PACIFIC POWER
A DIVISION OF PACIFICORP

825 NE Multnomah Street, Suite 2000
Portland, Oregon 97232

January 9, 2022

VIA ELECTRONIC FILING

Public Utility Commission of Oregon
Attn: Filing Center
201 High Street SE, Suite 100
Salem, OR 97301-3398

Re: UM 1020—PacifiCorp 2022 Blue Sky Grant Funding

At the request of Public Utility Commission of Oregon Staff, PacifiCorp d/b/a Pacific Power (PacifiCorp) provides for filing in the above-referenced docket the attached information regarding a project to which PacifiCorp proposes to provide Blue Sky grant funding. Staff is reviewing the project consistent with the processes outlined in Orders No. 17-289 and 17-455.

Please direct questions regarding this filing to Cathie Allen, Regulatory Affairs Manager, at (503) 813-5934.

Sincerely,

Matthew McVee
Vice President, Regulatory Policy and Operations

Applicant Information	
Host Organization	*Fort George Brewery & Public House*
City	*Astoria*
State	*OR*
Project Information	
Technology Type	*Solar PV*
Project Size (kW DC)	*560.00*
Annual energy generation (kWh/yr)	*615,231*
Electricity use of host facility (kWh/yr)	*1,213,000*
Generation as percent of on-site use	*51%*
Capacity factor	*13%*

Budget	
Total eligible project cost ($)	*$1,318,220.00*
Total project cost per watt ($/W)	*$2.35*
Blue Sky funding request ($)	*$100,000.00*
Funding request as % of total project cost	*8%*
Scoring	
Feasibility/Readiness (35 pts)	*28*
Costs and Financial Feasibility (20 pts)	*16*
Community Benefits & Blue Sky Exposure (40 pts)	*32*
Discretionary Points (5 pts)	*5*
Total Score (100 max)	*81*

OVERVIEW SUMMARY STATEMENT

Fort George Brewery & Public House (Fort George) is a for-profit company striving to be a positive force for Astoria's community by providing a safe, opportunity-rich workplace and an excellent beer experience. Fort George is a hub of community in Astoria, hosting community benefit nights with local nonprofits, community education lectures, and collaborative beer projects that raise awareness and funds for nonprofits. Fort George has strong sustainability initiatives and strives to be a leader in reducing emissions from the beer industry in Clatsop County. Fort George's co-founder and sustainability director are the project managers for the project. The proposed solar PV project would be installed on the roof of Fort George's waterfront distribution center. Savings from the project would support Fort George's community efforts and support the business as it expands its role as an economic and environmental leader in Astoria.

Key Strengths:

- The project offers a unique, high visibility opportunity for Blue Sky.
- The applicant is community-oriented and supports the cultural and economic development of Astoria.
- Demonstrated commitment to energy efficiency and sustainability.

Key Weaknesses:

- The applicant does not have specific plans to use savings toward community impact in the near future.
- The project will likely be installed regardless of Blue Sky funding.

A. PROJECT FEASIBILITY & READINESS

- **Technology.** The solar PV system will consist of REC 445AA watt solar modules, five SolarEdge SE100KUS (480) inverters, and a customized SunModo tilted racking system to maximize efficiency.
- **Project Team.** The applicant's project team is highly qualified and has two strong proponents in Fort George's co-founder and the sustainability director. The selected contractor, Advanced Energy Systems, has installed similar Blue Sky funded systems and is an ETO Trade Ally.
- **Project Site.** The array will be installed on the flat roof of the waterfront distribution center and has virtually no shading. A new roof is being installed prior to installation. A structural engineer has already conducted an analysis and determined that the structure will be able to handle the load of the solar installation.
- **Timeline & Status.** The project has already secured an interconnection agreement with Pacific Power and a full stie assessment, including structural analysis, has been completed. The solar installation is scheduled to be completed in August 2023.
- **O&M.** Advanced Energy will provide a 2-year workmanship warranty for the project. Any installation or system production issues that arise in this time frame will be addressed by Advanced Energy Systems free of charge. The solar panels have a warranty of 20 years, and the inverters are under warranty for 12 years. Fort George will coordinate with Advanced Energy Systems to plan for additional O&M needs. The project's production data will be displayed on site in real time, and will be collected, collated, and assessed regularly by the sustainability director. The project will be insured under the property's insurance.

- **Energy Production.** The energy estimate is based on industry-standard methods and includes a site-specific shade analysis. The estimated net capacity factor of 13% is reasonable.

B. PROJECT COSTS, FINANCING & ADDITIONALITY

- **Project Budget.** The proposed budget is within a reasonable range for this type and size of project. The budget includes some contingency. Multiple bids were requested, but only one was received.
- **Funding Sources.** The applicant is requesting 8% funding from Blue Sky. The project is receiving $144,460 from the Oregon Department of Energy and has applied for a 25% grant from the USDA Rural Energy for America Program. Fort George also plans to leverage tax credits and financing from U.S. Bank. Fort George is in good financial health and is able to pay for upfront costs of the system until Blue Sky reimbursement is received.
- **Additionality.** Blue Sky funding may not be required for the project to proceed but would support the financial viability of the project. Fort George is committed to installing solar and if they are able to finance what is needed to actualize the project with grants and out-of-pocket funds, the project will be installed without Blue Sky.

C. COMMUNITY BENEFITS AND BLUE SKY EXPOSURE

- **Community Benefits.** In addition to supporting the state's efforts for reduction of greenhouse gas emissions, Fort George is a leader in the economic revitalization of Astoria. Fort George works with local contractors on all of its projects, including the proposed solar installation. In the short-run, savings from the project will be used towards paying off the non-grant funded costs of the system. In the long-run, Fort George hopes to find innovative ways to use the savings in their community engagement and in supporting Astoria's economic growth.
- **Educational Benefits.** This project will be the first of its kind in the area. Signage will educate Fort George's customers about the benefits of solar energy and communicate the availability of Blue Sky. A public facing production monitoring website will be available and communicate environmental impacts, raising awareness of the importance and value of solar energy. The community will be invited to regular events held annually that will include education about solar energy and the project. Fort George will also reach out to local college administrators to provide educational opportunities relating to the benefits and career opportunities in solar power and renewable energy.
- **Community Leadership.** Fort George is a cultural and economic leader in the Astoria community, and the brewery serves as a hub of community activities. The brewery has been intentionally developed as a welcoming and beneficial space for all community members, including employees. The brewery hosts community benefit nights with local nonprofits, community education lectures, and collaborative beer projects that raise awareness and funds for nonprofits. Additionally, Fort George has a dedicated commitment to sustainability as a company and advocates for regional sustainability in the fermentation industry. Fort George submitted letters of support from Solar Oregon, Sustainable Northwest, and Skyline Energy Consulting.
- **Diversity, Equity, and Inclusion.** Astoria is a rural and low-income community, and Fort George serves all members of the community. Fort George's mission is to be a positive force for community and provide a safe, opportunity-rich workplace. They value and seek to employ individuals from diverse backgrounds.
- **Blue Sky Recognition & Exposure.** The project will provide Blue Sky recognition via onsite signage, a public facing production monitoring website, marketing on social media, newsletter and website posts, materials, and presentations at community events, and in any additional outreach that is developed. The applicant is also considering a large sign on the side of the building that faces Hwy 101, which would provide significant exposure. The solar array will be highly physically visible from various points in town, including from the Astoria-Megler Bridge. Fort George is a Blue Sky luminary partner. The Blue Sky participation rate in the region is 16%.

FORT GEORGE
BREWERY + PUBLIC HOUSE
ASTORIA, OREGON

September 16, 2022

To: Blue Sky Community Projects application review committee

Please find the following supporting documents for the grant application:

- Signed Certification page
- Letters of Support for the proposed project
- Pacific Power Interconnection Review Report
- Quote from Advanced Energy Systems with cost breakdown into the following categories: design/engineering, equipment, labor, permits, other
- Photos of the site from different vantage points
- Solar access report
- Energy production estimate
- Site plan showing the locations of major equipment, point of interconnection, and any trenching required
- Project development schedule showing major milestones (permitting complete, procurement, construction start and end, commissioning
- One-line electrical diagram
- Structural engineering drawings and calculations, and recommendations for building structural upgrades, if applicable
- Equipment specifications
- Installer qualifications and/or resume of the project lead (years of experience, number of similar systems installed, relevant licenses and certifications)

F. Certifications

The applicant certifies to each of the following (check all that are applicable):

☒	*I certify that the host organization owns the property or has a long-term lease agreement that allows for the installation of the proposed project.*
☒	I certify that the host organization *has operating funds and capacity necessary to complete and maintain the proposed project.*
☒	*I certify that in preparation for submitting this application I have reviewed the applicant as well as the award recipient requirements, understand that should this project be awarded funding, my organization will be able to meet the award recipient requirements as described on the Pacific Power website.*
☒	*I attest that the information provided above responding to this application is both accurate and current.*
☒	*I understand that submitting an application in no way obligates Pacific Power to provide funding and that funds are distributed at the sole discretion of Pacific Power.*

Signatures

The application form must be returned as a Microsoft Word document, but please feel free to provide your signed certification page in a separate document as a PDF or image file.

Signature	DocuSigned by: [signature] 2683F0A6006C40F...
Date	9/16/2022 | 11:47:40 PDT
Printed Name	Renee Johnson
Title	Sustainability Director
Organization	Fort George Brewery + Public House
Contact number	971-235-5546

If this request is being submitted by multiple parties or a party other than the host, please indicate below by providing the party's name, title and contact information. The project host/owner must approve the submittal on their behalf through signature demonstrating that the all parties linked to installation have reviewed the application and support the project.

Signature	DocuSigned by: [signature] 701C3F706B8D4CB...
Date	9/16/2022 | 14:33:24 PDT
Printed Name	Chris Nemlowill
Title	President
Organization	Fort George Brewery
Contact number	5037915355

FORT GEORGE
BREWERY + PUBLIC HOUSE
ASTORIA, OREGON

August 31, 2022

To Whom it May Concern:

Fort George Brewery & Public House is always looking for ways to be more efficient, reduce the size of our carbon footprint, and help make Astoria a better place. We plan to install a sizeable solar array and two additional EV chargers at our waterfront location.

We believe that the adoption renewable power and electric vehicles as a transportation choice is critical in stemming the CO2 emissions that contribute to climate change and we intend to promote this choice strongly. As such, I am highly supportive of installing a 560 KW system and two EV charging stations at our new warehouse & tap-house facility to support both customers and our new company EV vehicles.

The highly visible location will enable us to provide numerous educational opportunities and promote the Blue Sky program widely. We would appreciate assistance in getting this project off the ground as we continue to work towards a post-pandemic recovery.

This application process has put us in touch with several folks at USDA and ETO that have encouraged additional resiliency measures. As is often the case with projects at Fort George, we fully expect this project to evolve to include additional battery storage and any other resiliency measures that will help us to be more self sufficient and serve the community.

Sincerely,

Chris Nemlowill
Owner
Fort George Brewery & Public House
70 W. Marine Dr. / 1483 Duane St.
Astoria, OR 97103

SOLAR OREGON

September 13, 2022

Renée Johnson
Sustainability Director
Fort George Brewery + Public House
Astoria, Oregon 97103
Email: renee@fortgeorgebrewery.com

RE: Pacific Power Blue Sky Grant Letter of Support from Sustainable NW

Ms. Johnson,

Solar Oregon is a non-profit organization based on Portland, Oregon supporting solar energy education. We lead tours, deliver workshops, advocate for pro-solar policies to help homeowners and communities navigate and accelerate the development of solar energy in Oregon and southwest Washington over the last 36 years.

SOLAR OREGON MISSION: to lead the way to a clean energy future where human prosperity is achieved through efficient technology and renewable energy.

SOLAR OREGON VISION: Incorporate solar design as a standard in the built environment to lead the nation with a clean energy economy.

Recognizing that business, local governments and non-profit organizations all play a major role in reducing our energy footprint, Solar Oregon reaches out to the professional and corporate community. Together, we are building a body of people, knowledge and success that benefits all Oregonians.

Solar Oregon could not achieve our mission alone and we appreciate our partners, especially those that show a commitment to solar education and renewable energy leadership in the rural parts of our beautiful state. The Solar Oregon Board whole-heartedly supports selection of Fort George Brewery + Public House for a 2022 Blue Sky Grant from Pacific Power to support a landmark solar installation and solar education opportunities at their Astoria facility.

The attached photo was taken at a Solar Drinks and Information Session sponsored by Solar Oregon in August of 2017.

The Community panel included representatives from OSEIA, The Energy Trust of Oregon, and Energy Solutions and sparked conversations about renewables integration in Clatsop County.

Many thanks for your consideration of Fort George's application to your important program that is providing renewable power access in rural Oregon communities.

Best,

Kelly Yearick, Past President

SUSTAINABLE NORTHWEST

September 12, 2022

Renée Johnson
Sustainability Director
Fort George Brewery + Public House
Astoria, OR 97103
renee@fortgeorgebrewery.com

RE: Letter of Support Fort George Brewery + Public House to Pacific Power

Ms. Johnson,

Sustainable Northwest is pleased to provide this letter of support for the Fort George Brewery Pacific Power Blue Sky grant application. Sustainable Northwest brings entrepreneurial solutions to natural resource challenges to keep lands healthy and provide economic and community benefits. We believe a healthy economy, environment, and community are indivisible, and that all are strengthened by wise partnerships, policies, and investments.

Founded in 1994, our work focuses on forests, farms, and ranches; clean energy; water; and green markets throughout the Greater Northwest. Through this broad spectrum of work, we help to ensure both rural communities and urban centers have healthy landscapes, resilient economies, and engaged communities. We work on the ground in communities, collaborating to create long-term benefits.

To achieve our vision of healthy and resilient communities, strong economies and a healthy environment we must place equity at the center of our work. As we emphasize the indivisible link between economy and ecology, we are mindful that our efforts will only prosper through partnerships, programs, and policies that celebrate diversity, inclusion, equity, and justice.

We have reviewed Fort George Brewery + Public House application for the 2022 Pacific Power Blue Sky Grant and believe their project is aligned with Sustainable Northwest's mission. Sustainable Northwest supports truly equitable projects and opportunities for renewables options especially in our rural and underserved communities including Astoria, Oregon. We hold our work and partnerships to the same expectations and values we hold ourselves.

We commit to:

SUSTAINABLE NORTHWEST

- Supporting economic opportunities that benefit challenged communities and setting small businesses up for success in competitive markets,
- Advocating for policies that maximize benefits to local communities and underserved populations,
- Convening and assisting collaborative processes that elevate diverse perspectives, and resetting the table when power imbalances are recognized, Enhancing the capacity of rural, place-based organizations,
- Constant learning, listening, and course corrections.

Thank you for your consideration of the Fort George Blue Sky Grant application. This project is in full alignment with our vision for a resilient, sustainable rural Oregon. We support this project and look forward to a future with more renewable energy installations developed in lower socioeconomic areas of Oregon.

Sincerely,

Greg Block, President

Sustainable Northwest

September 8, 2022

Renée Johnson
Sustainability Director
Fort George Brewery + Public House
Astoria, Oregon 97103
Via email: renee@fortgeorgebrewery.com

RE: Fort George Brewery + Public House 2022 Pacific Power Blue Sky Funding Application

Renee,

It is with great enthusiasm that I write this letter of support for Fort George's application to install solar and participate in Pacific Power's Blue Sky program. I have lived in Astoria since 2015 and have seen very few renewables projects emerge on the Oregon Coast. There is a misperception that it rains here therefore maybe solar is not the right fit. Yet, my 10-kW system installed in 2015 works well, provides green power for my home, and is visible in the neighborhood. Unfortunately, with the exception of just a couple smaller systems (e.g. at Clatsop Community College) there are few examples of renewables to encourage other adopters. Even the Astoria School Board passed on the opportunity to size systems for installation at Lewis and Clark Elementary and Astoria High School when the community passed our recent Bond measure.

We need more early and visible adopters like Fort George to initiate renewables conversations in rural NW Oregon. Fort George's proposal includes a great location for solar and the company offers multiple, well-attended annual events and festivals to further support renewable energy education for the community. Fort George is truly a community hub.

As the owner of the Astoria-based renewable energy and environmental consulting firm 7Skyline, LLC (www.7Skyline.com) I have voluntarily provided a preliminary environmental screening for the project. With the exception of the potential for temporary traffic impacts during construction that can be mitigated, the project should not have any significant environmental impacts and would be a great addition to our downtown.

Please help us encourage more green power in Clatsop County and support one of our most important, community-minded employers in the region by selecting Fort George for Blue Sky.

Sincerely,

Jen Rouda
Principal Consultant
7Skyline, LLC
7 Skyline Place
Astoria, Oregon 97103
510-225-8330
jennifer@7skyline.com

Level 2 Interconnection Review Report

Completed for
FORT GEORGE BREWERY & PUBLIC HOUSE
(“Applicant”)

Proposed Interconnection
On PacifiCorp’s Existing
12.47-kV Circuit, 5A205
(Facility Point: 01208009.0077481)

4/21/2022

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1.0 Description of the Generating Facility

FORT GEORGE BREWERY & PUBLIC HOUSE ("Applicant") has proposed interconnecting 559.81 kW DC of new generation to PacifiCorp's ("Electric Company") existing 12.47-kV Circuit, 5A205, located in ASTORIA, OR. The Applicant's generation project will provide a nameplate output of 425 kW of AC generation.

2.0 Approval Criteria for Level 2 Interconnection Review

Pursuant to 860-039-0035(1) An Electric Company must apply the following Level 2 interconnection review procedure for an application to interconnect an eligible system that meets the following criteria:

(a) The facility has a capacity of two megawatts or less; and
(b) The facility does not qualify for or failed to meet applicable Level 1 interconnection review procedures.

3.0 Proposed Point of Interconnection

The proposed generation facility is to be interconnected to the existing 5A205 Circuit (12.47-kV), out of Youngs Bay Substation. The Applicant is looking to interconnect to facility point number 01208009.0077481.

4.0 Tier 2 Interconnection Review Results

4.1 860-039-0035(2) (a)

The aggregate generation capacity on the distribution circuit to which the net metering facility will interconnect, including the capacity of the net metering facility, will not cause any distribution protective equipment (including, but not limited to, substation breakers, fuse cutouts, and line reclosers), or customer equipment on the electric distribution system, to exceed 90 percent of the short circuit interrupting capability of the equipment. In addition, a net metering facility will not be connected to a circuit that already exceeds 90 percent of the short circuit interrupting capability, prior to interconnection of the facility.

Project fails review criteria?: False

These calculations use a generation power factor of 0.95, a single-phase fault current multiplier of 5, a three-phase fault current multiplier of 3, and line-to-line primary voltage of 12.47 kV.

Existing single-phase private generation: 31 kW.
Single-phase current produced on primary during normal operation: 4.53 Amps.
Single-phase current produced on primary during a fault condition: 22.7 Amps.

Existing three-phase private generation: 12 kW.
Three-phase current produced on primary during normal operation: 0.58 Amps.
Three-phase current produced on primary during a fault condition: 1.8 Amps.

Current produced by proposed generation system on primary: 20.71 Amps.

Current produced by proposed generation system on primary during a fault condition: 62.1 Amps.

Total fault current: 86.6 Amps.

The limiting distribution protective equipment is a single phase fuse cutout, with a rating of not less than 8000 Amps.

8000 x 0.9 = 7,200.0 Amps.

4.2 860-039-0035 (2) (b)

If there are posted transient stability limits to generating units located in the general electrical vicinity of the proposed point of common coupling, including, but not limited to within three or four transmission voltage level busses, the aggregate generation capacity, including the net metering facility, connected to the distribution low voltage side of the substation transformer feeding the distribution circuit containing the point of common coupling will not exceed 10 megawatts.

Project fails review criteria?: False
Are there posted transient stability limits to generation?: No

Aggregate single-phase generation on feeder: 31 kW
Aggregate three-phase generation on feeder: 12 kW
Proposed generation system: 425 kW

Total generation on circuit (existing and proposed): 468 kW
Generation limit: 10 MW

4.3 860-039-0035 (2) (c)

The aggregate generation capacity connected to the distribution circuit, including the net metering facility, will not contribute more than 10 percent to the distribution circuit's maximum fault current at the point on the high voltage (primary) level nearest the proposed point of common coupling.

Project fails review criteria?: False
Fault current at the point of interconnection without the contribution of customer generation = 2242
Fault current at the point of interconnection with the contribution of customer generation included = 2320

(2320 Amps - 2242 Amps) / 2242 Amps x 100 = 3.48%

4.4 860-039-0035 (2) (d)

If a net metering facility is to be connected to a radial distribution circuit, the aggregate generation capacity connected to the electric distribution system by non-public utility sources, including the net metering facility, will not exceed 10 percent (or 15 percent for solar electric generation) of the total circuit annual peak load. For the purposes of this subsection, annual peak load will be based on measurements taken over the 12 months previous to the submittal of the application, measured for the circuit at the substation nearest to the net metering facility.

Project fails review criteria?: True
Peak load on circuit 5A205: 3100 kW

Percentage of peak load for comparison (use 15% for solar, 10% for other generation types): 465 kW

Total customer generation on circuit (existing and proposed): 468 kW

4.5 860-039-0035 (2) (e)

If a net metering facility is to be connected to three-phase, three wire primary public utility distribution lines, a three-phase or single-phase generator will be connected phase-to-phase.

Project fails review criteria?: False
Circuit 5A205 is Three-Phase, Four Wire.
Generation is connected phase-to-phase?:

4.6 860-039-0035 (2) (f)

If a net metering facility is to be connected to three-phase, four wire primary public utility distribution lines, a three-phase or single-phase generator will be connected line-to-neutral and will be effectively grounded.

Project fails review criteria?: True
This review item refers to a customer generation facility's ability to manage a transient overvoltage condition. This can be accomplished by using a qualified inverter or by effectively grounding the generation system.

IEEE 1547.7 guidelines indicate this review item may be waived if the aggregate customer generation is less than 10% of the circuit's Light Load (for solar generation, the Daytime Light Load is used).

Light Load = 700 kW
10% of Light Load = 70 kW
Sum of customer generation (existing and proposed): 468 kW

Transient overvoltage management has been achieved for this installation, either through the use of a qualified inverter or by the addition of an effective grounding system?: False

4.7 860-039-0035 (2) (g)

If a net metering facility is to be connected to a single-phase shared secondary, the aggregate generation capacity on the shared secondary, including the net metering facility, will not exceed 20 kilovolt-amps.

Project fails review criteria?: False
Phasing of this installation: Three Phase
Existing customer generation on the secondary: 0 kW
Review item has been cleared by Engineering?:

4.8 860-039-0035 (2) (h)

If a net metering facility is single-phase and is to be connected to a transformer center tap neutral of a 240 volt service, the addition of the net metering facility will not create a current imbalance between the two sides of the 240 volt service that is greater than 20 percent of the nameplate rating of the service transformer.

Project fails review criteria?: False
This review item refers to connecting a single-phase 120 V inverter on a single-phase 240 V service.

Phasing of this installation: Three Phase
Voltage of this installation: 480V
Existing load on service transformer: kW

4.9 860-039-0035 (2) (i)

A net metering facility's point of common coupling will not be on a transmission line.

Project fails review criteria?: False
This installation will interconnect on distribution circuit 5A205.

4.10 860-039-0035 (2) (j)

If an eligible system's proposed point of common coupling is on a spot or area network, the interconnection must meet the following additional requirements:

A) For a net metering facility that will be connected to a spot network circuit, the aggregate generation capacity connected to that spot network from the net metering facilities, and any generating facilities, will not exceed five percent of the spot network's maximum load;

(B) For a net metering facility that utilizes inverter-based protective functions, which will be connected to an area network, the net metering facility, combined with any other generating facilities on the load side of network protective devices, will not exceed 10 percent of the minimum annual load on the network, or 500 kilowatts, whichever is less. For the purposes of this paragraph, the percent of minimum load for solar electric generation net metering facility will be calculated based on the minimum load occurring during an off-peak daylight period; and

(C) For a net metering facility that will be connected to a spot or an area network that does not utilize inverter-based protective functions, or for an inverter-based net metering facility that does not meet the requirements of paragraphs (A) or (B) of this subsection, the net metering facility will utilize low forward power relays or other protection devices that ensure no export of power from the net metering facility, including inadvertent export (under fault conditions) that could adversely affect protective devices on the network.

Project fails review criteria?: False
Circuit 5A205 is a Radial circuit.

Sum of customer generation (existing and proposed): 468 kW

Peak load on circuit 5A205: 3100 kW
5% of peak load on circuit : 155.0

Technology type of proposed generating facility: Inverter
Light Load = 700 kW
10% of Light Load = 70 kW

ADVANCED ENERGY SYSTEMS

Turning tax liability into renewable energy





Fort George Brewery - Distribution Facility

Site Location: 70 West Marine Drive
Astoria, Oregon 97103

560 KW Solar Electric System

8 Deg. South Tilt-Rack Array

Presented by
Justin Wilbur
Tuesday, March 29, 2022

Since 2002 Advanced Energy Systems has completed hundreds of solar energy installations throughout the state. Our clients include private commercial, industrial, and residential customers, as well as local, state and federal agencies. We provide a turn-key solution including site evaluation, energy analysis, grant writing, tax incentive analysis, engineering, custom design, project management, installation, and service. Advanced Energy Systems is an Oregon-based company. www.AESrenew.com

Advanced Energy Systems • 65 Centennial Loop, Eugene, OR 97401 • 541-683-2345 • www.aesrenew.com • CCB 160523

ADVANCED ENERGY SYSTEMS

Turning tax liability into renewable energy

To: Chris Nemlowill
Fort George Brewery - Distribution Facility
70 West Marine Drive
Astoria, Oregon 97103

560 KW Solar Electric System

System Description:

A 560 kW PV power system, including REC 445AA watt solar modules, a customized racking system, stainless steel module fastening hardware, 5 Solaredge SE100KUS (480) inverter(s), live solar monitoring web page and all necessary conduit, wire, fuses and disconnects for an NEC-compliant system. Permit fees and utility paperwork included.

