CITY OF SACRAMENTO

1231 I Street, Sacramento, CA 95814

Permit No: 0000766

Insp Area: 3

Site Address: 4758 8TH AV SAC
Parcel No: 015-0113-006

Sub-Type: AOTHR
Housing (Y/N): N

CONTRACTOR
UTILITY POWER GROUP
1 LIGHT SKY CT
SAC CA

OWNER
KITCHENS MYRNA L
4758 8TH AV
SACRAMENTO CA 95820

ARCHITECT

Nature of Work: INSTALL SOLAR ELECTRIC PHOTOVOLTAIC SYSTEM.

CONSTRUCTION LENDING AGENCY : I hereby affirm under penalty of perjury that there is a construction lending agency for the performance of the work for which this permit is issued (Sec. 3097, Civ. C).

Lender's Name_____ Lender'sAddress_____

LICENSED CONTRACTORS DECLARATION: I hereby affirm under penalty of perjury that I am licensed under provisions of Chapter 9 (commencing with section 7000) of Division 3 of the Business and Professions Code and my license is in full force and effect.

License Class_____ License Number 75ACAC Date 3/3/00 Contractor Signature_____

OWNER-BUILDER DECLARATION: I hereby affirm under penalty of perjury that I am exempt from the contractors License Law for the following reason (Sec. 7031.5, Business and Professions Code; any city or county which requires a permit to construct, alter, improve, demolish, or repair any structure, prior to its issuance, also requires the applicant for such permit to file a signed statement that he or she is licensed pursuant to the provisions of the Contractors License Law (Chapter 9 (commencing with Section 7000) of Division 8 of the Business and Professions Code) or that he or she is exempt therefrom and the basis for the alleged exemption. Any violation of Section 7031.5 by any applicant for a permit subjects the applicant to a civil penalty of not more than five hundred dollars ($500.00):

_____ I, as a owner of the property, or my employees with wages as their sole compensation, will do the work, and the structure is not intended or offered for sale (Sec. 7044, Business and Professional Code: The Contractors License Law does not apply to an owner of property who builds or improves thereon, and who does such work himself or herself or through his/her own employees, provided that such improvements are not intended or offered for sale. If, however, the building or improvement is sold within one year of completion, the owner-builder will have the burden of proving that he/she did not build or improve for the purpose of sale.)

_____ I, as owner of the property, am exclusively contracting with licensed contractors to construct the project (Sec. 7044, Business and Professions Code: The Contractors License Law does not apply to an owner of property who builds or improves thereon, and who contracts for such projects with a contractor(s) licensed pursuant to the Contractors License Law).

_____ I am exempt under Sec._____ B & PC for this reason:_____

Date_____ Owner Signature_____

IN ISSUING THIS BUILDING PERMIT, the applicant represents, and the city relies on the representation of the applicant, that the applicant verified all measurements and locations shown on the application or accompanying drawings and that the improvement to be constructed does not violate any law or private agreement relating to permissible or prohibited locations for such improvements. This building permit does not authorize any illegal location of any improvement or the violation of any private agreement relating to location of improvements.

I certify that I have read this application and state that all information is correct. I agree to comply with all city and county ordinances and state laws relating to building construction and herby authorize representative(s) of this city to enter upon the above-mentioned property for inspection purposes.

Date 3/3/00 Applicant/Agent Signature_____

WORKER'S COMPENSATION DECLARATION: I hereby affirm under penalty of perjury one of the following declarations:
_____ I have and will maintain a certificate of consent to self-insure for workers' compensation as provided for by Section 3700 of the Labor Code, for the performance of work for which the permit is issued.

_____ I have and will maintain workers' compensation insurance, as required by Section 3700 of the Labor Code, for the performance of the work for which this permit is issued. My workers' compensation insurance carrier and policy number are:

Carrier THE TRAVELERS INDEMNITY OF ILL Policy Number TC2JUB229T592A99 Exp Date 05/01/2000

_____ (This section need not be completed if the permit is for $100 or less) I certify that in the performance of the work for which this permit is issued, I shall not employ any person in any manner so as to become subject to the workers' compensation laws of California and agree that if I should become subject to the workers' compensation provisions of Section 3700 of the Labor Code, I shall forthwith comply with those provisions.

Date 3/3/00 Applicant Signature_____

WARNING: FAILURE TO SECURE WORKER'S COMPENSATION COVERAGE IS UNLAWFUL AND SHALL SUBJECT AN EMPLOYER TO CRIMINAL PENALTIES AND CIVIL FINES UP TO ONE HUNDRED THOUSAND DOLLARS ($100,000) IN ADDITION TO THE COST OF COMPENSATION, DAMAGES AS PROVIDED FOR IN SECTION 3706 OF THE LABOR CODE, INTEREST AND ATTORNEY'S FEE.

THIS PERMIT SHALL EXPIRE BY LIMITATION IF WORK IS NOT COMMENCED WITHIN 180 DAYS.

UTILITY POWER GROUP

9410-G DeSoto Avenue ❖ Chatsworth, California 91311 ❖ USA
(818) 700-1995 ❖ Fax (818) 700-2518

April 29, 1999

County of Sacramento
Building Inspection Division
827 7th Street, Room 102
Sacramento, CA 95817

Dear Sirs:

As prime contractor for SMUD's Solar Program, Utility Power Group hereby authorizes SMUD to act as our agent in obtaining permits for the projects.

