CITY OF SACRAMENTO

1231 I Street, Sacramento, CA 95814

Permit No: 0012732

Insp Area: 4

Site Address: 985 REGATTA DR SAC

Parcel No: 262-0320-020

Sub-Type: REM

Housing (Y/N): N

CONTRACTOR	***OWNER***	***ARCHITECT***
KYOCERA SOLAR INC	DERKS DAVID D/REBECCA L RO	
1 LIGHT SKY CT	985 REGATTA DR	
SACRAMENTO CA 95828	SACRAMENTO CA 95833	

Nature of Work: INSTALL SOLAR ELECTRIC (PHOTOVOLTAIC) SYSTEM ON ROOF

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 C10 License Number 777626 Date 10/31/00 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 abovementioned property for inspection purposes.

Date 10/31/00 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.

X 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 TOKIO MARINE & FIRE INS CO Policy Number WC1109073 Exp Date 05/01/2001

_____ (This section need not be completed if the permit is for one hundred dollars ($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 10/31/00 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.

REVISION ON ACTIVE PERMIT

NEW PLAN CHECK NO#: _____ DATE: 11/20/00

OLD PLAN CHECK NO#: _____

This sheet is to be used only when a permit has been issued, is still active, and the applicant wishes to make changes to the existing approved plans.

All revisions clouded? YES _____ NO _____

JOB ADDRESS 985 Regatta Dr SUITE _____ PERMIT NO 00127 32
Sacramento 95833

AREA _____ DBA: _____

DESCRIPTION OF REVISIONS Change conduit size to inverter

DISCIPLINE	B	L	P	M	E	F	S	R	D
CHECKED BY									
ROUTE TO									
CODE									
HOURS SPENT									

CONTACT: Kevin Hahner

ADDRESS: 1 Light Sky Ct
Sacramento 95828

PHONE#: 386 2682

OF PLANS SUBMITTED _____ SUBMITTED TO _____

I understand that I am responsible for all plan check fees that I incur during the course of this additional plan check and that any approved plans not claimed and paid for within 3 months of notification will be disposed of and an invoice procedure for the amount due will be initiated. I further understand that an unclaimed revision may result in delay of final approval for the subject project.

Paula Mitchell
Applicant signature Date

DATE NOTIFIED	PLAN BIN

APP FEE	PAID
42.50	

AGENCY	TOTAL HRS	TOTAL FEES
BLDG		
PW		
PLEASE PAY THIS AMOUNT		

0012732

Kyocera Solar, Inc.
Utility Power Group
1 Light Sky Ct.; Unit #1
Sacramento, CA 95828
(916) 386-2682
Fax (916) 386-0565

August 2, 2000

ISSUED
OCT 31 2000
Sacramento Building Division

CITY OF SACRAMENTO
PERMIT ASSISTANCE
OCT 23 2000
RECEIVED

City of Sacramento
Building Inspection Division
1231 "I" St.
Sacramento, CA 95814

Dear Sir or Madam:

As the Prime Contractor for SMUD's Photovoltaic Program, Kyocera Solar, Inc. hereby authorizes SMUD to act as our agent for purposes of obtaining permits and other permit/inspection related issues. The following persons are approved to act as agent for these matters: SMUD Personnel: David Rienhart, Paula Mitchell, Rudy Iwasko, Debbie Thompson. KSI Personnel: Matt Lafferty, Dave Metcalf, Lee Ulrich, Kevin Hahner.

The following information may prove helpful to you:

California Contractor's License #:	777036	Class:	C-10 Electrical
Expiration Date:	4/30/2002	Status:	Active
Contractor Bonding Company:	International Business and Mercantile Reassurance Company		
Bond #:	GCL1203491	Amount:	$7,500.00
Worker's Compensation Company:	Tokio Marine & Fire Insurance Company		
Policy #:	WC1109073	Expiration Date:	5/1/2001

KSI, formerly known as Utility Power Group, will continue to Design, Install & Certify PV Systems to the highest standards.

KSI thanks you for your ongoing cooperation and assistance. It is only through the combined cooperative efforts of everyone involved that we may forge ahead in our endeavor to provide clean energy for our community.

Sincerely,

Matt Lafferty

Matt Lafferty
Field Superintendent; RME

Plans on microfilm

0012732R

SMUD Solar – Structural Report
Field Observations and Summary Sheet

Prepared by: David W. Rienhart, SMUD Phone No. 916-732-5419

Owner: Rebecca Roseman and David Derks
Address: 985 Regatta Drive, Sacramento CA 95833
Date of Site Visit: September 6, 2000
Present: David Derks, Dave Rienhart, Rudy Iwasko

This set of plans and specifications must be kept on the job at all times and it is unlawful to make any changes or alterations on the same without permission from the Building ...

DEPT. OF PLANNING & DEVELOPMENT APPROVED UNDER TITLE 15 CITY CODE BUILDING INSPECTION DIVISION

Background:
Rafter span tables developed by Buehler and Buehler Associates Structural Engineers, Inc, were used to determine the adequacy of the roof system to support a photovoltaic (PV) system. The span tables were developed specifically for the proposed PV system and mounting methodology. Included with, and attached to this report are the Buehler and Buehler span tables and load calculations; and Point 2 Structural Engineers' PV mounting details and wind calculations.

Conclusion:
The roof structure of Roseman residence is suitable for the proposed installation of solar panels.

General Description:
This is a two-story residence of wood-frame construction built in 1979. Solar panels are to be located on the south side of the roof as indicated on the attached drawing. The home was in immaculate condition.

Observation:
Observations were made from the exterior and from the attic space above the ceiling where the PV system will be installed. See sketch and site survey notes on the following page. Pertinent information about the roof structure include:

ISSUED
OCT 3 1 2000
Sacramento Building Division

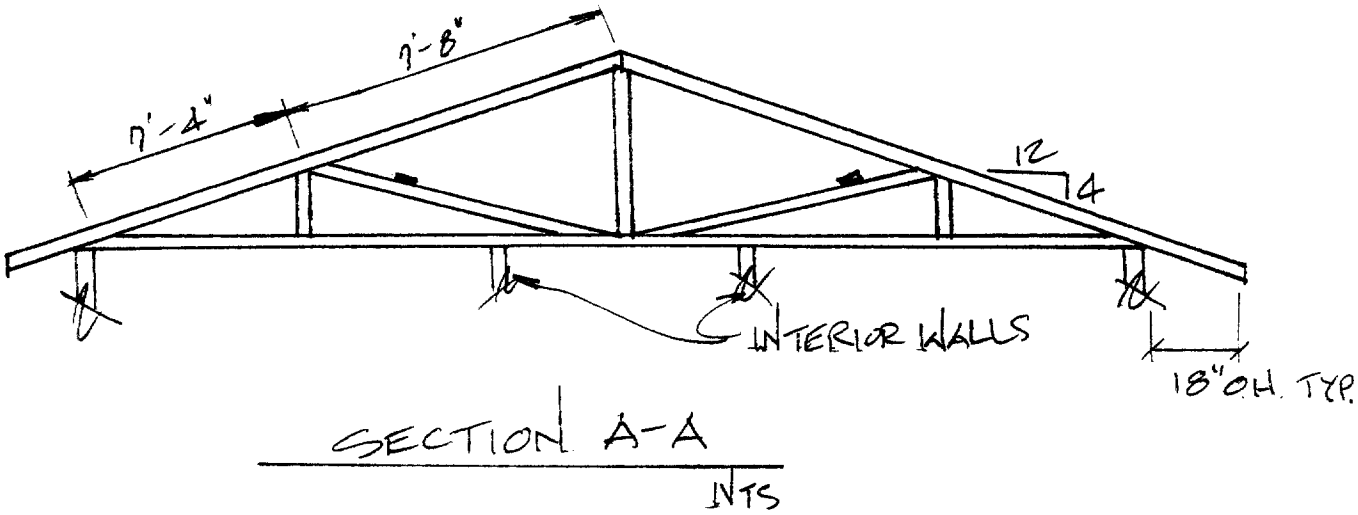
- The roof has a 4:12 slope.
- There is a flat ceiling (not a vaulted ceiling) below the roof.
- Roofing is one layer of composition shingles (4 months old).
- Roof sheathing is 7/16" plywood over 1x4 skip sheathing.
- Roof framing is manufactured engineered trusses spaced 24 inches on center.
- The proposed solar panels and associated mounting structure, add about 6 psf in the area directly below the solar panels. The roof load should be adequate because the added weight of the solar panels is considered to replace the live load (in the area directly below the solar panels).

