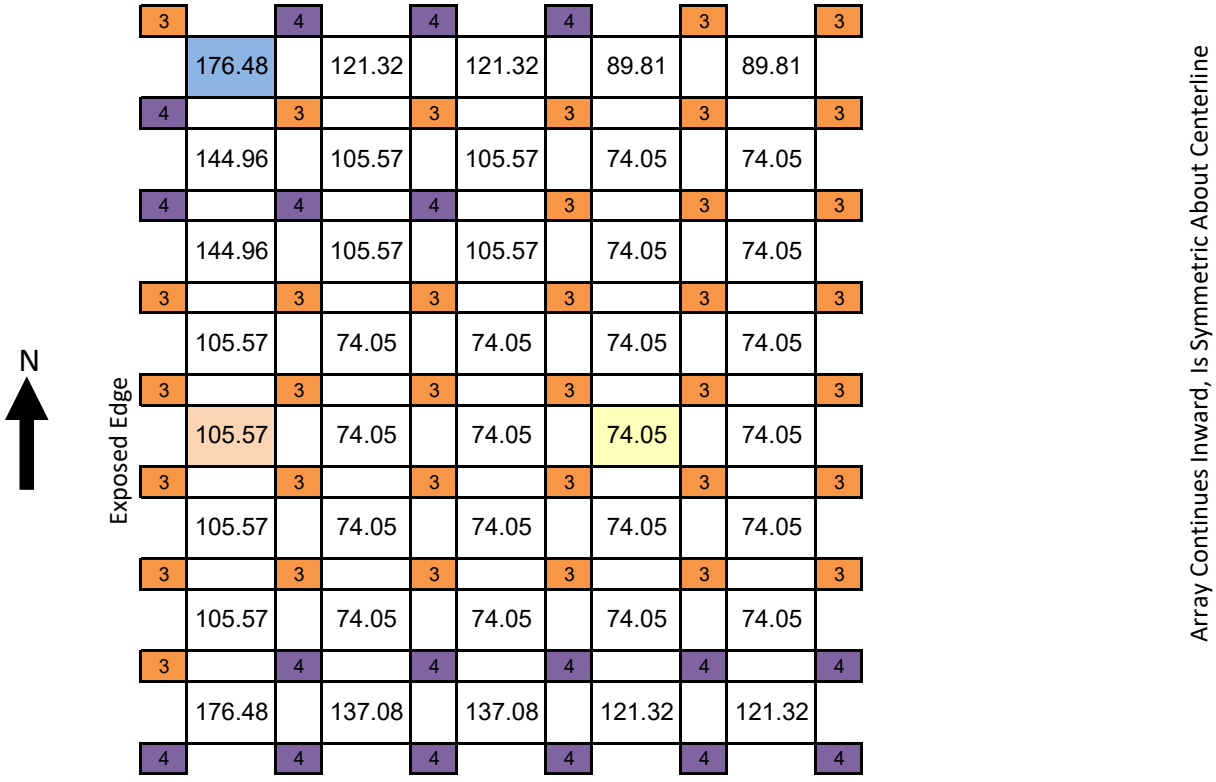
As shown in Image 3, the ballast required to resist lift - BWUz from Table 4 - is listed for each module location in Image 4. A portion of each BWUz value is distributed to each of the connected EcoFoot Bases, also detailed in Image 3 and included in Image 4. The total ballast required at each EcoFoot location is then calculated and rounded up to the next ballast block increment.

Image 3: Example of Module and Ballast Graphical Representation



The ballast prescription array shown in Image 4 is one of many similar arrays created automatically through EcoCalcs in order to address all possible array configurations. The data calculated in Table 4 was ultimately used to assign ballast to the system design in Sheet S-1.0 by Unirac. EcoCalcs and the resulting ballast plan S-1.0 are reviewed by CBC Engineers for correctness and completeness. Once approved, an engineering report including Sheet S-1.0 and any supporting material (this explanation included) are stamped and sealed by a professional engineer registered in the state where the project is proposed.

Image 4: Ballast Prescriptions Produced by Table 4



NOTE: The colored module locations in Image 4 correspond to the same colored areas in Table 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for more detailed calculations.

Detailed Calculations From Table 4

North Corner Module		
GCn Value from RWDI report:	-0.34	
qh value from Table 3:	27.97	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-9.45	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-260.01	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-105.89	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	176.48	lbf

East/West Edge Module		
GCn Value from RWDI report:	-0.25	
qh value from Table 3:	27.97	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-6.87	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-189.10	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-63.34	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	105.57	lbf

Interior Module		
GCn Value from RWDI report:	-0.20	
qh value from Table 3:	27.97	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-5.73	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-157.58	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-44.43	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	74.05	lbf

Max downpoint load calculations

No of Mid supports	1	
Tributary Area to support/bays/base	0.5	of module area
Wind force down (WL)	244 lbs	
Snow load Down (SL)	330.13 lbs	
Total Dead load per Bay (DL)	145.36 lbs	

Load Combinations

DL+ SL	475.49 lbs
DL+0.6WL	291.91 lbs
DL+0.75SL+0.45WL	**502.87 lbs**

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SEAOC PV1 - 2012 - Section 4: attached Arrays

Unirac utilizes the unattached design approach to account for seismic force as provided for by Section 16 of the 2016 California Building Code, the Structural Engineering Association of California PV1 Requirements (SEAOC PV1-2012) and ASCE 7. Section 1613.5 defines “Ballasted Photovoltaic System” which also defines "partially attached" systems, and provides guidance for designing arrays that utilize physical anchors and friction to resist seismic forces. SEAOC PV1 or ASCE 7 Chapter 13 defines the calculations required design attached photovoltaic systems, including friction to partially offset seismic forces.

The following explanation walks through calculations outlined in Section 4 - Attached Arrays. The attached approach begins with the project specific design criteria outlined in Table 6. These values reflect site inputs as well as assumptions permitted in the SEAOC PV1-2012 document Section 4 and ASCE 7 chapter 13 .

Table 6: Seismic Design Inputs

Number of blocks per Ecofoot	6.00
Wp=Weight per unit	275.53
Site Class	D
Seismic Design Category	0.00
Ip	1.50
Rp	1.50
'Seismic Calcs (Attached)'!A9	1.00
Fa (Site Class D)	1.6
Sms = Fa x Ss	0.15
Sds = (2/3) x Sms	0.10

Table 7: ASCE7 Inputs

z=height of point of attachment (in.)	1.00
h=structure height compared to base (in.)	1.00
Fp=0.4*ap*Sds*Wp*(1+2*z/h)/(Rp/Ip)	33.15
Fp=1.6*Sds*Ip*Wp	66.30
Fp=0.3*Sds*Ip*Wp	12.43
Fp	33.15
Fp (ASD)	23.21

SEAOC PV1 specifies that “PV support systems that are attached to the roof structure shall be designed to resist the lateral seismic force *Fp* specified in ASCE 7-16/22 Chapter 13.” Although SEAOC PV1 was released prior to ASCE 7-16/22, *Fp* is defined the same way in Chapter 13 of both ASCE verions 7-10, 7-16 and 7-22. Therefore the lateral seismic force analysis applied is valid for both ASCE 7-10, 16 and 22. In utilizing the *Fp* calculations for nominal, minimum, and maximum values laid out in Section 13.3.1, the values in Table 7 are found.

The following is excerpted from SEAOC PV1-2012, Section 4 – Attached Arrays:

“For attached roof-bearing systems, friction is permitted to contribute in combination with the design lateral strength of attachments to resist the lateral force Fp when all of the following conditions are met:

- “The maximum roof slope at the location of the array is less than or equal to 7 degrees (12.3 percent);
- “The height above the roof surface to the center of mass of the solar array is less than the smaller of 36 inches and half the least plan dimension of the supporting base of the array
- “Rp shall not exceed 1.5 unless it is shown that the lateral displacement behavior of attachments is compatible with the simultaneous development of frictional resistance.”

The EcoFoot 2+ and EcoFoot 5D systems have been demonstrated to be in conformance with the above stated stipulations. As such, and in accordance with the remainder of Section 4 – Attached Arrays from SEAOC PV1-2012, the force required to resist movement due to seismic shifting is calculated. Based on the minimum ultimate shear strength of the roof mounting method prescribed for this job, the total lateral load that one attachment may offset is calculated, and by extension the number of modules allowed per attachment point. These values can be found in Table 8.

All friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients, methodology that is in agreement with SEAOC PV2 and Los Angeles, CA stipulations.

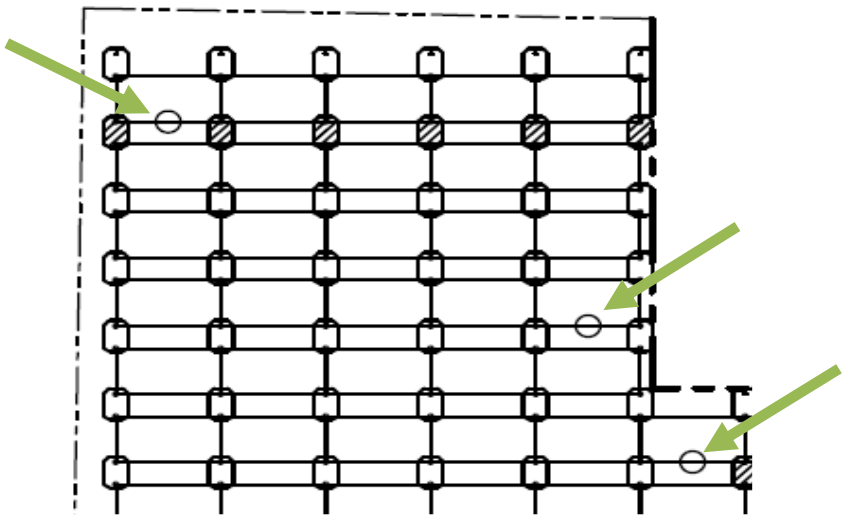
Table 8: Calculation of Physical Attachment Requirements

Friction Coefficient	0.37	*ASTM G115 Tested*
Ff (max friction) = (0.6-0.14*Sds)*(0.7*u)*Wp	41.93	*SEAOC section 4 (ASD), Friction Force*
Excess force per unit	-18.72	*Force to be offset by physical attachments*
Attachment system rating (allowable)	634.91	*ASD design load*
Number of panels per attachment	-33.91	*(if negative, no fasteners are needed)*

This final number of panels per attachment represents the maximum number of modules that any given attachment point may account for in terms of offsetting seismic force Fp. Physical attachments shall be installed per the manufacturer's instructions, and attached to the EcoFoot 2+ or EcoFoot 5D system per the installation instructions provided by Unirac.

On Sheet S-1.0 physical attachments are called out as shown below in Image 5:

Image 5: Example of ballast layout with seismic attachment callouts



SOLAR PROJECT DESIGN

Prepared For: Nova Consultants Inc
Project Name: City Hall
Project Address: 301 East Huron Street, Ann Arbor, MI 48104
Date: June 5, 2024

SOLUTION OVERVIEW

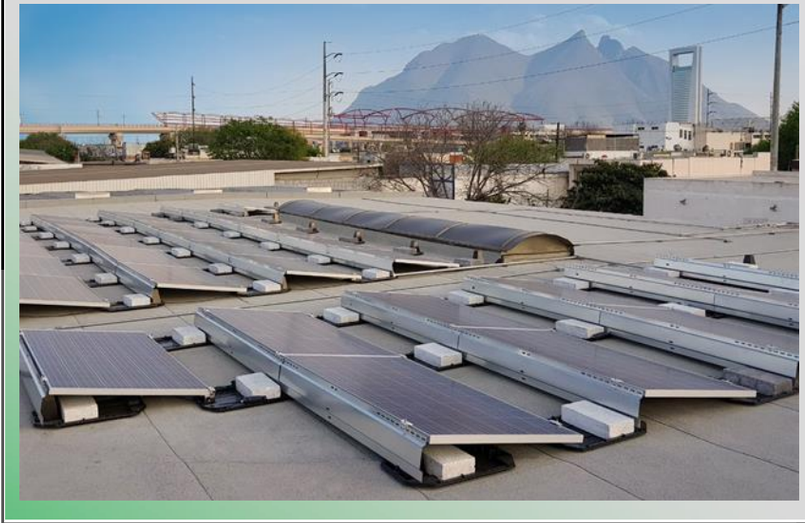
EcoFoot2+ Low-Slope Racking

With 500MW installed, EcoFoot Racking is preferred by installers for fast, simple installation and streamlined logistics. The enclosed provides the layout and system details for a complete solution for your project using this validated and reliable product.

EcoFoot2+ delivers key advantages for a successful, efficient installation.
Faster Installation: Installers complete projects in less time with self-aligning Bases, simple pre-assembled components, five-minute learning curve, and one-tool installation. Install speed is rated at 13.5 modules/installer-hour by DNV-GL.

Low Part Count & Streamlined Logistics: EcoFoot2+ consists of three core components: roof friendly, durable Base with integrated north/south Wire Clips, pre-assembled Clamps, and Wind Deflector to reduce ballast and provide east/west bonding. Stackable Bases fit up to 50kW per pallet, meaning fewer crane lifts and less space used on the job site.

Dedicated Support: Experienced project managers and field technicians support your project from bid to inspection. Project managers ensure you have needed details to obtain a permit and pass inspection. Our field team offers a dedicated phone line and email. On-site training is available.



VICINTY MAP

PROJECT SPECIFICATIONS

SYSTEM INFORMATION	
Total System Size (KW)	16.82
Total Module Quantity	29
Module Orientation	Landscape
EQUIPMENT	
Module Manufacturer	Jinko
Module Model	JKM 580N-72HL4-BDV
Module Wattage	580
Module Length (in.)	89.69
Module Width (in.)	44.65
Module Weight (lbs)	68.34
BUILDING DATA	
Roof Type	Other
Parapet Height (in)	6
Setback (in)	48
Roof Height (ft)	80
Roof Slope (degrees)	1.20
DESIGN VALUES	
ASCE Version	2010
Basic Windspeed (mph)	120
Wind Exposure Category	B
Occupancy Category	IV
Ground Snow Load (lb/ft^2)	20

DESIGN IS FINALIZED WHEN ACCOMPANIED BY STAMPED ENGINEERING REPORT.

CONTRACTOR IS RESPONSIBLE FOR VERIFYING ROOF CAPACITY.
CONTRACTOR IS RESPONSIBLE FOR CONFIRMING ALL DESIGN CRITERIA ARE CORRECT AND APPROPRIATE FOR THE PROJECT SITE.
CONTRACTOR MUST CONFIRM DESIGN MEETS ALL UTILITY AND AHJ REQUIREMENTS.
CONTRACTOR IS RESPONSIBLE FOR VERIFYING THAT BUILDING STRUCTURE AND RELATED CONNECTIONS CAN SUPPORT ALL LOADS IMPOSED BY PV SYSTEM.
REFER TO INSTALLATION MANUAL FOR FULL PRODUCT DETAILS AND ADDITIONAL INFORMATION.

Uplift, Sliding and Seismic Calculations

Explanation of EcoFoot System Calculations and Design Procedure

Installer Name:	Nova Consultants Inc
Project Name:	City Hall
Project Address:	301 East Huron Street Ann Arbor, MI 48104
Date Prepared:	6/5/2024

Calculation Explanation Key Sections:

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Below, Table 1 and Table 2 list the design criteria and project details for a proposed system in Ann Arbor, MI. These values will be used throughout the remainder of this explanation.

Table 1: System Design Criteria

Product Line	EcoFoot 2+
ASCE7 Version	2010
Ground Elevation (ft)	N/A
Roof Type	Other
Roof Height (ft.)	80
Roof Slope (deg)	1.20
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Parapet Height (in.)	6
3 Sec. Gust (mph)	120
Occupancy Category	IV
Wind Exposure	B
Snow Load (psf)	20.0
Seismic Data (SS)	0.0940
Soil Site Class	D-Stiff Soil
Coeff. Of Friction (fn)*	0.37

**req's slip sheets*

Table 2: PV Module Specifics

Module Manufacturer	Jinko
Module Model	JKM 580N-72HL4-BDV
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Module Length (in)	89.69
Module Width (in)	44.65
Module Weight (lbs.)	68.34

Utilizing the inputs from Tables 1 and 2, the factors in Table 3 are generated for the site. This list of factors is used in various ways to fully define a proposed system according to calculations laid out in the SEAOC and ASCE documents. In the scope of this explanation, factors are used to calculate velocity pressure, qh as defined in ASCE7-05, Section 6.5.10; ASCE7-10, Section 30.3.2; or ASCE7-16 and ASCE7-22, Section 26.10.2, and ultimately the amount of ballast required to offset uplift and drag forces.

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Table 3: Calculation Inputs, Constants, and Variables

Racking Component Weight per Module	15.19	lbs.
Ballast Block Weight	32	lbs.
Asymmetric lift load Ratio (North Row)	1.4	
Asymmetric lift load Ratio (South Row)	1.6	
Ala= Effective Lift Area of PV Module	27.511	ft^2
Ada= Effective Drag Area of PV Module	4.07	ft^2
dLF1= Dead Load of Module and Attributed Racking	83.528	lbs.
Roof Setback Minimum	48	in.
Load Combination Factor for Wind	0.6	
Load Combination Factor for Seismic	0.7	
α (from ASCE7 Table 6-2 or 26.9.1 or 26.11-1)=	7	
zg (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	1200	ft.
zmin (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	30	ft.
z selected (from zmin & inputs)=	80	ft.
Kz= Velocity pressure exposure coefficient at height	0.93	
Kzt= Topographic Factor	1	
Kd= Directionality Factor	0.85	
Ke= Ground Elevation Factor	1	
Wind design load factor	0.6	
Dead Load design load factor	0.6	
qh_wind= Velocity Pressure (0.00256*Kz*Kzt*Ke*Kd*V^2*I)	29.05	psf

An explanation of variables:

Asymmetric Lift Load Ratio: This is a ratio describing the leverage created by EcoFoot base dimensions, module attachment location and location of center of ballast mass. Assessed as a multiplier on top of ballast distribution scheme in Image 4.

dLF1= Dead Load of Module and Attributed Racking: the weight of one module and hardware attributed to that module, not including ballast.

Ala= Effective Lift Area of PV Module: The surface area of a module projected onto the horizontal plane for lift calculations.

Ada= Effective Drag Area of PV Module: The surface area of a module projected onto the horizontal plane for drag calculations.

qh= Velocity Pressure at height "h": Calculation prescribed by ASCE7-05, eq. 6-15, and ASCE7-10, eq. 30.3-1, or ASCE7-16 and ASCE 7-22, eq. 26.10-1 (subscript "h" used here for clarity, ASCE7 utilizes subscript "z").

Wind Tunnel Testing, Uplift and Drag Force Calculations

Wind tunnel testing of the EcoFoot product line to determine GCn values has been conducted by Rowan Williams Davies & Irwin Inc. (RWDI), a nationally recognized boundary-layer wind tunnel test firm. Testing was conducted in accordance with ASCE7-05, section 6.6; and ASCE7-10/16/22, section 31.2. Module-specific GCn data allows for precise application of ballast to prevent uplift. Deviation from prescriptive wind GCn values has been addressed according to SEAOC PV2 via a peer review of the wind tunnel testing and results by Maffei Structural Engineering.

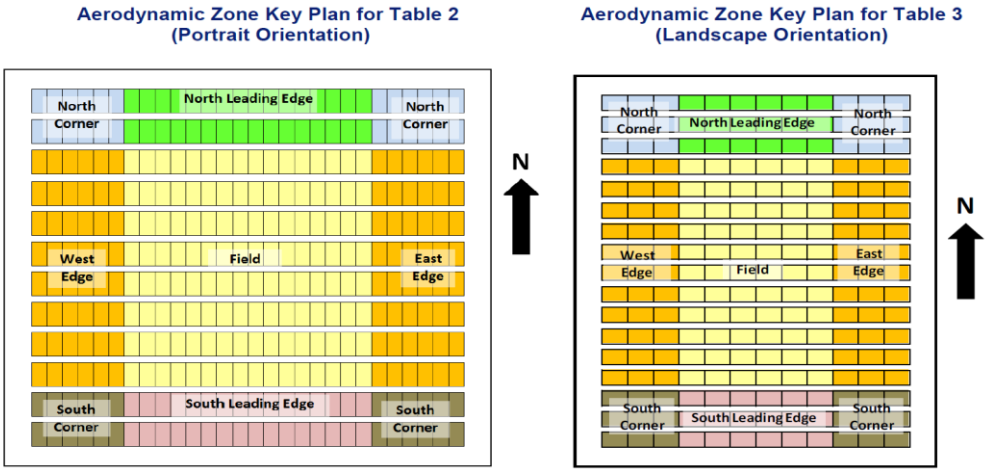
GCn and qh are used to calculate the pressure exerted on each module via the design wind pressure equations (ASCE7-05 – section 6.5.12.4, ASCE7-10 – section 30.4.2, ASCE7-16-30.5.2 and ASCE7-22 – section 30.3.2). Ballast required to offset uplift and drag forces (BWUz) is calculated in accordance with RWDI recoemndations. Detailed calculations for this project are found in Table 4. Resulting required ballast BWUz is displayed graphically in Image 3.

Table 4: Ballast to Resist Uplift Calculations for Project Proposed in Ann Arbor, MI 48104

			Load Sharing Area						
		#col x #rows	2x2	2x3			3x2	3x3	Down (1x1)
North Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.4	-8.4			-7.6	-6.9	23.0
	WLFUz=Uplift wind force =pUz*Ala	lbs.	-259.9	-229.7			-209.3	-189.8	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-105.8	-87.7			-75.5	-63.8	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	176.4	146.2			125.8	106.3	
North Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-8.6	-7.5			-7.2	-6.1	18.0
	WLFUz=Uplift wind force =pUz*Ala	lbs	-235.9	-206.7			-196.9	-168.5	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-91.4	-73.9			-68.0	-51.0	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	152.4	123.1			113.4	85.0	
E/W Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.4	-7.9			-7.6	-6.8	23.0
	WLFUz=Uplift wind force =pUz*Ala	lbs	-259.9	-216.4			-209.3	-186.3	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-105.8	-79.7			-75.5	-61.6	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	176.4	132.9			125.8	102.7	
Field	pUz=Uplift design wind pressure =qh*GCnUz	psf	-8.6	-7.5			-7.2	-6.1	18.0
	WLFUz=Uplift wind force =pUz*Ala	lbs	-235.9	-206.7			-196.9	-168.5	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-91.4	-73.9			-68.0	-51.0	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	152.4	123.1			113.4	85.0	
South Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.4	-7.9			-7.7	-6.8	23.0
	WLFUz=Uplift wind force =pUz*Ala	lbs	-259.9	-216.4			-211.1	-186.3	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-105.8	-79.7			-76.5	-61.6	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	176.4	132.9			127.6	102.7	
South Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-8.7	-7.5			-7.3	-6.1	18.0
	WLFUz=Uplift wind force =pUz*Ala	lbs	-239.5	-206.7			-200.5	-168.5	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-93.6	-73.9			-70.2	-51.0	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	156.0	123.1			116.9	85.0	

The aerodynamic differences among different sub-sections of a large array are handled by various calculation sections (North Corner, North Edge, E/W Edge...) and apply according to the excerpt from the RWDI report shown below in Image 1. The highlighted sections of Table 4 correspond to specific module locations, also shown in Image 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for expanded calculations pertaining to the highlighted sections.

Image 1: Aerodynamic Zones from RWDI Report



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To check the amount of drag a given sub-array will experience, the equation in Image 2 is utilized - an excerpt from RWDI's test report. Each sub-array is checked for sliding, proceeding from the smallest to largest or until drag no longer governs total required ballast.

Table 5 lists the calculations used to identify the total required ballast to counteract drag forces and prevent sliding. Friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients. Unless detailed information is available pertaining to the location of the sub-array, the roof's worst case uplift GCp are utilized in calculating drag and required ballast.

Image 2: Ballast to Resist Sliding Equation

Ballast (lb) to Resist Sliding

$$\alpha_D \cdot Ballast_{drag} = \alpha_W \cdot q_z \cdot \left[(GC_p)^*_{drag} \cdot A_{drag} \cdot \left(\frac{1}{f_n}\right) + |GC_p|^*_{uplift} \cdot A_{uplift} \right] - \alpha_D \cdot M \qquad (lb)$$

Table 5: Ballast to Resist Sliding Calculation

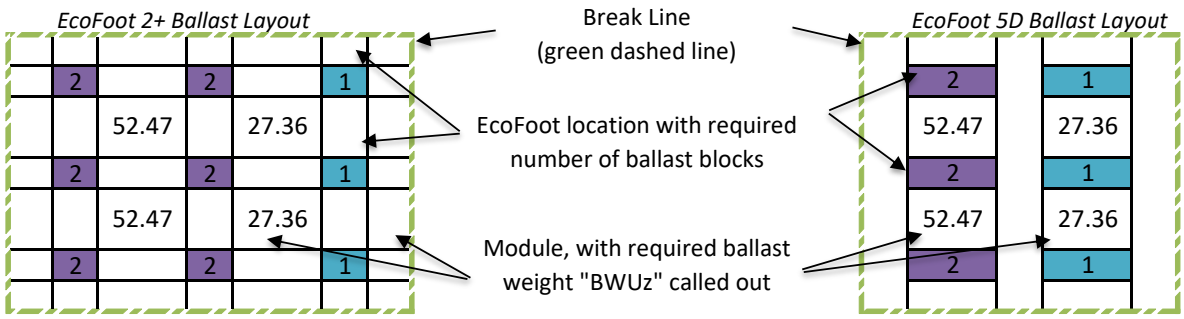
Sub-Array Module Count Total:	16
a_w = Wind Load Combination Factor =	0.6
a_d = Dead Load Combination Factor =	0.6
qz (qh in Table 3)	29.05
M = dLF1 from Table 3 =	83.53
f_n (also see Table 1) =	0.37
A_{uplift} = Ala in Table 3 =	27.51
A_{drag} = Ada in Table 3 =	4.07
$GC_{p\text{-}drag}$	1.65
$GC_{p\text{-}uplift}$	-0.66
Area Reduction Factor =	0.31
$(GCp)^*_{drag}$ =	0.51
$\lvert GCp \rvert^*_{uplift}$ =	0.21
Total Required Ballast Weight (Per Image 2)=	**3920.40**
$W_{ballastblock}$ =	32
Total Required Ballast Blocks:	**123**

Ballast Application to Sheet S-1.0

For easier interpretation, the results calculated in Table 4 are laid out in graphical representations of a solar array, shown in Image 4. Unirac engineers and drafters make use of this graphical layout when applying ballast to a given system design.

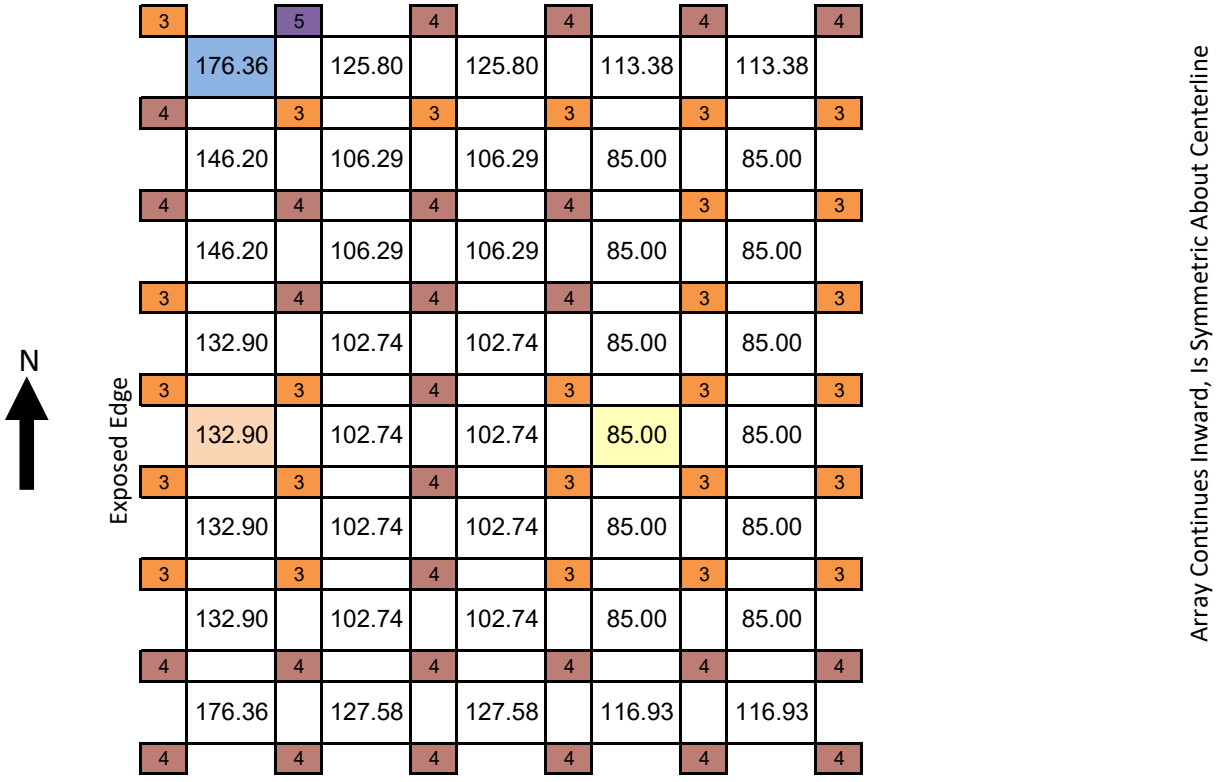
As shown in Image 3, the ballast required to resist lift - BWUz from Table 4 - is listed for each module location in Image 4. A portion of each BWUz value is distributed to each of the connected EcoFoot Bases, also detailed in Image 3 and included in Image 4. The total ballast required at each EcoFoot location is then calculated and rounded up to the next ballast block increment.

Image 3: Example of Module and Ballast Graphical Representation



The ballast prescription array shown in Image 4 is one of many similar arrays created automatically through EcoCalcs in order to address all possible array configurations. The data calculated in Table 4 was ultimately used to assign ballast to the system design in Sheet S-1.0 by Unirac. EcoCalcs and the resulting ballast plan S-1.0 are reviewed by CBC Engineers for correctness and completeness. Once approved, an engineering report including Sheet S-1.0 and any supporting material (this explanation included) are stamped and sealed by a professional engineer registered in the state where the project is proposed.

Image 4: Ballast Prescriptions Produced by Table 4



NOTE: The colored module locations in Image 4 correspond to the same colored areas in Table 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for more detailed calculations.

Detailed Calculations From Table 4

North Corner Module		
GCn Value from RWDI report:	-0.33	
qh value from Table 3:	29.05	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-9.45	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-259.89	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-105.82	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	176.36	lbf

East/West Edge Module		
GCn Value from RWDI report:	-0.27	
qh value from Table 3:	29.05	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-7.87	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-216.43	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-79.74	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	132.90	lbf

Interior Module		
GCn Value from RWDI report:	-0.21	
qh value from Table 3:	29.05	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-6.13	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-168.53	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-51.00	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	85.00	lbf

Max downpoint load calculations

No of Mid supports	1	
Tributary Area to support/bays/base	0.5	of module area
Wind force down (WL)	316 lbs	
Snow load Down (SL)	330.13 lbs	
Total Dead load per Bay (DL)	145.36 lbs	

Load Combinations

DL+ SL	475.49 lbs
DL+0.6WL	334.82 lbs
DL+0.75SL+0.45WL	**535.06 lbs**

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SEAOC PV1 - 2012 - Section 4: attached Arrays

Unirac utilizes the unattached design approach to account for seismic force as provided for by Section 16 of the 2016 California Building Code, the Structural Engineering Association of California PV1 Requirements (SEAOC PV1-2012) and ASCE 7. Section 1613.5 defines “Ballasted Photovoltaic System” which also defines "partially attached" systems, and provides guidance for designing arrays that utilize physical anchors and friction to resist seismic forces. SEAOC PV1 or ASCE 7 Chapter 13 defines the calculations required design attached photovoltaic systems, including friction to partially offset seismic forces.

The following explanation walks through calculations outlined in Section 4 - Attached Arrays. The attached approach begins with the project specific design criteria outlined in Table 6. These values reflect site inputs as well as assumptions permitted in the SEAOC PV1-2012 document Section 4 and ASCE 7 chapter 13 .

Table 6: Seismic Design Inputs

Number of blocks per Ecofoot	6.00
Wp=Weight per unit	275.53
Site Class	D-Stiff Soil
Seismic Design Category	0.00
Ip	1.50
Rp	1.50
'Seismic Calcs (Attached)'!A9	1.00
Fa (Site Class E)	2.5
Sms = Fa x Ss	0.15
Sds = (2/3) x Sms	0.10

Table 7: ASCE7 Inputs

z=height of point of attachment (in.)	1.00
h=structure height compared to base (in.)	1.00
Fp=0.4*ap*Sds*Wp*(1+2*z/h)/(Rp/Ip)	33.15
Fp=1.6*Sds*Ip*Wp	66.30
Fp=0.3*Sds*Ip*Wp	12.43
Fp	33.15
Fp (ASD)	23.21

SEAOC PV1 specifies that “PV support systems that are attached to the roof structure shall be designed to resist the lateral seismic force *Fp* specified in ASCE 7-16/22 Chapter 13.” Although SEAOC PV1 was released prior to ASCE 7-16/22, *Fp* is defined the same way in Chapter 13 of both ASCE verions 7-10, 7-16 and 7-22. Therefore the lateral seismic force analysis applied is valid for both ASCE 7-10, 16 and 22. In utilizing the *Fp* calculations for nominal, minimum, and maximum values laid out in Section 13.3.1, the values in Table 7 are found.

The following is excerpted from SEAOC PV1-2012, Section 4 – Attached Arrays:

“For attached roof-bearing systems, friction is permitted to contribute in combination with the design lateral strength of attachments to resist the lateral force Fp when all of the following conditions are met:

- “The maximum roof slope at the location of the array is less than or equal to 7 degrees (12.3 percent);
- “The height above the roof surface to the center of mass of the solar array is less than the smaller of 36 inches and half the least plan dimension of the supporting base of the array
- “Rp shall not exceed 1.5 unless it is shown that the lateral displacement behavior of attachments is compatible with the simultaneous development of frictional resistance.”

The EcoFoot 2+ and EcoFoot 5D systems have been demonstrated to be in conformance with the above stated stipulations. As such, and in accordance with the remainder of Section 4 – Attached Arrays from SEAOC PV1-2012, the force required to resist movement due to seismic shifting is calculated. Based on the minimum ultimate shear strength of the roof mounting method prescribed for this job, the total lateral load that one attachment may offset is calculated, and by extension the number of modules allowed per attachment point. These values can be found in Table 8.

All friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients, methodology that is in agreement with SEAOC PV2 and Los Angeles, CA stipulations.

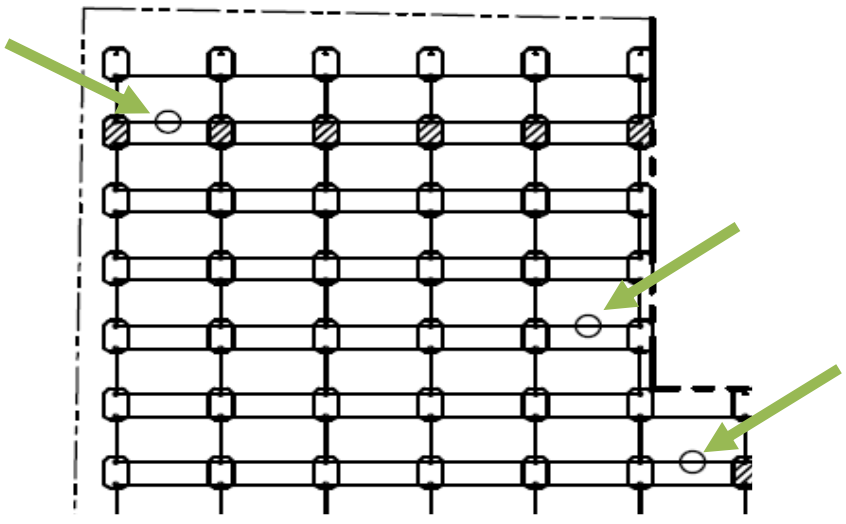
Table 8: Calculation of Physical Attachment Requirements

Friction Coefficient	0.37	*ASTM G115 Tested*
Ff (max friction) = (0.6-0.14*Sds)*(0.7*u)*Wp	41.93	*SEAOC section 4 (ASD), Friction Force*
Excess force per unit	-18.72	*Force to be offset by physical attachments*
Attachment system rating (allowable)	634.91	*ASD design load*
Number of panels per attachment	-33.91	*(if negative, no fasteners are needed)*

This final number of panels per attachment represents the maximum number of modules that any given attachment point may account for in terms of offsetting seismic force Fp. Physical attachments shall be installed per the manufacturer's instructions, and attached to the EcoFoot 2+ or EcoFoot 5D system per the installation instructions provided by Unirac.