Sincerely,

Gilbert Duran
Operations Manager

P2 [illegible]-0210 Revised Contract due to cost

Sacramento Municipal Utility District

PV PIONEER II PURCHASE AGREEMENT for MODULAR SYSTEMS

Buyer's Name Myrna L. Kitchens

PV Installation Address 4758 8th Avenue Sacramento, CA 9582

Mailing Address 4758 8th Avenue Sacramento, CA Zip Code 95820

Home Phone No. 451-7732 Work Phone No. 748-7887 Best Time To Call 2 ☐ a.m. ☒ p.m

The undersigned hereby contracts with and authorizes the Sacramento Municipal Utility District (SMUD) to furnish all necessary materials, labor and workmanship, to install, construct and place the improvements in accordance with the plans and specifications as herein described. SMUD will schedule the installation date with the Buyer.

SMUD Agrees to:
SMUD will provide the installed PV Pioneer II system for the sales price stated below. SMUD's Contractor(s) will install a PV Pioneer II System in compliance with SMUD's Interconnection Requirements, perform all work in a good workmanship like manner, maintain proper workman's compensation insurance, and shall comply with California Contractor's License regulations.

Buyer Agrees to:
Buyer will abide by the terms and conditions of the PV Pioneer II Purchase, Net Metering, Interconnection and Assignment of Warranties for Modular Systems Agreements. Buyer shall permit SMUD and its Contractors access to the PV Pioneer II site for system installations and inspections, maintenance, and/or monitoring. Owners of non-SMUD financed systems will provide to SMUD a $500 down payment prior to the installation. The balance of the Buyer's cost will be paid to SMUD within 30 days of the Buyer's receipt of the "Notice of Completion" provided by SMUD.

PV PIONEER II SYSTEM DESCRIPTION

Rated Output	Modular Package System Description
1716 Watts (AC)	52 PV Modules ☐ EPV ☒ Solarex Millenium ☐ Other 1 Inverter(s) Balance of System

Buyers Cost
PV Pioneer II System Cost *(including sales tax)* = $4066.92

* UPG-MATT To give Cost going thru roof to panel inside home

Non-SMUD Financed Systems
Buyer's Cost $_____ - $500 Down Payment = $_____ due SMUD within 30 days of Invoice

SMUD Financed Systems
Buyer's Cost $4066.92 + Application Fee $50.00 Optional Down Payment $0 = Loan Amount $4116.92

ACCEPTANCE OF PROPOSAL - The above prices, specifications and conditions are satisfactory and are hereby accepted. Additional Terms and Conditions are attached hereto and incorporated herein.

Myrna L. Kitchens 10/27/99
Signature of Buyer *Date* *Signature of Co-Buyer* *Date*

[signature] 10-27-99 732-6362
SMUD Representative Signature *Date* *Phone No.*

FOR ACCOUNTING USE ONLY **Area 152/CC 718/Distribution # 704502**

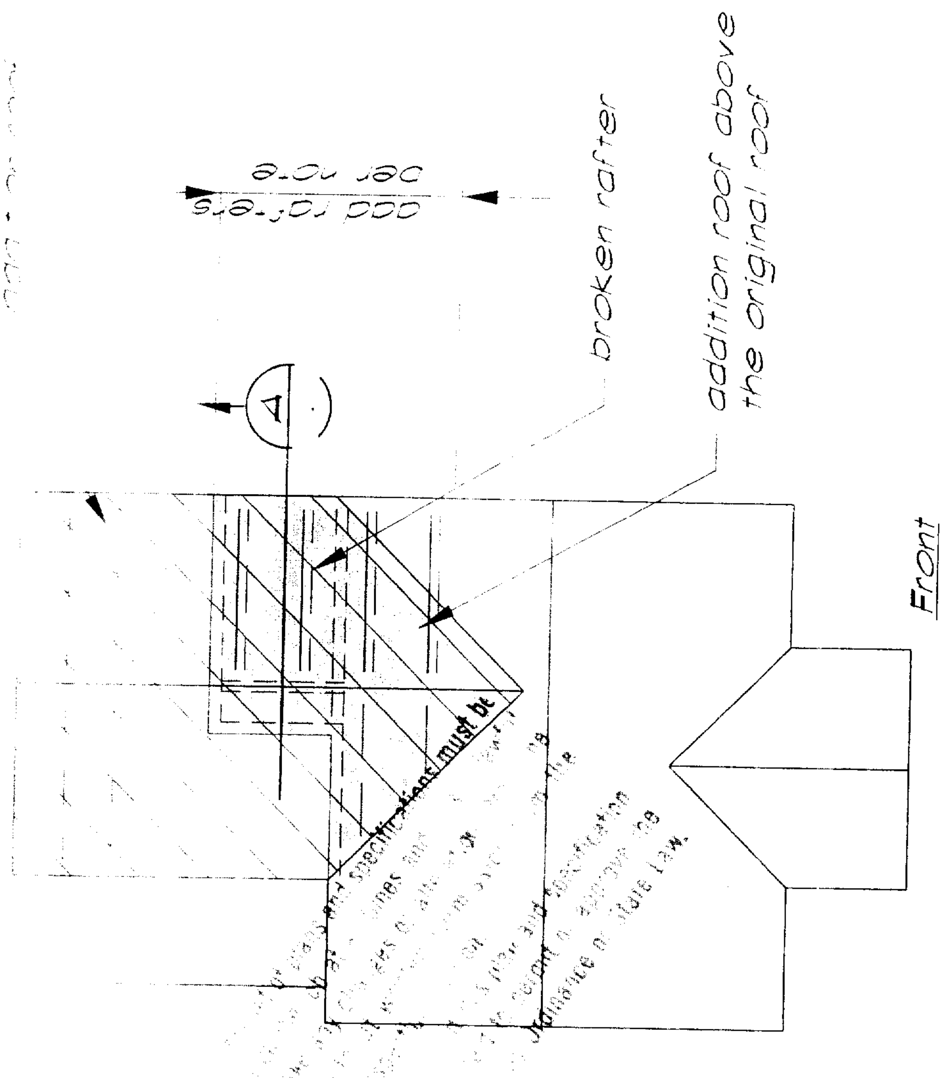
SMUD [illegible]