truss
Verify ~~compliance of connections~~ roof framing in field.
Matt P. 10/27/00

PV Pioneer Roof Inspection Form

Owner/Address:

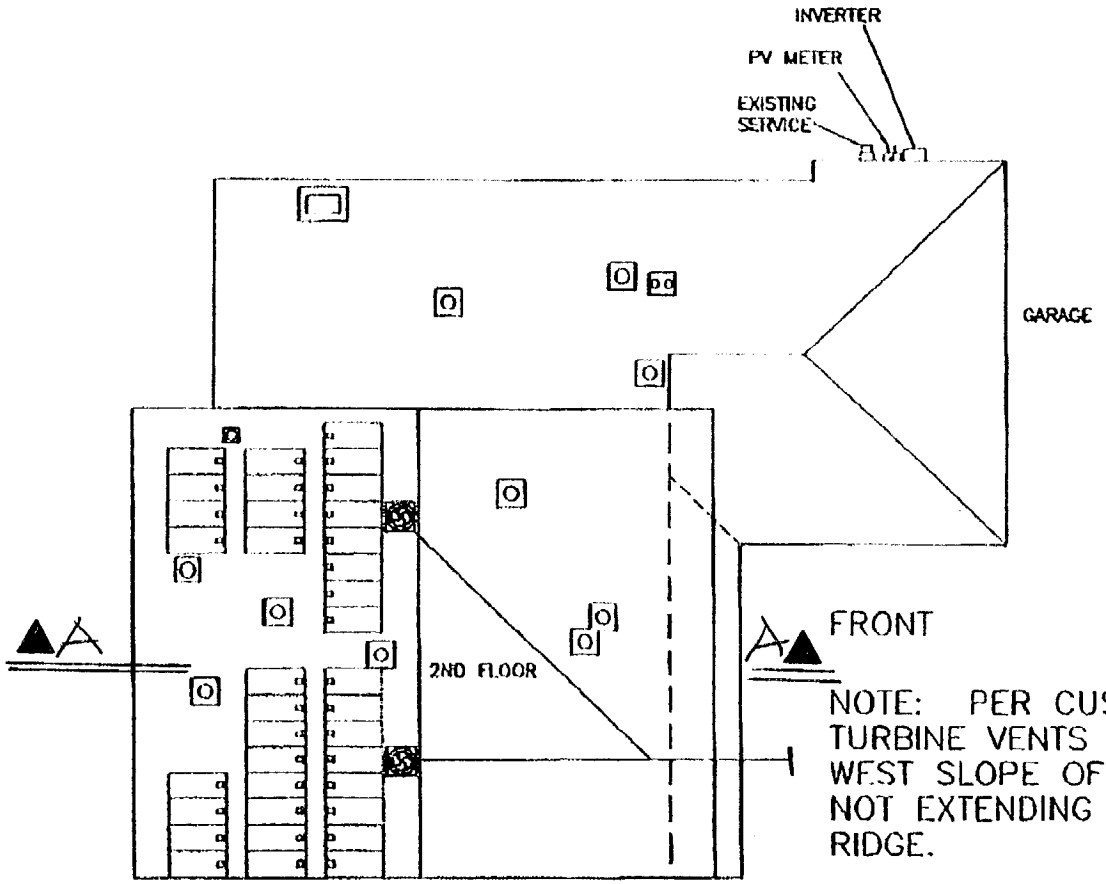
Roof Structure Sketch(s): Note rafter sizes, spacing, purlin locations and spacing, spans between rafter supports, roof pitch and, location of bearing walls when known.



Questionnaire:

1. Type of Roof Structure (framed or truss): Manufactured engineered trusses spaced 24 inches O.C.
2. Number layers of composition roofing: Single layer of composition 4 months old
3. Thickness and type of Substrate material (plywood, OSB, etc.): 7/16" plywood over 1x4 skip sheathing
4. Weight of PV modules being installed (lbs./SF): PV modules will be installed on uni-strut rails secured directly to rafters. See attached Engineering calculations and mounting methodology.
5. Floor construction (raised or slab-on-grade): Slab-on-grade
6. Condition of the foundation (note any defects): Foundation seemed in excellent condition
7. Age and condition of roofing: 4 months old
8. Condition of roof structure (note any signs of deterioration, roof leakage, etc.): New roof in excellent condition. No sign of water, or any other type of damage in the attic.
9. General Condition of Electrical System (note any defects): Service panel was in good condition. The owner had removed the plate between the busbars and panel door. He was told that the plate would have to be reinstalled per code compliance and safety reasons.

kW:	2.20
SYSTEM TYPE:	SIEMENS/TRACE
SLOPE:	20°
ORIENTATION:	36 ● 88°
G.P.S.:	38 -37- 23N 121 -29 01W



NOTE: PER CUSTOMER REQUEST, TURBINE VENTS MAY BE ADDED AT WEST SLOPE OF ROOF WITH FLASHING NOT EXTENDING BEYOND 30" FROM RIDGE.

36 SIEMENS SP75

COMP SHINGLES / 1X4 SKIP / 3/8" PLYWOOD
2X4 TRUSS ● 24" OC

PRELIMINARY DRAWING ONLY, NOT FOR CONSTRUCTION

REVISION DATE
—

APPROVALS	DATE
DRAWN: JK	7-10-00
APPROVED: ML	—
REVISED: —	—
MODULES: 36 SIEMENS SP75	
INVERTER: TRACE SUNTIE 2500	
SOURCE CIRCUITS: 6	
TOTAL kW: 2.20	
SOLID JOB #: P2-1998-0241	

KYOCERA SOLAR, INC
1 LIGHT SKY COURT SACRAMENTO, CA 95828
916.386.2682 916.386.0665 FAX

BECKY ROSEMAN
985 REGATTA WAY
SACRAMENTO, CA 95833

PROPOSED PV SYSTEM PLAN

SCALE: — SHEET 1 OF 1

DRAWING NO. PV2.1

BUEHLER & BUEHLER ASSOCIATES
STRUCTURAL ENGINEERS, INC
7300 Folsom Blvd. Suite 103
SACRAMENTO, CALIFORNIA 95826

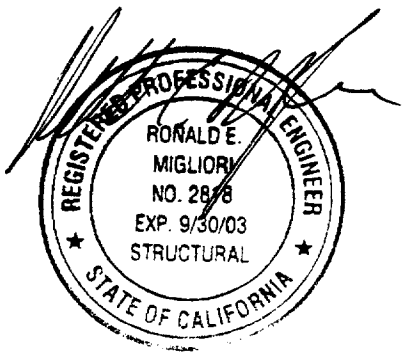
B&B

Kyocera Residential PV Panel System
for
SMUD Utilities
4:12 Slope / Flat Ceiling

Roof Rafter Size	Rafter Spacing	Maximum Allowable Span w/ 1 Panel	Maximum Allowable Span w/ 2 Panels	Maximum Allowable Span w/ 3 Panels	Maximum Allowable Span w/ 4 Panels
2x4	16"cc	9'-4"	9'-0"	N/A	N/A
	24"cc	8'-0"	8'-0"	N/A	N/A
2x6	16"cc	14'-0"	13'-9"	13'-6"	N/A
	24"cc	11'-6"	11'-6"	N/A	N/A
2x8	16"cc	17'-10"	17'-6"	17'-4"	17'-3"
	24"cc	14'-6"	14'-6"	14'-6"	N/A
2x10	16"cc	21'-10"	21'-6"	21'-3"	21'-0"
	24"cc	18'-0"	18'-0"	18'-0"	18'-0"
2x12	16"cc	25'-4"	25'-0"	24'-9"	24'-6"
	24"cc	21'-0"	21'-0"	21'-0"	21'-0"

This table based on the following criteria:

1) The roof pitch is 4:12 or greater comprised of composition roofing, 1/2" sheathing and/or skip sheathing
2) The dead load is 10 psf and the live load is 16 psf
3) The panels have a distributed weight of 6.3 psf
4) The roof is not comprised of trusses
5) There is not a ceiling attached to the underside of the rafter
6) The rafters are DF#2 or better
7) Panel and live loads do not occur simultaneously