On Sheet S-1.0 physical attachments are called out as shown below in Image 5:

Image 5: Example of ballast layout with seismic attachment callouts



SOLAR PROJECT DESIGN

Prepared For: Nova Consultants Inc
Project Name: City Hall
Project Address: 301 East Huron Street, Ann Arbor, MI 48104
Date: June 5, 2024

SOLUTION OVERVIEW

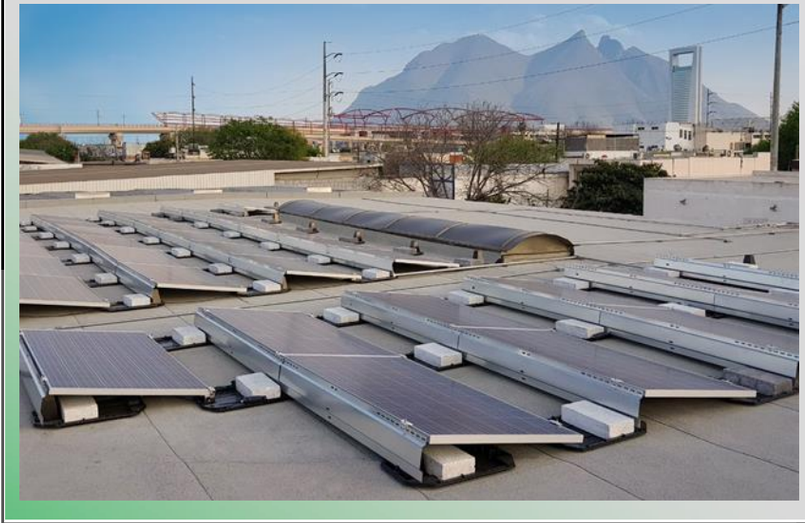
EcoFoot2+ Low-Slope Racking

With 500MW installed, EcoFoot Racking is preferred by installers for fast, simple installation and streamlined logistics. The enclosed provides the layout and system details for a complete solution for your project using this validated and reliable product.

EcoFoot2+ delivers key advantages for a successful, efficient installation.
Faster Installation: Installers complete projects in less time with self-aligning Bases, simple pre-assembled components, five-minute learning curve, and one-tool installation. Install speed is rated at 13.5 modules/installer-hour by DNV-GL.

Low Part Count & Streamlined Logistics: EcoFoot2+ consists of three core components: roof friendly, durable Base with integrated north/south Wire Clips, pre-assembled Clamps, and Wind Deflector to reduce ballast and provide east/west bonding. Stackable Bases fit up to 50kW per pallet, meaning fewer crane lifts and less space used on the job site.

Dedicated Support: Experienced project managers and field technicians support your project from bid to inspection. Project managers ensure you have needed details to obtain a permit and pass inspection. Our field team offers a dedicated phone line and email. On-site training is available.



VICINTY MAP

PROJECT SPECIFICATIONS

SYSTEM INFORMATION	
Total System Size (KW)	16.82
Total Module Quantity	29
Module Orientation	Landscape
EQUIPMENT	
Module Manufacturer	Jinko
Module Model	JKM 580N-72HL4-BDV
Module Wattage	580
Module Length (in.)	89.69
Module Width (in.)	44.65
Module Weight (lbs)	68.34
BUILDING DATA	
Roof Type	Other
Parapet Height (in)	6
Setback (in)	48
Roof Height (ft)	100
Roof Slope (degrees)	1.20
DESIGN VALUES	
ASCE Version	2010
Basic Windspeed (mph)	120
Wind Exposure Category	B
Occupancy Category	IV
Ground Snow Load (lb/ft^2)	20

DESIGN IS FINALIZED WHEN ACCOMPANIED BY STAMPED ENGINEERING REPORT.

CONTRACTOR IS RESPONSIBLE FOR VERIFYING ROOF CAPACITY.
CONTRACTOR IS RESPONSIBLE FOR CONFIRMING ALL DESIGN CRITERIA ARE CORRECT AND APPROPRIATE FOR THE PROJECT SITE.
CONTRACTOR MUST CONFIRM DESIGN MEETS ALL UTILITY AND AHJ REQUIREMENTS.
CONTRACTOR IS RESPONSIBLE FOR VERIFYING THAT BUILDING STRUCTURE AND RELATED CONNECTIONS CAN SUPPORT ALL LOADS IMPOSED BY PV SYSTEM.
REFER TO INSTALLATION MANUAL FOR FULL PRODUCT DETAILS AND ADDITIONAL INFORMATION.

Uplift, Sliding and Seismic Calculations

Explanation of EcoFoot System Calculations and Design Procedure

Installer Name:	Nova Consultants Inc
Project Name:	City Hall
Project Address:	301 East Huron Street Ann Arbor, MI 48104
Date Prepared:	6/5/2024

Calculation Explanation Key Sections:

Table Of Figures:

3rd Party Engineering Resources

Rowan, Williams, Davies, & Irwin Inc (RWDI) -- Wind Tunnel Testing Per ASCE 7 / IBC
Maffei Structural Engineering -- Peer Review of Wind Tunnel Testing
Testing Engineers, Inc. -- Friction Testing per ASTM G115
CBC Engineers -- Professional Engineering Review and Certification

Introduction, Site Specifics and Variable Definition

In order to efficiently design EcoFoot2+ and EcoFoot5D ballasted photovoltaic systems, Unirac makes use of a proprietary solar array design aid called “EcoCalcs”. Starting with a set of design criteria, shown here in Table 1 below, EcoCalcs utilizes methodologies laid out in the ASCE7 and SEAOC PV1/PV2 documents, and derivative building codes. Actual calculations for this project are included herein, and are accompanied by a step-by-step explanation of Unirac's design process.

The output of EcoCalcs is a comprehensive set of ballast prescriptions, including Image 3 found on Page 6. Ballast prescriptions are applied to a proposed system layout by the Unirac engineering team. Engineering Alliance, Unirac's professional engineering partner, has reviewed and verified EcoCalcs and reviews system designs to ensure that calculations and ballast prescriptions were correctly applied. Upon successful review, Engineering Alliance provides a stamped design review including relevant supporting documentation (this explanation included) and a stamped, approved ballast plan.

Please note: Unirac and Engineering Alliance are not conducting a structural review of the proposed site.

Below, Table 1 and Table 2 list the design criteria and project details for a proposed system in Ann Arbor, MI. These values will be used throughout the remainder of this explanation.

Table 1: System Design Criteria

Product Line	EcoFoot 2+
ASCE7 Version	2010
Ground Elevation (ft)	N/A
Roof Type	Other
Roof Height (ft.)	100
Roof Slope (deg)	1.20
Min Edge Setback (in)	48
Parapet Height (in.)	6
3 Sec. Gust (mph)	120
Occupancy Category	IV
Wind Exposure	B
Snow Load (psf)	20.0
Seismic Data (SS)	0.0940
Soil Site Class	D-Stiff Soil
Coeff. Of Friction (fn)*	0.37

**req's slip sheets*

Table 2: PV Module Specifics

Module Manufacturer	Jinko
Module Model	JKM 580N-72HL4-BDV
Module Orientation	Landscape
Module Power (w)	580
Module Length (in)	89.69
Module Width (in)	44.65
Module Weight (lbs.)	68.34

Utilizing the inputs from Tables 1 and 2, the factors in Table 3 are generated for the site. This list of factors is used in various ways to fully define a proposed system according to calculations laid out in the SEAOC and ASCE documents. In the scope of this explanation, factors are used to calculate velocity pressure, qh as defined in ASCE7-05, Section 6.5.10; ASCE7-10, Section 30.3.2; or ASCE7-16 and ASCE7-22, Section 26.10.2, and ultimately the amount of ballast required to offset uplift and drag forces.

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Table 3: Calculation Inputs, Constants, and Variables

Racking Component Weight per Module	15.19	lbs.
Ballast Block Weight	32	lbs.
Asymmetric lift load Ratio (North Row)	1.4	
Asymmetric lift load Ratio (South Row)	1.6	
Ala= Effective Lift Area of PV Module	27.511	ft^2
Ada= Effective Drag Area of PV Module	4.07	ft^2
dLF1= Dead Load of Module and Attributed Racking	83.528	lbs.
Roof Setback Minimum	48	in.
Load Combination Factor for Wind	0.6	
Load Combination Factor for Seismic	0.7	
α (from ASCE7 Table 6-2 or 26.9.1 or 26.11-1)=	7	
zg (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	1200	ft.
zmin (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	30	ft.
z selected (from zmin & inputs)=	100	ft.
Kz= Velocity pressure exposure coefficient at height	0.99	
Kzt= Topographic Factor	1	
Kd= Directionality Factor	0.85	
Ke= Ground Elevation Factor	1	
Wind design load factor	0.6	
Dead Load design load factor	0.6	
qh_wind= Velocity Pressure (0.00256*Kz*Kzt*Ke*Kd*V^2*I)	30.97	psf

An explanation of variables:

Asymmetric Lift Load Ratio: This is a ratio describing the leverage created by EcoFoot base dimensions, module attachment location and location of center of ballast mass. Assessed as a multiplier on top of ballast distribution scheme in Image 4.

dLF1= Dead Load of Module and Attributed Racking: the weight of one module and hardware attributed to that module, not including ballast.

Ala= Effective Lift Area of PV Module: The surface area of a module projected onto the horizontal plane for lift calculations.

Ada= Effective Drag Area of PV Module: The surface area of a module projected onto the horizontal plane for drag calculations.

qh= Velocity Pressure at height "h": Calculation prescribed by ASCE7-05, eq. 6-15, and ASCE7-10, eq. 30.3-1, or ASCE7-16 and ASCE 7-22, eq. 26.10-1 (subscript "h" used here for clarity, ASCE7 utilizes subscript "z").

Wind Tunnel Testing, Uplift and Drag Force Calculations

Wind tunnel testing of the EcoFoot product line to determine GCn values has been conducted by Rowan Williams Davies & Irwin Inc. (RWDI), a nationally recognized boundary-layer wind tunnel test firm. Testing was conducted in accordance with ASCE7-05, section 6.6; and ASCE7-10/16/22, section 31.2. Module-specific GCn data allows for precise application of ballast to prevent uplift. Deviation from prescriptive wind GCn values has been addressed according to SEAOC PV2 via a peer review of the wind tunnel testing and results by Maffei Structural Engineering.

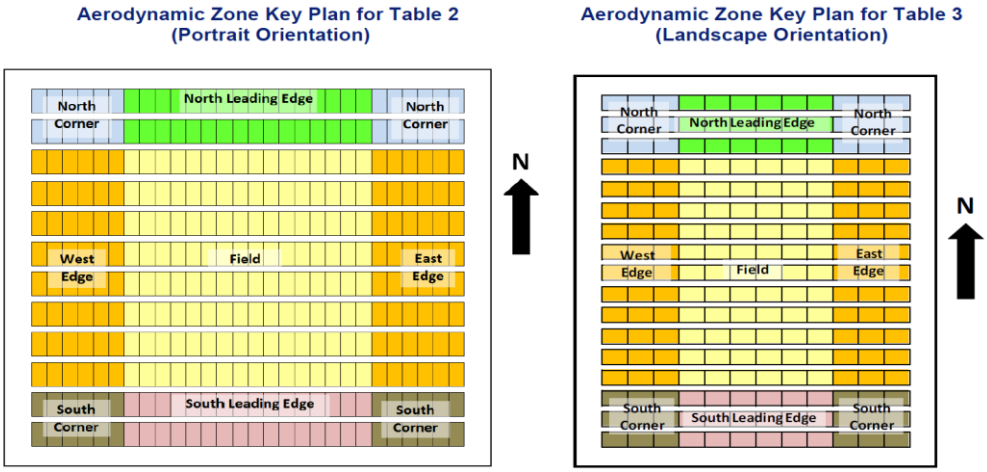
GCn and qh are used to calculate the pressure exerted on each module via the design wind pressure equations (ASCE7-05 – section 6.5.12.4, ASCE7-10 – section 30.4.2, ASCE7-16-30.5.2 and ASCE7-22 – section 30.3.2). Ballast required to offset uplift and drag forces (BWUz) is calculated in accordance with RWDI recoemndations. Detailed calculations for this project are found in Table 4. Resulting required ballast BWUz is displayed graphically in Image 3.

Table 4: Ballast to Resist Uplift Calculations for Project Proposed in Ann Arbor, MI 48104

			Load Sharing Area						
		#col x #rows	2x2	2x3			3x2	3x3	Down (1x1)
North Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-10.2	-9.0			-8.2	-7.5	24.8
	WLFUz=Uplift wind force =pUz*Ala	lbs.	-281.2	-248.6			-226.5	-205.4	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-118.6	-99.0			-85.8	-73.1	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	197.7	165.0			143.0	121.8	
North Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.3	-8.1			-7.7	-6.6	19.4
	WLFUz=Uplift wind force =pUz*Ala	lbs	-255.3	-223.6			-213.0	-182.3	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-103.0	-84.0			-77.7	-59.3	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	171.7	140.1			129.5	98.8	
E/W Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-10.2	-8.5			-8.2	-7.3	24.8
	WLFUz=Uplift wind force =pUz*Ala	lbs	-281.2	-234.2			-226.5	-201.5	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-118.6	-90.4			-85.8	-70.8	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	197.7	150.6			143.0	118.0	
Field	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.3	-8.1			-7.7	-6.6	19.4
	WLFUz=Uplift wind force =pUz*Ala	lbs	-255.3	-223.6			-213.0	-182.3	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-103.0	-84.0			-77.7	-59.3	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	171.7	140.1			129.5	98.8	
South Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-10.2	-8.5			-8.3	-7.3	24.8
	WLFUz=Uplift wind force =pUz*Ala	lbs	-281.2	-234.2			-228.4	-201.5	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-118.6	-90.4			-86.9	-70.8	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	197.7	150.6			144.9	118.0	
South Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-9.4	-8.1			-7.9	-6.6	19.4
	WLFUz=Uplift wind force =pUz*Ala	lbs	-259.1	-223.6			-216.9	-182.3	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-105.3	-84.0			-80.0	-59.3	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	175.6	140.1			133.4	98.8	

The aerodynamic differences among different sub-sections of a large array are handled by various calculation sections (North Corner, North Edge, E/W Edge...) and apply according to the excerpt from the RWDI report shown below in Image 1. The highlighted sections of Table 4 correspond to specific module locations, also shown in Image 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for expanded calculations pertaining to the highlighted sections.

Image 1: Aerodynamic Zones from RWDI Report



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To check the amount of drag a given sub-array will experience, the equation in Image 2 is utilized - an excerpt from RWDI's test report. Each sub-array is checked for sliding, proceeding from the smallest to largest or until drag no longer governs total required ballast.

Table 5 lists the calculations used to identify the total required ballast to counteract drag forces and prevent sliding. Friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients. Unless detailed information is available pertaining to the location of the sub-array, the roof's worst case uplift GCp are utilized in calculating drag and required ballast.

Image 2: Ballast to Resist Sliding Equation

Ballast (lb) to Resist Sliding

$$\alpha_D \cdot Ballast_{drag} = \alpha_W \cdot q_z \cdot \left[(GC_p)^*_{drag} \cdot A_{drag} \cdot \left(\frac{1}{f_n}\right) + |GC_p|^*_{uplift} \cdot A_{uplift} \right] - \alpha_D \cdot M \qquad (lb)$$

Table 5: Ballast to Resist Sliding Calculation

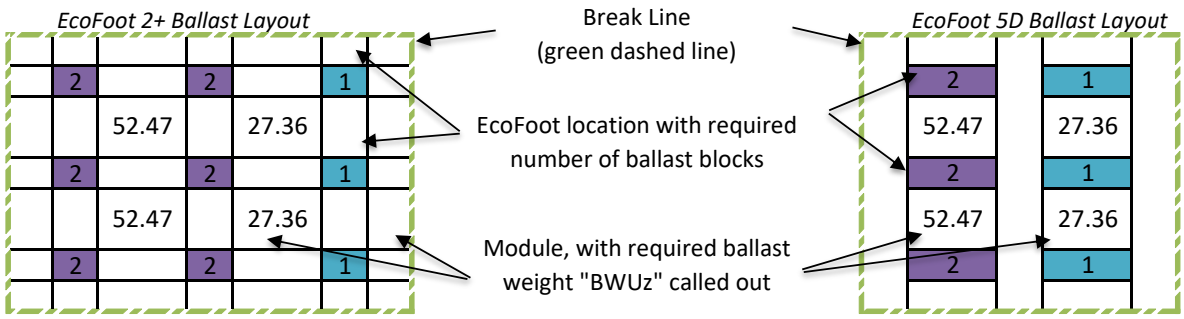
Sub-Array Module Count Total:	16
a_w = Wind Load Combination Factor =	0.6
a_d = Dead Load Combination Factor =	0.6
qz (qh in Table 3)	30.97
M = dLF1 from Table 3 =	83.53
f_n (also see Table 1) =	0.37
A_{uplift} = Ala in Table 3 =	27.51
A_{drag} = Ada in Table 3 =	4.07
$GC_{p\text{-}drag}$	1.67
$GC_{p\text{-}uplift}$	-0.67
Area Reduction Factor =	0.31
$(GCp)^*_{drag}$ =	0.52
$\lvert GCp \rvert^*_{uplift}$ =	0.21
Total Required Ballast Weight (Per Image 2)=	**4351.07**
$W_{ballastblock}$ =	32
Total Required Ballast Blocks:	**136**

Ballast Application to Sheet S-1.0

For easier interpretation, the results calculated in Table 4 are laid out in graphical representations of a solar array, shown in Image 4. Unirac engineers and drafters make use of this graphical layout when applying ballast to a given system design.

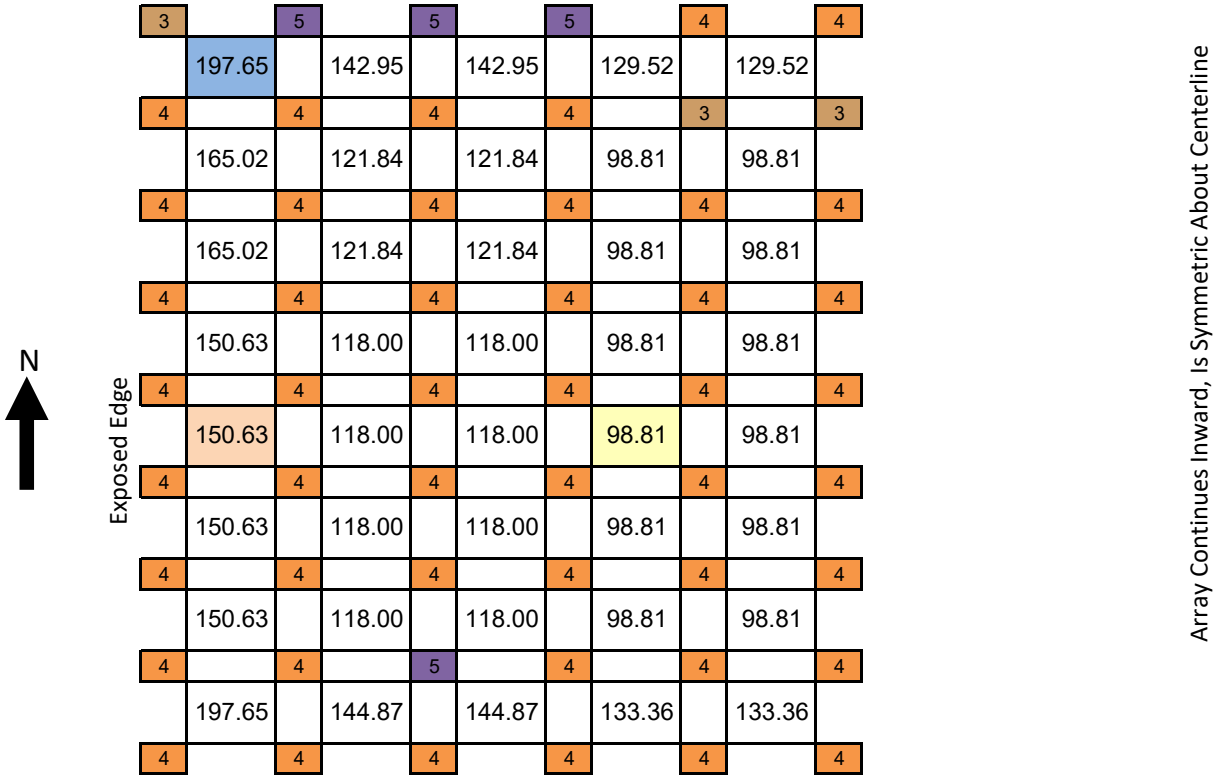
As shown in Image 3, the ballast required to resist lift - BWUz from Table 4 - is listed for each module location in Image 4. A portion of each BWUz value is distributed to each of the connected EcoFoot Bases, also detailed in Image 3 and included in Image 4. The total ballast required at each EcoFoot location is then calculated and rounded up to the next ballast block increment.

Image 3: Example of Module and Ballast Graphical Representation



The ballast prescription array shown in Image 4 is one of many similar arrays created automatically through EcoCalcs in order to address all possible array configurations. The data calculated in Table 4 was ultimately used to assign ballast to the system design in Sheet S-1.0 by Unirac. EcoCalcs and the resulting ballast plan S-1.0 are reviewed by CBC Engineers for correctness and completeness. Once approved, an engineering report including Sheet S-1.0 and any supporting material (this explanation included) are stamped and sealed by a professional engineer registered in the state where the project is proposed.

Image 4: Ballast Prescriptions Produced by Table 4



NOTE: The colored module locations in Image 4 correspond to the same colored areas in Table 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for more detailed calculations.

Detailed Calculations From Table 4

North Corner Module		
GCn Value from RWDI report:	-0.33	
qh value from Table 3:	30.97	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-10.22	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-281.18	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-118.59	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	197.65	lbf

East/West Edge Module		
GCn Value from RWDI report:	-0.27	
qh value from Table 3:	30.97	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-8.51	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-234.16	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-90.38	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	150.63	lbf

Interior Module		
GCn Value from RWDI report:	-0.21	
qh value from Table 3:	30.97	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-6.63	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-182.34	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-59.28	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	98.81	lbf

Max downpoint load calculations

No of Mid supports	1	
Tributary Area to support/bays/base	0.5	of module area
Wind force down (WL)	342 lbs	
Snow load Down (SL)	330.13 lbs	
Total Dead load per Bay (DL)	145.36 lbs	

Load Combinations

DL+ SL	475.49 lbs
DL+0.6WL	350.34 lbs
DL+0.75SL+0.45WL	**546.70 lbs**

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SEAOC PV1 - 2012 - Section 4: attached Arrays

Unirac utilizes the unattached design approach to account for seismic force as provided for by Section 16 of the 2016 California Building Code, the Structural Engineering Association of California PV1 Requirements (SEAOC PV1-2012) and ASCE 7. Section 1613.5 defines “Ballasted Photovoltaic System” which also defines "partially attached" systems, and provides guidance for designing arrays that utilize physical anchors and friction to resist seismic forces. SEAOC PV1 or ASCE 7 Chapter 13 defines the calculations required design attached photovoltaic systems, including friction to partially offset seismic forces.

The following explanation walks through calculations outlined in Section 4 - Attached Arrays. The attached approach begins with the project specific design criteria outlined in Table 6. These values reflect site inputs as well as assumptions permitted in the SEAOC PV1-2012 document Section 4 and ASCE 7 chapter 13 .

Table 6: Seismic Design Inputs

Number of blocks per Ecofoot	6.00
Wp=Weight per unit	275.53
Site Class	D-Stiff Soil
Seismic Design Category	0.00
Ip	1.50
Rp	1.50
'Seismic Calcs (Attached)'!A9	1.00
Fa (Site Class E)	2.5
Sms = Fa x Ss	0.15
Sds = (2/3) x Sms	0.10

Table 7: ASCE7 Inputs

z=height of point of attachment (in.)	1.00
h=structure height compared to base (in.)	1.00
Fp=0.4*ap*Sds*Wp*(1+2*z/h)/(Rp/Ip)	33.15
Fp=1.6*Sds*Ip*Wp	66.30
Fp=0.3*Sds*Ip*Wp	12.43
Fp	33.15
Fp (ASD)	23.21

SEAOC PV1 specifies that “PV support systems that are attached to the roof structure shall be designed to resist the lateral seismic force *Fp* specified in ASCE 7-16/22 Chapter 13.” Although SEAOC PV1 was released prior to ASCE 7-16/22, *Fp* is defined the same way in Chapter 13 of both ASCE verions 7-10, 7-16 and 7-22. Therefore the lateral seismic force analysis applied is valid for both ASCE 7-10, 16 and 22. In utilizing the *Fp* calculations for nominal, minimum, and maximum values laid out in Section 13.3.1, the values in Table 7 are found.

The following is excerpted from SEAOC PV1-2012, Section 4 – Attached Arrays:

“For attached roof-bearing systems, friction is permitted to contribute in combination with the design lateral strength of attachments to resist the lateral force Fp when all of the following conditions are met:

- “The maximum roof slope at the location of the array is less than or equal to 7 degrees (12.3 percent);
- “The height above the roof surface to the center of mass of the solar array is less than the smaller of 36 inches and half the least plan dimension of the supporting base of the array
- “Rp shall not exceed 1.5 unless it is shown that the lateral displacement behavior of attachments is compatible with the simultaneous development of frictional resistance.”

The EcoFoot 2+ and EcoFoot 5D systems have been demonstrated to be in conformance with the above stated stipulations. As such, and in accordance with the remainder of Section 4 – Attached Arrays from SEAOC PV1-2012, the force required to resist movement due to seismic shifting is calculated. Based on the minimum ultimate shear strength of the roof mounting method prescribed for this job, the total lateral load that one attachment may offset is calculated, and by extension the number of modules allowed per attachment point. These values can be found in Table 8.

All friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients, methodology that is in agreement with SEAOC PV2 and Los Angeles, CA stipulations.

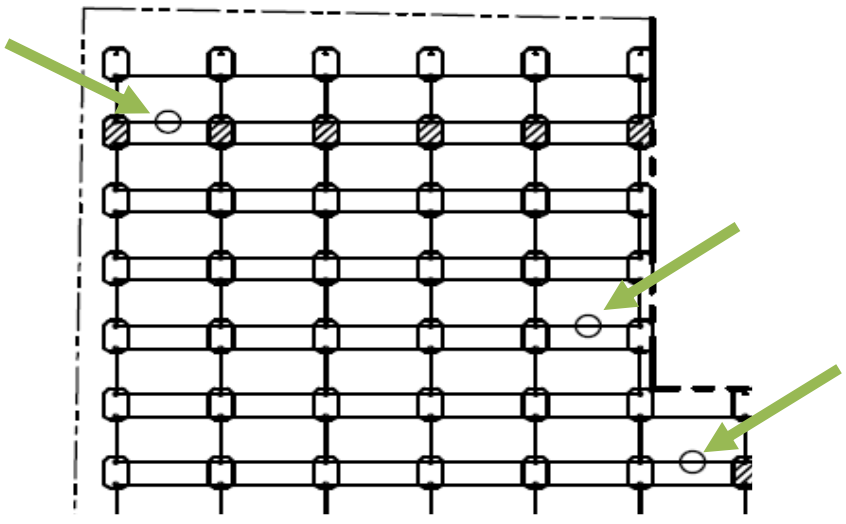
Table 8: Calculation of Physical Attachment Requirements

Friction Coefficient	0.37	*ASTM G115 Tested*
Ff (max friction) = (0.6-0.14*Sds)*(0.7*u)*Wp	41.93	*SEAOC section 4 (ASD), Friction Force*
Excess force per unit	-18.72	*Force to be offset by physical attachments*
Attachment system rating (allowable)	634.91	*ASD design load*
Number of panels per attachment	-33.91	*(if negative, no fasteners are needed)*

This final number of panels per attachment represents the maximum number of modules that any given attachment point may account for in terms of offsetting seismic force Fp. Physical attachments shall be installed per the manufacturer's instructions, and attached to the EcoFoot 2+ or EcoFoot 5D system per the installation instructions provided by Unirac.

On Sheet S-1.0 physical attachments are called out as shown below in Image 5:

Image 5: Example of ballast layout with seismic attachment callouts



LIST OF DRAWINGS

NUM	TITLE	REV	50% REVIEW 3-22-2024	INTERCONNECT 5-8-2024	BID REVIEW 6-28-2024	INTERCONNECT REV. 7-8-2024	ADDENDUM-2 1-27-2025
	GENERAL						
G001	COVER SHEET		●	●	●	●	●
G002	GENERAL NOTES AND SYMBOLS		●		●		
	CIVIL						
C101	SITE PLAN		●		●		
C102	CONSTRUCTION PLAN		●		●		
	ELECTRICAL						
E101	ELECTRICAL SITE PLAN		●	●	●	●	
E102	AC POWER PLAN		●		●		
E103	DC POWER PLAN		●		●		
E104	GROUNDING PLAN				●		●
E105	PV WIRING PLAN		●		●		●
E401	ELECTRICAL EQUIPMENT RACK (ON ROOF)		●		●		
E402	ELECTRICAL EQUIPMENT ELEVATION (GROUND LEVEL)		●		●		
E501	ELECTRICAL DETAILS		●		●		●
E601	ONE-LINE DIAGRAM		●	●	●		●
E701	LABELS AND PLACARDS		●	●	●		
E702	ELECTRICAL SPECIFICATIONS				●		
E801	DATA SHEETS				●		
E802	DATA SHEETS				●		
E803	DATA SHEETS				●		
E804	DATA SHEETS				●		
E805	DATA SHEETS				●		
	STRUCTURAL						
S-1.0	UNIRAC - ROOF BALLAST LAYOUT				●		
EF2+	UNIRAC - ECOLIBRIUM-ECOFOOT2; MULTI-PAGE REPORT				●		

PROJECT TO BE SUBMITTED AND REVIEWED UNDER THE 2015 MICHIGAN REHABILITATION CODE FOR EXISTING BUILDINGS (MRCEB) SECTION 301.1.2 "WORK AREA COMPLIANCE METHOD" PER SECTION 504.1 LEVEL-2 ALTERATIONS (CH 5-13).

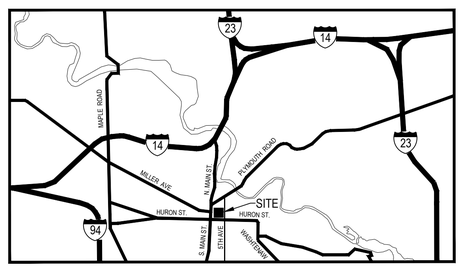
NOVA PROJECT #23-11-1168-FS1
84.6 kW AC, 1000 V DC (MAX.), 96.8 kW DC SOLAR PHOTOVOLTAIC SYSTEM

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

NOVA PROJECT MANAGER: JEFF ECKHOUT



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SITE LOCATION MAP

NO SCALE

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21580 Novi Road
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Phone: (248) 347-3512
Fax: (248) 347-4152

www.novaconsultants.com

ISSUED

DATE	DESCRIPTION	APPVD.
3-22-2024	50% REVIEW	
5-8-2024	INTERCONNECT	JE
6-28-2024	BID REVIEW	
* 7-8-2024	INTERCONNECT REV.	
2 1-27-2025	ADDENDUM-2	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

COVER SHEET

PROJECT NUMBER	23-11-1168-FS1
DRAWN BY	RGM, GAK, BD
SHEET NUMBER	G001
SCALE	NONE
SHEET SIZE	22x34

STANDARD METHODS OF NOTATION

- SHEET KEY NOTES □TAGS□
- ITEM DESIGNATION □E601 WIRE AND CONDUIT SCHEDULE□
- REVISION □ADDENDUM TAG
- DETAIL NUMBER (ELEVATION TAG) SHEET WHERE FOUND — 3 / E402
- DETAIL NUMBER (SECTION CUT TAG) SHEET WHERE FOUND — 5 / E201
- DETAIL NUMBER — 1 / E103 — SHEET WHERE FOUND — (BUBBLE DETAIL) — ENLARGEMENT AREA
- DETAIL NUMBER / NAME (DRAWING TITLE & IDENTIFICATION) SHEET WHERE FOUND / SCALE — 1 / E104 · DET. · SCALE: N.T.S.
- SPOT ELEVATION — 10'-0" A.F.F.
- MATCH LINE — SHEET C102 / SHEET C103
- CENTER LINE
- LIGHT LINE INDICATES E□ISTING WORK
- HEAVY LINE INDICATES NEW WORK
- DASHED LINE INDICATES DEMOLITION
- UNDERGROUND CONDUIT AND WIRING

NOTE: SOME SYMBOLS AND ABBREVIATIONS SHOWN MAY NOT APPLY TO THIS PROJECT.

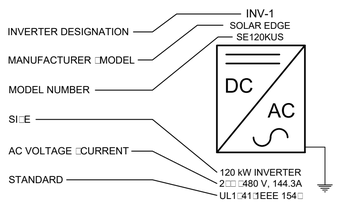
SITE, ROOF □ FLOOR PLAN SYMBOLS

- 1-1 / STRING # / INVERTER # — PV STRING DESIGNATION
- MODULE □SITE □ ROOF PLAN□
- SWITCHGEAR
- INV-1 — INVERTER
- PB — PANEL BOARD
- D — DISCONNECT
- M — METER
- T — TRANSFORMER
- CT — CT CABINET
- C — COMBINER
- DUPLE□ RECEPTACLE
- EV CHARGING STATION
- EV CHARGING ONLY □PARKING SPACE□
- COPPER CLAD GROUND ROD
- SILT FENCE
- CHAIN LINK FENCE
- 0 — GRAPHIC SCALE
- NORTH — NORTH ARROW

ELECTRICAL DETAIL SYMBOLS

- 1-1 / STRING # / INVERTER # — PV STRING DESIGNATION
- MODULE □PV WIRING PLAN□
- SWITCHGEAR
- INVERTER
- PB — PANEL BOARD
- D — DISCONNECT
- M — METER
- T — TRANSFORMER
- CT — CT CABINET
- C — COMBINER
- DUPLE□ RECEPTACLE
- EV CHARGING STATION
- EV CHARGING ONLY □PARKING SPACE□
- COPPER CLAD GROUND ROD

INVERTER ANNOTATION



ONE LINE DIAGRAM SYMBOLS □SHEET E601□

- 1-1 / STRING # / INVERTER # — PV STRING DESIGNATION
- MOD 1 (−) (+) — MODULE □ONE - LINE DIAGRAM□
- OPTIMI□ER
- RAPID SHUTDOWN
- PANELBOARD □PB□W□MAIN BREAKER
- DISCONNECT
- FUSED DISCONNECT
- DISCONNECT SWITCH
- TRANSFORMER
- FUSE
- CIRCUIT BREAKER
- CURRENT TRANSFORMER □CTs□
- POTENTIAL TRANSFORMER □PTs□
- BUS BAR
- WYE TRANSFORMER CIRCUIT CONNECTION
- DELTA TRANSFORMER CIRCUIT CONNECTION
- GROUND
- INVERTER
- DISCONNECT
- METER
- COMBINER
- SURGE PROTECTIVE DEVICE □SPD□
- DUPLE□ RECEPTACLE
- GFCI DUPLE□ RECEPTACLE
- GFCI WITH IN USE COVER OUTDOOR RATED WEATHER RESISTANT
- EV CHARGING STATION
- UTILITY POLE TO GRID
- STRING 1-1 - (POS.) / STRING 1-1 - (NEG.) — CIRCUIT HOMERUN W□STRING IDENTIFIER
- ROOF / ELEC ROOM — AREA DIVIDER LINE □E601 ONE-LINE DIAGRAM□

ELECTRICAL ABBREVIATION LIST

ABBREVIATION	DESCRIPTION
A	AMPERES
A.F.F.	ABOVE FINISH FLOOR
AU□	AU□ILIARY
AWG	AMERICAN WIRE GAUGE
BKR	BREAKER
CB	CIRCUIT BREAKER
CKT	CIRCUIT
CT	CURRENT TRANSFORMER
DEMO	DEMOLITION
DIM	DIMENSION
DISC	DISCONNECT
DP	DISTRIBUTION PANEL
DWG	DRAWING
ELEC	ELECTRICAL
EM □EMER	EMERGENCY
EMT	ELECTRICAL METALLIC TUBING
EVCS	ELECTRIC VEHICLE CHARGING STATION
E□ □E□IST	E□ISTING
FLR	FLOOR
G □GRD □EG	GROUND
GFCI □GFI	GROUND FAULT CIRCUIT INTERRUPTER
HP	HORSEPOWER
HV	HIGH VOLTAGE
H□	HERT□
INV	INVERTER
IG	ISOLATED GROUND
JB	JUNCTION BO□
kV	KILOVOLT
kVA	KILOVOLT- AMPERES
kW	KILOWATT
kWH	KILOWATT - HOURS
MA□	MA□IMUM
MPPT	MA□IMUM POWER POINT TRACKING
MDP	MAIN DISTRIBUTION PANEL
MIN	MINIMUM
MISC	MISCELLANEOUS
MTD	MOUNTED
NEC	NATIONAL ELECTRICAL CODE
N□A	NOT APPLICABLE
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
OC	ON CENTER
OCPD	OVER CURRENT PROTECTION DEVICE
PNL	PANEL
P	POLE
PH	PHASE
PV	PHOTOVOLTAIC
PT	POTENTIAL TRANSFORMER
PDP	POWER DISTRIBUTION PANEL
RSD	RAPID SHUTDOWN DEVICE
RECEPT	RECEPTACLE
RE□D	RE□UIRED
RSC	RIGID STEEL CONDUIT
SW	SWITCH
SWBD	SWITCH BOARD
SWGR	SWITCH GEAR
TELCOM	TELECOMMUNICATIONS
TP	TAMPERPROOF
TYP	TYPICAL
U.O.N.	UNLESS OTHERWISE NOTED
V	VOLTS
V.I.F.	VERIFY IN FIELD
W	WIRE
WP	WEATHERPROOF
□FMR	TRANSFORMER

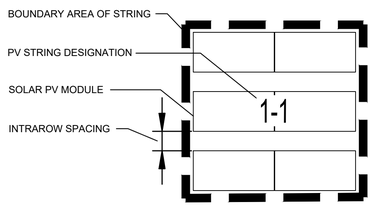
STANDARD MOUNTING HEIGHTS

DESCRIPTION	HEIGHT
PANELBOARD	6□0" A.F.F. TO TOP OF BO□
RECEPTACLE OUTLET	16" A.F.F. TO BOTTOM OF BO□. □MIN.□ 48" A.F.F. TO TOP OF BO□ □MA□.□
CONDUIT IN TRENCH	18" BELOW GRADE - TO TOP OF CONDIUT □MIN.□

LINES □ WIRES

- GAS — GAS — GAS LINE
- AC WIRING
- AC WIRING UNDERGROUND
- DC WIRING
- STRING WIRING
- GROUND WIRE
- CONDUIT DOWN
- CONDUIT UP

PV ARRAY ANNOTATION PLAN



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21580 No□ Road
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DATE	DESCRIPTION	APPVD.
6-28-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

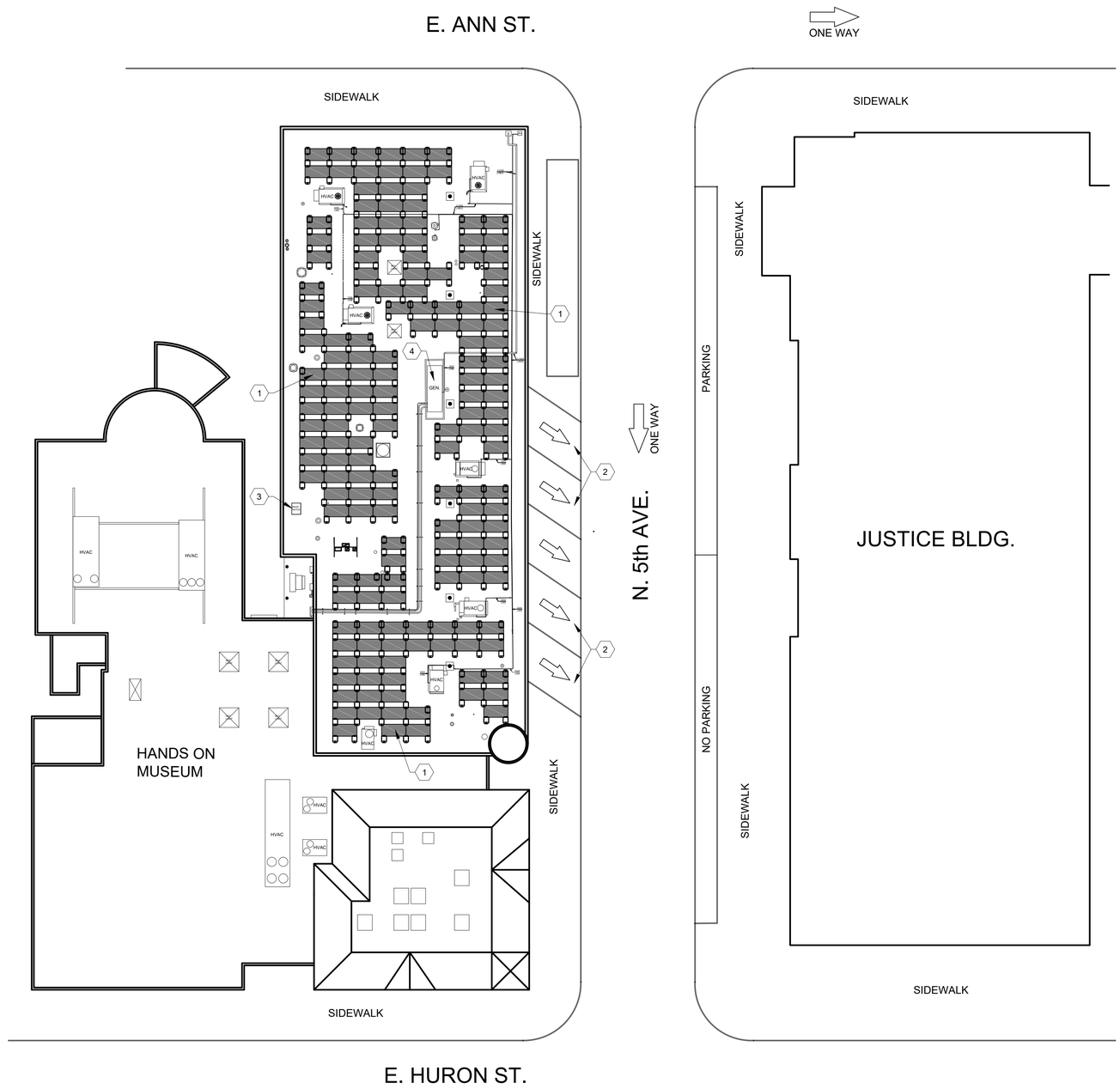
84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

GENERAL NOTATION

PROJECT NUMBER 23-11-1168-FS1

DRAWN BY GAK | SCALE | SHEET SI□E 22□34

SHEET NUMBER G002



NORTH

SITE PLAN

SCALE: 1"□20□

0 5□ 10□ 20□ 40□

SCALE: 1"□20□

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE □NEC□ 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN E□UIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.

