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Davis PV Plant Operation and Maintenance Manual

September 1994

Prepared by:

PVUSA Project Team

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September 1994

PVUSA Project Team

for

Pacific Gas and Electric Company
Research and Development
San Ramon, CA 94583

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DAVIS PV PLANT OPERATION AND MAINTENANCE MANUAL

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Davis PV Plant Operation and Maintenance Manual

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I. INTRODUCTION

A. Project Description

The Photovoltaics for Utility Scale Applications (PVUSA) test site at Davis, California, is an 86-acre parcel that is managed and operated by Bechtel Construction Company for PG&E's Research and Development Department (R&D). PVUSA is a national cooperative research and demonstration project formed in 1987 to assess the potential of utility scale photovoltaic (PV) systems. Information on the project organization, scope, and funding can be found in published PVUSA progress reports.

Fencing surrounds 66 acres, within which are 20-kW (nominal) PV systems, identified as emerging module technology (EMT) systems, and utility scale (US) PV systems with nominal ratings of 200 kW and 400 kW. Provisions have been made for additional systems. Support facilities include the following:

- Instrumentation and control (I&C) building, houses 12.47-kV and 480-V switchgear, data acquisition system (DAS) computers, and solar radiation measurement devices. The 30-by-50-foot building is also the temporary construction office.
- Visitor's Center (10 by 40 feet), serves as a meeting area and houses information displays.
- Graveled work areas, roads, drainage system, direct buried power, DAS cables, and miscellaneous structures.

The site was leased from the city of Davis for 20 years (March 1, 1987 to February 28, 2007). The agreement is located in subject file CITY BUSINESS. Land-use planning is limited by the existing lease agreement. However, updated site drawings are issued periodically to the Davis Public Works Department. The Community Development Agency Planning Division of Yolo County is responsible for issuing and enforcing building permits at PVUSA Davis. The entrance to the site is under the jurisdiction of the Yolo County Department of Public Works and Transportation. Refer to Yolo County subject file COUNTY BUSINESS for existing building and easement permits.

B. Terms and Definitions

Array: An assembly of modules and panels integrated to form a dc power-producing unit. Includes the support structure, foundations, tracking system, and other components as required.

Blocking Diode: A diode used to block reverse flow of current into a PV source circuit.

Bypass Diode: A diode used to bypass and allow current flow around a failed module or group of modules.

Cell: The basic device that converts sunlight directly into dc electricity.

Clinometer: An instrument that indicates the angle of inclination by providing a dc voltage proportional to the angle. Used to monitor tracker position with reference to the horizontal.

Direct Normal Irradiance (DNI): The irradiance measured perpendicular to the sun, including only direct beam and circumsolar components.

Field: Outdoor area where the array and other electrical components are located.

Fixed Flat Plate: Nonconcentrating solar array on a fixed structure.

Global Horizontal Irradiance: Total irradiance, consisting of direct beam plus diffuse irradiance, as measured from a horizontal position.

Global Normal Irradiance: Total irradiance, consisting of direct beam plus diffuse irradiance as measured perpendicular to the sun.

Inverter: Equipment that converts dc electricity to ac electricity using power semiconductor components.

Insolation: Sunlight energy received over a period of time, in watthours per square meter.

Irradiance: Sunlight power measured in watts per square meter. Near noon on a typical clear day, sunlight would have an irradiance of approximately 1,000 W/m².

Module: The smallest complete, environmentally protected assembly of PV cells, optics, and other components, exclusive of tracking, designed to generate dc power when exposed to sunlight.

Module Back Temperature: The temperature of the back of the module.

Monopole: Conductors between modules and from modules to the common neutral connection point of a three-wire source circuit. Essentially one half (positive to neutral *or* negative to neutral) of a three-wire source circuit.

One-Axis Irradiance: The irradiance measured by a pyranometer mounted on a structure that tracks the sun's movement in a single axis.

Panel: A collection of modules mechanically connected, wired, and designed to provide a field-installable unit.

Photovoltaic (PV): The direct conversion of sunlight into dc electricity.

Photovoltaic (PV) Source Circuit: Conductors between modules and from modules to the common connection point(s) of the dc system. The minimum segment of modules required to provide monopole or system voltage to the PCU.

Photovoltaic (PV) System: The total components and subsystems which, in combination, convert solar energy into electrical energy suitable for connection to a utilization load.

Plane-of-Array (POA) Irradiance: The irradiance measured by a pyranometer mounted on the array support structure.

Power Conditioning Unit (PCU): Equipment used to change voltage level or wave form, or both, of electrical energy. A PCU typically includes an inverter (to change dc input to ac output). **Note:** PCU may include system protection, controls, maximum power tracking, and transformer.

Power Conditioning Unit (PCU) Output Circuit: Conductors between the power conditioning unit and connection to service or another electric power production source, such as a utility.

PVUSA Test Conditions (PTC): Defined as 1,000 W/m² plane-of-array irradiance, 20°C ambient temperature, and 1 m/s wind speed. For concentrators, a direct normal irradiance of 850 W/m² is used.

Pyranometer, Pyrhelimeter: Instruments that provide a dc signal voltage proportional to the irradiance they are exposed to.

Uninterruptible Power Supply (UPS): A power supply consisting of a battery-supplied inverter. Supplies ac power to equipment that must not be shut down in the event of a loss of normal power.

C. Manual Scope

This Operation and Maintenance (O&M) Manual contains the information necessary to run the PVUSA facility in Davis, California. It is categorized to provide ready access to specific areas of interest to maintenance personnel. The manual contains references to more specific information available in drawings, data sheets, files, or vendor manuals. Vendor drawing references in this manual use the supplier document register number assigned by Bechtel, not the vendor's drawing number. Maintenance personnel should read and understand this manual as a prerequisite to safe operations and facility maintenance.

D. Site Files

An on-site file system is organized by subject (Appendix A). The files contain test procedures, test reports, miscellaneous vendor information, service manuals, and historical data. In addition, various components, systems, and PG&E drawings are compiled in several binders. An O&M database (electronic file) contains O&M activities and details. The database is updated periodically.

E. Site Drawings

Throughout this manual, references are made to both vendor and PG&E drawings. All referenced drawings are located at the Davis site I&C building and may be found on stick files or in drawing file cabinets. PG&E and vendor drawing registers are located in Appendix B, PVUSA Design Document Register (DDR), and Appendix C, Supplier Document Register (SDR). Some reproduced drawings are in Appendix D.

II. SAFETY

A. Site Safety Directives

1. General Directive

The PVUSA site has relatively few safety hazards compared to conventional power plants. An electrical accident is the predominant personnel hazard. Minor mechanical, chemical, and environmental safety issues must also be considered.

2. Electrical Hazards

PVUSA Davis has two incoming ac feeder lines: a 12.47-kV feed to the I&C building switchgear and a 480-V feed from a pole-mounted transformer. See main single-line diagram (drawing 478561). The US systems are energized by the 12.47-kV feeder line from the I&C building; the EMT systems are connected to the 480-V circuit.

PV represents a serious electrical hazard due to high dc voltages and currents that are generated. Dc voltage is always present during daylight hours at the arrays (unless shunted). Before performing maintenance on any dc circuit, familiarize yourself with the vendor O&M manual and vendor circuitry drawings. Be sure to isolate the dc circuit, if possible; otherwise, review the maintenance procedure with your supervisor before attempting to work on "live" dc circuits.

The following are established guidelines for maintenance on ac circuits:

- Familiarize yourself with the single-line diagram (drawing 478561) before starting work.
- Follow the approved PG&E safe clearance procedures.
- Follow PG&E's Accident Prevention Rules (APR) when working on the 12.47-kV circuits. A copy of the APR is available at the site.
- Wear the required clothing and use the required equipment to perform maintenance on the 12.47-kV circuits.
- Use the required personal protective equipment (rubber gloves and eye protection) when working on energized circuits in excess of 50 Vac/dc.

Important: Only qualified operators totally familiar with the system should enter or work on energized equipment.

Caution: Lethal dc currents are generated during daylight hours. Do not attempt to perform maintenance on any ac or dc circuits when you are alone.

3. Mechanical Hazards

PVUSA Davis has few mechanical safety hazards. The storm water pumps are a potential rotating equipment hazard and can start automatically. Precautions should be taken when working around the pumps while they are energized. Four PV systems have tracking capabilities. Although the systems move slowly, use caution to avoid pinches, severed digits, or clothing tangled in the moving parts. The site has a quad all-terrain vehicle (ATV). Do not operate the ATV if you are alone at the site—it has a high potential for overturning. PVUSA Davis owns a mechanical scissor lift. Operate the lift in accordance with the manufacturer's instructions and site guidelines (posted on the safety bulletin board).

4. Chemical Hazards

PVUSA Davis maintains a log of Material Safety Data Sheets (MSDS) for all known hazardous materials kept on site. They are located in a binder labeled MSDS in the reference bookcase. Plant operators should disseminate the information to all employees working at the site. They should also ensure that the log is periodically updated. Site chemical hazards include fuel, lubricants, cleaners, and Liquinox™ for wet megger testing. Store flammable materials in the flammable storage cabinet when not in use.

5. Environmental Hazards

- a. Do not drink the well water—it is nonpotable. PVUSA Davis is constructed over an abandoned organic vegetation settlement area with a relatively shallow water table (20-40 feet). The state has not tested the water.
- b. Depending on prevailing winds, agricultural chemical spraying from adjacent fields may pose a health risk. You should avoid contact with drifting spray.
- c. Wildland (grass) fires are frequent in the area. You should disk fire breaks and mow dead weeds in May or June.
- d. Site burning of weeds, trash, or rubbish is strictly prohibited and enforced by the Air Quality Control Board. **Do not burn materials on site.** Controlled burning by the Davis Fire Department may be a viable option.
- e. Smoke detectors in the I&C building and Visitor's Center are monitored 24 hours a day by Honeywell®, who will notify authorities and the designated operator if a fire is detected at the site.

6. Vermin

Insects, snakes, and mammals are prevalent at the site. Black widow spiders and hornets are the greatest personnel safety risks. Exercise caution when placing your hands into a possible spider habitat. Spider bite kits are located with the first aid kits on site. Hornets are especially prevalent around the buildings in the fall, and they should be exterminated when the site is manned.

B. PVUSA Safety and Health Action Plan

The PVUSA Safety and Health Action Plan was established to provide guidelines to implement and administer the Injury and Illness Prevention Program (IIPP) for PVUSA and to assign specific responsibilities for executing the program. The Plan provides assistance to management, supervisors, maintenance personnel, and other project personnel in the recognition, evaluation, and control of hazardous activities and conditions within their respective areas of responsibility. Bound copies are in the reference bookcase.

C. Safety Equipment

The site is equipped with all the necessary safety equipment, which is stored in the following locations:

1. Fire Extinguishers

Fire extinguishers are in the I&C building (4 each), site safety boxes (3 each), Visitor's Center (1 each), and the two site trucks (1 each). The equipment should be checked monthly (verified on the tags) and recharged annually.

2. Safety Field Boxes

Three safety field boxes are painted red and located in the field at Integrated Power Corporation (IPC) US-1, EMT systems, and Advanced Photovoltaic Systems (APS). Each box contains an alarm siren, cable cutters, diagonal pliers, first aid blanket, fire extinguishers, spider bite kit, and a wooden cane to extricate personnel from electrical wires. The contents of the boxes should be checked monthly and replaced as necessary (e.g., battery for alarm siren).

3. First Aid Kits

First aid kits are in the I&C building (2 each), the Visitor's Center (1 each), and the two site trucks (1 each). They should be inspected annually and the contents replaced as necessary.

4. Medium-Voltage Test Equipment

PVUSA Davis has two hot sticks: one for 12.47-kV testing with a voltmeter and another for application of personal ground sets. The site has two sets of personal grounds, cleaning kits for the hot sticks, and a test instrument for the medium-voltage voltmeter. The equipment is in the switchgear room and storage shed.

5. Personal Protective Equipment

PVUSA Davis has a protective suit for use with 12.47-kV circuits and several pairs of ASTM-approved gloves (rubber and protective leathers) for use with energized circuits. The rubber gloves should be replaced or retested every six months in accordance with ASTM F496.

6. Cellular Telephone

The portable cellular phone should be taken to the field when no other means of communications are available. It should be used to contact an emergency medical technician or an ambulance in the event of a severe electrical shock or other medical incidents that require immediate attention. The emergency response phone number is 1-911. The phone should be periodically checked to ensure that the battery and phone functions are operating.

7. Flammable Storage Containers

The site has two fireproof containers in the yard area west of the main building. The containers should be locked when not in use, and their contents, if hazardous materials, must be recorded and an MSDS must be on file. A review of hazardous materials stored on site should be conducted with all employees who have access to the containers. Hazardous material storage should be kept to a minimum.

D. Davis Police Shooting Range

The Davis Police Department maintains and operates a shooting range south of the PVUSA site. Because stray bullets could enter the PVUSA site, evacuate the area when the shooting range is in use. The Davis Police Department will contact the PVUSA site in advance of any planned shooting activities.

III. SITE FACILITIES, SUPPORT SYSTEMS, AND OPERATIONS

A. Utility Interface

1. Layout

The PVUSA Davis site is located 1.2 miles north of the city of Davis on Pole Line Road (24662 County Road 102). See drawing 478521 for the site plan, drawing 478567 for the outdoor electrical layout plan, and drawing 478568 for the indoor electrical layout plan.

The metal-clad fault interrupter switch no.12489, 480-V DP01, 480-V EFP01, and 480-V EFP02, protective relay cabinets, transfer trip, and all auxiliary power equipment are in the electrical room of the I&C building.

PG&E's distribution circuit 1106 runs along Road 102 and was extended to reach the southeast area of the facility. It is a three-phase, 12.47-kV (distribution line), three-wire (neutral is grounded at PG&E's Davis substation) circuit that also serves two other independent power producers. Circuit 1106 enters the site via air switch 20039. The load side of switch 20039 is divided in two. One branch is connected to a pole-mounted switch (20013) before it goes underground to the I&C building, where it terminates on a metal-clad fault interrupter switch (12489) that feeds the 12.47-kV utility scale systems (US-1 and future US-2). The other branch feeds pole-mounted fuses (3 each) and a step-down, pole-mounted transformer (TR1). Then, it clears through a disconnect at grade level (switch 12465) before going into the I&C building via underground conduits. At the I&C building, the wires from switch 12465 are terminated at the 480-V distribution panel DP01, which serves the facility loads and EMTs. See main single-line diagram, drawing 478561.

2. Protection

Protection requirements are consistent with PG&E's Power Producers' Interconnection Handbook. Although the facility is owned by PG&E, the Handbook's technical requirements for independent power producers were followed. The two protection requirements are described in Sections 2a and 2b.

a. Transfer Trip

Transfer trip is a protection circuit that trips the 12.47-kV fault interrupter switch 12489 when an abnormal event occurs at the PG&E substation that feeds circuit 1106. (An abnormal event is defined as something that causes the loss of circuit 1106, such as tripping the PG&E Davis substation breaker.) A trip signal from the substation is electrically generated, sent via dedicated telephone lease line, received at the PVUSA Davis site transfer trip box, and decoded. Then, a trip signal is sent to switch 12489. The PG&E Davis substation monitors the status of the transfer trip box and switch 12489. See drawings 498248 and 493877. If a transfer trip signal is initiated to trip switch 12489, notify the dispatch office at Vaca-Dixon. Switch 12489 should remain open until the

dispatch office gives permission to close (clearance). For transfer trip problems, call the protection engineer's office at PG&E's Sacramento Valley Region.

b. Protective Relays

- i. Ground Fault (59N): Ground faults are detected on the 12.47-kV service by monitoring voltage imbalance across the open delta winding of a wye-open delta grounding transformer bank. See drawing 492692. All US-1 and EMT systems are tripped when a ground fault occurs on the 12.74-kV service.
- ii. Over- and Undervoltage (27/59): Over- and undervoltages are detected on the 12.47-kV service by monitoring the bus voltage on switch 12489 via wye-to-wye potential transformer PT1. One single-phase 27/59 relay performs the monitoring, and a trip signal is sent to switch 12489 and EMT breakers 52-7 and 52-8 when the voltage exceeds $\pm 10\%$ of the nominal voltage (12.47 kV). See drawing 492692.
- iii. Over- and Underfrequency (81O/U): Over- and underfrequency are detected on the 12.47-kV service by monitoring the bus voltage on switch 12489 via wye-to-wye potential transformer PT1. One single-phase 81O/U relay performs the monitoring, and a trip signal is sent to switch 12489 and EMT breakers 52-7 and 52-8 when the frequency exceeds ± 1 Hz of the nominal frequency (60 Hz). See drawing 492692.
- iv. Overcurrent With Voltage Control (51C): "Overcurrent" is detected on each phase of the three US-1 systems. The overcurrent detection circuit is only enabled when an undervoltage condition exists. If the current set point is exceeded during an undervoltage condition, the corresponding circuit breaker on the US-1 system is tripped. The APS and IPC systems have three 51C relays each. The Siemens Solar Industries (SSI) system has six 51C relays (three each on the two inverter breakers).