Total Cost Installed		**$1,318,220**
Less Tax Credit & Incentive:		
Federal Investment Tax Credit (ITC)	(342,737)	
Blue Sky Grant at $100,000	(100,000)	
USDA REAP Grant	(329,555)	
Available Federal & State Depreciation Benefits	(531,902)	
Total Tax Credit & Incentive	($1,304,194)	
Installed Net Cost Sub-Total		**$14,026**
Income Benefit		
35 Year Energy Savings	(2,092,739)	
Net System Balance		**($2,078,713)**

Cost Detail:

Design / Engineering	$1,820
Equipment	$912,591
Labor	$396,419
Permits	$7,390
Other	$0

Fort George Brewery - Distribution Facility - 560 KW Solar Electric System Period Cash Flow (with BlueSky and USDA REAP Grants)

		System Cost	Energy Tax Credit	MACRS Tax Deductions		Net Tax Benefits	Pacific Power	USDA	System Revenue	Net Cash Flow	
	Year	Cash Outflow	Federal Investment Tax Credit	Federal Depreciation @ 35% Tax Rate	State Depreciation @ 9.9% Tax Rate	Net Credits	Blue Sky Grant	REAP Grant	Annual Energy Savings	Cash Flow	Net Cash Balance
1	2021	($1,318,220)	$342,737	$251,054	$17,596	$611,386	$100,000	$329,555	$40,274	($237,005)	**($237,005)**
2	2022				28,153	28,153			41,162	69,315	**(167,690)**
3	2023				16,892	16,892			42,070	58,962	**(108,728)**
4	2024				10,135	10,135			42,999	53,134	**(55,594)**
5	2025				10,135	10,135			43,947	54,082	**(1,511)**
6	2026				5,068	5,068			44,917	49,985	**48,473**
7	2027								45,908	45,908	**94,381**
8	2028								46,921	46,921	**141,302**
9	2029								47,956	47,956	**189,259**
10	2030								49,014	49,014	**238,273**
11	2031								50,096	50,096	**288,369**
12	2032								51,201	51,201	**339,570**
13	2033								52,331	52,331	**391,901**
14	2034								53,486	53,486	**445,386**
15	2035								54,666	54,666	**500,052**
16	2036								55,872	55,872	**555,924**
17	2037								57,105	57,105	**613,028**
18	2038								58,364	58,364	**671,393**
19	2039								59,652	59,652	**731,045**
20	2040								60,968	60,968	**792,013**
21	2041								62,314	62,314	**854,327**
22	2042								63,688	63,688	**918,016**
23	2043								65,094	65,094	**983,109**
24	2044								66,530	66,530	**1,049,639**
25	2045								67,998	67,998	**1,117,637**
26	2046								69,498	69,498	**1,187,135**
27	2047								71,032	71,032	**1,258,167**
28	2048								72,599	72,599	**1,330,766**
29	2049								74,201	74,201	**1,404,966**
30	2050								75,838	75,838	**1,480,804**
31	2051								77,511	77,511	**1,558,315**
32	2052								79,221	79,221	**1,637,536**
33	2053								80,969	80,969	**1,718,505**
34	2054								82,756	82,756	**1,801,261**
35	2055								84,582	84,582	**1,885,843**
Totals:		($1,318,220)	$342,737	$251,054	$87,978	$681,769	$100,000	$329,555	$2,092,739	$1,885,843	

Summary

Initial System Cost	($1,318,220)
Total Tax Credits	681,769
REAP Grant	329,555
Blue Sky Grant	100,000
35 Year Total Energy Savings	**2,092,739**
Net System Benefit	**$1,885,843**
Project IRR	**23.6%**
Simple Payback	**6 Years**

Fort George Brewery - Distribution Facility - 560 KW Solar Electric System Period Cash Flow (with USDA REAP Grant)

		System Cost	Energy Tax Credit	MACRS Tax Deductions		Net Tax Benefits		USDA	System Revenue	Net Cash Flow	
	Year	Cash Outflow	Federal Investment Tax Credit	Federal Depreciation @ 35% Tax Rate	State Depreciation @ 9.9% Tax Rate	Net Credits		REAP Grant	Annual Energy Savings	Cash Flow	Net Cash Balance
1	2021	($1,318,220)	$342,737	$286,054	$19,576	$648,366		$329,555	$40,274	($300,025)	**($300,025)**
2	2022				31,321	31,321			41,162	72,483	**(227,542)**
3	2023				18,793	18,793			42,070	60,863	**(166,679)**
4	2024				11,276	11,276			42,999	54,274	**(112,405)**
5	2025				15,034	15,034			43,947	58,981	**(53,423)**
6	2026				7,517	7,517			44,917	52,434	**(989)**
7	2027								45,908	45,908	**44,919**
8	2028								46,921	46,921	**91,840**
9	2029								47,956	47,956	**139,796**
10	2030								49,014	49,014	**188,811**
11	2031								50,096	50,096	**238,907**
12	2032								51,201	51,201	**290,108**
13	2033								52,331	52,331	**342,439**
14	2034								53,486	53,486	**395,924**
15	2035								54,666	54,666	**450,590**
16	2036								55,872	55,872	**506,462**
17	2037								57,105	57,105	**563,566**
18	2038								58,364	58,364	**621,931**
19	2039								59,652	59,652	**681,583**
20	2040								60,968	60,968	**742,551**
21	2041								62,314	62,314	**804,865**
22	2042								63,688	63,688	**868,553**
23	2043								65,094	65,094	**933,647**
24	2044								66,530	66,530	**1,000,177**
25	2045								67,998	67,998	**1,068,175**
26	2046								69,498	69,498	**1,137,673**
27	2047								71,032	71,032	**1,208,704**
28	2048								72,599	72,599	**1,281,303**
29	2049								74,201	74,201	**1,355,504**
30	2050								75,838	75,838	**1,431,342**
31	2051								77,511	77,511	**1,508,853**
32	2052								79,221	79,221	**1,588,074**
33	2053								80,969	80,969	**1,669,043**
34	2054								82,756	82,756	**1,751,799**
35	2055								84,582	84,582	**1,836,381**
Totals:		($1,318,220)	$342,737	$286,054	$103,516	$732,306	$0	$329,555	$2,092,739	$1,836,381	

Summary

Initial System Cost	($1,318,220)
Total Tax Credits	732,306
REAP Grant	329,555
35 Year Total Energy Savings	**2,092,739**
Net System Benefit	**$1,836,381**
Project IRR	**19.0%**
Simple Payback	**7 Years**

ADVANCED ENERGY SYSTEMS

Turning tax liability into renewable energy

Fort George Brewery - Distribution Facility - 560 KW Solar Electric System

Energy Savings

First Year Savings
615,231 kWh First Year Savings
x $0.065 From Pacific Power
= $40,274 Savings

35 Year Energy Savings
19,799,541 kWh
at 2.7% Energy Rate Inflation
= $2,092,739 Total Savings

Environmental Benefits

During its lifetime, this system will offset:

14,315.1 Tons of CO_2

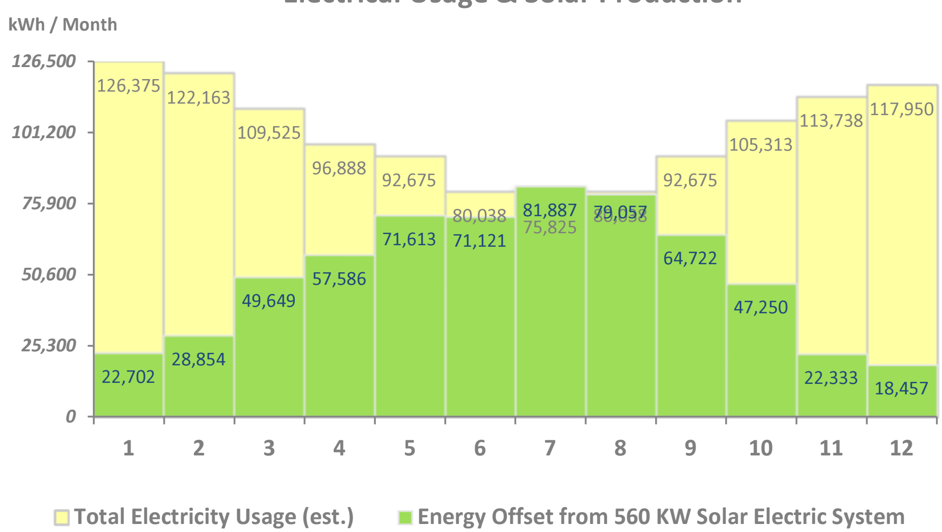
Which is the equivalent to the conservation of:

207,210 Trees

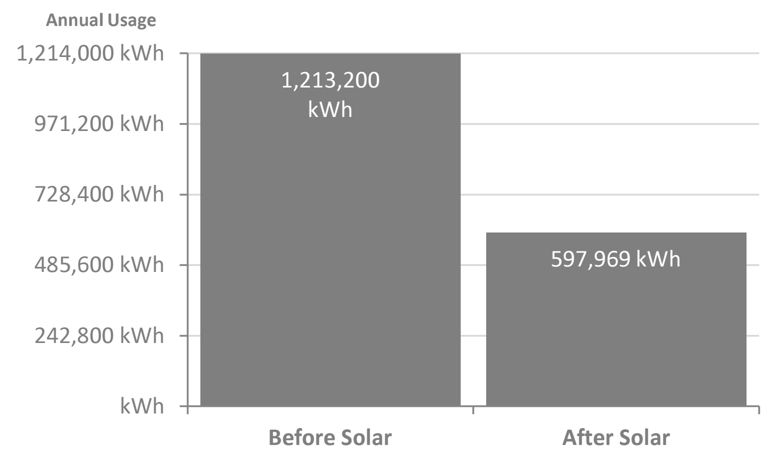
or. . .

909,030 Gallons of Gasoline

Electrical Usage & Solar Production



Utility Provided Energy Offset by Solar: 51%



Notes:

Notes - Proposal:

1. The prices quoted are valid through May 31, 2022.

2. A negative Net System Balance occurs when the combination of the tax credit, allowable depreciation, electric utility grant, and energy savings exceed the installed system cost over the 35 year system life. This represents an expected positive return. The tax credit and depreciation benefits are subject to eligibility and must be verified by your Financial Advisor.

3. The Federal Investment Tax Credit (ITC) can be carried back one year, taken in the first year, and carried forward until used up.

4. The MACRS Depreciation is calculated at the Federal tax rate and an Oregon tax rate listed in the financial summaries. Please check with your Financial Advisor to verify tax rates and adjust if necessary. System cost basis for depreciation purposes is reduced by 50% of ITC. The cost basis for depreciation also has any cash grants (USDA and BlueSky) deducted from system cost.

5. The system will require electrical and structural engineering reports to verify feasibility. These reports are required for obtaining permits. The costs of these reports are included in the total system cost quoted above. The cost estimates in this proposal assume standard installation techniques applicable to most buildings. If engineering determines structural or electrical upgrades are necessary to meet current building codes, the cost of the upgrades will be presented as a change order. Additional cost from change orders is also eligible for tax credits and depreciation benefits to the system owner.

6. Live web based monitoring requires an owner supplied connection to the internet no farther than 25 feet distance from the Solar Inverter. The monitoring system sends energy production data out to the solar monitoring database. This data is then accessed from an internet connected computer, website, or kiosk instantly.

7. The USDA REAP Grant and Pacific Power Blue Sky Grant are competitively awarded, and not guaranteed.

Photos of the Site

View from the west

Electrical Room, View from the south

View from the southeast

North Side of the building

8 deg tilt - 560 kW USDA REAP Fort George Brewery, 70 West Marine Drive Astoria, Oregon 97103

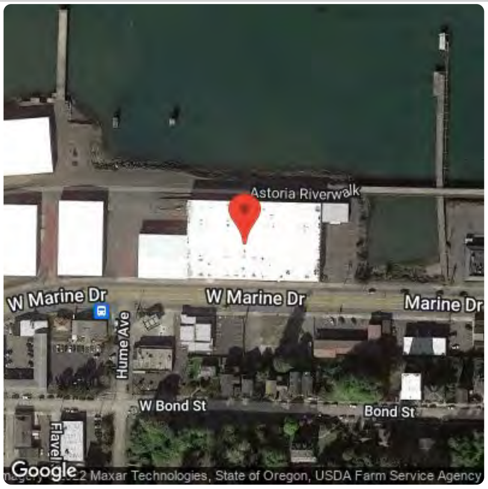
Report

Project Name	Fort George Brewery
Project Address	70 West Marine Drive Astoria, Oregon 97103
Prepared By	AES Design info@aesrenew.com

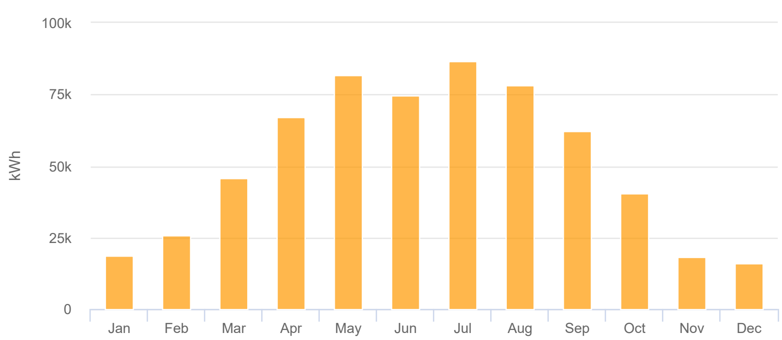
System Metrics

Design	8 deg tilt - 560 kW USDA REAP
Module DC Nameplate	559.8 kW
Inverter AC Nameplate	437.5 kW Load Ratio: 1.28
Annual Production	615.2 MWh
Performance Ratio	85.9%
kWh/kWp	1,099.0
Weather Dataset	TMY, 10km Grid (46.15,-123.85), NREL (prospector)
Simulator Version	5059dd9741-c5e0721255-7687e1d04d-81a823811a

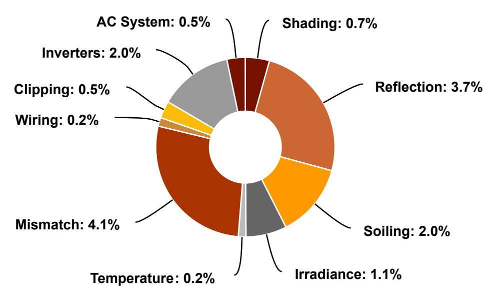
Project Location



Monthly Production



Sources of System Loss



Annual Production

	Description	Output	% Delta
Irradiance (kWh/m²)	Annual Global Horizontal Irradiance	1,204.5	
	POA Irradiance	1,279.3	6.2%
	Shaded Irradiance	1,270.9	-0.7%
	Irradiance after Reflection	1,223.4	-3.7%
	Irradiance after Soiling	1,198.9	-2.0%
	Total Collector Irradiance	**1,198.9**	**0.0%**
Energy (kWh)	Nameplate	671,570.8	
	Output at Irradiance Levels	664,124.4	-1.1%
	Output at Cell Temperature Derate	662,739.0	-0.2%
	Output After Mismatch	635,319.4	-4.1%
	Optimal DC Output	633,827.2	-0.2%
	Constrained DC Output	630,892.6	-0.5%
	Inverter Output	618,313.6	-2.0%
	Energy to Grid	**615,222.0**	**-0.5%**
Temperature Metrics			
	Avg. Operating Ambient Temp		11.1 °C
	Avg. Operating Cell Temp		17.4 °C
Simulation Metrics			
	Operating Hours		4638
	Solved Hours		4638

Condition Set

Description	Condition Set 1
Weather Dataset	TMY, 10km Grid (46.15,-123.85), NREL (prospector)
Solar Angle Location	Meteo Lat/Lng
Transposition Model	Perez Model
Temperature Model	Sandia Model

Temperature Model Parameters

Rack Type	a	b	Temperature Delta
Fixed Tilt	-3.56	-0.075	3°C
Flush Mount	-2.81	-0.0455	0°C

Soiling (%)

J	F	M	A	M	J	J	A	S	O	N	D
2	2	2	2	2	2	2	2	2	2	2	2

Irradiation Variance	5%
Cell Temperature Spread	4° C
Module Binning Range	-2.5% to 2.5%
AC System Derate	0.50%

Module Characterizations

Module	Uploaded By	Characterization
REC445AA 72 (REC)	Folsom Labs	Spec Sheet Characterization, PAN

Component Characterizations

Device	Uploaded By	Characterization

Components

Component	Name	Count
Inverters	Sunny Tripower_Core1 62-US-41 (SMA)	7 (437.5 kW)
Strings	10 AWG (Copper)	77 (12,094.4 ft)
Module	REC, REC445AA 72 (445W)	1,258 (559.8 kW)

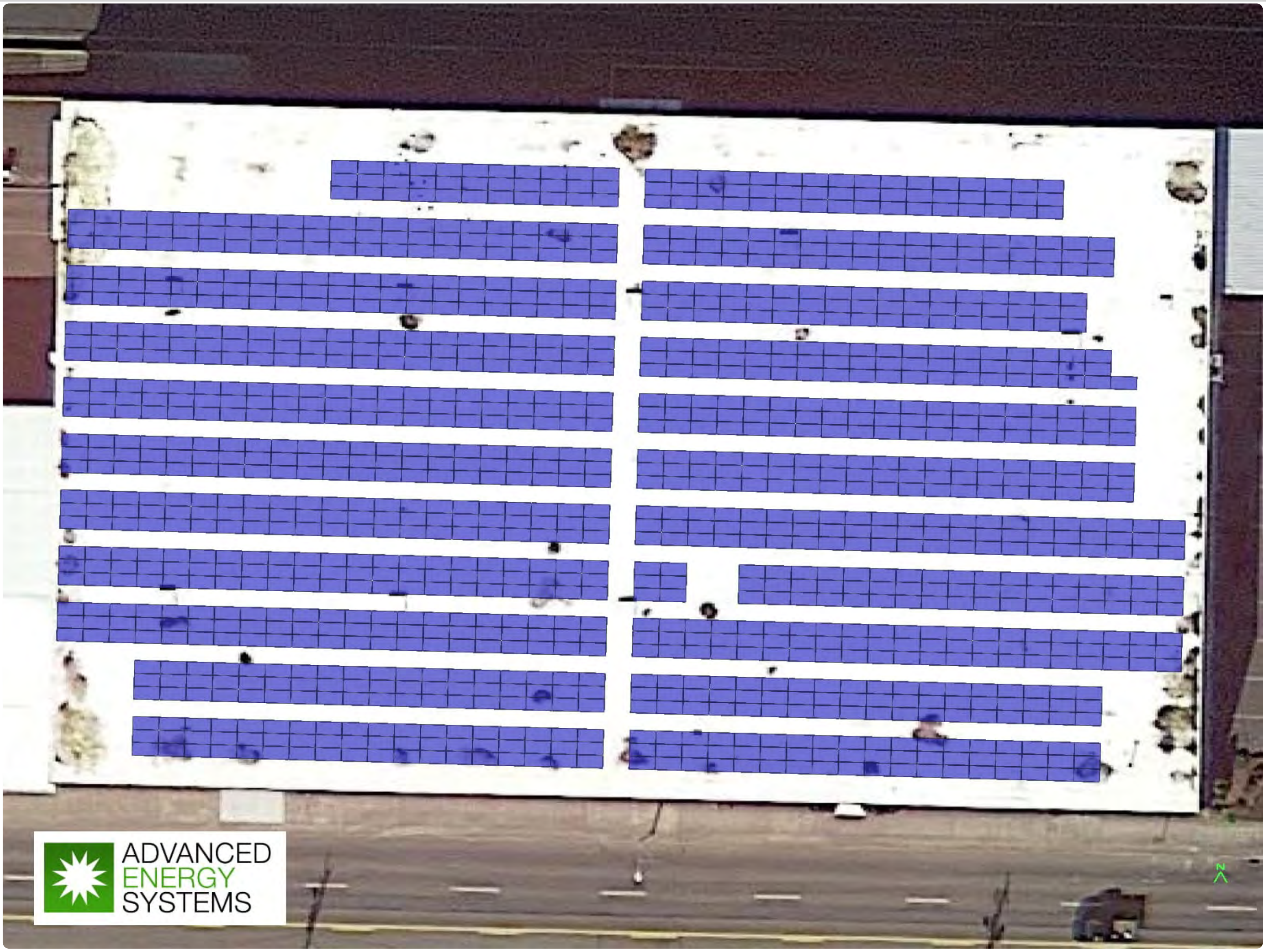
Wiring Zones

Description	Combiner Poles	String Size	Stringing Strategy
Wiring Zone	-	4-17	Along Racking

Field Segments

Description	Racking	Orientation	Tilt	Azimuth	Intrarow Spacing	Frame Size	Frames	Modules	Power
Field Segment 1	Fixed Tilt	Landscape (Horizontal)	8°	181.58595°	4.5 ft	3x1	426	1,258	559.8 kW

Detailed Layout



8 deg tilt - 560 kW USDA REAP Fort George Brewery, 70 West Marine Drive Astoria, Oregon 97103

Shading Heatmap

Shading by Field Segment

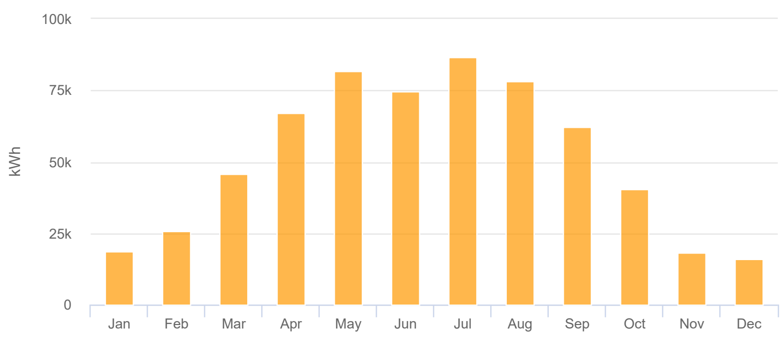
Description	Tilt	Azimuth	Modules	Nameplate	Shaded Irradiance	AC Energy	TOF[2]	Solar Access	Avg TSRF [2]
Field Segment 1	8.0°	181.6°	1,258	559.8 kWp	1,270.9kWh/m^2	615.2 MWh[1]	91.3%	99.3%	90.7%
Totals, weighted by kWp			**1,258**	**559.8 kWp**	**1,270.9kWh/m^2**	**615.2 MWh**	**91.3%**	**99.3%**	**90.7%**

[1] approximate, varies based on inverter performance
[2] based on location Optimal POA Irradiance of 1,400.6kWh/m^2 at 36.1° tilt and 188.6° azimuth

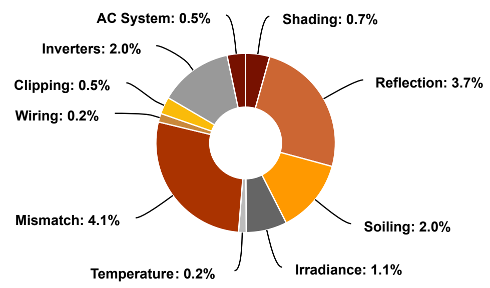
Solar Access by Month

Description	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
Field Segment 1	98%	99%	99%	99%	99%	99%	99%	100%	100%	99%	99%	98%
Solar Access, weighted by kWp	**98.2%**	**99.2%**	**99.4%**	**99.5%**	**99.5%**	**99.4%**	**99.5%**	**99.5%**	**99.5%**	**99.5%**	**98.9%**	**97.7%**
AC Power (kWh)	**18,645.9**	**25,584.8**	**45,819.8**	**67,019.7**	**81,816.1**	**74,535.6**	**86,671.7**	**78,023.2**	**62,084.4**	**40,665.7**	**18,150.2**	**16,205.0**