WHITE - PVDT **YELLOW** - SMUD File **PINK** - Buyer

BUEHLER & BUEHLER ASSOCIATES
STRUCTURAL ENGINEERS, INC.
[illegible] Folsom Blvd Suite [illegible]
[illegible]RAMENTO CALIFORNIA 95826

JOB SMUD Solar
JOB NO 9924200 DATE 2-9-00
CLIENT SMUD BY BCM SHEET NO

ISSUED
MAR 0 3 2000
Sacramento Building Division



Roof Framing Plan — no scale

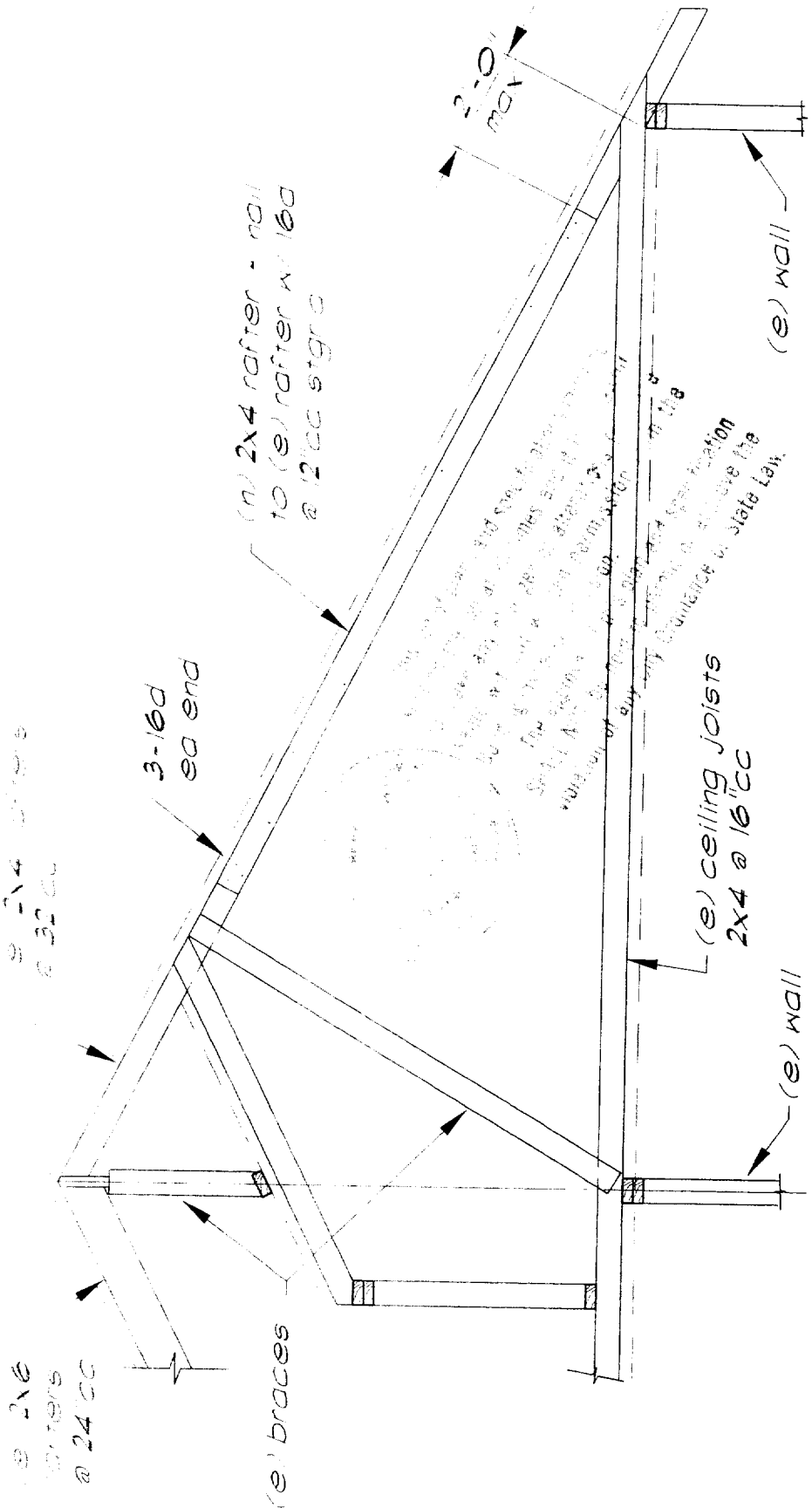
REGISTERED PROFESSIONAL ENGINEER
M. TODD THORP
No. 2990
Exp. 6/30/00
STRUCTURAL
STATE OF CALIFORNIA