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STRUCTURAL ENGINEERS, INC
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SACRAMENTO, CALIFORNIA 95826

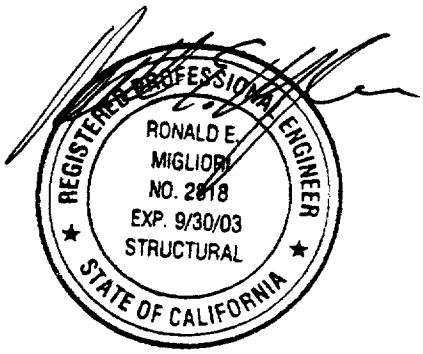
B&B

Kyocera Residential PV Panel System
for
SMUD Utilities
4:12 Slope/Vaulted Ceiling

Roof Rafter Size	Rafter Spacing	Maximum Allowable Span w/ 1 Panel	Maximum Allowable Span w/ 2 Panels	Maximum Allowable Span w/ 3 Panels	Maximum Allowable Span w/ 4 Panels
2x4	16"cc	8'-9"	8'-0"	N/A	N/A
	24"cc	7'-4"	N/A	N/A	N/A
2x6	16"cc	13'-0"	12'-9"	12'-9"	N/A
	24"cc	10'-9"	10'-9"	N/A	N/A
2x8	16"cc	16'-6"	16'-4"	16'-0"	16'-0"
	24"cc	13'-10"	13'-10"	13'-10"	N/A
2x10	16"cc	20'-4"	20'-0"	19'-10"	19'-6"
	24"cc	16'-10"	16'-10"	16'-10"	16'-10"
2x12	16"cc	23'-6"	23'-4"	23'-0"	23'-0"
	24"cc	19'-6"	19'-6"	19'-6"	19'-6"

This table based on the following criteria:

1) The roof pitch is 4:12 or greater comprised of composition roofing, 1/2" sheathing and/or skip sheathing, insulation and gyp board ceiling
2) The dead load is 14 psf and the live load is 16 psf
3) The panels have a distributed weight of 6.3 psf
4) The roof is not comprised of trusses
5) The rafters are DF#2 or better
6) Panel and live loads do not occur simultaneously



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STRUCTURAL ENGINEERS, INC
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SACRAMENTO, CALIFORNIA 95826

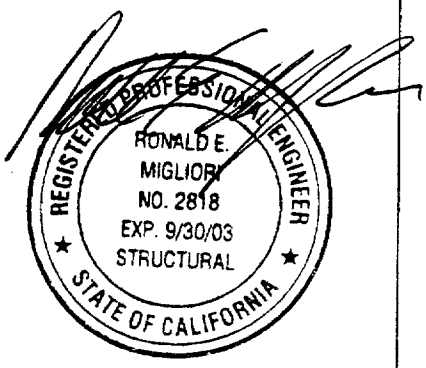
B&B

Kyocera Residential PV Panel System
for
SMUD Utilities
3:12 Slope / Flat Ceiling

Roof Rafter Size	Rafter Spacing	Maximum Allowable Span w/ 1 Panel	Maximum Allowable Span w/ 2 Panels	Maximum Allowable Span w/ 3 Panels	Maximum Allowable Span w/ 4 Panels
2x4	16"cc	9'-0"	9'-0"	N/A	N/A
	24"cc	7'-4"	N/A	N/A	N/A
2x6	16"cc	13'-4"	13'-4"	13'-4"	N/A
	24"cc	10'-10"	10'-10"	N/A	N/A
2x8	16"cc	16'-10"	16'-10"	16'-10"	16'-10"
	24"cc	13'-10"	13'-10"	13'-10"	N/A
2x10	16"cc	20'-8"	20'-8"	20'-8"	20'-8"
	24"cc	16'-10"	16'-10"	16'-10"	16'-10"
2x12	16"cc	24'-0"	24'-0"	24'-0"	24'-0"
	24"cc	19'-6"	19'-6"	19'-6"	19'-6"

This table based on the following criteria:

1) The roof pitch is 2:12 to 3:12 comprised of composition roofing, 1/2" sheathing and/or skip sheathing
2) The dead load is 10 psf and the live load is 20 psf
3) The panels have a distributed weight of 6.3 psf
4) The roof is not comprised of trusses
5) There is not a ceiling attached to the underside of the rafter
6) The rafters are DF#2 or better
7) Panel and live loads do not occur simultaneously



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SACRAMENTO, CALIFORNIA 95826

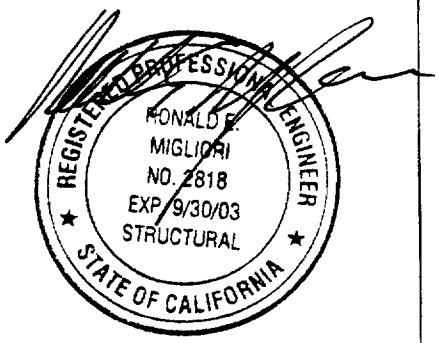
B&B

Kyocera Residential PV Panel System
for
SMUD Utilities
3:12 Slope / Vaulted Ceiling

Roof Rafter Size	Rafter Spacing	Maximum Allowable Span w/ 1 Panel	Maximum Allowable Span w/ 2 Panels	Maximum Allowable Span w/ 3 Panels	Maximum Allowable Span w/ 4 Panels
2x4	16"cc	8'-6"	8'-6"	N/A	N/A
	24"cc	7'-0"	N/A	N/A	N/A
2x6	16"cc	12'-6'	12'-6'	12'-6'	N/A
	24"cc	10'-4"	10'-4"	N/A	N/A
2x8	16"cc	15'-10"	15'-10"	15'-10"	N/A
	24"cc	13'-0"	13'-0"	13'-0"	N/A
2x10	16"cc	19'-4"	19'-4"	19'-4"	19'-4"
	24"cc	15'-10"	15'-10"	15'-10"	N/A
2x12	16"cc	22'-6"	22'-6"	22'-6"	22'-6"
	24"cc	18'-4"	18'-4"	18'-4"	18'-4"

This table based on the following criteria:

1) The roof pitch is 2:12 to 3:12 comprised of composition roofing, 1/2" sheathing and/or skip sheathing, insulation and gyp board ceiling
2) The dead load is 14 psf and the live load is 20 psf
3) The panels have a distributed weight of 6.3 psf
4) The roof is not comprised of trusses
5) The rafters are DF#2 or better
6) Panel and live loads do not occur simultaneously



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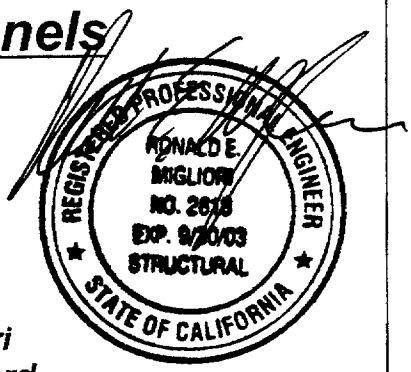
B&B

SMUD Utilities Kyocera Panels

SMUD
Sacramento, CA

Structural Calculations
August 7, 2000



BBA Principal in Charge: Ron Migliori
BBA Project Engineer: Nicole Woodward

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STRUCTURAL ENGINEERS, INC.
7300 Folsom Blvd. Suite 103
SACRAMENTO, CALIFORNIA 95826

JOB SMUD - Kyocera Panels
JOB NO. 500- DATE 8/3/00
CLIENT SMUD BY NW SHEET NO. 1

Design Loads

4:12 Slope / Flat Ceiling

skip sheathing 1.1 psf
comp roof 3.5 psf
1/2" sheathing 1.6 psf
joists (2x12 @ 16" oc) 3.3 psf
9.5 psf (1.05) = 10 psf

Live Load
@ 4:12 LL = 16 psf
@ 3:12 LL = 20 psf

Vaulted ceiling
roof dead 9.5 psf
insulation 1.0 psf
gyp board 2.8 psf
13.3 psf (1.05) = 14 psf