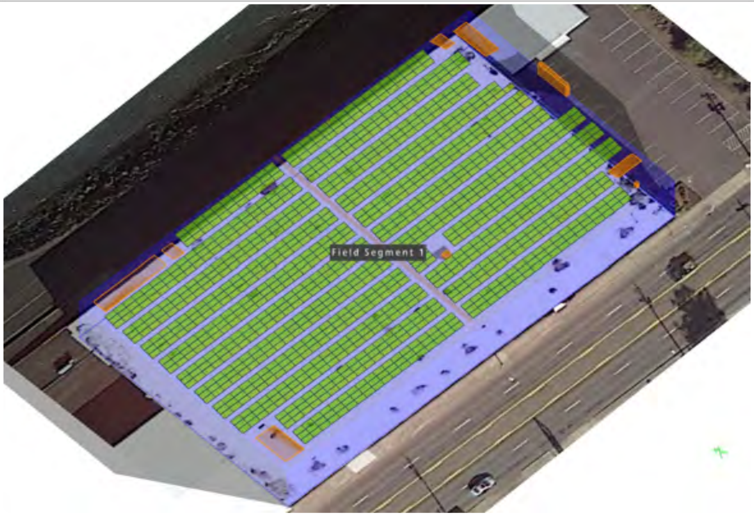
Monthly Production



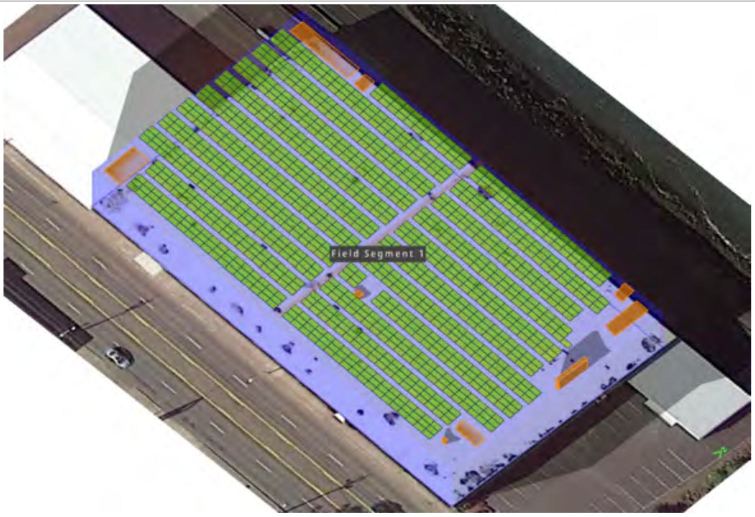
Sources of System Loss

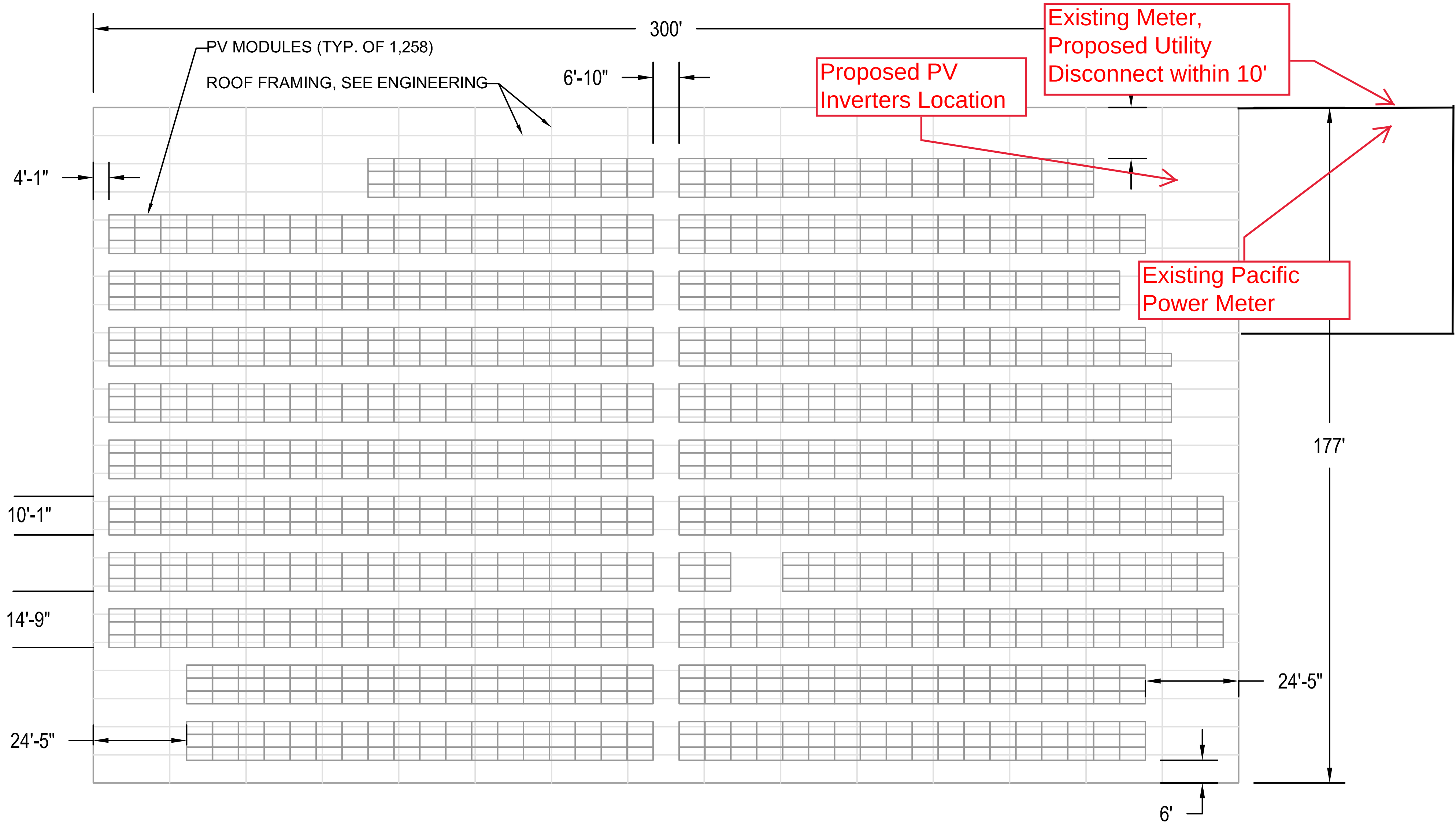


Southwestern Angle



Southeastern Angle





SYSTEM CHARACTERISTICS	
(1,258) REC 445AA Modules	
Module Tilt: 8° | Azimuth: 182°	
Tilted, Positively Attached Racking	

N

S

DRAFT #2 BY: TB
Revised 03/17/22

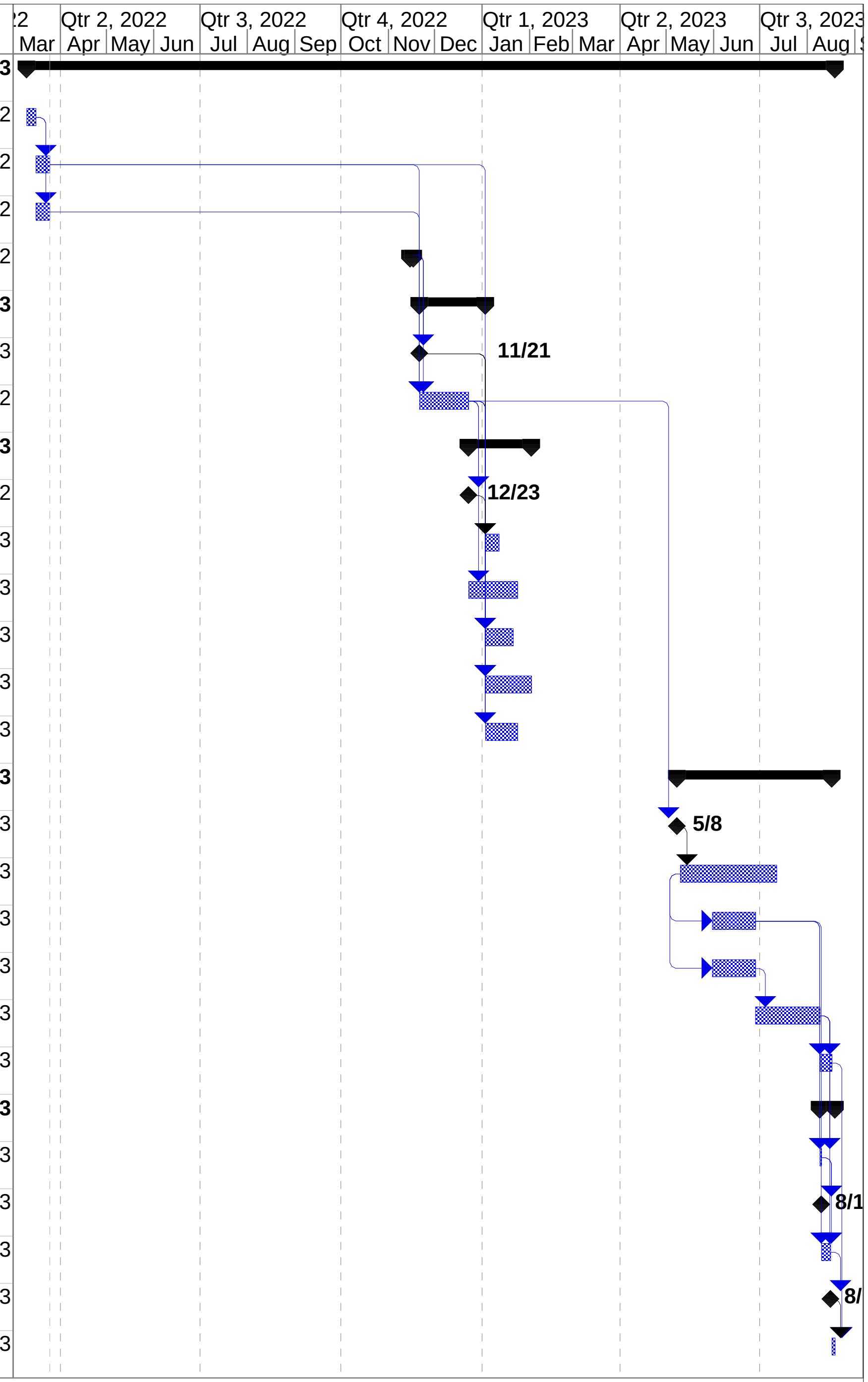
Fort George Brewery Distribution

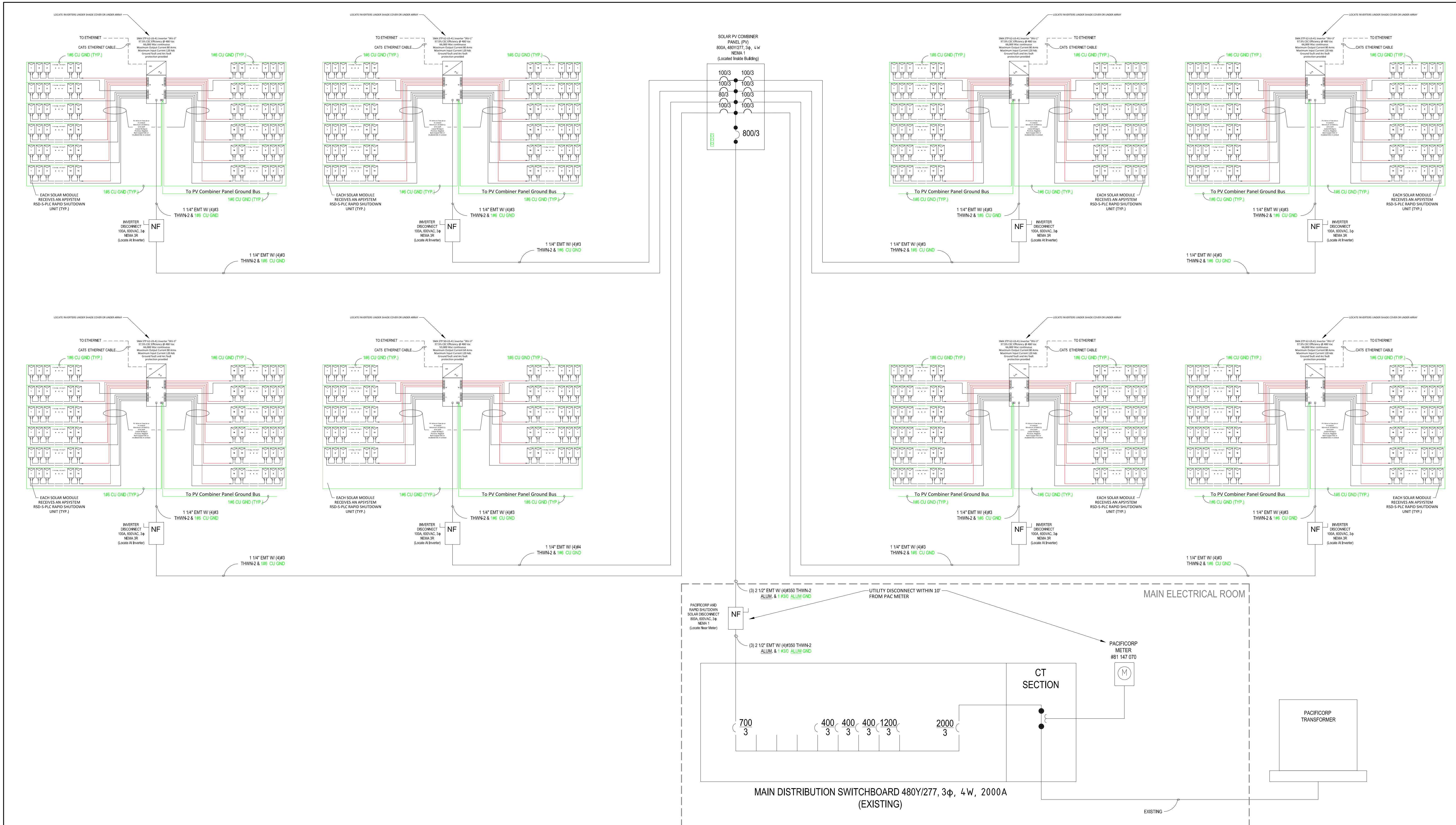
560 kW Solar Energy System
70 West Marine Drive
Astoria, Oregon 97103

This design was created using solar energy.

ADVANCED ENERGY SYSTEMS
65 Centennial Lp, Eugene OR 97401
Office (541) 683-2345
Fax (541) 683-2040
CCB# 160523
www.aesrenew.com

ID	Task Name	Duration	Start	Finish
1	**Project Duration**	**377 days?**	**Thu 3/10/22**	**Fri 8/18/23**
2	Design Contract	4 days?	Thu 3/10/22	Tue 3/15/22
3	Structural Engineering	7 days	Wed 3/16/22	Thu 3/24/22
4	Electrical Engineering	7 days	Wed 3/16/22	Thu 3/24/22
5	**Contract**	2 days	Tue 11/15/22	Wed 11/16/22
6	**Design and Permits**	**31 days**	**Mon 11/21/22**	**Mon 1/2/23**
7	Utility Interconnection	31 days	Mon 11/21/22	Mon 1/2/23
8	Permit Application / Review	24 days	Mon 11/21/22	Thu 12/22/22
9	**Equipment Procurement**	**29 days**	**Fri 12/23/22**	**Wed 2/1/23**
10	Initiate Roofing Subcontract	2 days	Fri 12/23/22	Mon 12/26/22
11	Award Subcontracts	7 days	Tue 1/3/23	Wed 1/11/23
12	Procure PV Modules	22 days	Fri 12/23/22	Mon 1/23/23
13	Procure Inverters	14 days	Tue 1/3/23	Fri 1/20/23
14	Procure Racking System	22 days	Tue 1/3/23	Wed 2/1/23
15	Procure Balance of System Electrical	15 days	Tue 1/3/23	Mon 1/23/23
16	**Installation**	**73 days?**	**Mon 5/8/23**	**Wed 8/16/23**
17	Mobilize at Site	2 days	Mon 5/8/23	Tue 5/9/23
18	Install Racking	45 days	Wed 5/10/23	Tue 7/11/23
19	Install Inverters	20 days	Wed 5/31/23	Tue 6/27/23
20	Install Rapid Shutdown Devices (RSD)	20 days?	Wed 5/31/23	Tue 6/27/23
21	Install PV Modules	30 days	Wed 6/28/23	Tue 8/8/23
22	Install Monitoring	6 days	Wed 8/9/23	Wed 8/16/23
23	**Commissioning**	**8 days**	**Wed 8/9/23**	**Fri 8/18/23**
24	Start-up/Check-out System	1 day	Wed 8/9/23	Wed 8/9/23
25	Substantial Completion	1 day	Thu 8/10/23	Thu 8/10/23
26	Final Permit Sign-off	4 days	Thu 8/10/23	Tue 8/15/23
27	Utility Final Approval	1 day	Wed 8/16/23	Wed 8/16/23
28	Owner Training, O&M Manuals	2 days	Thu 8/17/23	Fri 8/18/23





SYSTEM CHARACTERISTICS
599,810 W DC
(1258) REC445AA 72 Modules
(1) SMA STP 50-US-41 Inverter
(6) SMA STP 62-US-41 Inverters
(1258) APsystem RSD-S-PLC Shutdown Units

Version #1 - KD
Revised 03/24/22

STATE OF OREGON
KENNETH A. DENOUDEN
10/01/2022
No. 5253S
ELECTRICAL SUPERVISOR

Fort George Brewery
560kW Solar PV System
70 W. Marine Drive
Astoria, OR 97103

ADVANCED ENERGY SYSTEMS
65 Centennial Lp, Eugene OR 97401
Office (541) 683-2345
Fax (541) 683-2040
CCB# 160523
www.aesrenew.com

STRUCTURAL SOURCE, LLC

CONSULTING STRUCTURAL ENGINEERS

86705 Pine Grove Road, Eugene, OR 97402

Phone (541) 912-3958 / Fax (541) 343-3401

STRUCTURAL CALCULATIONS

FORT GEORGE BREWERY DISTRIBUTION PHOTOVOLTAIC ARRAY ANCHORAGE

70 WEST MARINE DRIVE, ASTORIA, OR

Project Number 22-107

STRUCTURAL REGISTERED PROFESSIONAL ENGINEER
78254
OREGON
MAY 16, 2006
KEVIN WILGER
RENEWS: 6/30/2022

Prepared for

ADVANCED ENERGY SYSTEMS

MARCH 24, 2022

STRUCTURAL
SOURCE, LLC
CONSULTING STRUCTURAL ENGINEERS

86705 Pine Grove Road, Eugene, OR 97402 (541) 912-3958 tructura - ource com

FORT GEORGE BREWERY DISTRIBUTION
PHOTOVOLTAIC ARRAY ANCHORAGE

70 WEST MARINE DRIVE, ASTORIA, OR

STRUCTURAL SUMMARY

A erie of ne photovo taic (PV) arra are propo ed to be attached to the roof of an exi ting ood-framed indu tria bui ding Ca cu ation and detai for anchorage of the arra to the roof are provided in thi engineering pac age Information from the origina tructura con truction document dated 5/11/60 ere u ed for the eva uation

The exi ting roof i framed ith 2X tongue and groove dec ing panning acro 4X14 pur in paced at 7 -4 on center hich are upported b g u am beam paced at 20 -0 on center The beam are configured in a three- pan arrangement There i a center ection ith a g u am beam that i upported b hinge connector at each end The t o end pan have arger g u am that canti ever into the center pan to pic up the centra g u am reaction Attached ca cu ation confirm that the exi ting framing i be acceptab e to upport the additiona oading from the propo ed PV arra A o ab e tre e for the roof framing member ere cho en from the 1958 edition of the Uniform Bui ding Code Excerpt from thi code are inc uded i thi ca cu ation pac age

The PV arra i upported b a rac ing tem ith component manufactured b Sunmodo pecifica for thi purpo e Thi tem uti i e a erie for braced frame paced at 6 -0 on center ith vertica anding direct on top of the 4X14 pur in Hori onta tee pipe beam pan from braced frame to braced frame A uminum rai are attached to the top of the pipe beam and the PV pane are c amped to the e rai Diagona brace are a o in ta ed para e to the pipe beam for atera tabi it The vertica of the tem are tee pipe a o ith prefabricated ba e p ate The e ba e p ate are ag bo ted direct into the top of the pur in for up ift re i tance See attached ca cu ation , and anchorage detai for additiona information

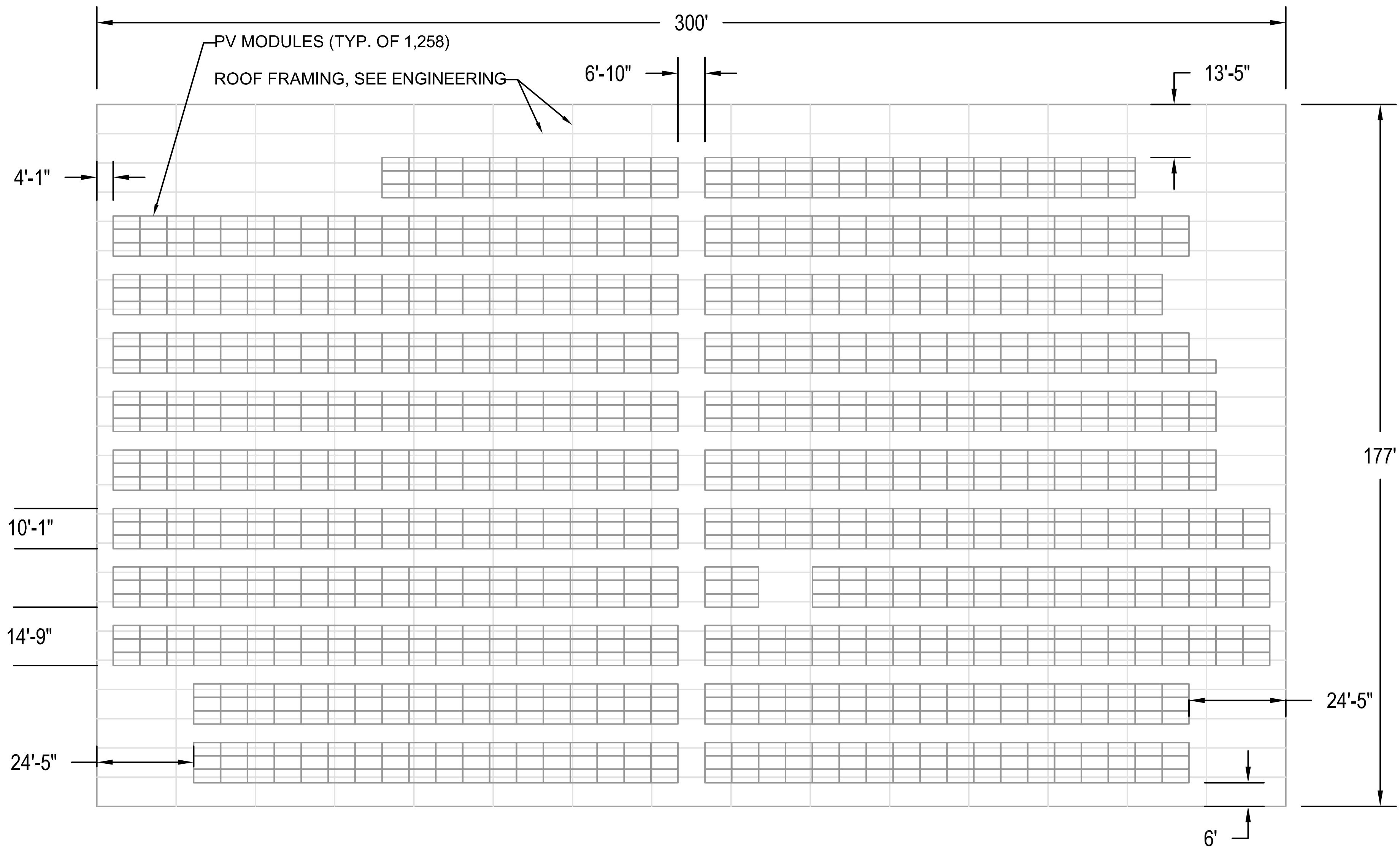
A ide from the engineering item mentioned above, no further revie of the exi ting bui ding tructure ha been performed b Structura Source at thi time

Regard ,

Kevin Wilger

evin Wi ger, S E

Principa
Structura Source, LLC



SYSTEM CHARACTERISTICS	
(1,258) REC 445AA Modules	
Module Tilt: 8° | Azimuth: 182°	
Tilted, Positively Attached Racking	

N
S

DRAFT #2 BY: TB
Revised 03/17/22

Fort George Brewery Distribution

560 kW Solar Energy System
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This design was created using solar energy.