Notes:

1. 2x4 rafters in this area of the addition roof above the original house shall be doubled by added a new 2x4 nailed to each existing rafter. Nail the new rafter to the existing with 16d @ 12"cc stgr'd. The new rafter shall extend to within 2'-0" of the support.

BUEHLER & BUEHLER ASSOCIATES
STRUCTURAL ENGINEERS, INC.
[illegible] Folsom Blvd Suite [illegible]
[illegible] RAMENTO CALIFORNIA 95826

JOB SMUD Solar
JOB # 9924200 DATE 2-9-00
CLIENT SMUD BY BCM SHEET NO



Section A — ½"=1'-0"

REGISTERED PROFESSIONAL ENGINEER
M. TODD THORP
No. 2990
Exp. 6/30/00
STRUCTURAL
CALIFORNIA

B&B

BUEHLER & BUEHLER
ASSOCIATES
STRUCTURAL
ENGINEERS

RECEIVED

JAN 26 2000

Building Inspection Division

January 19, 2000

Ms. Debbie Thompson
Sacramento Municipal Utility District
6301 S Street
Sacramento, CA 95817-1899

Subject: ***SMUD Solar - Kitchens Residence***
BBA Project No.: 99242.00

Dear Debbie,

We have visited the site and completed this report of our findings for the subject building. Please see the attached field observation and summary sheet for background information.

Our conclusion is that the roof structure of the subject building must be strengthened in order to make it suitable for the proposed installation of solar panels. Please see the attached sketches for remedial structural work.

This conclusion is based on our limited observations of the structure. Defects that we encountered have been noted. Other structural defects may be present in areas not subject to our observation.

Very truly yours,

Bruce Montgomery
BUEHLER & BUEHLER ASSOCIATES
Structural Engineers, Inc.

REGISTERED PROFESSIONAL ENGINEER
M. TODD
THORP
No. 2030
Exp. 6/30/00
STRUCTURAL
STATE OF CALIFORNIA

1918 [illegible]
FAX [illegible]

Matt P. 3/3/00

SMUD Solar - Structural Report
Field Observations and Summary Sheet

Owner	Myrna Kitchens
Address	4758 8th Avenue Sacramento, CA 95820
Date of site visit:	October 27, 1999.
Present	Debbie Thompson, Myrna Kitchens

General Description:
Single-story residence. Wood-frame construction. The house faces north. A ridge runs east to west over the front portion of the house. The ridge for the south (rear) portion of the house runs north and south, joining the main roof in valleys. The roof slope is 6:12 typically. Solar panels are to be placed on the south roof as shown on SMUD's Proposed P.V. System Plan. The present roof is composition shingles over 1/2 inch plywood.

Observations
Observations were made from the exterior and from above the ceiling. Access to the ceiling space was obtained from an access hatch in the laundry room. Observed roof framing appears to be dry and in good condition.

The original house was extended by an addition located to the south and east. The roof addition was built over the original roof. Framing for the addition is typically 2x6 rafters at 24"cc which are braced to the ceiling and partition walls at the ridge and midway between the ridge and wall.

Framing for the original house was 2x4 rafters at 32" cc. These rafters are braced to the ceiling below. The rafter spans approximately 10 feet between the wall and the brace point. One of the rafters has a split on the bottom edge.

Conclusions
The roof of the addition appears to have adequate capacity for the addition of the solar panels without modifications. The original roof will need strengthening in order to add solar panels. Calculated stresses for the rafters exceed code limits. Sketches of strengthening measures are attached to this report.

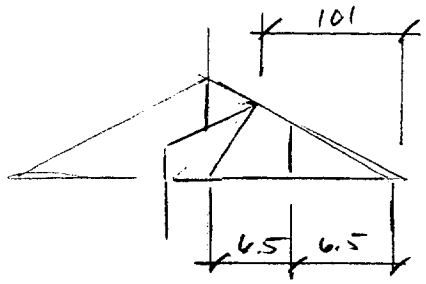
B&B

BUEHLER & BUEHLER ASSOCIATES
STRUCTURAL ENGINEERS, INC.
2300 Folsom Blvd. Suite 103
SACRAMENTO, CALIFORNIA 95826

JOB NO 99242 DATE 2/7/00
CLIENT SMVD BY SHEET NO. 1 of 2

Ceiling Joist

2x4 @ 16" oc
L = 13'-0



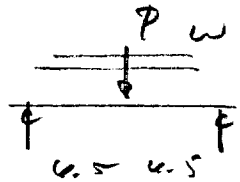
Assume DF #2
E = 1.7 x 10^6, f_b = 1290 psi