SHEET KEY NOTES

1. 96.8 kW DC SOLAR ARRAY, 84.6 kW AC SOLAR ARRAY
2. NO PARKING, FIRE LANES □E□ISTING□
3. ROOF ACCESS HATCH □E□ISTING□
4. E□ISTING GENERATOR

PV SYSTEM DESCRIPTION - GENERAL

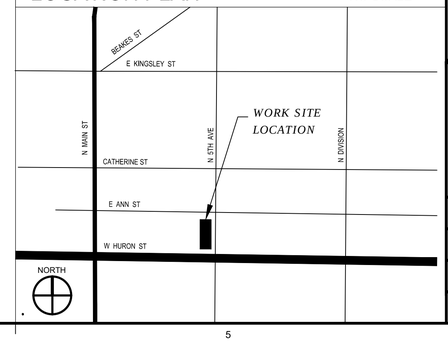
ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
A□IMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

LEGEND

□ □	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER

LOCATION PLAN

NO SCALE



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DATE	DESCRIPTION	APPVD.
3-22-2024	50□ REVIEW	
6-28-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

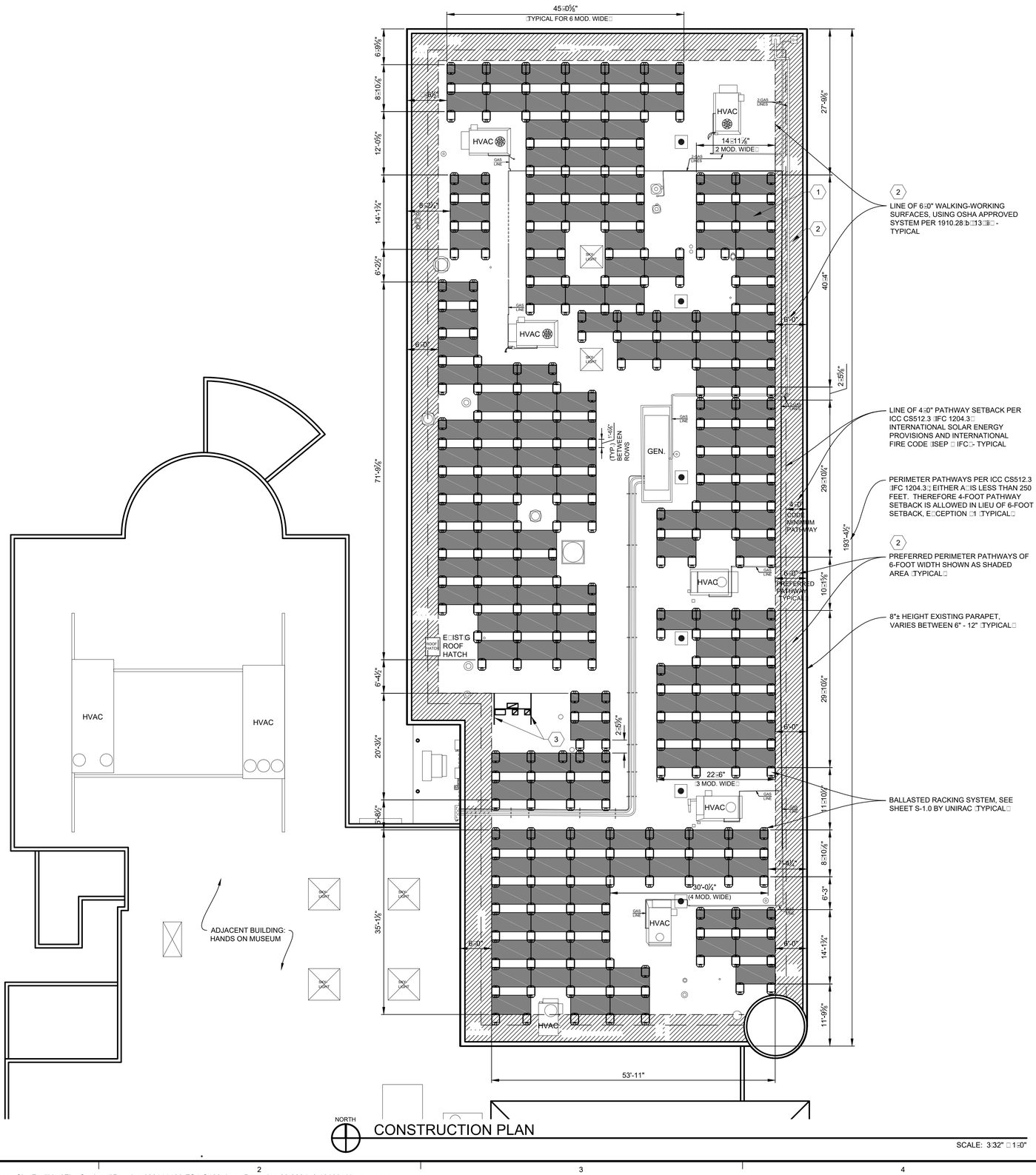
FIRE STATION 1

111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

96.8 kW DC SOLAR ARRAY
84.6 kW AC SOLAR ARRAY

SITE PLAN

PROJECT NUMBER	23-11-1168-FS1
DRAWN BY	BD, GAK
SCALE	AS NOTED
SHEET SI□E	22□34
SHEET NUMBER	C101



CONSTRUCTION PLAN

SCALE: 3/32" = 1'-0"

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.

SHEET KEY NOTES

1. 96.8 kW DC PV ARRAY, 84.6 kW AC PV ARRAY.
2. 6'-0" PREFERRED PERIMETER PATHWAY (4'-0" CODE MIN.)
3. SERVICE RACK WITH INVERTERS AND PB-A.

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
AZIMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

(2) LINE OF 6'-0" WALKING-WORKING SURFACES, USING OSHA APPROVED SYSTEM PER 1910.28(b)(13)(i) - TYPICAL

LINE OF 4'-0" PATHWAY SETBACK PER ICC CS512.3 (IFC 1204.3) INTERNATIONAL SOLAR ENERGY PROVISIONS AND INTERNATIONAL FIRE CODE (SEP) (IFC)- TYPICAL

PERIMETER PATHWAYS PER ICC CS512.3 (IFC 1204.3) EITHER AXIS LESS THAN 250 FEET. THEREFORE 4-FOOT PATHWAY SETBACK IS ALLOWED IN LIEU OF 6-FOOT SETBACK, EXCEPTION #1 (TYPICAL)

(2) PREFERRED PERIMETER PATHWAYS OF 6-FOOT WIDTH SHOWN AS SHADED AREA (TYPICAL)

8"± HEIGHT EXISTING PARAPET, VARIES BETWEEN 6" - 12" (TYPICAL)

BALLASTED RACKING SYSTEM, SEE SHEET S-1.0 BY UNIRAC (TYPICAL)

LEGEND

INVERTER

PB — PANEL BOARD

0 5'-1 1/2" 10'-9" 21'-6"
SCALE: 1" = 3/32"

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DATE	DESCRIPTION	APPVD.
3-22-2024	50% REVIEW	
6-28-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

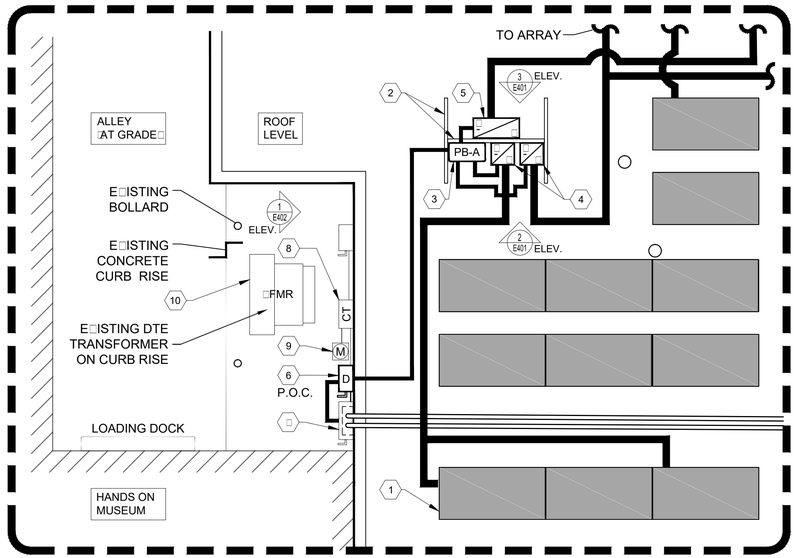
FIRE STATION 1

111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

96.8 kW DC SOLAR ARRAY
84.6 kW AC SOLAR ARRAY

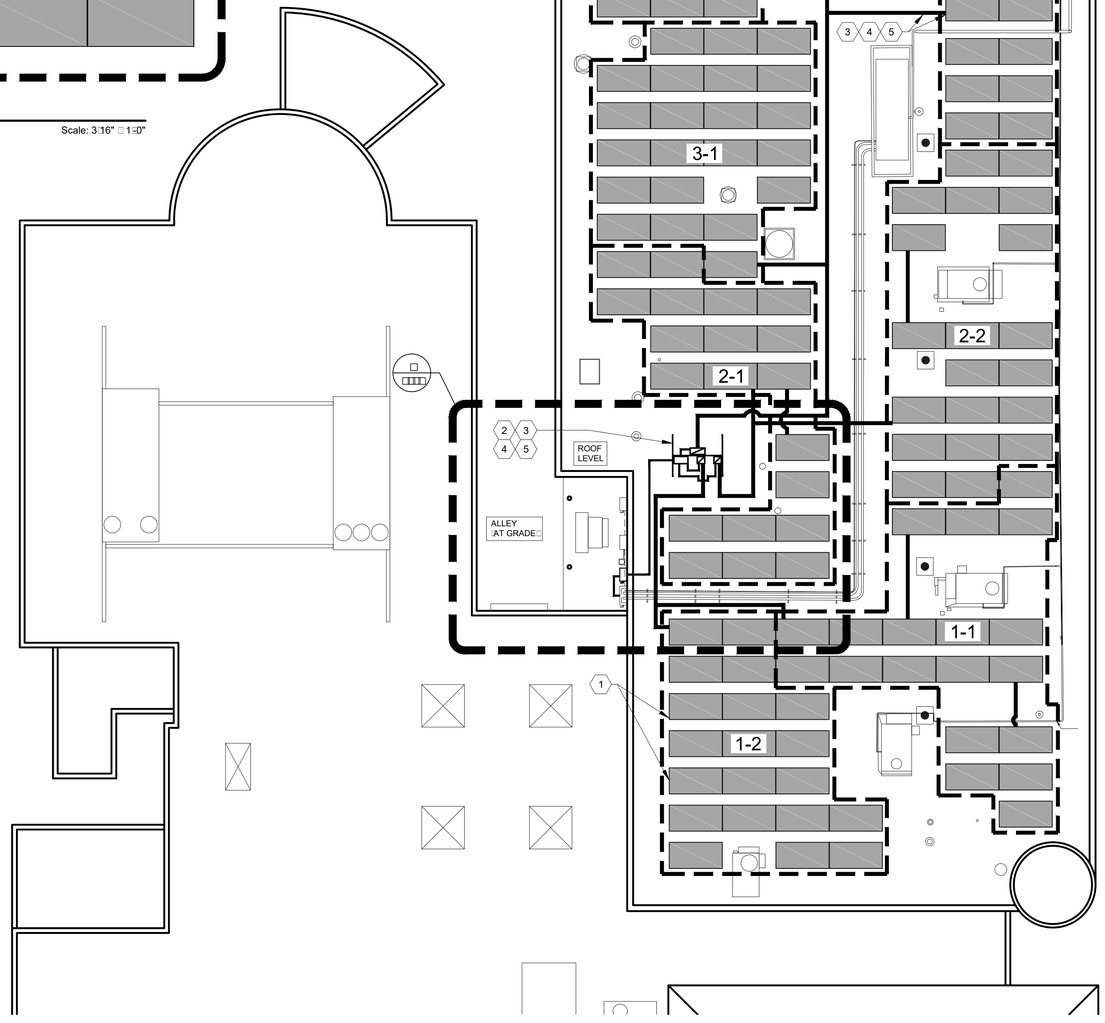
CONSTRUCTION PLAN

PROJECT NUMBER	23-11-1168-FS1
DRAWN BY	BD, GAK
SCALE	AS NOTED
SHEET SIZE	22x34
SHEET NUMBER	C102



PLAN DETAIL - AT EQUIPMENT RACKS

Scale: 3/16" = 1'-0"



NORTH

ELECTRICAL SITE PLAN

SCALE: N.T.S.

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.

SHEET KEY NOTES

1. 96.8 kW DC SOLAR ARRAY, 84.6 kW AC SOLAR ARRAY
2. SERVICE RACK (ON ROOF)
3. PB-A, (ON ROOF)
4. (2) 11.3 kW INVERTERS 1 & 2, (ON ROOF)
5. (1) 50 kW INVERTER 3, (ON ROOF)
6. SOLAR PV DISCONNECT-A (P.O.C.), LOCKABLE WITH BLADE STYLE VISIBLE BREAK TO BE INSTALLED WITHIN 5 FEET OF DTE UTILITY METER
7. (E) EXIST. MAIN-1 DISCONNECT
8. EXIST. CT CABINET
9. EXIST. UTILITY METER
10. EXIST. DTE TRANSFORMER
11. DC HOME RUNS UNDER MODULES: PV WIRING SHALL BE SECURED VIA HEYCO CABLE CLIPS OR EQUAL.
12. DC HOME RUNS NOT UNDER MODULES, AND AC WIRING: WIRING SHALL BE IN CONDUIT PER CODE, SEE VERTICAL CONDUIT SUPPORT (WALL) AND CONDUIT SUPPORT DETAILS (ROOF) ON SHEET E501.
13. SEE CONDUIT AND WIRE SIZE CHART ON SHEET E601

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
AZIMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

LEGEND

1-1 (1-1 = STRING #, INVERTER #)	PV STRING DESIGNATION
	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER
XFMR	TRANSFORMER
	AC WIRING CONDUIT
	DC WIRING CONDUIT
(P.O.C.)	POINT OF CONNECTION

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DATE	DESCRIPTION	APPVD.
3-22-2024	50% REVIEW	
5-8-2024	INTERCONNECT	JE
6-28-2024	BID REVIEW	
7-8-2024	INTERCONNECT REV.	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

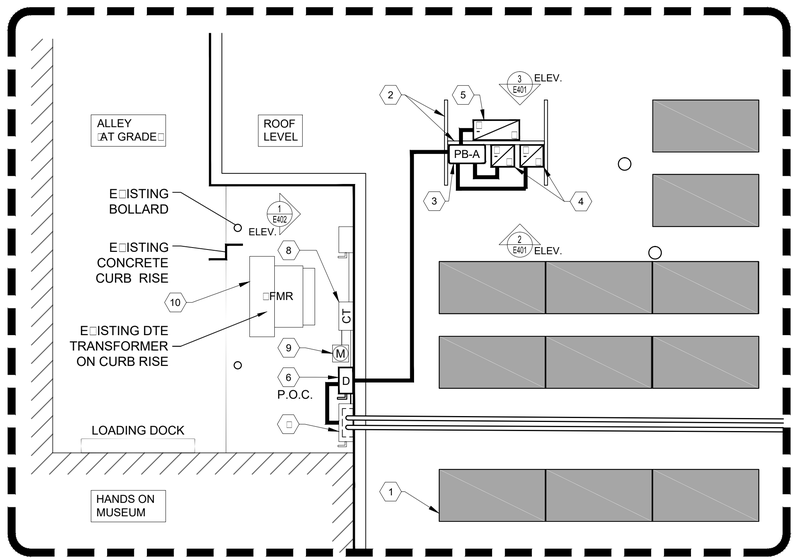
111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

ELECTRICAL SITE PLAN

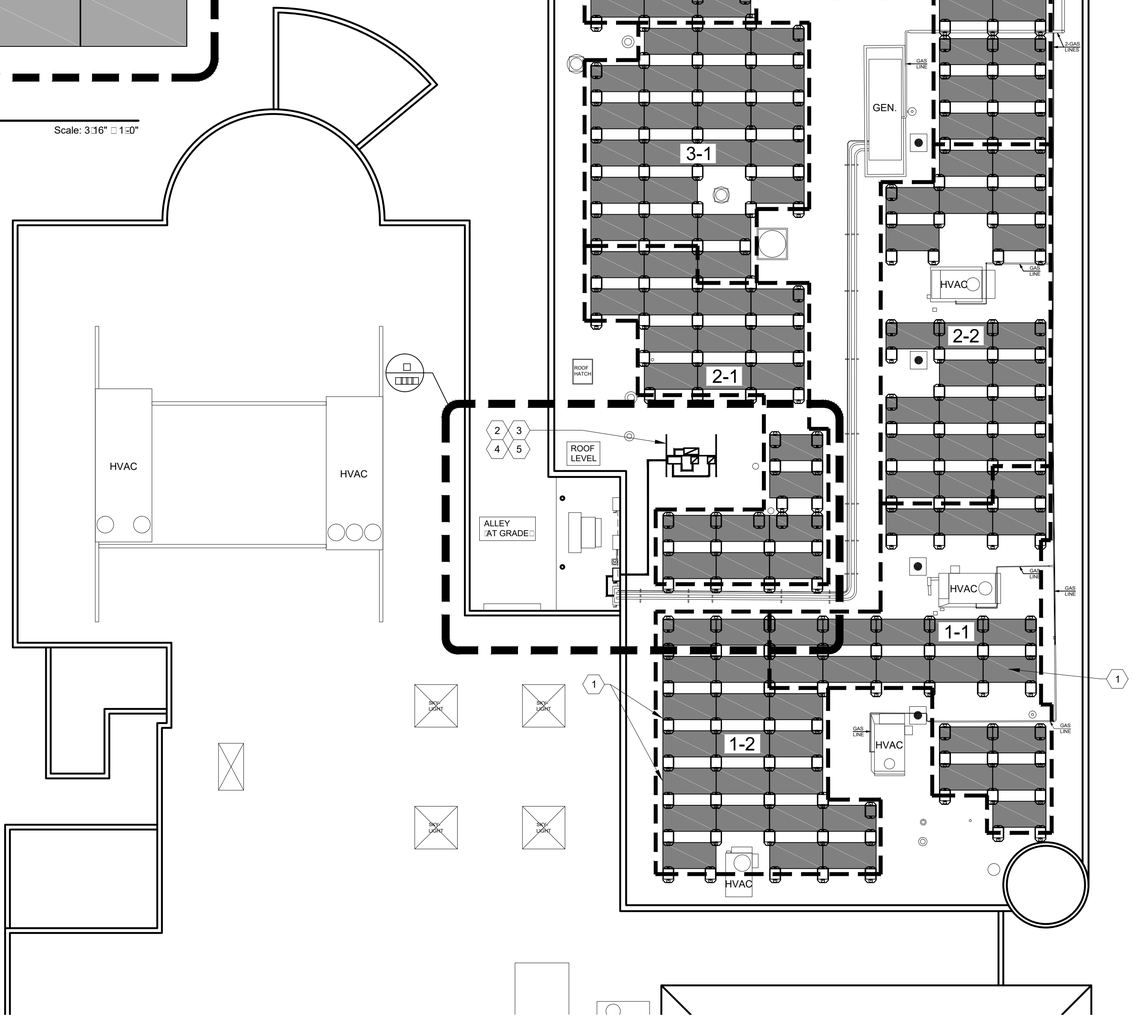
PROJECT NUMBER: 23-11-1168-FS1

DRAWN BY	SHEET NUMBER
BD, GAK	E101
SCALE: AS NOTED	
SHEET SIZE: 22"x34"	



PLAN DETAIL - AT EUIPMENT RACKS

Scale: 3/16" 1'-0"



AC POWER PLAN

SCALE: N.T.S.

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EUIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.

SHEET KEY NOTES

1. 96.8 kW DC SOLAR ARRAY, 84.6 kW AC SOLAR ARRAY
2. SERVICE RACK (ON ROOF)
3. PB-A, (ON ROOF)
4. (2)1)3 kW INVERTERS 1 2.(ON ROOF)
5. (1)50 kW INVERTER 3, (ON ROOF)
6. DISCONNECT-A (P.O.C.)
7. E(IST. MAIN-1 DISCONNECT
8. E(IST. CT CABINET
9. E(IST. UTILITY METER
10. E(IST. DTE TRANSFORMER

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
A(IMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER
XFMR	TRANSFORMER
	AC WIRING CONDUIT
(P.O.C.)	POINT OF CONNECTION

NOVA Cons(ltants, Inc.
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No(i, MI 483(5
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DATE	DESCRIPTION	APPVD.
3-22-2024	50% REVIEW	
6-28-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

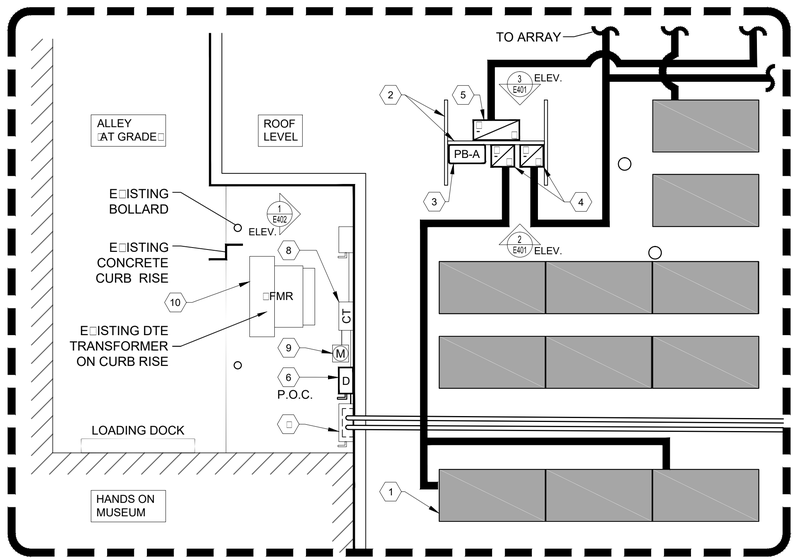
111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

96.8 kW DC SOLAR ARRAY
84.6 kW AC SOLAR ARRAY

AC POWER PLAN

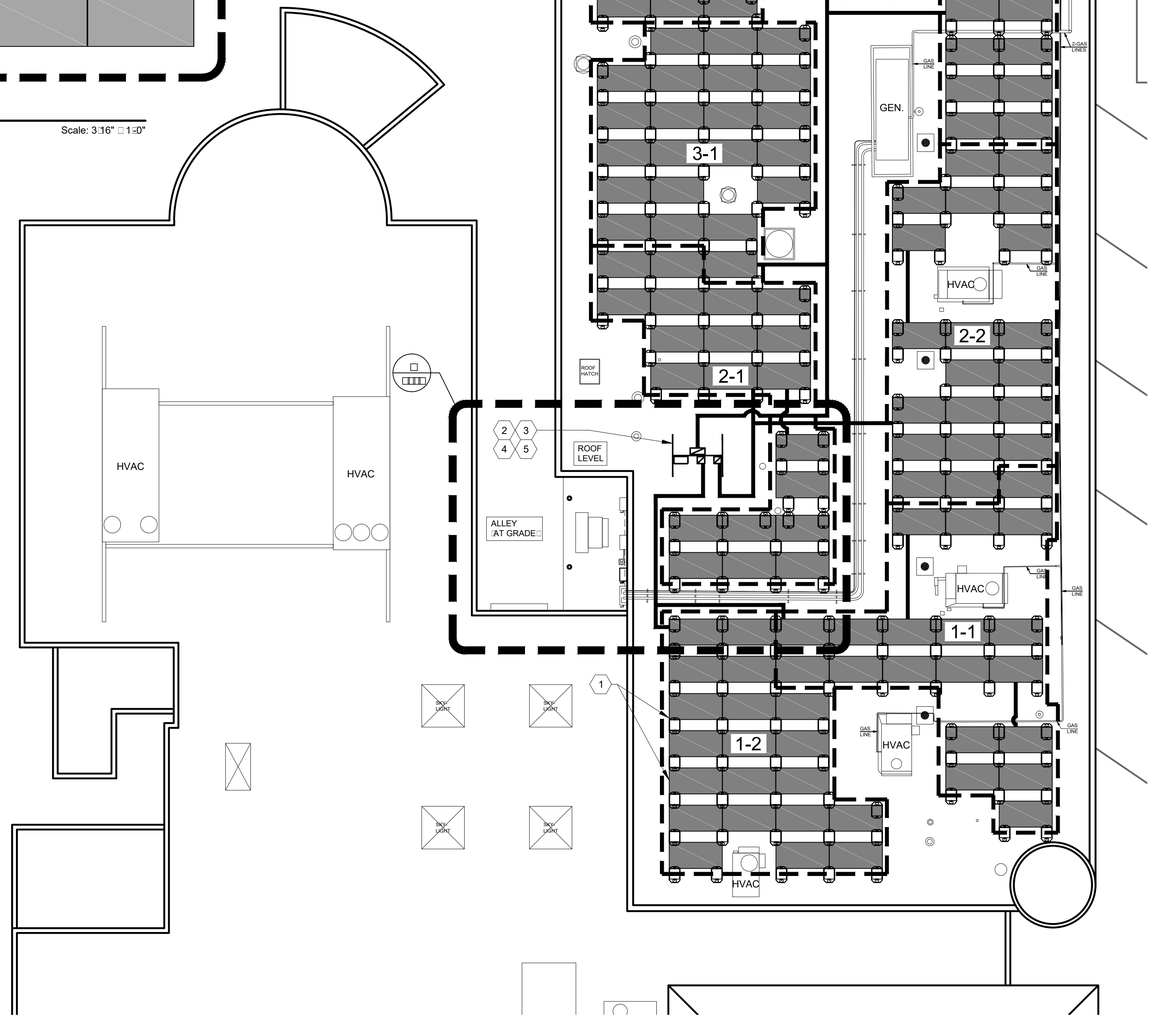
PROJECT NUMBER: 23-11-1168-FS1

DRAWN BY	SHEET NUMBER
BD, GAK	E102
SCALE: AS NOTED	
SHEET SI(E: 22(34	



PLAN DETAIL - AT EQUIPMENT RACKS

Scale: 3/16" = 1'-0"



NORTH

DC POWER PLAN

SCALE: N.T.S.

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.

SHEET KEY NOTES

1. 96.8 kW DC SOLAR ARRAY, 84.6 kW AC SOLAR ARRAY
2. SERVICE RACK (ON ROOF)
3. PB-A, (ON ROOF)
4. (2)1(.)3 kW INVERTERS 1 (2,(ON ROOF)
5. (1(.)50 kW INVERTER 3,(ON ROOF)
6. DISCONNECT-A (P.O.C.)
7. (EXIST. MAIN-1 DISCONNECT
8. EXIST. CT CABINET
9. EXIST. UTILITY METER
10. EXIST. DTE TRANSFORMER
11. DC HOME RUNS UNDER MODULES: PV WIRING SHALL BE SECURED VIA HEYCO CABLE CLIPS OR EQUAL.
12. DC HOME RUNS NOT UNDER MODULES, AND AC WIRING: WIRING SHALL BE IN CONDUIT PER CODE, SEE VERTICAL CONDUIT SUPPORT (WALL) AND CONDUIT SUPPORT DETAILS (ROOF) ON SHEET E501.
13. SEE CONDUIT AND WIRE SIZE CHART ON SHEET E601

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
AZIMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER
XFMR	TRANSFORMER
	AC WIRING CONDUIT
	DC WIRING CONDUIT
(P.O.C.)	POINT OF CONNECTION

NOVA Consultants, Inc.
21580 Novi Road
Suite 300
Novi, MI 48375
Phone: (248)-34(-3512
Fax: (248)-34(-4152
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ISSUED

DATE	DESCRIPTION	APPVD.
6-28-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

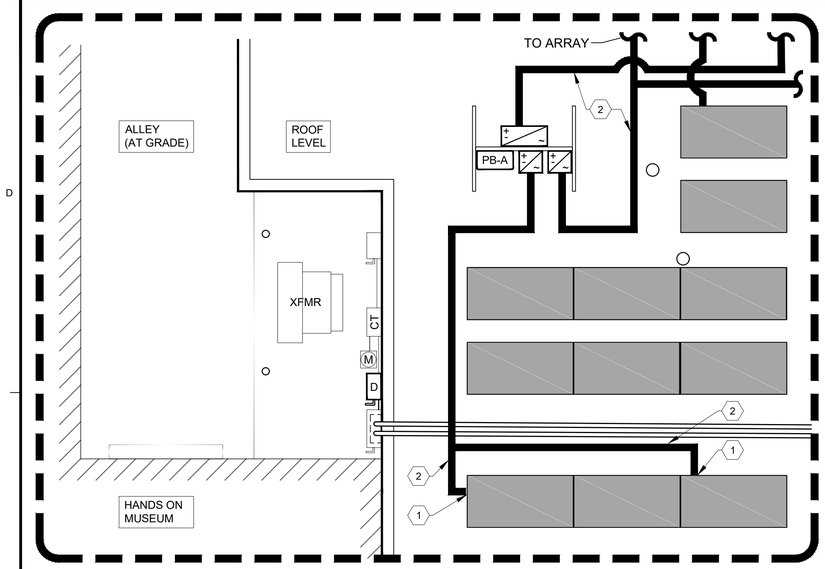
111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

DC POWER PLAN

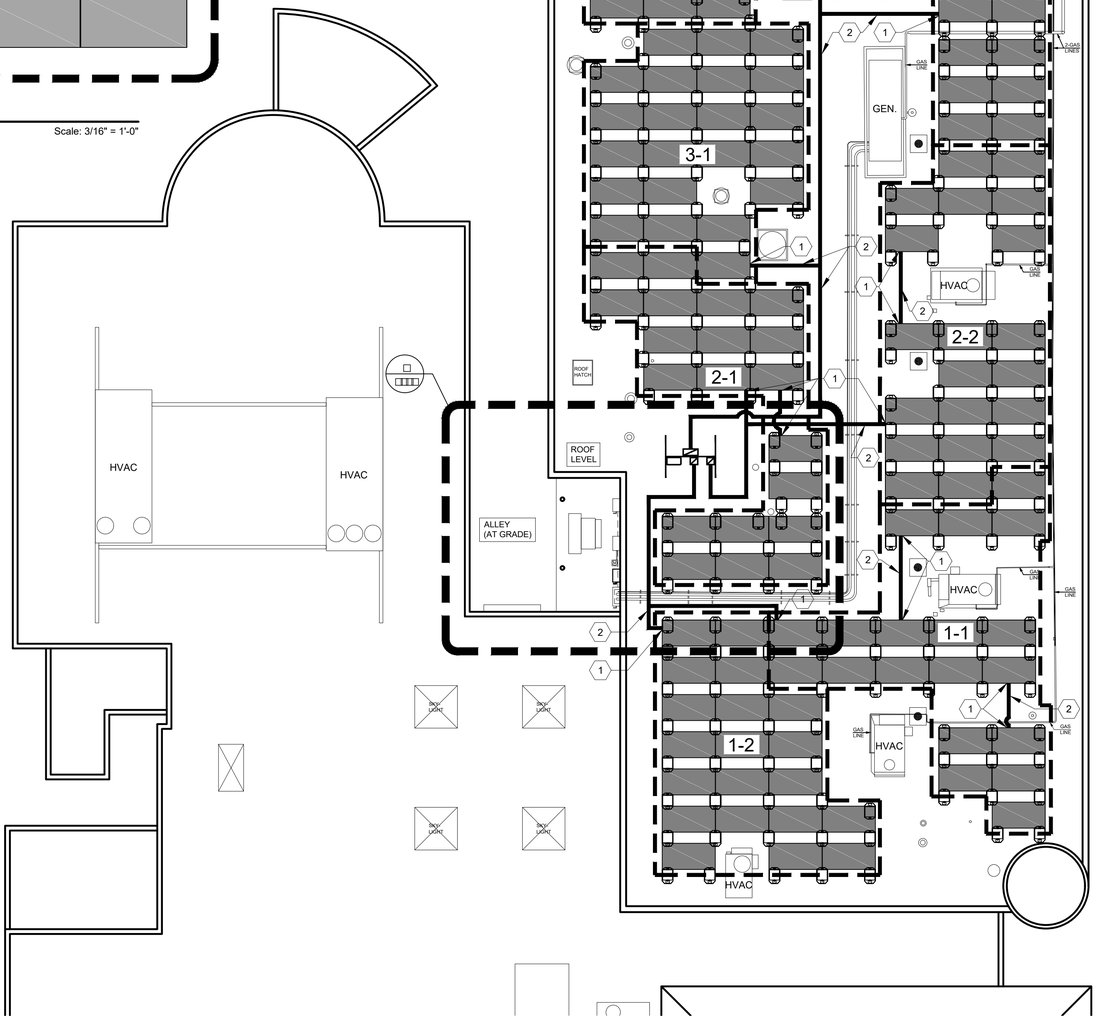
PROJECT NUMBER	
23-11-1168-FS1	
DRAWN BY: RGM, GAK	SHEET NUMBER: E103
SCALE: AS NOTED	
SHEET SIZE: 22(34	

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\Fire Station 1\Drawings\23111168-FS1-E103.dwg Date: J(n 2(2024; 4:02PM User: george



PLAN DETAIL - AT EQUIPMENT RACK(S)

Scale: 3/16" = 1'-0"



NORTH

GROUNDING PLAN

SCALE: N.T.S.