3. Uninterruptible Power Supply (UPS)

One 3.0-kVA and one 1.8-kVA single-phase UPS provide power to the Davis facility critical loads. They supply power for all protective relays and trip circuits for switch 12489, EMT breakers 52-7 and 52-8, and the DAS equipment (i.e., computers and their peripherals). See drawing 478538.

4. 12-kV Switchgear

The 12.74-kV service can be isolated by using the 12-kV switchgear, operable by PVUSA-designated operators. The 12-kV switchgear has two sections—metering and switch compartments. The metering compartment complies with the requirements of the Electric Utility Service Equipment Requirements Committee (EUSERC). It houses the current transformers (CTs) and potential transformers (PTs) used for metering, DAS, and protection. PTs and CTs are ANSI accuracy class 0.3.

The switch compartment houses a McGraw Edison (now Cooper Industries) fault interrupter that is rated 600 A and is equipped with electromechanical close and trip devices. The fault interrupter (switch 12489) can be tripped locally or remotely, but can only be closed locally. For more information, see drawing 19271-SC-D81-9. Contact Western Utilities Transformer, Inc., for repairs (subcontract file 19271-TSC-D222).

B. Site Operations

1. General Conditions

A lease agreement between PG&E and the city of Davis commenced on March 1, 1987, and it expires on February 28, 2007. The entire agreement is in the subject file CITY BUSINESS. The annual lease payments are established by a formula set forth in Section 3 of the lease agreement. Additionally, the following permits and registrations are renewed on an annual basis:

- a. Yolo County Business License (see subject file COUNTY BUSINESS)
Business License Office
292 West Beamer Street
Woodland, CA 95695
(916) 666-8812
- b. Vehicle Registrations (see subject file VEHICLES)
DMV Renewal
P.O. Box 942839
Sacramento, CA 94239-0199

2. General Instructions

PVUSA Davis is a switching center that reports to the Vaca-Dixon substation dispatch office. All PVUSA operations affecting the 12.47-kV site feeder are performed in accordance with the following PG&E documents:

Electric General Operating Instructions (March 1990)
General Operating Orders, Rev. 12 (April 1989)

The following standard practices are issued by PG&E and used by PVUSA to govern switching, tagging, clearances, and protective suits and gloves:

Standard Practice 403-1: Switching procedures, forms, and use
Standard Practice 403-3: Tag usage
Standard Practice 403-4: Clearance instructions
Standard Practice 571-3: Protective suits and gloves

Copies of the operating instructions, orders, and standard practices are located in the Switching Procedure binder. Clearance forms and logs are in the PVUSA Switching Operations Logbook binder. Additionally, all clearance, caution, and test tags are

located in the site file cabinet. A clearance board in the site office depicts the facility's single-line diagram. The board should be used to indicate the location of all tags used in the facility.

3. Daily Operations

The site is staffed on a daily basis. Site access is monitored during off-hours by a Honeywell® security system; entry and exit are controlled by a remote security keypad. The security system is armed and disarmed with a secret digital code. Daily operations may include site tours, analysis of site and host PV systems, routine and nonroutine switching of electrical systems, PV system troubleshooting, PV system repair, routine and nonroutine maintenance, PV training seminars, and general field operations.

4. Weekly Operations

Weekly site operations include performance and construction reports, site coordination schedules, task lists for site staff, perimeter yard fence walkdowns, and other nonroutine operations tasks.

5. Monthly Operations

Monthly tasks include reading the electric meters and reporting all site loads and generation. The power control summary is sent to PG&E's Power Control in San Francisco. Additionally, site staff calculate the 480-V loads and generation, along with the dc generation, of the 480-V EMT-1 systems.

Figure III-1 shows the form used to transmit monthly generation and station loads. The form should be faxed to PG&E Power Control (415) 973-8804.

6. Quarterly Operations

The PVUSA staff issues a quarterly report which summarizes all PVUSA and host activities.

7. Annual Operations

The PVUSA staff issues an annual report that provides an overview of PVUSA activities for the past year.

1 PG. FAX TO: PG&E Power Control (415)973-8804 Attn: Joan Childs/Alan Saunders
 FROM: Tim Townsend, PVUSA Davis (916)753-0795
 DATE: 07/26/94

PVUSA DAVIS SITE:
 PHOTOVOLTAIC GENERATION AND STATION LOAD SUMMARY

(1) DATE	(2) 480 V METER READING	(3) OUT	(4) 12 kV METER READING	(5) OUT	NET SITE LOAD (6) MONTHLY kWh IN {(2)new- (2)old} *40 + 1200* {(4)new- (4)old}	NET SITE GENERATION (7) MONTHLY kWh OUT {(3)new- (3)old} *40 + 1200* {(5)new- (5)old}	(8) GROSS 480 V GENERATION ONLY DC kWh	(9) AC kWh	(10) 480 V STATION LOAD kWh
1/1/94	fill in				0	0	dc data is FYI.		0
2/1		meter			0	0	480 Vac generation		0
3/1			readings		0	0	is used to auto-		0
4/1				in these	0	0	matically calc.		0
5/1	four				0	0	station loads.		0
6/1		columns			0	0			0
etc.					0	0			0

net load & gen. are
 calculated automatically

Figure III-1. PV generation and station load summary.

IV. TESTING

A. Acceptance Testing

Equipment testing on installed systems is performed on site prior to system acceptance. Field testing is not as rigorous as factory testing since the field introduces site-specific factors, and it is not a controlled environment. Switchgear and transformers are tested at the factory in accordance with applicable sections of ANSI/IEEE standards C37 and C57. Specialty equipment, such as the power conditioning unit (PCU), is tested in accordance with joint PVUSA/manufacturer test procedures. Industry standards for test methods and procedures are under development. Certifications, documentation, and test results are in the PVUSA project files in Davis, San Ramon, and San Francisco.

PVUSA has developed a series of field acceptance tests which cover all facets of the system, including completeness, quality of construction, and adherence to design, functionality, and safe equipment operation under abnormal conditions. The test procedures must be reviewed and tailored to each system as system designs and operations vary. The acceptance process and tests are summarized in the contract files for each system. During the tests, and prior to successful completion of the acceptance testing, the ownership of the system is retained by the PV system supplier.

1. Module Qualification

Factory qualification tests were performed to certify the acceptability of the design, materials, and manufacturing processes of the modules to be furnished. The tests were conducted on modules manufactured on the contractor's production line. Flatplate modules must have successfully passed the tests described in the *Interim Qualification Tests (IQT) and Procedures for Terrestrial Photovoltaic Thin-Film, Flatplate Modules* (SERI/TR-213-3624, January 1990, R. DeBlasio, et al., National Renewable Energy Laboratory). See also Appendix D of the US-1 and US-2 Technical Specifications.

2. Testing Prior to Paralleling

After verifying that construction is complete, conduct the following tests before the system is energized, that is, paralleled to the utility distribution circuit. The equipment vendor's presence is recommended to facilitate adjustment or repair, as necessary.

- a. PV array tests include the Field Wet Resistance Test (FWRT; see Section IV.B.1 and Appendix E) and the I-V curve test (see Section IV.B.2).
- b. Preparallel tests, as outlined in the PG&E Power Producer's Interconnection Handbook (PPIH), are conducted to ensure that the system can be energized safely. Preparallel tests are done on the following equipment: power isolation transformers, instrument transformers, circuit breaker at inverter output, fused disconnect switches, protective relays, cables, and buses. Protective functions required by the PPIH that are supplied with the PV system will also be part of the preparallel tests. Successful completion of these tests is necessary before permission to parallel is granted by PG&E.

3. Test on Initial Operation

After PG&E gives permission to parallel, conduct an initial start-up test to verify proper system functions. Simulate abnormal conditions and verify system reaction and functions. Upon successful completion, the system is commissioned for operation, that is, generate power and feed power into the utility distribution circuit. A 30-day conditioning period follows. The purpose of the conditioning period is to verify continuous and consistent full-system operation and to allow initial degradation of amorphous systems. The equipment vendor's presence is recommended to facilitate adjustment or repair, as necessary.

4. Performance

After the conditioning period, system data are collected for 30 operational days, cumulative. These data are used to determine the system's performance and plant rating. See Appendix C of the applicable Technical Specification for details of the rating methodology. During this time, power quality tests are performed. Satisfactory completion of these tests concludes the acceptance testing.

5. Other

Special testing (e.g., infrared scanning, electric and magnetic fields [EMF], and total harmonic distortion [THD]) should only be conducted by trained technicians or specialists. The PVUSA Davis site manager coordinates special tests.

B. Periodic Testing

Periodic testing at PVUSA is performed to ensure safe operating conditions and to determine cumulative system degradation. Some testing performed during acceptance testing is repeated at one-year intervals. The schedule includes an FWRT, ground resistance testing, APS ground anchor corrosion current, and PV system I-V curves.

1. Field Wet Resistance Test (FWRT)

This test verifies the electrical insulation of the modules and dc components as installed. It also provides some measure of assurance that the modules will survive the site environment. Leakage current shall be less than 50 μ A (microampere) per module at twice the system operating voltage (to ground) plus 1,000 V. The test essentially repeats the wet hi-pot test conducted as part of the module qualification tests. The FWRT procedure is in Appendix E.

2. I-V Curves

Current (I) versus voltage (V) curves (I-V) are measured by a specialized device called the I-V curve tracer, which characterizes the PV system under known (measured) test conditions. Data recorded by the DS600 I-V curve tracer are translated to PVUSA test conditions (PTC), recorded in a spreadsheet for comparison and analysis, and stored for future reference. Figure IV-1 shows a typical display for a completed I-V curve scan.

To operate the I-V curve tracer, the power conditioning system (PCS) is taken off line, and the array is isolated from external sources. Connections are made between the curve tracer and the positive and negative bus of the source circuit, possibly while energized. Information about the I-V curve tracer and related software are contained in the DS600 Operating Manual located in the O&M bookcase. Tabulated and graphical I-V curve data values for each PV system are located in subject file I-V CURVES.

Figure IV-1. Advance Photovoltaic Systems section I-V curve.

3. Ground Resistance Testing

Ground resistance testing is conducted to ensure personnel safety (maintaining low-ground grid resistance) and proper operation of electronic equipment. Ground resistance is measured according to the IEEE 80-1986 standard "Fall of Potential" method, using a Biddle ground resistance micro-ohmmeter or equivalent. See Appendix F for measurement procedures and subject file GROUND RESISTANCE READINGS for further information.

4. APS Soil Anchor Corrosion Testing

The test is conducted annually to quantify the corrosion rate of the APS soil anchors in mils per year. The site soil conditions are highly corrosive, and PVUSA has reason to suspect that the soil anchor coating may be inadequate. The soil anchor test provides a basis for determining the integrity of the soil anchors.

- a. Test Procedure: Measure the current passing through the soil anchor and the anode at the seven test stations, each of which has a jumper (connected on terminals) that connects the anode to the soil anchor. Remove this jumper temporarily to connect (in series) an ammeter and obtain the current readings, in milliamperes. Alternatively, use the current shunt to measure the voltage drop across the shunt, and convert the voltage measured to milliamperes. See Figure IV-2 for the location of the seven test stations and Appendix G for the tabulated values of previously measured currents. See vendor drawings for additional information on the location and internal wiring of the test stations.
- b. Test Data: Test data for August 1992, July 1993, and August 1994 are available in the subject file APS TESTING. The test data reflect readings of the anodic current in milliamperes and should be converted to a corrosion rate expressed in mils per year. To convert the current readings (in milliamperes) to mils per year, use the following equation:

$$\text{Corrosion rate (mils/year)} = \frac{\text{Current (mA)} \times 0.492}{\text{Surface Area of the Soil Anchor (ft}^2\text{)}} \quad (\text{IV-1})$$

Where:

$$\begin{aligned} \text{Surface area of outer soil anchors} &= 9 \text{ ft}^2 \\ \text{Surface area of other soil anchors} &= 5 \text{ ft}^2 \end{aligned}$$

- c. Pass/Fail or Acceptance Criteria: There is no exact number (mils per year) for the pass or fail value. The intent is to conduct the tests at periodic intervals to observe an annual trend in the corrosion rate. An increasing corrosion rate may indicate that the soil anchor coating is deteriorating and extensive corrosion may be occurring. Consult with a resource person who has an understanding of the materials and cathodic protection. (Note: 1 ampere-year of anodic current flow consumes 20.11 pounds of iron.)

C. Special Testing

1. Harmonics

Harmonic testing is conducted on the US-1 systems as part of the acceptance tests. The Technical Specification requires THD levels recommended by IEEE 519-1981: current THD should not exceed 5%, and voltage THD should not exceed 3%. All measurements are performed at the PV system ac output during stable peak power conditions (clear sky). Follow-up and periodic testing on THD are not required after system acceptance.

2. Near Field Radio Frequency Interference and Electromagnetic Interference

RFI and EMI have not been a concern, and therefore no tests are planned.

Figure IV-2. Location of seven test stations on US-1 APS System for soil anchor corrosion monitoring.

3. Electric and Magnetic Field (EMF) Testing

EMF measurements were conducted at PVUSA Davis and Kerman. PVUSA EMF data indicate that 60-Hz magnetic fields associated with PV arrays are significantly less than for household appliances.¹ Magnetic fields associated with PCUs are greater than those associated with PV arrays. PG&E substation maintenance personnel have been trained to conduct EMF tests, if needed. No periodic EMF test schedules are planned.

4. Power Quality (PQ)

PQ measurements are performed as special testing by Technical and Ecological Services (TES), using a Basic Measurement, Inc. (BMI) model 3060, 3030, or 4800 powerscope, or similar equipment. No periodic PQ tests are planned at this time.

5. Other Special Testing

From time to time, PVUSA project personnel may require special tests. Some examples are infrared scanning for hot spot detection and interaction between paralleled PCUs of different manufacturers. Tests of this nature will be detailed by Engineering and approved by Project Management. Special procedures will govern their conduct.

¹C. Jennings, G. Chang, and K. Bell. 1993. "PV EMF." In *Proceedings of the 23rd IEEE PV Specialists Conference*. Louisville, Kentucky, May 10-14, 1993.

V. PV FACILITY EMT-1

A. Layout

1. Single-Line Diagram

See drawing 478562 for the EMT-1 480-V single-line diagram (Appendix D). A full list of design drawings is in Appendix B, PVUSA Design Document Register (DDR).

2. Physical

The EMT-1 area is directly north of the control building and is separated from it by a graveled parking area and a chain link fence. The EMT-1 area accommodates four EMT-1 flatplate systems in 12 rows of panels, occupying 320 feet by 150 feet. To the north, an ENTECH concentrator extends westward, occupying about 30 feet by 325 feet. Layout drawings include the site plan (478521), foundations (478539 and 478540), structures (478542), and raceway (478567). A full list of drawings may be found in the DDR (Appendix B).