Table 25-U-J-1 max L = 11'-6"
f_b = 1310

Calc (5+10)(1.33) = 20 #/ft (17.3 LL)
$f_b = 1.5(20)(13^2)/3.57 = 1419$ psi
$\Delta_{LL} = 22.5(17.3)(13)^4/6.25(1.7\times10^6)$
= .80" = L/193

Ceiling joist w/ point load from rafter truss

Case I DL only



w = 5(1.33) = 6.7 #/ft
P = (5+4)(1.33)(5) = 60 #
(i.e. PV)
$M = \frac{6.7(13)^2}{8} + 60(13/4) = 336$ #'
$f_b = \frac{12M}{3.57} = 1131$ psi

Alt add 2x6 ceiling joist @ 16" oc

$f_b = \frac{12M}{7.56} = 533$ psi

@ 32" oc $f_b = 2(533) = 1067$ psi max
shared $\frac{20.8}{20.8+6.25} = .76$ 1067(.76) = 820 psi

BUEHLER & BUEHLER ASSOCIATES
STRUCTURAL ENGINEERS, INC.
300 Folsom Blvd. Suite 103
SACRAMENTO, CALIFORNIA 95826

JOB NO 9926 DATE 2/7/00
CLIENT SMUD BY SHEET NO. 2 of 2

Case II roof LL + DL

$P = 16(1.33)(5) = 107^{\#}$ LL
$+ 60 = 167^{\#}$ DL

$M = 6.7(13)^2/8 + 167(13/4) = 683^{\#'}$
141 541

2x6 $f_b = 12M/3.57 = 2396$ psi

alt add 2x6 @ 16" O.C.
$f_b = 12M/7.56 = 1084$ psi
share $1084(1.76) = 823$ psi

alt to reinf roof
dbl rafters 2x4 @ 16" max

$w = (5+4) + 16 = 25$ psf $\times 1.33$
9 DL LL $= 33$ #/'

$f_b = \frac{1.5(33)(10)^2}{3.06} = 1634$ psi

$F_b' = 1.5(875)(1.25) = 1640$ psi
ok //

Millennia MST-56, -50 & -43 Photovoltaic Modules

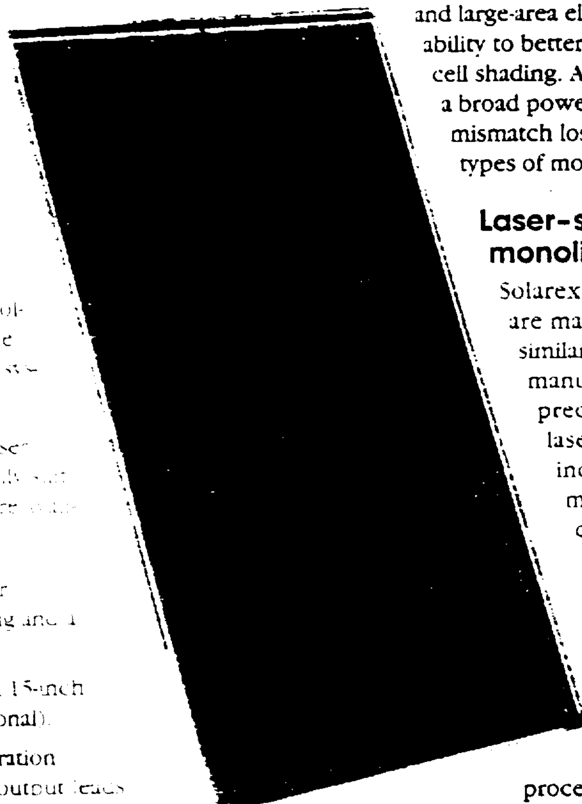
SOLAREX

MST-56, -50 and -43 modules are part of Solarex's Millennia™ line of photovoltaics, which uses advanced tandem-junction thin-film technology to transform light energy into electricity. Solarex is a pioneer in thin-film manufacturing, which creates solar cells by depositing semiconductor alloys in thin layers on glass, using less material than traditional sawn-wafer methods. A major development in both efficiency and stability, the tandem-junction cell stacks two cells vertically, with each cell tuned for optimum conversion of different spectral segments.

The MST-56, -50 and -43 are designed specifically for applications which require moderate to high DC voltage arrays, and can result in cost savings up to 25% in such arrays. These applications include residential, commercial, and industrial utility interactive arrays, building facades, and direct-coupled battery-less water pumping systems. EPRI has identified the Millennia technology as among the most promising in the [illegible] large-scale utility photovoltaic systems [illegible] programs.

[illegible] uniform color and precise laser [illegible] Millennia modules are especially [illegible] architectural applications. They are [illegible] configurations:

- [illegible] architectural-grade clear [illegible] extruded aluminum framing and a [illegible] junction box.
- double-glass frameless laminate with 15-inch output leads (mounting system optional).
- as a single-glass "plate"; this configuration includes no frame and no electrical output leads.



Stabilized, guaranteed power

All Solarex Millennia photovoltaics are fully derated [illegible] attenuation which occurs during the first week [illegible] thin film product's solar exposure. They are rated at their stabilized, rather than initial power values, and are guaranteed to deliver at least 80% of their rated minimum power ten years after purchase. Contact Solarex Marketing for full terms of this limited warranty.