SHEET GENERAL NOTES

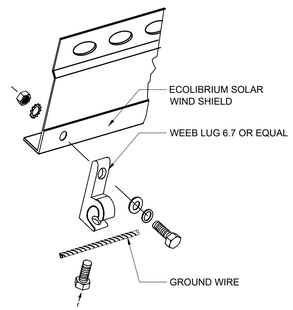
1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS..
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. CONDUIT FILL TO BE LESS THAN 40%.
4. CONTRACTOR TO VERIFY THAT MODULES ARE COMPATABLE WITH RACKING SYSTEM FOR ADEQUATE BONDING AND GROUNDING.
5. CONTRACTOR TO VERIFY WITH RACKING MANUFACTURER THE NUMBER OF GROUNDING LUGS REQUIRED. 1 LUG PER. CONTINUOUS ARRAY, NOT TO EXCEED 150' x 150'.
6. SOLAR PV WIRING METHODS AND WIRING SYSTEMS TO BE INSTALLED GROUNDING COMPLIANT WITH ARTICLE 250 PER NEC 690, PARTS IV AND V.
7. SEE SHEET E501 FOR GROUNDING DETAILS (2)

SHEET KEY NOTES

1. INSTALL GROUND LUG PER MANUFACTURER SPECIFICATIONS
2. RACK TO RACK GROUNDING BARE #6 CU. RACK TO INVERTER GROUNDING USE GREEN USE-2 #6 CU

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
AZIMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS



2 / E104 GROUNDING LUG DETAIL

SCALE: N.T.S.

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
+/- ~	INVERTER
PB	PANEL BOARD
D	DISCONNECT
M	METER
XFMR	TRANSFORMER
———	GROUND WIRE
(P.O.C.)	POINT OF CONNECTION

0 5'-41/2" 10'-9" 21'-6"

SCALE: 1 = 3/32"

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ISSUED

DATE	DESCRIPTION	APPVD.
6-28-2024	BID REVIEW	
1-27-2025	ADDENDUM-2 (2)	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

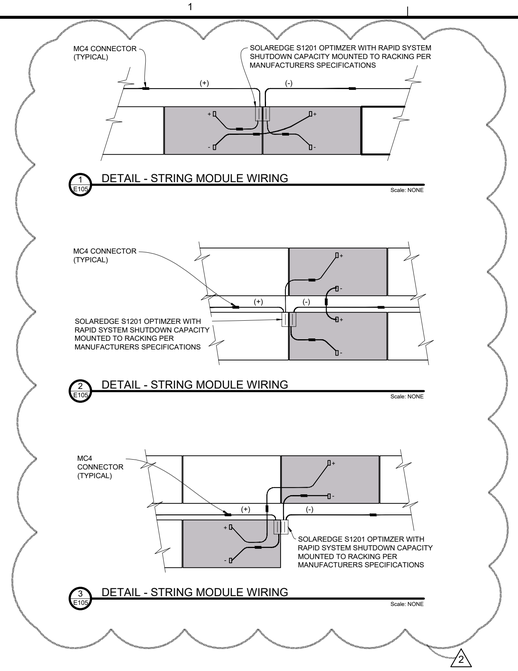
FIRE STATION 1

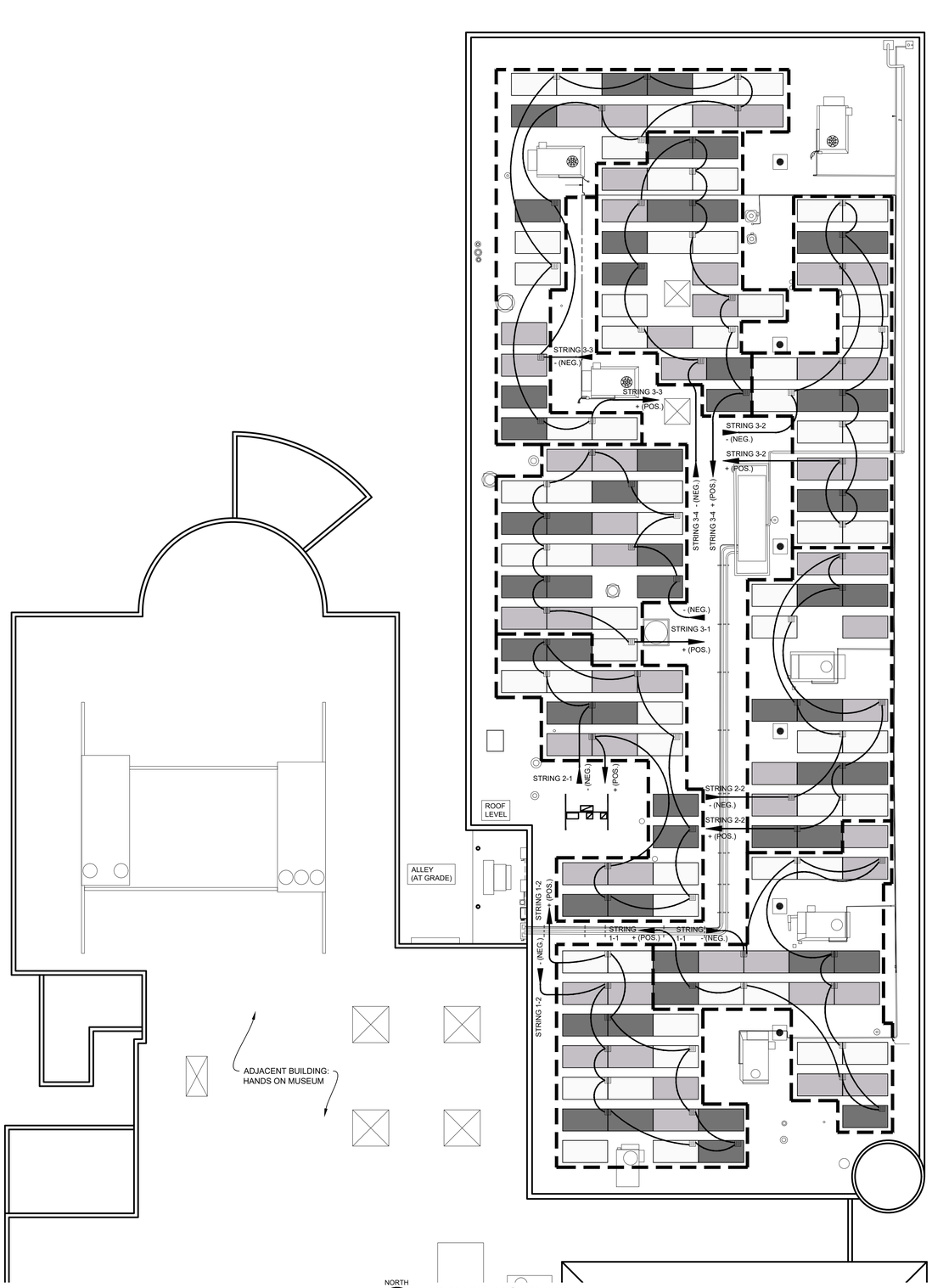
111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

GROUNDING PLAN

PROJECT NUMBER	23-11-1168-FS1
DRAWN BY	RGM, GAK
SCALE	AS NOTED
SHEET SIZE	22x34
SHEET NUMBER	E104





SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. FIELD ADJUST THE ARRAY LAYOUT BASED ON ROOF OBSTRUCTIONS IF NECESSARY.
4. PANEL MODULE PAIRS ARE WIRED IN SERIAL. POSITIVE OF FIRST PANEL TO NEGATIVE OF SECOND PANEL WITH REMAINING PANEL FEEDS CONNECTED TO S1201 OPTIMIZERS.

2

SHEET KEY NOTES

1. DC HOME RUNS UNDER MODULES: PV WIRING SHALL BE SECURED VIA HEYCO CABLE CLIPS OR EQUAL.
2. DC HOME RUNS NOT UNDER MODULES, AND AC WIRING: WIRING SHALL BE IN CONDUIT PER CODE, SEE VERTICAL CONDUIT SUPPORT (WALL) AND CONDUIT SUPPORT DETAILS (ROOF) ON SHEET E501.
3. SEE CONDUIT AND WIRE SIZE CHART ON SHEET E601.

PV SYSTEM DESCRIPTION - GENERAL

ARRAY TYPE	BALLASTED ROOF MOUNT
TILT	10°
AZIMUTH	182°
INTRAROW SPACING	1.6 FT. PER RACKING SPECIFICATIONS

LEGEND

1-1 (STRING # / INVERTER #)	PV STRING DESIGNATION
	INVERTER
D	DISCONNECT
M	METER
	STRING WIRING

0 5'-41/2" 10'-9" 21'-6"
SCALE: 1 = 3/32"

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DATE	DESCRIPTION	APPVD.
6-28-2024	BID REVIEW	
1-27-2025	ADDENDUM-2 (2)	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

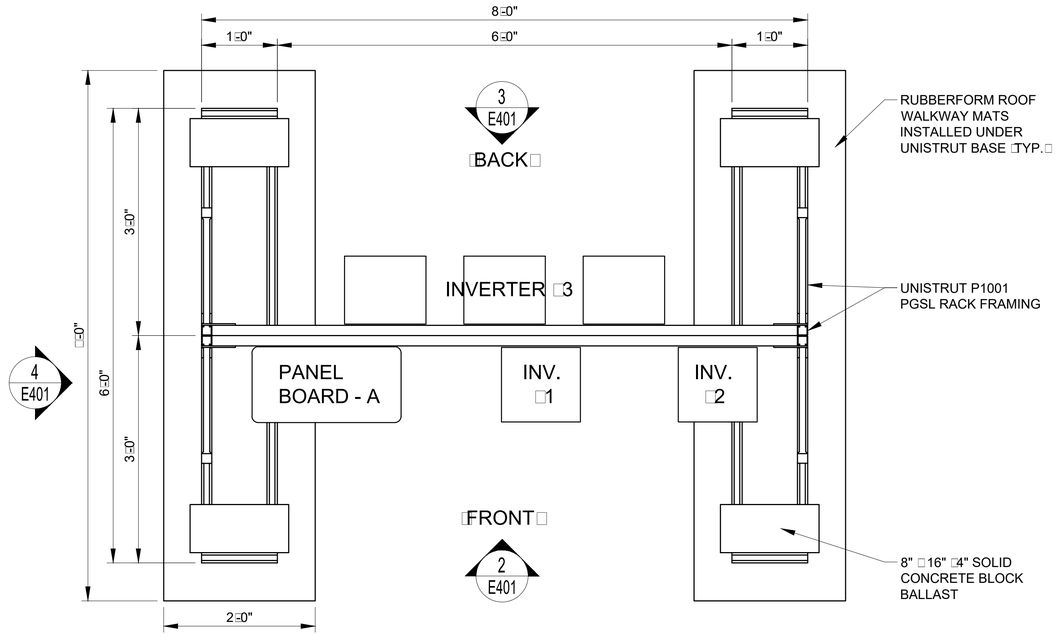
CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1
111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

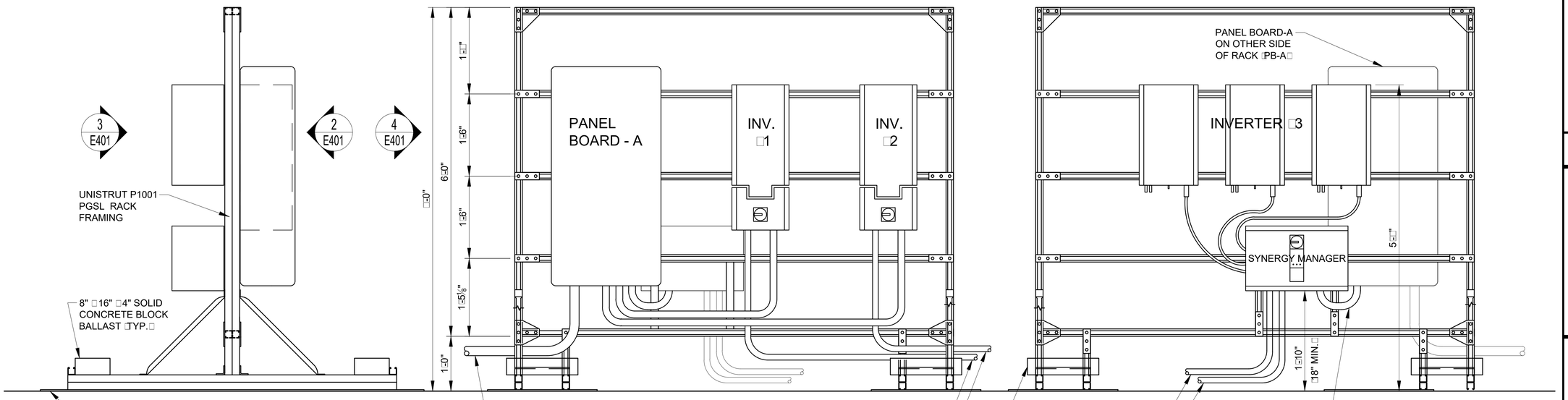
PV WIRING PLAN

PROJECT NUMBER	23-11-1168-FS1
DRAWN BY	BD, GAK
SCALE	AS NOTED
SHEET SIZE	22x34
SHEET NUMBER	E105



ELECTRICAL E UIPMENT RACK PLAN - ON ROOF

Scale: 1" 1'-0"



SIDE ELEVATION

Scale: 1" 1'-0"

FRONT ELEVATION

Scale: 1" 1'-0"

BACK ELEVATION

Scale: 1" 1'-0"

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RGM	

CITY OF ANN ARBOR
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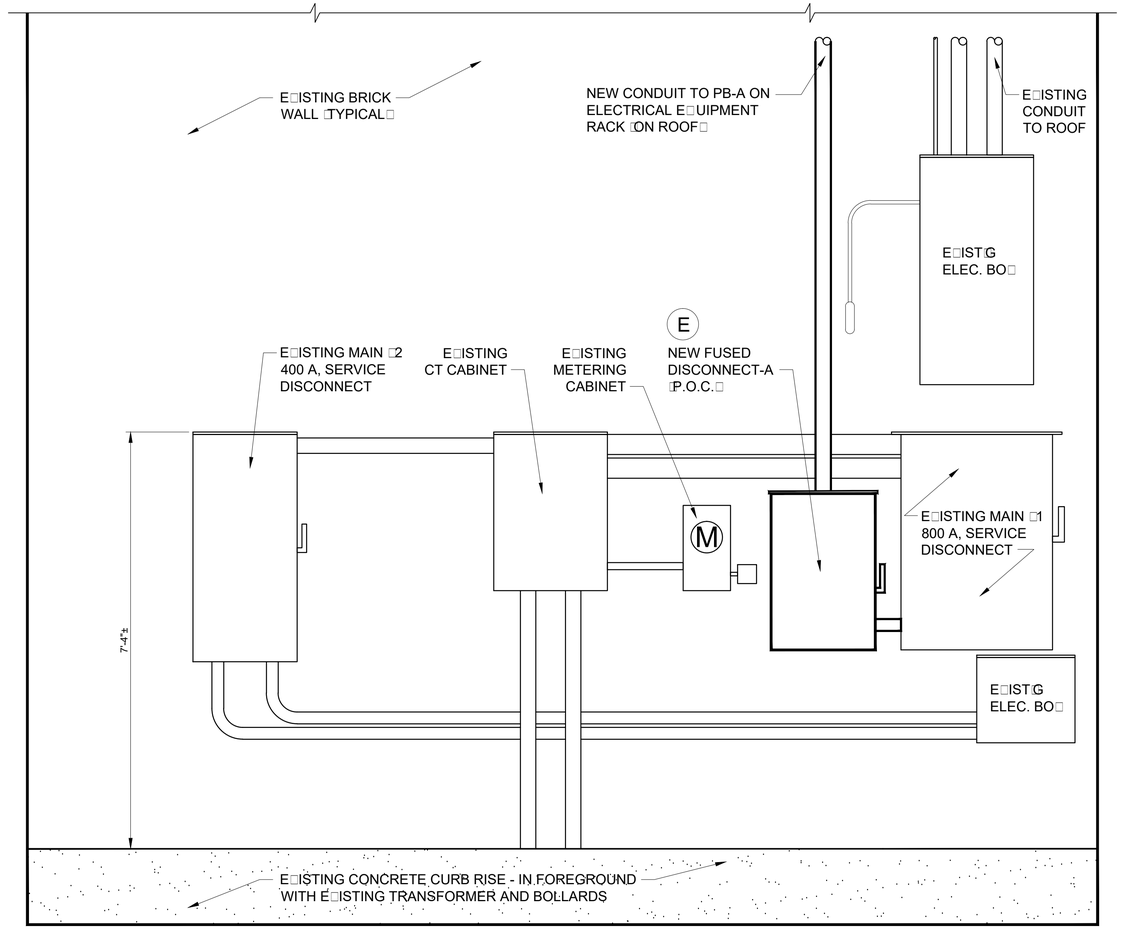
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

ELECTRICAL
E UIPMENT
RACK
ON ROOF

PROJECT NUMBER
23-11-1168-FS1

DRAWN BY	SHEET NUMBER
BD, GAK	E401
SCALE: AS NOTED	
SHEET SI E: 22 34	



ELECTRICAL E□UIPMENT ELEVATION - OUTSIDE - GROUND LEVEL IN ALLEY

Scale: 3⁄4" □ 1□0"

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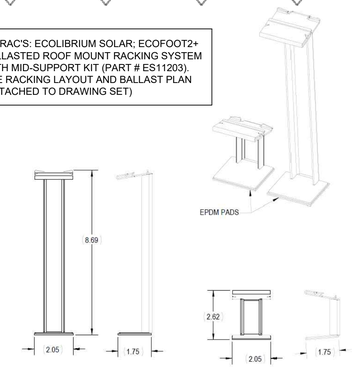
96.8 kW DC SOLAR ARRAY

ELECTRICAL E□UIPMENT ELEVATION □GROUND LEVEL□

PROJECT NUMBER
23-11-1168-FS1

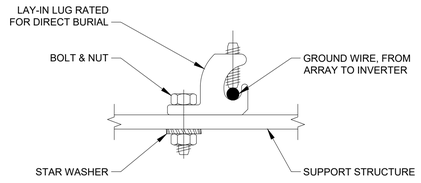
DRAWN BY	SHEET NUMBER
BD, GAK	E402
SCALE	
SHEET SI□E	
22□34	

UNIRAC'S: ECOLIBRIUM SOLAR; ECOFOOT2+ BALLASTED ROOF MOUNT RACKING SYSTEM WITH MID-SUPPORT KIT (PART # ES11203). SEE RACKING LAYOUT AND BALLAST PLAN (ATTACHED TO DRAWING SET)



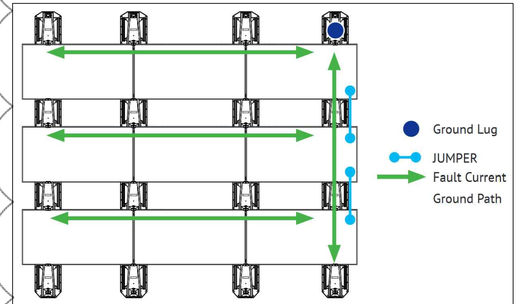
12 E501 MID-SUPPORT KIT

RACK	LUG	HARDWARE
GALVANIZED STEEL	COPPER	GALVANIZED STEEL
ALUMINUM	STAINLESS OR TIN-PLATED COPPER	STAINLESS STEEL
STAINLESS STEEL	COPPER, STAINLESS OR TIN-PLATED COPPER	STAINLESS STEEL



9 E501 GROUNDING DETAIL - MECH. / ELEC.

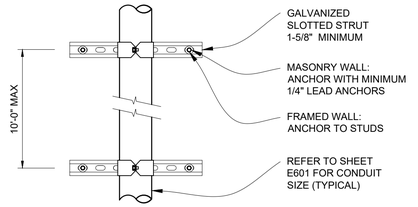
SCALE: NONE



Wind Deflectors carry module-to-module East/West ground bond. Bonding jumpers carry row-to-row North/South ground bond.

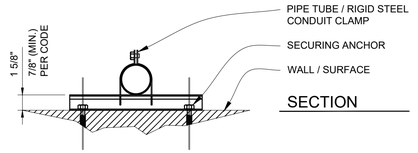
13 E501 MANUFACTURERS GROUNDING PLAN DET.

SCALE: N.T.S.



PLAN VIEW

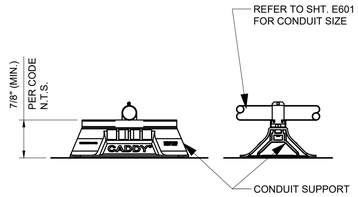
NOTE:
SUPPORT CONDUIT PER NEC 2023
MINIMUM EVERY 10'-0"



SECTION

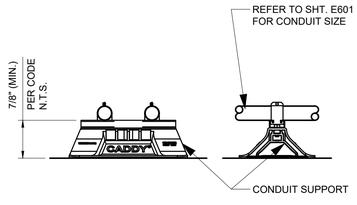
1 E501 VERTICAL CONDUIT SUPPORT - WALL

N.T.S.



2 E501 CONDUIT SUPPORT DETAIL - ROOF

N.T.S.



3 E501 CONDUIT SUPPORT DETAIL - ROOF

N.T.S.

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. CONDUIT FILL TO BE LESS THAN 40%.

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RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

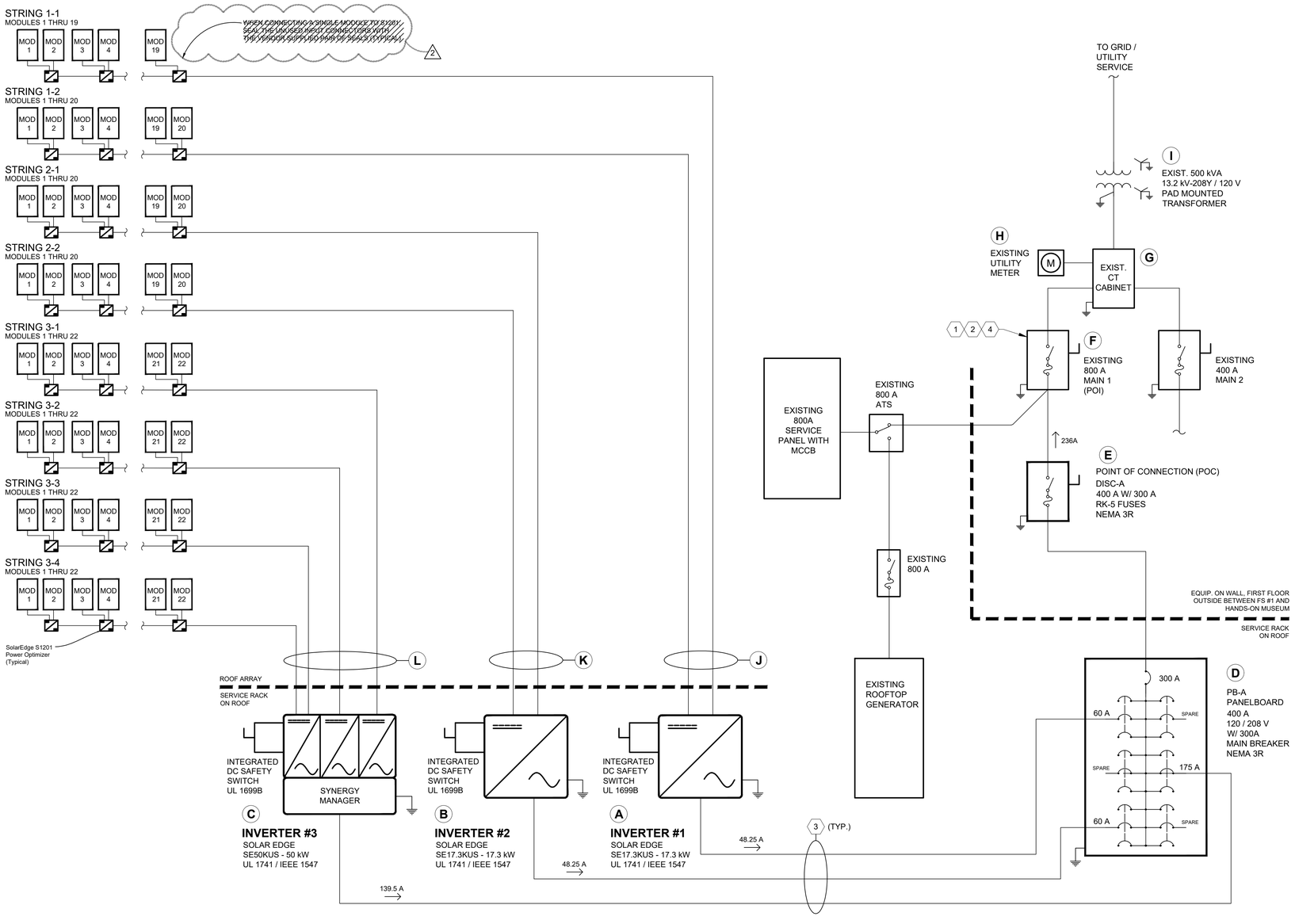
ELECTRICAL DETAILS

PROJECT NUMBER 23-11-1168-FS1

DRAWN BY	SHEET NUMBER
GAK	E501
SCALE	
SHEET SIZE 22x34	

CONDUIT AND WIRE SIZE CHART

Item	Description	Label	Route	Conduit	Wire (CU)	Neutral / Ground (CU)
A	Inverter - 17.3kW, 120/208V and DC Combiner Box	INV-1	A-D	1" EMT	(3) #6 XHHW-2	(2) #10 XHHW-2
B	Inverter - 17.3kW, 120/208V and DC Combiner Box	INV-2	B-D	1" EMT	(3) #6 XHHW-2	(2) #10 XHHW-2
C	Inverter - 50kW, 120/208V and DC Combiner Box	INV-3	C-D	1 1/2" EMT	(3) 2/0 XHHW-2	(2) #6 XHHW-2
D	PanelBoard - 400A, 120/208V, NEMA 3R W/300 A Main Breaker	PB-A				
E	Disconnect - 400A, 120/208 V, NEMA 3R, W/ 300A RK-5 Fuses	DISC - A	D-E	2" EMT	(3) 350 KCMIL XHHW-2	(2) #4 XHHW-2
F	Existing 800A Main Disconnect - Point of Interconnect (POI)	POI	E-F	2" EMT	(3) 350 KCMIL XHHW-2	(2) #4 XHHW-2
G	Existing CT Cabinet		F-G	Existing	Existing	Existing
H	Existing Utility Meter		G-H	Existing	Existing	Existing
I	Existing Utility Transformer		G-I	Existing	Existing	Existing
J	DC Home Runs Inverter 1	1-1 to 1-2	J-A	1" EMT	(4) - #10 PV Wire 2000V	(1) - #6 USE-2
K	DC Home Runs Inverter 2	2-1 to 2-2	K-B	1" EMT	(4) - #10 PV Wire 2000V	(1) - #6 USE-2
L	DC Home Runs Inverter 3	3-1 to 3-4	L-C	1 1/4" EMT	(8) - #10 PV Wire 2000V	(1) - #6 USE-2



A1 ONE LINE DIAGRAM

SCALE: N.T.S.

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. THE INVERTERS INCLUDE RESIDUAL CURRENT DETECTION GFIC AS PART OF THE DC GROUND FAULT DETECTION METHOD REQUIRED BY UL 1741.
3. ARTICLE 310.15 (B)(2) EXCEPTION: TYPE XHHW-2 INSULATED CONDUCTORS SHALL NOT BE SUBJECT TO THIS AMPACITY ADJUSTMENT PER 310.15.
4. DC CONDUCTORS SHALL BE DERATED PER 310.15.
5. SOLAR EDGE INVERTERS ARE CERTIFIED UL 1699B FOR ARC FAULT PROTECTION PER SECTION 690.11.
6. INVERTERS INCLUDE ANTI-ISLANDING PROTECTION COMPLIANT WITH UL 1741 AND IEEE 1547 PER NEC 690.
7. CONTRACTOR TO FIELD VERIFY THAT ALL LISTED GROUNDING ELECTRODES ARE PRESENT AND PROPERLY TERMINATED ON SITE.
8. CONTRACTOR TO VERIFY THAT ALL CIRCUIT BREAKERS ARE SUITABLE FOR BACKFEED.

2

SHEET KEY NOTES

1. AC GROUNDING CONNECTION TO EXISTING MAIN DISCONNECT PROVIDES CONNECTION TO BUILDING GROUNDING ELECTRODE GROUNDING CONDUCTORS AND BONDING JUMPERS TO BE INSTALLED TO COMPLY WITH ARTICLE 250.
2. NEW SUPPLY SIDE AC CONNECTION POWER PRODUCTION CONDUCTORS MUST MEET NEC 690, AND 705.11(D) AND (F) FOR SERVICE DISCONNECTING MEANS AND OVERCURRENT PROTECTION.
3. REFER TO CHART FOR CONDUIT AND WIRE SIZES.
4. INSTALL PLACARD SHOWING LOCATIONS OF DISCONNECT AND SOLAR ARRAY.

PV SYSTEM DESCRIPTION

FOR TOTAL SYSTEM:

PV MODULE MODEL:	JINKO SOLAR, JKM580N-72HL4-BDV (580 W)
PV MODULE SIZE:	89.69" L X 44.65" W X 1.18" D
NUMBER OF MODULES:	167
PV MODULE P_{MAX}:	580 W
OPTIMIZERS: (84)	SOLAR EDGE S1201 (DUAL OPTIMIZER)
INVERTERS : (3)	1. SOLAR EDGE - SE 17.3 KUS 2. SOLAR EDGE - SE 17.3 KUS 3. SOLAR EDGE - SE 50 KUS
NO. OF STRINGS PER INVERTER:	INV #1 (2 STRINGS)
NO. OF STRINGS PER INVERTER:	INV #2 (2 STRINGS)
NO. OF STRINGS PER INVERTER:	INV #3 (4 STRINGS)
DC TO AC RATIO:	1.14
NUMBER OF STRINGS:	8
TOTAL NAMEPLATE SIZE:	96.86 kW DC 84.6 kW AC

NOTE: PV SYSTEM IS 600 V DC (MAX.)

LEGEND

- DISCONNECT SWITCH
- GROUND
- 1-1 PV STRING DESIGNATION (STRING # / INVERTER #)

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21580 Novi Road
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ISSUED

DATE	DESCRIPTION	APPVD.
3-22-2024	50% REVIEW	
5-8-2024	INTERCONNECT	JE
6-28-2024	BID REVIEW	
1-27-2025	ADDENDUM-2	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

ONE LINE DIAGRAM

PROJECT NUMBER 23-11-1168-FS1

DRAWN BY RGM, GAK | SHEET NUMBER E601

SCALE

SHEET SIZE 22x34

PHOTOVOLTAIC SYSTEM DISCONNECT

LABEL 1

EACH PV STSTEM DISCONNECTING MEANS MUST BE LABELED WITH THIS PLACARD

WARNING

ELECTRIC SHOCK HA□ARD

DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND LOAD SIDES
MAY BE ENERGI□ED IN THE OPEN POSITION

LABEL 2

THE UTILITY METERING CABINET, EACH INVERTER, EACH DC AND AC DISCONNECTING MEANS □SWITCHES AND BREAKERS□MUST BE LABELED WITH THIS PLACARD

WARNING

ELECTRIC SHOCK HA□ARD

IF GROUND FAULT IS INDICATED ALL
NORMALLY GROUNDED CONDUCTORS
MAY BE UNGROUNDED AND ENERGI□ED

LABEL 3

PHOTOVOLTAIC SYSTEM DC DISCONNECT

MA□ SYSTEM DC VOLTAGE		1000 V
SHORT CIRCUIT DC CURRENT	1□.3kW INV-1	55 A

LABEL 4A

INVERTER DC DISCONNECT MUST BE LABELED WITH THIS PLACARD
TOP OF LABEL IS WHITE ON BLACK, BOTTOM IS BLACK ON WHITE

PHOTOVOLTAIC SYSTEM DC DISCONNECT

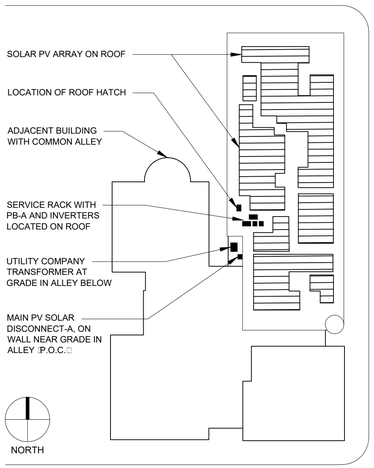
MA□ SYSTEM DC VOLTAGE		1000 V
SHORT CIRCUIT DC CURRENT	1□.3kW INV-2	55 A

LABEL 4B

INVERTER DC DISCONNECT MUST BE LABELED WITH THIS PLACARD
TOP OF LABEL IS WHITE ON BLACK, BOTTOM IS BLACK ON WHITE

CAUTION

POWER TO THIS FACILITY IS ALSO SUPPLIED FROM THE FOLLOWING SOURCES WITH DISCONNECTS AS SHOWN:



LABEL 6

INSTALL MAP PLACARD AS PER UTILITY RE□UIREMENTS, SIGNAGE SHALL BE RED BACKGROUND WITH WHITE ENGRAVED LETTERS: □CAUTION ¾", POWER TO...¼"□ CALL OUTS ⅛"□

THIS LABEL TO BE INSTALLED ON FENCE BESIDE GATE AND AT DISCONNECT DISC-MAIN.

WARNING

DUAL POWER SUPPLY

SOURCES UTILITY GRID AND
PV SOLAR ELECTRIC SYSTEM

LABEL □

E□UIPMENT BACK FED FROM PHOTOVOLTAIC SYSTEMS MUST BE LABELED WITH THIS PLACARD INCLUDING BOTH 480 V. DISCONNECTS AND PRIMARY SWITCH AT SUBSTATION

PHOTOVOLTAIC SYSTEM DC DISCONNECT

MA□ SYSTEM DC VOLTAGE		1000 V
SHORT CIRCUIT DC CURRENT	50kW INV-3	139.5 A

LABEL 4C

INVERTER DC DISCONNECT MUST BE LABELED WITH THIS PLACARD
TOP OF LABEL IS WHITE ON BLACK, BOTTOM IS BLACK ON WHITE

PHOTOVOLTAIC SYSTEM AC POINT OF INTERCONNECTION

RATED AC OUTPUT CURRENT	236 A
NOMINAL OPERATING AC VOLTAGE	208 VAC

LABEL 5

INTERACTIVE SYSTEM POINT OF CONNECTION - P.O.C. □DISC-A□ MUST BE LABELED WITH THIS PLACARD
TOP OF LABEL IS WHITE ON BLACK, BOTTOM IS BLACK ON WHITE

PHOTOVOLTAIC SOLAR BREAKER

LABEL 8

DO NOT RELOCATETHIS OVERCURRENT DEVICE

LABEL 9

WARNING

THIS E□UIPMENT FED BY MULTIPLE SOURCES. TOTAL RATING OF ALL OVERCURRENT DEVICE SHALL NOT E□CEED AMPACITY OF BUSSBAR

LABEL 10

PHOTOVOLTAIC SYSTEM kWH METER

LABEL 11

AC DISCONNECT

LABEL 12

EACH AC DISCONNECTING MEANS MUST BE LABELED WITH THIS PLACARD

DC DISCONNECT

LABEL 13

EACH DC DISCONNECTING MEANS MUST BE LABELED WITH THIS PLACARD

CAUTION

PV OUTPUT CIRCUIT

LABEL 14

CAUTION

INVERTER OUTPUT CIRCUIT

LABEL 15

PHOTOVOLTAIC SYSTEM E□UIPPED WITH RAPID SHUTDOWN

LABEL 16

INVERTER AND P.O.I.

DC PHOTOVOLTAIC SOURCE CIRCUIT

LABEL 1□

CAUTION SOLAR CIRCUIT

LABEL 19

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FIRE STATION 1

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ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

LABELS AND PLACARDS

PROJECT NUMBER 23-11-1168-FS1

DRAWN BY BD, GAK

SCALE

SHEET SI□E 22□34

SHEET NUMBER E□01

1. BASIC ELECTRICAL RE□UIREMENTS

A. FURNISH AND INSTALL THE MATERIAL, E□UIPMENT AND SYSTEMS COMPLETE AS SPECIFIED AND□OR INDICATED ON THE DRAWINGS.

B. COMPLY WITH THE 2023 NATIONAL ELECTRICAL CODE □NEC□AND ALL APPLICABLE MUNICIPAL, STATE, LOCAL CODES.

C. OBTAIN ALL APPLICABLE PERMITS INCLUDING BUILDING AND ELECTRICAL, LICENSES AND INSPECTIONS AS RE□UIRED.

D. ALL MATERIALS AND E□UIPMENT SHALL BE LISTED AND LABELED BY UL OR OTHER NATIONALLY RECOGNI□ED TESTING LABORATORY.

E. SUBMIT SHOP DRAWINGS, WIRING DIAGRAMS, SPECIFICATIONS, OPERATING DATA, AND□OR CATALOG CUTS FOR ALL E□UIPMENT.

F. FOLLOW □UALITY ASSURANCE PROJECT PLAN □APP□ STARTUP AND COMMISSIONING PROTOCOL.

G. UPON COMPLETION OF THE ELECTRICAL INSTALLATION, THE CONTRACTOR SHALL DELIVER TO NOVA ONE □1□ SET OF PRINTS OF AS-BUILT CONTRACT DRAWINGS SHOWING ALL ADDITIONS AND CHANGES DURING THE INSTALLATION. THESE DRAWINGS SHALL BE SUITABLE FOR USE IN PREPARATION OF RECORD DRAWINGS.