B. Inverters

Five 25-kW inverters, DECC/Helionetics Model 61635, are installed and operational. The units are described in DECC Manual 523-1254 (Bechtel VP 12971-PO-D27-010). See Appendix H for troubleshooting information.

C. Data Acquisition System

A remote data input/output (RDIO) unit adjacent to each 25-kW inverter contains a Campbell Scientific, Inc. (CSI) data logger that is scanned continuously by a central computer. The system is described in the CSI O&M Manual (Bechtel VP 19271-PO-DO26-35) and Section IX of this manual.

D. Structures

Four EMT-1 array structures are identical designs, with structural steel framework supported by reinforced concrete caissons. The EMT-1 objective to evaluate module performance and reliability dictated the need for common EMT-1 structures. Details of the EMT-1 fixed flatplate structures may be found in drawings 478539, 478540, and 478542.

E. Arrays

1. ARCO Solar, Inc. (Subcontract D31)

The array is a fixed flatplate PV system consisting of two source circuits, each containing 200 M660 modules grouped in 20 panels of 10 modules each. Each source circuit is an 86-foot-long row of panels with a slant height of 9-1/2 feet. The ARCO system is described in the ARCO O&M Manual (Bechtel VP 19271-SC-D31-018). A full list of ARCO drawings is in Appendix C, Supplier Document Register (SDR).

2. Utility Power Group (Subcontract D32)

The UPG array is a fixed flatplate PV system consisting of 13 source circuits, each containing 384 UPG 4-W modules grouped in 8 panels of 48 modules each. Each panel has four vertical strings of 12 modules. The physical layout consists of three 144-foot-long rows of 140-module strings. Three filler strings are inserted to preserve symmetry. Slant height is a little over 9 feet. The UPG system is described in the UPG O&M Manual (Bechtel VP 19271-SC-D31-12). A full list of UPG drawings is in Appendix C.

3. ENTECH (Subcontract D33)

The array is a linear concentrator PV system which tilts (north-south) and rolls (east-west) to follow the sun. Three source circuits, each with 20 air-cooled linear Fresnel 22.5x lens concentrator modules, are arranged in a single continuous row about 325 feet long. Each collector module is shaped like a cylinder (10 feet long by 3 feet wide) and is mounted on a tracking frame structure supported on vertical posts. The ENTECH concentrator is described in the ENTECH O&M Manual (Bechtel VP 19271-SC-D33-58). A full list of ENTECH drawings is in Appendix C.

4. ECD/Sovonics (Subcontract D34)

The array is a fixed flatplate PV system consisting of four source circuits, each containing 300 P23S modules grouped in 30 panels of 10 modules each. Each source circuit is a 120-foot-long row of panels with a slant height of 11 feet. The ECD/Sovonics system is described in the ECD/Sovonics O&M Manual (Bechtel VP 19271-SC-D34-011). A full list of ECD/Sovonics drawings is in Appendix C.

5. Solarex (Subcontract D35)

The array is a fixed flatplate PV system consisting of 14 source circuits, each containing 24 bi-facial modules grouped in 4 panels of 6 modules each. The physical layout consists of two 112-foot-long rows of 28 panels, each having a slant height of 10 feet. The Solarex system is described in the Solarex O&M Manual (Bechtel VP 19271-SC-D35-20). A full list of Solarex drawings is in Appendix C.

F. Reference Documentation

O&M manuals for the five EMT-1 PV systems and the DECC/Helionetics inverters are located in the EMT-1 section of the Reference Library. The manuals contain information on manufacturer contacts. Appendix I contains a summary of warranty provisions. See the individual contract files for specific information. Claims under warranty provision of the contract should be discussed with the Procurement Manager. Appendix J contains a summary of technical PV parameters for all PV systems.

VI. PV FACILITY EMT-2

A. Layout

1. Single-Line Diagram

See drawing 478563 for the EMT-2 480-V single-line diagram . A full list of drawings is in Appendix B, PVUSA DDR.

2. Physical

The EMT-2 area is directly west of the EMT-1 area and is separated from it by a 30-foot-wide graveled access road. The EMT-2 area is approximately 300 feet by 150 feet and contains installed foundations, structures, and balance-of-system (BOS) equipment for three EMT-2 flatplate systems. Layout drawings include the site plan (478521), foundation (478539), structures (356183), and raceway (478569). A full list of drawings is in the project DDR (Appendix B).

Contact the Electric Power Research Institute (EPRI) for information on its high-concentration photovoltaic (HCPV) tracker (3412 Hillview Avenue, Palo Alto, California 94403, 415-855-2162). The system is incomplete—it has no inverter or DAS connection to PVUSA.

B. Inverters

Three 25-kW inverters, DECC/Helionetics Model 61635, are installed but are not operational (no PV arrays). The units are described in DECC Manual 523-1254 (Bechtel VP 19271-PO-D27-010) in the Reference Library. See Appendix H for troubleshooting information.

C. Data Acquisition System

An RDIO unit adjacent to each 25-kW inverter contains a CSI data logger that is scanned continuously by a central computer. The system is described in the CSI O&M Manual (Bechtel VP 19271-PO-D026-35) and Section IX of this manual.

D. Arrays

1. Astro Power (hold, not installed)
2. EPRI HCPV tracker (hold, only partially installed)

E. Reference Documentation

O&M manuals are located in the EMT-2 section of the Reference Library. Each manual contains information on a manufacturer contact. Appendix I contains a summary of warranty provisions. See the individual contract files for specific information. Claims under warranty provision of the contract should be discussed with the Procurement Manager. Appendix J contains a summary of technical PV parameters for all PV systems.

VII. PV FACILITY US-1

The three Davis US-1 systems were furnished and installed as turnkey PV power systems, which includes the PV array, PCU(s), switchgear, and step-up/isolation transformer. The output of each US-1 system is connected to an underground 15-kV cable, "daisy-chained" as shown schematically on the main single-line diagram, drawing 478561 (Appendix B). A list of drawings is available in Appendix C. Additionally, troubleshooting information is in Appendix H, a summary of warranty provisions is in Appendix I (see individual contract files for specific information), and a summary of technical PV parameters is in Appendix J.

A. Siemens Solar Industries (SSI) Array

1. Single-Line Diagram

The electrical single-line diagram of the SSI US-1 system is shown on drawing 19271-SC-D100-38. The PV array consists of eight bipolar source circuits, with an 820-V pole-to-pole open-circuit voltage and a 720-V operating voltage (See the SSI O&M Manual for voltages under various conditions). Four dc source circuits are fed into inverter "A" and four into inverter "B." Each inverter is rated 100 kW, and ac outputs are fed into transformer TR111 via circuit breakers 52-111 and 52-112. Power factor correction capacitors are connected between the inverter output and low-voltage circuit breakers 52-111 and 52-112. Transformer TR111 is the main step-up transformer, with one delta and one wye low-voltage winding and one delta medium-voltage winding. A 15-kV disconnect switch provides the power interface point to the PVUSA 15-kV cable.

The dc analog display meters at the circuit breaker area measure one dc source circuit, but the display is scaled up to reflect an equivalent value for eight source circuits (the entire array field). Three meters independently display the equivalent array dc current, array dc voltage, and array dc power. The other array analog meter at the circuit breaker area displays the 15-kV ac output real power.

DAS signals are brought to interface junction box (IJB) 11, where a CSI data logger monitors dc ground faults and sends a trip signal to the inverter(s) if a dc ground fault is detected.

Circuit breakers 52-111 and 52-112 are equipped with three overcurrent with voltage control relays monitoring the three phases. These circuit breakers are used to isolate the inverters from the utility ac source.

Additional information on the SSI system may be found in Volumes 1 and 2 of the SSI O&M Manual in the Reference Library.

2. Physical Layout

The SSI US-1 system is located at the southeast corner of the PVUSA perimeter fence. It consists of eight north-to-south rows of one-axis passive tracking PV arrays. A

graveled path allows access to the middle of the fourth and fifth rows, where the circuit breakers (52-111, 52-112), step-up transformer (TR111), and 15-kV disconnect switch (89-111) are positioned. A graveled access to inverter "A" and inverter "B" is also provided. Inverter "A" is located between rows two and three, and inverter "B" is located between rows six and seven. See drawing 19271-SC-D100-6 for the layout of the PV system. Each inverter is equipped with dc disconnect switches that isolate the four dc source circuits from the inverters.

3. Inverters

Two BluePoint Associates 100-kW, 480-V, three-phase inverters, Model 3B, convert the PV dc power to ac power. Each inverter has four identically constructed bridge assemblies; each bridge is dedicated to a dc source circuit fed into the inverter. There are two sets of ac output, one configured as delta and the other as wye. The inverters operate at a fixed dc voltage and do not peak-power track. For more information on the inverters, see BluePoint O&M Manual 19271-SC-D100-83 located in the US-1 section in the Reference Library.

4. Switchgear

Outputs of the two inverters are fed into two circuit breakers (52-111 and 52-112). Then, the 480-V output is stepped up to 12.47 kV through step-up transformer TR111, which has two low-voltage windings and one medium-voltage winding. The medium-voltage power is fed into the 15-kV switchgear (89-111). The SSI switchgear equipment includes circuit breakers 52-111 and 52-112, step-up transformer TR111, disconnect switch 89-111, and metering and DAS. See drawing 19271-SC-D100-76.

5. Trackers

The tracking system of the SSI one-axis system uses the Sun-Seeker passive actuators manufactured by Robbins Engineering. An actuator consists of two evaporator tubes (east and west) linked by tubing to opposite ends of a "piston-type" double-acting actuator cylinder. The evaporator tubes are filled with refrigerant oil and R-22 Freon. The entire PV array field consists of 32 actuators, whose combined refrigerant R-22 is equivalent to the refrigerant needed for the air-conditioning units of 100 cars. See drawing 19271-SC-D100-96 for more information about the trackers.

6. Special Features

The SSI US-1 system uses passive trackers that follow the sun during the summer months, when the demand on the utility's electrical system is at its peak. Three tracker rows are each equipped with a clinometer to monitor the tracker position. The SSI US-1 crystalline silicon modules have the highest efficiency commercially available for PV technology.

B. Integrated Power Corporation (IPC) Array

1. Single-Line Diagram

The electrical single-line diagram of the IPC US-1 system is shown on drawing 19271-SC-D99-32. The PV array consists of 11 bipolar source circuits, with a 970-V open-circuit voltage and a 680-V operating voltage pole-to-pole (Refer to the IPC O&M Manual for voltages under various conditions). The 11 dc source circuits are collected at the dc collection box. Two dc source circuits are connected in parallel through a 150-A dc “reduced-power-contractor,” which opens (dropping the two source circuits) when the dc source circuit power available to the PCU exceeds 218 kW. A single bipolar output from the dc collection box is fed into the main dc switch (89-122) before going into the PCU. The 380-V, three-phase output of the PCU is fed into transformer TR121 via circuit breaker 52-121 and switch (89-121). Transformer TR121 is the main step-up transformer; it has a wye low-voltage winding, a delta medium-voltage winding, and bayonet fuses for overcurrent protection and maintenance. The medium-voltage cable uses elbow connectors on the high side of transformer TR121, which may be disconnected (under no-load conditions) and “parked” on insulated parking bushings to function as an isolation point.

Three overcurrent with voltage control relays monitor the PCU output and trip circuit breaker 52-121 when parameters monitored are beyond normal. See Volumes 1, 2, and 3 of the IPC O&M Manual in the Reference Library for additional information.

2. Physical Layout

The IPC US-1 system is located to the west of the SSI US-1 system. It consists of 11 north-to-south rows of one-axis active tracking PV arrays. The tracker-winch drive assembly is located at the geometric center on the east end of the array. A graveled access is also provided to the PCU, transformer TR121, metering PT, CT compartment, and IJB12. The center of each row has separate positive and negative dc source circuit switches and the tracker-winch cable. See drawing 19271-SC-D99-16 for the overall layout of the PV system.

3. Inverters

The inverter provided by IPC is a 200-kW, 380-V, three-phase Omnion Series 3200 PCU. The PCU has five bridge assemblies that use insulated gate bipolar transistors (IGBTs) to convert the dc power to ac power. The ac and dc power may be isolated from the PCU by switches 89-121 and 89-122 located on the outside wall of the PCU. See the Omnion O&M Manual for more information on the inverter. The manual is in the US-1 section in the Reference Library.

4. Switchgear

Unlike the two other US-1 systems at Davis, the IPC US-1 system does not have a medium-voltage switch; however, it can be isolated from the 15-kV cable at the elbow

cable connectors at transformer TR121. **Warning:** A medium-voltage enclosure, located near transformer TR121 and the PCU, houses the medium-voltage metering instrument transformers. This enclosure is always “hot” when medium-voltage switch 12489 at the I&C building is closed.

5. Tracking Drive

The tracker drive system consists of an IPC TM3™ tracker controller, a winch assembly (including a gear reduction drive motor, electric disk brake, and control sensors), a 1-3/8-inch-diameter wire rope assembly, a 21-ton-capacity turning sheave, and a center torque rim located on each tracker row. The winch assembly and the turning sheave are mounted at either end of the field’s east-west centerline on top of massive concrete piers (see drawings 19271-SC-D99-5, 19271-SC-D99-8, and 19271-SC-D99-71). All tracker control sensors are mounted to the winch frame within the winch enclosure (see drawing 19271-SC-D99-71). The winch enclosure has removable side panels for maintenance access. The tracker controller is mounted adjacent to the winch for immediate access to the emergency stop button.

The tracker cable extends from east to west in a continuous loop across the center of the array field, where it is redirected around a turning sheave and returns to the winch. The cable is preloaded to 36,000 pounds to maintain cable tension under maximum loads due to wind, cable stretching, and thermal expansion. Two cable turnbuckle assemblies are provided to allow future tensioning of the cable by a qualified subcontractor. They are located east of the storage shed (see drawing 19271-SC-D99-18). The tracker cable is attached to each center torque rim with attachment cables and wire rope clips (see drawing 19271-SC-D99-9). These attachment cables are used to maintain or adjust the tilt of the tracker row. See drawing 19271-SC-D99-76-1 (Volume 1) for more information on the trackers.

6. Special Features

The IPC tracker controller uses a “back-tracking” algorithm that eliminates row-to-row shading. This maximizes system output during early mornings and late afternoons, while maintaining minimum row-to-row spacing.

C. Advanced Photovoltaic Systems (APS) Array

1. Single-Line Diagram

The electrical single-line diagram of the APS US-1 system is shown on drawing 19271-SC-D101-2. The PV array consists of four monopole source circuits, with a 575-V pole-to-pole open-circuit voltage and a 343-V operating voltage (refer to the APS O&M Manual for voltages under various conditions). The system has four inverter modules; each dc source circuit is fed to its corresponding inverter module. Output of two inverter modules is connected in parallel and fed into transformer TR131 via circuit breaker 52-131. The other two inverter module outputs are paralleled, then fed to transformer TR131 via circuit breaker 52-132. Transformer TR131 is the main step-up transformer,

configured with a “forked wye” low-voltage winding (396 V) and a delta medium-voltage winding. A 15-kV fused disconnect switch (89-131) provided by APS is the power interface point to the PVUSA medium-voltage cable. Power factor correction capacitors and harmonic filter capacitors are connected on the low-voltage side of transformer TR131 via circuit breaker 52-133.

See Volumes 1 and 2 of the APS O&M Manual located in the Reference Library for more information.

2. Physical Layout

The APS US-1 system is located north of the SSI and IPC systems. The array field consists of five rows of 80 module sections at a fixed tilt of 30 degrees facing south; slant height is 42.25 feet. Each source circuit consists of one row (24 sections) and one fourth (6 sections) of the northernmost row. A 20-foot-wide ungraveled access runs through the middle of each row.

The PCU shelter is located between rows two and three, underneath array row two. See drawings 19271-SC-D101-4, 19271-SC-D101-22, and 19271-SC-D101-50 for the layout of the PV system.