BUEHLER & BUEHLER ASSOCIATES
STRUCTURAL ENGINEERS, INC.
7300 Folsom Blvd. Suite 103
SACRAMENTO, CALIFORNIA 95826

JOB SMUD - Kyocera Panels
JOB NO. 500- DATE 9/3/00
CLIENT SMUD BY NIN SHEET NO. 3

Kyocera Residential PV Panel System
for
SMUD Utilities
4:12 Slope / Flat Ceiling

dead (psf) 10.0
live (psf) 16.0
panel (psf) 6.3

Roof Rafter Size	Rafter Spacing	dead load	live load	panel load (plf)	panel - live (plf)	w (D+L)	Cd	Allowable Shear	Cd	Allowable Moment	EI (x10^6)
2x4	16"cc	13.3	21.3	25.2	3.9	34.6	1.25	416.3	1.25	418.8	8.6
	24"cc	20.0	32.0	25.2	0.0	52.0	1.25	416.3	1.25	418.8	8.6
2x6	16"cc	13.3	21.3	25.2	3.9	34.6	1.25	653.8	1.25	896.3	33.3
	24"cc	20.0	32.0	25.2	0.0	52.0	1.25	653.8	1.25	896.3	33.3
2x8	16"cc	13.3	21.3	25.2	3.9	34.6	1.25	861.3	1.25	1437.5	76.2
	24"cc	20.0	32.0	25.2	0.0	52.0	1.25	861.3	1.25	1437.5	76.2
2x10	16"cc	13.3	21.3	25.2	3.9	34.6	1.25	1098.8	1.25	2145.0	158.3
	24"cc	20.0	32.0	25.2	0.0	52.0	1.25	1098.8	1.25	2145.0	158.3
2x12	16"cc	13.3	21.3	25.2	3.9	34.6	1.25	1336.3	1.25	2883.8	284.8
	24"cc	20.0	32.0	25.2	0.0	52.0	1.25	1336.3	1.25	2883.8	284.8

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STRUCTURAL ENGINEERS, INC.
7300 Folsom Blvd. Suite 103
SACRAMENTO, CALIFORNIA 95826

JOB SMUD - Kyocera Panels
JOB NO. 500- DATE 8/3/00
CLIENT SMUD BY NIN SHEET NO. 5

Kyocera Residential PV Panel System
for
SMUD Utilities
4:12 Slope / Flat Ceiling

		3 Panel Condition							4 Panel Condition						
Roof Rafter Size	Rafter Spacing	Assumed Length	Panel Length	Actual Moment		Actual Shear		Dead Load Deflection	Assumed Length	Panel Length	Actual Moment		Actual Shear		Dead Load Deflection
2x4	16"cc	12.00	12.0	693.0	no good	231.0	ok	2.1	16.00	16.0	1232.0	no good	308.0	ok	6.6
	24"cc	12.00	12.0	936.0	no good	312.0	ok	2.8	16.00	16.0	1664.0	no good	416.0	ok	8.9
2x6	16"cc	13.50	12.0	876.0	ok	259.5	ok	0.9	16.00	16.0	1232.0	no good	308.0	ok	1.7
	24"cc	12.00	12.0	936.0	no good	312.0	ok	0.7	16.00	16.0	1664.0	no good	416.0	ok	2.3
2x8	16"cc	17.33	12.0	1431.4	ok	330.4	ok	1.0	17.25	16.0	1431.3	ok	331.9	ok	1.0
	24"cc	14.50	12.0	1366.6	ok	377.0	ok	0.7	16.00	16.0	1664.0	no good	416.0	ok	1.0
2x10	16"cc	21.25	12.0	2131.2	ok	401.2	ok	1.1	21.00	16.0	2110.1	ok	401.9	ok	1.1
	24"cc	18.00	12.0	2106.0	ok	468.0	ok	0.8	18.00	16.0	2106.0	ok	468.0	ok	0.8
2x12	16"cc	24.75	12.0	2868.3	ok	463.6	ok	1.1	24.50	16.0	2853.3	ok	465.8	ok	1.1
	24"cc	21.00	12.0	2866.5	ok	546.0	ok	0.8	21.00	16.0	2866.5	ok	546.0	ok	0.8

shear assumes 3 panels at end of member (distributed weight)
moment assumes 3 panels at midspan (distributed weight)
deflection uses the moment created by the combined dead and panel / live load

shear assumes 4 panels at end of member (distributed weight)
moment assumes 4 panels at midspan (distributed weight)
deflection uses the moment created by the combined dead and panel / live load

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JOB SMUD - Kyocera Panels
JOB NO. 500- DATE 6/3/00
CLIENT SMUD BY NIN SHEET NO. 7

Kyocera Residential PV Panel System
for
SMUD Utilities
4:12 Slope/Vaulted Ceiling

dead (psf) 14.0
live (psf) 16.0
panel (psf) 6.3

Roof Rafter Size	Rafter Spacing	dead load	live load	panel load (plf)	panel - live (plf)	w (D+L)	Cd	Allowable Shear	Cd	Allowable Moment	EI (x10^6)
2x4	16"cc	18.6	21.3	25.2	3.9	39.9	1.25	416.3	1.25	418.8	8.6
	24"cc	28.0	32.0	25.2	0.0	60.0	1.25	416.3	1.25	418.8	8.6
2x6	16"cc	18.6	21.3	25.2	3.9	39.9	1.25	653.8	1.25	896.3	33.3
	24"cc	28.0	32.0	25.2	0.0	60.0	1.25	653.8	1.25	896.3	33.3
2x8	16"cc	18.6	21.3	25.2	3.9	39.9	1.25	861.3	1.25	1437.5	76.2
	24"cc	28.0	32.0	25.2	0.0	60.0	1.25	861.3	1.25	1437.5	76.2
2x10	16"cc	18.6	21.3	25.2	3.9	39.9	1.25	1098.8	1.25	2145.0	158.3
	24"cc	28.0	32.0	25.2	0.0	60.0	1.25	1098.8	1.25	2145.0	158.3
2x12	16"cc	18.6	21.3	25.2	3.9	39.9	1.25	1336.3	1.25	2883.8	284.8
	24"cc	28.0	32.0	25.2	0.0	60.0	1.25	1336.3	1.25	2883.8	284.8

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JOB SMUD - KYOCERA PANELS
JOB NO. 500- DATE 9/3/00
CLIENT SMUD BY NIW SHEET NO. 9

Kyocera Residential PV Panel System
for
SMUD Utilities
4:12 Slope/Vaulted Ceiling

		3 Panel Condition							4 Panel Condition						
Roof Rafter Size	Rafter Spacing	Assumed Length	Panel Length	Actual Moment		Actual Shear		Dead Load Deflection	Assumed Length	Panel Length	Actual Moment		Actual Shear		Dead Load Deflection
2x4	16"cc	12.00	12.0	788.8	no good	262.9	ok	2.4	16.00	16.0	1402.2	no good	350.6	ok	7.5
	24"cc	12.00	12.0	1080.0	no good	360.0	ok	3.3	16.00	16.0	1920.0	no good	480.0	no good	10.3
2x6	16"cc	12.75	12.0	890.2	ok	279.3	ok	0.8	16.00	16.0	1402.2	no good	350.6	ok	1.9
	24"cc	12.00	12.0	1080.0	no good	360.0	ok	0.8	16.00	16.0	1920.0	no good	480.0	ok	2.7
2x8	16"cc	16.00	12.0	1394.4	ok	348.6	ok	0.8	16.00	16.0	1402.2	ok	350.6	ok	0.8
	24"cc	13.83	12.0	1434.5	ok	414.9	ok	0.6	16.00	16.0	1920.0	no good	480.0	ok	1.2
2x10	16"cc	19.83	12.0	2123.9	ok	428.4	ok	0.9	19.50	16.0	2076.8	ok	426.0	ok	0.9
	24"cc	16.83	12.0	2124.4	ok	504.9	ok	0.7	16.83	16.0	2124.4	ok	504.9	ok	0.7
2x12	16"cc	23.00	12.0	2838.3	ok	493.6	ok	0.9	23.00	16.0	2873.6	ok	499.8	ok	1.0
	24"cc	19.50	12.0	2851.9	ok	585.0	ok	0.7	19.50	16.0	2851.9	ok	585.0	ok	0.7
		shear assumes 3 panels at end of member (distributed weight) moment assumes 3 panels at midspan (distributed weight) deflection uses the moment created by the combined dead and panel / live load							shear assumes 4 panels at end of member (distributed weight) moment assumes 4 panels at midspan (distributed weight) deflection uses the moment created by the combined dead and panel / live load						