When first deployed, a typical Millennia module [illegible] much as [illegible] above its rated power. In some applications this initial power bonus must be considered [illegible] power system components such as wiring, [illegible] switchgear.

Millennia array savings

Because these modules are designed specifically for medium- and high-voltage arrays, they can provide savings beyond their competitive price tags. A 200-volt array, for example, needs only three modules in series instead of the twelve needed with traditional modules, which can reduce interconnection time and materials.

Additional savings may be realized because a Millennia module doesn't require the protection of bypass diodes in a high-voltage array. Its microstructural uniformity and large-area electrical connections give it the ability to better withstand reverse voltages due to cell shading. Also, Millennia modules operate on a broad power curve, reducing the curve mismatch losses that can affect arrays of other types of modules.

Laser-scribed, monolithic structure

Solarex amorphous silicon modules are made by automated processes similar to the ones used in semiconductor manufacturing, producing a monolithic precision-coated module. A patented laser-scribing procedure forms individual solar cells within the module, with all intercell electrical connections *internal to the module*. Since the module has no intercell solder joints, it is innately reliable and unique among large power-producing photovoltaics.

The conductive oxide layer is applied by a proprietary process which results in excellent film uniformity, improved optical coupling and enhanced module efficiency. The combination of laser processing and our ultra-uniform textured tin oxide film produce a module which is both attractive and efficient. The laser's precision means cell divisions can be very thin, allowing more glass surface to be devoted to power production.

Enhanced on-site performance

Photovoltaic modules are rated under a set of standard conditions which include a solar spectrum approximating the spectrum at sea level at the Equator-often called the AM (for Air Mass) 1.5 spectrum. Recent U.S. government testing indicates that a Millennia module's efficiency actually increases at sites which are clearer than an AM 1.5 site, such as high-elevation sites.

630 Solarex Court, Frederick, Maryland 21703 USA • PHONE (301) 698-4200 • FAX (301) 698-4201

Attractive and uniform

These modules are extremely attractive, with a smooth, uniformly black surface ideal for many architectural applications. They provide an excellent match or contrast to many standard building materials.

Proven reliability and materials

The MST-56, -50, and -43 are designed to qualify under IEC 1646 (CEC 701) which includes tests measuring the effects of extended solar exposure, application of reverse voltage, robustness of terminations, hail impact, annealing, and:

- 200 cycles between -40°C and 90°C;
- 10 cycles between -40°C and 90°C at 85% relative humidity;
- wet high-voltage leakage (before and after above tests).

The materials in these modules reflect Solarex's 25 years of experience with modules and systems installed in virtually every climate on Earth. The modules are a lamination of two 3mm sheets of impact-resistant solar-grade glass with EVA (ethylene vinyl acetate) encapsulation providing a weatherproof seal. The framed versions are framed with corrosion-resistant, clear anodized extruded aluminum: strong, attractive framing compatible with Solarex mounting hardware and a broad range of other mounting structures.

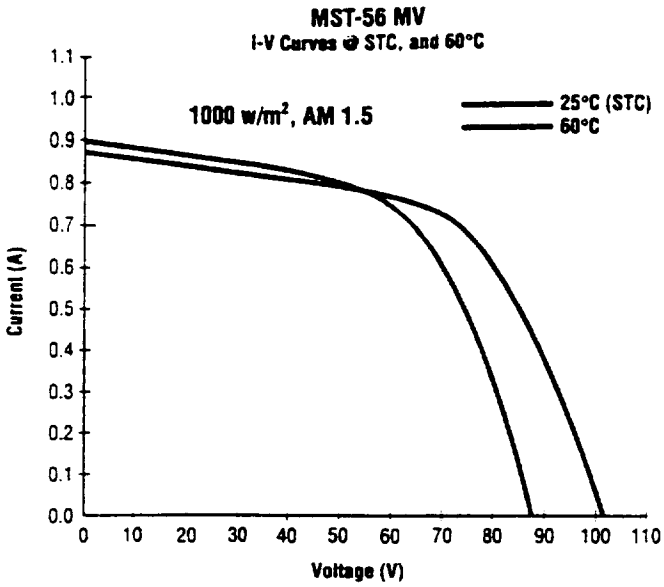
Safety approved

MST-56, -50, and -43 modules are listed by Underwriters Laboratory for electrical and fire safety.

MST-56 Power Output (W) at Various Irradiance Levels and Cell Temperatures*

Cell Temperature	Irradiance (W/m²)					
°C	100	300	600	800	1000	1200
[illegible]	5.53	17.95	36.29	48.31	60.09	71.38
[illegible]	5.12	16.78	33.89	45.18	56.00	66.82
[illegible]	4.69	15.48	31.48	41.82	51.67	61.53
[illegible]	4.21	14.08	28.60	37.97	47.11	56.00

* Note: The relationships between an MST module's power output and its temperature and irradiance are not linear. This table is useful in estimating exact output of an MST-56 at irradiance levels and cell temperatures other than STC. To estimate MST-50 and -43 output, apply the ratio of the modules' nominal powers to the table figures. That is, for MST-50 figures, multiply the table figures by 50/56, or 0.893; for the MST-43, multiply by 0.768.