3. Inverters

The PCU solar inverter consists of a central processing module (CPM), four identical inverter modules, and an ac switch module. The CPM provides microprocessor control of APS operations and harmonic filtering: it monitors the diagnostic circuitry in each module and automatically controls system operations accordingly. Detection of a fault causes the microcomputer to perform a controlled system power-down. For array or line faults, the microcomputer automatically restarts the system after the fault has cleared. The system must be manually reset after equipment-related failures.

Each inverter module is connected across a single field array source circuit through a dc source disconnect switch, which provides a positive means of disengaging the inverter module from the source circuit. During operation, each inverter module converts the dc power from the source circuit to three-phase, six-pulse ac power. Inverters do not peak-power track but have operator-adjustable voltage and current set points. Diagnostic circuitry within each inverter module monitors various functions and automatically controls the dc voltage and current inputs accordingly. Automatic crossover between voltage control and current control operation is provided at control limits set by the operator. The output of the inverter modules is paired to produce six-phase, 12-pulse ac power, which is delivered across the ac switch module to the transformer. The ac switch module provides ac line protection, ground fault detection, and ac instrumentation.

See Volumes 1 and 2 of the APS O&M Manual located in the Reference Library for more information.

4. Switchgear

Transformer TR131 and medium-voltage switch 89-131 are south of the PCU shelter. An overhead wireway feeds the inverters' output to the low-voltage side of transformer TR131. The metering PTs and CTs are inside the oversized transformer (TR131) enclosure. See drawing 19271-SC-D101-90 for more information on the switchgear installation.

5. Special Features

Two roll-up doors give maintenance personnel easy egress from the PCU shelter when the inverter module doors are open. The APS array field structure is an innovative, low-cost design: it uses sheet metal channels and commercially available structural framing and joists. The rear posts of the section structures are attached to Chance® screw anchors.

6. Module Replacement Procedure

The procedure for replacement of APS US-1 modules is located in the Reference Library, in APS US-1 O&M Manual, Volume 1, supplier document 80110 Revision B.

VIII. OTHER INSTALLATIONS

A. PV Installations

1. EPRI HCPV Tracker

The EPRI HCPV tracker was installed north of the EMT-1 ENTECH array in January 1990. It was to become an EMT system upon turnover from EPRI; however, the present plans are unclear due to EPRI funding uncertainties. EPRI maintains control of the system, and any maintenance activities to be performed by PVUSA personnel are on an as-requested basis. The EPRI phone number is (415) 855-2162.

2. PG&E Tracker

The PG&E tracker, located west of the site pumps, was completed in January 1989. The test tracker was installed to study the structure and alternative bypass diode configuration. Westinghouse® dummy modules installed on the tracker provided a medium for structure testing. After structure testing was completed in June 1989, the tracker was used to test tracker controllers. All testing has been completed, and there are no future plans for using the tracker. There are no maintenance requirements. The 15-A breaker (52-21) adjacent to the pump controller is opened and locked out.

3. Experimental Cable Support Structure

In December 1990, an innovative PV cable support structure was designed by PG&E and Bechtel. Four reinforced steel ground anchors, each set to a depth of 45 feet, were drilled and grouted in preparation for installation of a 20-kW array north of the ENTECH array. The project was canceled due to the economics associated with the installed cost. Additional information can be found in the subject file CABLE SUPPORT STRUCTURE.

B. Non-PV Installations

1. Sea Van

The 8-by-20-foot sea van adjacent to the storage shed is used for storage of the ATV and other large equipment. The sea van is weatherproof, secured, and situated within the security zone of the yard.

2. Storage Shed

The 8-by-40-foot wooden storage shed west of the I&C building is used to warehouse spare parts (see Section XIII of this manual for inventory information). The double doors on the north and south ends require periodic maintenance (e.g., hinges). The building's composition roof should be inspected periodically to ensure its integrity.

3. Signs

a. Information

PVUSA information signs include the site entrance, visitor parking, appointment, Honeywell® security, and EMT-1 and US-1 tour path system descriptions. The following vendors have manufactured signs for PVUSA:

All Action Awards, Woodland, CA (916) 666-3220
Sign Language, Woodland, CA (916) 666-9205

b. Safety

Safety signs at PVUSA are posted in accordance with PG&E substation standards. Additionally, PVUSA has posted visitor warning signs at the entrance to the tour path. Obtain signs from PG&E or the signmakers listed in 3.a.

c. No Trespassing

Large “No Trespassing” signs are placed along the main entrance road and the unfenced westerly 20 acres. The signs should be inspected, repaired, or replaced as required.

4. Visitor’s Center

The PVUSA Visitor’s Center 10-by-40-foot trailer is located northeast of the I&C building. It has a Bard® heat pump system, a bathroom for the handicapped, a 240/120-V power supply, audio/visual equipment, and PV exhibits. The center is used for PV safety discussions, PVUSA overview discussions, and the PVUSA orientation film. Information about the trailer, deck, audiovisual equipment, furniture, and heat pump system may be found in the contract files (D75, D94, D110, D112, D117, D120, D147). Periodic maintenance should be performed on the heat pump system, and annual inspection of the roofing and sealants is advisable. The deck requires coating every 3 to 5 years.

IX. DATA ACQUISITION SYSTEM

A. Description

Data acquisition at PVUSA provides the necessary information for reporting PV system performance. Components are grouped by function. Sensors generate and transfer signals to data loggers. The data loggers sample, digitize, convert, and store each parameter. Personal computers (PCs) poll each data logger and store the measured parameters for analysis and reporting. Data are shared between the PCs through a local area network (LAN) and are loaded into a database for generating periodic and ad hoc reports.

This section overviews the system, provides basic operation and troubleshooting procedures, and, where necessary, describes unique aspects of the data system. Documentation is available in the PVUSA DAS User's Manual Quicktour in the DAS room and in the site documentation bookcase. A separate PVUSA DAS O&M Manual describes the theory of operation, available functions, limitations of the system, details of the software code, and software maintenance. Since this system is primarily an integration of off-the-shelf software and hardware, the reader will frequently be referred to the manuals for these specific products.

B. Hardware Layout

The data acquisition system integrates four major subsystems:

- Remote Data Units (RDUs): The PVUSA data acquisition system is based on a distributed network of CSI 21X and CR7 data loggers. These RDUs are centrally connected to a 486 PC. RDUs are located at each EMT site or other area, such as the meteorological tower. The RDU converts analog signals to engineering unit values. The data logger functions are programmed to collect values every 5 seconds and average them over a 10-minute period. All RDUs are interconnected via coaxial cable network.
- Data Acquisition Controller (DAC): Interfaces to all of the RDUs via one serial port and the coaxial network. DAC collects all RDU data; separates the data into 10-minute average, 5-second, and alarm data files; and displays real-time data on the screen.
- Data Display System (DDS): Collects DAC data files, generates daily summaries, and makes these summaries available to a remote user via modem.
- Database Computer (DBC): Contains the database software developed using Gupta SQLbase and SQL Windows system.

Figure IX-1 shows the basic interconnection of the subsystems. The PVUSA DAS O&M Manual shows the location of the DAC and DDS computer I/O ports, computer jumper settings, and pinouts of the nonstandard cables.

Figure IX-1. Basic DAS interconnection.

C. Hardware

1. Remote Data Units (RDUs)

Each Davis site RDU consists of a Campbell 21X or CR7 data logger and the following hardware installed in a NEMA 4 enclosure suitable for exterior mounting: fused ac power junction box, 72-hour backup battery, terminal strip for signals, six 3-A relays controlled by the data logger, and an MD-9 interface that connects RDUs to the coaxial network. US systems house the RDU in an IJB and contain additional hardware for interfacing 12-kV systems.

The data loggers must be programmed to automatically measure the input channels every 5 seconds, average the samples over a 10-minute interval, and place the results in a data logger output storage buffer. Individual data loggers can also be triggered to place 5-second data into output storage. See the DAS O&M and CSI PC208 manuals for full programming details.

Each data logger is powered by an external battery that is continually recharged as long as ac power is present in the RDU enclosure. If ac power is lost, the data logger will continue to collect data and communicate to the DAC for up to 5 days. In this way, data collection is virtually unaffected by normal ac power outages.

Normally, 10-minute data are uploaded to DAC every 20 minutes, but if needed, the data logger can hold approximately 5 days of 10-minute data in output storage before data overflow occurs. If 5-second data are placed into output storage, data overflow occurs in approximately 40 minutes.

Troubleshooting system software and hardware require detailed documentation. Physical and software configurations are documented in vendor- and project-supplied drawings. RDUs are documented in the CSI manuals. Southwest Technology Development Institute (SWTDI) drawings filed under 19271-PO-D026, and PVUSA DAS drawings 478569-478580 or 492685-492696 (see Appendix B). Signal interface downstream of the RDU is contained in the subject file by system.

2. Data Acquisition Controller (DAC)

The Dell D50 DAC computer has a 50-MHz 486 processor, 230-Mbyte hard disk, and 8-Mbyte RAM. Operation of the data monitoring program begins when the DTASRV program is run in Windows™ for Workgroups. Once enabled, DTASRV runs custom software to monitor all of the Davis and remote PV systems. Data are collected, displayed, and 10-minute averages stored for automatic loading into the SQL database at midnight. The computer interfaces all Davis RDUs via one serial port (COM2:). This serial port is, in turn, connected to the CSI coaxial network using the CSI SC-532 and MD-9 interface. DAC also uses an external modem configured on COM1: Port 1 to dial the Naval Observatory time standard. DAC is connected to the shared HP LaserJet III printer via parallel port LPT1. DAC is also connected to the DDS through an Ethernet LAN. The system is configured as shown on the data sheet for each computer contained in the DAS HARDWARE subject file. Specific information on the programs used for data collection are contained in subject file DAS USER'S MANUAL AND TROUBLESHOOTING GUIDE. Table IX-1 lists the interface ports utilized by DAC.

Table IX-1
Port Assignments on DAC

Port	Connected To	Usage	Connector Type
LPT1:	HP LaserJet III	Printer	DB25
COM1:	Supra Modem	Remote communications	DB9
COM2:	CSI MD-9	Local CSI RDUs	DB9

3. Data Display System (DDS)

DDS performs functions that include secondary data processing, remote data acquisition from Kerman DAS, and summary report generation. DDS also provides an environment that can be used for data plotting or for special activities without interfering with data collection software. Table IX-2 lists the interface ports utilized by DDS.

Table IX-2
Port Assignments on DDS

Port	Connected To	Usage	Connector Type
LPT1:	EPSON LQ1050	Printer	DB25
COM1:	U.S. Robotics Modem	Remote Communications	DB9
SCSI	MO Drive	Removable Storage	SCSI

MO = magneto optical

D. Software

The DAS software design provides a flexible yet reliable environment for data acquisition. The primary function of this software is to provide a foolproof automated system of data collection, storage, and processing that still allows the user flexibility to perform special tests or modifications. The four DAS subsystems run software packages (see DAS O&M Manual). The following commercial software packages are integrated into this system, and their manuals are at PVUSA Davis.

Operating System: Microsoft DOS and Windows for Workgroups

Scheduling: Above & Beyond

C Compilers: Turbo C and Borland C++

C Addins: Win++ Library

Applications: Microsoft Excel, Microsoft Word for Windows, Microsoft Access, Procomm for Windows, WinZip, and PKZip

1. DAC

The DAC system collects all of the data from the RDUs via one serial port. The DAC software is driven by a control program called DTASRV written by Endecon Engineering and run under Windows™ 3.1 or higher. The primary function of this package is to collect and store RDU data on the LAN. Additional features are the support of dynamic data exchange (DDE) for the display of real-time data. The primary data collection is performed as follows:

1. The RDUs sample and convert to engineering units every 5 seconds.
2. RDU 5-second data are averaged, totaled, or sampled every 10 minutes and placed in RDU output storage. Some 5-second data may be placed in RDU output storage when manually triggered by the operator.
3. DAC DTASRV program collects data every 20 minutes from the RDUs' output storage data and store them on the DAC hard disk in YYDDDXX.AVG named data files (YY = year, DDD = day number of the current year, and XX = RDU number.) See Table IX-3 for a description of each RDU number in the current configuration.
4. After midnight, new files are copied from DAC's \DTASRV\DATA directory to the DDS computer \DATA directory, and to the \DATA\TO_LOAD and DDC_DATA directories on DBC.

Additionally, DAC provides real-time data from each system. Real-time data are displayed on the DAC screen but not stored. An Excel macro is used to generate a display screen where DDE linked data are written. Steps 1 and 2 are controlled by each RDU, and Steps 3 and 4 are performed by DAC. In short, the DAC program interrogates each RDU separately. DTASRV transfers all of the output storage data from the RDU and appends it to the daily data file for that RDU. Refer to the DAS O&M Manual and the CSI PC-208 Manual for more information about the software and programming configurations.

2. DAC Data File Format

Data files consist of a header line followed by 144 lines (records) of comma-separated 10-minute averages. The header line contains five-digit codes representing a data type for each field in the following records. The field codes describe the type of data so that software may be written to automatically decipher each record. More than 20 fields are contained in each record. Refer to the data format and channel map sections of the DAS O&M Manual for details on header line format and the current record format for each RDU.

3. Archived and Stored Data

The last storage step in data flow is the MO drive backup performed once a month using an archiver (Winzip or PKZip) software. The data files are compressed and collated into an archive named MMMYYavg.zip (MMM = month name). Zip files are copied to

Table IX-3
RDU Number, Location, and Description

RDU Number	Location	Description
1	Davis EMT1	Siemens Solar Industries
2	Davis EMT1	Solarex
3	Davis EMT1	Sovonics
4	Davis EMT1	Utility Power Group
5	Davis EMT1	ENTECH
6	Davis EMT2	Astropower
7	Davis EMT	Reserved for EMT4
8	Davis EMT	Reserved for EMT4
11	Davis US1	Siemens Solar Industries
12	Davis US1	Integrated Power Corporation
13	Davis US1	Advanced Photovoltaic Systems
30	Davis Weather	Site weather station
32	Davis Pumps	Site flood control
33	Davis Power	Site power delivery
81	Maui EMT	Sovonics
82	NYSERDA US1 Host	Integrated Power Corporation
83	Austin US1 Host	Integrated Power Corporation
84	Kerman US2	Siemens Solar Industries
85	Maspeth/NREL Host	United Solar Systems Corporation
86	SMUD US2 Host	Utility Power Group
87	DOD US2 Host	To be determined
88	VEPCO EMT Host	Astropower
89	C&SW US2	ENTECH
90	C&SW US2	Utility Power Group

C&SW = Central and Southwest Utilities
 DOD = Department of Defense
 NREL = National Renewable Energy Laboratory
 NYSERDA = New York State Energy Research and Development Authority
 SMUD = Sacramento Municipal Utility District
 VEPCO = Virginia Electric Power Company

500-Mbyte MO cartridges. Redundant copies of the MO drive cartridges are stored at the Davis site and at the project offices in San Ramon.

4. Troubleshooting

The complexity of networked computers running Windows™ is such that simple troubleshooting is not always possible or advised. A trained operator is the best reference if the computer does not respond properly or if data are not displayed. If the system is hung up and complete power-on reset of the hardware does not alleviate the problem, the following references should be consulted:

Computer:	Dell System 486D/50 User's Guide
Printer:	Hewlett Packard LaserJet III User's Guide
Modem:	U. S. Robotics User's Manual
Data Loggers:	CR7, 21X, or CR10 User's Manual
Software:	DAS O&M Manual

E. Maintenance

Periodic maintenance is required to ensure accurate data and storage. Clean radiometers on alternate work days. Service computers monthly to archive data. Annual activities include replacing data logger batteries, calibrating instruments, and backing up data. Refer to the maintenance schedule in Appendix K for frequency and tasks.