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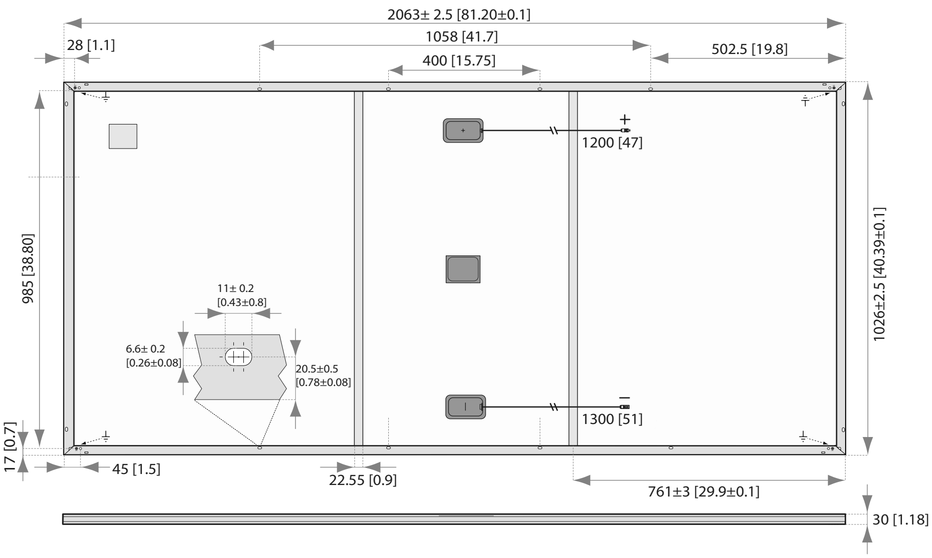
PRODUCT DATASHEET



Measurements in mm [in]

GENERAL DATA

Cell type:	144 half-cut cells with REC heterojunction cell technology 6 strings of 24 cells in series	Connectors:	Stäubli MC4 Evo 2 PV-KBT4-EVO-2/PV-KST4-EVO-2 (4 mm²) in accordance with IEC 62852 IP68 only when connected
Glass:	0.13 in (3.2 mm) solar glass with anti-reflection surface treatment	Cable:	12 AWG (4 mm²) PV wire, 47 + 51 in (1.2 + 1.3 m) in accordance with EN 50618
Backsheet:	Highly resistant polymeric construction	Dimensions:	81.2 x 40.39 x 1.18 in (2063 x 1026 x 30 mm) 22.7 sq ft (2,12 m²)
Frame:	Anodized aluminum	Weight:	52 lbs (23,5 kg)
Junction box:	3-part, 3 bypass diodes, IP67 rated in accordance with IEC 62790	Origin:	Made in Singapore

ELECTRICAL DATA

Product Code*: RECxxxAA 72

STC	Power Output - P_{MAX} (Wp)	430	435	440	445	450
	Watt Class Sorting - (W)	-0/+5	-0/+5	-0/+5	-0/+5	-0/+5
	Nominal Power Voltage - V_{MPP} (V)	44.1	44.5	44.8	45.3	45.6
	Nominal Power Current - I_{MPP} (A)	9.76	9.79	9.84	9.85	9.88
	Open Circuit Voltage - V_{OC} (V)	52.6	52.8	52.9	53.0	53.1
	Short Circuit Current - I_{SC} (A)	10.46	10.50	10.52	10.54	10.55
	Power Density (W/sq ft)	203.79	206.16	208.53	210.90	213.27
	Panel Efficiency (%)	20.3	20.6	20.8	21.0	21.3
NMOT	Power Output - P_{MAX} (Wp)	328	332	336	339	343
	Nominal Power Voltage - V_{MPP} (V)	41.6	41.9	42.2	42.7	43.0
	Nominal Power Current - I_{MPP} (A)	7.88	7.91	7.95	7.95	7.98
	Open Circuit Voltage - V_{OC} (V)	49.6	49.8	49.8	49.9	50.0
	Short Circuit Current - I_{SC} (A)	8.45	8.48	8.50	8.51	8.52

Values at standard test conditions (STC: air mass AM 1.5, irradiance 10.75 W/sq ft (1000 W/m²), temperature 77°F (25°C), based on a production spread with a tolerance of P_{MAX}, V_{OC} & I_{SC} ±3% within one watt class.
Nominal module operating temperature (NMOT: air mass AM 1.5, irradiance 800 W/m², temperature 68°F (20°C), windspeed 3.3 ft/s (1 m/s).
*Where xxx indicates the nominal power class (P_{MAX}) at STC above and is followed by the suffix XV for 1500V rated modules.

CERTIFICATIONS

IEC 61215:2016, IEC 61730:2016, UL 61730	
IEC 62804	PID
IEC 61701	Salt Mist
IEC 62716	Ammonia Resistance
UL 1703	Fire Type Class 2
IEC 62782	Dynamic Mechanical Load
IEC 61215-2:2016	Hailstone (35mm)
AS4040.2 NCC 2016	Cyclic Wind Load
ISO 14001:2004, ISO 9001:2015, OHSAS 18001:2007, IEC 62941	

WARRANTY

	Standard	REC ProTrust	
Installed by an REC Certified Solar Professional	No	Yes	Yes
System Size	All	≤25 kW	25-500 kW
Product Warranty (yrs)	20	25	25
Power Warranty (yrs)	25	25	25
Labor Warranty (yrs)	0	25	10
Power in Year 1	98%	98%	98%
Annual Degradation	0.25%	0.25%	0.25%
Power in Year 25	92%	92%	92%

See warranty documents for details. Conditions apply.

MAXIMUM RATINGS

Operational temperature:	-40 ... +85°C
Maximum system voltage:	1500 V
Design load (+): snow Maximum test load (+):	3600 Pa (75.2 lbs/sq ft)* 5400 Pa (112.8 lbs/sq ft)*
Design load (-): wind Maximum test load (-):	1600 Pa (33.4 lbs/sq ft)* 2400 Pa (50.1 lbs/sq ft)*
Max series fuse rating:	25 A
Max reverse current:	25 A

* Calculated using a safety factor of 1.5
* See installation manual for mounting instructions

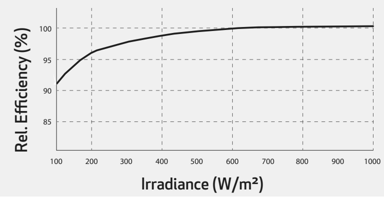
TEMPERATURE RATINGS*

Nominal Module Operating Temperature:	44°C (±2°C)
Temperature coefficient of P_{MAX}:	-0.26 %/°C
Temperature coefficient of V_{OC}:	-0.24 %/°C
Temperature coefficient of I_{SC}:	0.04 %/°C

*The temperature coefficients stated are linear values

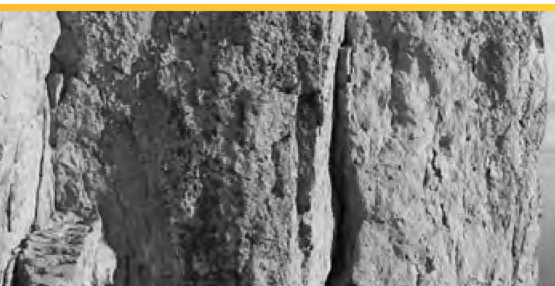
LOW LIGHT BEHAVIOUR

Typical low irradiance performance of module at STC:



Specifications subject to change without notice.

Ref: PM-DS-12-03-Rev- B 08.20



REC Group is an international pioneering solar energy company dedicated to empowering consumers with clean, affordable solar power in order to facilitate global energy transitions. Committed to quality and innovation, REC offers photovoltaic modules with leading high quality, backed by an exceptional low warranty claims rate of less than 100ppm. Founded in Norway in 1996, REC employs 2,000 people and has an annual solar panel capacity of 1.8 GW. With over 10 GW installed worldwide, REC is empowering more than 16 million people with clean solar energy. REC Group is a Bluestar Elkem company with headquarters in Norway, operational headquarters in Singapore, and regional bases in North America, Europe, and Asia-Pacific.

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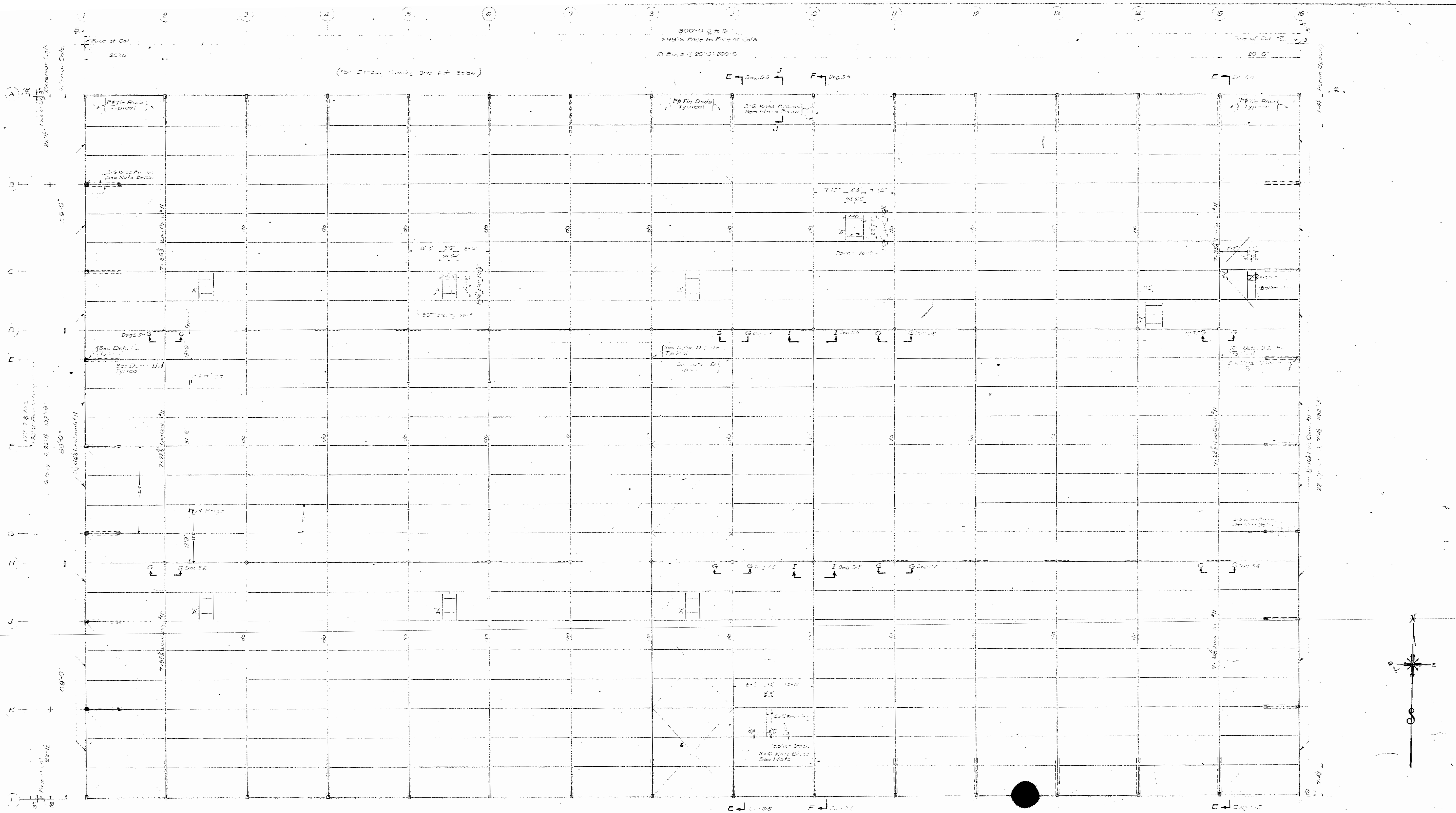


ROOF PLAN

NOTE: All Purlins to be 4×14 – Select Struct. Grade Unless Otherwise Noted.
Deck to be 2" Tongue and Groove Construction Grade Planking, laid perpendicular to purlins, ends to bear on purlins.

NOTE:
For Sections see Drawing S-5.
For Elevations and Additional Sections see Drawing S-6.
ROOF LIVE LOAD – 25#/□'.
For Vert. Curt. ... Framing See Dwg. S-2.
WIND LOAD – 25#/□'.

COMPONENTS AND CLADDING ROOF WIND LOADS
MONOSLOPE FREE ROOF

Per ASCE 7-16 Chapters 26, 29, and 30

qh = Velocity Pressure at Height H
= 0.00256 Kz Kzt Kd Ke V²

h =	35.0	(feet) Average Height at Rooftop Array
Kz =	1.18	for 30 to 35 ft Array Height and Exposure D (ASCE7-16 Table 26.10-1)
Kzt =	1.00	for Level Terrain
Kd =	0.85	for Components and Cladding of Buildings (ASCE7-16 Table 26.6-1)
Ke =	1.00	Ground Elevation Factor for elevation < 1,000 feet
V =	120	Basic Wind Speed (mph) from OSSC for Clatsop County Category II Bldg Special Wind Region per OSSC Table 1609.3
L =	142.0	(feet) Longest Horizontal Roof Dimension
W =	10.1	(feet) Least Horizontal Roof Dimension

Monoslope free roof w/ 8 degree slope, so use ASCE 7-16 Figure 30.7-1
For 10'-1 1/2" wide array with 6'-0" veritcal spacing:
Effective Wind Area = 10.1' (0.5) 6.0' = 30.3 sq. ft.which is > a² and < 4a²

Zonal Dim. "a" = smaller of 10% of least horiz. dim. or 40% of roof height,
= 1.01 feet, but not less than larger of 4% of least horiz. dim. or 3 feet
= 3.00 feet
Therefore "a" = 3.00 feet

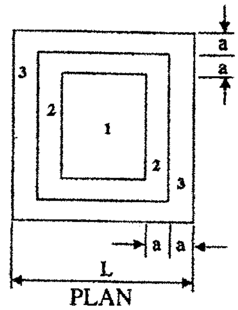
Pult = qh G Cp

G Cp =	-1.40	Neg. External Pressure Coefficient for Zone 1
	-2.10	Neg. External Pressure Coefficient for Zone 2
	-2.10	Neg. External Pressure Coefficient for Zone 3
G Cp =	1.60	Pos. External Pressure Coefficient for Zone 1
	2.40	Pos. External Pressure Coefficient for Zone 2
	2.40	Pos. External Pressure Coefficient for Zone 3

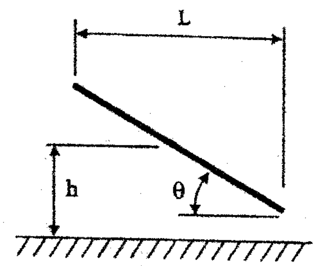
Zone 1 Negative Design Wind Pressure
Pult = -51.8 psf
Zone 2 Negative Design Wind Pressure
Pult = -77.6 psf
Zone 3 Negative Design Wind Pressure
Pult = -77.6 psf

Zone 1 Positive Design Wind Pressure
Pult = 59.2 psf
Zone 2 Positive Design Wind Pressure
Pult = 88.7 psf
Zone 3 Positive Design Wind Pressure
Pult = 88.7 psf

Diagrams



PLAN



ELEVATION

Notation

a = 10% of least horizontal dimension or $0.4h$, whichever is smaller but not less than 4% of least horizontal dimension or 3 ft (0.9 m).
h = Mean roof height, in ft (m).
L = Horizontal dimension of building, measured in along-wind direction, in ft (m).
θ = Angle of plane of roof from horizontal, in degrees.

Net Pressure Coefficients, C_N

Roof Angle, θ	Effective Wind Area	Clear Wind Flow					
		Zone 3		Zone 2		Zone 1	
0°	$\leq a^2$	2.4	−3.3	1.8	−1.7	1.2	−1.1
	$> a^2, \leq 4.0a^2$	1.8	−1.7	1.8	−1.7	1.2	−1.1
	$> 4.0a^2$	1.2	−1.1	1.2	−1.1	1.2	−1.1
7.5°	$\leq a^2$	3.2	−4.2	2.4	−2.1	1.6	−1.4
	$> a^2, \leq 4.0a^2$	2.4	−2.1	2.4	−2.1	1.6	−1.4
	$> 4.0a^2$	1.6	−1.4	1.6	−1.4	1.6	−1.4
15°	$\leq a^2$	3.6	−3.8	2.7	−2.9	1.8	−1.9
	$> a^2, \leq 4.0a^2$	2.7	−2.9	2.7	−2.9	1.8	−1.9
	$> 4.0a^2$	1.8	−1.9	1.8	−1.9	1.8	−1.9
30°	$\leq a^2$	5.2	−5	3.9	−3.8	2.6	−2.5
	$> a^2, \leq 4.0a^2$	3.9	−3.8	3.9	−3.8	2.6	−2.5
	$> 4.0a^2$	2.6	−2.5	2.6	−2.5	2.6	−2.5
45°	$\leq a^2$	5.2	−4.6	3.9	−3.5	2.6	−2.3
	$> a^2, \leq 4.0a^2$	3.9	−3.5	3.9	−3.5	2.6	−2.3
	$> 4.0a^2$	2.6	−2.3	2.6	−2.3	2.6	−2.3
		Obstructed Wind Flow					
		Zone 3		Zone 2		Zone 1	
0°	$\leq a^2$	1	−3.6	0.8	−1.8	0.5	−1.2
	$> a^2, \leq 4.0a^2$	0.8	−1.8	0.8	−1.8	0.5	−1.2
	$> 4.0a^2$	0.5	−1.2	0.5	−1.2	0.5	−1.2
7.5°	$\leq a^2$	1.6	−5.1	1.2	−2.6	0.8	−1.7
	$> a^2, \leq 4.0a^2$	1.2	−2.6	1.2	−2.6	0.8	−1.7
	$> 4.0a^2$	0.8	−1.7	0.8	−1.7	0.8	−1.7
15°	$\leq a^2$	2.4	−4.2	1.8	−3.2	1.2	−2.1
	$> a^2, \leq 4.0a^2$	1.8	−3.2	1.8	−3.2	1.2	−2.1
	$> 4.0a^2$	1.2	−2.1	1.2	−2.1	1.2	−2.1
30°	$\leq a^2$	3.2	−4.6	2.4	−3.5	1.6	−2.3
	$> a^2, \leq 4.0a^2$	2.4	−3.5	2.4	−3.5	1.6	−2.3
	$> 4.0a^2$	1.6	−2.3	1.6	−2.3	1.6	−2.3
45°	$\leq a^2$	4.2	−3.8	3.2	−2.9	2.1	−1.9
	$> a^2, \leq 4.0a^2$	3.2	−2.9	3.2	−2.9	2.1	−1.9
	$> 4.0a^2$	2.1	−1.9	2.1	−1.9	2.1	−1.9

Notes

1. C_N denotes net pressures (contributions from top and bottom surfaces).
2. Clear wind flow denotes relatively unobstructed wind flow with blockage less than or equal to 50%. Obstructed wind flow denotes objects below roof inhibiting wind flow (>50% blockage).
3. For values of θ other than those shown, linear interpolation is permitted.
4. Plus and minus signs signify pressures acting toward and away from the top roof surface, respectively.
5. Components and cladding elements shall be designed for positive and negative pressure coefficients shown.

FIGURE 30.7-1 Components and Cladding ($0.25 \leq h/L \leq 1.0$): Net Pressure Coefficient, C_N, for Open Buildings—Monoslope Free Roofs, $\theta \leq 45°$

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General Beam

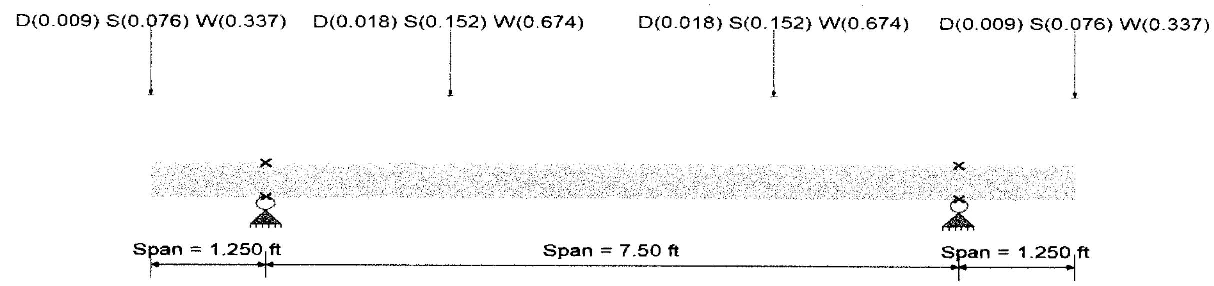
File: Fort George PV.ec6

Lic. # : KW-06009704
Structural Source, LLC

DESCRIPTION: typ. aluminum rail with 3 rails per column of modules

General Beam Properties

Elastic Modulus	10,000.0 ksi					
Span #1	Span Length =	1.250 ft	Area =	10.0 in^2	Moment of Inertia =	0.7270 in^4
Span #2	Span Length =	7.50 ft	Area =	10.0 in^2	Moment of Inertia =	0.7270 in^4
Span #3	Span Length =	1.250 ft	Area =	10.0 in^2	Moment of Inertia =	0.7270 in^4



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Load(s) for Span Number 1
Point Load : D = 0.0090, S = 0.0760, W = 0.3370 k @ 0.0 ft, (point load from PV panel)

Load(s) for Span Number 2
Point Load : D = 0.0180, S = 0.1520, W = 0.6740 k @ 2.0 ft, (point load from PV panel)

Point Load : D = 0.0180, S = 0.1520, W = 0.6740 k @ 5.50 ft, (point load from PV panel)

Load(s) for Span Number 3
Point Load : D = 0.0090, S = 0.0760, W = 0.3370 k @ 1.250 ft, (point load from PV panel)

DESIGN SUMMARY

Maximum Bending =	0.599 k-ft	Maximum Shear =	0.4353 k
Load Combination	+D+0.750L+0.750S+0.450W+H	Load Combination	+D+0.750L+0.750S+0.450W+H
Span # where maximum occurs	Span # 2	Span # where maximum occurs	Span # 1
Location of maximum on span	3.797 ft	Location of maximum on span	1.250 ft

Maximum Deflection

Max Downward Transient Deflection	0.816 in	110
Max Upward Transient Deflection	-0.348 in	86
Max Downward Total Deflection	0.878 in	102
Max Upward Total Deflection	-0.374 in	80

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values (k-ft)							Shear Values (k)		
Segment Length	Span #	M	V	Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 1.25 ft	1				-0.27	0.27					0.44		
Dsgn. L = 7.50 ft	2			0.60	-0.27	0.60					0.44		
Dsgn. L = 1.25 ft	3				-0.27	0.27					0.22		
+D+H													
Dsgn. L = 1.25 ft	1				-0.01	0.01					0.02		
Dsgn. L = 7.50 ft	2			0.02	-0.01	0.02					0.02		
Dsgn. L = 1.25 ft	3				-0.01	0.01					0.01		
+D+L+H													
Dsgn. L = 1.25 ft	1				-0.01	0.01					0.02		
Dsgn. L = 7.50 ft	2			0.02	-0.01	0.02					0.02		
Dsgn. L = 1.25 ft	3				-0.01	0.01					0.01		
+D+Lr+H													
Dsgn. L = 1.25 ft	1				-0.01	0.01					0.02		
Dsgn. L = 7.50 ft	2			0.02	-0.01	0.02					0.02		
Dsgn. L = 1.25 ft	3				-0.01	0.01					0.01		
+D+S+H													
Dsgn. L = 1.25 ft	1				-0.11	0.11					0.17		
Dsgn. L = 7.50 ft	2			0.23	-0.11	0.23					0.17		

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General Beam

File: Fort George PV.ec6

Lic. # : KW-06009704
Structural Source, LLC

DESCRIPTION: typ. aluminum rail with 3 rails per column of modules

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	Summary of Moment Values (k-ft) Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Shear Values (k) Va Max	Vnx	Vnx/Omega
Dsgn. L = 1.25 ft	3				-0.11	0.11					0.08		
+D+0.750Lr+0.750L+H													
Dsgn. L = 1.25 ft	1				-0.01	0.01					0.02		
Dsgn. L = 7.50 ft	2			0.02	-0.01	0.02					0.02		
Dsgn. L = 1.25 ft	3				-0.01	0.01					0.01		
+D+0.750L+0.750S+H													
Dsgn. L = 1.25 ft	1				-0.08	0.08					0.13		
Dsgn. L = 7.50 ft	2			0.18	-0.08	0.18					0.13		
Dsgn. L = 1.25 ft	3				-0.08	0.08					0.07		
+D+0.60W+H													
Dsgn. L = 1.25 ft	1				-0.26	0.26					0.42		
Dsgn. L = 7.50 ft	2			0.58	-0.26	0.58					0.42		
Dsgn. L = 1.25 ft	3				-0.26	0.26					0.21		
+D+0.750Lr+0.750L+0.450W+H													
Dsgn. L = 1.25 ft	1				-0.20	0.20					0.32		
Dsgn. L = 7.50 ft	2			0.44	-0.20	0.44					0.32		
Dsgn. L = 1.25 ft	3				-0.20	0.20					0.16		
+D+0.750L+0.750S+0.450W+H													
Dsgn. L = 1.25 ft	1				-0.27	0.27					0.44		
Dsgn. L = 7.50 ft	2			0.60	-0.27	0.60					0.44		
Dsgn. L = 1.25 ft	3				-0.27	0.27					0.22		
+0.60D+0.60W+0.60H													
Dsgn. L = 1.25 ft	1				-0.26	0.26					0.42		
Dsgn. L = 7.50 ft	2			0.57	-0.26	0.57					0.42		
Dsgn. L = 1.25 ft	3				-0.26	0.26					0.21		
+D+0.70E+0.60H													
Dsgn. L = 1.25 ft	1				-0.01	0.01					0.02		
Dsgn. L = 7.50 ft	2			0.02	-0.01	0.02					0.02		
Dsgn. L = 1.25 ft	3				-0.01	0.01					0.01		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 1.25 ft	1				-0.08	0.08					0.13		
Dsgn. L = 7.50 ft	2			0.18	-0.08	0.18					0.13		
Dsgn. L = 1.25 ft	3				-0.08	0.08					0.07		
+0.60D+0.70E+H													
Dsgn. L = 1.25 ft	1				-0.01	0.01					0.01		
Dsgn. L = 7.50 ft	2			0.01	-0.01	0.01					0.01		
Dsgn. L = 1.25 ft	3				-0.01	0.01					0.01		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
	1	0.0000	0.000	+D+0.750L+0.750S+0.450W+H	-0.3742	0.000
+D+0.750L+0.750S+0.450W+H	2	0.8779	3.797		0.0000	0.000
	3	0.0000	3.797	+D+0.750L+0.750S+0.450W+H	-0.3748	1.250

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2	Support 3	Support 4
Overall MAXimum		1.011	1.011	
Overall MINimum				
+D+H		0.027	0.027	
+D+L+H		0.027	0.027	
+D+Lr+H		0.027	0.027	
+D+S+H		0.255	0.255	
+D+0.750Lr+0.750L+H		0.027	0.027	
+D+0.750L+0.750S+H		0.198	0.198	
+D+0.60W+H		0.634	0.634	
+D+0.750Lr+0.750L+0.450W+H		0.482	0.482	
+D+0.750L+0.750S+0.450W+H		0.653	0.653	
+0.60D+0.60W+0.60H		0.623	0.623	
+D+0.70E+0.60H		0.027	0.027	
+D+0.750L+0.750S+0.5250E+H		0.198	0.198	
+0.60D+0.70E+H		0.016	0.016	
D Only		0.027	0.027	
Lr Only				
L Only				
S Only		0.228	0.228	
W Only		1.011	1.011	
E Only				