2. BASIC ELECTRICAL MATERIALS AND METHODS.

A. RACEWAYS

INSTALL ALL WIRING IN CONDUIT EXCEPT AS OTHERWISE INDICATED. MINIMUM CONDUIT SIZE TO BE ¾". CONDUIT SHALL BE RIGID GALVANI□ED STEEL ABOVE GROUND AND WHERE USED AS ELBOWS AND STUB-UPS UNDERGROUND. ELECTRICAL METALLIC TUBING □EMT□MAY BE INSTALLED ABOVE GROUND WHERE NOT SUBJECT TO DAMAGE. UNDERGROUND CONDUIT SHALL BE SCHEDULE 40 PVC. INSTALL CONDUITS PARALLEL AND PERPENDICULAR TO WALLS AND OTHER SURFACES. CLEAN, CAP, AND PROVIDE A PULL STRING IN EACH CONDUIT TO BE LEFT EMPTY.

B. BO□ES

JUNCTION BO□ES AND PULL BO□ES SHALL BE STAMPED STEEL OR CAST ALUMINUM, UL LISTED FOR THE APPLICATION.

C. DISCONNECT SWITCHES

UNLESS OTHERWISE INDICATED, DISCONNECT SWITCHES USED INDOORS SHALL HAVE A NEMA 12 ENCLOSURE AND DISCONNECT SWITCHES USED OUTDOORS SHALL HAVE A NEMA 3R ENCLOSURE. DISCONNECT SWITCHES SHALL BE PAD LOCKABLE IN THE OPEN POSITION.

D. GROUNDING

PROVIDE GROUNDING OF THE ENTIRE ELECTRICAL SYSTEM IN ACCORDANCE WITH NEC ARTICLE 250.

PROVIDE E□UIPMENT GROUNDING CONDUCTORS IN ALL BRANCH CIRCUITS AND ALL FEEDERS.

GROUNDING CONDUCTORS SHALL BE CLASS B STRANDED COPPER, GREEN INSULATED. TERMINATE EACH END USING A SUITABLE LISTED CONNECTOR.

BOND PV MODULES AS SHOWN ON THE DRAWINGS. CONNECT BONDING PIGTAILS TO MODULES PER MANUFACTURER'S INSTRUCTIONS. WHERE USED LUGS SHALL BE UL LISTED FOR DIRECT BURIAL.

GROUNDING ELECTRODES □GROUND RODS□SHALL BE COPPER-CLAD STEEL, MINIMUM 5/8" DIAMETER AND 8 FT. LONG.

BOND TOGETHER METAL STRUCTURES PER NEC 250.110.

E. WIRE AND CABLE

1□ WIRE FOR AC CIRCUITS SHALL BE RATED 90 DEGREES C WET OR DRY AND SHALL BE STRANDED COPPER WIRES, TYPE THHN□THWN-2 AND RATED 600V.

2□ WIRE FOR MEDIUM VOLTAGE SHALL BE 1C-15kV CLASS.

3□ WIRE FOR DC CIRCUITS SHALL BE RATED 90 DEGREES C WET OR DRY AND SHALL BE STRANDED COPPER. ALL DC WIRING NOT IN RACEWAY SHALL BE INSULATED TYPE USE-2 OR PV RATED TO 2000V.

4□ DC E□UIPMENT GROUNDING CONDUCTOR SHALL BE MINIMUM OF □6 AWG COPPER AND BE MECHANICALLY ATTACHED TO EACH PV RACKING STRUCTURE UNLESS OTHERWISE NOTED.

5□ NO SPLICES SHALL BE MADE E□CEPT WITHIN BO□ES UL LISTED FOR THE PURPOSE.

F. SENSORS AND SENSOR WIRING

1□ FURNISH AND INSTALL PYRANOMETERS, TEMPERATURE SENSORS, ETC. AS RE□UIRED AND AS SHOWN ON DRAWINGS. ALL WIRING USED FOR CONTROLS AND MONITORING SHALL BE APPROVED BY NOVA.

3. DATA AND COMMUNICATIONS SYSTEMS

A. ALL DATA AND COMMUNICATIONS WIRING □INCLUDING CELL MODEMS□SHALL BE COORDINATED WITH THE CITY OF ANN ARBOR AND INSTALLED BY ELECTRICAL CONTRACTOR OR AS DIRECTED BY NOVA.

4. IDENTIFICATION AND LABELS

A. ALL WIRES SHALL BE LABELED AT EACH END.

B. ALL E□UIPMENT MUST BE LABELED PER NEC ARTICLE 690 AND SHEET E-□01.

C. PROVIDE LABEL ON EACH PIECE OF E□UIPMENT, SUCH AS INVERTER, COMBINER BO□ES, DISCONNECT SWITCHES, ETC. THE LABEL SHALL IDENTIFY THE E□UIPMENT BY THE NAME USED ON THE DRAWINGS, SUCH AS INVERTERS, COMBINER BO□ES, DISCONNECT SWITCHES.

5. PV SYSTEM E□UIPMENT

A. PV MODULES:

1□ JINKO SOLAR □EAGLE□JKM580N-□2HL4-BDV □580W□

a. MA□ POWER OUTPUT: P□a□□580W AT STC

b. VOLTAGE AT MA□ POWER: V□p □42.59V

c. OPEN CIRCUIT VOLTAGE: Voc □51.4□V

d. CURRENT AT MA□ POWER: I □pp □13.62A

e. SHORT CIRCUIT CURRENT: I sc □14.3□A

2□ MODULES PER STRING □ VARIES, SEE ONE LINE DRAWING ON SHEET E601

3□ STRINGS PER INVERTER □2 □INV. □1□□2 □INV. □2□ □4 □INV. □3□

4□ NUMBER OF STRINGS □8

5□ No. OF MODULES □16□

6□ NEG LEAD LENGTH □LANDSCAPE□□55.12"

□□ POS LEAD LENGTH □LANDSCAPE□□55.12"

B. POWER OPTIMI□ER

1□ SOLAREDGE S1201 □DUAL OPTIMI□ER□

2□ INPUT WIRE LENGTH IN FEET

INPUT 1	OUTPUT
5.25□	□□□1□38□□□0.32□

3□ RATED INPUT DC POWER □1200W

4□ USE WITH 2 MODULES CONNECTED IN PARALLEL

5□ PHOTOVOLTAIC RAPID SHUTDOWN SYSTEM, COMPLIANT WITH NEC 2014, 201□, 2023

C. TOTAL ARRAY:

1□ DC NAMEPLATE RATING: □16□□580□□96.86 kW

D. RACKING SYSTEM:

1□ UNIRAC'S ECOLIBRIUM SOLAR, ECOFOOT2□WITH BALLAST

2□ MODULES TILTED 10 DEGREES

E. INVERTER

1□ SOLAREDGE SE 1□3K US □SE 50K US

2□ NUMBER OF INVERTERS □2 □1

3□ MEETS IEEE-154□, RULE 21, RULE 14 □HI□

4□ UL LISTED TO UL-1□41, UL-1□41 SA, UL-1699B. CSA 2.22

5□ NOMINAL INPUT VOLTAGE DC□TO DC- □ 3□0 TO 600 VDC RANGE □EACH□

6□ MA□IMUM INPUT VOLTAGE DC□TO DC- □600 VDC □EACH□

□□ MA□ INPUT CURRENT: 48.25A □INV-1□□48.25A □INV-2□□3 □46.5A □139.5A □INV-3□

8□ NOMINAL OUTPUT VOLTAGE: 120 □208 VAC

9□ CONTINUOUS CURRENT OUTPUT: 48.25A □INV-1□□48.25A □INV-2□□139.5A □INV-2□

10□MA□ CONTINUOUS OUTPUT POWER: 1□3kW □INV-1□□1□3kW □INV-2□□50kW □INV-3□

5. INSTALLATION

A.

1□ STORE MODULES IN MANUFACTURER'S PACKAGING UNTIL READY TO INSTALL.

2□ PREPARE SURFACE AND INSTALL PER MANUFACTURER'S RECOMMENDATIONS.

3□ ATTACH MODULE GROUNDING TERMINAL TO GROUNDING SYSTEM PER DRAWINGS.

NOVA Cons□ltants, Inc.
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ISSUED

DATE	DESCRIPTION	APPVD.
6-28-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

ELECTRICAL SPECIFICATIONS

PROJECT NUMBER
23-11-1168-FS1

DRAWN BY
RGM, GAK

SCALE

SHEET SI□E
22□34

SHEET NUMBER
E□02

EAGLE
MODULES

THE MOST DEPENDABLE
SOLAR PRODUCT

EAGLE 72 G6B

565-585 WATT • N-TYPE BIFACIAL

Positive power tolerance of 0~+3%

- NYSE-listed since 2010, Bloomberg Tier 1 manufacturer
- Top performance in the strictest 3rd party labs
- Automated manufacturing utilizing artificial intelligence
- Vertically integrated, tight controls on quality
- Premium solar factories in USA, Vietnam, and Malaysia

KEY FEATURES

N-Type Technology
N-type cells offer Jinko's in-house TOPCon technology with better performance and improved reliability.

Multi Busbar Half Cell Technology
Better light trapping and current collection to improve module power output and reliability.

Bifacial Power Gain
N-Type architecture increases bifaciality for higher backside bonus and better lifetime yield.

Low Temperature Coefficient
Best in class temperature coefficient for highest lifetime energy yield in all climates.

Industrial Grade Construction
Fire Type 29 with optimized dual-glass construction and thick frame for highest mechanical load resistance.

Shade Tolerant
Twin array design allows continued performance even with shading by trees or debris.

Protected Against All Environments
Certified to withstand humidity, heat, rain, marine environments, wind, hailstorms, and packed snow.

Warranty
12-year product and 30-year linear power warranty.

- ISO9001:2015 Quality Standards
- ISO14001:2015 Environmental Standards
- IEC61215, IEC61730 certified products
- ISO45001: 2018 Occupational Health & Safety Standards
- UL61730 certified products

TÜVRheinland CE c UL us LISTED IEC

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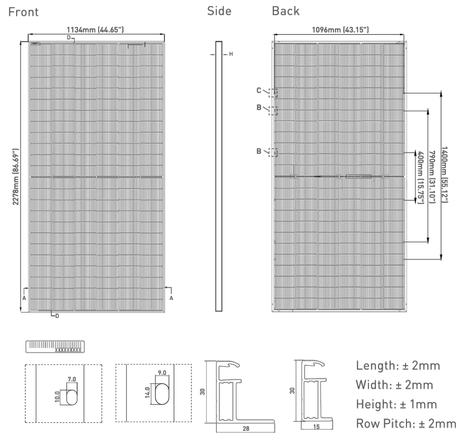
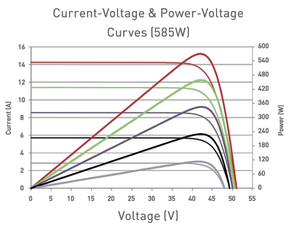
Jinko Solar

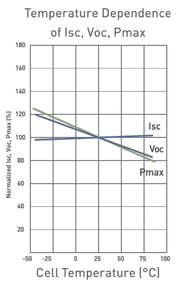
ENGINEERING DRAWINGS



Length: ± 2mm
Width: ± 2mm
Height: ± 1mm
Row Pitch: ± 2mm

ELECTRICAL PERFORMANCE & TEMPERATURE DEPENDENCE





MECHANICAL CHARACTERISTICS

No. of Half Cells	144 (2 x 72)
Dimensions	2278 x 1134 x 30mm (89.69 x 44.65 x 1.18in)
Weight	32kg (70.55lbs)
Front Glass	2.0mm, Anti-Reflection Coating
Back Glass	2.0mm, Heat Strengthened Glass
Frame	Anodized Aluminum Alloy
Junction Box	IP68 Rated
Output Cables	12 AWG, 1400mm (55.12in)
Fire Type	Type 29
Pressure Rating	5400Pa (Snow) & 2400Pa (Wind)

TEMPERATURE CHARACTERISTICS

Temperature Coefficients of Pmax	-0.29%/°C
Temperature Coefficients of Voc	-0.25%/°C
Temperature Coefficients of Isc	0.045%/°C
Nominal Operating Cell Temperature (NOCT)	45±2°C
Bifacial Factor	80±5%

MAXIMUM RATINGS

Operating Temperature (°C)	-40°C~+85°C
Maximum System Voltage	1500VDC
Maximum Series Fuse Rating	30A

PACKAGING CONFIGURATION

(Two pallets = One stack)

36pcs/pallets, 72pcs/stack, 720pcs/40 HQ Container

BIFACIAL OUTPUT-REARSIDE POWER GAIN

5%	Maximum Power (Pmax)	593Wp	599Wp	604Wp	609Wp	614Wp
	Module Efficiency (%)	22.97%	23.17%	23.37%	23.57%	23.78%
15%	Maximum Power (Pmax)	650Wp	656Wp	661Wp	667Wp	673Wp
	Module Efficiency (%)	25.15%	25.37%	25.60%	25.82%	26.05%
25%	Maximum Power (Pmax)	706Wp	713Wp	719Wp	725Wp	731Wp
	Module Efficiency (%)	27.34%	27.58%	27.82%	28.07%	28.31%

WARRANTY

12-year product and 30-year linear power warranty

1st year degradation not to exceed 1%, each subsequent year not to exceed 0.4%, minimum power at year 30 is 87.4% or greater.

ELECTRICAL CHARACTERISTICS

Module Type	JKM565N-72HL4-BDV		JKM570N-72HL4-BDV		JKM575N-72HL4-BDV		JKM580N-72HL4-BDV		JKM585N-72HL4-BDV	
	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT	STC	NOCT
Maximum Power (Pmax)	565Wp	425Wp	570Wp	429Wp	575Wp	432Wp	580Wp	436Wp	585Wp	440Wp
Maximum Power Voltage (Vmp)	42.14V	39.52V	42.29V	39.65V	42.44V	39.78V	42.59V	39.87V	42.74V	40.03V
Maximum Power Current (Imp)	13.41A	10.75A	13.48A	10.81A	13.55A	10.87A	13.62A	10.94A	13.69A	10.99A
Open-circuit Voltage (Voc)	50.87V	48.32V	51.07V	48.51V	51.27V	48.70V	51.47V	48.89V	51.67V	49.08V
Short-circuit Current (Isc)	14.19A	11.46A	14.25A	11.50A	14.31A	11.55A	14.37A	11.60A	14.43A	11.65A
Module Efficiency STC (%)	21.87%		22.07%		22.26%		22.45%		22.65%	

***STC:** Irradiance 1000W/m² Cell Temperature 25°C AM = 1.5
NOCT: Irradiance 800W/m² Ambient Temperature 20°C AM = 1.5 Wind Speed 1m/s

*Power measurement tolerance: ±3%

The company reserves the final right for explanation on any of the information presented hereby. JKM565-585N-72HL4-BDV-F2-US

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Jinko Solar

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CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1
111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

DATA SHEETS

PROJECT NUMBER 23-11-1168-FS1
DRAWN BY GAK
SCALE
SHEET SI□E 22□34
SHEET NUMBER E801

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\Fire Station 1\Drawings\23111168-FS1-E801.dwg Date: J□n 28 2024; 10:30AM User: george

Power Optimizer

For North America

S1201

POWER OPTIMIZER

SolarEdge's most advanced, cost-effective Power Optimizer for commercial and large field installations

- **Greater Energy Yields**
  - High efficiency (99.5%) with module-level MPPT, for maximized system energy production and revenue, and fast project ROI
  - Supports high power and bifacial PV modules, and high string current for more power per string.
- **Maximum Protection with Built-In Safety**
  - Designed to automatically reduce high DC voltage to touch-safe levels, upon grid/inverter shutdown, with SafeDC™
  - Includes SolarEdge Sense Connect, allowing continuous monitoring to detect overheating due to installation issues or connector-level wear and tear
- **Lower BoS Costs**
  - Flexible system design enables maximum space utilization and up to 2x longer string lengths, 50% less cables, fuses and combiner boxes
  - Supports connection of two PV modules in series with easy cable management and fast installation times
- **Simpler O&M**
  - Module-level system monitoring enabling pinpointed fault detection and remote, time-saving troubleshooting

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Power Optimizer

For North America

S1201

	S1201	Units
INPUT		
Rated Input DC Power(1)	1200	W
Absolute Maximum Input Voltage (Voc)	125	Vdc
MPPT Operating Range	12.5 – 105	Vdc
Maximum Short Circuit Current (Isc) of Connected PV Module	15	Adc
Maximum Efficiency	99.5	%
Weighted Efficiency	98.8	%
Overvoltage Category	II	
OUTPUT DURING OPERATION		
Maximum Output Current	18	Adc
Maximum Output Voltage	80	Vdc
OUTPUT DURING STANDBY (POWER OPTIMIZER DISCONNECTED FROM INVERTER OR INVERTER OFF)		
Safety Output Voltage per Power Optimizer	1	Vdc
STANDARD COMPLIANCE		
Photovoltaic Rapid Shutdown System	Compliant with NEC 2014, 2017, 2020	
EMC	FCC Part15, IEC 61000-6-2, and IEC 61000-6-3	
Safety	IEC62109-1 (class II safety), UL1741, UL3741, CSA C22.2#107.1	
Material	UL94 V-0, UV Resistant	
RoHS	Yes	
Fire Safety	VDE-AR-E 2100-712:2013-05	
INSTALLATION SPECIFICATIONS		
Maximum Allowed System Voltage	1000	Vdc
Dimensions (W x L x H)	129 x 155 x 59 / 5.08 x 6.10 x 2.32	mm / in
Weight	1106 / 2.4	gr / lb
Input Connector	MC4(2)	
Input Wire Length	1.6 / 5.25(3)	m / ft
Output Connector	MC4	
Output Wire Length	(+) 5.3 (-) 0.10 / (+) 17.38, (-) 0.32	m / ft
Operating Temperature Range(4)	-40 to +85 / -40 to +185	°C / °F
Protection Rating	IP68 / NEMA6P	
Relative Humidity	0 – 100	%

(1) Rated power of the module at STC will not exceed the power optimizer Rated Input DC Power. Modules with up to +5% power tolerance are allowed.
(2) For other connector types please contact SolarEdge.
(3) The Sense Connect feature is only enabled on the output cable connectors.
(4) For ambient temperatures above +65°C / +149°F power de-rating is applied.

PV System Design Using a SolarEdge Inverter(5)(6)(7)		208V Grid SE10K	208V Grid SE17.3K*	277/480V Grid SE20K, SE30K	277/480V Grid SE40K*	
Compatible Power Optimizers		S1201				
Minimum String Length	Power Optimizers	8	10	15	15	
	PV Modules	15	19	29	29	
Maximum String Length	Power Optimizers	30	30	30	30	
	PV Modules	60	60	60	60	
Maximum Continuous Power per String		7200	8820	15300	15300	W
Maximum Allowed Connected Power per String(7)		1 string – 8400	1 string – 10020	1 string – 17550	2 strings or less – 17550	W
		2 strings or more – 10600	2 strings or more – 13000	2 strings or more – 23000	3 strings or more – 23000	
Parallel Strings of Different Lengths or Orientations		Yes				
Maximum Difference in Number of Power Optimizers Allowed Between the Shortest and Longest String Connected to the Same Inverter Unit		5 Power Optimizers				

*The same rules apply for Synergy units of equivalent power ratings, that are part of the modular Synergy Technology inverter.
(5) S1201 cannot be mixed with any other Power Optimizers models in the same string.
(6) For each string, a Power Optimizer may be connected to a single PV module if 1) each Power Optimizer is connected to a single PV module or 2) it is the only Power Optimizer connected to a single PV module in the string.
(7) To connect more STC power per string, design your project using SolarEdge Designer.

RoHS

Intertek

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ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

DATA SHEETS

PROJECT NUMBER
23-11-1168-FS1

DRAWN BY: GAK
SCALE:
SHEET SI□E: 22□34

SHEET NUMBER
E802

INVERTER - 1 □ 2

Three Phase Inverters for the 120/208V Grid

For North America

SE10KUS / SE17.3KUS

INVERTERS

The best choice for SolarEdge enabled systems

- Specifically designed to work with power optimizers
- Quick and easy inverter commissioning directly from a smartphone using SolarEdge SetApp
- Fixed voltage inverter for superior efficiency and longer strings
- Built-in type 2 DC and AC Surge Protection, to better withstand lightning events
- Small, lightest in its class, and easy to install outdoors or indoors on provided bracket
- Integrated arc fault protection and rapid shutdown for NEC 2014, 2017, and 2020, per article 690.11 and 690.12
- Built-in module-level monitoring with Ethernet, wireless or cellular communication for full system visibility
- Integrated Safety Switch
- UL1741 SA and SB certified, for CPUC Rule 21 grid compliance

W□INTERNAL SIMCARD CELLULAR PLUG-IN AND DATA PLAN

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Three Phase Inverters for the 120/208V Grid(1)

For North America

~~SE10KUS~~ / SE17.3KUS

INVERTER - 1 □ 2

Model Number	SE10KUS	SE17.3KUS	
Applicable to inverters with part number	SEXXK-US□2IXXXX		
OUTPUT			
Rated AC Power Output	10000	17300	W
Maximum Apparent AC Output Power	10000	17300	VA
AC Output Line Connections	3W + PE, 4W + PE		
AC Output Voltage Minimum-Nominal-Maximum(2) (L-N)	105 – 120 – 132.5		Vac
AC Output Voltage Minimum-Nominal-Maximum(2) (L-L)	183 – 208 – 229		Vac
AC Frequency Minimum-Nominal-Maximum(2)	59.3 – 60 – 60.5		Hz
Continuous Output Current (per Phase)	27.8	48.25	Aac
GFDI Threshold	1		A
Utility Monitoring, Islanding Protection, Country Configurable Set Points	Yes		
THD	≤ 3		%
Power Factor Range	+/- 0.85 to 1		
INPUT			
Maximum DC Power (Module STC)	17500	30275	W
Transformer-less, Ungrounded	Yes		
Maximum Input Voltage DC+ to DC-	600		Vdc
Operating Voltage Range	370 – 600		Vdc
Maximum Input Current	27.8	48.25	Adc
Maximum Input Short Circuit Current	55		Adc
Reverse-Polarity Protection	Yes		
Ground-Fault Isolation Detection	167kΩ Sensitivity(3)		
CEC Weighted Efficiency	97	97.5	%
Night-time Power Consumption	< 4		W
ADDITIONAL FEATURES			
Supported Communication Interfaces	2 x RS485, Ethernet, Cellular (optional)		
Inverter Commissioning	With the SetApp mobile application using built-in Wi-Fi access point for local connection		
Rapid Shutdown	NEC2014, NEC2017 and NEC2020 compliant/certified		
RS485 Surge Protection Plug-in	Supplied with the inverter, Built-in		
AC, DC Surge Protection	Type II, field replaceable, Built-in		
DC Fuses (Single Pole)	25A, Built-in		
Smart Energy Management	Export Limitation		
DC SAFETY SWITCH			
DC Disconnect	Integrated		
STANDARD COMPLIANCE			
Safety	UL1741, UL1741 SA, UL1741 SB, UL1699B, CSA C22.2, Canadian AFCI according to T.I.L. M-07		
Grid Connection Standards	IEEE1547-2018, Rule 21, Rule 14 (HI)		
Emissions	FCC part15 class A		
INSTALLATION SPECIFICATIONS			
AC Output Conduit size /AWG range	¾" or 1" / 6 - 10 AWG		
DC Input Conduit size / AWG range	¾" or 1" / 6 - 12 AWG		
Number of DC inputs pairs	4		
Dimensions with Safety Switch (H x W x D)	31.8 x 12.5 x 11.8 / 808 x 317 x 300		in / mm
Weight with Safety Switch	78.2 / 35.5		lb / kg
Cooling	Fans (user replaceable)		
Noise	< 62		dBA
Operating Temperature Range	-40 to +140 / -40 to +60(4)		°F / °C
Protection Rating	NEMA 3R		
Mounting	Bracket provided		

(1) For 277/480V inverters refer to the Three Phase Inverters for the 277/480V Grid for North America datasheet.
(2) For other regional settings please contact SolarEdge support.
(3) Where permitted by local regulations.
(4) For power de-rating information refer to the Temperature De-rating - Technical Note (North America).

CE

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84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

DATA SHEETS

PROJECT NUMBER 23-11-1168-FS1
DRAWN BY GAK
SCALE
SHEET SI□E 22□34
SHEET NUMBER E803

INVERTER - 3

Three Phase Inverter with Synergy Technology

For the 208V Grid for North America

SE50KUS

INVERTERS

Powered by unique pre-commissioning process for rapid system installation

- Pre-commissioning feature for automated validation of system components and wiring during the site installation process and prior to grid connection
- Easy 2-person installation with lightweight, modular design (each inverter consists of 3 Synergy units and 1 Synergy Manager)
- Independent operation of each Synergy unit enables higher uptime and easy serviceability
- Built-in thermal sensors detect faulty wiring ensuring enhanced protection and safety
- Built-in arc fault protection and rapid shutdown
- Built-in PID mitigation for maximized system performance
- Monitored* and field-replaceable surge protection devices, to better withstand surges caused by lightning or other events
- Built-in module-level monitoring with Ethernet or cellular communication for full system visibility

*Applicable only for DC and AC SPDs

W□INTERNAL SIMCARD CELLULAR PLUG-IN AND DATA PLAN

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solaredge

Three Phase Inverter with Synergy Technology

For the 208V Grid for North America

SE50KUS

INVERTER - 3

MODEL NUMBER	SExxK-USx2Ixxxx	
APPLICABLE TO INVERTERS WITH PART NUMBER	SE50KUS	UNITS
OUTPUT		
Rated AC Active Output Power	50000	W
Maximum AC Apparent Output Power	50000	VA
AC Output Line Connections	3W + PE, 4W + PE	
Supported Grids	WYE: TN-C, TN-S, TN-C-S, TT, IT, Delta: IT	
AC Output Voltage Minimum-Nominal-Maximum(1) (L-N)	105 – 120 – 132.5	Vac
AC Output Voltage Minimum-Nominal-Maximum(1) (L-L)	183 – 208 – 229	Vac
AC Frequency Min-Nom-Max(1)	59.5 – 60 – 60.5	Hz
Maximum Continuous Output Current (per Phase, PF=1)	139.5	Aac
GFDI Threshold	1	A
Utility Monitoring, Islanding Protection, Configurable Power Factor, Country Configurable Thresholds	Yes	
Total Harmonic Distortion	≤ 3	%
Power Factor Range	±0.85 to 1	
INPUT		
Maximum DC Power (Module STC) Inverter / Synergy Unit	87500 / 29165	W
Transformer-less, Ungrounded	Yes	
Maximum Input Voltage DC+ to DC-	600	Vdc
Operating Voltage Range	370 – 600	Vdc
Maximum Input Current	3 x 46.5	Adc
Reverse-Polarity Protection	Yes	
Ground-Fault Isolation Detection	167kΩ sensitivity per Synergy Unit(2)	
CEC Weighted Efficiency	97	%
Nighttime Power Consumption	< 12	W
ADDITIONAL FEATURES		
Supported Communication Interfaces(3)	2 x RS485, Ethernet, Wi-Fi (optional), Cellular (optional)	
Smart Energy Management	Export Limitation	
Inverter Commissioning	With the SetApp mobile application using built-in Wi-Fi access point for local connection	
Arc Fault Protection	Built-in, User Configurable (According to UL1699B)	
Photovoltaic Rapid Shutdown System	NEC 2014, 2017 and 2020, Built-in	
PID Rectifier	Nighttime, built-in	
RS485 Surge Protection (ports 1+2)	Type II, field replaceable, integrated	
AC, DC Surge Protection	Type II, field replaceable, integrated	
DC Fuses (Single Pole)	25A, integrated	
Pre-Commissioning	Built-in(4)	
DC SAFETY SWITCH		
DC Disconnect	Built-in	
STANDARD COMPLIANCE		
Safety	UL1699B, UL1741, UL1741 SA, UL1741 SB, UL1998, CSA C22.2#107.1, Canadian AFCI according to T.I.L. M-07	
Grid Connection Standards	IEEE 1547-2018, Rule 21, Rule 14 (HI)	
Emissions	FCC part 15 class A	

(1) For other regional settings please contact SolarEdge support.
(2) Where permitted by local regulations.
(3) For specifications of the optional communication options, visit the Communication product page or the Knowledge Center to download the relevant product datasheet.
(4) Not available for P/Ns SExxK-xxxxxBPxx.

Three Phase Inverter with Synergy Technology

For the 208V Grid for North America

SE50KUS

INVERTER - 3 □cont.□

MODEL NUMBER		SExxK-USx2Ixxxx	
APPLICABLE TO INVERTERS WITH PART NUMBER		SE50KUS	UNITS
INSTALLATION SPECIFICATIONS			
Number of Synergy Units per Inverter		3	
AC Max Conduit Size		2 ½"	in
Max AWG Line / PE		4/0 / 1/0	
DC Max Conduit Size		1 x 3"; 2 x 2"	in
DC Input Inverter / Synergy Unit	Multi-input (SExxK-USxxxxxZ4)	12 / 4 pairs; 6 – 12 AWG	
	Combined input (SExxK-USxxxxxW4)	3 pairs / 1 pair, Max 2 AWG; copper or aluminum	
Dimensions (H x W x D)		Synergy Unit: 22 x 12.9 x 10.75 / 558 x 328 x 273 Synergy Manager: 14.17 x 22.4 x 11.6 / 360 x 560 x 295	in / mm
Weight		Synergy Unit: 70.4 / 32 Synergy Manager: 39.6 / 18	lb / kg
Operating Temperature Range		-40 to +140 / -40 to +60(5)	℉ / ℃
Cooling		Fan (user replaceable)	
Noise		< 67	dBA
Protection Rating		NEMA 3R	
Mounting		Brackets provided	

(5) For power de-rating information refer to the Temperature Derating Technical Note for North America.

NOVA Cons□ltants, Inc.
21580 No□ Road
S□ite 300
No□, MI 483□5
Phone: □248□34□-3512
Fa□: □248□34□-4152
www.no□acons□ltants.co□

ISSUED

DATE	DESCRIPTION	APPVD.
6-28-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1
111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

DATA SHEETS

PROJECT NUMBER 23-11-1168-FS1
DRAWN BY GAK
SCALE
SHEET SI□E 22□34
SHEET NUMBER E804

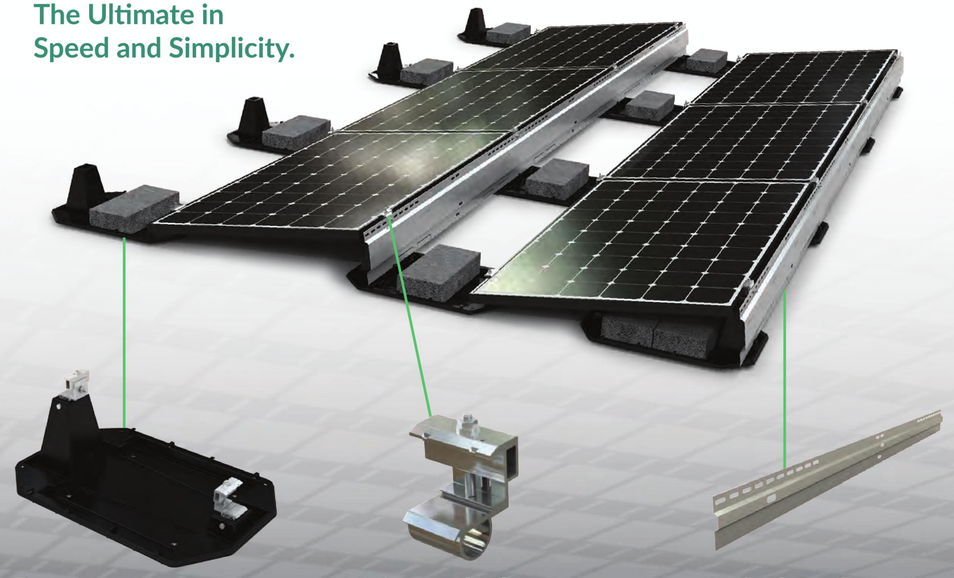
EcoFoot2+®

Ballasted Racking System

Installer-Preferred for Low-Slope Roofs

Three Main Components.

The Ultimate in Speed and Simplicity.



Base

UL-Listed ASA based resin is a durable material commonly used for automotive and construction products. Wire Clips are built-in for easy wire management. Class A fire rated and UL2703 Certified.

Universal Clamp

The preassembled Universal Clamp is ready to go right out of the box. Simply drop the Clamp into the Base. Integrated Bond Pin achieves integrated grounding without the use of grounding washers. Fits 30-50mm module frames with a single component.

Wind Deflector

Corrosion-resistant wind deflector on every module helps minimize uplift, reduce ballast requirements and carries UL2703 validated ground path from modules and racking components.

Ecolibrium Solar

Contact: 740.249.1877 | sales@ecolibriumsolar.com | www.ecolibriumsolar.com

Pure Performance

Unbeatable, Right Out of the Box.

No other racking products install flat roof arrays better than EcoFoot2+ Racking Solution. Installers prefer EcoFoot2+ because it's fast, simple, and durable. The line-up is unbeatable:

- Ready-to-go, preassembled components and simple installation
- No PV panel prep required: bases self-align
- Low-effort roof layout, just two chalk lines required
- No training required, 5-minute learning curve

Commercial

Residential

Design Flexibility

Wire Management Built-In

Master the Most Challenging Rooftop

Stackable Bases fit up to 50kW of Bases delivered on a standard pallet.

System Benefits

- Low part count
- Rapid system deployment
- Preassembled Universal Clamp
- Increased design flexibility
- More ballast capacity
- Simplified logistics
- Ship up to 50kW per pallet

Validation Summary

- Certified to UL2703 Fire Class A for Type I and II modules
- Certified to UL2703
- Grounding and Bonding
- Wind tunnel tested to 150mph
- SEAOC seismic compliant
- CFD and structurally tested
- DNV GL rated at 13.5 panels per installer-hour

Technical Specifications

Dimensions: 26.5"L x 18.25"W x 8.3"H
Typical System Weight: 3.5–6 lbs. per sq. ft.
Module orientation: Landscape/Portrait
Tilt angle: Landscape 10°/Portrait 5°
Module inter-row spacing: 18.9"
Roof pitch: 0° to 7°
Clamping range: 30-50mm
Ballast requirements: 4" x 8" x 16"
Warranty: 25 years
Slip sheets: not required by Ecolibrium Solar.
If required by roofer, use 20"x29" under Base.