Electrical Characteristics at STC[1]

	MST-56	MST-50	MST-43
Maximum power (P_{max})	56.0W	50.0W	43.0W
Voltage at P_{max}	73V	72V	71V
Current at P_{max}	0.761A	0.688A	0.616A
Open-circuit voltage (V_{oc})	102V	101V	101V
Short-circuit current (I_{sc})	0.871A	0.829A	0.787A
Guaranteed minimum P_{max}	53.0W	47.0W	38.7W
Nominal voltage (battery charging)	.....	48V	.....
Maximum system voltage	.....	600V	.....

(1) ***Important Note:*** When these MST modules are first deployed, their output characteristics are higher than the above figures. Power may be as much as 18% higher; voltage, 12% higher; and current, 6% higher. This initial power bonus must be considered when designing the power system.

The above data represent the performance of typical modules, after attenuation, as measured at their output terminals, and are based on measurements made at Standard Test Conditions (STC), which are:

- Illumination of 1 kW/m² (1 sun) with a spectral distribution of AM 1.5;
- Cell temperature of 25°C.

Mechanical Characteristics

Weight: (unframed) ..... 33±1 pounds (15 kg)

Thickness of laminate: ... 6.5±1mm

Framed module: ..... 26-1/4" X 48-3/8" X 2"

Frameless configurations: . 25-7/8" X 48" X 0.26" ± .025"

For more information, contact:

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

OMNION SERIES 2400 2.2 kW PCS SPECIFICATION
Model # 2.2-6-DID

This document represents specifications for an Omnion Series 2400 2.2 kW utility interconnected power conversion system for use with a photovoltaic array. The inverter shall be self-commutated utilizing insulated gate bi-polar transistors (IGBTs) in a circuit topology suitable for meeting the specifications delineated herein.

1.0 Codes and Standards

1.1 Equipment and services supplied shall be controlled to meet the guidelines for engineering design included in the standards and codes listed below. In case of conflict, this specification shall govern.

1.1.1 National Electrical Code - 1996

1.1.2 IEEE 929-1988 Recommended Practice for Utility Interface of Residential and Intermediate PV Systems

1.1.3 IEEE 519 - 1992 Guide for Harmonic Control and Reactive Compensation of Static Power Controllers

1.1.4 UL 1741-Standard for Power Conditioning Units for Use in Residential Photovoltaic Power Conditioning Systems.

1.1.5 UL 943 Standard for Ground Fault Sensing and Relaying Equipment

1.1.6 UL 1053 Standard for Ground Fault Circuit Interrupters

1.1.5 UL Photovoltaic Power Systems Accessory Equipment

1.1.6 FCC Part 15 Subpart B Class A and Class B for conducted limits

ENGINEERING

8952 NEW DAWN DRIVE
SACRAMENTO, CA 95826

GENE S. PORTER INC. (916) 362-4363 FAX (916) 362-1715

August 17, 1999

S.M.U.D.
P.O. Box 15830
Sacramento, CA

Re: P.V. System
Module Fastening
To Existing Roof Plywood

Atten: Dave W. Reinhart

Dear Dave:

I have reviewed the P.V. Module Fastening and prepared calculations verifying that two 5/16" x 2" S,S. lag screws per module are adequate to fasten modules to the existing roof plywood.

The lag screws are adequate to resist uplift and shear forces on modules.

8/16/99

REGISTERED PROFESSIONAL ENGINEER
GENE S. PORTER
CIVIL
STATE OF CALIFORNIA

EXP 3/31/01

Sincerely,

Gene S. Porter

Jefferson Shingleton, PE
Consulting Engineer

DATE: 4/10/98

CLIENT: **Solarex**
PROJECT: **MST-XX/R Sloped Roof Analysis**

Problem: Investigate the applicability of Solarex MST-XX/R modules for residential sloped-roof applications.

Discussion: The Solarex MST-XX/R module is designed to be mounted upon a roof surface by means of lag screws fastened through asphalt shingles into minimum 1/2" thickness plywood sheating in conventional sloped roof applications. As such, positive loads (acting downward on the module surface) are carried directly by the roof surface. Negative loads (uplift loads acting upward on the module surface) are transmitted to the roof sheathing by the development of withdrawal loads on the lag screws. This investigation will address the allowable withdrawal load for the lag screws in the roof sheathing, and will determine the corresponding maximum allowable design wind speed that achieves that maximum allowable lag screw withdrawal load for a variety of design conditions.

The specific roof types addressed here include one and two-story gable and hip-style roofs with a roof slope of between 10 and 45 degrees (pitch 2:12 to 12:12.)

The analysis will not address the maximum allowable pressure on the module. That has been addressed by full-scale load testing that has been performed on the MST-XX/R module by [illegible]

The analysis will not address the maximum allowable load on the roof, since this will be determined by the specific design of the roof under consideration. It can be said, however, that with the addition of the additional approximately 37 lb (4.2 psf) dead load that each TF module imposes on the roof surface the overall design loads on the roof will be essentially unchanged with the addition of the TF modules.