1. Calibration

With the exception of the weather station and CSI data loggers, calibrate all equipment annually. PG&E's Gas Control-Meteorology group calibrates the weather station twice a year. The contact is Ken Ericsson at 510-866-5956 or company email at KxE1@TESAbs@GSV (Internet kxe1@pge.com). Calibrate the CSI data loggers every 3 years in accordance with the procedure outlined in the Campbell Industries, Inc., O&M Manual located in the Reference Library. Table IX-4 indicates the calibration procedure reference and frequency for systems at PVUSA Davis.

Table IX-4
Calibration Procedures

System	Subsystem	Procedure (Manual)	Frequency
DAS	Data Loggers	CSI	3 years
	Weather Station	PVUSA Calibration	Biannual
EMT Metering	AC/DC Metering	EMT Calibration	Annual
	Inverters	DECC Helionetics	Annual
US1 Metering	Power/Energy	PVUSA Calibration	Annual
	Inverters	Subject File	Annual
I&C Metering	Power	PVUSA Calibration	Annual
	Energy	PG&E	Annual
Pumps	Level Switch	N/A	Annual
	Data Logger	PVUSA Calibration	Annual

N/A = Not available, under development

2. I-V Curves

Take I-V curves annually to determine array problems and track system degradation. Maintain historical data in the contract files by system purchase order number. Additional information on I-V curves may be found in Section IV.

3. UPS

Reliable data collection is achieved primarily by maintaining power to DAS. Power support for DAS computers is provided by the two UPS systems in the switchgear room at the I&C building. The UPS systems provide a minimum of 8 hours of standby power to DAC, DDS, and DBC.

F. System Rating Methodology

To model the instantaneous output of a system under ambient condition, PVUSA developed a model (Equation IX-1) to predict PV power as a function of POA irradiance, ambient temperature, and wind speed (measured at 10 meters above ground). The model has two principal uses: to calculate the expected power under PVUSA Test Conditions (PTC) for vendor acceptance tests, and to track variations in the PTC rating over longer periods.

The useful range of Equation IX-1 depends on the linearity of the system with respect to changes in irradiance, ambient temperature, and wind speed. The range is additionally dependent on the distribution of conditions which make up the data set. PVUSA has found this model to be accurate for rating systems under PTC, especially when the data set has a concentration of data samples with conditions near PTC.

1. Performance Model

Equation IX-1 describes ac power as a function of POA, ambient temperature, and wind speed. A linear regression is performed on test data to determine the constants A, B, C, and D. With these constants known, the ac rating is calculated by evaluating Equation IX-1 at the PTC values for each variable.

$$\text{AC Power, kW} = I_{\text{POA}} * (A + B * I_{\text{POA}} + C * T_{\text{amb}} + D * W) \quad (\text{IX-1})$$

Where:

kW = ac power in kW at the specific I_{POA} , T_{ambient} , and wind speed
 I_{POA} = plane-of-array irradiance (W/m^2)
 T_{ambient} = ambient temperature ($^{\circ}\text{C}$)
W = wind speed (meters/second)
A, B, C, D = regression constants derived from operational data

Equation IX-2 describes ac power as a function of POA irradiance and module temperature. This equation is not used in PVUSA's performance test, but is commonly used by PV manufacturers to describe performance under standard test conditions (STC). It is included to illustrate another measure of performance. A linear regression is performed to determine constants K1 and K2, and the expected power can then be calculated.

$$\text{AC Power, kW} = I_{\text{POA}} * (K1 + K2 * T_{\text{mod}}) \quad (\text{IX-2})$$

Where:

T_{mod} = module temperature ($^{\circ}\text{C}$)
K1, K2 = regression constants

Equation IX-3 describes the back-of-module temperature as a function of irradiance, ambient temperature, and wind speed. It is not used explicitly in the rating procedure, but is used to calculate supplementary performance information. It is also the starting point from which Equation IX-1 is derived. Equation IX-1 results from substituting Equation IX-3 into Equation IX-2 and simplifying. Equation IX-3 is used to obtain estimates of T_{mod} under PTC.

$$T_{\text{mod}}, ^{\circ}\text{C} = C1 * I_{\text{POA}} + C2 * T_{\text{amb}} + C3 * W \quad (\text{IX-3})$$

Where:

C1, C2, C3 = regression constants

2. Data Set

The following data items were extracted from each 10-minute average to determine each system's rating: day number, time, POA, ac power, wind speed, ambient temperature, PCU on/off status, and back-of-module temperature. To reduce model extrapolation error, the POA irradiance had to be greater than 750 W/m². To reduce error contributed by transient or nonuniform sky conditions, data were excluded if the reference and POA observations differed by more than 10%. After calculating an initial rating, Equation IX-1 was used to backcast the measured power at each data point. Then, a plot of predicted versus measured power was viewed to identify any anomalous points. Table IX-5 shows the computed coefficients for all of the accepted systems to date.

Table IX-5
Power Equation Coefficients for EMT and US Systems

System	Coefficient A	Coefficient B	Coefficient C	Coefficient D	PTC Rating	R ²
SSI EMT1	21.6890	-1.2016	-0.094	0.167	18.7±0.7 kW	0.990
Solarex EMT1	17.0671	-0.5480	-0.045	0.109	15.7±0.5 kW	0.990
Sovonics EMT1	17.4300	-0.3350	0.013	-0.014	17.3±0.7 kW	0.990
UPG EMT1	15.7140	-1.5450	0.081	-0.045	15.7±0.27 kW	0.980
ENTECH EMT1	25.6000	-5.6510	-0.066	0.328	16.5±0.5 kW	0.920
APS US1	563.2000	-39.0000	-2.370	2.750	479±13 kW	0.970
IPC US1	282.1400	-70.1520	-0.898	1.582	196±3 kW	0.975
SSI US2	701.1000	-142.2000	-3.384	6.412	498±6 kW	0.970
Maui EMT1	19.9590	-2.6420	0.056	0.079	18.5±1 kW	0.993
Austin US1 Host	22.8300	-3.4160	-0.081	0.124	17.9±0.6 kW	0.940

R² = Regression constant: 1 = perfect, less than 0.9 = suspect.

X. GENERAL SITE MAINTENANCE

A. Flood Control

A series of graded control ditches direct storm water runoff to a collection basin. The collection basin is equipped with two vertical lift pumps that automatically transfer the storm water to the site settlement pond. In the event of pond overflow, water flows through a lowered riprapped area and corrugated metal pipe riser on the southwest corner of the settlement pond into a seasonal ditch. The flood control components described in the following subsections require varying degrees of maintenance.

1. Ditches

Site ditches require periodic cleaning and occasional slope reestablishment due to localized soil erosion. The soil conditions at the site contribute to soil piping (due to drying/wetting cycles) and sheet erosion. Ditch bank protection may be useful in reducing the erosion problem. Enkamat® appears to be the most cost-effective erosion matting. Enkamat, a registered trademark of Axzo Industrial Systems Company, is distributed locally by the American Excelsior Company, Sacramento, California. Additionally, concrete cutoff walls installed adjacent to the most erosion-prone ditches stop the soil piping process and surface erosion propagation. Refer to site contract file D183 for information on the cutoff walls.

2. Sump Pumps

The collection basin is serviced by two vertical shaft 30-hp, 2,000-gpm Gould submersible pumps. The pumps require an annual (fall) check of the float operation and greasing before being subjected to winter rains. The pumps are critical to the dispersal of storm water, and therefore their operability should be monitored following every significant rainfall occurrence. Refer to subject file 18059-DM-01 for vendor information on pumps.

3. Site Retention/Settlement Pond

The PVUSA settlement pond was an old sewage retention basin. An existing transfer valve within the basin's area has been removed from service. The pond occupies an area of approximately 4.5 acres with a capacity of approximately 11 acre-feet. It is surrounded by earthen dikes which retain the storm water until it reaches the CMP overflow elevation and spills to the southwest into a seasonal waterway. The pond should be visually inspected when full to ensure that the dikes have not failed. Dike repairs, if needed, will likely require heavy equipment and should be undertaken by an experienced waterway contractor.

4. Dikes

Earthen dikes on two sides of the PVUSA site are intermittently surfaced by degraded asphalt and concrete. It is not likely that the dikes will require maintenance because they

are no longer used as a waterway boundary. Native weeds pose a potential fire hazard during dry seasons; they should be cut once a year, in early summer.

B. Roads/Parking

Over 8,000 feet of permanent roads traverse the PVUSA job site. The roads were established with a minimum of 1 foot of coarse drain rock surfaced with aggregate base. Due to the characteristics of the native soils, use a soil-stabilizing mat prior to constructing new roads. The roads begin to soften as the adjacent and underlying soils become saturated; therefore, they must be occasionally graded to keep them properly maintained. An occasional load of aggregate base placed discretely along the site roads should be all the additional maintenance required.

The parking area along the perimeter of the I&C building provides ample parking for at least 40 vehicles. The parking area requires essentially the same maintenance as the permanent site roads.

C. Vegetation

Tumbleweeds and other unsightly weeds are a potential problem for maintenance of site ditches and for fire control. A mower may be used behind the ATV to eliminate weeds in the flat, open areas (See Section XII for information about mobile equipment). The ditches require more labor-intensive hand cleaning. PG&E horticulturists are investigating herbicides and ground cover to control weeds. PG&E also has developed a weed control manual, which is available at the site.

D. Fences and Gates

The 86-acre facility is leased from the city of Davis. The majority of the site (approximately 65 acres) is surrounded by an 8-foot-high, 3-barbed-strand, chain link fence. Additionally, the I&C building area is secured by a 7-foot-high chain link fence. The fence boundary should be periodically checked. Due to the site's location and readily accessible boundaries, intruders could be a problem. Contact Pisor Fence, Citrus Heights, California, for repairs (916-969-8850).

The ten vehicle gates and two personnel gates are locked most of the time. Only a few are required for site maintenance purposes. Gate keys are available in the key control box in the I&C building. The gates should be oiled for ease of operation.

E. Pests

1. Insects

Site structures attract yellow jackets and other wasps in large numbers. Experience dictates calling in an exterminator to control infestations. Monthly spraying around the

I&C building and Visitor's Center, as well as annual visits by the "beeman," are mandatory when the site is staffed.

2. Varmints

Many forms of wildlife occupy the fenced-in area. However, only coyotes and ground squirrels pose a concern to site maintenance. A few coyotes have wandered onto the site and have even approached the I&C building. Yolo County Animal Control will destroy any coyote who approaches the site and appears to be sick. **Warning:** If a coyote is not frightened by your presence, it is probably sick and may be dangerous.

Ground squirrels present a formidable problem for maintenance of dikes and ditches. Repair of burrows is probably the most sensible approach. **Caution:** Poisons are not recommended as the site is a native habitat for burrowing owls and predator birds.

3. Birds

Birds are plentiful and pose a minor problem to PV performance. Excessive bird excretions on the PV modules reduce the output of the PV cells. The modules should be washed occasionally with site water. Do not use detergents because they leave a film residue. The site water trailer is suitable for this maintenance activity. **Important:** Bird eradication is not acceptable due to the presence of protected species in the area. Specifically, the site is a nesting area for the burrowing owl.

F. Site Well

The site well is located west and adjacent to the I&C building. It is 125 feet deep, and the bottom (20 feet) is perforated. The well is serviced with a 1/2-hp red jacket submersible pump and an FM 135 pressure tank. The system was installed by G. Gakin Well Drilling, Elverta, California. Refer to site file 19271-SC-D88 for additional information. The aboveground portion of well piping and valves has been insulated to protect the system from freezing. The pump shutoff is located at the pressure tank, and a low-point drain is available to drain down the system. **Warning:** The site water is nonpotable.

G. Septic System

The septic system consists of a 1,500-gallon septic tank and four leach lines. The system was installed by Yolo Pumping Service, who may be called to pump down the septic tank when service is required (phone 916-662-5534). Refer to job site file 19271-SC-D91.

H. Buildings

Site buildings include the Visitor's Center trailer, the I&C building, an EPRI trailer, and a storage building. The Visitor's Center trailer contains samples of the various PV site modules, photos and displays of interest to the PV community, video equipment for viewing an

introductory PV videotape, and seating to accommodate meetings and tour groups. Restroom facilities are also located there. The I&C building contains office space for site personnel, and has separate rooms for the DAS and electrical switchgear. The EPRI trailer contains the system control computers and work space for fabrication and assembly of equipment. A 10-by-40-foot wooden storage shed is used to warehouse spare parts. See Appendix K for maintenance requirements for site buildings.

XI. SITE ACCESS CONTROL

A. Unescorted Access

Unescorted access is limited to the PVUSA staff who have received a security system passcode from the site manager.

B. Escorted Access

Escorted visits to PVUSA are encouraged and may be arranged by contacting the site manager (916-753-0725). Tours are conducted from 1 P.M. to 4 P.M., Monday through Friday, and normally last 45 minutes. Visitors are required to sign in at the Visitor's Center and listen to a short safety briefing prior to departing on the designated tour path. Visitors and tour groups must comply with the tour requirements posted on the bulletin board in the I&C building. All visitors must be accompanied by site personnel, who are responsible for their safety. The Davis site is host to over 700 visitors per year.

C. Key Control

The keys to all locks are kept in the key box in the I&C building. Each key is identified by lock location and serial number. All vehicle and personnel gates are keyed alike. The two main entrance gates are secured with a double lock (a PVUSA master lock tied with a PG&E #2).

D. Security System

Honeywell® installed the PVUSA site security system and is monitoring it. The system is armed and disarmed by a keypad adjacent to the vehicle gate entrance into the yard area. Site personnel have secret codes, assigned by the site manager, and required to control the system. The system is separated into seven zones, as follows:

- Zone #1 I&C building smoke detectors
- Zone #2 Visitor's Center smoke detectors
- Zone #3 Main entrance road infrared beams
- Zone #4 I&C yard area infrared beams
- Zone #5 I&C building internal infrared beams
- Zone #6 Visitor's Center infrared beams
- Zone #7 480-V circuit breaker supervisory control

If a zone activates an alarm while the system is armed, expect the following:

1. An audible horn located on the east exterior wall of the I&C building will sound for 15 minutes.
2. Honeywell® will contact a site supervisor to request permission for the police or fire department to respond.

If zones #1, #2, #5, or #6 sound an alarm, respond immediately. These zones do not “false,” and the likelihood of a problem is significant. Experience indicates that zones #3 and #4 “false” quite frequently; therefore, it is advisable not to request a police response to these zones. The audible horn should provide sufficient deterrent to trespassers. The alarm on zone #7 is for informational use and does not require immediate response.

The site had two trespassings and burglaries during Phase I construction. These occurrences were investigated by the Yolo County Sheriff's Department, but neither case was solved. Since installation of the security system, only one attempted trespassing has occurred, and it was deterred by the yard area infrared beams and audible horn. For additional information, refer to the following:

Site subcontract file D171 and D109
Honeywell® monitoring 1-800-523-8914
Reference calls to Honeywell® Job box #502523

E. Emergency Access

1. Davis Fire Department

The Davis Fire Department has a knox-box behind the PVUSA sign at the main entrance off Poleline Road. The box contains three keys which give the Fire Department emergency access to the site, I&C building, and Visitor's Center. The knox-box is only accessible to the Davis Fire Department.

2. PG&E

The main vehicle gates are accessible to PG&E personnel on an emergency basis. The PG&E #2 lock provides access; however, entering the vehicle gate into the yard area will activate the security alarm.

XII. MOBILE EQUIPMENT

A. Pickup Trucks

A four-wheel-drive Ford Ranger pickup truck is used to pull the water trailer through the arrays during wet megger testing and to periodically clean the modules. A full-size Ford F150 pickup truck is used for long-distance commuting, emergency response, and town runs.

B. Water Trailer

A 550-gallon Aqua-Tranz water trailer is used for wet megger testing, firefighting, and cleaning the arrays. The water trailer is equipped with 50 feet of 1-inch hose, a 5-hp gasoline-powered engine, and a 160-gpm pump. The engine requires routine oil changes, so the oil level should be checked before each usage. The pump has a drain plug which allows the operator to drain the pump when it is not in use. The pump should be drained when the ambient temperatures are forecasted to approach freezing. Refer to site file 19271-PO-D56 for detailed information on the Aqua-Tranz water trailer.