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JOB SMUD - Kyocera Panels
JOB NO. 500- DATE 8/3/00
CLIENT SMUD BY NIW SHEET NO. 11

Kyocera Residential PV Panel System
for
SMUD Utilities
3:12 Slope / Flat Ceiling

dead (psf) 10.0
live (psf) 20.0
panel (psf) 6.3

Roof Rafter Size	Rafter Spacing	dead load	live load	panel load (plf)	panel - live (plf)	w (D+L)	Cd	Allowable Shear	Cd	Allowable Moment	EI (x10^6)
2x4	16"cc	13.3	26.6	25.2	0.0	39.9	1.25	416.3	1.25	418.8	8.6
	24"cc	20.0	40.0	25.2	0.0	60.0	1.25	416.3	1.25	418.8	8.6
2x6	16"cc	13.3	26.6	25.2	0.0	39.9	1.25	653.8	1.25	896.3	33.3
	24"cc	20.0	40.0	25.2	0.0	60.0	1.25	653.8	1.25	896.3	33.3
2x8	16"cc	13.3	26.6	25.2	0.0	39.9	1.25	861.3	1.25	1437.5	76.2
	24"cc	20.0	40.0	25.2	0.0	60.0	1.25	861.3	1.25	1437.5	76.2
2x10	16"cc	13.3	26.6	25.2	0.0	39.9	1.25	1098.8	1.25	2145.0	158.3
	24"cc	20.0	40.0	25.2	0.0	60.0	1.25	1098.8	1.25	2145.0	158.3
2x12	16"cc	13.3	26.6	25.2	0.0	39.9	1.25	1336.3	1.25	2883.8	284.8
	24"cc	20.0	40.0	25.2	0.0	60.0	1.25	1336.3	1.25	2883.8	284.8

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JOB SMUD - Kyocera Panels
JOB NO. 500- DATE 01/3/00
CLIENT SMUD BY NIW SHEET NO. 13

Kyocera Residential PV Panel System
for
SMUD Utilities
3:12 Slope / Flat Ceiling

Roof Rafter Size	Rafter Spacing	3 Panel Condition: Assumed Length	Panel Length	Actual Moment		Actual Shear		Dead Load Deflection	4 Panel Condition: Assumed Length	Panel Length	Actual Moment		Actual Shear		Dead Load Deflection
2x4	16"cc	12.00	12.0	718.2	no good	239.4	ok	2.2	16.00	16.0	1276.8	no good	319.2	ok	6.8
	24"cc	12.00	12.0	1080.0	no good	360.0	ok	3.3	16.00	16.0	1920.0	no good	480.0	no good	10.3
2x6	16"cc	13.33	12.0	886.2	ok	265.9	ok	0.9	16.00	16.0	1276.8	no good	319.2	ok	1.8
	24"cc	12.00	12.0	1080.0	no good	360.0	ok	0.8	16.00	16.0	1920.0	no good	480.0	ok	2.7
2x8	16"cc	16.83	12.0	1412.7	ok	335.8	ok	0.9	16.83	16.0	1412.7	ok	335.8	ok	0.9
	24"cc	13.83	12.0	1434.5	ok	414.9	ok	0.6	16.00	16.0	1920.0	no good	480.0	ok	1.2
2x10	16"cc	20.67	12.0	2130.9	ok	412.4	ok	1.0	20.67	16.0	2130.9	ok	412.4	ok	1.0
	24"cc	16.83	12.0	2124.4	ok	504.9	ok	0.7	16.83	16.0	2124.4	ok	504.9	ok	0.7
2x12	16"cc	24.00	12.0	2872.8	ok	478.8	ok	1.0	24.00	16.0	2872.8	ok	478.8	ok	1.0
	24"cc	19.50	12.0	2851.9	ok	585.0	ok	0.7	19.50	16.0	2851.9	ok	585.0	ok	0.7

shear assumes 3 panels at end of member (distributed weight)
moment assumes 3 panels at midspan (distributed weight)
deflection uses the moment created by the combined dead and panel / live load

shear assumes 4 panels at end of member (distributed weight)
moment assumes 4 panels at midspan (distributed weight)
deflection uses the moment created by the combined dead and panel / live load

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JOB SMUD - Kyocera Panels
JOB NO. 500- DATE 8/3/00
CLIENT SMUD BY NIW SHEET NO. 15

Kyocera Residential PV Panel System
for
SMUD Utilities
3:12 Slope / Vaulted Ceiling

dead (psf) 14.0
live (psf) 20.0
panel (psf) 6.3

Roof Rafter Size	Rafter Spacing	dead load	live load	panel load (plf)	panel - live (plf)	w (D+L)	Cd	Allowable Shear	Cd	Allowable Moment	EI (x10^6)
2x4	16"cc	18.6	26.6	25.2	0.0	45.2	1.25	416.3	1.25	418.8	8.6
	24"cc	28.0	40.0	25.2	0.0	68.0	1.25	416.3	1.25	418.8	8.6
2x6	16"cc	18.6	26.6	25.2	0.0	45.2	1.25	653.8	1.25	896.3	33.3
	24"cc	28.0	40.0	25.2	0.0	68.0	1.25	653.8	1.25	896.3	33.3
2x8	16"cc	18.6	26.6	25.2	0.0	45.2	1.25	861.3	1.25	1437.5	76.2
	24"cc	28.0	40.0	25.2	0.0	68.0	1.25	861.3	1.25	1437.5	76.2
2x10	16"cc	18.6	26.6	25.2	0.0	45.2	1.25	1098.8	1.25	2145.0	158.3
	24"cc	28.0	40.0	25.2	0.0	68.0	1.25	1098.8	1.25	2145.0	158.3
2x12	16"cc	18.6	26.6	25.2	0.0	45.2	1.25	1336.3	1.25	2883.8	284.8
	24"cc	28.0	40.0	25.2	0.0	68.0	1.25	1336.3	1.25	2883.8	284.8

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JOB SMUD - Kyocera Panels
JOB NO. 500- DATE 8/3/00
CLIENT SMUD BY NIN SHEET NO. 17

Kyocera Residential PV Panel System
for
SMUD Utilities
3:12 Slope / Vaulted Ceiling

		3 Panel Condition							4 Panel Condition						
Roof Rafter Size	Rafter Spacing	Assumed Length	Panel Length	Actual Moment		Actual Shear		Dead Load Deflection	Assumed Length	Panel Length	Actual Moment		Actual Shear		Dead Load Deflection
2x4	16"cc	12.00	12.0	814.0	no good	271.3	ok	2.5	16.00	16.0	1447.0	no good	361.8	ok	7.8
	24"cc	12.00	12.0	1224.0	no good	408.0	ok	3.7	16.00	16.0	2176.0	no good	544.0	no good	11.7
2x6	16"cc	12.50	12.0	883.2	ok	282.6	ok	0.7	16.00	16.0	1447.0	no good	361.8	ok	2.0
	24"cc	12.00	12.0	1224.0	no good	406.0	ok	1.0	16.00	16.0	2176.0	no good	544.0	ok	3.0
2x8	16"cc	15.83	12.0	1416.5	ok	357.9	ok	0.8	16.00	16.0	1447.0	no good	361.8	ok	0.9
	24"cc	13.00	12.0	1436.5	ok	442.0	ok	0.6	16.00	16.0	2176.0	no good	544.0	ok	1.3
2x10	16"cc	19.33	12.0	2112.1	ok	437.1	ok	0.9	19.33	16.0	2112.1	ok	437.1	ok	0.9
	24"cc	15.83	12.0	2130.0	ok	538.2	ok	0.6	16.00	16.0	2176.0	no good	544.0	ok	0.6
2x12	16"cc	22.50	12.0	2861.6	ok	508.7	ok	0.9	22.50	16.0	2861.6	ok	508.7	ok	0.9
	24"cc	18.33	12.0	2855.9	ok	623.2	ok	0.6	18.33	16.0	2855.9	ok	623.2	ok	0.6

shear assumes 3 panels at end of member (distributed weight)
moment assumes 3 panels at midspan (distributed weight)
deflection uses the moment created by the combined dead and panel / live load

shear assumes 4 panels at end of member (distributed weight)
moment assumes 4 panels at midspan (distributed weight)
deflection uses the moment created by the combined dead and panel / live load