Ecolibrium Solar

740-249-1877 | www.ecolibriumsolar.com
507 Richland Avenue, Athens, OH 45701

EcoFoot2+ Sales Sheet v2.1 121919

NOVA Consultants, Inc.
21580 Novi Road
Suite 300
Novi, MI 48375
Phone: 248-347-3512
Fax: 248-347-4152
www.novaconsultants.com

ISSUED

DATE	DESCRIPTION	APPVD.
6-28-2024	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 1

111 NORTH 5TH AVENUE
ANN ARBOR, MI 48104

84.6 kW AC SOLAR ARRAY
96.8 kW DC SOLAR ARRAY

DATA SHEETS

PROJECT NUMBER 23-11-1168-FS1
DRAWN BY GAK
SCALE
SHEET SIZE 22x34
SHEET NUMBER E805

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\Fire Station 1\Drawings\23111168-FS1-E805.dwg Date: Jun 28 2024; 10:48AM User: george

BOM and AVG PSF Array 1			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	60	5	300
WIND DEFLECTORS K	32	6	192
BALLAST BLOCKS	126	32	4032
PANELS	32	68.34	2186.88000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		6730.08000	
ARRAY AREA(sft)		1439.72	
AVG PSF		4.67458	

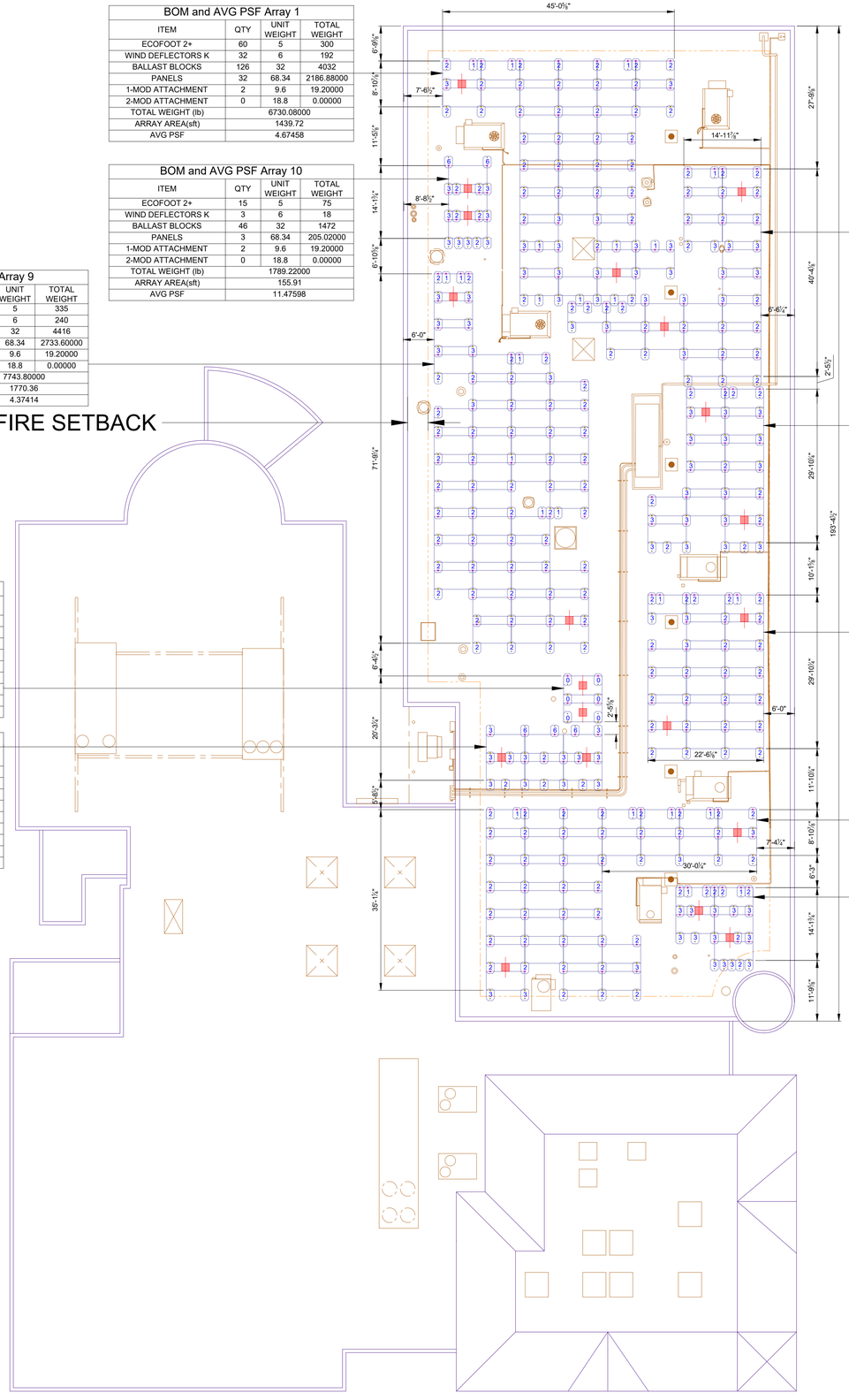
BOM and AVG PSF Array 10			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	15	5	75
WIND DEFLECTORS K	3	6	18
BALLAST BLOCKS	46	32	1472
PANELS	3	68.34	205.02000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		1789.22000	
ARRAY AREA(sft)		155.91	
AVG PSF		11.47598	

BOM and AVG PSF Array 9			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	67	5	335
WIND DEFLECTORS K	40	6	240
BALLAST BLOCKS	138	32	4416
PANELS	40	68.34	2733.60000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		7743.80000	
ARRAY AREA(sft)		1770.36	
AVG PSF		4.37414	

4' FIRE SETBACK

BOM and AVG PSF Array 8			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	6	5	30
WIND DEFLECTORS K	2	6	12
BALLAST BLOCKS	0	32	0
PANELS	2	68.34	136.68000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		197.88000	
ARRAY AREA(sft)		108.67	
AVG PSF		1.82093	

BOM and AVG PSF Array 7			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	19	5	95
WIND DEFLECTORS K	6	6	36
BALLAST BLOCKS	62	32	1984
PANELS	6	68.34	410.04000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		2544.24000	
ARRAY AREA(sft)		289.86	
AVG PSF		8.77748	



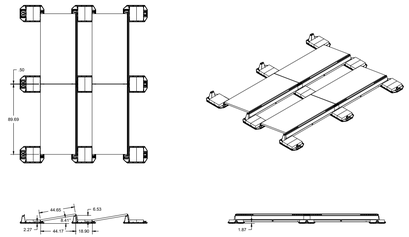
BOM and AVG PSF Array 2			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	38	5	190
WIND DEFLECTORS K	19	6	114
BALLAST BLOCKS	87	32	2784
PANELS	19	68.34	1298.46000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		4405.66000	
ARRAY AREA(sft)		884.44	
AVG PSF		4.98130	

BOM and AVG PSF Array 3			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	27	5	135
WIND DEFLECTORS K	13	6	78
BALLAST BLOCKS	71	32	2272
PANELS	13	68.34	888.42000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		3392.62000	
ARRAY AREA(sft)		608.78	
AVG PSF		5.57282	

BOM and AVG PSF Array 4			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	31	5	155
WIND DEFLECTORS K	17	6	102
BALLAST BLOCKS	63	32	2016
PANELS	17	68.34	1161.78000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		3453.98000	
ARRAY AREA(sft)		766.29	
AVG PSF		4.50741	

BOM and AVG PSF Array 6			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	51	5	255
WIND DEFLECTORS K	30	6	180
BALLAST BLOCKS	103	32	3296
PANELS	30	68.34	2050.20000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		5800.40000	
ARRAY AREA(sft)		1345.24	
AVG PSF		4.31180	

BOM and AVG PSF Array 5			
ITEM	QTY	UNIT WEIGHT	TOTAL WEIGHT
ECOFOOT 2+	22	5	110
WIND DEFLECTORS K	5	6	30
BALLAST BLOCKS	55	32	1760
PANELS	5	68.34	341.70000
1-MOD ATTACHMENT	2	9.6	19.20000
2-MOD ATTACHMENT	0	18.8	0.00000
TOTAL WEIGHT (lb)		2260.90000	
ARRAY AREA(sft)		246.5	
AVG PSF		9.17201	



JINKO SOLAR JKM580N-72HL4-BDV 580W

ECOFOOT2+ LANDSCAPE ELEVATION/ISO VIEWS

SCALE: NTS UNITS: INCHES

MODULE NOTES

-PV MODULE SPECS (W): 580

-PV MODULE QUANTITY: 167

-SYSTEM POWER RATING (STC KWDC): 96.86

-ORIENTATION/TILT (DEGREE): LANDSCAPE/8.41°

BALLAST NOTES

-BALLAST BLOCK: 16"x8"x4" @ 32 LBS

ECOFOOT 2+ (BLOCK PER E2+):

N = BASE WITH BLOCK COUNT

= SEISMIC ATTACHMENT / 1 MODULE ATTACHMENT

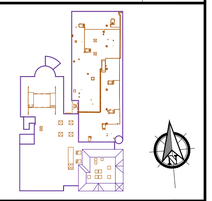
ARRAY OF GREATEST AVERAGE PSF = 11.47

BILL OF MATERIALS

PART NO	NAME	QTY
ES20207	ECOFOOT2+	336
ES10466	UNIVERSAL CLAMP KIT	265
ES20311K	WIND DEFLECTOR	167
ES10970	ECOFOOT MLPE BRACKET	167
ES10378	38" BONDING JUMPER	56
ES11203	MID-SUPPORT KIT	167
310999	FLASHLOC RM	20
ES10843	ROOF TO STRUT	20
ES10844	STRUT TO MODULE	20
ES20501	1 5/8" X 1 5/8" 12 GAUGE STRUT (10')	6
USER SUPPLIED	32 LBS BALLAST BLOCK (SOURCED LOCALLY OR SUPPLIED BY OTHERS)	751
008009P	ILSCO LAY IN LUG	10

SITE NOTES

BASIC WIND SPEED (MPH)	115
EXPOSURE CATEGORY	B
GROUND SNOW LOAD (PSF)	20
OCCUPANCY CATEGORY	IV
SEISMIC (Ss)	0.094
ROOF HEIGHT (FT)	30
PARAPET HEIGHT (IN)	12
SETBACK TYP. (IN)	48
ROOF SLOPE (DEG)	1.2
ROOFING TYPE	EPDM MEMBRANE
ASCE7 VERSION	2010
BUILDING CODE	IBC2015



NO.	REVISION	BY	DATE
0	INITIAL RELEASE	MN	2024-6-5
A	LAYOUT CHANGE	MN	2024-8-1

UNIRAC®

1411 BROADWAY BOULEVARD NE
ALBUQUERQUE, NEW MEXICO, USA, 87102
WWW.UNIRAC.COM

PRODUCED FOR: NOVA CONSULTANTS INC

PROJECT NAME: FIRE STATION 1

111 N 5TH AVE
ANN ARBOR, MI 48104

Date: 2024-08-01

Scale: CUSTOM

Drawn By: MN

Sheet: S-1.0

DRAWING INDICATES PLACEMENT OF EQUIPMENT AND BALLAST. PLEASE REFER TO INSTALLATION MANUAL FOR FULL PRODUCT DETAILS. INSTALLER IS RESPONSIBLE FOR VERIFICATION OF SITE AND PROJECT SPECIFICS. DESIGN IS FINALIZED WHEN ACCOMPANIED BY STAMPED ENGINEERING REPORT.

SOLAR PROJECT DESIGN

Prepared For: Nova Consultants Inc
Project Name: Fire Station 1
Project Address: 111 N 5th Ave, Ann Arbor, MI 48104
Date: August 1, 2024

SOLUTION OVERVIEW

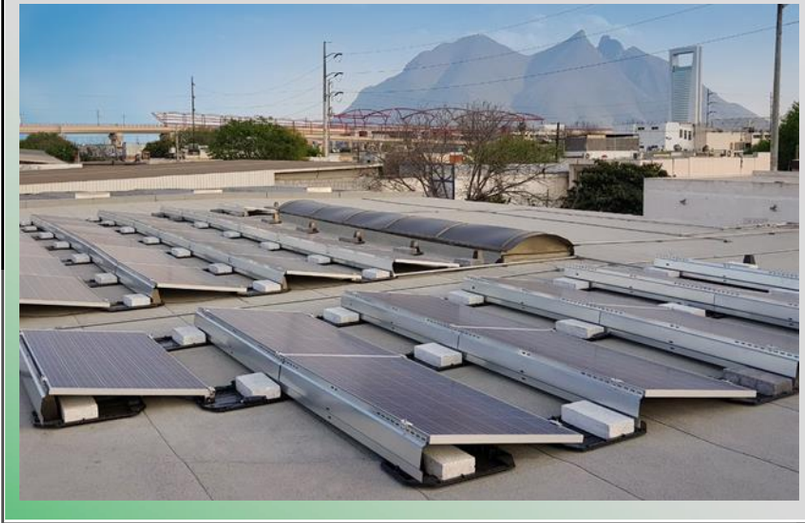
EcoFoot2+ Low-Slope Racking

With 500MW installed, EcoFoot Racking is preferred by installers for fast, simple installation and streamlined logistics. The enclosed provides the layout and system details for a complete solution for your project using this validated and reliable product.

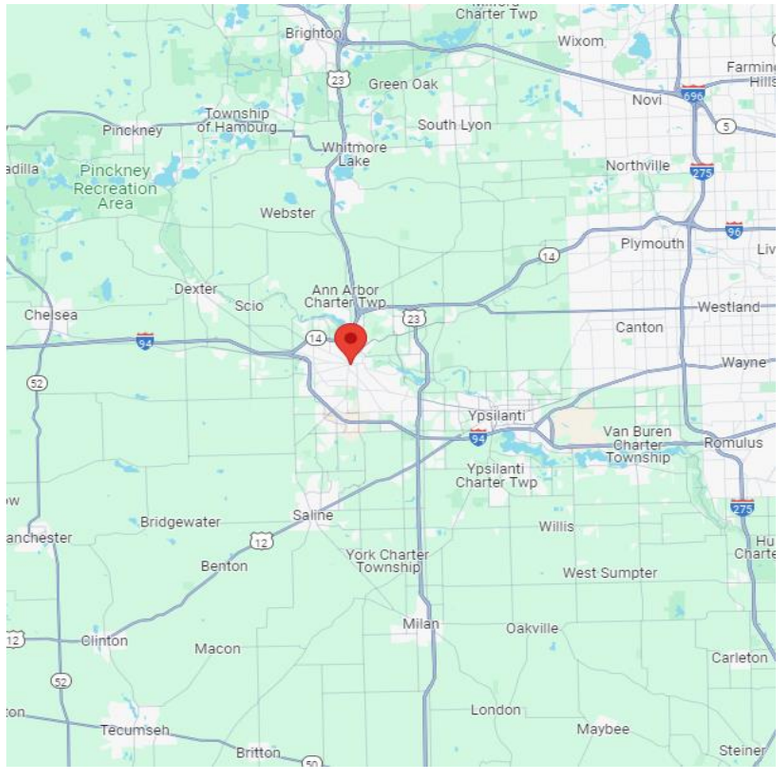
EcoFoot2+ delivers key advantages for a successful, efficient installation.
Faster Installation: Installers complete projects in less time with self-aligning Bases, simple pre-assembled components, five-minute learning curve, and one-tool installation. Install speed is rated at 13.5 modules/installer-hour by DNV-GL.

Low Part Count & Streamlined Logistics: EcoFoot2+ consists of three core components: roof friendly, durable Base with integrated north/south Wire Clips, pre-assembled Clamps, and Wind Deflector to reduce ballast and provide east/west bonding. Stackable Bases fit up to 50kW per pallet, meaning fewer crane lifts and less space used on the job site.

Dedicated Support: Experienced project managers and field technicians support your project from bid to inspection. Project managers ensure you have needed details to obtain a permit and pass inspection. Our field team offers a dedicated phone line and email. On-site training is available.



VICINTY MAP



PROJECT SPECIFICATIONS

SYSTEM INFORMATION	
Total System Size (KW)	96.86
Total Module Quantity	167
Module Orientation	Landscape
EQUIPMENT	
Module Manufacturer	JINKO SOLAR
Module Model	JKM580N-72HL4-BDV
Module Wattage	580
Module Length (in.)	89.69
Module Width (in.)	44.65
Module Weight (lbs)	68.34
BUILDING DATA	
Roof Type	EPDM Membrane
Parapet Height (in)	12
Setback (in)	48
Roof Height (ft)	30
Roof Slope (degrees)	1.20
DESIGN VALUES	
ASCE Version	2010
Basic Windspeed (mph)	115
Wind Exposure Category	B
Occupancy Category	IV
Ground Snow Load (lb/ft^2)	20

DESIGN IS FINALIZED WHEN ACCOMPANIED BY STAMPED ENGINEERING REPORT.

CONTRACTOR IS RESPONSIBLE FOR VERIFYING ROOF CAPACITY.
CONTRACTOR IS RESPONSIBLE FOR CONFIRMING ALL DESIGN CRITERIA ARE CORRECT AND APPROPRIATE FOR THE PROJECT SITE.
CONTRACTOR MUST CONFIRM DESIGN MEETS ALL UTILITY AND AHJ REQUIREMENTS.
CONTRACTOR IS RESPONSIBLE FOR VERIFYING THAT BUILDING STRUCTURE AND RELATED CONNECTIONS CAN SUPPORT ALL LOADS IMPOSED BY PV SYSTEM.
REFER TO INSTALLATION MANUAL FOR FULL PRODUCT DETAILS AND ADDITIONAL INFORMATION.

Uplift, Sliding and Seismic Calculations

Explanation of EcoFoot System Calculations and Design Procedure

Installer Name:	Nova Consultants Inc
Project Name:	Fire Station 1
Project Address:	111 N 5th Ave Ann Arbor, MI 48104
Date Prepared:	8/1/2024

Calculation Explanation Key Sections:

Table Of Figures:

3rd Party Engineering Resources

Rowan, Williams, Davies, & Irwin Inc (RWDI) -- Wind Tunnel Testing Per ASCE 7 / IBC
Maffei Structural Engineering -- Peer Review of Wind Tunnel Testing
Testing Engineers, Inc. -- Friction Testing per ASTM G115
CBC Engineers -- Professional Engineering Review and Certification

Introduction, Site Specifics and Variable Definition

In order to efficiently design EcoFoot2+ and EcoFoot5D ballasted photovoltaic systems, Unirac makes use of a proprietary solar array design aid called "EcoCalcs". Starting with a set of design criteria, shown here in Table 1 below, EcoCalcs utilizes methodologies laid out in the ASCE7 and SEAOC PV1/PV2 documents, and derivative building codes. Actual calculations for this project are included herein, and are accompanied by a step-by-step explanation of Unirac's design process.

The output of EcoCalcs is a comprehensive set of ballast prescriptions, including Image 3 found on Page 6. Ballast prescriptions are applied to a proposed system layout by the Unirac engineering team. Engineering Alliance, Unirac's professional engineering partner, has reviewed and verified EcoCalcs and reviews system designs to ensure that calculations and ballast prescriptions were correctly applied. Upon successful review, Engineering Alliance provides a stamped design review including relevant supporting documentation (this explanation included) and a stamped, approved ballast plan.

Please note: Unirac and Engineering Alliance are not conducting a structural review of the proposed site.

Below, Table 1 and Table 2 list the design criteria and project details for a proposed system in Ann Arbor, MI. These values will be used throughout the remainder of this explanation.

Table 1: System Design Criteria

Product Line	EcoFoot 2+
ASCE7 Version	2010
Ground Elevation (ft)	N/A
Roof Type	EPDM Membrane
Roof Height (ft.)	30
Roof Slope (deg)	1.20
Min Edge Setback (in)	48
Parapet Height (in.)	12
3 Sec. Gust (mph)	115
Occupancy Category	IV
Wind Exposure	B
Snow Load (psf)	20.0
Seismic Data (SS)	0.0940
Soil Site Class	D-Stiff Soil
Coeff. Of Friction (fn)*	0.49

**req's slip sheets*

Table 2: PV Module Specifics

Module Manufacturer	JINKO SOLAR
Module Model	JKM580N-72HL4-BDV
Module Orientation	Landscape
Module Power (w)	580
Module Length (in)	89.69
Module Width (in)	44.65
Module Weight (lbs.)	68.34

Utilizing the inputs from Tables 1 and 2, the factors in Table 3 are generated for the site. This list of factors is used in various ways to fully define a proposed system according to calculations laid out in the SEAOC and ASCE documents. In the scope of this explanation, factors are used to calculate velocity pressure, qh as defined in ASCE7-05, Section 6.5.10; ASCE7-10, Section 30.3.2; or ASCE7-16 and ASCE7-22, Section 26.10.2, and ultimately the amount of ballast required to offset uplift and drag forces.

unirac.com 1411 Broadway Blvd NE, Albu□uer□ue, NM 87102 505-242-6411

Table 3: Calculation Inputs, Constants, and Variables

Racking Component Weight per Module	15.19	lbs.
Ballast Block Weight	32	lbs.
Asymmetric lift load Ratio (North Row)	1.4	
Asymmetric lift load Ratio (South Row)	1.6	
Ala= Effective Lift Area of PV Module	27.511	ft^2
Ada= Effective Drag Area of PV Module	4.07	ft^2
dLF1= Dead Load of Module and Attributed Racking	83.528	lbs.
Roof Setback Minimum	48	in.
Load Combination Factor for Wind	0.6	
Load Combination Factor for Seismic	0.7	
α (from ASCE7 Table 6-2 or 26.9.1 or 26.11-1)=	7	
zg (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	1200	ft.
zmin (from ASCE7 Table 6-2 or 26.9.1 or 26.11.1)=	30	ft.
z selected (from zmin & inputs)=	30	ft.
Kz= Velocity pressure exposure coefficient at height	0.70	
Kzt= Topographic Factor	1	
Kd= Directionality Factor	0.85	
Ke= Ground Elevation Factor	1	
Wind design load factor	0.6	
Dead Load design load factor	0.6	
qh_wind= Velocity Pressure (0.00256*Kz*Kzt*Ke*Kd*V^2*I)	20.16	psf

An explanation of variables:

Asymmetric Lift Load Ratio: This is a ratio describing the leverage created by EcoFoot base dimensions, module attachment location and location of center of ballast mass. Assessed as a multiplier on top of ballast distribution scheme in Image 4.

dLF1= Dead Load of Module and Attributed Racking: the weight of one module and hardware attributed to that module, not including ballast.

Ala= Effective Lift Area of PV Module: The surface area of a module projected onto the horizontal plane for lift calculations.

Ada= Effective Drag Area of PV Module: The surface area of a module projected onto the horizontal plane for drag calculations.

qh= Velocity Pressure at height "h": Calculation prescribed by ASCE7-05, eq. 6-15, and ASCE7-10, eq. 30.3-1, or ASCE7-16 and ASCE 7-22, eq. 26.10-1 (subscript "h" used here for clarity, ASCE7 utilizes subscript "z").

Wind Tunnel Testing, Uplift and Drag Force Calculations

Wind tunnel testing of the EcoFoot product line to determine GCn values has been conducted by Rowan Williams Davies & Irwin Inc. (RWDI), a nationally recognized boundary-layer wind tunnel test firm. Testing was conducted in accordance with ASCE7-05, section 6.6; and ASCE7-10/16/22, section 31.2. Module-specific GCn data allows for precise application of ballast to prevent uplift. Deviation from prescriptive wind GCn values has been addressed according to SEAOC PV2 via a peer review of the wind tunnel testing and results by Maffei Structural Engineering.

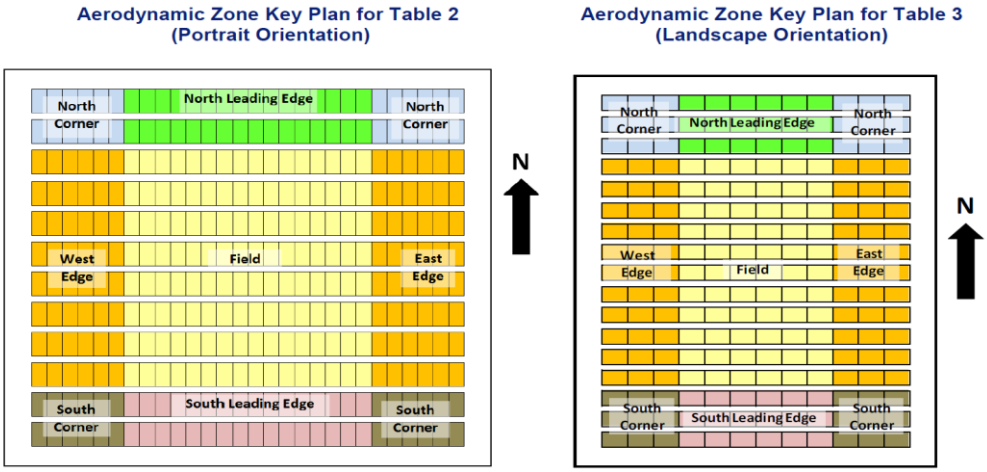
GCn and qh are used to calculate the pressure exerted on each module via the design wind pressure equations (ASCE7-05 – section 6.5.12.4, ASCE7-10 – section 30.4.2, ASCE7-16-30.5.2 and ASCE7-22 – section 30.3.2). Ballast required to offset uplift and drag forces (BWUz) is calculated in accordance with RWDI recoemndations. Detailed calculations for this project are found in Table 4. Resulting required ballast BWUz is displayed graphically in Image 3.

Table 4: Ballast to Resist Uplift Calculations for Project Proposed in Ann Arbor, MI 48104

			Load Sharing Area						
		#col x #rows	2x2	2x3			3x2	3x3	Down (1x1)
North Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-6.8	-6.0			-5.4	-5.0	12.8
	WLFUz=Uplift wind force =pUz*Ala	lbs.	-187.4	-164.7			-147.7	-136.3	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-62.4	-48.7			-38.5	-31.7	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	103.9	81.2			64.2	52.8	
North Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-5.4	-4.7			-4.5	-4.1	11.8
	WLFUz=Uplift wind force =pUz*Ala	lbs	-147.7	-130.6			-125.0	-113.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-38.5	-28.3			-24.9	-18.0	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	64.2	47.1			41.4	30.1	
E/W Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-6.8	-5.0			-5.4	-4.1	12.8
	WLFUz=Uplift wind force =pUz*Ala	lbs	-187.4	-136.3			-147.7	-113.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-62.4	-31.7			-38.5	-18.0	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	103.9	52.8			64.2	30.1	
Field	pUz=Uplift design wind pressure =qh*GCnUz	psf	-5.4	-4.7			-4.5	-4.1	11.8
	WLFUz=Uplift wind force =pUz*Ala	lbs	-147.7	-130.6			-125.0	-113.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-38.5	-28.3			-24.9	-18.0	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	64.2	47.1			41.4	30.1	
South Corner	pUz=Uplift design wind pressure =qh*GCnUz	psf	-6.8	-5.0			-5.8	-4.1	12.8
	WLFUz=Uplift wind force =pUz*Ala	lbs	-187.4	-136.3			-159.0	-113.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-62.4	-31.7			-45.3	-18.0	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	103.9	52.8			75.5	30.1	
South Edge	pUz=Uplift design wind pressure =qh*GCnUz	psf	-6.2	-4.7			-5.4	-4.1	11.8
	WLFUz=Uplift wind force =pUz*Ala	lbs	-170.4	-130.6			-147.7	-113.6	
	DLFUz=Net ASD uplift = dLF1*0.6 + WLFUz*0.6	lbs	-52.1	-28.3			-38.5	-18.0	
	BWuz=ballast required = -DLFUz/0.6	**lbs**	86.9	47.1			64.2	30.1	

The aerodynamic differences among different sub-sections of a large array are handled by various calculation sections (North Corner, North Edge, E/W Edge...) and apply according to the excerpt from the RWDI report shown below in Image 1. The highlighted sections of Table 4 correspond to specific module locations, also shown in Image 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for expanded calculations pertaining to the highlighted sections.

Image 1: Aerodynamic Zones from RWDI Report



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505-242-6411

To check the amount of drag a given sub-array will experience, the equation in Image 2 is utilized - an excerpt from RWDI's test report. Each sub-array is checked for sliding, proceeding from the smallest to largest or until drag no longer governs total required ballast.

Table 5 lists the calculations used to identify the total required ballast to counteract drag forces and prevent sliding. Friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients. Unless detailed information is available pertaining to the location of the sub-array, the roof's worst case uplift GCp are utilized in calculating drag and required ballast.

Image 2: Ballast to Resist Sliding Equation

Ballast (lb) to Resist Sliding

$$\alpha_D \cdot Ballast_{drag} = \alpha_W \cdot q_z \cdot \left[(GC_p)^*_{drag} \cdot A_{drag} \cdot \left(\frac{1}{f_n}\right) + |GC_p|^*_{uplift} \cdot A_{uplift} \right] - \alpha_D \cdot M \qquad (lb)$$

Table 5: Ballast to Resist Sliding Calculation

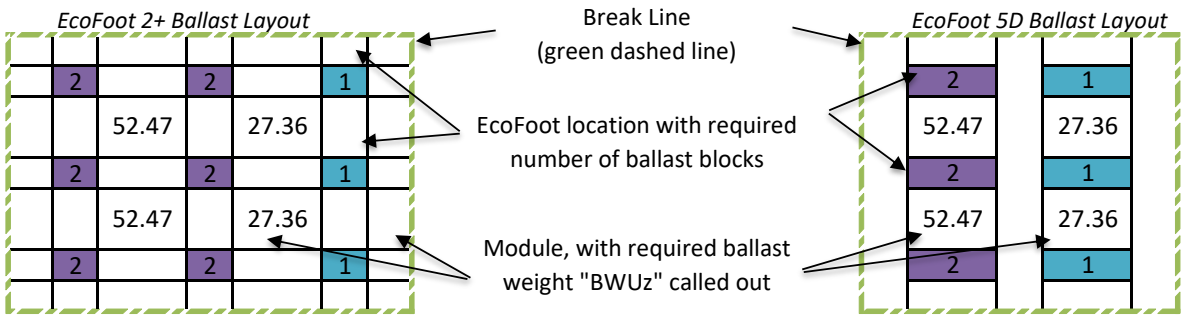
Sub-Array Module Count Total:	16
a_w = Wind Load Combination Factor =	0.6
a_d = Dead Load Combination Factor =	0.6
qz (qh in Table 3)	20.16
M = dLF1 from Table 3 =	83.53
f_n (also see Table 1) =	0.49
A_{uplift} = Ala in Table 3 =	27.51
A_{drag} = Ada in Table 3 =	4.07
$GC_{p\text{-}drag}$	1.42
$GC_{p\text{-}uplift}$	-0.62
Area Reduction Factor =	0.31
$(GCp)^*_{drag}$ =	0.44
$\lvert GCp \rvert^*_{uplift}$ =	0.19
Total Required Ballast Weight (Per Image 2)=	**1546.31**
$W_{ballastblock}$ =	32
Total Required Ballast Blocks:	**49**

Ballast Application to Sheet S-1.0

For easier interpretation, the results calculated in Table 4 are laid out in graphical representations of a solar array, shown in Image 4. Unirac engineers and drafters make use of this graphical layout when applying ballast to a given system design.

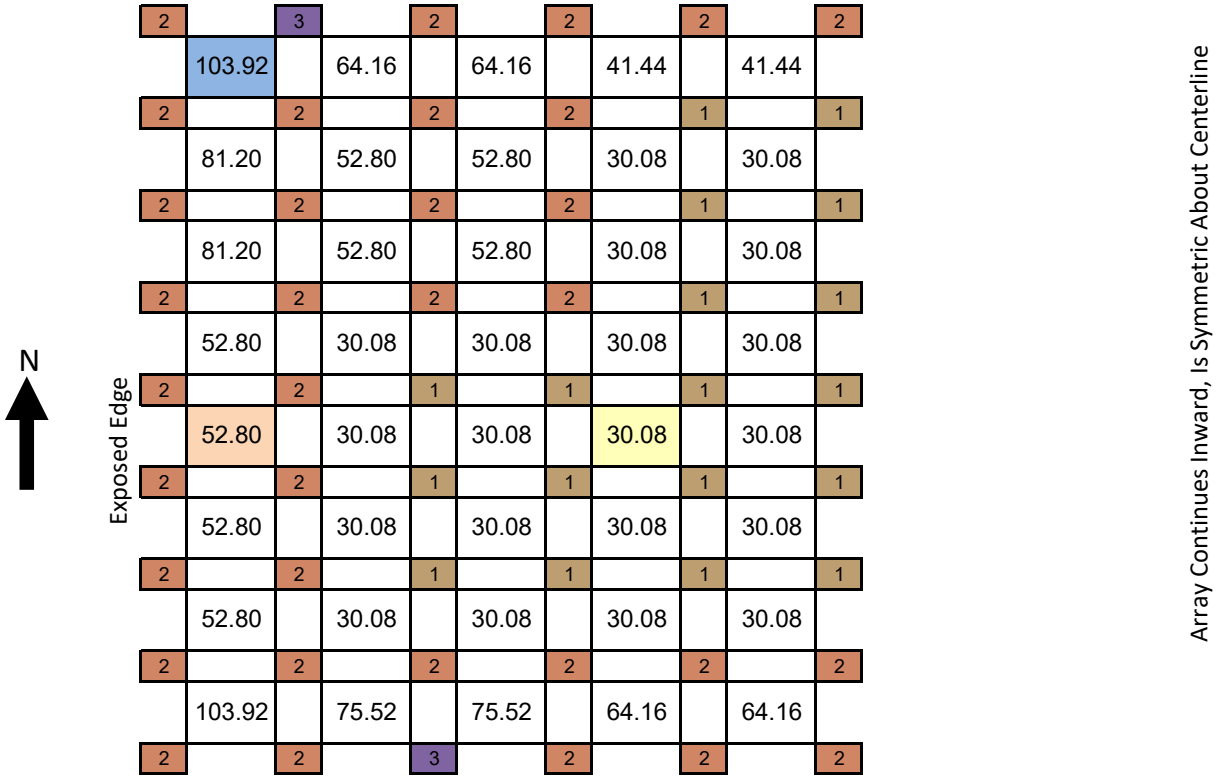
As shown in Image 3, the ballast required to resist lift - BWUz from Table 4 - is listed for each module location in Image 4. A portion of each BWUz value is distributed to each of the connected EcoFoot Bases, also detailed in Image 3 and included in Image 4. The total ballast required at each EcoFoot location is then calculated and rounded up to the next ballast block increment.

Image 3: Example of Module and Ballast Graphical Representation



The ballast prescription array shown in Image 4 is one of many similar arrays created automatically through EcoCalcs in order to address all possible array configurations. The data calculated in Table 4 was ultimately used to assign ballast to the system design in Sheet S-1.0 by Unirac. EcoCalcs and the resulting ballast plan S-1.0 are reviewed by CBC Engineers for correctness and completeness. Once approved, an engineering report including Sheet S-1.0 and any supporting material (this explanation included) are stamped and sealed by a professional engineer registered in the state where the project is proposed.

Image 4: Ballast Prescriptions Produced by Table 4



NOTE: The colored module locations in Image 4 correspond to the same colored areas in Table 4: blue - the north corners, orange - the east or west edge, yellow - the deep interior. See Page 7 for more detailed calculations.

Detailed Calculations From Table 4

North Corner Module		
GCn Value from RWDI report:	-0.34	
qh value from Table 3:	20.16	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-6.81	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-187.45	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-62.35	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	103.92	lbf

East/West Edge Module		
GCn Value from RWDI report:	-0.25	
qh value from Table 3:	20.16	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-4.96	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-136.33	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-31.68	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	52.80	lbf

Interior Module		
GCn Value from RWDI report:	-0.20	
qh value from Table 3:	20.16	
pUz = Uplift design wind pressure in Z direction = qh*GCn:	-4.13	psf
Am = Surface Area of Module:	27.81	sqft
Θm = Module Incline:	8.41	deg
Ala = PV Module Lift Area = Am * Cos (Θm):	27.51	sqft
WLFUz=Uplift wind load force in Z direction=pUz*Ala	-113.60	lbf
dLF1 = Dead load of one module and attributed hardware:	83.53	lbf
DLFUz=Uplift design load using ASD combo #7 = dLF1*0.6 + WLFUz*0.6	-18.05	lbf
BWuz=ballast weight required to resist wind uplift= -DLFUz/0.6	30.08	lbf

Max downpoint load calculations

No of Mid supports	1	
Tributary Area to support/bays/base	0.5	of module area
Wind force down (WL)	176 lbs	
Snow load Down (SL)	330.13 lbs	
Total Dead load per Bay (DL)	145.36 lbs	

Load Combinations

DL+ SL	**475.49 lbs**
DL+0.6WL	251.01 lbs
DL+0.75SL+0.45WL	472.20 lbs

SEAOC PV1 - 2012 - Section 4: attached Arrays

Unirac utilizes the unattached design approach to account for seismic force as provided for by Section 16 of the 2016 California Building Code, the Structural Engineering Association of California PV1 Requirements (SEAOC PV1-2012) and ASCE 7. Section 1613.5 defines “Ballasted Photovoltaic System” which also defines "partially attached" systems, and provides guidance for designing arrays that utilize physical anchors and friction to resist seismic forces. SEAOC PV1 or ASCE 7 Chapter 13 defines the calculations required design attached photovoltaic systems, including friction to partially offset seismic forces.

The following explanation walks through calculations outlined in Section 4 - Attached Arrays. The attached approach begins with the project specific design criteria outlined in Table 6. These values reflect site inputs as well as assumptions permitted in the SEAOC PV1-2012 document Section 4 and ASCE 7 chapter 13 .

Table 6: Seismic Design Inputs

Number of blocks per Ecofoot	6.00
Wp=Weight per unit	275.53
Site Class	D-Stiff Soil
Seismic Design Category	A
Ip	1.50
Rp	1.50
'Seismic Calcs (Attached)'!A9	1.00
Fa (Site Class E)	2.5
Sms = Fa x Ss	0.15
Sds = (2/3) x Sms	0.10

Table 7: ASCE7 Inputs

z=height of point of attachment (in.)	1.00
h=structure height compared to base (in.)	1.00
Fp=0.4*ap*Sds*Wp*(1+2*z/h)/(Rp/Ip)	33.15
Fp=1.6*Sds*Ip*Wp	66.30
Fp=0.3*Sds*Ip*Wp	12.43
Fp	33.15
Fp (ASD)	23.21

SEAOC PV1 specifies that “PV support systems that are attached to the roof structure shall be designed to resist the lateral seismic force *Fp* specified in ASCE 7-16/22 Chapter 13.” Although SEAOC PV1 was released prior to ASCE 7-16/22, *Fp* is defined the same way in Chapter 13 of both ASCE verions 7-10, 7-16 and 7-22. Therefore the lateral seismic force analysis applied is valid for both ASCE 7-10, 16 and 22. In utilizing the *Fp* calculations for nominal, minimum, and maximum values laid out in Section 13.3.1, the values in Table 7 are found.

The following is excerpted from SEAOC PV1-2012, Section 4 – Attached Arrays:

“For attached roof-bearing systems, friction is permitted to contribute in combination with the design lateral strength of attachments to resist the lateral force Fp when all of the following conditions are met:

- “The maximum roof slope at the location of the array is less than or equal to 7 degrees (12.3 percent);
- “The height above the roof surface to the center of mass of the solar array is less than the smaller of 36 inches and half the least plan dimension of the supporting base of the array
- “Rp shall not exceed 1.5 unless it is shown that the lateral displacement behavior of attachments is compatible with the simultaneous development of frictional resistance.”

The EcoFoot 2+ and EcoFoot 5D systems have been demonstrated to be in conformance with the above stated stipulations. As such, and in accordance with the remainder of Section 4 – Attached Arrays from SEAOC PV1-2012, the force required to resist movement due to seismic shifting is calculated. Based on the minimum ultimate shear strength of the roof mounting method prescribed for this job, the total lateral load that one attachment may offset is calculated, and by extension the number of modules allowed per attachment point. These values can be found in Table 8.

All friction values have been identified by Testing Engineers (IAS accredited) according to ASTM G115 - Standard Guide for Measuring and Reporting Friction Coefficients, methodology that is in agreement with SEAOC PV2 and Los Angeles, CA stipulations.