General Beam

DESCRIPTION: typ. aluminum rail with 3 rails per column of modules

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2	Support 3	Support 4
H Only				

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General Section Property Calculator

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Lic. # : KW-06009704 | Structural Source, LLC

DESCRIPTION: 2 1/2" diameter 10S pipe section

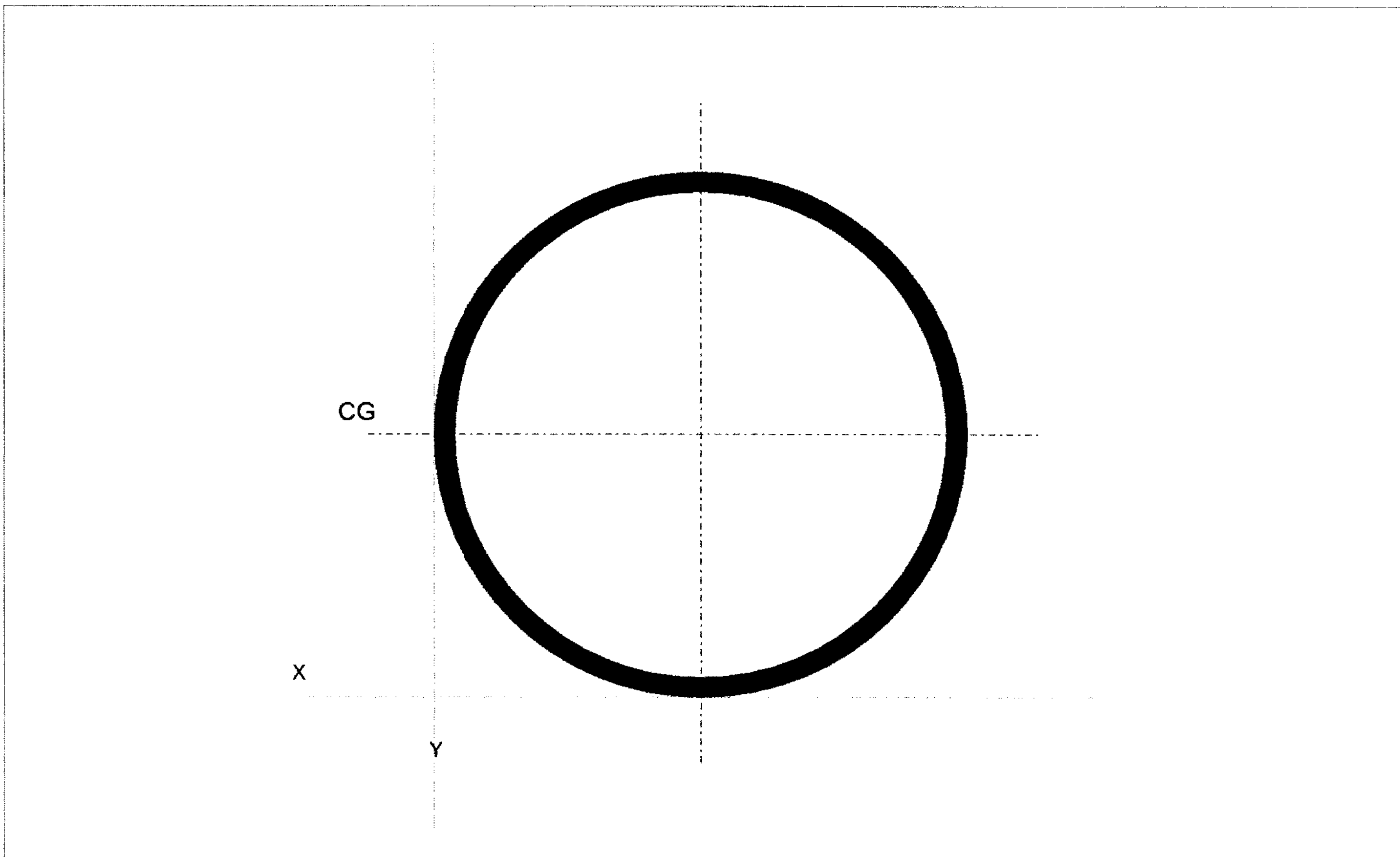
Final Section Properties

Total Area	:	1.039 in^2	Ixx	:	0.9883 in^4	Sxx : - Y	:	0.6879 in^3
			Iyy	:	0.9883 in^4	Sxx : +Y	:	0.6879 in^3
Calculated final C.G. distance from Datum :								
X cg Dist.	:	1.438 in	Zxx	:	0.9120 in^3	Syy : - X	:	0.6873 in^3
Y cg Dist.	:	1.438 in	Zyy	:	0.9120 in^3	Syy : +X	:	0.6873 in^3
Edge Distances from CG. :						r xx	:	0.9753 in
+X	:	1.438 in	+Y	:	1.437 in	r yy	:	0.9753 in
-X	:	-1.438 in	-Y	:	-1.437 in			

Rotation of All Components @ Angle : 0.00 deg CCW

Minumim Section Properties

Rotation Angle (CCW)	-0.120	deg CCW	I: Moment of Inertia	0.9883 in^4
r: Radius of Gyration	0.9753	in	S: Modulus	0.6879 in^3
			Z: Plastic Modulus	0.9120 in^3



Rectangular & Circular Shapes

Circular Shape : 1	Radius =	1.438 in	Thickness	0.120 in
	Area =	6.496 in^2	Xcg =	1.438 in
			Ycg =	1.438 in

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Steel Beam

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Lic. # : KW-06009704
Structural Source, LLC

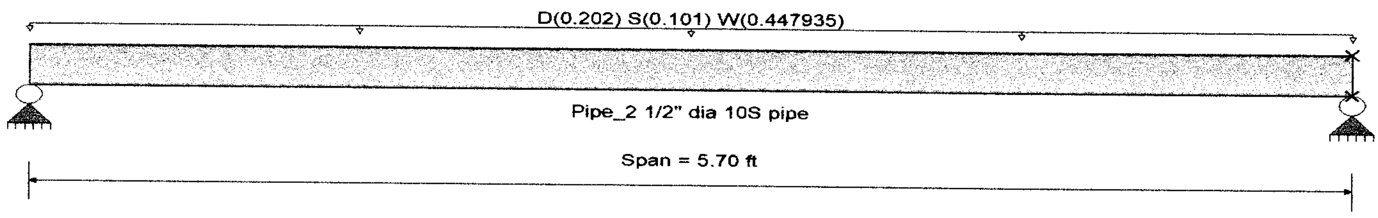
DESCRIPTION: typical pipe beam for racking system

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-16

Material Properties

Analysis Method :	Allowable Strength Design	Fy : Steel Yield :	50.0 ksi
Beam Bracing :	Beam is Fully Braced against lateral-torsional buckling	E: Modulus :	29,000.0 ksi
Bending Axis :	Major Axis Bending		



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loading
Uniform Load : D = 0.040, S = 0.020, W = 0.08870 ksf, Tributary Width = 5.050 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.862 : 1	Maximum Shear Stress Ratio =	0.148 : 1
Section used for this span	Pipe_2 1/2" dia 10S	Section used for this span	Pipe_2 1/2" dia 10S
Ma : Applied	1.962 k-ft	Va : Applied	1.377 k
Mn / Omega : Allowable	2.275 k-ft	Vn/Omega : Allowable	9.332 k
Load Combination	+D+0.750S+0.450W	Load Combination	+D+0.750S+0.450W
Location of maximum on span	2.850ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.372 in	Ratio =	183 >=180.
Max Upward Transient Deflection	0.000 in	Ratio =	0 <180.0
Max Downward Total Deflection	0.402 in	Ratio =	170 >=120.
Max Upward Total Deflection	0.000 in	Ratio =	0 <120.0

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values							Summary of Shear Values		
Segment Length	Span #	M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
D Only													
Dsgn. L = 5.70 ft	1	0.367	0.063	0.84		0.84	3.80	2.28	1.00	1.00	0.59	15.59	9.33
+D+S													
Dsgn. L = 5.70 ft	1	0.548	0.094	1.25		1.25	3.80	2.28	1.00	1.00	0.87	15.59	9.33
+D+0.750S													
Dsgn. L = 5.70 ft	1	0.503	0.086	1.14		1.14	3.80	2.28	1.00	1.00	0.80	15.59	9.33
+D+0.60W													
Dsgn. L = 5.70 ft	1	0.847	0.145	1.93		1.93	3.80	2.28	1.00	1.00	1.35	15.59	9.33
+D+0.450W													
Dsgn. L = 5.70 ft	1	0.727	0.124	1.65		1.65	3.80	2.28	1.00	1.00	1.16	15.59	9.33
+D+0.750S+0.450W													
Dsgn. L = 5.70 ft	1	0.862	0.148	1.96		1.96	3.80	2.28	1.00	1.00	1.38	15.59	9.33
+0.60D+0.60W													
Dsgn. L = 5.70 ft	1	0.700	0.120	1.59		1.59	3.80	2.28	1.00	1.00	1.12	15.59	9.33
+0.60D													
Dsgn. L = 5.70 ft	1	0.220	0.038	0.50		0.50	3.80	2.28	1.00	1.00	0.35	15.59	9.33

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750S+0.450W	1	0.4022	2.866		0.0000	0.000

Steel Beam

DESCRIPTION: typical pipe beam for racking system

Vertical Reactions

Support notation : Far left is #1

Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	1.377	1.377
Overall MINimum	0.288	0.288
D Only	0.587	0.587
+D+S	0.874	0.874
+D+0.750S	0.802	0.802
+D+0.60W	1.352	1.352
+D+0.450W	1.161	1.161
+D+0.750S+0.450W	1.377	1.377
+0.60D+0.60W	1.118	1.118
+0.60D	0.352	0.352
S Only	0.288	0.288
W Only	1.277	1.277

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Project ID:
Project Descr:

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Wood Beam

File: Fort George PV.ec6
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Lic. # : KW-06009704 | Structural Source, LLC

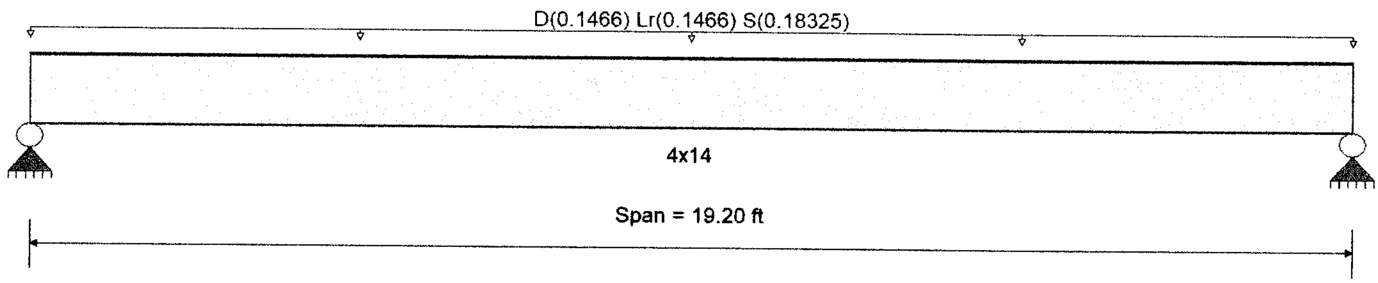
DESCRIPTION: typical 4x14 purlin

CODE REFERENCES

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-10

Material Properties

Analysis Method :	Allowable Stress Design	Fb +	1,575.0 psi	*E : Modulus of Elasticity*	
Load Combination	ASCE 7-10	Fb -	1,575.0 psi	Ebend- xx	1,600.0 ksi
		Fc - Prll	1,700.0 psi	Eminbend - xx	690.0 ksi
Wood Species	: Douglas Fir-Larch	Fc - Perp	625.0 psi		
Wood Grade	: Select Structural circa 1958	Fv	180.0 psi		
		Ft	1,000.0 psi	Density	31.210 pcf
Beam Bracing	: Beam is Fully Braced against lateral-torsional buckling				



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : D = 0.020, Lr = 0.020, S = 0.0250 ksf, Tributary Width = 7.330 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	**0.983: 1**	Maximum Shear Stress Ratio	=	**0.441 : 1**
Section used for this span		**4x14**	Section used for this span		**4x14**
	=	1,780.99psi		=	91.21 psi
	=	1,811.25psi		=	207.00 psi
Load Combination		+D+S+H	Load Combination		+D+S+H
Location of maximum on span	=	9.600ft	Location of maximum on span	=	18.149 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.519 in	Ratio =	443 >=360
Max Upward Transient Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.934 in	Ratio =	246 >=240
Max Upward Total Deflection	0.000 in	Ratio =	0 <240

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
+D+H													0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.558	0.250	0.90	1.000	1.00	1.00	1.00	1.00	1.00	6.76	791.55	1417.50	1.25	40.54	162.00
+D+L+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.503	0.225	1.00	1.000	1.00	1.00	1.00	1.00	1.00	6.76	791.55	1575.00	1.25	40.54	180.00
+D+Lr+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.804	0.360	1.25	1.000	1.00	1.00	1.00	1.00	1.00	13.51	1,583.10	1968.75	2.51	81.07	225.00
+D+S+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.983	0.441	1.15	1.000	1.00	1.00	1.00	1.00	1.00	15.20	1,780.99	1811.25	2.82	91.21	207.00
+D+0.750Lr+0.750L+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.704	0.315	1.25	1.000	1.00	1.00	1.00	1.00	1.00	11.82	1,385.21	1968.75	2.19	70.94	225.00
+D+0.750L+0.750S+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.847	0.379	1.15	1.000	1.00	1.00	1.00	1.00	1.00	13.09	1,533.63	1811.25	2.43	78.54	207.00
+D+0.60W+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.314	0.141	1.60	1.000	1.00	1.00	1.00	1.00	1.00	6.76	791.55	2520.00	1.25	40.54	288.00

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Wood Beam

File: Fort George PV.ec6

Lic. # : KW-06009704
Structural Source, LLC

DESCRIPTION: typical 4x14 purlin

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
+D+0.70E+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.314	0.141	1.60	1.000	1.00	1.00	1.00	1.00	1.00	6.76	791.55	2520.00	1.25	40.54	288.00
+D+0.750Lr+0.750L+0.450W+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.550	0.246	1.60	1.000	1.00	1.00	1.00	1.00	1.00	11.82	1,385.21	2520.00	2.19	70.94	288.00
+D+0.750L+0.750S+0.450W+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.609	0.273	1.60	1.000	1.00	1.00	1.00	1.00	1.00	13.09	1,533.63	2520.00	2.43	78.54	288.00
+D+0.750L+0.750S+0.5250E+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.609	0.273	1.60	1.000	1.00	1.00	1.00	1.00	1.00	13.09	1,533.63	2520.00	2.43	78.54	288.00
+0.60D+0.60W+0.60H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.188	0.084	1.60	1.000	1.00	1.00	1.00	1.00	1.00	4.05	474.93	2520.00	0.75	24.32	288.00
+0.60D+0.70E+0.60H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 19.20 ft	1	0.188	0.084	1.60	1.000	1.00	1.00	1.00	1.00	1.00	4.05	474.93	2520.00	0.75	24.32	288.00

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	0.9345	9.670		0.0000	0.000

Maximum Deflections for Load Combinations

Load Combination	Span	Max. Downward Defl		Location in Span		Max. Upward Defl		Location in Span	
+D+H	1	0.4153	in	9.670	ft	0.0000	in	0.000	ft
+D+L+H	1	0.4153	in	9.670	ft	0.0000	in	0.000	ft
+D+Lr+H	1	0.8307	in	9.670	ft	0.0000	in	0.000	ft
+D+S+H	1	0.9345	in	9.670	ft	0.0000	in	0.000	ft
+D+0.750Lr+0.750L+H	1	0.7268	in	9.670	ft	0.0000	in	0.000	ft
+D+0.750L+0.750S+H	1	0.8047	in	9.670	ft	0.0000	in	0.000	ft
+D+0.60W+H	1	0.4153	in	9.670	ft	0.0000	in	0.000	ft
+D+0.70E+H	1	0.4153	in	9.670	ft	0.0000	in	0.000	ft
+D+0.750Lr+0.750L+0.450W+H	1	0.7268	in	9.670	ft	0.0000	in	0.000	ft
+D+0.750L+0.750S+0.450W+H	1	0.8047	in	9.670	ft	0.0000	in	0.000	ft
+D+0.750L+0.750S+0.5250E+H	1	0.8047	in	9.670	ft	0.0000	in	0.000	ft
+0.60D+0.60W+0.60H	1	0.2492	in	9.670	ft	0.0000	in	0.000	ft
+0.60D+0.70E+0.60H	1	0.2492	in	9.670	ft	0.0000	in	0.000	ft
D Only	1	0.4153	in	9.670	ft	0.0000	in	0.000	ft
Lr Only	1	0.4153	in	9.670	ft	0.0000	in	0.000	ft
S Only	1	0.5192	in	9.670	ft	0.0000	in	0.000	ft

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.167	3.167
Overall MINimum	1.759	1.759
+D+H	1.407	1.407
+D+L+H	1.407	1.407
+D+Lr+H	2.815	2.815
+D+S+H	3.167	3.167
+D+0.750Lr+0.750L+H	2.463	2.463
+D+0.750L+0.750S+H	2.727	2.727
+D+0.60W+H	1.407	1.407
+D+0.70E+H	1.407	1.407
+D+0.750Lr+0.750L+0.450W+H	2.463	2.463
+D+0.750L+0.750S+0.450W+H	2.727	2.727
+D+0.750L+0.750S+0.5250E+H	2.727	2.727
+0.60D+0.60W+0.60H	0.844	0.844
+0.60D+0.70E+0.60H	0.844	0.844
D Only	1.407	1.407
Lr Only	1.407	1.407
S Only	1.759	1.759
H Only		

TABLE No. 25-A—Continued

SPECIES AND COMMERCIAL GRADE	SYMBOL:	Compression Parallel to Grain (ALLOWABLE UNIT STRESSES, POUNDS PER SQ. INCH)	Compression Perpendicular to Grain	Extreme Fiber in Bending (and Tension Parallel to Grain)	Maximum Horizontal Shear	Modulus of Elasticity	Rules under which Graded
		c	q	f or t	H	E	
DOUGLAS FIR COAST REGION (Cont'd)							
Dense Select Structural	P.&T.	1,480	410	1,710	110[illegible]	1,600,000	U.B.C. Standard No. 25-2-58
→ Select Structural	P.&T.	1,350	375	1,575	110[7]		
Dense Construction	P.&T.	1,260	410	1,350	110[illegible]		
Construction	P.&T.	1,080	350	1,080	110[illegible]		
DOUGLAS FIR INLAND REGION:							
Select Structural	J.&P.	1,750	455	2,150	145	1,600,000	U.B.C. Standard No. 25-4-58
Structural	J.&P.	1,400	400	1,900	100		
Common Structural	J.&P.	1,250	380	1,450	95		
Select Structural	P.&T.	1,750	455	....	....		
Structural	P.&T.	1,400	400	....	....		
Common Structural	P.&T.	1,250	380	....	....		
HEMLOCK, EASTERN:							
Select Structural	J.&P.-B.&S.	850	380	1,300	85	1,100,000	U.B.C. Standard No. 25-5-58
Prime Structural	J.&P.	775		1,200	60		
Common Structural	J.&P.	650		1,100	60		
Utility Structural	J.&P.	600		950	60		
Select Structural	P.&T.	850		....	....		
HEMLOCK, WEST COAST:							
Select Structural	L.F.	990	330	1,440	90[illegible]	1,400,000	U.B.C. Standard No. 25-6-58
1500 f.—Industrial	L.F.	900	330	1,350	90		
1200 f.—Industrial	L.F.	810	330	1,080	70		
Select Structural	J.&P.	1,080	330	1,440	90[illegible]		

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Wood Beam

File: Fort George PV.ec6
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Lic. # : KW-06009704 Structural Source, LLC

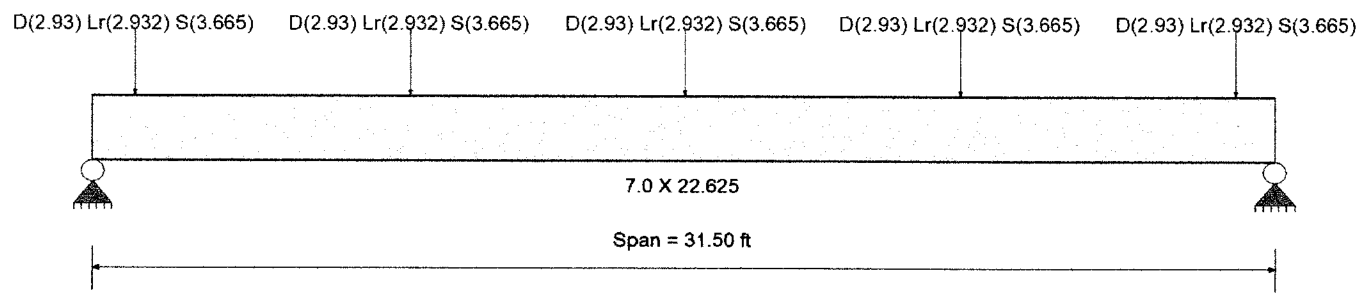
DESCRIPTION: center span glulam beam

CODE REFERENCES

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-10

Material Properties

Analysis Method :	Allowable Stress Design	Fb +	2,600.0 psi	*E : Modulus of Elasticity*	
Load Combination :	ASCE 7-10	Fb -	2,600.0 psi	Ebend- xx	1,600.0 ksi
		Fc - Prll	2,000.0 psi	Eminbend - xx	620.0 ksi
Wood Species	: Douglas Fir-Larch	Fc - Perp	415.0 psi		
Wood Grade	: glulam combination number 11 circa 1958	Fv	165.0 psi		
		Ft	2,000.0 psi	Density	31.210 pcf
Beam Bracing	: Beam is Fully Braced against lateral-torsional buckling				



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 1.140 ft, (point load from purlins)
Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 8.470 ft, (point load from purlins)
Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 15.80 ft, (point load from purlins)
Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 23.130 ft, (point load from purlins)
Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 30.460 ft, (point load from purlins)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	**0.769 : 1**	Maximum Shear Stress Ratio	=	**0.496 : 1**
Section used for this span		**7.0 X 22.625**	Section used for this span		**7.0 X 22.625**
	=	2,300.50psi		=	94.19 psi
	=	2,990.00psi		=	189.75 psi
Load Combination		+D+S+H	Load Combination		+D+S+H
Location of maximum on span	=	15.750ft	Location of maximum on span	=	23.223 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	1.020 in	Ratio =	370 >=240
Max Upward Transient Deflection	0.000 in	Ratio =	0 <240
Max Downward Total Deflection	1.836 in	Ratio =	205 >=180
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
+D+H													0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.437	0.282	0.90	1.000	1.00	1.00	1.00	1.00	1.00	50.86	1,022.06	2340.00	4.42	41.85	148.50
+D+L+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.393	0.254	1.00	1.000	1.00	1.00	1.00	1.00	1.00	50.86	1,022.06	2600.00	4.42	41.85	165.00
+D+Lr+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.629	0.406	1.25	1.000	1.00	1.00	1.00	1.00	1.00	101.76	2,044.81	3250.00	8.84	83.72	206.25
+D+S+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.769	0.496	1.15	1.000	1.00	1.00	1.00	1.00	1.00	114.49	2,300.50	2990.00	9.94	94.19	189.75
+D+0.750Lr+0.750L+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.550	0.355	1.25	1.000	1.00	1.00	1.00	1.00	1.00	89.04	1,789.12	3250.00	7.73	73.25	206.25

Wood Beam

DESCRIPTION: center span glulam beam

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	Moment Values M	Moment Values fb	Moment Values F'b	Shear Values V	Shear Values fv	Shear Values F'v
+D+0.750L+0.750S+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.663	0.427	1.15	1.000	1.00	1.00	1.00	1.00	1.00	98.58	1,980.89	2990.00	8.56	81.10	189.75
+D+0.60W+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.246	0.159	1.60	1.000	1.00	1.00	1.00	1.00	1.00	50.86	1,022.06	4160.00	4.42	41.85	264.00
+D+0.70E+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.246	0.159	1.60	1.000	1.00	1.00	1.00	1.00	1.00	50.86	1,022.06	4160.00	4.42	41.85	264.00
+D+0.750Lr+0.750L+0.450W+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.430	0.277	1.60	1.000	1.00	1.00	1.00	1.00	1.00	89.04	1,789.12	4160.00	7.73	73.25	264.00
+D+0.750L+0.750S+0.450W+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.476	0.307	1.60	1.000	1.00	1.00	1.00	1.00	1.00	98.58	1,980.89	4160.00	8.56	81.10	264.00
+D+0.750L+0.750S+0.5250E+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.476	0.307	1.60	1.000	1.00	1.00	1.00	1.00	1.00	98.58	1,980.89	4160.00	8.56	81.10	264.00
+0.60D+0.60W+0.60H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.147	0.095	1.60	1.000	1.00	1.00	1.00	1.00	1.00	30.52	613.23	4160.00	2.65	25.11	264.00
+0.60D+0.70E+0.60H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 31.50 ft	1	0.147	0.095	1.60	1.000	1.00	1.00	1.00	1.00	1.00	30.52	613.23	4160.00	2.65	25.11	264.00

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	1.8356	15.750		0.0000	0.000