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B&B

Kyocera Residential PV Panel System
for
SMUD Utilities
4:12 Slope / Flat Ceiling

Roof Rafter Size	Rafter Spacing	Maximum Allowable Span w/ 1 Panel	Maximum Allowable Span w/ 2 Panels	Maximum Allowable Span w/ 3 Panels	Maximum Allowable Span w/ 4 Panels
2x4	16"cc	9'-4"	9'-0"	N/A	N/A
	24"cc	8'-0"	8'-0"	N/A	N/A
2x6	16"cc	14'-0"	13'-9"	13'-6"	N/A
	24"cc	11'-6"	11'-6"	N/A	N/A
2x8	16"cc	17'-10"	17'-6"	17'-4"	17'-3"
	24"cc	14'-6"	14'-6"	14'-6"	N/A
2x10	16"cc	21'-10"	21'-6"	21'-3"	21'-0"
	24"cc	18'-0"	18'-0"	18'-0"	18'-0"
2x12	16"cc	25'-4"	25'-0"	24'-9"	24'-6"
	24"cc	21'-0"	21'-0"	21'-0"	21'-0"

This table based on the following criteria:

1) The roof pitch is 4:12 or greater comprised of composition roofing, 1/2" sheathing and/or skip sheathing
2) The dead load is 10 psf and the live load is 16 psf
3) The panels have a distributed weight of 6.3 psf
4) The roof is not comprised of trusses
5) There is not a ceiling attached to the underside of the rafter
6) The rafters are DF#2 or better
7) Panel and live loads do not occur simultaneously

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SACRAMENTO, CALIFORNIA 95826

B&B

Kyocera Residential PV Panel System
for
SMUD Utilities
3:12 Slope / Flat Ceiling

Roof Rafter Size	Rafter Spacing	Maximum Allowable Span w/ 1 Panel	Maximum Allowable Span w/ 2 Panels	Maximum Allowable Span w/ 3 Panels	Maximum Allowable Span w/ 4 Panels
2x4	16"cc	9'-0"	9'-0"	N/A	N/A
	24"cc	7'-4"	N/A	N/A	N/A
2x6	16"cc	13'-4"	13'-4"	13'-4"	N/A
	24"cc	10'-10"	10'-10"	N/A	N/A
2x8	16"cc	16'-10"	16'-10"	16'-10"	16'-10"
	24"cc	13'-10"	13'-10"	13'-10"	N/A
2x10	16"cc	20'-8"	20'-8"	20'-8"	20'-8"
	24"cc	16'-10"	16'-10"	16'-10"	16'-10"
2x12	16"cc	24'-0"	24'-0"	24'-0"	24'-0"
	24"cc	19'-6"	19'-6"	19'-6"	19'-6"

This table based on the following criteria:

1) The roof pitch is 2:12 to 3:12 comprised of composition roofing, 1/2" sheathing and/or skip sheathing
2) The dead load is 10 psf and the live load is 20 psf
3) The panels have a distributed weight of 6.3 psf
4) The roof is not comprised of trusses
5) There is not a ceiling attached to the underside of the rafter
6) The rafters are DF#2 or better
7) Panel and live loads do not occur simultaneously

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SACRAMENTO, CALIFORNIA 95826

JOB SMUD

JOB NO. _____ DATE _____

CLIENT _____ BY _____ SHEET NO. _____

Appendix :

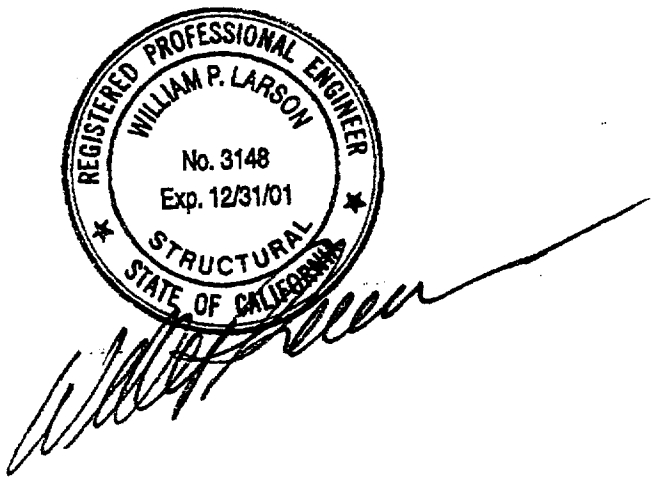
Calculations for Kyocera Panel frame and anchorage

POINT 2
STRUCTURAL
ENGINEERS

2300 N STREET, SUITE 4, SACRAMENTO, CA 95816-5757
PHONE: (916) 442-4642 FAX:(916) 442-4648

PROJECT		PROJECT NO.
CLIENT		
ENGINEER	DATE	PAGE of

Kyocera Residential PV Panel System
Structural Calculations



POINT 2 Structural Engineers
Job No. 2000-069

June 00

POINT 2
STRUCTURAL
ENGINEERS

2300 N STREET, SUITE 4, SACRAMENTO, CA 95816-5757
PHONE: (916) 442-4842 FAX:(916) 442-4848

PROJECT		PROJECT NO.
CLIENT		
ENGINEER	DATE	PAGE of

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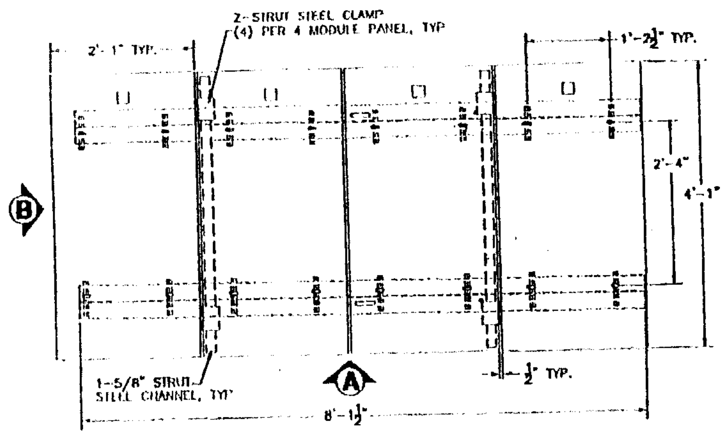
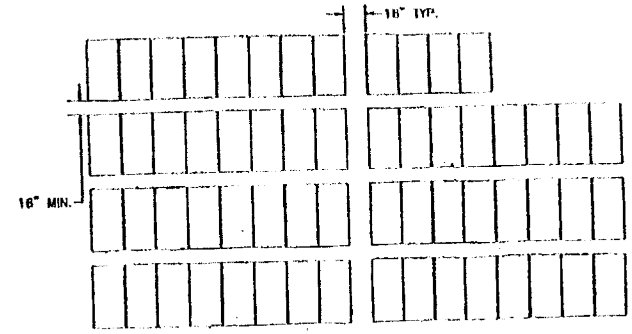
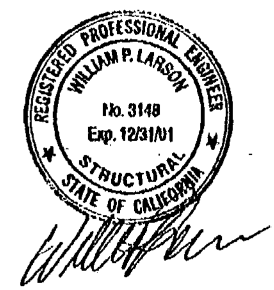


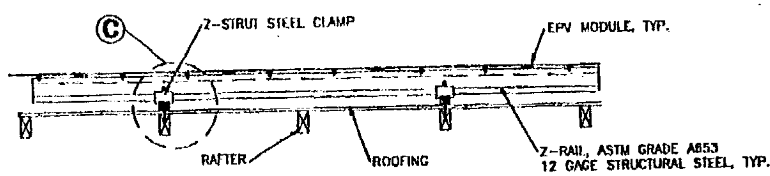
(4) EPV MODULE PANEL



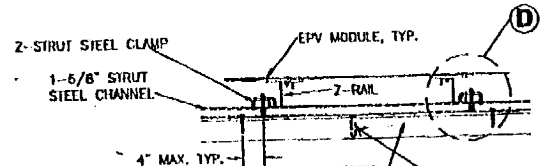
60 MODULE ARRAY

THIS IS A 60 MODULE OR 1.86kW ARRAY WITH AMPLE ROOF AREA AND NO OBSTRUCTIONS. PANEL CONFIGURATIONS ARE SUBJECT TO ACTUAL ROOF AREA, OBSTRUCTIONS, SHADING, ETC.