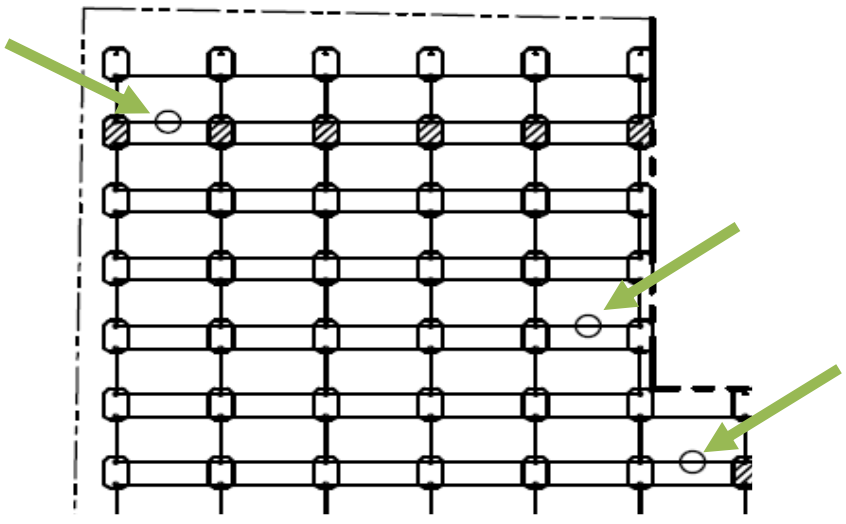
Table 8: Calculation of Physical Attachment Requirements

Friction Coefficient	0.49	*ASTM G115 Tested*
Ff (max friction) = (0.6-0.14*Sds)*(0.7*u)*Wp	55.38	*SEAOC section 4 (ASD), Friction Force*
Excess force per unit	-32.17	*Force to be offset by physical attachments*
Attachment system rating (allowable)	634.91	*ASD design load*
Number of panels per attachment	-19.74	*(if negative, no fasteners are needed)*

This final number of panels per attachment represents the maximum number of modules that any given attachment point may account for in terms of offsetting seismic force Fp. Physical attachments shall be installed per the manufacturer's instructions, and attached to the EcoFoot 2+ or EcoFoot 5D system per the installation instructions provided by Unirac.

On Sheet S-1.0 physical attachments are called out as shown below in Image 5:

Image 5: Example of ballast layout with seismic attachment callouts



LIST OF DRAWINGS

NUM	TITLE	REV	DATE: 12-13-2024	12-13-2024	1-10-2025	1-24-2025
			ISSUED: INTERCONNECT	70% REVIEW	BID REVIEW	INTERCONNECT REV-1
	GENERAL					
G001	COVER SHEET		●	●	●	●
G002	GENERAL NOTATION				●	
	CIVIL					
C101	SITE PLAN			●	●	
C102	CONSTRUCTION PLAN			●	●	
C103	FOUNDATION PLAN				●	
	ELECTRICAL					
E101	ELECTRICAL PLAN		●	●	●	●
E104	GROUNDING PLAN			●	●	
E501	ELECTRICAL DETAILS			●	●	
E601	ONE-LINE DIAGRAM		●	●	●	●
E602	CONDUIT AND WIRE SIZE CHART		●	●	●	
E701	LABELS AND PLACARDS			●	●	
E801	DATA SHEETS		●	●	●	

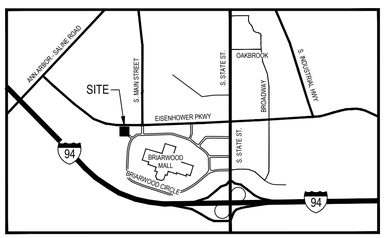
NOVA PROJECT #23-11-1168-FS6
60 kW AC, 360 KWh MICROGRID BATTERY ENERGY STORAGE SYSTEM

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

NOVA PROJECT MANAGER: JEFF ECKHOUT



N

SITE LOCATION MAP

NO SCALE

NOVA Consultants, Inc.
21580 Novi Road
Suite 300
Novi, MI 48375

Phone: (248) 347-3512
Fax: (248) 347-4152

www.novaconsultants.com

ISSUED

DATE	DESCRIPTION	APPVD.
12-13-2024	INTERCONNECT	
12-13-2024	70% REVIEW	
1-10-2025	BID REVIEW	
1-24-2025	INTERCONNECT REV-1	

1

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

COVER SHEET

PROJECT NUMBER	23-11-1168-FS6
DRAWN BY	RGM, GAK
SCALE	NONE
SHEET SIZE	22x34
SHEET NUMBER	G001

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\Fire Station 6\Drawings\23111168-FS6-G001.dwg Date: Jan 24 2025; 8:53AM User: george kachadoorian

STANDARD METHODS OF NOTATION

- SHEET KEY NOTES (TAGS)
- ITEM DESIGNATION (E601 WIRE AND CONDUIT SCHEDULE)
- REVISION / ADDENDUM TAG
- DETAIL NUMBER (ELEVATION TAG) SHEET WHERE FOUND
- DETAIL NUMBER (SECTION CUT TAG) SHEET WHERE FOUND
- DETAIL NUMBER SHEET WHERE FOUND (BUBBLE DETAIL) ENLARGEMENT AREA
- DETAIL NUMBER / NAME (DRAWING TITLE & IDENTIFICATION) SHEET WHERE FOUND / SCALE
- SPOT ELEVATION
- MATCH LINE
- CENTER LINE
- LIGHT LINE INDICATES EXISTING WORK
- HEAVY LINE INDICATES NEW WORK
- DASHED LINE INDICATES DEMOLITION
- UNDERGROUND CONDUIT AND WIRING

SITE, ROOF & FLOOR PLAN SYMBOLS

- PV STRING DESIGNATION
- MODULE (SITE & ROOF PLAN)
- SWITCHGEAR
- INVERTER
- PANEL BOARD
- DISCONNECT
- METER
- TRANSFORMER
- CT CABINET
- COMBINER
- DUPLEX RECEPTACLE
- EV CHARGING STATION
- EV CHARGING ONLY (PARKING SPACE)
- COPPER CLAD GROUND ROD
- SILT FENCE
- CHAIN LINK FENCE
- GRAPHIC SCALE
- NORTH ARROW

ELECTRICAL DETAIL SYMBOLS

- PV STRING DESIGNATION
- MODULE (PV WIRING PLAN)
- SWITCHGEAR
- INVERTER
- PANEL BOARD
- DISCONNECT
- METER
- TRANSFORMER
- CT CABINET
- COMBINER
- DUPLEX RECEPTACLE
- EV CHARGING STATION
- EV CHARGING ONLY (PARKING SPACE)
- COPPER CLAD GROUND ROD

ONE LINE DIAGRAM SYMBOLS (SHEET E601)

- PV STRING DESIGNATION
- MODULE (ONE - LINE DIAGRAM)
- OPTIMIZER
- RAPID SHUTDOWN
- PANELBOARD (PB) W/ MAIN BREAKER
- DISCONNECT
- FUSED DISCONNECT
- DISCONNECT SWITCH
- TRANSFORMER
- FUSE
- CIRCUIT BREAKER
- CURRENT TRANSFORMER (CTs)
- POTENTIAL TRANSFORMER (PTs)
- BUS BAR
- WYE TRANSFORMER CIRCUIT CONNECTION
- DELTA TRANSFORMER CIRCUIT CONNECTION
- GROUND
- INVERTER
- DISCONNECT
- METER
- COMBINER
- SURGE PROTECTIVE DEVICE (SPD)
- DUPLEX RECEPTACLE
- GFCI DUPLEX RECEPTACLE
- GFCI WITH IN USE COVER OUTDOOR RATED WEATHER RESISTANT
- EV CHARGING STATION
- UTILITY POLE TO GRID
- CIRCUIT HOMERUN W/ STRING IDENTIFIER
- AREA DIVIDER LINE (E601 ONE-LINE DIAGRAM)

ELECTRICAL ABBREVIATION LIST

ABBREVIATION	DESCRIPTION
A	AMPERES
A.F.F.	ABOVE FINISH FLOOR
AUX	AUXILIARY
AWG	AMERICAN WIRE GAUGE
BKR	BREAKER
CB	CIRCUIT BREAKER
CKT	CIRCUIT
CT	CURRENT TRANSFORMER
DEMO	DEMOLITION
DIM	DIMENSION
DISC	DISCONNECT
DP	DISTRIBUTION PANEL
DWG	DRAWING
ELEC	ELECTRICAL
EM / EMER	EMERGENCY
EMT	ELECTRICAL METALLIC TUBING
EVCS	ELECTRIC VEHICLE CHARGING STATION
EX / EXIST	EXISTING
FLR	FLOOR
G / GRD / EG	GROUND
GFCI / GFI	GROUND FAULT CIRCUIT INTERRUPTER
HP	HORSEPOWER
HV	HIGH VOLTAGE
HZ	HERTZ
INV	INVERTER
IG	ISOLATED GROUND
JB	JUNCTION BOX
kV	KILOVOLT
kVA	KILOVOLT- AMPERES
kW	KILOWATT
kWH	KILOWATT - HOURS
MAX	MAXIMUM
MPPT	MAXIMUM POWER POINT TRACKING
MDP	MAIN DISTRIBUTION PANEL
MIN	MINIMUM
MISC	MISCELLANEOUS
MTD	MOUNTED
NEC	NATIONAL ELECTRICAL CODE
N/A	NOT APPLICABLE
NIC	NOT IN CONTRACT
NTS	NOT TO SCALE
OC	ON CENTER
OCPD	OVER CURRENT PROTECTION DEVICE
PNL	PANEL
P	POLE
PH	PHASE
PV	PHOTOVOLTAIC
PT	POTENTIAL TRANSFORMER
PDP	POWER DISTRIBUTION PANEL
RSD	RAPID SHUTDOWN DEVICE
RECEPT	RECEPTACLE
REQ'D	REQUIRED
RSC	RIGID STEEL CONDUIT
SW	SWITCH
SWBD	SWITCH BOARD
SWGR	SWITCH GEAR
TELCOM	TELECOMMUNICATIONS
TP	TAMPERPROOF
TYP	TYPICAL
U.O.N.	UNLESS OTHERWISE NOTED
V	VOLTS
V.I.F.	VERIFY IN FIELD
W	WIRE
WP	WEATHERPROOF
XFMR	TRANSFORMER

INVERTER ANNOTATION

INV-1
SOLAR EDGE
SE120KUS

- INVERTER DESIGNATION
- MANUFACTURER / MODEL
- MODEL NUMBER
- SIZE
- AC VOLTAGE / CURRENT
- STANDARD

120 kW INVERTER
277 / 480 V, 144.3A
UL1741/1EEE 1547

NOTE: SOME SYMBOLS AND ABBREVIATIONS SHOWN MAY NOT APPLY TO THIS PROJECT.

STANDARD MOUNTING HEIGHTS

DESCRIPTION	HEIGHT
PANELBOARD	6'-0" A.F.F. TO TOP OF BOX
RECEPTACLE OUTLET	16" A.F.F. TO BOTTOM OF BOX. (MIN.) 48" A.F.F. TO TOP OF BOX (MAX.)
CONDUIT IN TRENCH	18" BELOW GRADE - TO TOP OF CONDIUT (MIN.)

LINES & WIRES

- GAS LINE
- AC WIRING
- AC WIRING UNDERGROUND
- DC WIRING
- STRING WIRING
- GROUND WIRE
- CONDUIT DOWN
- CONDUIT UP

PV ARRAY ANNOTATION PLAN

- BOUNDARY AREA OF STRING
- PV STRING DESIGNATION
- SOLAR PV MODULE
- INTRAROW SPACING

1-1

NOVA Consultants, Inc.
21580 Novi Road
Suite 300
Novi, MI 48375

Phone: (248) 347-3512
Fax: (248) 347-4152

www.novaconsultants.com

ISSUED

DATE	DESCRIPTION	APPVD.
1-10-2025	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

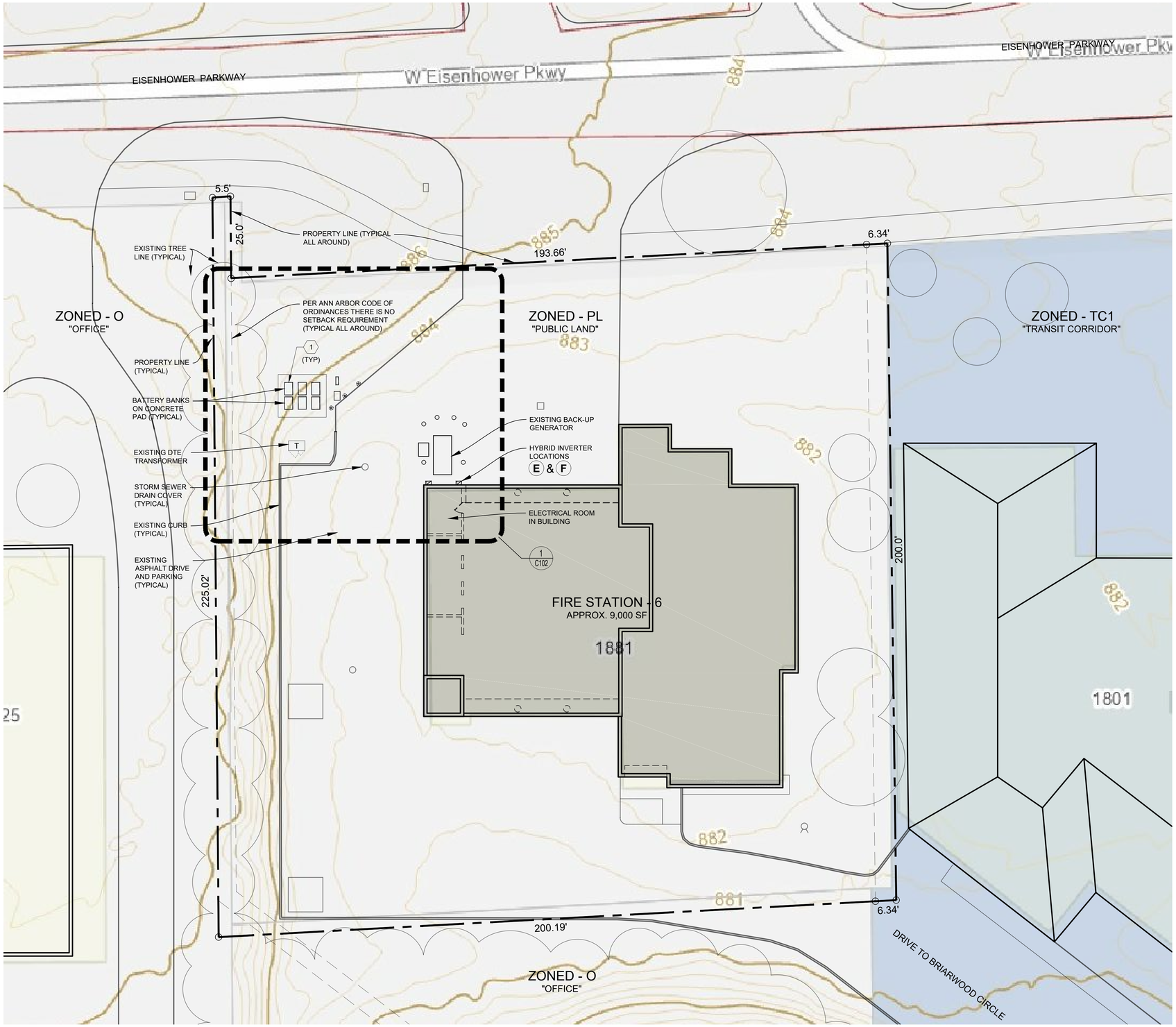
FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

GENERAL NOTATION

PROJECT NUMBER 23-11-1168-FS6
DRAWN BY GAK
SCALE
SHEET SIZE 22x34
SHEET NUMBER G002



NORTH

SITE PLAN

SCALE: 1/16" = 1'-0"

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. EXISTING APPROXIMATELY 9,000 SF 1-STORY MUNICIPAL BUILDING (MASONRY CONSTRUCTION) INCLUDING GARAGE, ZONED PL "PUBLIC LAND", ON .95 ACRES LOCATED IN CITY OF ANN ARBOR AND WITHIN WASHTENAW COUNTY.
3. LEGAL DESCRIPTION: PRT OF NW 1/4 SEC 8 T3S R6E ALSO PRT OF LOT 10 BRIARWOOD SUB COM NW COR LOT 10 BRIARWOOD SUB TH N 86 DEG 38 MIN 10 SEC E 6.34 FT FOR POB TH S 00 DEG 50 MIN 20 SEC E 200 FT TH S 86 DEG 38 MIN 10 SEC W 206.62 FT TH N 00 DEG 50 MIN 20 SEC W 225.02 FT TH N 86 DEG 38 MIN 10 SEC E 5.51 FT TH S 03 DEG 21 MIN 50 SEC E 25 FT TH 200 FT TO POB
4. PARCEL NUMBER: 09-12-08-200-011

* INFORMATION FROM CITY OF ANN ARBOR - WASHTENAW COUNTY "PARCEL VIEWER"; ON THE INTERNET AT BSAONLINE.COM

INVERTER DESCRIPTION

(E) PRIMARY (HV-1)
HYBRID INVERTER-1
SOL-ARK
(C&I) HYBRID INVERTER 30K-208V
COMMERCIAL & INDUSTRIAL
MODEL: 30K-3P-208V
30kW INVERTER
120 / 208 V, 83.4 A 1000V DC
UL1741/IEEE 1547

SOL-ARK PRODUCT SKU:
30K-3P-208V

(F) SECONDARY (HV-2)
HYBRID INVERTER-2
SOL-ARK
(C&I) HYBRID INVERTER 30K-208V
COMMERCIAL & INDUSTRIAL
MODEL: 30K-3P-208V
30kW INVERTER
120 / 208 V, 83.4 A 1000V DC
UL1741/IEEE 1547

SOL-ARK PRODUCT SKU:
30K-3P-208V

SEE PRODUCT EQUIPMENT DATA SHEET ON E801

(1) BATTERY ENERGY STORAGE SYSTEM

MANUFACTURER:	SOL-ARK (L3 SERIES LIMITLESS LITHIUM)
BATTERY ENERGY CAPACITY:	60 kWh
BATTERY MODEL NAME:	SOL-ARK, L3 HVR-60 (OUTDOOR)
ESS MODEL NAME:	SOL-ARK, L3 HVR-60kWh-30k (OUTDOOR)
NUMBER OF BATTERIES:	(2) BANKS X (3) BATTERIES = 6 BATTERIES
BESS CAPACITY:	360 kWh (6 X 60 kWh = 360 kWh)
SOL-ARK PRODUCT SKU:	L3-HVR-60KWH

SEE PRODUCT EQUIPMENT DATA SHEET ON E801

LEGEND

INVERTER

BATTERY PACK

T — TRANSFORMER

3 WORKING DAYS
BEFORE YOU DIG
CALL MISS DIG
1-800-482-7171

FOR FREE LOCATION OF PUBLIC UTILITY LINES IN MICHIGAN CALL: 811

0 4' 8' 16' 32'
SCALE: 1/16" = 1'-0"

NOVA Consultants, Inc.
21580 Novi Road
Suite 300
Novi, MI 48375

Phone: (248) 347-3512
Fax: (248) 347-4152

www.novaconsultants.com

ISSUED

DATE	DESCRIPTION	APPVD.
1-10-2025	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

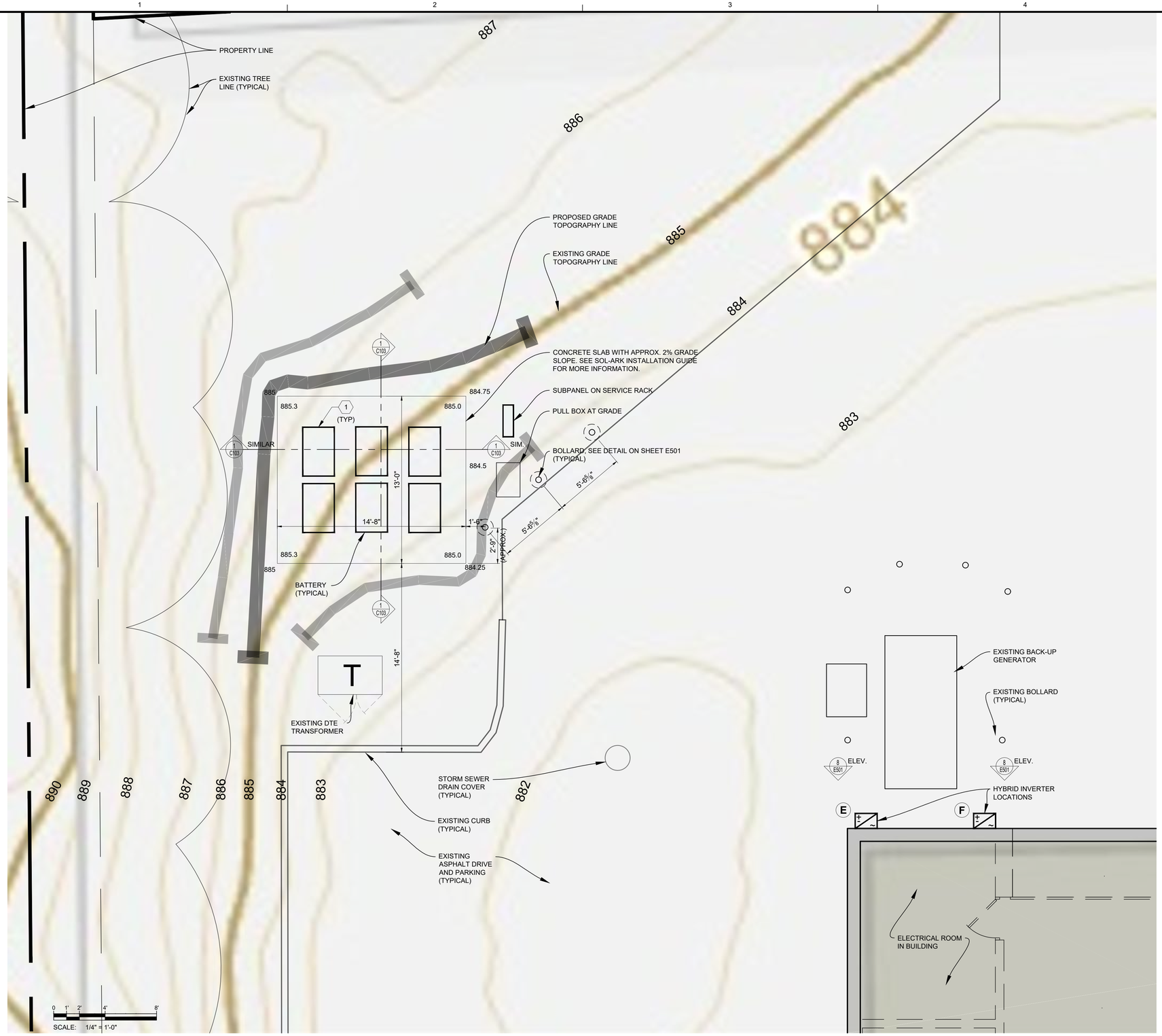
FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

SITE PLAN

PROJECT NUMBER	23-11-1168-FS6
DRAWN BY	RGM, GAK
SCALE	AS NOTED
SHEET SIZE	22x34
SHEET NUMBER	C101



1 C102 CONSTRUCTION PLAN DETAIL - BATTERY YARD

NTS

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. CONDUIT FILL TO BE LESS THAN 40%.

INVERTER DESCRIPTION

(E) PRIMARY (HV-1)
HYBRID INVERTER-1
SOL-ARK
(C&I) HYBRID INVERTER 30K-208V
COMMERCIAL & INDUSTRIAL
MODEL: 30K-3P-208V
30kW INVERTER
120 / 208 V, 83.4 A 1000V DC
UL1741/IEEE 1547

SOL-ARK PRODUCT SKU:
30K-3P-208V

(F) SECONDARY (HV-2)
HYBRID INVERTER-2
SOL-ARK
(C&I) HYBRID INVERTER 30K-208V
COMMERCIAL & INDUSTRIAL
MODEL: 30K-3P-208V
30kW INVERTER
120 / 208 V, 83.4 A 1000V DC
UL1741/IEEE 1547

SOL-ARK PRODUCT SKU:
30K-3P-208V

SEE PRODUCT EQUIPMENT DATA SHEET ON E801

(1) BATTERY ENERGY STORAGE SYSTEM

MANUFACTURER:	SOL-ARK (L3 SERIES LIMITLESS LITHIUM)
BATTERY ENERGY CAPACITY:	60 kWh
BATTERY MODEL NAME:	SOL-ARK, L3 HVR-60 (OUTDOOR)
ESS MODEL NAME:	SOL-ARK, L3 HVR-60kWh-30k (OUTDOOR)
NUMBER OF BATTERIES:	(2) BANKS X (3) BATTERIES = 6 BATTERIES
BESS CAPACITY:	360 kWh (6 X 60 kWh = 360 kWh)
SOL-ARK PRODUCT SKU:	L3-HVR-60KWH

SEE PRODUCT EQUIPMENT DATA SHEET ON E801

LEGEND

- INVERTER
- L3 HVR — BATTERY STACK ENCLOSURE
- T — TRANSFORMER - EXISTING
- PBA — PANEL BOARD - EXISTING
- D — DISCONNECT - EXISTING
- M — METER - EXISTING

3 WORKING DAYS
BEFORE YOU DIG
CALL MISS DIG
1-800-482-7171
FOR FREE LOCATION OF PUBLIC UTILITY LINES IN MICHIGAN CALL: 811

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ISSUED

DATE	DESCRIPTION	APPVD.
11-26-2024	PRELIMINARY DRAFT	
1-10-2025	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

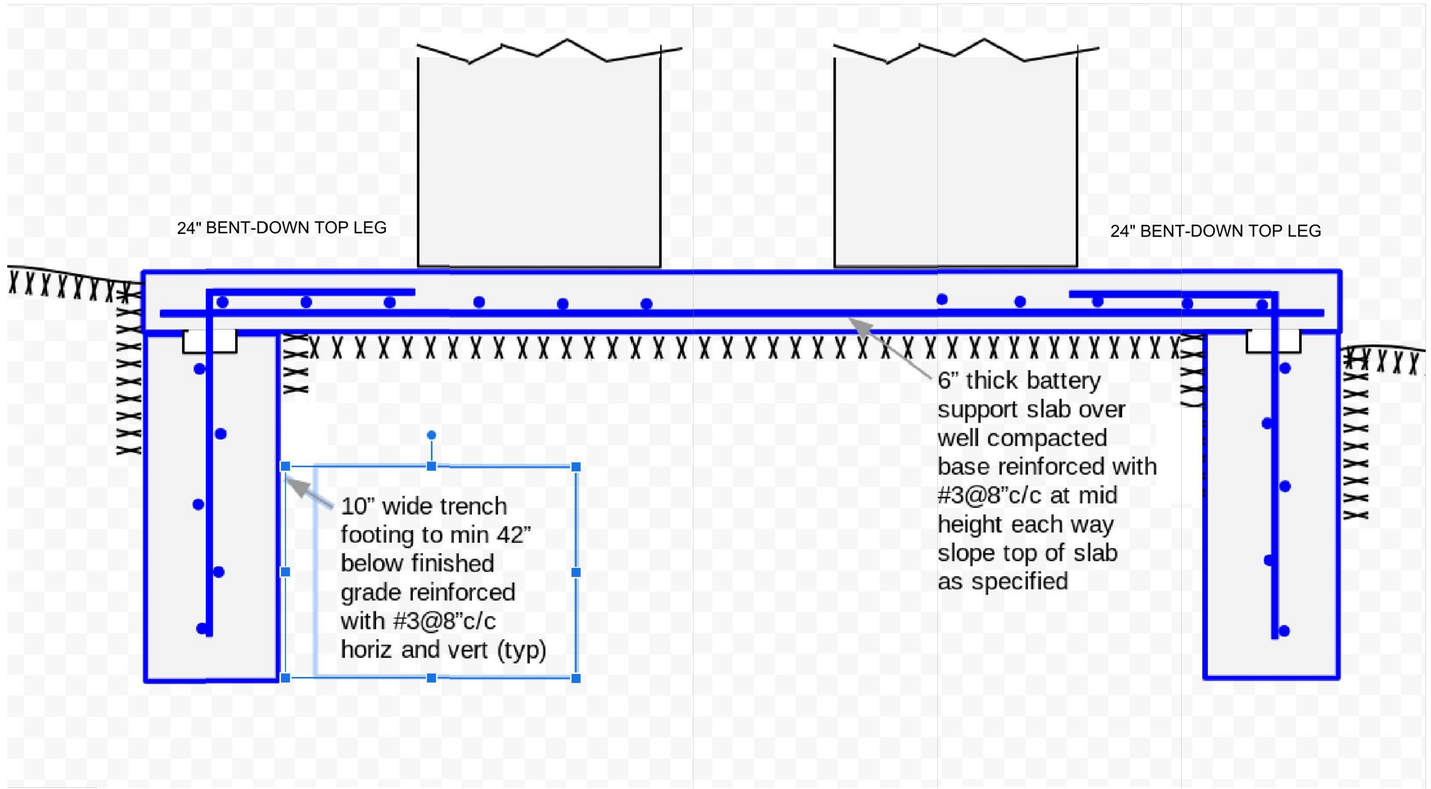
FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

CONSTRUCTION PLAN

PROJECT NUMBER	23-11-1168-FS6
DRAWN BY	GAK
SCALE	AS NOTED
SHEET SIZE	22x34
SHEET NUMBER	C102



FOUNDATION SECTION THROUGH BATTERY PAD

(for Plan Layout, Location, and other details see sheets C102 and E101)

concrete: f'c = 4000 psi

reinforcing steel: ASTM A615 Gr 60

1 / C103 CONSTRUCTION PLAN DETAIL - BATTERY YARD

NTS

NovC1J2404--241225

3 WORKING DAYS
BEFORE YOU DIG
CALL MISS DIG
1-800-482-7171

FOR FREE LOCATION OF PUBLIC UTILITY LINES IN MICHIGAN CALL: 811

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ISSUED

DATE	DESCRIPTION	APPVD.
1-10-2025	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

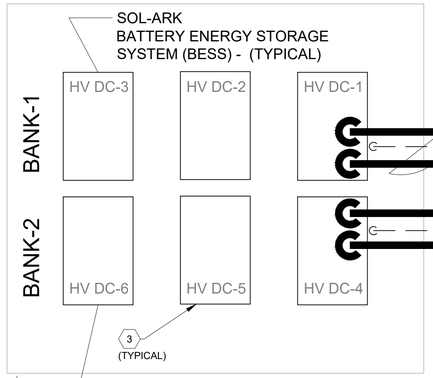
FIRE STATION 6

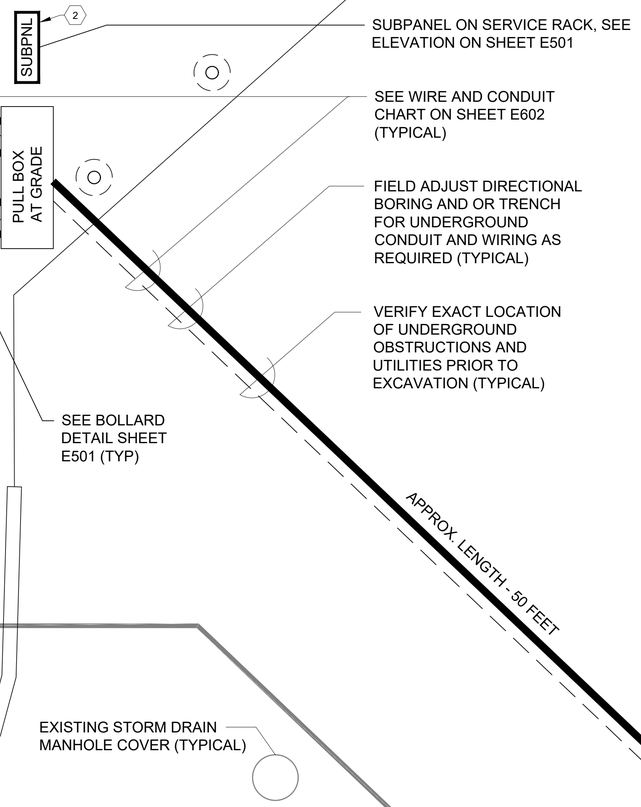
1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

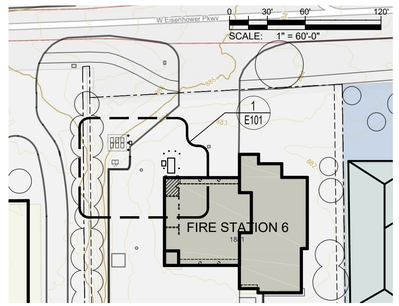
60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

FOUNDATION

PROJECT NUMBER	23-11-1168-FS6
DRAWN BY	GAK
SCALE	AS NOTED
SHEET SIZE	22x34
SHEET NUMBER	C103







ELECTRICAL PLAN

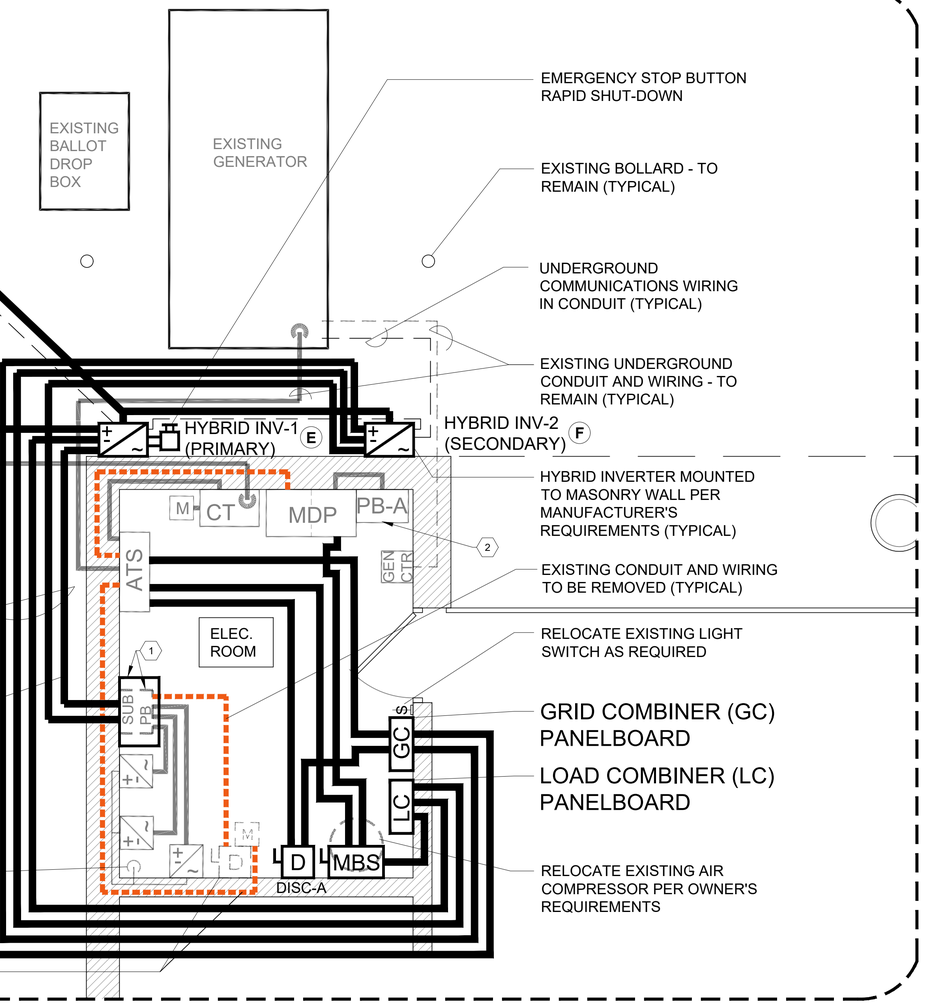
NTS

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. REFER TO SHEET E601 FOR ONE-LINE DIAGRAM FOR INTERCONNECTION BETWEEN EQUIPMENT.
3. CONDUIT FILL TO BE LESS THAN 40%.