Maximum Deflections for Load Combinations

Load Combination	Span	Max. Downward Defl		Location in Span		Max. Upward Defl		Location in Span	
+D+H	1	0.8155	in	15.750	ft	0.0000	in	0.000	ft
+D+L+H	1	0.8155	in	15.750	ft	0.0000	in	0.000	ft
+D+Lr+H	1	1.6316	in	15.750	ft	0.0000	in	0.000	ft
+D+S+H	1	1.8356	in	15.750	ft	0.0000	in	0.000	ft
+D+0.750Lr+0.750L+H	1	1.4276	in	15.750	ft	0.0000	in	0.000	ft
+D+0.750L+0.750S+H	1	1.5806	in	15.750	ft	0.0000	in	0.000	ft
+D+0.60W+H	1	0.8155	in	15.750	ft	0.0000	in	0.000	ft
+D+0.70E+H	1	0.8155	in	15.750	ft	0.0000	in	0.000	ft
+D+0.750Lr+0.750L+0.450W+H	1	1.4276	in	15.750	ft	0.0000	in	0.000	ft
+D+0.750L+0.750S+0.450W+H	1	1.5806	in	15.750	ft	0.0000	in	0.000	ft
+D+0.750L+0.750S+0.5250E+H	1	1.5806	in	15.750	ft	0.0000	in	0.000	ft
+0.60D+0.60W+0.60H	1	0.4893	in	15.750	ft	0.0000	in	0.000	ft
+0.60D+0.70E+0.60H	1	0.4893	in	15.750	ft	0.0000	in	0.000	ft
D Only	1	0.8155	in	15.750	ft	0.0000	in	0.000	ft
Lr Only	1	0.8161	in	15.750	ft	0.0000	in	0.000	ft
S Only	1	1.0201	in	15.750	ft	0.0000	in	0.000	ft

Vertical Reactions

Support notation : Far left is #1   Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	16.435	16.540
Overall MINimum	9.133	9.192
+D+H	7.302	7.348
+D+L+H	7.302	7.348
+D+Lr+H	14.608	14.702
+D+S+H	16.435	16.540
+D+0.750Lr+0.750L+H	12.782	12.863
+D+0.750L+0.750S+H	14.152	14.242
+D+0.60W+H	7.302	7.348
+D+0.70E+H	7.302	7.348
+D+0.750Lr+0.750L+0.450W+H	12.782	12.863
+D+0.750L+0.750S+0.450W+H	14.152	14.242
+D+0.750L+0.750S+0.5250E+H	14.152	14.242
+0.60D+0.60W+0.60H	4.381	4.409
+0.60D+0.70E+0.60H	4.381	4.409
D Only	7.302	7.348
Lr Only	7.307	7.353
S Only	9.133	9.192
H Only		

Title Block Line 1
You can change this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Project Title:
Engineer:
Project ID:
Project Descr:

Printed: 24 MAR 2022, 3:28PM

Wood Beam

File: Fort George PV.ec6
Software copyright ENERCALC, INC. 1983-2020, Build:12.20.5.17

Lic. # : KW-06009704 Structural Source, LLC

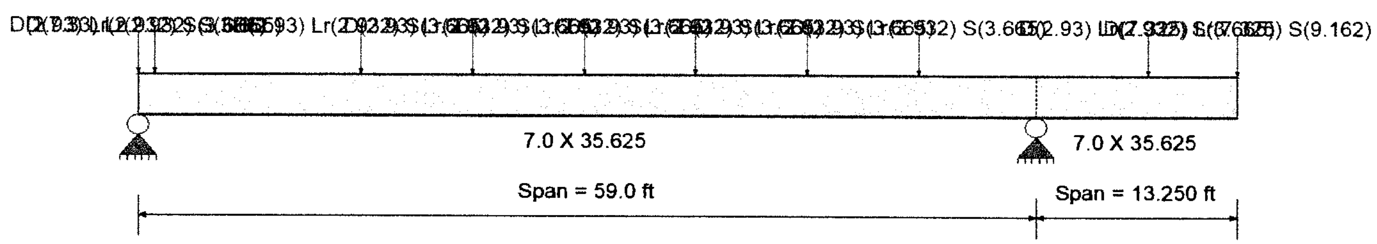
DESCRIPTION: end span glulam beam with cantilever

CODE REFERENCES

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-10

Material Properties

Analysis Method :	Allowable Stress Design	Fb +	2,600.0 psi	*E : Modulus of Elasticity*	
Load Combination	ASCE 7-10	Fb -	2,600.0 psi	Ebend- xx	1,600.0 ksi
		Fc - Prll	2,000.0 psi	Eminbend - xx	620.0 ksi
Wood Species	: Douglas Fir-Larch	Fc - Perp	415.0 psi		
Wood Grade	: glulam combination number 11 circa 1958	Fv	165.0 psi		
		Ft	2,000.0 psi	Density	31.210 pcf
Beam Bracing	: Beam is Fully Braced against lateral-torsional buckling				



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Load for Span Number 1
- Point Load : D = 7.330, Lr = 2.932, S = 3.665 k @ 1.140 ft, (point load from purlins)
- Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 14.670 ft, (point load from purlins)
- Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 22.0 ft, (point load from purlins)
- Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 29.330 ft, (point load from purlins)
- Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 36.670 ft, (point load from purlins)
- Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 44.0 ft, (point load from purlins)
- Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 51.330 ft, (point load from purlins)
- Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 0.0 ft, (point load from purlins)

Load for Span Number 2
- Point Load : D = 2.930, Lr = 2.932, S = 3.665 k @ 7.330 ft, (point load from purlins)
- Point Load : D = 7.325, Lr = 7.325, S = 9.162 k @ 13.250 ft, (point load from purlins)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.736 : 1	Maximum Shear Stress Ratio	=	**0.900 : 1**
Section used for this span		**7.0 X 35.625**	Section used for this span		**7.0 X 35.625**
	=	2,200.68 psi		=	170.71 psi
	=	2,990.00 psi		=	189.75 psi
Load Combination		+D+S+H	Load Combination		+D+S+H
Location of maximum on span	=	59.000 ft	Location of maximum on span	=	56.034 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	1.697 in	Ratio =	417 >=240
Max Upward Transient Deflection	-0.244 in	Ratio =	1300 >=240
Max Downward Total Deflection	3.408 in	Ratio =	207 >=180
Max Upward Total Deflection	-0.658 in	Ratio =	482 >=180

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
+D+H													0.00	0.00	0.00	0.00

Title Block Line 1
You can change this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Project Title:
Engineer:
Project ID:
Project Descr:

Printed: 24 MAR 2022, 3:28PM

Wood Beam

File: Fort George PV.ec6

Lic. # : KW-06009704
Structural Source, LLC

DESCRIPTION: end span glulam beam with cantilever

Load Combination		Max Stress Ratios									Moment Values			Shear Values		
Segment Length	Span #	M	V	C_d	$C_{F/V}$	C_i	C_r	C_m	C_t	C_L	M	fb	F'b	V	fv	F'v
Length = 59.0 ft	1	0.451	0.547	0.90	1.000	1.00	1.00	1.00	1.00	1.00	130.26	1,055.73	2340.00	13.50	81.19	148.50
Length = 13.250 ft	2	0.427	0.547	0.90	1.000	1.00	1.00	1.00	1.00	1.00	123.28	999.10	2340.00	10.81	81.19	148.50
+D+L+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.406	0.492	1.00	1.000	1.00	1.00	1.00	1.00	1.00	130.26	1,055.73	2600.00	13.50	81.19	165.00
Length = 13.250 ft	2	0.384	0.492	1.00	1.000	1.00	1.00	1.00	1.00	1.00	123.28	999.10	2600.00	10.81	81.19	165.00
+D+Lr+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.603	0.741	1.25	1.000	1.00	1.00	1.00	1.00	1.00	241.83	1,959.87	3250.00	25.40	152.80	206.25
Length = 13.250 ft	2	0.603	0.741	1.25	1.000	1.00	1.00	1.00	1.00	1.00	241.83	1,959.87	3250.00	21.07	152.80	206.25
+D+S+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.736	0.900	1.15	1.000	1.00	1.00	1.00	1.00	1.00	271.54	2,200.68	2990.00	28.38	170.71	189.75
Length = 13.250 ft	2	0.736	0.900	1.15	1.000	1.00	1.00	1.00	1.00	1.00	271.54	2,200.68	2990.00	23.64	170.71	189.75
+D+0.750Lr+0.750L+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.529	0.654	1.25	1.000	1.00	1.00	1.00	1.00	1.00	212.19	1,719.68	3250.00	22.43	134.90	206.25
Length = 13.250 ft	2	0.529	0.654	1.25	1.000	1.00	1.00	1.00	1.00	1.00	212.19	1,719.68	3250.00	18.50	134.90	206.25
+D+0.750L+0.750S+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.636	0.782	1.15	1.000	1.00	1.00	1.00	1.00	1.00	234.47	1,900.28	2990.00	24.66	148.33	189.75
Length = 13.250 ft	2	0.636	0.782	1.15	1.000	1.00	1.00	1.00	1.00	1.00	234.47	1,900.28	2990.00	20.43	148.33	189.75
+D+0.60W+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.254	0.308	1.60	1.000	1.00	1.00	1.00	1.00	1.00	130.26	1,055.73	4160.00	13.50	81.19	264.00
Length = 13.250 ft	2	0.240	0.308	1.60	1.000	1.00	1.00	1.00	1.00	1.00	123.28	999.10	4160.00	10.81	81.19	264.00
+D+0.70E+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.254	0.308	1.60	1.000	1.00	1.00	1.00	1.00	1.00	130.26	1,055.73	4160.00	13.50	81.19	264.00
Length = 13.250 ft	2	0.240	0.308	1.60	1.000	1.00	1.00	1.00	1.00	1.00	123.28	999.10	4160.00	10.81	81.19	264.00
+D+0.750Lr+0.750L+0.450W+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.413	0.511	1.60	1.000	1.00	1.00	1.00	1.00	1.00	212.19	1,719.68	4160.00	22.43	134.90	264.00
Length = 13.250 ft	2	0.413	0.511	1.60	1.000	1.00	1.00	1.00	1.00	1.00	212.19	1,719.68	4160.00	18.50	134.90	264.00
+D+0.750L+0.750S+0.450W+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.457	0.562	1.60	1.000	1.00	1.00	1.00	1.00	1.00	234.47	1,900.28	4160.00	24.66	148.33	264.00
Length = 13.250 ft	2	0.457	0.562	1.60	1.000	1.00	1.00	1.00	1.00	1.00	234.47	1,900.28	4160.00	20.43	148.33	264.00
+D+0.750L+0.750S+0.5250E+H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.457	0.562	1.60	1.000	1.00	1.00	1.00	1.00	1.00	234.47	1,900.28	4160.00	24.66	148.33	264.00
Length = 13.250 ft	2	0.457	0.562	1.60	1.000	1.00	1.00	1.00	1.00	1.00	234.47	1,900.28	4160.00	20.43	148.33	264.00
+0.60D+0.60W+0.60H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.152	0.185	1.60	1.000	1.00	1.00	1.00	1.00	1.00	78.16	633.44	4160.00	8.10	48.71	264.00
Length = 13.250 ft	2	0.144	0.185	1.60	1.000	1.00	1.00	1.00	1.00	1.00	73.97	599.46	4160.00	6.49	48.71	264.00
+0.60D+0.70E+0.60H					1.000	1.00	1.00	1.00	1.00	1.00			0.00	0.00	0.00	0.00
Length = 59.0 ft	1	0.152	0.185	1.60	1.000	1.00	1.00	1.00	1.00	1.00	78.16	633.44	4160.00	8.10	48.71	264.00
Length = 13.250 ft	2	0.144	0.185	1.60	1.000	1.00	1.00	1.00	1.00	1.00	73.97	599.46	4160.00	6.49	48.71	264.00

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.4083	27.358		0.0000	0.000
	2	0.0000	27.358	+D+S+H	-0.6582	13.250

Maximum Deflections for Load Combinations

Load Combination	Span	Max. Downward Defl		Location in Span		Max. Upward Defl		Location in Span	
+D+H	1	1.7114	in	27.687	ft	0.0000	in	0.000	ft
+D+L+H	1	1.7114	in	27.687	ft	0.0000	in	0.000	ft
+D+Lr+H	1	3.0694	in	27.358	ft	0.0000	in	0.000	ft
+D+S+H	1	3.4083	in	27.358	ft	0.0000	in	0.000	ft
+D+0.750Lr+0.750L+H	1	2.7299	in	27.358	ft	0.0000	in	0.000	ft
+D+0.750L+0.750S+H	1	2.9841	in	27.358	ft	0.0000	in	0.000	ft
+D+0.60W+H	1	1.7114	in	27.687	ft	0.0000	in	0.000	ft
+D+0.70E+H	1	1.7114	in	27.687	ft	0.0000	in	0.000	ft
+D+0.750Lr+0.750L+0.450W+H	1	2.7299	in	27.358	ft	0.0000	in	0.000	ft
+D+0.750L+0.750S+0.450W+H	1	2.9841	in	27.358	ft	0.0000	in	0.000	ft
+D+0.750L+0.750S+0.5250E+H	1	2.9841	in	27.358	ft	0.0000	in	0.000	ft
+0.60D+0.60W+0.60H	1	1.0268	in	27.687	ft	0.0000	in	0.000	ft
+0.60D+0.70E+0.60H	1	1.0268	in	27.687	ft	0.0000	in	0.000	ft
D Only	1	1.7114	in	27.687	ft	0.0000	in	0.000	ft
Lr Only	1	1.3581	in	27.358	ft	0.0000	in	0.000	ft

DESCRIPTION: end span glulam beam with cantilever

Maximum Deflections for Load Combinations

Load Combination	Span	Max. Downward Defl	Location in Span	Max. Upward Defl	Location in Span
S Only	1	1.6969 in	27.358 ft	0.0000 in	0.000 ft

Vertical Reactions

Support notation : Far left is #1

Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Overall MAXimum	31.807	52.340	
Overall MINimum	14.437	27.710	
+D+H	17.370	24.630	
+D+L+H	17.370	24.630	
+D+Lr+H	28.921	46.792	
+D+S+H	31.807	52.340	
+D+0.750Lr+0.750L+H	26.033	41.251	
+D+0.750L+0.750S+H	28.198	45.412	
+D+0.60W+H	17.370	24.630	
+D+0.70E+H	17.370	24.630	
+D+0.750Lr+0.750L+0.450W+H	26.033	41.251	
+D+0.750L+0.750S+0.450W+H	28.198	45.412	
+D+0.750L+0.750S+0.5250E+H	28.198	45.412	
+0.60D+0.60W+0.60H	10.422	14.778	
+0.60D+0.70E+0.60H	10.422	14.778	
D Only	17.370	24.630	
Lr Only	11.550	22.163	
S Only	14.437	27.710	
H Only			

TABLE NO. 25-C—ALLOWABLE UNIT STRESSES—STRUCTURAL GLUED LAMINATED DOUGLAS FIR (COAST REGION), AND SOUTHERN PINE LUMBER DRY CONDITIONS OF USE

Allowable unit stresses are for normal conditions of loading, pounds per square inch.

COMBINATION NUMBER	SPECIES AND COMMERCIAL GRADE COMBINATION			EXTREME FIBER IN BENDING "f"		TENSION PARALLEL TO GRAIN "t"		COMPRESSION PARALLEL TO GRAIN "c"		HORIZONTAL SHEAR "H"	COMPRESSION PERPENDICULAR TO GRAIN "c⊥"
	1	2	3	4	5	6	7	8	9	10	11
	Grade of Laminations at Top and Bottom	Number at Top and Bottom	Grade of Inner Laminations	From 4 to 14 Laminations	15 or More Laminations	From 4 to 14 Laminations	15 or More Laminations	From 4 to 14 Laminations	15 or More Laminations		
DOUGLAS FIR											
1	Clear (Dense)*	One	Dense Select Structural	3000	3000	3000	3000	2400	2500	165	450
2	Clear (Dense)*	One	Dense Const.	3000	3000	2600	3000	2200	2300	165	450
3	Dense Select Structural	All	Dense Select Structural	2800	3000	3000	3000	2100	2300	165	450
4	Clear (Close-Grain)*	One	Select Structural	2800	2800	2800	2800	2200	2200	165	415
5	Select Structural	All	Select Structural	2600	2800	2800	2800	2200	2200	165	415
6	Select Structural	Two	Construction	2600	2600	2600	2600	2000	2000	165	415
7	Clear (Medium Grain)*	One	Construction	2600	2600	2200	2400	1900	2000	165	385
8	Dense Const.	All	Dense Const.	2400	2600	2600	3000	2200	2300	165	450
9	Dense Const.	1/14 of total	Construction	2400	2600	2200	2400	1900	2000	165	450
10	Select Structural	One	Construction	2400	2600	2200	2400	1900	2000	165	415
11	Select Structural	Two	Standard	2600	2600	2400	2400	2000	2000	165	415
12	Clear (Medium Grain)*	One	Standard	2200	2200	2000	2400	1800	1900	165	385
13	Select Structural	One	Standard	2200	2200	2000	2400	1800	1900	165	415
14	Construction	All	Construction	2000	2200	2200	2400	1900	2000	165	385
15	Construction	One	Standard	2000	2200	2000	2100	1800	1900	165	385
16	Standard	All	Standard	1600	2000	2000	2400	1800	1900	165	385

*The rate of growth and density requirements of inner laminations shall apply to clear outer laminations.

(Continued)

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PROJECT: FORT GEORGE BREWERY ROOFTOP PV
PAGE NUMBER:
ENGINEER: KEW
DATE: 3-22-22

STEEL POST UPLIFT ANCHORAGE

POST SPACING
= 6.0' ON CENTER
TRIB WIDTH
= 10.1' / 2 BEAMS = 5.05'
TRIB AREA
= 6.0' (5.05')
= 30.3 ☐

UPLIFT FORCE
= 30.3 ☐ (77.6 PSF (0.6) - 0.6 (4 PSF))
= 1340#   ASD   DL

DETERMINE MIN. LENGTH OF TWO 5/16" DIA. LAG BOLTS INTO 4X14 PURLINS

ALLOWABLE WIDTHRAWL FROM NDS TABLE 12.2A W/ G = 0.50
= 266 PLI FOR LDF = 1.0

MIN. EMBEDMENT
= 1340# / 1.6 (2 SCREWS) 266 PLI
= 1.57"   LDF

LAG BOLT HAS TO PASS THROUGH:
1/4" BASE PLATE + 2X T&G DECKING
= 1 3/4"
LAG BOLT TIP LENGTH
= 5/16"

USE 5/16" DIA. X 4" LAG BOLTS
EMBEDMENT
= 4" - 1.75" - 0.30"
= 1.95" > 1.57" OK

Table 12.2A Lag Screw Reference Withdrawal Values, W[1]

Tabulated withdrawal design values (W) are in pounds per inch of thread penetration into side grain of wood member. Length of thread penetration in main member shall not include the length of the tapered tip (see 12.2.1.1).

Specific Gravity, G[2]	Lag Screw Diameter, D										
	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"
0.73	397	469	538	604	668	789	905	1016	1123	1226	1327
0.71	381	450	516	579	640	757	868	974	1077	1176	1273
0.68	357	422	484	543	600	709	813	913	1009	1103	1193
0.67	349	413	473	531	587	694	796	893	987	1078	1167
0.58	281	332	381	428	473	559	641	719	795	869	940
0.55	260	307	352	395	437	516	592	664	734	802	868
0.51	232	274	314	353	390	461	528	593	656	716	775
0.50	225	266	305	342	378	447	513	576	636	695	752
0.49	218	258	296	332	367	434	498	559	617	674	730
0.47	205	242	278	312	345	408	467	525	580	634	686
0.46	199	235	269	302	334	395	453	508	562	613	664
0.44	186	220	252	283	[illegible]	369	423	475	525	574	621
0.43	179	212	243	273	302	357	409	459	508	554	600
0.42	175	206	235	264	[illegible]	[illegible]	395	443	490	535	579
0.41	167	198	226	254	281	332	381	428	473	516	559
0.40	[illegible]	190	218	245	[illegible]	320	367	412	455	497	538
0.39	155	183	210	236	261	308	353	397	438	479	518
0.38	148	176	202	227	[illegible]	[illegible]	[illegible]	381	422	461	498
0.37	143	169	194	218	241	285	326	367	405	443	479
0.36	137	163	186	209	231	273	313	352	389	425	460
0.35	132	156	179	200	222	262	300	337	373	407	441
0.34	110	130	149	167	185	218	250	281	311	339	367

1. Tabulated withdrawal design values, W, for lag screw connections shall be multiplied by all applicable adjustment factors (see Table 11.3.1).
2. Specific gravity, G, shall be determined in accordance with Table 12.3.3A.

adjustment factors (see Table 11.3.1) to obtain adjusted withdrawal design values, W'.

$$W = 1380\, G^{5/2} D \qquad (12.2\text{-}3)$$

(b) The nail or spike reference withdrawal design value, W, in lbs/in. of penetration, for a smooth shank stainless steel nail or spike driven into the side grain of a wood member, with the nail or spike axis perpendicular to the wood fibers, shall be determined from Table 12.2D or Equation 12.2-4, within the range of specific gravities, G, and nail or spike diameters, D, given in Table 12.2D. Reference withdrawal design values, W, shall be multiplied by all applicable adjustment factors (see Table 11.3.1) to obtain adjusted withdrawal design values, W'.

$$W = 465\, G^{3/2} D \qquad (12.2\text{-}4)$$

(c) For calculation of the fastener reference withdrawal design value in pounds, the unit reference withdrawal design value in lbs/in. of fastener penetration from 12.2.3.1a or 12.2.3.1b shall be multiplied by the length of fastener penetration, p_t, into the wood member.

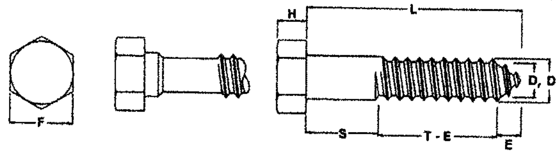
12.2.3.2 Deformed shank nails

(a) The reference withdrawal design value, in lbs/in. of ring shank penetration, for a Roof Sheathing Ring Shank nail or Post-Frame Ring Shank nail driven in the side grain of the main member, with the nail axis perpendicular to the wood fibers, shall be determined from Table 12.2E or Equation 12.2-5, within the range of specific gravities and nail diameters given in Table 12.2E. Reference withdrawal design values, W, shall be multiplied by all applicable adjustment factors (see Table 11.3.1) to obtain adjusted withdrawal design values, W'.

$$W = 1800\, G^2 D \qquad (12.2\text{-}5)$$

Table L2 Standard Hex Lag Screws[1]

D = diameter
D_r = root diameter
S = unthreaded body length
T = minimum thread length[2]



Reduced Body Diameter

Full-Body Diameter

E = length of tapered tip
L = lag screw length
N = number of threads/inch
F = width of head across flats
H = height of head

Length, L		Diameter, D: 1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"
	D_r	0.173"	0.227"	0.265"	0.328"	0.371"	0.471"	0.579"	0.683"	0.780"	0.887"	1.012"
	E	5/32"	3/16"	7/32"	9/32"	5/16"	13/32"	1/2"	19/32"	11/16"	25/32"	7/8"
	H	11/64"	7/32"	1/4"	19/64"	11/32"	27/64"	1/2"	37/64"	43/64"	3/4"	27/32"
	F	7/16"	1/2"	9/16"	5/8"	3/4"	15/16"	1-1/8"	1-5/16"	1-1/2"	1-11/16"	1-7/8"
	N	10	9	7	7	6	5	4-1/2	4	3-1/2	3-1/4	3-1/4
1"	S	1/4"	1/4"	1/4"	1/4"	1/4"						
	T	3/4"	3/4"	3/4"	3/4"	3/4"						
	T-E	19/32"	9/16"	17/32"	15/32"	7/16"						
1-1/2"	S	1/4"	1/4"	1/4"	1/4"	1/4"						
	T	1-1/4"	1-1/4"	1-1/4"	1-1/4"	1-1/4"						
	T-E	1-3/32"	1-1/16"	1-1/32"	31/32"	15/16"						
2"	S	1/2"	1/2"	1/2"	1/2"	1/2"	1/2"					
	T	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"					
	T-E	1-11/32"	1-5/16"	1-9/32"	1-7/32"	1-3/16"	1-3/32"					
2-1/2"	S	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"					
	T	1-3/4"	1-3/4"	1-3/4"	1-3/4"	1-3/4"	1-3/4"					
	T-E	1-19/32"	1-9/16"	1-17/32"	1-15/32"	1-7/16"	1-11/32"					
3	S	1"	1"	1"	1"	1"	1"	1"	1"	1"		
	T	2"	2"	2"	2"	2"	2"	2"	2"	2"		
	T-E	1-27/32"	1-13/16"	1-25/32"	1-23/32"	1-11/16"	1-19/32"	1-1/2"	1-13/32"	1-5/16"		
4"	S	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
	T	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"
	T-E	2-11/32"	2-5/16"	2-9/32"	2-7/32"	2-3/16"	2-3/32"	2"	1-29/32"	1-13/16"	1-23/32"	1-5/8"
5"	S	2"	2"	2"	2"	2"	2"	2"	2"	2"	2"	2"
	T	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"
	T-E	2-27/32"	2-13/16"	2-25/32"	2-23/32"	2-11/16"	2-19/32"	2-1/2"	2-13/32"	2-5/16"	2-7/32"	2-1/8"
6"	S	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"	2-1/2"
	T	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"
	T-E	3-11/32"	3-5/16"	3-9/32"	3-7/32"	3-3/16"	3-3/32"	3"	2-29/32"	2-13/16"	2-23/32"	2-5/8"
7"	S	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"
	T	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"
	T-E	3-27/32"	3-13/16"	3-25/32"	3-23/32"	3-11/16"	3-19/32"	3-1/2"	3-13/32"	3-5/16"	3-7/32"	3-1/8"
8"	S	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"	3-1/2"
	T	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"
	T-E	4-11/32"	4-5/16"	4-9/32"	4-7/32"	4-3/16"	4-3/32"	4"	3-29/32"	3-13/16"	3-23/32"	3-5/8"
9"	S	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"	4"
	T	5"	5"	5"	5"	5"	5"	5"	5"	5"	5"	5"
	T-E	4-27/32"	4-13/16"	4-25/32"	4-23/32"	4-11/16"	4-19/32"	4-1/2"	4-13/32"	4-5/16"	4-7/32"	4-1/8"
10"	S	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"	4-1/2"
	T	5-1/2"	5-1/2"	5-1/2"	5-1/2"	5-1/2"	5-1/2"	5-1/2"	5-1/2"	5-1/2"	5-1/2"	5-1/2"
	T-E	5-11/32"	5-5/16"	5-9/32"	5-7/32"	5-3/16"	5-3/32"	5"	4-29/32"	4-13/16"	4-23/32"	4-5/8"
11"	S	5"	5"	5"	5"	5"	5"	5"	5"	5"	5"	5"
	T	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"
	T-E	5-27/32"	5-13/16"	5-25/32"	5-23/32"	5-11/16"	5-19/32"	5-1/2"	5-13/32"	5-5/16"	5-7/32"	5-1/8"
12"	S	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"
	T	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"
	T-E	5-27/32"	5-13/16"	5-25/32"	5-23/32"	5-11/16"	5-19/32"	5-1/2"	5-13/32"	5-5/16"	5-7/32"	5-1/8"

1. Tolerances are specified in ANSI/ASME B18.2.1. Full-body diameter and reduced body diameter lag screws are shown. For reduced body diameter lag screws, the unthreaded body diameter may be reduced to approximately the root diameter, D_r.
2. Minimum thread length (T) for lag screw lengths (L) is 6" or 1/2 the lag screw length plus 0.5", whichever is less. Thread lengths may exceed these minimums up to the full lag screw length (L).