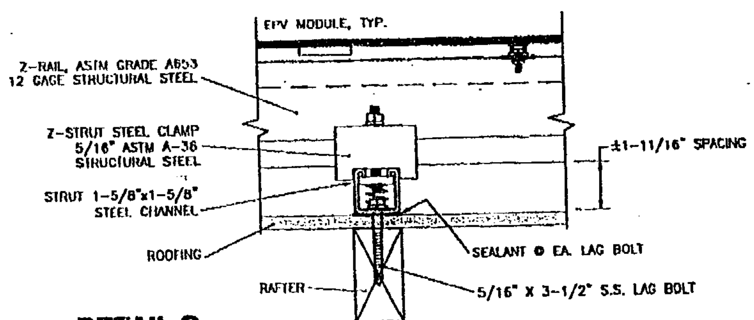


VIEW A

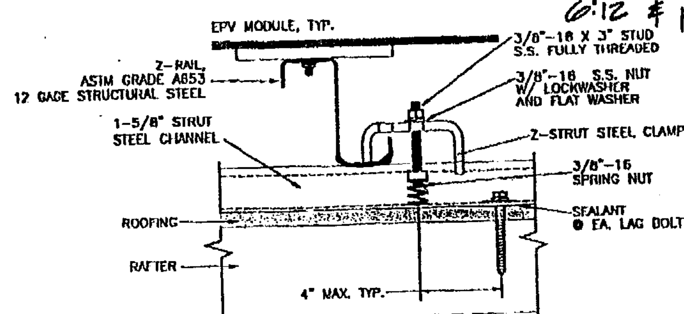


VIEW B

ADD (1) 5/16"φ X 3½" LAG SCREW WHEN ROOF PITCH EXCEEDS 6:12 & PANELS ARE LOCATED WITHIN 10' OF RIDGE



DETAIL C



DETAIL D

REVISION	DATE

MATERIAL	N/A
FINISH	N/A
THIRD ANGLE PROJECTION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES [mm]
TOLERANCES ARE: DECIMALS: X.XX ± .XX, X.XXX ± .XX; FRACTIONS: ± 1/16"; ANGLES: ± N/A

APPROVALS		DATE
DRAWN	JJK	6-16-00
APPROVED		
REV.		
B.O.M. #	XXXX-XXXX	

DO NOT SCALE DRAWING

KYOCERA SOLAR, INC.
SACRAMENTO, CALIFORNIA

EPV PANEL
MOUNTING DETAILS
FOR RESIDENTIAL ROOF TOPS

SIZE	SALES ORDER #	DRAWING NO.
B	XXXXX	EPV2-1
SCALE N/A	REV. NC	SHEET 1 OF 1

POINT 2
STRUCTURAL
ENGINEERS

2300 N STREET, SUITE 4, SACRAMENTO, CA 95816-5757
PHONE: (916) 442-4842 FAX:(916) 442-4848

PROJECT		PROJECT NO.
CLIENT		
ENGINEER	DATE	PAGE of

STRUCTURAL DESIGN CRITERIA

Building Codes

- 1997 Uniform Building Code
- ASCE 7-95 Minimum Design Loads for Buildings and Other Structures.
- AISC Manual for Steel Construction
- AISI Cold formed steel Design Manual
- ANSI NDS-1991 Revised National Design Specification for Wood Construction.

Design Criteria

- Non snow load location
- Panels average installation height of 40 feet
- Roof slopes between 2:12 and 8:12
- Wind exposure category C
- Importance factor 1.0
- Basic Wind Speed 90mph

Design Assumptions

- Panel rails are supported torsionally and laterally by PV panel adhesive
- Runners are supported with steel standoffs at 24" on center into 2x thickness framing members.

Materials

- Cold formed steel ASTM A653M-95 Grade SQ Fy=40
- Wood Douglas fir No 2 or better

POINT 2
STRUCTURAL
ENGINEERS
2300 N STREET, SUITE 4, SACRAMENTO, CA 95816-5757
PHONE: (916) 442-4842 FAX:(916) 442-4848

PROJECT
CLIENT
ENGINEER DATE / / PAGE 3 of
PROJECT NO. 200069

VELOCITY PRESSURE (6.5)

$$q_z = .00256\, K_z K_{zt} V^2 I$$

(TABLE 6.3) $K_z = 1.04$

(SEC. 6.5.5) ASSUME MIN $K_{zt} = 1.0$

(TABLE 6.2) $I = .87$

$$q_z = .00256(1.04)(1.0)(90)^2(.87) = 18.72 \text{ PSF}$$

GUST FACTOR (6.6)

$G = .85$ (SECTION 6.6.1)

PRESSURE & FORCE COEFFICIENTS (6.7)

A.) MONOSLOPE ROOFS $10^\circ < \theta < 30^\circ$

AREA TRIB TO ONE PANEL

$$A = \left[\frac{23.5'' (48'')}{144}\right] 2 = 15.67 \text{ SF}$$

① $GC_p = -1.25$

② $GC_p = -1.5$

③ $GC_p = -2.7$

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PRESSURE & FORCE COEFFICIENTS CONT.

B) GABLED & HIPPED ROOF.

$\theta > 10$ & $\leq 45°$

① $GC_p = -.90$ & $.48$

② $GC_p = -2.2$

③ $GC_p = -3.5$

INTERNAL PRESSURE COEF. (TABLE 6.4)

OPEN BUILDINGS $GC_{pi} = 0.0$

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DESIGN WIND PRESSURE, TABLE 6.1

WORST CASE $GC_p = -2.2$

$P = qGC_p$

$= 18.72(2.2) = 41.28$ PSF

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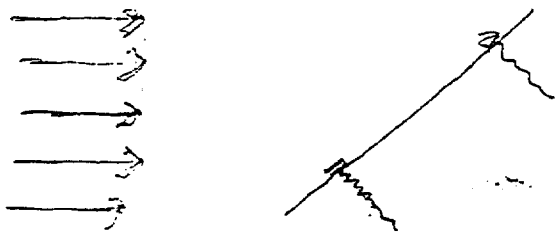
SHEAR CAPACITY (CONT)

$Z = Z11(C_D)(C_M)(C_t)$

$Z = 310(1.6)(.75)(.7)$

$= 260\ \#/LAG$



$Z_\alpha' = \frac{(W_p)Z}{W_p\cos^2\alpha + 2\sin^2\alpha}$ $\quad \alpha_{MAX} = 33.7°$

$Z_\alpha' = \frac{(2.0)266(260)}{(2.5)266(\cos^2 33.7) + 260(\sin^2 33.7)}$

$= \frac{172,900}{2.5(266)(.69215) + 260(.308)}$

$= 320\ \#$

CHK $Z_\alpha' = 320(4) = 1279 > 780$ (SEE 12/C3)

USE 4 LAG SCREWS - 5/16" Ø x 3 1/2"

✓ 6:12 SLOPE $\alpha = 26.6°$

$Z_\alpha' = \frac{266(2.5)(260)}{(2.5)266(\cos^2 26.6) + 260(\sin^2 26.6)}$

$= \frac{172,900}{556 + 72}$

$= 296$

C4

PART IX: LAG SCREWS

9.1-GENERAL

9.1.1-Quality of Lag Screws

Design provisions and design values herein apply to lag screws conforming to ANSI/ASME Standard B18.2.1-1981 (Reference 3). See Appendix L for lag screw dimensions.

9.1.2-Fabrication and Assembly

9.1.2.1 Lead holes for lag screws shall be bored as follows:

(a) The clearance hole for the shank shall have the same diameter as the shank, and the same depth of penetration as the length of unthreaded shank.

(b) The lead hole for the threaded portion shall have a diameter equal to 65% to 85% of the shank diameter in wood with $G > 0.6$, 60% to 75% in wood with $0.5 < G \leq 0.6$, and 40% to 70% in wood with $G \leq 0.5$ (see Table 9A) and a length equal to at least the length of the threaded portion. The larger percentile in each range shall apply to lag screws of greater diameters.