C. ATV

The ATV Honda Four Trax is used to access the site facilities. For safety purposes, the ATV should only be operated when two or more individuals are present at the site. The ATV requires normal periodic maintenance in accordance with the Honda owner's manual. Refer to job site file 19271-PO-D170 for pertinent information and a copy of the owner's manual.

D. Scissor Lift

The Economy model SPL 26-60 scissor lift is used for site photography and system maintenance tasks. The battery system may be charged from a 120-Vac power supply, and the lift is equipped with a self-contained charging unit that shuts off automatically when the batteries are fully charged. The unit may remain plugged into an electric source when not in use.

XIII. INVENTORY

A. Storage Shed

1. Spare Parts

A limited amount of spare parts are maintained at Davis because most equipment has been under factory warranty. Fuses and small electronic components are stored in the bins in the storage shed. See Table XIII-1 for a complete list of fuses and electronic components. APS spare parts are stored in the APS inverter cabinet and include NOS-6, NOS-10, NOS-30, NOS-60, and KWS-R-45 fuses.

2. Other Equipment

A spare tracker controller board for the ENTECH system is stored on the rack north of the bins. Spare modules are stored on the shelves at the north end of the building.

B. Other Items

1. Instrumentation

Test equipment is stored on the work bench or in the cabinets in the switchgear room and consists of the following:

- Tektronics model 2211 digital storage scope
- Fluke model 45 dual-display multimeter
- Two Fluke model 11 multimeters
- B&K model 2940 multimeter
- Simpson model 405 megger
- Simpson model 400-2 megger
- Two FW Bell model CG-100A clamp-on ammeters
- Raytek model RAYRPM2EMLS infrared thermometer
- TIF model 5500 halogen leak detector
- Amprobe Model AM4B 1,000-V Multimeter

2. Computers/Data Loggers

Computers for DAS-related activities are described in detail in Section IX of this manual. PG&E also provides computers for use by the site manager, research analyst, research engineer, and secretary.

3. Safety Equipment

See Section II C.

Table XIII-1
PVUSA Davis Parts Inventory

Bin A	Description	Qty
A-01	10 * 3 wood screws	Box
A-02	Misc. wood screws	
A-03	1/4-20 * 1-1/2 Mach. screws	Box
A-04	1/4-20 * 1/2 Mach. screws	Box
A-05	Misc. screws, nuts, etc.	
A-06	Ancor screws	20
A-07		
A-08	Misc. nails	
A-09	DB-9 connectors	2m, 1f
A-10	DB-9 Hood	1
A-11	DB-25 connector	1m, 3f
A-12	DB-25 Hood	1
A-13	RF Adaptor	3
A-14	Lamp cord connector	1
A-15	Fan cord w/ plug	1
A-16	120V cord plugs	5
A-17	Misc. heat sinks	12
A-18	Alligator clips	20
A-19	Inline fuse holder - 5A, 20mm	2
A-20	Barrier strips	2
A-21	Resistors	Box
A-22	Resistors	
A-23	Varistors	5
A-24		
A-25		
APS Cab	NOS-6 fuse	3
APS Cab	NOS-10 fuse	1
APS Cab	NOS-30 fuse	1
APS Cab	NOS-60 fuse	3
APS Cab	KWS-R-45 fuse	1

Table XIII-1 (cont.)
PVUSA Davis Parts Inventory

Bin B	Description	Qty	Bin#	Description	Qty
B-01	AGC 1	10	B-32	MDA 1	20
B-02	AGC 1.5	10	B-33	MDA 2	18
B-03	AGC 3	17	B-34	NON 10	5
B-04	A6Y 3	10	B-35	NON 30	3
B-05	A7OP 60	6	B-36	NOS 25	10
B-06	JJS 45	7	B-37	NOS 45	8
B-07	ATM 3	10	B-38	TR 50R	3
B-08	A25X 10-1	10	B-39	TRM 6	10
B-09	ATQ 1	0	B-40	TRS 20R	10
B-10	FLS-R 30	5			
B-11	FNQ 0.2	19			
B-12	FNQ 1	20			
B-13	FNQ 3	19			
B-14	FNQ 20	10			
B-15	FRS-R 12	5			
B-16	FWH 50	5			
B-17	FWP 35	3			
B-18	FWP 40	1			
B-19	FWP 50	5			
B-20	FWP 100	14			
B-21	FWP 200	2			
B-22	FWP 300-A	2			
B-23	FWX 10	5			
B-24	KAA 20	6			
B-25	KAA 30	3			
B-26	KLM 30	10			
B-27	KTK-R 3	10			
B-28	KTK 6	8			
B-29	KTK 25	27			
B-30	KWS-R 40	10			
B-31	MDA 0.5	20			

Table XIII-1 (cont.)
PVUSA Davis' Parts Inventory

Bin C	Description	Qty	Bin#	Description	Qty
C-01			C-32		
C-02	Campbell power cords	3	C-33		
C-03	Pump security relay	1	C-34		
C-04	SS-581 Switch	1	C-35		
C-05	Pyranometer ser# PY5580	1	C-36		
C-06	Fluke test leads	1 pair	C-37	KAC-400	
C-07	Enclosure vent	2	C-38	KAC-400	
C-08	30 AWG Hook-up wire	1 roll	C-39	ENTECH control bd	
C-09			C-40		
C-10					
C-11					
C-12					
C-13					
C-14					
C-15					
C-16					
C-17					
C-18					
C-19					
C-20					
C-21					
C-22					
C-23					
C-24					
C-25					
C-26					
C-27					
C-28					
C-29					
C-30					
C-31					

XIV. CONTACTS

A. City of Davis

Davis Police Department
Shooting Range
Phone

(916) 756-3740

Davis Fire Department
Ken Haggard, Fire Captain
Phone
Emergency Phone

(916) 756-3743

(916) 756-3400

Public Works Department
Property Lease and Site Planning
David Pelz
Phone

(916) 757-5686

Environmental Issues
Paul Junker
Phone

(916) 756-3746

B. Yolo County

Sheriff's Department
Joel P. Hardin, Deputy Sheriff
Emergency Phone Number

(916) 666-8282

Community Development Agency
Planning Division
Phone (General Calls)

(916) 666-8037

Planning Department
Phone (Building Permits)
Phone (Building Inspection)

(916) 666-8055

(916) 666-8037

Department of Public Works
and Transportation
Phone (Site Entrance)

(916) 666-8775

C. PG&E Sacramento Valley Region

Kevin Darr, Construction Test Supervisor
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(916) 757-5241

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Fax

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(916) 388-7304

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D. PG&E R&D and General Office; Endecon Engineering

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(510) 866-5447

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(916) 753-8469

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F. Factory Service Representatives

APS (US-1 PV System)

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Princeton, NJ 08543

Ron Matlin

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(609) 275-5000

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(609) 255-0599

Augustyn and Company (Meteorological Equipment)

1029 Solano Ave, Suite C

Albany, CA 94706

Jim Augustyn

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(510) 525-9410

BluePoint Associates (PCU)

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Art Dickerson

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(714) 261-0413

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(415) 855-2954

ENTECH (PV System)

1015 Royal Lane, P.O. Box 612246

Dallas/Ft. Worth Airport, TX 75261

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Fax

(214) 456-0904

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Sacramento, CA 95815

Bob Mendoza, Sales Consultant

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Pacific Bell (Phones)
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George Martinier
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Robbins Engineering, Inc. (Passive Trackers)
751 S. Richmond Road, Suite F
Ridgecrest, CA 93555
Roland Robbins
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(619) 375-9764

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4650 Adohr Lane, P.O. Box 6032
Camarillo, CA 93011
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Phone
Pager
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(805) 388-6255
(805) 266-6489
(805) 388-6395

Solarex (PV System)
630 Solarex Court
Fredrick, MD 21701
Don Warfield
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(310) 698-4372
(310) 698-4201

Southwest Technology Development Institute
(Remote Data Units)
1505 Payne Street/NMSU
Las Cruces, NM 88003
Steve Durand
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(505) 646-4247
(505) 646-3041

Sovonics (PV System)
5278 Eastgate Mall
San Diego, CA 92128
Larry Slominski
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Fax

(800) 397-2083
(619) 625-2083

UPG (PV System)
9410 Desoto Ave, Unit G
Chatsworth, CA 91311
Mike Stern
Phone

(818) 700-1995

G. Host Sites (Data Acquisition Systems)

Name: Maui
Sponsor: Maui Electric
Address: Maui Electric Company Limited
P.O. Box 398
Hahului, Hawaii 96732
Contact: Mr. Ken Sakai
Phone: (808) 871-8461
Fax: (808) 871-2322

Name: NYSERDA
Sponsor: New York State Energy Research and Development Authority
Address: Jennifer Harvey
New York State Energy Research and Development Authority
2 Rockefeller Plaza
Albany, New York 12204
Phone: (518) 465-6251 ext 264
Fax: (518) 432-4630
Address: State University of New York-Farmingdale (Host Site)
Farmingdale, New York
Contact: Newell Thomas
Ascension Technology
235 Bearhill Road
Waltham, Massachusetts 02154
Phone: (617) 890-8844
Fax: (617) 890-2050

Name: Austin Convention Center
Sponsor: City of Austin Power and Light
Address: Austin Convention Center
Corner of Red River and Ceasar Chavez
Austin, Texas 78701
Contacts: John Hoffner: (512) 322-6284
Leslie Libby: (512) 322-6290
Resource Planning and Evaluation
Town Lake Center
721 Barton Springs Road
Austin, Texas 78704
Fax: (512) 322-6083

Name: Kerman PV Power Plant
Sponsor: Pacific Gas and Electric Company
Address: PG&E, Fresno Division
Contact: Mr. Dan Divine
San Joaquin Valley Region
Fresno Division
2161 South Orange
Fresno, California
Phone: (209) 263-7115
Fax: (209) 263-7111

Name: Maspeth/NREL
Sponsor: National Renewable Energy Laboratory
Address: New York City Transit Authority (NYTA)
55-04 Maspeth Avenue
Maspeth, New York
Contact: Mr. Byron Stafford
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401-3393
Phone: (303) 384-6426
Fax: (303) 231-1030

Name: Hedge Substation PV Power Plant
Sponsor: Sacramento Municipal Utility District
Address: Hedge Substation
Sacramento County
Sacramento, California
Contact: Donald E. Osborn
SMUD Solar Program
6201 South St., MS 75
Sacramento, CA 95852-1830
Phone: (916) 732-6679
Fax: (916) 732-5695

Name: Department of Defense-Yuma
Sponsor: Department of Defense Tri Services Group

Name: Virginia Electric Power Company (VEPCO)
Sponsor: VEPCO
Address: 5000 Dominion Blvd.
Glen Allen, VA 23060
Contact: Al MacDonald
Phone: (804) 273-2981

Name: Central and Southwest Utilities #1
Sponsor: Central and Southwest Utilities
Address: Fort Davis, Texas
Contact: Brian Champion
Phone: (915) 426-2031
Fax: (915) 426-2113

XV. REFERENCES AND STANDARDS

A. References

1. PG&E Power Producers' Interconnection Handbook, 1993
2. PG&E Accident Prevention Rules, 01-69004-93
3. PG&E Standard Practice 403-1, Switching Procedures, Applicable Forms, and Their Use
4. PG&E Standard Practice 403-3, Proper Use of Tags and Control Handle Barricades: Man-on-Line, Non-Test, Caution, and Approved Tag Holders
5. PG&E Standard Practice 403-4, Instructions for Obtaining Clearances to Work on Apparatus and Lines
6. Geotechnical Investigation for PG&E PVUSA Project, Davis, California, December 1986, prepared by Bechtel Civil, Inc.
7. PVUSA Project Safety and Health Action Plan, R&D Report 007.5-94.9, April 1993
8. PVUSA US-2, Kerman Request for Proposal

B. Codes and Standards

1. ANSI C2-1990, National Electrical Safety Code
2. Occupational Safety and Health Administration (OSHA) Directives
3. California Code of Regulations, 1991
4. NFPA 70-1993, National Electrical Code
5. IEEE 928-1986, Recommended Criteria for Terrestrial PV Power Systems
6. IEEE 929-1988, Recommended Practice for Utility Interface of Residential and Intermediate PV Systems
7. IEEE 80-1986, Guide for Safety in Substation Grounds
8. IEEE 519-1981, Guide for Harmonic Control and Reactive Compensation of Static Power Controllers
9. ANSI/IEEE C37-1990, Circuit Breakers, Switchgear, Relays, Substations, and Fuses

10. ANSI/IEEE C57-1990, Distribution, Power, and Regulating Transformers
11. Code UBC-1991, Uniform Building Code
12. AISC-1989, Manual of Steel Construction, Allowable Stress Design, 9th edition
13. ANSI/ASCE 7-88, Building Code Requirements for Minimum Design Loads in Buildings and Other Structures
14. ACI 318-1989, Building Code Requirements for Reinforced Concrete
15. AWS D1.1-90, Structural Welding Code - Steel, 12th edition
16. AWS D1.3-89, Structural Welding Code - Sheet Steel, 2nd edition
17. AISI SG-673-1980, Specification for Design of Cold-Formed Steel Structural Members

C. Drawings

1. Site Plan, PG&E Drawing 478521 (see Appendix D)
2. Main Single-Line Diagram, PG&E Drawing 478561 (see Appendix D)

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- F. Installation & Operation Manual PV Power Conversion Unit 61635

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Endecon IOMS

- A. Tim Townsend
- B. Max Parker
- C. Paul Hutchinson

Environmental

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Host Segments

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- D. Interoffice Memo 1990 (WTC)
- E. Purchase Memo
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- G. Interoffice Memo 1991 (DJS)
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- E. Wet Megger Test Surfactants

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PVUSA Literature

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- B. Brochures
- C. Papers

PVUSA Monthly Technical Report

- A. Reports 1989

PVUSA Quarterly Tech Reports 1990

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- B. 2nd Quarter
- C. 3rd Quarter
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- C. Stray Bullets/Scheduled Shoots
- D. Safety Incident SSI
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Solar Energy Industries Association (SEIA) Report

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Site Operations Manual (O&M Manual)

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Site Topics

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- B. Bird Control
- C. Coatings
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- E. PVUSA/PG&E Power Quality
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- A. Schedule/Cost

Solar Central Receiver

- A. Summary Review

Steering Committee

- A. Meeting, April 24, 1991

Technical Review Committee

- A. Meeting Notes
- B. Handouts for Meeting on
October 1, 1990

Technology Transfer Meetings

- A. March 28, 1989
- B. August 31, 1989
- C. May 21, 1990
- D. April 22, 1990

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Visitors

Warranty Provisions

Wells Fargo

- A. Statements 1991
- B. Statements 1992
- C. Statements 1993
- D. Statements 1994

Index to Subcontractors
PVUSA Project-Job 19271 Subcontractor List

Account Status
 Closed/Active

C	13564	Data Preference	Computer rental
C	D-001	Granite Const.	Site preparation
C	D-002	Morris Electric	Electrical installation
C	D-003	Lagenour & Meikle	Pre-site surveying
C	D-004	Walsh Const.	Sump pump installation
C	D-005	Central Fence	Perimeter fencing
C	D-006	Modulaire	Trailer rental
C	D-007	J.V. Sanitation	Portable toilets
A	D-008	Alhambra Water	Drinking water
C	D-009	J.H. Kleinfelder	Soils testing
C	D-010	Bechtel Leasing	Truck leasing
C	D-011	Morton & Pitalo	Surveying
C	D-012	The Office Place	Copy machine & office supplies
C	D-013	Kelly Services	Temp. employee
C	D-014	Bechtel Leasing	Hard hats
C	D-015	River Valley Concrete	I&C building foundation
C	D-016	Businessland	Printer
C	D-017	Gilkey Const.	I&C building installation
C	D-018	Hawkins Safety	Delineators
C	D-019	Pac Machine Co.	Rental of diesel pump
C	D-020	Yuba City Steel	Structural steel
C	D-021	River Valley Concrete	Concrete work
C	D-022	Okonite Co.	Cable
C	D-023	Granite Const.	Repair work
C	D-024	Dutra Const.	Site maintenance
C	D-025	—	Well water system
C	D-026	N.M. Solar Energy Inst.	DAS system
C	D-027	Helionetics	Power conditioning units (Dows)
C	D-028	Kimzey Welding	Time capsules
C	D-029	McCune Audio Visual	Sound system
C	D-030	Ewing Foley	Uninterruptible power supply
C	D-031	ARCO Solar (Siemens)	EMT-1 (Dows)
C	D-032	UPG	EMT-1 (Dows)
C	D-033	ENTECH	EMT-1 (Dows)
C	D-034	Sovonics (ECD) United Solar	EMT-1 (Dows)
C	D-035	Solarex Corp.	EMT-1 (Dows)
C	D-036	The Office Place	Miscellaneous & answer machine
C	D-037	Bechtel Leasing	Purchase of truck
C	D-038	Collins Electric	Electrical