SHEET KEY NOTES

1. REMOVE AND REPLACE WITH NEW
2. FOR POWERING THE BATTERY HVAC UNITS, FROM EXISTING PANELBOARD A OR B, INSTALL A NEW 100A 2 POLE BREAKER. INSTALL A SERVICE RACK ON BATTERY PAD WITH A NEW 100A SUBPANEL, SINGLE PHASE, NEMA 3R, 120/208V WITH 100A MAIN BREAKER, 6 – 2 POLE 15A BREAKERS. EACH OF THE 6 BREAKERS TO FEED EACH BATTERY HVAC UNIT. INSTALL ONE 15A SINGLE POLE BREAKER TO FEED A NEW OUTDOOR RATED SERVICE RECEPTACLE UNDERNEATH THE SUBPANEL. INSTALL NEW WIRE AND CONDUIT FROM PANELBOARD A OR B TO SUBPANEL, FROM SUBPANEL TO BATTERY HVAC UNITS AND RECEPTACLE PER NEC 2023. 1



LEGEND

	INVERTER
L3 HVR	BATTERY STACK ENCLOSURE
T	TRANSFORMER - EXISTING
PBA	PANEL BOARD - EXISTING
D	DISCONNECT - EXISTING
M	METER - EXISTING
	COMMUNICATION WIRE / CONDUIT
	AC CONDUIT
	EXISTING DC CONDUIT
	EXISTING AC CONDUIT
	EXISTING CONDUIT TO BE REMOVED

INVERTER DESCRIPTION 1

E PRIMARY (HV-1)
HYBRID INVERTER-1
SOL-ARK
(C&I) HYBRID INVERTER 30K-208V
COMMERCIAL & INDUSTRIAL
MODEL: 30K-3P-208V
30kW INVERTER
120 / 208 V, 83.4 A 1000V DC
UL1741/1EEE 1547

SOL-ARK PRODUCT SKU:
30K-3P-208V

F SECONDARY (HV-2)
HYBRID INVERTER-2
SOL-ARK
(C&I) HYBRID INVERTER 30K-208V
COMMERCIAL & INDUSTRIAL
MODEL: 30K-3P-208V
30kW INVERTER
120 / 208 V, 83.4 A 1000V DC
UL1741/1EEE 1547

SOL-ARK PRODUCT SKU:
30K-3P-208V

SEE PRODUCT EQUIPMENT DATA SHEET ON E801

3 BATTERY ENERGY STORAGE SYSTEM 1

MANUFACTURER:	SOL-ARK (L3 SERIES LIMITLESS LITHIUM)
BATTERY ENERGY CAPACITY:	60 kWh
BATTERY MODEL NAME:	SOL-ARK, L3 HVR-60 (OUTDOOR)
ESS MODEL NAME:	SOL-ARK, L3 HVR-60kWh-30k (OUTDOOR)
NUMBER OF BATTERIES:	(2) BANKS X (3) BATTERIES = 6 BATTERIES
BESS CAPACITY:	360 kWh (6 X 60 kWh = 360 kWh)
SOL-ARK PRODUCT SKU:	L3-HVR-60KWH

SEE PRODUCT EQUIPMENT DATA SHEET ON E801

3 WORKING DAYS
BEFORE YOU DIG
CALL MISS DIG
1-800-482-7171
FOR FREE LOCATION OF PUBLIC UTILITY LINES
IN MICHIGAN CALL: 811

1 E101 PLAN DETAIL - ELECTRICAL ROOM & BESS (BATTERY YARD)

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ISSUED

DATE	DESCRIPTION	APPVD.
12-30-2024	INTERCONNECT	
1-10-2025	BID REVIEW	
1-24-2025	INTERCONNECT REV-1	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

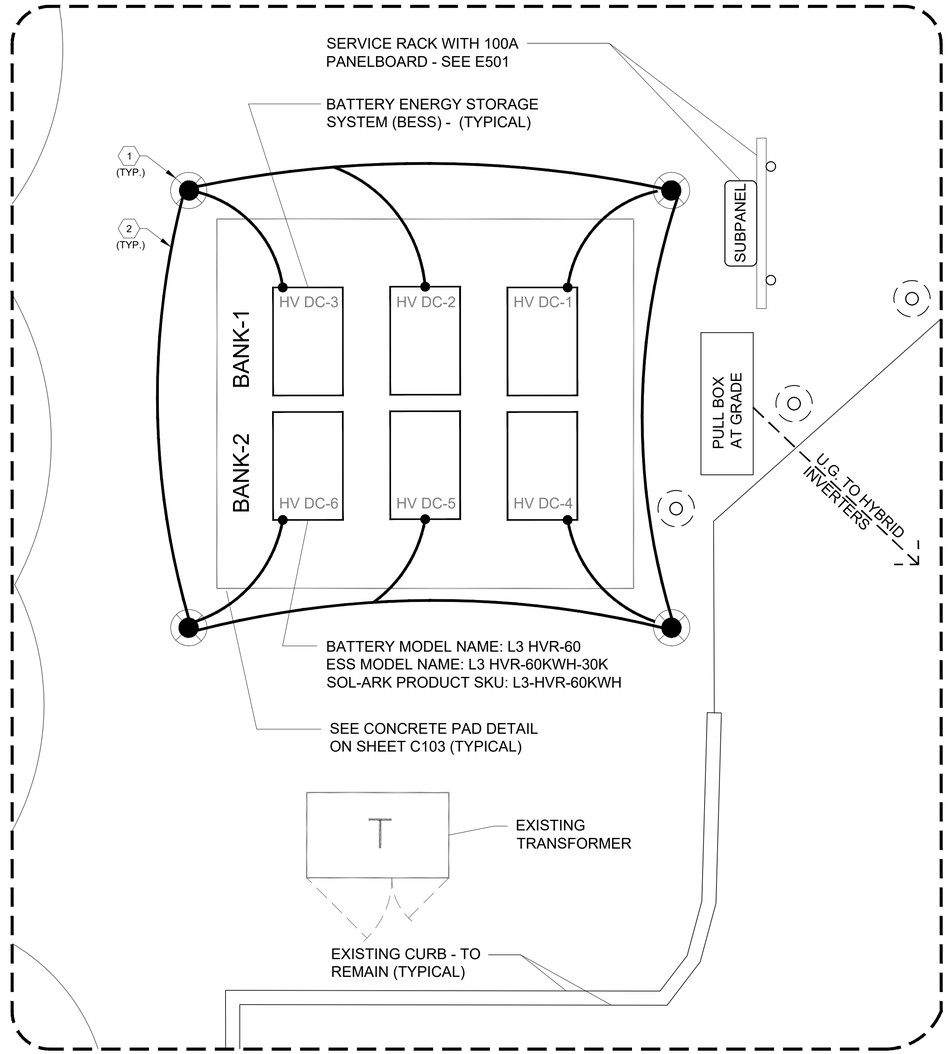
FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

ELECTRICAL
PLAN

PROJECT NUMBER	23-11-1168-FS6
DRAWN BY	GAK
SCALE	AS NOTED
SHEET SIZE	22x34
SHEET NUMBER	E101



1 E104 GROUNDING PLAN DETAIL @ BESS (BATTERY YARD)

SCALE: 3/8" = 1'-0"

SHEET GENERAL NOTES

1. ALL WORK SHALL BE IN ACCORDANCE WITH THE CURRENT MICHIGAN ELECTRICAL CODE, 2023 NATIONAL ELECTRICAL CODE (NEC), 2015 MICHIGAN BUILDING CODE, CURRENT INTERNATIONAL FIRE CODE, AND ALL APPLICABLE LOCAL CODES AND STANDARDS.
2. GROUNDING SHALL COMPLY WITH CURRENT MICHIGAN ELECTRICAL CODE REQUIREMENTS.
3. ALL EXPOSED METAL SURFACES SHALL BE GROUNDED WITH EQUIPMENT GROUNDING CONDUCTORS.

SHEET KEY NOTES

1. GROUND RODS TO BE 5/8" X 8'-0" LONG COPPER CLAD STEEL.
2. 1/0 BARE COPPER, CAD WELD TO GROUND ROD, TYPICAL.

LEGEND

- COPPER CLAD GROUND ROD
- T — TRANSFORMER (EXISTING)
- GROUND WIRE

NORTH

NOVA Consultants, Inc.
21580 Novi Road
Suite 300
Novi, MI 48375
Phone: (248) 347-3512
Fax: (248) 347-4152
www.novaconsultants.com

ISSUED

DATE	DESCRIPTION	APPVD.
1-10-2025	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY: RGM
CHECKED BY: JE

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 6

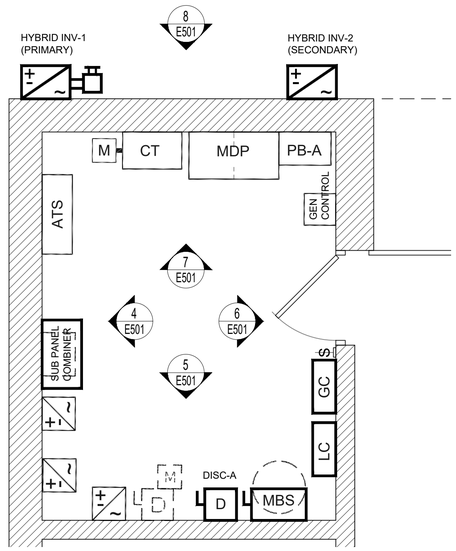
1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

GROUNDING PLAN

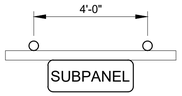
PROJECT NUMBER: 23-11-1168-FS6
DRAWN BY: GAK
SCALE: AS NOTED
SHEET SIZE: 22x34
SHEET NUMBER: E104

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\Fire Station 6\Drawings\23111168-FS6-E104.dwg Date: Jan 10 2025; 2:05PM User: george kachadoorian



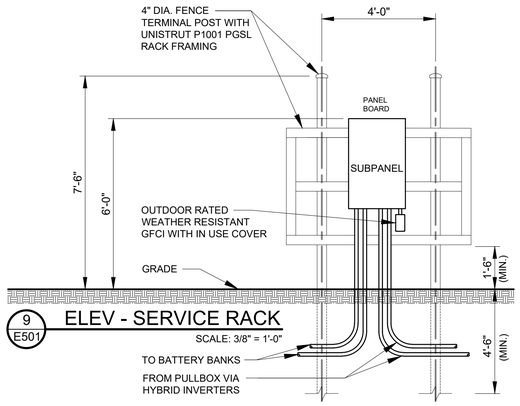
10 E501 ELECTRICAL ROOM - KEY PLAN

SCALE: 3/8" = 1'-0"



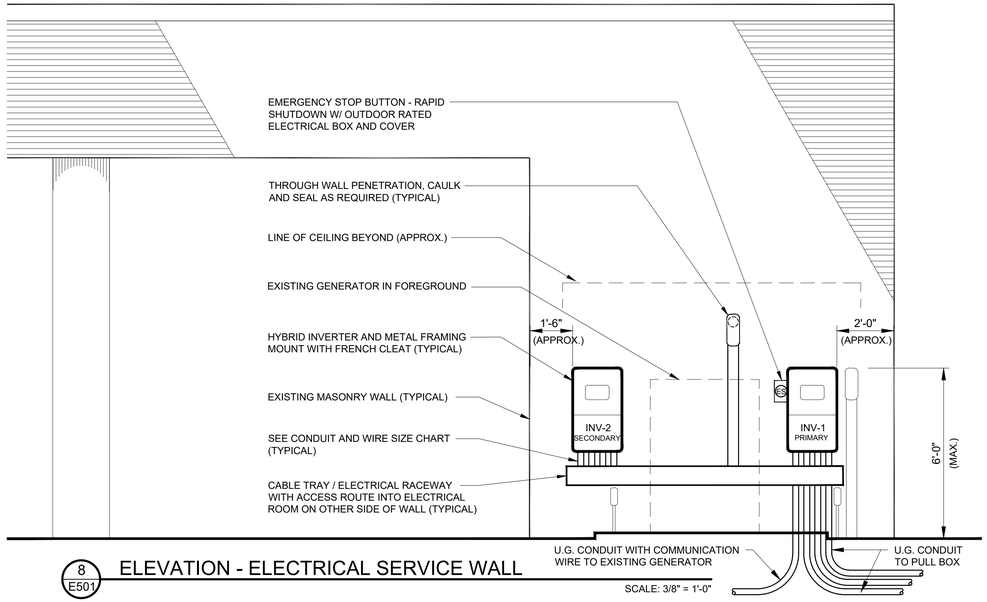
NORTH PLAN - SERVICE RACK

SCALE: 3/8" = 1'-0"



9 E501 ELEV - SERVICE RACK

SCALE: 3/8" = 1'-0"



8 E501 ELEVATION - ELECTRICAL SERVICE WALL

SCALE: 3/8" = 1'-0"

7 E501 INT. EL. - NORTH

SCALE: 3/8" = 1'-0"

6 E501 INT. ELEV. - EAST WALL

SCALE: 3/8" = 1'-0"

5 E501 INT. ELEV. - SOUTH WALL

SCALE: 3/8" = 1'-0"

4 E501 INT. ELEV. - WEST

SCALE: 3/8" = 1'-0"

3 E501 DETAIL - SECURING CONDUIT TO STEEL

SCALE: NONE

2 E501 TRENCH DETAIL - UNDERGROUND

SCALE: NONE

1 E501 BOLLARD DETAIL

SCALE: 3/4" = 1'-0"

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Novi, MI 48375

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ISSUED

DATE	DESCRIPTION	APPVD.
12-13-2025	70% REVIEW	
1-10-2025	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

EQUIPMENT RACK & ELEC. SERVICE ELEVATIONS

PROJECT NUMBER	
23-11-1168-FS6	
DRAWN BY: GAK	SHEET NUMBER: E501
SCALE: AS NOTED	
SHEET SIZE: 22x34	

GENERAL NOTE:

SEE DRAWING E801 FOR DATA SHEETS INCLUDING CERTIFICATIONS AND LISTINGS

FROM UTILITY GRID

(EXISTING) **TRANSFORMER** (DTE) 120 / 208V SECONDARY

O (EXISTING) **GENERATOR** 150kW

2-WIRE START WIRE (COMMUNICATIONS)

OUTSIDE ELECTRICAL ROOM

ROOF

ELECTRICAL ROOM

STRING 1-1 (EXISTING) MODULES 1 THRU 16

STRING 1-2 (EXISTING) MODULES 1 THRU 16

STRING 1-3 (EXISTING) MODULES 1 THRU 16

A (EXISTING) **INVERTER-1**

SOLAR EDGE SE14.4KUS - 208V W/ INTERNAL DC DISCONNECT

40A

D **SUB PANEL COMBINER** 200A, 120/280V, 3P, 4W PV SUB PANEL

50A 50A 50A 80A 80A

CONTACTORS

60A 60A

M (EXISTING) **UTILITY METER** 208V, 3Ø

L (EXISTING) **CT CABINET**

CT

I **DISC-A** SOLAR PV DISC AND (P.O.I.) POINT OF INTERCONNECTION 400A, 120/208V FUSED DISCONNECT SWITCH W/ 400A RK-5 FUSES NEMA 1

K (EXISTING) **ATS** 400A

1 320A

1 320A

J **MANUAL BYPASS SWITCH** 400A

E **PRIMARY (HV-1) HYBRID INVERTER-1**

SOL-ARK (C&I) HYBRID INVERTER 30K-208V COMMERCIAL & INDUSTRIAL MODEL: 30K-3P-208V 30kW INVERTER 120 / 208 V, 83.4 A 1000V DC UL1741/1EEE 1547

EMERGENCY STOP BUTTON RAPID SHUT-DOWN

COMMUNICATION TO BATTERY BANK-1 PER MANUFACTURERS REQUIREMENTS (TYP.) 1

PARALLEL COMMUNICATIONS

DC 9 10 AC

COMMUNICATION

LOADS GEN

DC INPUTS BATT GRID

50A 50A ESEN

BATTERY INPUTS / OUTPUTS (TYPICAL)

F **SECONDARY (HV-2) HYBRID INVERTER-2**

SOL-ARK (C&I) HYBRID INVERTER 30K-208V COMMERCIAL & INDUSTRIAL MODEL: 30K-3P-208V 30kW INVERTER 120 / 208 V, 83.4 A 1000V DC UL1741/1EEE 1547

1 COMMUNICATION TO BATTERY BANK-2 PER MANUFACTURERS REQUIREMENTS (TYP.)

HYBRID INVERTERS LOCATED ON WALL ADJACENT TO EXISTG GENERATOR (TYP.)

DC 9 10 AC

COMMUNICATION

LOADS GEN

DC INPUTS BATT GRID

50A 50A ESEN

50A 50A 50A 50A 50A 50A 50A 50A

70A DC FUSE 70A DC FUSE 70A DC FUSE 70A DC FUSE

BATTERY BUSBARS

CURRENT LIMITING FUSE 125A DC

HV DC - 4 L3 HVR-60kWH-30k

HV DC - 1 L3 HVR-60kWH-30k

HV DC - 5 L3 HVR-60kWH-30k

HV DC - 2 L3 HVR-60kWH-30k

HV DC - 6 L3 HVR-60kWH-30k

HV DC - 3 L3 HVR-60kWH-30k

125A DC FUSE

BATTERY STACKS HV DC - 1 THRU 6 ON CONCRETE PAD LOCATED ADJACENT TO EXISTING XFMR IN GREEN SPACE (SEE E101)

CONNECT BUS BARS IN PARALLEL USING 1-1/4" EMT CONDUIT WITH (2) TWO #1, AND (1) ONE #6 GROUND WIRES (TYPICAL)

1 (TYP)

Q **BATTERY BANK-2**

P **BATTERY BANK-1**

STRING 2-1 (EXISTING) MODULES 1 THRU 16

STRING 2-2 (EXISTING) MODULES 1 THRU 16

STRING 2-3 (EXISTING) MODULES 1 THRU 16

B (EXISTING) **INVERTER-2**

SOLAR EDGE SE14.4KUS - 208V W/ INTERNAL DC DISCONNECT

40A

STRING 3-1 (EXISTING) MODULES 1 THRU 16

STRING 3-2 (EXISTING) MODULES 1 THRU 16

STRING 3-3 (EXISTING) MODULES 1 THRU 14

C (EXISTING) **INVERTER-3**

SOLAR EDGE SE14.4KUS - 208V W/ INTERNAL DC DISCONNECT

40A

SolarEdge P505 Power Optimizer at each module (Typical)

H **LOAD COMBINER PANELBOARD** 400A

400A BUS 200A 200A

N (EXISTING) **MAIN DISTRIBUTION PANEL**

MAIN DISC FOR BLDG 400A

PB-A & PB-B

SOUTH DOORS

NORTH DOORS

VENT EXHAUST

AIR COND.

AIR COND.

WEST WELDER

G **GRID COMBINER PANELBOARD** 400A

400A BUS 200A 200A PV LOAD

1 160A

1 160A

1 160A

1 160A

1 BATTERY ENERGY STORAGE SYSTEM

MANUFACTURER:	SOL-ARK (L3 SERIES LIMITLESS LITHIUM)
BATTERY ENERGY CAPACITY:	60 kWh
BATTERY MODEL NAME:	SOL-ARK, L3 HVR-60 (OUTDOOR)
ESS MODEL NAME:	SOL-ARK, L3 HVR-60kWh-30k (OUTDOOR)
NUMBER OF BATTERIES:	(2) BANKS X (3) BATTERIES = 6 BATTERIES
BESS CAPACITY:	360 kWh (6 X 60 kWh = 360 kWh)

A1 ONE LINE DIAGRAM

SCALE: N.T.S.

NOVA Consultants, Inc.
21580 Novi Road
Suite 300
Novi, MI 48375

Phone: (248) 347-3512
Fax: (248) 347-4152

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ISSUED

DATE	DESCRIPTION	APPVD.
12-23-2024	90% REVIEW	
12-30-2024	INTERCONNECT	
1-10-2025	BID REVIEW	
1-24-2025	INTERCONNECT REV-1	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

ONE LINE DIAGRAM

PROJECT NUMBER 23-11-1168-FS6

DRAWN BY RGM, GAK

SCALE

SHEET SIZE 22x34

SHEET NUMBER E601

CONDUIT AND WIRE SIZE CHART

Item	Description	Label	Route	Conduit	Wire (CU)	Neutral / Ground (CU)
A	Existing Inverter-1 - 14.4kW, 120/208V, 40A, 3P, 4W	INV-1	A-D	1" PVC	3 - #6 THWN-2	2 - #8 THWN-2
B	Existing Inverter-2 - 14.4kW, 120/208V, 40A, 3P, 4W	INV-2	B-D	1" PVC	3 - #6 THWN-2	2 - #8 THWN-2
C	Existing Inverter-3 - 14.4kW, 120/208V, 40A, 3P, 4W	INV-3	C-D	1" PVC	3 - #6 THWN-2	2 - #8 THWN-2
D	Sub Panel Combiner - 120/208V, 200A, 3P, 4W	SUB-PANEL				
						Ground (CU)
E	Hybrid Inverter-1 - 30kW, 120/208V, 83.4A, 3P, 4W	HI-1	D-E	1 1/4" EMT	4 - #4 THWN-2	1 - #8 THWN-2
F	Hybrid Inverter-2 - 30kW, 120/208V, 83.4A, 3P, 4W	HI-2	D-F	1 1/4" EMT	4 - #4 THWN-2	1 - #8 THWN-2
G	Grid Combiner Panelboard- 120/208V, 400A, 3P, 4W, NEMA1	GC	E-G	2" EMT	4 - 3/0 THWN-2	1 - #6 THWN-2
			F-G	2" EMT	4 - 3/0 THWN-2	1 - #6 THWN-2
			G-I	(2) 2" EMT	(2) 4 - 3/0 THWN-2	(2) 1 - #3 THWN-2
H	Load Combiner Panelboard- 120/208V, 400A, 3P, 4W, NEMA1	LC	E-H	2" EMT	4 - 3/0 THWN-2	1 - #6 THWN-2
			F-H	2" EMT	4 - 3/0 THWN-2	1 - #6 THWN-2
I	PV Disconnect A - 120/208V, 400A, 3P, 4W, W/400A RK-5 Fuses	PV DISC - A	H-J	(2) 2" EMT	(2) 4 - 3/0 THWN-2	(2) 1 - #3 THWN-2
J	Manual Bypass Switch	MBS	I-K	(2) 2" EMT	(2) 4 - 3/0 THWN-2	(2) 1 - #3 THWN-2
K	Existing Automatic Transfer Switch	ATS	J-K	(2) 2" EMT	(2) 4 - 3/0 THWN-2	(2) 1 - #3 THWN-2
L	Existing CT Cabinet	PB-A	K-L	EXISTING	EXISTING	EXISTING
M	Existing Utility Meter	METER	L-M	EXISTING	EXISTING	EXISTING
N	Existing Main Distribution Section Panel	MDP	J-N	EXISTING	EXISTING	EXISTING
O	Existing Generator - 150kW	GEN	O-K	EXISTING	EXISTING	EXISTING
P	BATTERY BANK-1 (HV DC-1 THRU HV DC-3)	HV DC-1,2,3	P-E	(2) 1" PVC/HDPE	(2) 2 - #4 THWN-2	(2) 1 - #8 THWN-2
Q	BATTERY BANK-2 (HV DC-4 THRU HV DC-6)	HV DC-4,5,6	Q-F	(2) 1" PVC/HDPE	(2) 2 - #4 THWN-2	(2) 1 - #8 THWN-2

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ISSUED

DATE	DESCRIPTION	APPVD.
12-30-2024	INTERCONNECT	
1-10-2025	BID REVIEW	
1-21-2025	INTERCONNECT REV-1	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

CONDUIT AND
WIRE SIZE CHART

PROJECT NUMBER 23-11-1168-FS6

DRAWN BY GAK | SHEET NUMBER E602

SCALE

SHEET SIZE 22x34

BATTERY DISCONNECT

DO NOT RELOCATE THIS OVERCURRENT DEVICE

LABEL 1

REQ'D BY: NEC 705.12
LABEL LOCATION: BATTERY BREAKERS

WARNING

ELECTRIC SHOCK HAZARD

DO NOT TOUCH TERMINALS
TERMINALS ON BOTH LINE AND LOAD SIDES
MAY BE ENERGIZED IN THE OPEN POSITION

LABEL 2

THE UTILITY METERING CABINET, EACH INVERTER, EACH DC AND AC DISCONNECTING MEANS (SWITCHES AND BREAKERS) MUST BE LABELED WITH THIS PLACARD

WARNING

ELECTRIC SHOCK HAZARD

IF GROUND FAULT IS INDICATED ALL
NORMALLY GROUNDED CONDUCTORS
MAY BE UNGROUNDED AND ENERGIZED

LABEL 3

LABEL LOCATION:
HYBRID INVERTER

CAUTION-TRI POWER SOURCE

FIRST SOURCE IS UTILITY ELECTRICAL GRID
SECOND SOURCE IS AC BATTERY
THIRD SOURCE IS PV INVERTER

LABEL 4

REQ'D BY: NEC 705.10
LABEL LOCATION:
SUB PANEL OR BACKUP LOADS PANEL, HYBRID INVERTER OUTPUT PANEL, MAIN SERVICE PANEL, METER/MAIN, AND PV AC DISCONNECT

WARNING

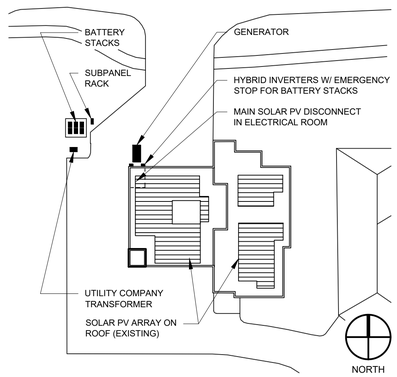
TRI POWER SOURCE SECOND SOURCE IS BATTERY BACKUP SYSTEM THIRD SOURCE IS PHOTOVOLTAIC SYSTEM.

LABEL 5

LABEL LOCATION:
POINT OF INTERCONNECTION
PER CODE: NEC705.12(C)

CAUTION: MULTIPLE SOURCES OF POWER

POWER TO THIS FACILITY IS ALSO SUPPLIED FROM THE FOLLOWING SOURCES WITH DISCONNECTS AS SHOWN:



LABEL 6

INSTALL MAP PLACARD AS PER UTILITY REQUIREMENTS, SIGNAGE SHALL BE RED BACKGROUND WITH WHITE ENGRAVED LETTERS: (CAUTION ¾", POWER TO...(¼"), CALL OUTS (⅛")

THIS LABEL TO BE INSTALLED ON BOTH FENCED IN ELECTRICAL SERVICE YARDS.

WARNING

THIS EQUIPMENT FED BY MULTIPLE SOURCES. TOTAL RATING OF ALL OVERCURRENT DEVICE SHALL NOT EXCEED AMPACITY OF BUSSBAR

LABEL 7

LABEL LOCATION:
P.O.I.

DO NOT ADD LOADS

LABEL 8

REQ'D BY: NEC 705.10
LABEL LOCATION:
SUB PANEL OR BACKUP LOADS PANEL, HYBRID INVERTER OUTPUT PANEL, MAIN SERVICE PANEL, METER/MAIN, AND PV AC DISCONNECT

WARNING - Electric Shock Hazard
No user serviceable parts inside
Contact authorized service provider for assistance

LABEL 9

LABEL LOCATION:
HYBRID INVERTER, JUNCTION BOX, BATTERY COMBINER
(PER CODE: NEC690.13.G.3 & NEC 690.13.G.4)

AC DISCONNECT

LABEL 10

EACH AC DISCONNECTING MEANS MUST BE LABELED WITH THIS PLACARD

PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN

LABEL 11

HYBRID INVERTER AND P.O.I.

CAUTION SOLAR CIRCUIT

LABEL 12

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ISSUED

DATE	DESCRIPTION	APPVD.
11-27-2024	70% REVIEW	
1-10-2025	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

DESIGNED BY | CHECKED BY

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

LABELS AND PLACARDS

PROJECT NUMBER 23-11-1168-FS6

DRAWN BY GAK | SCALE | SHEET SIZE 22x34

SHEET NUMBER E701

Commercial: 30K-3P-208V

Perfect for Light Commercial

Simplifies adding energy storage to small commercial buildings.

Native 120/208 3P output simplifies installation removing the need for bulky step-down transformers

AC/DC Coupling Capability

Enabling seamless integration with existing grid-tied PV systems

Allows for efficient DC coupling using the integrated 4x channel MPPT charge controller.

Modular & Scalable Energy

Modular and flexible design allowing for easy installation and expansion.

Accommodates a range of system sizes with outputs starting from 30kW going to 300kW

Seamless Backup Power

Helps met your corporate renewable energy goals and decarbonization efforts

Blazing fast 5ms transfer time with 200A grid relay allows for business continuity during grid outages.

DATASHEET

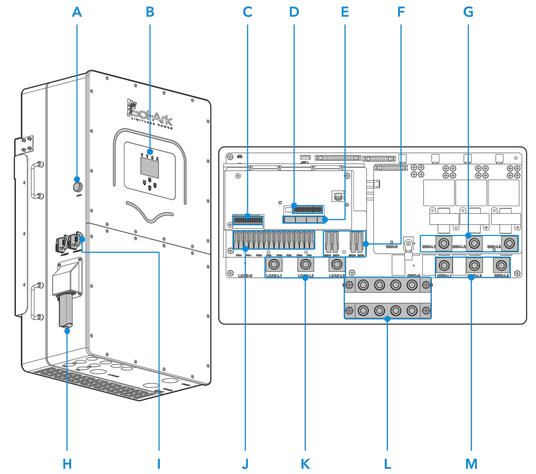
30K-208V

C&I Hybrid Inverter

Inverter Model Name: / Sol-Ark Product SKU:	30K-3P-208V / 30K-3P-208V
Input Data (PV)	
Max. Allowed PV Power (STC)	39,000W
MPPT Voltage Range	150-500V
Startup Voltage	180V
Max. Input Voltage [1]	550V
Max. operating input current per MPPT	36A
Max. short circuit current per MPPT	55A
No. of MPP Trackers	4
No. of PV Strings per MPPT	2
Max. AC Coupled Input Power	30,000W
Output Data (AC)	
Nominal AC Voltage (3Φ)	120/208V
Grid Frequency	50 / 60Hz
Real Power, max continuous (3Φ)	30,000W
Max. Output Current	83.4A
Peak Apparent Power (10s, off-grid, 3Φ)	45,000VA
Max. Grid Passthrough Current (10min)	200A
Continuous Grid Passthrough Current	180A
Power Factor Output Range	+/- 0.8 adjustable
Backup Transfer Time	5ms (adjustable)
CEC Efficiency	96.5%
Max Efficiency	97.5%
Design (DC to AC)	Transformerless DC
Stackable	Up to 10 in parallel
Battery Input Data (DC)	
Battery Chemistry	Lithium iron phosphate
No. of Battery Inputs	2
Battery Input Terminal Rating	50A
Nominal DC Voltage	≥300V
Operating Voltage Range	160 - 500V
Battery Capacity Range	50 – 9900Ah
Max. Battery Charge / Discharge Current	100A (50A per input)
Charge Controller Type	3-Stage with Equalization
Grid to Battery Charging Efficiency	96.0%
Automatic Generator Start (AGS)	2 Wire Start - Integrated
BMS Communication [2]	CANBus & RS485
General Data	
Dimensions (H x W x D)	894 x 528 x 295 mm (35.2 x 20.8 x 11.6 in)
Weight	80 Kg / 176 lb.
Enclosure	IP65 / NEMA 3R
Ambient Temperature	-40 - 60°C, >45°C Derating
Noise	< 30 dB @ 25°C (77°F)
Idle Consumption - No Load	60W
Communication and Monitoring	Wi-Fi & LAN Hardware Included
Warranty [3]	10 Years (15 Years)
Category	
Certifications and Listings (Grid Support Interactive Inverter)	UL 1741-2021 (UL1741SB), CSA C22.2 No 107.1-16, IEEE 1547-2018 & 1547a-2020 & 1547.1-2020 (SRD V2.0), UL 1741 CRD-PCS, UL1699B, CEC, SGIP [4]
PV DC Disconnect Switch – NEC 240.15	Integrated
Ground Fault Detection – NEC 690.5	Integrated
PV Rapid Shutdown Control – NEC 690.12	Integrated
PV Arc Fault Detection – NEC 690.11	Integrated
PV Input Lightning Protection	Integrated
PV String Input Reverse Polarity Protection	Integrated
Surge Protection	DC Type II / AC Type III

1. See Installation Guide for more details on sizing array strings. The highest input voltage is based on the open-circuit voltage of the array at the minimum design temperature.
2. Active BMS communication is required for all lithium batteries. A list of compatible batteries can be found on our website.
3. 5-year extension is available for purchase by registered Gold level installers only.
4. Pending listing.

1.1 General Description



Component	Name	Component	Name
A	ON / OFF Button	H	Wi-Fi / Ethernet dongle
B	LCD touch screen	I	2x PV DC disconnects
C	Pin board 1 for sensors and accessories	J	4x MPPT inputs
D	Pin board 2 for sensors and accessories	K	LOAD terminal
E	Communication port board	L	NEUTRAL / GROUND Busbars
F	2x (50A) Battery port	M	GRID terminal
G	GEN terminal		

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ISSUED

DATE	DESCRIPTION	APPVD.
12-13-2024	INTERCONNECT	
1-10-2025	BID REVIEW	

REVISED

NO.	DATE	DESCRIPTION	APPVD.

CERTIFICATION

INSTALLATION GUIDE
AND USER MANUAL

L3 SERIES LIMITLESS LITHIUM™

L3 HVR

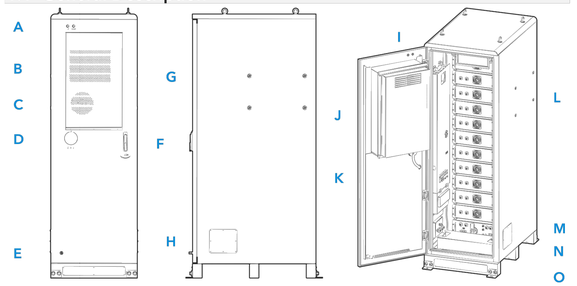
Sol-Ark | L3 Series Limitless Lithium™ Battery Energy Storage System

208V Options
Battery Energy Storage System

Battery Model Name: / ESS Model Name: / Sol-Ark Product SKU:	Outdoor: L3 HVR-60 / L3 HVR-60KWH-30K / L3-HVR-60KWH	Indoor: L3 HV-40 / L3 HV-40KWH-30K / L3-HV-40KWH
System Data		
Compatible Inverter Model	Sol-Ark 30K-3P-208V	
Cell Chemistry	Lithium Iron Phosphate	
Nameplate Energy Capacity (DC)	61.44 kWh	40.96 kWh
Usable Energy Capacity (DC) [1]	55.30 kWh	36.86 kWh
Built-In DC Disconnect Rating	200A	
Internal Fuse Rating	160A	
Max. # Battery Units Per Inverter	6	16
Max. # Inverters in Parallel	6	10
Recommend Depth of Discharge	90%	
Roundtrip Efficiency Charge/Discharge (DC)	94% (25C, 0.5C)	
System Nominal Voltage (DC)	307V	410V
System Operating Voltage (DC)	294V – 336V	392V – 448V
Battery Pack Internal Configuration	6s6p	8s1p
Charge/Discharge Current (DC) [2]		
• Recommend	100A	50A
• Max. Continuous	100A	
• Peak Discharge (60 sec @ 25°C)	125A	
Battery Max. Continuous Charge/Discharge Power (DC)	61.44kW	40.96kW
ESS Max. Continuous Charge/Discharge Power (AC)	30kW	
Fault Current Contribution per Battery	4,200A / 1.47ms	
Mechanical Specifications		
Product Dimensions (WxDxH)	76x107x226 cm (30x42x89 in)	58x58x163 cm (23x23x64 in)
Net Weight (We need 6 stacks)	950 kg (2,095 lbs) x 6	628 kg (1,384 lbs)
Mounting Type	Outdoor Enclosure	Freestanding Rack Mount
Material and Finish	Steel – Corrosion Resistant Powder Coat	Steel – Powder Coated
Operating Temperature [3] and Humidity	-20°C – 50°C (14°F – 122°F) – 5%–85% RH	4°C – 43°C (40°F – 110°F) – 5%–85% RH
Operating Altitude [4]	3000m (9,843 ft)	
Storage Conditions [5]	-4°F – 95°F – Up to 85% RH (non-condensing) and State of Charge (SOC) 30%	
Ingress Rating	IP55 (NEMA 3R)	IP20 (NEMA 1)
Noise Level @ 1m	75 dBA at 30°C (86°F)	< 40 dBA at 30°C (86°F)
Seismic Mounting	Up to Category F	
Communication Ports	CAN2.0/RS485	
Battery Module Specifications		
Battery Module Nominal Energy Capacity	5.12kWh	
Battery Module Nominal Voltage and Capacity	51.2V / 100Ah	
Terminal Type	Amphenol SurLok - Push Lock Connector	
Warranty and Certification		
Performance Warranty [6]	10 years or 196MWh Throughput	10 years or 130MWh Throughput
Product Warranty	10 Years	
Certifications	UL1973, UL9540, UL9540a, UN38.3, FCC, Prop 65	

1. DC usable energy, test conditions: 90% DOD, 0.3C charge and discharge at 25°C. System usable energy may very due to system configuration parameters.
2. Output current is affected by battery temperature and SOC.
3. Temperature is based on the average cell temperature as measured by the BMS. Charging is disabled below 0°C (32°F). Derating occurs above 45°C (113°F). See Sol-Ark technical sales for outdoor sites.
4. Battery will operate at a maximum of 1C charge/discharge up to 2000m, above 2000m maximum output is derated to 0.8C, contact Sol-Ark for details.
5. Storage temperature of the battery with no charge or discharge
6. EOL (End of Life) 70% retained capacity. See L3 Series warranty document for details.

1.1 General Description



Component	Name
A	Indicator Lights (ON & ALARM)
B	HVAC Unit Air Outlet
C	HVAC Unit Air Intake
D	Emergency Stop Button (shuts down battery output)
E	HVAC Condensate Drain Outlet
F	Keyed Cabinet Door Handle
G	Inverter Carrier Mounting Holes
H	R/L side Condit Entry Cover
I	Lifting Points
J	HVAC Unit (heating/cooling)
K	Auxiliary Power Input Terminals and Internal Systems Breakers
L	12x L3 HVR-5.1kWh Battery Modules
M	1x L3 HVR BMS-750V - Battery Management Unit (BMU)
N	Safety Cover for Built-in DC busbar
O	Cabinet Mounting Feet

L3 HVR FASTENER TORQUE TABLE

⚠ *Do not use impact drivers to tighten any fasteners on the cabinet or inverter*

Connection	Torque [ft-lb or in-lb]	Torque [Nm]
M10 - Mounting Feet Bolts	37ft-lb	51 N-m
M6 - Internal Busbar +/- Connections	7.7 ft-lb	10.5N-m
M10 - Ext. Grounding Screws	37ft-lb	51N-m
M12 - Inverter Mounting Carrier Bolts	74 ft-lb	100 N-m
M4 - Inverter to Carrier Socket Screws	12 in-lb	1.37N-m

DESIGNED BY	CHECKED BY
RGM	JE

CITY OF ANN ARBOR
SOLAR FACILITIES

FIRE STATION 6

1881 BRIARWOOD CIRCLE
ANN ARBOR, MI 48108

60 kW AC INVERTER(S)
360 KWh BESS (BATTERY)
SUPPORTED MICROGRID

DATA SHEETS

PROJECT NUMBER	
23-11-1168-FS6	
DRAWN BY: GAK	SHEET NUMBER: E801
SCALE: AS NOTED	
SHEET SIZE: 22x34	

Dwg: J:\PROJECTS\23 projs\23-11-1168 City of Ann Arbor - Solar at City Facilities\Fire Station 6\Drawings\23111168-FS6-E801.dwg Date: Jan 9 2025; 5:50PM User: george kachadoorian