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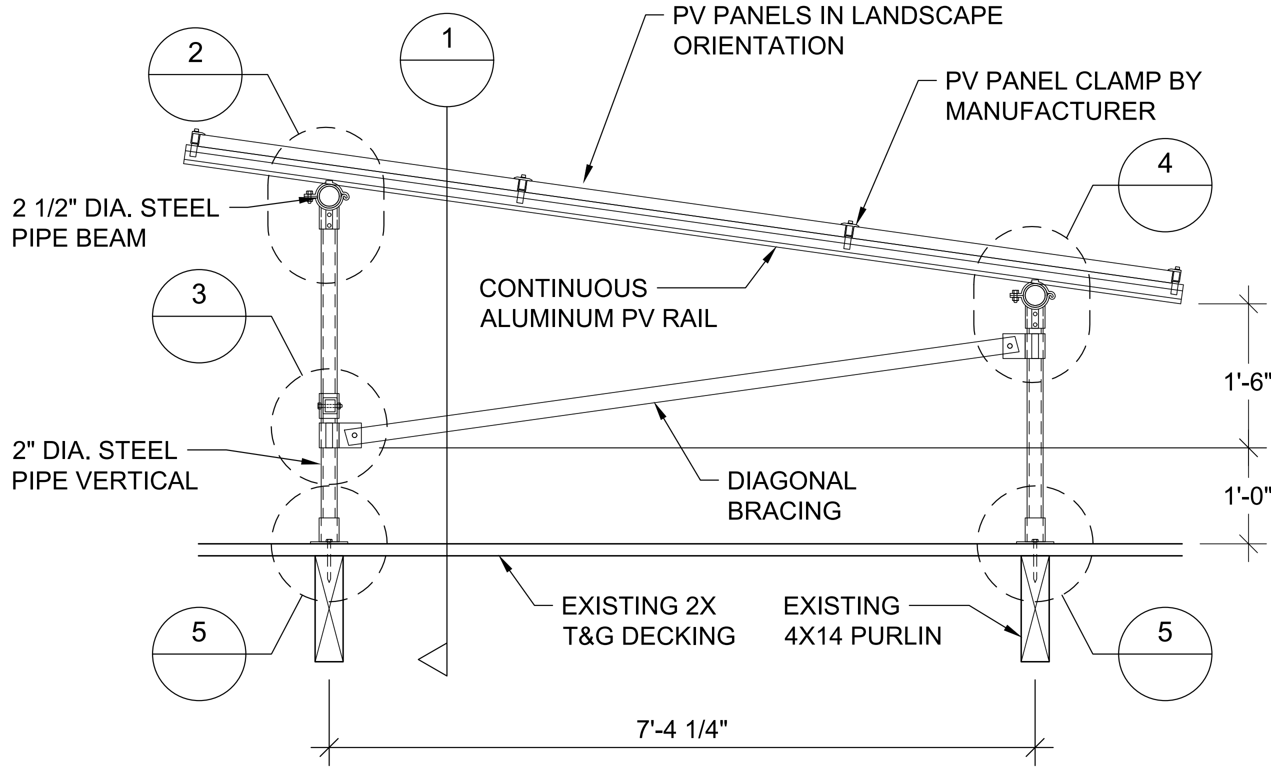
PROJECT : FORT GEORGE BREWING COMPANY PV

PAGE NUMBER :

ENGINEER : KEW

DATE : 3/24/2022

NOTES:
1. ALUMINUM RAILS SHALL SUNMODO HR300 RAILS, WITH 3 RAILS PER COLUMN OF PV PANELS EQUALLY SPACED ACROSS THE PANEL WIDTH.
2. VERTICALS SHALL BE LOCATED DIRECTLY OVER EXISTING 4X14 PURLINS AND SPACED AT 6'-0" ON CENTER MAXIMUM SPACING ALONG LENGTH OF PURLINS.
3. MAXIMUM CANTILEVER OF 2 1/2" DIAMETER PIPE BEAMS SHALL BE 2'-0" PAST LAST VERTICAL.
4. STEEL PIPE SHALL BE SCHEDULE 10S HOT-DIP GALVANIZED WITH Fy = 50 KSI.



A TYPICAL RACKING SECTION

SCALE: 1/2" = 1'-0"

RENEWS: 6/30/2022

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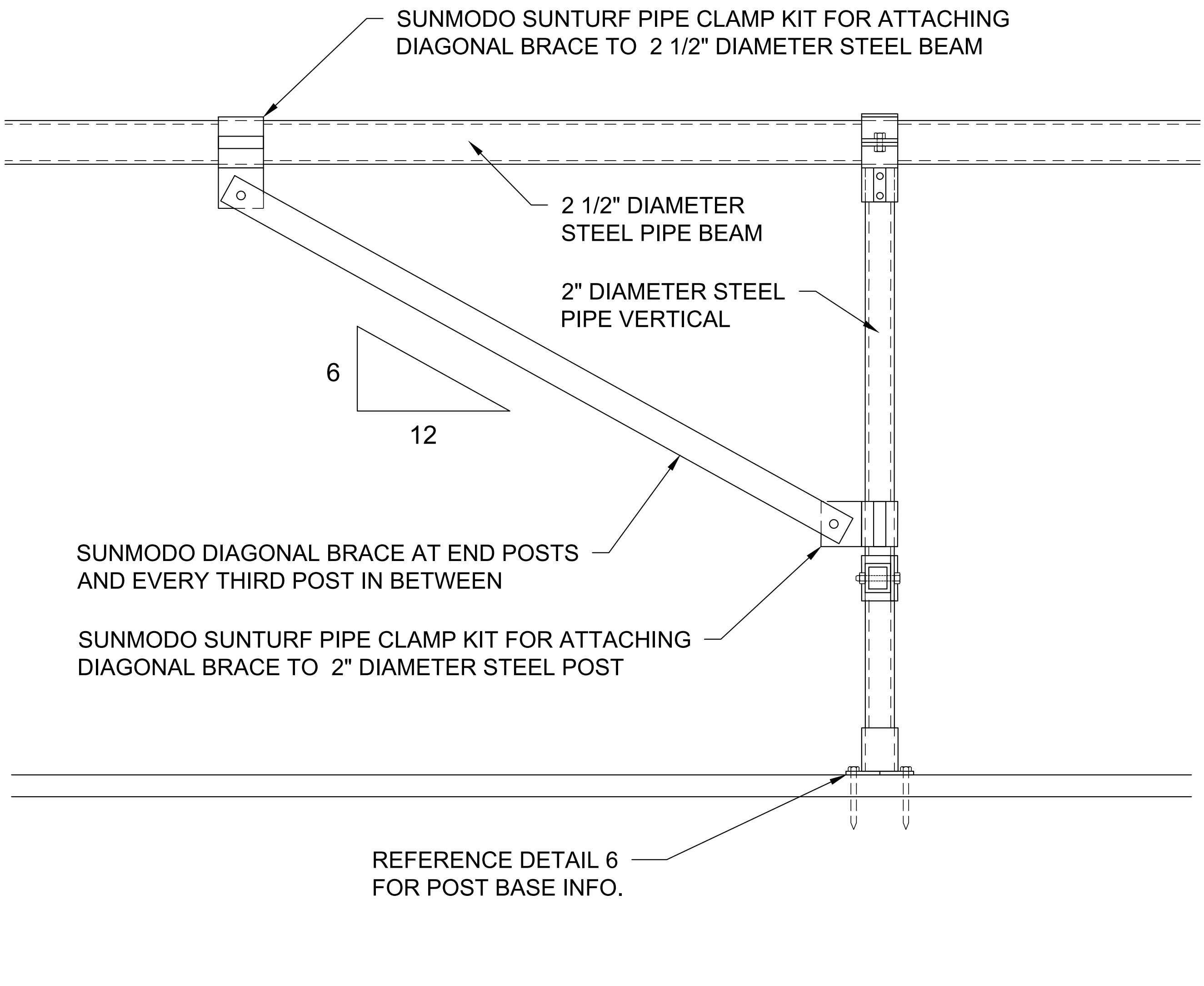
ENGINEER : KEW

DATE : 3/24/2022

NOTE: PV PANELS AND RAILS NOT SHOWN FOR CLARITY



1 RACKING DETAIL

SCALE: 1" = 1'-0"

RENEWS: 6/30/2022

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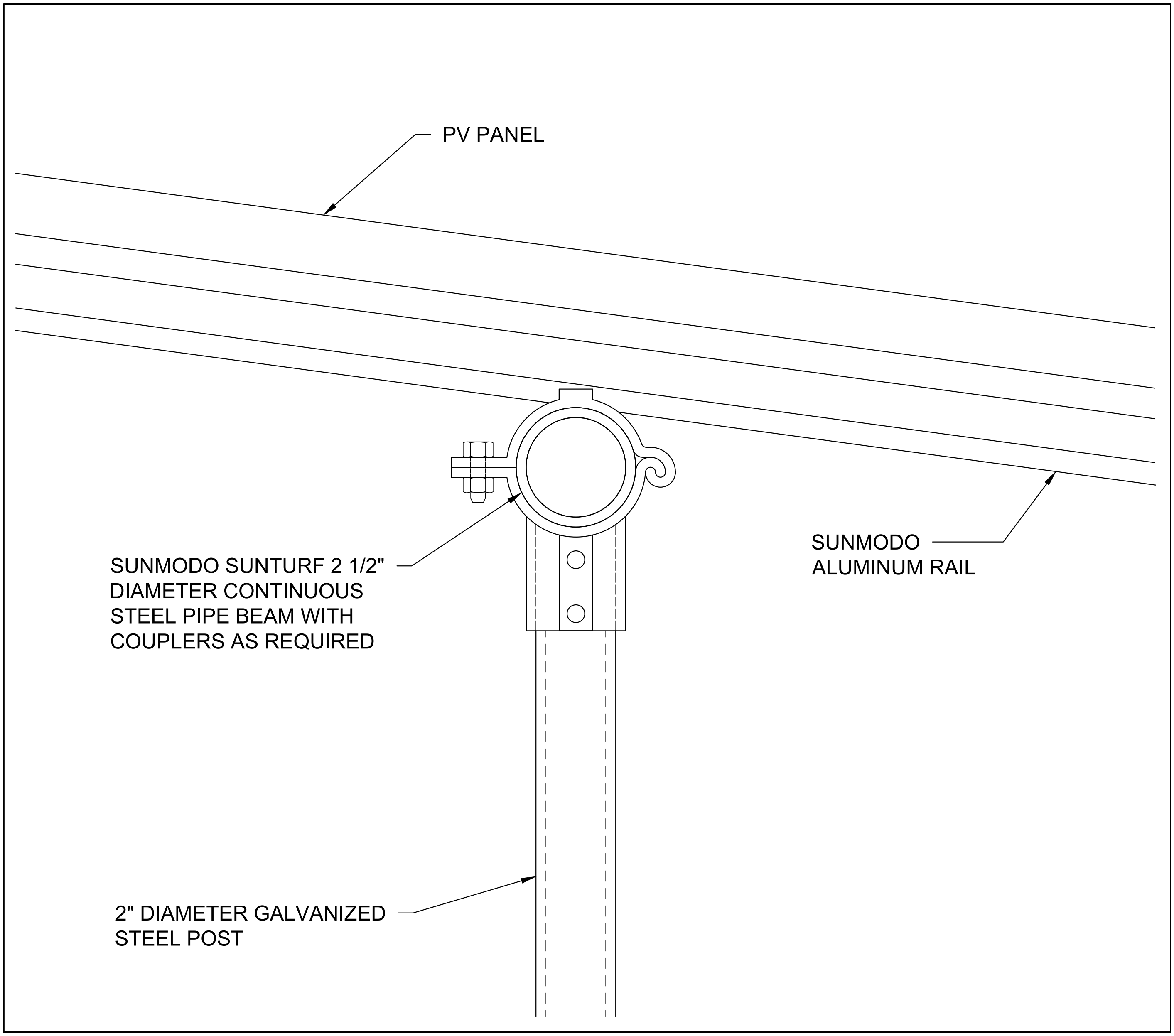
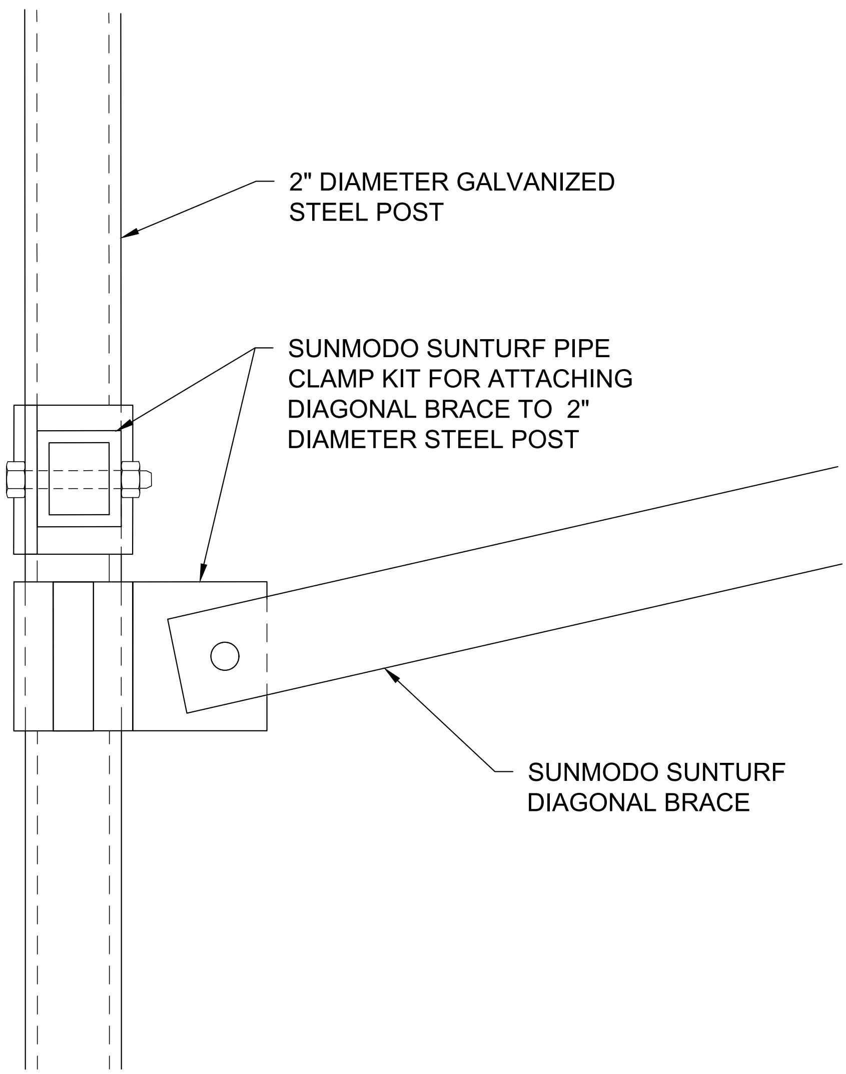


2 RACKING DETAIL

SCALE: 3" = 1'-0"

RENEWS: 6/30/2022



3

RACKING DETAIL

SCALE: 3" = 1'-0"

STRUCTURAL REGISTERED PROFESSIONAL ENGINEER
78254
Kevin Wilger
OREGON
MAY 16, 2006
KEVIN WILGER

RENEWS: 6/30/2022

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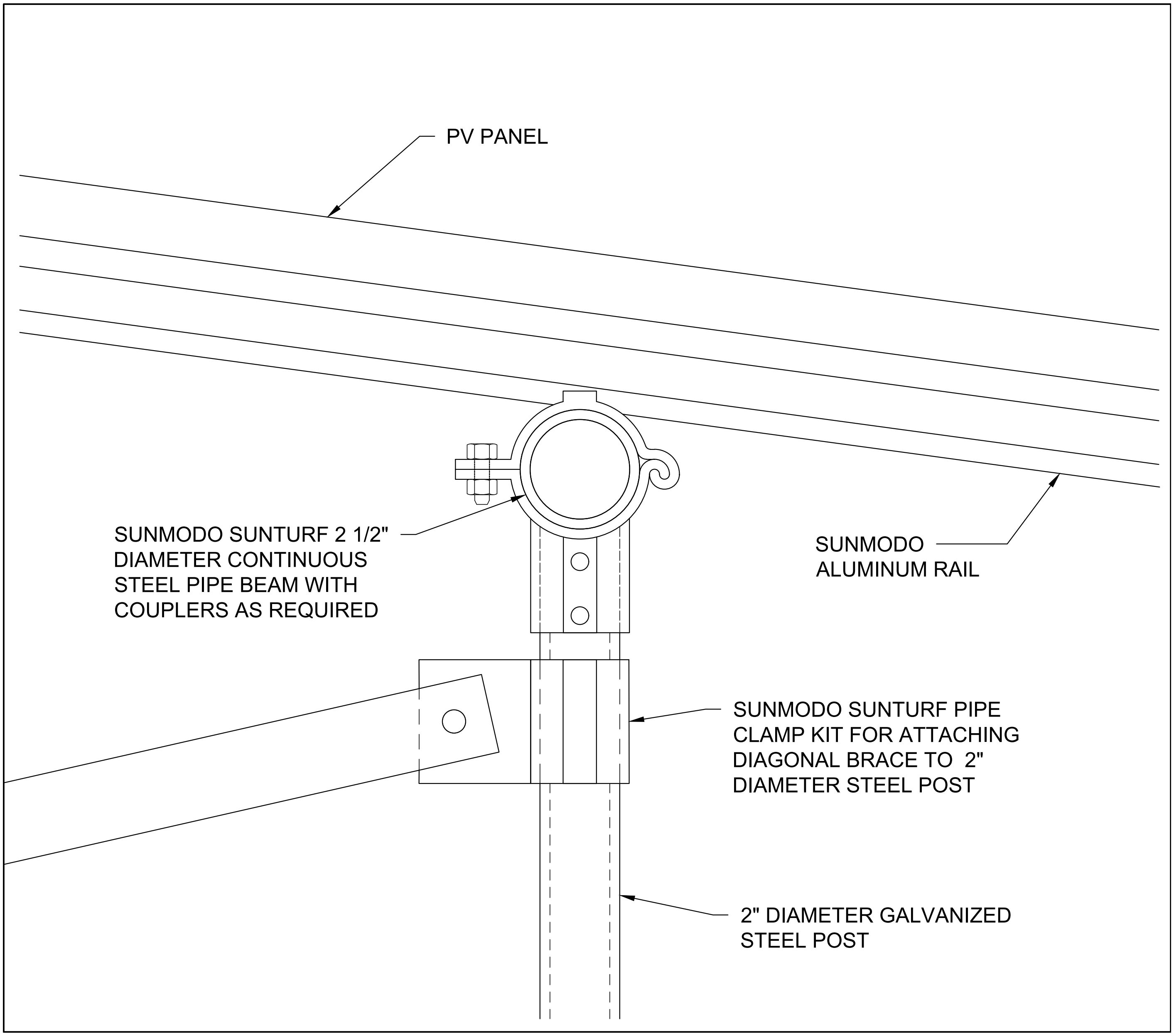
PROJECT : FORT GEORGE BREWING COMPANY PV

PAGE NUMBER :

ENGINEER : KEW

DATE : 3/24/2022



4 RACKING DETAIL

SCALE: 3" = 1'-0"

STRUCTURAL REGISTERED PROFESSIONAL ENGINEER
78254
OREGON
MAY 16, 2006
KEVIN WILGER

RENEWS: 6/30/2022

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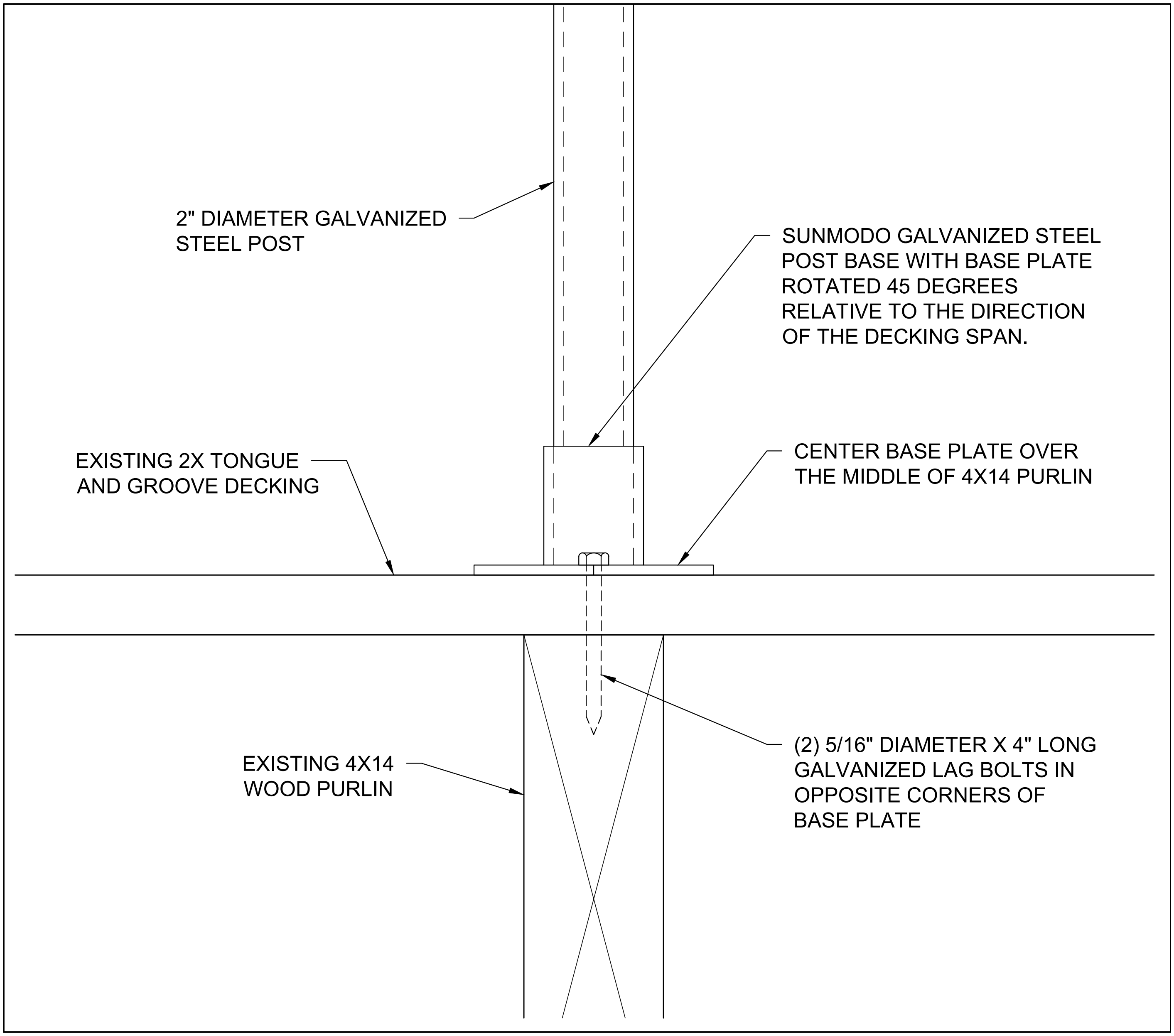
PROJECT : FORT GEORGE BREWING COMPANY PV
PAGE NUMBER :