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Account Status
Closed/Active

C	D-039	Eaton Financial	Copier
C	D-040	Walnut Creek Honda	Maintenance vehicle
C	D-041	Qualimetrics	Meteorological inst.
C	D-042	Davis Honda	Mower
C	D-043	Eppley Laboratory	Solar inst. (Dows)
C	D-044	The Office Place	Facsimile machine
C	D-045	City Appliance	Trouble call
C	D-046	Okonite Co.	Cable
C	D-047	Eppley Laboratory	Solar track (Dows)
C	D-048	Houston Wire (CED/Royal)	Cable
C	D-049	Advanced Logical Solutions	SCADA
C	D-050	Chinook Const.	Wall texturizing
C	D-051	Sears Roebuck	Refrigerator and microwave
C	D-052	City Appliance	Trouble call
C	D-053	Tri City Maintenance	Install counter & flooring tiles
C	D-054	Woodland Welding Works	Service platform
C	D-055	N.M. Solar Energy Inst.	Retesting and verification
C	D-056	MRI	Water trailer
C	D-057	The Office Place	Task chair, keyboard tray
C	D-058	Hansen Decorating	Paint interior walls
C	D-059	Solon Fire Control	Hydrant valve, wrench
C	D-060	Chinook Const.	Concrete work
C	D-061	San Sierra Business Systems	Repair copier
C	D-062	Hoover Horticultural	Site entrance
C	D-063	Woodland Welding Works	Supports, frating
C	D-064	Pisor Fence	Storage area
C	D-065	The Bee Man	Wasps
C	D-066	The Good Guys	VHS movie camera
C	D-067	Dutra Const.	Storm water pond
C	D-068	Woodland Welding Works	Channels, plates
C	D-069	Modern Alloys, Inc.	Install ARCO panels
C	D-070	VWR Scientific Co.	Liquinox detergent
C	D-071	Standard Meter Lab	Insulation tester
C	D-072	Willard Nott & Co.	Relays, test plugs
		Basler Electric	
C	D-073	G.E. Supply Co.	Enclos., term blk., fuse
C	D-074	The Paint Chip	Mini-blinds
C	D-075	The Office Place	Folding tables, chairs
C	D-076	Okonite Co.	15 kV Shielded cable

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Account Status
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C	D-077	VWR Scientific Co.	Liquinox detergent
C	D-078	Okonite Co.	Copper cable
C	D-079	Campbell Scientific	Modems, batteries
C	D-080	Hoover Horticultural	Tumbleweed removal
C	D-081	Electrical Power	Vacuum interrupter
C	D-082	Maxim Electronic Sales	Bell current gun model
C	D-083	Bernards Tires	Tires for Ford truck
C	D-084	American Sanitation	Portable toilets
C	D-085	A. Teichert	Ground work
C	D-086	Mr. B's Caterers	Caterer (3/90 technology update)
C	D-088	G. Gakin	Well water system
C	D-089	Adia	Temp helpers (technology update)
C	D-090	Adia	Administrative assistant
C	D-091	Yolo Plumbing	Leach line
C	D-092	Hoover	Herbicide spraying
C	D-093	Breckenridge & Sons	Supports-Solarex array
C	D-094	Commercial Office Trailer	Building, 12'x 40'
C	D-095	Photon	EMT-2
A	D-096	AstroPower	EMT-2
C	D-097	Arco	EMT-2
C	D-098	Chronar	US-1
A	D-099	IPC	US-1
A	D-100	Siemens	US-1
A	D-101	APS	US-1
C	D-101	Hoover	Control veg growth
C	D-102	Latham Lumber	Trusses for EMT-2
C	D-103	Malcolm Drilling	Concrete for EMT-2
C	D-104	Chinook Const.	Erect super supports
C	D-105	J F Computer	Zenith computer
C	D-106	F Chart Software	PV-F chart software
C	D-107	Carpet Dealer	Visitor's Center mini blinds
C	D-108	The Office Place	Office supplies
C	D-109	Collins Electric	Electrical for EMT-2
C	D-110	Commercial Office Trailer	Trailer tie downs
C	D-111	Yolo Plumbing	Trailer well hookup
C	D-112	Summerland	Construct deck
C	D-113	Cofab	Embeds
C	D-114	Okonite Co.	Cable
C	D-115	Cons. Electrical	Cable

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Account Status
Closed/Active

C	D-116	Dutra Const.	US-1 road work & main.
C	D-117	Kirk Cabinet	Cabinet under sink
C	D-118	American Sanitation	Portable toilets
C	D-119	Mr. B's Caterers	Catering
C	D-120	Associated Sound	Sound system
C	D-121	Asco Delta	Feeder panel
C	D-122	All Action Awards	Signs
C	D-123	Square D Company	Transducers
C	D-124	Scientific Columbus	Meters
C	D-125	Basler Electric/Willard	Relays
C	D-126	Western Electro-Mechanical	Relays
A	D-127	AT&T	Phone system
C	D-128	VWR Scientific Co.	Liquinox detergent
C	D-129	Qualimetrics, Inc.	Temp/humidity probe
C	D-130	VWR Scientific Co.	Liquinox detergent
C	D-131	JF Computer Solutions	Hard disk drive
C	D-132	Okonite Co.	Cable
C	D-133	JF Computer Solutions	Hard disk drive
A	D-134	San Sierra Business Systems	Copier
C	D-135	Camera World	Site camera
C	D-136	American Excelsior	Ditch mats
C	D-137	All Phase Electric	12-kV switch
C	D-138	Okonite Co.	Cable
C	D-139	Battery Bill, Inc.	Batteries
C	D-140	Grainger	Light, soldering station
C	D-141	American Red Cross	First aid training
C	D-142	Golden Software Inc.	3D software
C	D-143	McCurrys Companies	Slide projector
C	D-144	Mr. B's Caterers	Catering
C	D-145	Lustre-Cal	Safety labels
C	D-146	The Dutch Cleanzers	Site cleaning
C	D-147	General Electric Systems	Color monitor
C	D-148	California Sheds	Storage shed
C	D-149	Woodland Welding Works	Brackets
C	D-150	VWR Scientific Co.	Liquinox detergent
C	D-151	American Sanitation	Portable toilet
C	D-152	Mr. B's Caterers	Catering
C	D-153	Velocity Engineering	Backup tapes
C	D-154	Harbor Freight Tools	Tools

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Account Status
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C	D-155	Egghead Software	Software (WordPerfect)
C	D-156	Photo & Sound	Repair of Irwins
C	D-157	Opamp Tech Books	Books
C	D-158	Velocity Engineering	Backup tapes
C	D-159	Souza's Lettering	PVUSA caps
A	D-160	Grainger	Tools
C	D-161	VWR Scientific Co.	Liquinox detergent
C	D-162	Eppley Laboratory	One-axis tracker
C	D-163	Freeway Ford	Repair truck
C	D-164	VWR Scientific Co.	Liquinox detergent
C	D-165	Bernards	Truck brakes
C	D-166	Allied Electronics	Restock Ins. tester
C	D-167	Standard Meter Lab	Insolation tester
C	D-168	Souza's Lettering	PVUSA caps
C	D-169	Cole-Parmer	Conductivity meter
C	D-170	Honda of Sacramento	Honda 2 wheeler
A	D-171	Honeywell	Security system
C	D-172	VWR Scientific Co.	Liquinox detergent
C	D-173	Pisor Fence	Repair of fence
C	D-174	UARCO Inc.	SF printer cables
C	D-175	GE Computer Service	Rental of ground megger
C	D-176	Rust & Sons Tractor Service	Road maintenance
C	D-177	Kortick Manufacturing Co.	Electric equipment
C	D-178	All Action Awards	Bakelite tags
C	D-179	MRI	Repair water trailer
C	D-180	Pisor Fence	Repair fence
C	D-181	American Sanitation	Portable toilets
C	D-182	Western Traction Co.	Repair scissor lift
C	D-183	Syblon-Reid	Erosion work
A	D-184	Static Power Conver.	Inverter tech. services
C	D-185	Absolute Cellular	Truck phone repair
C	D-186	G.E. Supply Co.	Plugs and cord
C	D-187	Rust & Sons Tractor Service	Mowing
C	D-188	Saybo Signs	No trespassing signs
C	D-189	Machado Landscaping	Front landscaping
A	D-190	Yolo Plumbing	Plump septic tank
C	D-191	McNeils Carpet	DAS carpet
C	D-192	Sac Decor. & Paint	Paint DAS room
C	D-193	UARCO Inc.	Computer desk

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C	D-194	Grainger	Safety box
C	D-195	VIP Plumbing	VC plumbing
C	D-196	Absolute Cellular	Motorola phone
C	D-197	Ophir Oil Co.	Oil roads
C	D-198	Construction Specialties	Office partition
C	D-200	Sirlin Photography	Fazio prints
C	D-201	Freeway Ford	Repair Ford
C	D-202	Pisor Fence	Repair fence
C	D-203	Western Traction Co.	Repair lift
C	D-204	McMaster-Carr	Shed shelving
C	D-205	Omnifax	L95 fax
A	D-206	Cellular One	Phone service
C	D-207	Jackson Ford	1992 F150
C	D-208	Southwest Tech Dev Ins	Sovonics J-box
C	D-209	Jerry's Auto Stereo	Truck phone
C	D-210	Sterling May Co	4trax trailer
C	D-211	Solar Cells, Inc.	EMT-3
C	D-212	Sun Power Corp.	EMT-3
C	D-213	Amonix, Inc.	EMT-3
A	D-215	Siemens	US-2 Kerman, Key-2K
A	D-217	Frank Beane	Safety inspection
C	D-218	TGR Container Sales	Sea van
C	D-219	Fuses Unlimited	Fuses
C	D-220	VIP Plumbing	Sump pump
C	D-221	EETS	12 kV repair
C	D-222	Western UTS	12 kV repair
C	D-223	Fuses Unlimited	Fuses
A	D-227	American Red Cross	CPR training
C	D-228	Lucas Sensing	Clinometer
C	D-229	Anixter	600 v cable
C	D-230	Rust & Sons Tractor Service	Mowing
C	D-231	VWR Scientific Co.	Liquinox detergent
A	D-232	ENTECH	EMT-1 spare parts
C	D-233	Western Traction Co.	Scissor lift
C	D-234	Collins Electric	Erosion control
C	D-235	Dutch Cleanzers	Clean site
C	D-236	Kortick Manufacturing Co.	Grounding set
C	D-237	Professional Plastics	Breaker tubes
C	D-238	McMaster-Carr	Heat tracer

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C	D-239	Batteries Inc.	Batteries
C	D-240	Adam & Smith	IPC cable tightening
C	D-241	APS US-1	Inverter training
C	D-241	Quality Overhead Doors	APS inverter doors
C	D-243	MRI	Repair water heater
A	D-244	APS	Remove & replace modules from APS US-1 System, inverter training
C	D-245	Pisor Fence	Fence repair
C	D-246	Airco	AC Service
C	D-247	OMNIFAX	Repair of fax
C	D-248	Keith Volker	Fire breaks
C	D-249	CED	APS fuses
C	D-250	Collins Electric	Maintenance contract
C	D-251	Sign Language	US-1 tour signs
	D-252	N/A	
C	D-253	Western States	Tour path repair
C	D-254	BMI	Calibration of BMI
A	D-255	Taylor Made	Service contract
C	D-280	Davis Rent-All	O&M workshop rentals
C	DE-302	Solidstate Controls, Inc.	UPS
C	M-001	Goulds Pump	Sump pumps

Appendix B
PVUSA DAVIS DESIGN DOCUMENT REGISTER

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PVUSA
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----DOCUMENT ID NUMBER-----		CROSS REFERENCE		OPTION1.		-----DOCUMENT REVISION -----			
TYPE NUMBER.....	SHEET	NUMBER.....	OWN RD Q UNIT	OPTION2.	DESCRIPTION.....	REV..	REV DAT	S	OUT DAT
						OPTIONAL S2 COMMENTS.. XMTL.#			
BDWG 063115	1		AD ED		ELECTRICAL CIRCUIT SCHEDULE	6	901012	901012	
BDWG 063116	1		AD ED		ELECTRICAL RACEWAY SCHEDULE	6	901012	901012	
BDWG 063117	1		AD ED		PVUSA DRAWING LIST	0			NOT ISSUED
BDWG 063118	1		AD ED		CONSTRUCTION NOTES SEPARATION DISTANCE [MINIMUM] DIRECT BURIED CABLES AND RACEWAYS	0	880719	880719	
BDWG 356183	1		AD CD		EMT-2 FIXED FLAT PLATE SUPPORT STRUCTURES GENERAL ARRANGEMENT	1	890630	890630	
BDWG 356184	1		AD CD		EMT-2 FRAMING-PLAN AND SECTIONS	1	890630	890630	
BDWG 356185	1		AD CD		EMT-2 FOUNDATION DETAILS	1	890630	890630	
BDWG 356186	1		AD CD		EMT-2 SUPPORT STRUCTURES DETAILS	1	890630	890630	
BDWG 478521	1		AD CD		SITE PLAN	4			PRELIM.R/4
BDWG 478522	1		AD CD		KEY PLAN AND DRAWING INDEX FOR DAVIS SITE PREPARATION	2	880830	880830	
BDWG 478523	1		AD CD		SITE PREPARATION GENERAL NOTES AND LEGEND	3	890727	890727	
BDWG 478524	1		AD CD		SITE CLEARING PLAN-EAST	1	870831	870831	
BDWG 478525	1		AD CD		SITE CLEARING PLAN-WEST	1	870831	870831	
BDWG 478526	1		AD CD		SITE PREPARATION PLAN-EAST	4		881222	PRELIM.R/4
BDWG 478527	1		AD CD		SITE PREPARATION PLAN-WEST	2	880222	880222	
BDWG 478528	1		AD CD		GRADING AND DRAINAGE-SECTIONS AND DETAILS	2	890727	890727	
BDWG 478529	1		AD CD		ROAD PROFILES	1	870831	870831	
BDWG 478530	1		AD CD		GRADING SECTIONS AND ROAD PROFILES	2	890727	890727	
BDWG 478531	1		AD CD		COUNTY ROAD WIDENING-PLAN AND SECTIONS	1	870831	870831	
BDWG 478532	1		AD CD		STORM WATER SUMP-PLANS, SECTIONS AND DETAILS	1	870514	870514	