9.1.2.2 Lead holes or clearance holes shall not be required for 3/8" and smaller diameter lag screws loaded primarily in withdrawal in wood with $G \leq 0.5$ (see Table 9A), provided that edge distances, end distances, and spacing are sufficient to prevent unusual splitting.

9.1.2.3 The threaded portion of the lag screw shall be inserted in its lead hole by turning with a wrench, not by driving with a hammer.

9.1.2.4 Soap or other lubricant shall be used on the lag screws or in the lead holes to facilitate insertion and prevent damage to the lag screw.

9.2-WITHDRAWAL DESIGN VALUES

9.2.1-Withdrawal from Side Grain

Table 9.2A contains nominal withdrawal design values for a single lag screw inserted in side grain, with the lag screw axis perpendicular to the wood fibers. The withdrawal design value for a lag screw depends upon the specific gravity of the species (see Table 9A). Tabulated nominal design values, W, shall be multiplied by all applicable adjustment factors (see Table 7.3.1) to obtain allowable design values, W'.

9.2.2-End Grain Factor, C_{eg}

When lag screws are loaded in withdrawal from end grain, the tabulated nominal withdrawal design values, W, shall be multiplied by the end grain factor, $C_{eg} = 0.75$.

9.2.3-Tensile Strength of Lag Screw

When lag screws are loaded in withdrawal, the allowable tensile strength of the lag screw at the net (root) section shall not be exceeded (see 7.2.3).

9.3-LATERAL DESIGN VALUES

9.3.1-Wood-to-Wood Connections

For single shear (two member) wood-to-wood connections (see Appendix I) where:

(a) the lag screw is inserted in the side grain of the main member with the lag screw axis perpendicular to the wood fibers

(b) edge distances, end distances and spacing are sufficient to develop full design values (see 9.4)

(c) the depth of lag screw penetration in the main member is greater than or equal to the minimum penetration required for reduced design values (see 9.3.3)

(d) lag screw thread length is as specified in Appendix L (for lag screws with thread length greater than that specified in Appendix L, nominal lateral design values shall be permitted to be determined using D = root diameter of threaded portion of lag screw)

the nominal lag screw lateral design values, Z, shall be the lesser of:

YIELD MODE

[Eq. 9.3-1]

$$Z = \frac{D\, t_s\, F_{es}}{4K_\theta}$$ MODE I_s

[Eq. 9.3-2]

$$Z = \frac{k\, D\, t_s\, F_{em}}{2.8\,(2 + R_e)\,K_\theta}$$ MODE III_s

[Eq. 9.3-3]

$$Z = \frac{D^2}{3K_\theta}\sqrt{\frac{1.75\, F_{em}\, F_{yb}}{3\,(1 + R_e)}}$$ MODE IV

TABLE 9.2A-LAG SCREW WITHDRAWAL DESIGN VALUES (W)[1]

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

Specific Gravity	Lag Screw Unthreaded Shank Diameter, D										
G	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	312	369	423	475	525	574	621
0.43	179	212	243	273	302	357	409	459	508	554	600
0.42	173	205	235	264	291	344	395	443	490	535	579
0.41	167	198	226	254	281	332	381	428	473	516	559
0.40	161	190	218	245	271	320	367	412	455	497	538
0.39	155	183	210	236	261	308	353	397	438	479	518
0.38	149	176	202	227	251	296	340	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
0.31	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 7.3.1).

in which

$$K = -1 + \sqrt{\frac{2\,(1 + R_e)}{R_e} + \frac{F_{yb}\,(2 + R_e)\,D^2}{2\,F_{em}\,t_s^2}}$$

$R_e = F_{em}/F_{es}$

t_s = thickness of side member, inches

F_{em} = dowel bearing strength of main member (member holding point), psi (see Table 9A)

F_{es} = dowel bearing strength of side member, psi (see Table 9A)

F_{yb} = bending yield strength of lag screw, psi

D = unthreaded shank diameter of lag screw, inches

$K_\theta = 1 + (\theta_{max}/360°)$

θ_{max} = maximum angle of load to grain ($0° \le \theta \le 90°$) for any member in a connection

When a member is loaded at an angle to grain, the dowel bearing strength, $F_{e\theta}$, for the member shall be determined as follows (see Appendix J):

[Eq. 9.3-4]

$$F_{e\theta} = \frac{F_{e||}\,F_{e\perp}}{F_{e||}\,\sin^2\theta + F_{e\perp}\,\cos^2\theta}$$

in which

θ = angle between direction of load and direction of grain (longitudinal axis of member)

Table 9.3A provides nominal lateral design values for various cut thread lag screw connections with wood side members. Nominal lag screw design values, Z, shall be multiplied by all applicable adjustment factors (see Table 7.3.1) to obtain allowable lag screw design values, Z'. Design values for one species of wood shall be permitted to be used for other species having the same or higher dowel bearing strength, F_e (see Table 9A).

TABLE 9.3B-LAG SCREW DESIGN VALUES (Z) for SINGLE SHEAR (two member) CONNECTIONS[1,2,3] with 1/4" ASTM A36 steel side plate, or ASTM A446, Grade A steel side plate (for t_s < 1/4")

STEEL SIDE PLATE	LAG SCREW DIAMETER	G=0.67 RED OAK		G=0.55 MIXED MAPLE SOUTHERN PINE		G=0.50 DOUGLAS FIR-LARCH		G=0.49 DOUGLAS FIR-LARCH (N)		G=0.46 DOUGLAS FIR (S) HEM-FIR (N)	
t_s inches	D inches	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.	$Z_{\parallel}$ lbs.	$Z_{\perp}$ lbs.
1/4"	1/4	330	260	310	230	300	220	300	210	290	200
	5/16	450	330	410	290	400	280	400	270	390	260
	3/8	550	390	510	350	490	330	480	320	470	310
	7/16	700	480	650	430	620	400	620	400	600	380
	1/2	870	580	810	520	780	490	770	480	750	460
	5/8	1290	820	1190	720	1140	680	1140	670	1100	640
	3/4	1810	1100	1660	960	1600	910	1580	890	1540	860
	7/8	2420	1410	2220	1240	2130	1170	2120	1140	2060	1100
	1	3130	1760	2870	1540	2750	1460	2730	1430	2650	1380
	1-1/8	3930	2150	3610	1880	3460	1770	3430	1750	3340	1670
	1-1/4	4840	2580	4440	2260	4260	2120	4220	2090	4100	1990
3 gage t_s=0.239"	1/4	300	230	270	210	260	190	260	190	260	180
	5/16	400	300	370	270	360	250	360	250	350	240
	3/8	500	350	460	320	440	300	440	290	430	280
7 gage t_s=0.179"	1/4	270	210	250	180	240	170	240	170	230	160
	5/16	370	270	340	240	330	230	330	230	320	220
	3/8	460	320	420	290	410	270	400	270	390	260
10 gage t_s=0.134"	1/4	250	190	230	170	220	160	220	160	210	150
	5/16	350	260	330	230	310	220	310	210	300	210
	3/8	440	310	400	280	390	260	390	260	380	250
11 gage t_s=0.120"	1/4	250	190	230	170	220	160	220	160	210	150
	5/16	350	260	320	230	310	210	310	210	300	200
	3/8	430	310	400	270	380	260	380	250	370	240
12 gage t_s=0.105"	1/4	240	190	220	170	210	160	210	150	210	150
	5/16	350	250	320	220	310	210	300	210	300	200
	3/8	430	300	400	270	380	250	380	250	370	240
14 gage t_s=0.075"	1/4	240	180	220	160	210	150	210	150	200	140

1. Tabulated lateral design values (Z) for lag screw connections shall be multiplied by all applicable adjustment factors (Table 7.3.1).
2. Tabulated lateral design values (Z) are for "full diameter" lag screws (see Reference 3) inserted in side grain with lag screw axis perpendicular to wood fibers, and with the following lag screw bending yield strengths (F_{yb}):
   F_{yb} = 70,000 psi for D = 1/4"
   F_{yb} = 60,000 psi for D = 5/16"
   F_{yb} = 45,000 psi for D ≥ 3/8"
3. Tabulated lateral design values (Z) are based on dowel bearing strengths (F_e) of 58,000 psi for ASTM A36 steel, and 45,000 psi for ASTM A446, Grade A steel.