References

1) "ASCE 7-95 - Minimum Design Loads for Buildings and Other Structures", American Society of Civil Engineers, Reston, VA
2) "Guide to the Use of the Wind Load Provisions of ASCE 7-95", American Society of Civil Engineers, Reston, VA
3) **"National Design Specification for Wood Construction", National Forest Products** Association, Washington, DC

Procedure:

1) Calculate maximum allowable lag bolt design withdrawal load.
2) Calculate maximum allowable module design uplift pressure.
3) **Calculate maximum allowable design windspeed.**

Design Conditions:

Module Specifications

Ml := 48.39	Module Length, inches
Mw := 26.30	Module Width, inches
Mwt := 37	Module Weight, lbs

#11589

By Trial and Error, select V that results in design pressure equal to the maximum allowable uplift load determined by the lag screw analysis above:

$V := 146$ 3-second Gust Wind Speed, mph

Calculate q:

$Kz := 0.85$ Table 6-3, Exposure C; H,15 ft above ground

$Kzt := 1.0$ PV modules mounted upon the roof surface are considered to be "Components and Cladding" by ASCE 7-95, designed for Exposure C. So long as H is less than 30', speed-up effects from local terrain need not be considered, and Kzt = 1.0.

$I := 1.0$ Table 1-1 The Importance factor of 1.0 reflects the selection of a 50-year return period for the design wind speeds.

$q := 0.00256 \cdot Kz \cdot Kzt \cdot V^2 \cdot I$ **Equation 6-1**

$q = 46.384$ **psf**

Calculate P:

$GCp = -0.9$ Figure 6-5B, External Pressure Coefficients, GCp, for Loads on Building Components and Cladding for Enclosed or Partially enclosed Buildings with Mean Roof Height h Less than or Equal to 60 ft

$GCpi = -0.18$ Table 6-4 Internal Pressure Coefficients for Buildings, GCpi This internal pressure coefficient is chosen to reflect the partial pressure equalization that occurs on the back surface of air-permeable cladding, such as roof tiles

$P = q \cdot GCp + q \cdot GCpi$

$P = 50.091$ PSF, Pounds Per Square Foot

Result: The MST-XX/R module may be used as described for 3-second design wind speeds up to 146 mph.

The pressure coefficient, GCp, and the velocity pressure coefficient, Kz, depend on the height of the roof, the slope of the roof, the module location on the roof and the type of roof. For the gable and hip roof styles evaluated here, for roof slopes greater than 10 degrees (2:12 pitch) and less than 45 degrees (12:12 pitch), the pressure coefficient is higher for modules that are placed in the perimeter zone of the roof, defined by a border approximately 3' wide around the top, bottom and side edges of the roof. As a result, the maximum allowable design wind speed may be significantly lower in those cases.

In order to demonstrate the magnitude of these effects, the analyses described above were perfomed for a matrix of cases involving different roof heights and module locations on the roof. The results of these analyses are summarized in the following table:

Table of Maximum Allowable 3-Sec Gust Wind Speed, Mph, Gable or Hip-Style Roofs

Roof Slope:	10 - 30 Degrees		30 - 45 Degrees	
Roof Pitch:	2:12 - 7:12		7:12 - 12:12	
Roof Height	Module Location on Roof Center	Perimeter	Module Location on Roof Center	Perimeter
15'	146	100	140	129
30'	136	94	130	120

For lower or higher roof pitches, for multiple-span roofs and roof types other than gable or hip-style, and for roofs that are higher than 30', the pressure coefficient may also be higher, leading to lower maximum allowable wind speeds in those cases. For a more detailed evaluation of these effects, see References 1 and 2.

$$Ma := Ml \cdot \frac{Mw}{144}$$

$Ma = 8.838$ square feet

$$Mwta := \frac{Mwt}{Ma}$$

$Mwta = 4.187$ **Module Weight, psf**

Lag Screw Specifications

- Diameter = 5/16"
- Material = Stainless Steel
- Length = Adequate for full engagement of sheathing

Roof Specifications

- Roof Sheathing = 1/2" Plywood, G=0.55
- Roof Pitch = 4:12 Nominal
- Roof Style = Gabled or Hip, h=15' above ground
- TF modules excluded from roof perimeter zone

$$Rs := \mathrm{atan}\left(\frac{4}{12}\right)$$

$Rs = 18.435 \cdot \mathrm{deg}$

Calculate maximum allowable lag bolt design withdrawal load

From Table [illegible] "Lag Screw Design Withdrawal Values", Ref 2, for G=0.55

[illegible] Design Withdrawal Value, lbs per inch

From Appendix [illegible] Duration of Load Factor=1.33 for wind loads

$Plag := $ [illegible]

$Plag = 204.155$ Lag Allowable Design Load, lbs

Calculate maximum allowable module uplift load

$Pmod := Plag \cdot 2 + Mwt \cdot \cos(Rs)$	**Adjusted for dead weight of module acting at roof slope**
$Pmod = 443.411$	**Maximum allowable module uplift load, lbs**
$Pmoda := \frac{Pmod}{Ma}$	
$Pmoda = 50.172$	**Maximum allowable module uplift load, psf**

Calculate maximum allowable design windspeed

The procedures of ASCE 7-95 are employed, with guidance provided from Ref. 2. A wind speed is first assumed, and the design pressure calculated for that wind speed. The resulting design pressure is then compared to the maximum allowable uplift load calculated above. An adjustment is made for the assumed design wind speed, and the procedure is repeated until the assumed design wind speed produces a design wind pressure equal to the maximum allowable module uplift load