ENGINEER : KEW
DATE : 3/24/2022



5

RACKING DETAIL

SCALE: 3" = 1'-0"

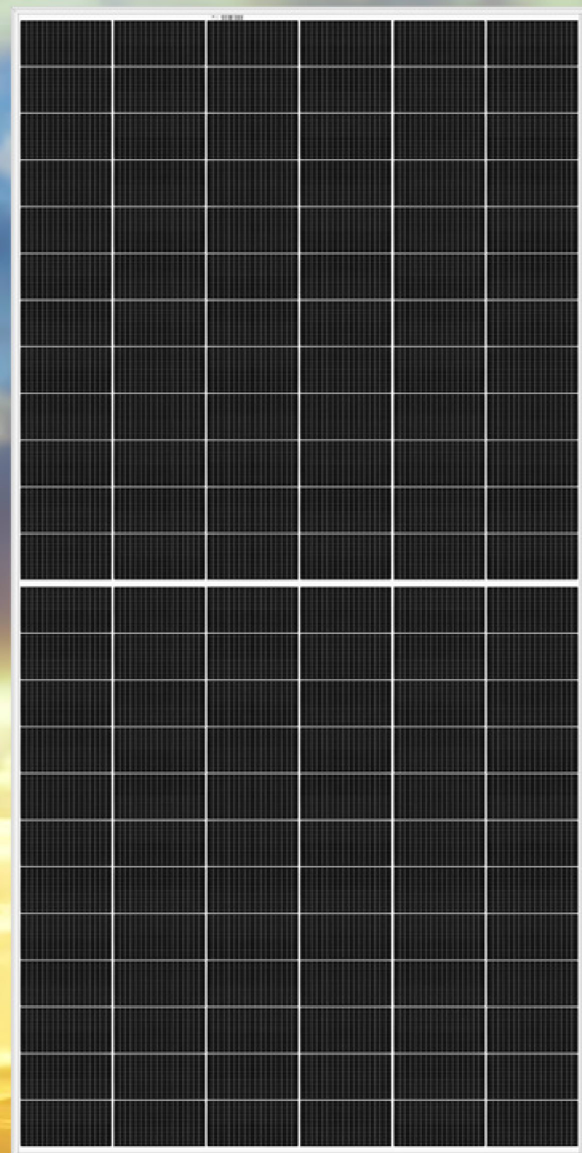
STRUCTURAL REGISTERED PROFESSIONAL ENGINEER
78254
Kevin Wilger
OREGON
MAY 16, 2006
KEVIN WILGER

RENEWS: 6/30/2022

SOLAR'S MOST TRUSTED

REC

REC ALPHα 72 SERIES



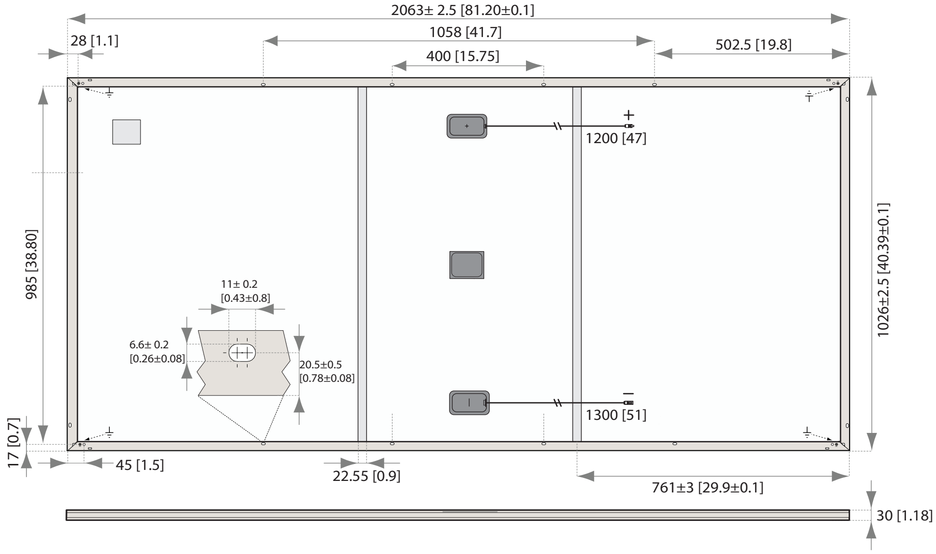
450 WP POWER

inter solar award 2020 WINNER

EXPERIENCE α PERFORMANCE

REC ALPHA 72 SERIES

PRODUCT DATASHEET



Measurements in mm [in]

GENERAL DATA

Cell type:	144 half-cut cells with REC heterojunction cell technology 6 strings of 24 cells in series	Connectors:	Stäubli MC4 Evo 2 PV-KBT4-EVO-2/PV-KST4-EVO-2 (4 mm²) in accordance with IEC 62852 IP68 only when connected
Glass:	0.13 in (3.2 mm) solar glass with anti-reflection surface treatment	Cable:	12 AWG (4 mm²) PV wire, 47 + 51 in (1.2 + 1.3 m) in accordance with EN 50618
Backsheet:	Highly resistant polymeric construction	Dimensions:	81.2 x 40.39 x 1.18 in (2063 x 1026 x 30 mm) 22.7 sq ft (2,12 m²)
Frame:	Anodized aluminum	Weight:	52 lbs (23,5 kg)
Junction box:	3-part, 3 bypass diodes, IP67 rated in accordance with IEC 62790	Origin:	Made in Singapore

ELECTRICAL DATA

Product Code*: RECxxxAA 72

STC	Power Output - P_{MAX} (Wp)	430	435	440	445	450
	Watt Class Sorting - (W)	-0/+5	-0/+5	-0/+5	-0/+5	-0/+5
	Nominal Power Voltage - V_{MPP} (V)	44.1	44.5	44.8	45.3	45.6
	Nominal Power Current - I_{MPP} (A)	9.76	9.79	9.84	9.85	9.88
	Open Circuit Voltage - V_{OC} (V)	52.6	52.8	52.9	53.0	53.1
	Short Circuit Current - I_{SC} (A)	10.46	10.50	10.52	10.54	10.55
	Power Density (W/sq ft)	203.79	206.16	208.53	210.90	213.27
	Panel Efficiency (%)	20.3	20.6	20.8	21.0	21.3
NMOT	Power Output - P_{MAX} (Wp)	328	332	336	339	343
	Nominal Power Voltage - V_{MPP} (V)	41.6	41.9	42.2	42.7	43.0
	Nominal Power Current - I_{MPP} (A)	7.88	7.91	7.95	7.95	7.98
	Open Circuit Voltage - V_{OC} (V)	49.6	49.8	49.8	49.9	50.0
	Short Circuit Current - I_{SC} (A)	8.45	8.48	8.50	8.51	8.52

Values at standard test conditions (STC: air mass AM 1.5, irradiance 10.75 W/sq ft (1000 W/m²), temperature 77°F (25°C), based on a production spread with a tolerance of P_{MAX}, V_{OC} & I_{SC} ±3% within one watt class.
Nominal module operating temperature (NMOT: air mass AM 1.5, irradiance 800 W/m², temperature 68°F (20°C), windspeed 3.3 ft/s (1 m/s).
*Where xxx indicates the nominal power class (P_{MAX}) at STC above and is followed by the suffix XV for 1500V rated modules.

CERTIFICATIONS

IEC 61215:2016, IEC 61730:2016, UL 61730	
IEC 62804	PID
IEC 61701	Salt Mist
IEC 62716	Ammonia Resistance
UL 1703	Fire Type Class 2
IEC 62782	Dynamic Mechanical Load
IEC 61215-2:2016	Hailstone (35mm)
AS4040.2 NCC 2016	Cyclic Wind Load
ISO 14001:2004, ISO 9001:2015, OHSAS 18001:2007, IEC 62941	

WARRANTY

	Standard	REC ProTrust	
Installed by an REC Certified Solar Professional	No	Yes	Yes
System Size	All	≤25 kW	25-500 kW
Product Warranty (yrs)	20	25	25
Power Warranty (yrs)	25	25	25
Labor Warranty (yrs)	0	25	10
Power in Year 1	98%	98%	98%
Annual Degradation	0.25%	0.25%	0.25%
Power in Year 25	92%	92%	92%

See warranty documents for details. Conditions apply.

MAXIMUM RATINGS

Operational temperature:	-40 ... +85°C
Maximum system voltage:	1500 V
Design load (+): snow Maximum test load (+):	3600 Pa (75.2 lbs/sq ft)* 5400 Pa (112.8 lbs/sq ft)*
Design load (-): wind Maximum test load (-):	1600 Pa (33.4 lbs/sq ft)* 2400 Pa (50.1 lbs/sq ft)*
Max series fuse rating:	25 A
Max reverse current:	25 A

* Calculated using a safety factor of 1.5
*See installation manual for mounting instructions

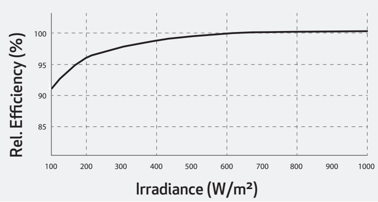
TEMPERATURE RATINGS*

Nominal Module Operating Temperature:	44°C (±2°C)
Temperature coefficient of P_{MAX}:	-0.26 %/°C
Temperature coefficient of V_{OC}:	-0.24 %/°C
Temperature coefficient of I_{SC}:	0.04 %/°C

*The temperature coefficients stated are linear values

LOW LIGHT BEHAVIOUR

Typical low irradiance performance of module at STC:



Specifications subject to change without notice.

Ref: PM-DS-12-03-Rev- B 08.20

REC Group is an international pioneering solar energy company dedicated to empowering consumers with clean, affordable solar power in order to facilitate global energy transitions. Committed to quality and innovation, REC offers photovoltaic modules with leading high quality, backed by an exceptional low warranty claims rate of less than 100ppm. Founded in Norway in 1996, REC employs 2,000 people and has an annual solar panel capacity of 1.8 GW. With over 10 GW installed worldwide, REC is empowering more than 16 million people with clean solar energy. REC Group is a Bluestar Elkem company with headquarters in Norway, operational headquarters in Singapore, and regional bases in North America, Europe, and Asia-Pacific.

REC

www.recgroup.com

SUNNY TRIPOWER CORE1 33-US / 50-US / 62-US

Fully integrated

- Innovative design requires no additional racking for rooftop installation
- Integrated DC and AC disconnects and overvoltage protection
- 12 direct string inputs for reduced labor and material costs

Increased power, flexibility

- Multiple power ratings for small to large scale commercial PV installations
- Six MPP trackers for flexible stringing and maximum power production
- OptiTrac™ Global Peak shade tolerant MPP tracking

Enhanced safety, reliability

- Integrated SunSpec PLC signal for module-level rapid shutdown compliance to 2017 NEC
- Next-gen DC AFCI arc-fault protection certified to new Standard UL 1699B

Smart monitoring, control, service

- Advanced smart inverter grid support capabilities
- Increased ROI with SMA ennexOS cross sector energy management platform
- SMA Smart Connected proactive O&M solution reduces time spent diagnosing and servicing in the field

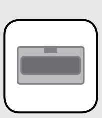
SUNNY TRIPOWER CORE1 33-US / 50-US / 62-US

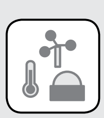
It stands on its own

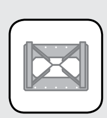
The Sunny Tripower CORE1 is the world's first free-standing PV inverter for commercial rooftops, carports, ground mount and repowering legacy solar projects. Now with expanded features and new power classes, the CORE1 is the most versatile, cost-effective commercial solution available. From distribution to construction to operation, the Sunny Tripower CORE1 enables logistical, material, labor and service cost reductions. Integrated SunSpec PLC for rapid shutdown and enhanced DC AFCI arc-fault protection ensure compliance to the latest safety codes and standards. With Sunny Tripower CORE1 and SMA's ennexOS cross sector energy management platform, system integrators can deliver comprehensive commercial energy solutions for increased ROI.

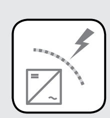
Technical data*	Sunny Tripower CORE1 33-US	Sunny Tripower CORE1 50-US	Sunny Tripower CORE1 62-US
Input (DC)			
Maximum array power	50000 Wp STC	75000 Wp STC	93750 Wp STC
Maximum system voltage	1000 V		
Rated MPP voltage range	330 V ... 800 V	500 V ... 800 V	550 V ... 800 V
MPPT operating voltage range	150 V ... 1000 V		
Minimum DC voltage / start voltage	150 V / 188 V		
MPP trackers / strings per MPP input	6 / 2		
Maximum operating input current / per MPP tracker	120 A / 20 A		
Maximum short circuit current per MPPT / per string input	30 A / 30 A		
Output (AC)			
AC nominal power	33300 W	50000 W	62500 W
Maximum apparent power	33300 VA	50000 VA	66000 VA
Output phases / line connections	3 / 3-(N)-PE		
Nominal AC voltage	480 V / 277 V WYE		
AC voltage range	244 V ... 305 V		
Maximum output current	40 A	64 A	79.5 A
Rated grid frequency	60 Hz		
Grid frequency / range	50 Hz, 60 Hz / -6 Hz ... +6Hz		
Power factor at rated power / adjustable displacement	1 / 0.0 leading ... 0.0 lagging		
Harmonics THD	<3 %		
Efficiency			
CEC efficiency (preliminary)	97.5%	98%	98%
Protection and safety features			
Load rated DC disconnect	●		
Load rated AC disconnect	●		
Ground fault monitoring: Riso / Differential current	● / ●		
DC AFCI arc-fault protection	●		
SunSpec PLC signal for rapid shutdown	●		
DC reverse polarity protection	●		
AC short circuit protection	●		
DC surge protection: Type 2 / Type 1+2	○ / ○		
AC surge protection: Type 2 / Type 1+2	○ / ○		
Protection class / overvoltage category (as per UL 840)	I / IV		
General data			
Device dimensions (W / H / D)	621 mm / 733 mm / 569 mm (24.4 in x 28.8 in x 22.4 in)		
Device weight	84 kg (185 lbs)		
Operating temperature range	-25 °C ... +60 °C (-13 °F ... +140 °F)		
Storage temperature range	-40 °C ... +70 °C (-40 °F ... +158 °F)		
Audible noise emissions (full power @ 1m and 25 °C)	65 dB (A)		
Internal consumption at night	5 W		
Topology	Transformerless		
Cooling Concept	OptiCool (forced convection, variable speed fans)		
Enclosure protection rating	Type 4X, 3SX (as per UL 50E)		
Maximum permissible relative humidity (non-condensing)	100 %		
Additional information			
Mounting	Free-standing with included mounting feet		
DC connection	Amphenol UTX PV connectors		
AC connection	Screw terminals - 4 AWG to 4/0 AWG CU/AL		
LED indicators (Status / Fault / Communication)	●		
Network interfaces: Ethernet / WLAN / RS485	● (2 ports) / ● / ○		
Data protocols: SMA Modbus / SunSpec Modbus / Webconnect	● / ● / ●		
Multifunction relay	●		
OptiTrac Global Peak (shade-tolerant MPP tracking)	●		
Integrated Plant Control / Q on Demand 24/7	● / ●		
Off-Grid capable / SMA Fuel Save Controller compatible	● / ●		
SMA Smart Connected (proactive monitoring and service support)	●		
Certifications (pending as of June 2018)			
Certifications and approvals	UL 1741, UL 1699B, UL 1998, IEEE 1547, CAN/CSA-C22.2 No. 62109		
FCC compliance	FCC Part 15 Class A		
Grid interconnection standards	UL 1741 SA - CA Rule 21, HECO Rule 14H		
Advanced grid support capabilities	L/HFRT, L/HVRT, Volt-VAr, Volt-Watt, Frequency-Watt, Ramp Rate Control, Fixed Power Factor		
Warranty			
Standard	10 years		
Optional extensions	15 / 20 years		
○ Optional features ● Standard features – Not available	* Preliminary data as of June 2018		
Type designation	STP33-US-41	STP50-US-41	STP62-US-41

Accessories


SMA Data Manager M
EDMM-US-10


SMA Sensor Module
MD.SEN-US-40


Universal Mounting System
UMS_KIT-10


AC Surge Protection Module Kit
AC_SPD_KIT1-10, AC_SPD_KIT2_T1T2
DC Surge Protection Module Kit
DC_SPD_KIT4-10, DC_SPD_KIT5_T1T2

Toll Free +1 888 4 SMA USA
www.SMA-America.com

SMA America, LLC

OWN THE ROOF

SunModo offers the next generation Flat Roof Mount System with SunTurf™. The streamlined design is robust, versatile, and specially engineered for multiple configurations.

By spanning over roof obstructions, the system takes full advantage of the available roof surface thereby maximizing the PV system size and increasing your ROI.

The SunTurf™ Roof Mount Advantage

- ✓ Elevated solar arrays to maximize roof space and system size.
- ✓ Easy access to roof surfaces for maintenance and repair.
- ✓ Components optimized for strength, durability and fast installation.
- ✓ Easily scalable from kilowatts to multimegawatts PV Arrays.
- ✓ UL 2703 Listed by Intertek.

Key Features of SunTurf™ Ground Mount System

SUNMODO
We've Got Your Rack!

The SunTurf™ flat roof system is perfect to elevate above obstructions such as HVAC, Pipes and Vents. The streamlined design combines the simplicity of a pipe-based system with next-level engineering. No drilling is required to attach the aluminum rails to the horizontal pipe. The system can be easily adjusted to account for multiple roof pitches on site.

Technical Data

Application	Flat Roof
Material	High grade aluminum, galvanized steel and 304 stainless steel hardware
Module Orientation	Portrait and landscape
Tilt Angle	Range between 10 to 50 degrees
Mounting Options	Wood roof joists, metal beams and concrete roof surfaces
Structural Integrity	IBC compliant, stamped engineering letters available
Certification	UL 2703 Listed by ETL
Warranty	20 Years

Statement of Qualifications

ADVANCED
ENERGY
SYSTEMS

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A1. HISTORY & ORGANIZATION

Advanced Energy Systems LLC (AES), founded in 2002, embodies 25 years of hands-on involvement in the renewable energy industry and is, today, the leading commercial solar integrator in Oregon. AES provides turn-key systems including, site evaluation, energy analysis, tax and utility incentive administration, engineering, design, project management, as well as remote monitoring and system maintenance.

AES specializes in commercial, municipal, and industrial solar electric systems, with dozens of installations in all parts of the state. Our local design team, installation crew, and management staff provide broad experience and an in-depth understanding of all aspects of Oregon's renewable energy sector. Since 2002, AES has installed the majority of commercial solar energy systems in Oregon.

Remaining at the forefront of the state's developing green economy, AES has, in many instances, partnered with local equipment manufacturers, by installing modules built in Hillsboro, inverters assembled in Bend, and metal racking formed in Portland. We are proud of this utilization of local materials and services, which helps Oregon's local economy. The resultant shortened shipping distances and simplified logistics with local suppliers also increases overall economy and measured sustainability in our projects.

A2. TEAM QUALIFICATIONS

Eric Nill,
Principal, Managing Member LLC

Eric is privileged to lead the company's team of 22 solar professionals that includes electricians, solar technicians, plumbers, PV systems designers, sales consultants and administrative staff. In 2010, Eric was elected to the Board of Directors of the Oregon Solar Industries Association (OSEIA), serving a second term as Board vice-chair. He is an Oregon Department of Energy Tax Credit Certified Technician and holds a Certificate from NABCEP in PV technology.

Previously, Eric served as CTO and construction manager for the Guaranty group of auto and RV dealerships with locations in Oregon, California and Arizona. Prior to joining Guaranty, Eric founded, and managed, Valhall, Inc., a company that built energy-efficient and affordable housing using factory processes developed in Sweden. Eric holds an M.A. in International Studies (focused in resource economics) and MBA from the University of Oregon and a B. A. in International Relations from Pomona College.

Ken DenOuden
Senior Project Manager, Supervising Electrician

A native Oregonian, Ken was born and raised in the Eugene area. He is a graduate of the University of Oregon with a degree in economics and business administration. Having worked for more than two decades with major electrical contractors in the Oregon region, Ken has a deep background in all phases of electrical construction, budgeting, and project management.

Ken has an Oregon Journeyman Electrical License, an Oregon Supervising Electrical License, an Idaho Master Electrical License, and is a NABCEP certified solar installer. With an interest in solar and renewable energy since childhood, Ken is dedicated to expanding the utilization of renewable energy in the marketplace. Ken's specific expertise includes:

- 25+ years of experience in construction and electrical design. Has been employed by Advanced Energy Systems for 13 Years as lead electrical designer, PM, and supervising electrician.
- NABCEP certified Solar PV Installer – 091110-27
- Supervising Electrician State of Oregon - 5253S
- Project Managed installation of over 16MW of Solar PV.
- Lead electrical design professional
- Management of design team members
- Project Management Professional (PMP) - 1514122

Thomas Brex
Director of Operations, Lead Solar PV Layout Designer & Project Manager

Thomas has been with Advanced Energy Systems for twelve years. He has substantial expertise in the Computer Assisted Design, layout, material integration, installation, and procurement relating to solar PV systems. Having completed advanced studies in solar technologies, Thomas also has a Bachelor of Arts degree in Religion and Philosophy from Prescott College in Prescott Arizona.

Since joining Advanced Energy Systems, Thomas has contributed to hundreds of solar installations. Thomas has vast experience with project development, project management, contract negotiation, system design, grant writing, coordination with engineers, permitting, material procurement, scheduling, field team support, owner training, and warranty service.

Paul Vermilyea
Construction Superintendent

Paul is among the most experienced Solar PV installers in the State of Oregon having personally supervised the installation of over 16 MW of solar capacity, as well as dozens of battery and generator projects during his professional career. Paul has been employed by Advanced Energy Systems for 15 years. He has an outstanding record of supervising multiple teams of electricians and solar installers. Paul is also the service director and normally the company's interface with building and electrical inspectors at job completion.

- Journeyman Electrician State of Oregon - 21079J

A3. BUSINESS LICENSES & PROFESSIONAL CERTIFICATIONS

Advanced Energy Systems, LLC was incorporated within the State of Oregon in 2004. AES is in good standing with the Secretary of State of Oregon and with all of its licensing bodies. AES's relevant licenses include:

License	License Number
Oregon General Contractor License	CCB 160523
Oregon Electrical Contractor License	C341
Oregon Plumbing Contractor License	20-431PB
NABCEP Certification	091110-27
Energy Trust of Oregon Solar Trade Ally	1006
ODOE Solar Tax Credit Technician	

Figure 1: AES Licenses & Certifications

A4. REPRESENTATIVE PROJECTS

CASE STUDY #1: OREGON DEPARTMENT OF TRANSPORTATION 1.75 MW BALDOCK PROJECT

The Oregon Department of Transportation in partnership with Solar Way (a consortium comprised of **Advanced Energy Systems**, **Moyano Group**, PGE, US Bank, Aadland Evans, **Good Company**, Energy Trust of Oregon, Oregon Department of Energy, Solar World, PV Powered, and United Fund Advisors), activated a 1.75 MW Solar Electric System on the I-5 Baldock Rest Area near Aurora, Oregon. The system feeds directly into the PGE grid to offset ODOT highway lighting energy needs. The system is a showcase for Oregon's emerging green technology sector because the manufacturer of the solar modules and inverters, as well as the engineers, and construction contractors are all located in Oregon.

Figure 1: ODOT Baldock Rest Area

CASE STUDY #2 TOYOTA OF CORVALLIS - NET ZERO, LEED PLATIMUN BUILDING

AES completed a 274 kW installation for Toyota of Corvallis. The array covers the roof of the new building designed to be a model of efficiency. The building was awarded LEED Platinum, the highest standard measured by the US Green Building Council.

The system uses SolarWorld PV modules on a ballasted racking system, and three Solectria PVI 75 inverters.

Figure 2: Toyota of Corvallis

CASE STUDY #3: EWEB HOWARD ELEMENTARY SCHOOL BESS

Eugene Water and Electric Board (EWEB) and The Eugene School District 4J partnered to construct a 560kW, 480VAC, 1020kWh BESS system. EWEB owns the BESS and supplies energy and backup power to the school. The project is being used as a test case by EWEB and is also paired with a newly installed water well to be used for neighborhood emergency water in the event of a major disruption.
AES partnered with WorleyParsons to design in install this project.

Figure 3: Howard Elementary School BESS

CASE STUDY #4: OREGON MILITARY DEPARTMENT JOINT FORCE HQ

Oregon Military built their new HQ in Salem with a 120kW Solar Photovoltaic System mounted to the metal Standing Seam roof.

The system comprised of 348 Solarworld 345 watt modules, Solaredge inverters, and an Ironridge racking system. It produces approximately 144,000 kWh of electricity per year. During the system's estimated 35 year lifespan, the energy produced will offset over 3,700 tons of CO_2, 390,000 gallons of gasoline, or over 28 acres of forest preserved from deforestation.

Figure 6: Oregon Military Joint Force HQ

CASE STUDY #5: JUNCTION CITY HIGH SCHOOL

AES completed a 74 kW installation for the Junction City School District. The array covers the roof of the new classroom building designed to offset a portion of the schools energy consumption. Built off of the standing seam roofing, the array is flush mounted using S-5! Standing seam clamps and a Sunmodo racking system.

The system uses SolarWorld PV modules, Solaredge DC to DC optimizers and Inverters.

Figure 5: Junction City High School

For more project examples, please see our website's commercial and municipal projects page: http://aesrenew.com/commercial-projects/