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----DOCUMENT ID NUMBER-----		CROSS REFERENCE		OPTION1.		----- DOCUMENT REVISION -----					
TYPE	NUMBER.....	SHEET	NUMBER.....	OWN	RD Q UNIT	OPTION2. DESCRIPTION.....	REV..	REVDAT	S	OUTDAT	OPTIONAL S2 COMMENTS.. XMTL.#
BDWG	478533	1		AD	CD	STORM WATER DISCHARGE PLANS, SECTIONS AND DETAILS	2	880222		880222	
BDWG	478534	1		AD	CD	BUILDING LOCATIONS	1	880826		880826	
BDWG	478535	1		AD	CD	BUILDING FOUNDATIONS	1			890809	
BDWG	478536	1		AD	CD	I&C BUILDING PLANS AND ELEV.	4	900322		900322	
BDWG	478537	1		AD	CD	I&C BUILDING SCHEDULES & DETAIL	0	880122		880122	
BDWG	478538	1		AD	CD	I&C BUILDING GROUNDING & LIGHTING LAYOUT	5	890830		890830	
BDWG	478539	1		AD	CD	EMT-1,ARRAY AND PCU FOUNDATION PLAN	4	890710		890710	
BDWG	478540	1		AD	CD	EMT-,ARRAY,PCU AND MISC. FOUNDATIONS PLAN AND DETAILS	3	890710		890710	
BDWG	478541	1		AD	CD	MET. INST.SERV.PLATFORM PLAN, SECT.& DET.	1	880713		880713	
BDWG	478542	1		AD	CD	EMT-1 FIXED PLATE SUPPORT STRUCTURES PLANS & ELEVATIONS	1				PRELIM.R/1
BDWG	478551	1		AD	ED	ELECTRICAL ELEMENTARY DIAGRAM 480V EMT-1 BREAKER	4	900625		900625	
BDWG	478552	1		AD	ED	ELECTRICAL WIRING DIAGRAM PROTECTIVE RELAY CABINET	3	900625		900625	
BDWG	478553	1		AD	ED	ELECTRICAL ARRANGEMENT OF PROTECTIVE RELAY CABINET	2	900322		900322	
BDWG	478554	1		AD	ED	ELECTRICAL WIRING DIAGRAM 480V EMT-2 FEEDER PANEL EFPO2	2	900625		900625	
BDWG	478555	12		AD	ED	PCU #4 & JB #4 WIRING DIAG.	3	900504		900504	
BDWG	478556	13		AD	ED	PCU #5 & JB #5 WIRING DIAG.	2	900504		900504	
BDWG	478557	14		AD	ED	480V EMT FDR PANEL EFPO1 WIRING DIAGRAM	5	901012		901012	
BDWG	478558	15		AD	ED	MISC.DEVICES MET.INSTR. & SOLAR INSTR.	1	880812		880812	
BDWG	478560	1		AD	ED	KEY PLAN OF WIRING DIAGRAMS	3	900504		900504	
BDWG	478561	1		AD	ED	MAIN SINGLE LINE DIAGRAM	B	890728		890728	

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----DOCUMENT ID NUMBER-----		CROSS REFERENCE		OPTION1.		----- DOCUMENT REVISION -----			
TYPE	NUMBER.....	SHEET	NUMBER.....	OWN	RD Q UNIT	OPTION2.	DESCRIPTION.....	REV..	REVDAT S OUTDAT OPTIONAL S2 COMMENTS.. XMTL.#
BDWG	478562	1		AD	ED		EMERGING TECHNOLOGY ONE 480V SINGLE LINE DIAGRAM	5	931105 931105
BDWG	478563	1		AD	ED		EMERGING TECHNOLOGY #2 480V SINGLE LINE DIAGRAM	1	931105 931105
BDWG	478564	1		AD	ED		CABLE BLOCK DIAGRAM	9	...ELIM.R/9
BDWG	478565	1		AD	ED		US-1 ELECTRICAL RACEWAY PLAN SECTIONS AND DETAILS	2	901012 901012
BDWG	478567	1		AD	ED		EMT-1 ELECTRICAL RACEWAY PLAN SECTIONS AND DETAILS	5	890830 890830
BDWG	478568	1		AD	ED		I & C BUILDING RACEWAY, SECTIONS AND DETAILS	6	900322 900322
BDWG	478569	1		AD	ED		EMT-2 ELECTRICAL RACEWAY PLAN SECTIONS AND DETAILS	1	900330 900330
BDWG	478570	1		AD	ED		RDI/O UNIT NO.1 WIRING DIAG.	2	900504 900504
BDWG	478571	1		AD	ED		RDI/O UNIT NO. 2 WIRING DIAG.	2	900504 900504
BDWG	478572	1		AD	ED		RDI/O UNIT NO. 3 WIRING DIAG.	2	900504 900504
BDWG	478573	1		AD	ED		RDI/O UNIT NO. 4 WIRING DIAG.	2	900504 900504
BDWG	478574	1		AD	ED		RDI/O UNIT NO. 5 WIRING DIAG.	2	900504
BDWG	478575	1		AD	ED		RDI/O UNIT NO. 30 MET INSTRUMENTS AND SIGNAL CONDITIONING UNIT WIRING DIAG.	1	880812 880812
BDWG	478576	1		AD	ED		RDI/O UNIT NO. 32 SUMP PUMP & CONTR. PNL WIRING DIAG.	1	880812 880812
BDWG	478577	1		AD	ED		RDI/O UNIT NO. 33 ELECTRICAL ROOM SIGNALS WIRING DIAG.	3	900322 900322
BDWG	478578	1		AD	ED		PCU #1 & JB #1 WIRING DIAG.	2	900504 900504
BDWG	478579	1		AD	ED		PCU #2 & JB #2 WIRING DIAG.	2	900504 900504
BDWG	478580	1		AD	ED		PCU #3 & JB #3 WIRING DIAG.	2	900504 900504
BDWG	492685	1		AD	ED		RDI/O UNIT #6 WIRING DIAGRAM	2	900504 900504
BDWG	492686	1		AD	ED		RDI/O UNIT #7 WIRING DIAGRAM	2	900504 900504

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----DOCUMENT ID NUMBER-----		CROSS REFERENCE		OPTION1.		----- DOCUMENT REVISION -----					
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BDWG 492687	1		AD ED		RD1/O UNIT #8 WIRING DIAGRAM	2	900504	900504			
BDWG 492688	1		AD ED		PCU #6 & JB #6 WIRING DIAGRAM	2	900504	900504			
BDWG 492689	1		AD ED		DCU #7 AND JB #7 WIRING DIAGRAM	2	900504	900504			
BDWG 492690	1		AD ED		PCU #8 AND JB #8 WIRING DIAGRAM	2	900504	900504			
BDWG 492691	1		AD ED		ELECTRICAL WIRING DIAGRAM 12KV SWITCHGEAR SWGR01	3	900717	900717			
BDWG 492692	1		AD ED		ELECTRICAL ELEMENTARY DIAGRAM PROTECTIVE RELAYING	2	900625	900625			
BDWG 492693	1		AD ED		ELEMENTARY DIAGRAM 480V EMT-2 BKR EFPO2	2	900625	900625			
BDWG 492694	1		AD ED		ELECTRICAL WIRING DIAGRAM INTERFACE JUNCTION BOX #IJB-11	1	900913	900913			
BDWG 492695	1		AD		ELECTRICAL WIRING DIAGRAM INTERFACE JUNCTION BOX #IJB-12	1	901119	901119			
BDWG 492696	1		AD ED		ELECTRICAL WIRING DIAGRAM INTERFACE JUNCTION BOX #IJB-13	1	901119	901119			

Appendix C
SUPPLIER DOCUMENT REGISTER

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-----DOCUMENT ID NUMBER-----				SUPPLIERS			SUPPLIER		----- DOCUMENT SUBMITTAL -----									
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER.....	OWN	RD	Q	UNIT	-----	DESCRIPTION.....	SBMTL	INDATE	S	OUTDAT	SPLR.REV S2	COMMENTS..	XMTL.#	
sdoc	D-021	1	1					AD		PCU PAD RAIN GAUGE PAD REBARS DETAILS (SHT 1)	1	880615	2	880617			032	
sdoc	D-021	2	1					AD		CAISSON TYPE C REBAR DETAILS (SHT 2)	1	880615	2	880617			032	
sdoc	D-021	3	1					AD		CAISSON TYPE C LAYOUT SHT K-1	1	880615	2	880617			032	
sdoc	D-E-302	1	1	36088D				AD SIZE:C	ED V	SCI	DATASHIELD SS3000 (120VAC) SYSTEM OUTLINE	1	930331	1	930406			389
sdoc	D-E-302	2	1	35841D				AD SIZE:C	ED V	SCI	DATASHIELD SS3000 (120VAC) SYSTEM SCHEMATIC	1	930331	1	930406			389
sdoc	D-E-302	3		#95-003000-90				AD SIZE:A	ED P	SCI	SS3000 UNINTERRUPTIBLE POWER SYSTEM USER MANUAL	1	930301	1	930323	-		384
sdoc	D-E-302	4	1	80-104038				AD SIZE:B	ED P	SCI	ASSEMBLY CABINET, BATTERY SS5000	1	930719	5	930719			395
sdoc	DM01	1	1					AD		GOULDS	GOULDS PUMPS	2	871019	1				
sdoc	D0-017	1	1					AD			SYSTEM CONTRACTOR'S RESPONSIBILITY	1	880223	1	880229			
sdoc	D0-017	1	2					AD			STRUCTURAL LAYOUT AND FRAME ELEVATION	1	880223	2	880223			
sdoc	D0-017	1	3					AD			STRUCTURAL DETAILS	1	880223	1	880229			
sdoc	D0-017	1	4					AD			STRUCTURAL DETAILS	1	880223	1	880229			
sdoc	D0-017	1	5					AD			ROOF COVERING DETAILS	1	880223	1	880229			
sdoc	D0-017	1	6					AD			ROOF COVERING DETAILS	1	880223	1	880229			
sdoc	D0-017	1	7					AD			STEEL OX-WALL DETAILS	1	880223	1	880229			
sdoc	D0-017	1	8					AD			BUILDING FRAME ANALYSIS	2	880401	1	880407			
sdoc	D0-017	2	1					AD			BUILDING PLAN VIEW & ELEVATION VIEW LAYOUT	2	880401	1	880407			
sdoc	D0-017	2	2					AD			BUILDING DETAIL, ROOF FAN, AIR COND.	2	880408	1	880413			
sdoc	D0-017	3	1					AD			INSULATION ALL HARDWARE	2	880408	1	880413			
sdoc	D0-017	3	2					AD			HOLLOW METAL DOOR - INTERIOR	1	880316	1	880318			
sdoc	D0-017	4	2					AD			ELECTRICAL ROOM UNIT HEATER	1	880408	1	880413			

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PVUSA
PVUSA - DAVIS SUPPLIER DOCUMENT REGISTER

-----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		----- DOCUMENT SUBMITTAL -----									
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sdoc	PO-D026	1	1		AD			SWTDI	STORAGE & INSTALLATION MANUAL	1	880608	1	880621				
sdoc	PO-D026	2	1		AD			SWTDI	PROJECT SCHEDULE	1	880608	1	880621				
sdoc	PO-D026	3	1		AD			SWTDI	PARTS LIST & COST	1	880608	1	880621				
sdoc	PO-D026	4	1	1-1	AD			SWTDI	RDI/O UNIT ARRANGEMENT 3-1	6	901026						
sdoc	PO-D026	5	1	1-2	AD			SWTDI	SUMMING J-BOX ARRANGEMENT	2	880923	1	880927				
sdoc	PO-D026	6	1	1-3	AD			SWTDI	DAS CDLE OUTLINE DIMENSIONS	2	880923	1	880927				
sdoc	PO-D026	7	1	2-1	AD			SWTDI	RDI/O UNIT ARRANGEMENT & MTG DETAILS	2	880923	1	880927				
sdoc	PO-D026	8	1	2-2	AD			SWTDI	SUMMING J-BOX ARRANGEMENT & MTG DETAILS	2	880923	1	880927				
sdoc	PO-D026	9	1	2-3	AD			SWTDI	RDI/O UNIT MTG PLATE ASSY	2	880923	1	880927				
sdoc	PO-D026	10	1	3-1	AD			SWTDI	DAS BLOCK DIAGRAM	2	880923	1	880927				
sdoc	PO-D026	11	1	3-2	AD			SWTDI	RDI/O UNIT BLOCK DIAGRAM	2	880923	1	880927				
sdoc	PO-D026	12	1	3-3	AD			SWTDI	SUMMING J-BOX BLOCK DIAGRAM	2	880923	1	880927				
sdoc	PO-D026	13	1	3-4	AD			SWTDI	RDI/OU/EMT-1 TYPICAL WIRING DIAGRAM 3-2	6	901026						
sdoc	PO-D026	14	1	3-5	AD			SWTDI	DAS CDLE WIRING DIAGRAM	2	880923	1	880927				
sdoc	PO-D026	15	1	3-6	AD			SWTDI	DAS CHANNEL MAP	2	880923	1	880927				
sdoc	PO-D026	16	1	3-7	AD			SWTDI	RDI/OU/MET TOWER WIRING DIAG.	2	880923	1	880927				
sdoc	PO-D026	17	1	3-8	AD			SWTDI	RDI/OU/SUMP PUMP WIRING DIAG.	2	880923	1	880927				
sdoc	PO-D026	18	1	3-9	AD			SWTDI	RDI/OU/ELECT. ROOM WIRING DIAG.	2	880923	1	880927				
sdoc	PO-D026	19	1		AD			SWTDI	TEST PLAN	1	880606	N	880616				
sdoc	PO-D026	20	1		AD			SWTDI	MAUI DAS WIRING DIAGRAM	1	890920	N	880928			INFO ONLY	
sdoc	PO-D026	21	1		AD			SWTDI	MAUI DAS CHANNEL MAP	1	890920	N	880928			INFO ONLY	
sdoc	PO-D026	22	1		AD			SWTDI	RDI/O FOR EMT-1 ENCL DIMENSION 2-4A	5	901026						
sdoc	PO-D026	23	1		AD			SWTDI	RDI/O FOR EMT-1 ENCL DIMENSION 2-6A	5	901026						

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-----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		-----DOCUMENT SUBMITTAL -----									
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER.....	OWN	RD	Q UNIT	-----	DESCRIPTION.....	SBMTL	INDATE	S	OUTDAT	SPLR.REV	S2	COMMENTS..	XMTL.#
sdoc	PO-D026	24	1			AD		SWTDI	US-1 IJB DIMENSION 2-8A	5	901026						
sdoc	PO-D026	25	1			AD		SWTDI	RD 1/O EMT-2 WIRING DIAG. 3-4	5	901026						
sdoc	PO-D026	26	1			AD		SWTDI	RD 1/O EMT-2 MOUNTING PLATE HOLES 2-7A	4	901026						
sdoc	PO-D026	27	1			AD		SWTDI	US-1 DAS MOUNTING PLATE HOLES 2-9A	4	901026						
sdoc	PO-D026	28	1			AD		SWTDI	RD 1/O EMT-1 MOUNTING PLATE HOLES 2-5A	4	901026						
sdoc	PO-D026	29	1			AD		SWTDI	RD 1/O EMT-2 #6, 7, 8, UNIT ARRANGEMENT 3-3	3	901026						
sdoc	PO-D026	30	1			AD		SWTDI	US-1 DAS UNIT ARRANGEMENT 3-5	3	901026						
sdoc	PO-D026	31	1			AD		SWTDI	US-1 DAS WIRING DIAGRAM 3-6	3	901026						
sdoc	PO-D026	32	1			AD		SWTDI	US-1 IJB ELEMENTARY DIAG. 3-7	3	901026						
sdoc	PO-D026	33	1	4-1		AD		SWTDI	RD 1/O EMT-1 & EMT-2 CHANNEL MAP	3	901026						
sdoc	PO-D026	34	1	4-2		AD		SWTDI	US-1 CHANNEL MAP	3	901026						
sdoc	PO-D026	34	2	4-3		AD		SWTDI	US-1 CHANNEL MAP	3	901026						
sdoc	PO-D026	34	3	4-4		AD		SWTDI	US-1 CHANNEL MAP	3	901026						
sdoc	PO-D026	34	4	4-5		AD		SWTDI	US-1 CHANNEL MAP	3	901026						
sdoc	PO-D026	35	1			AD			21X OPERATOR'S MANUAL	1	900301	1	900316				
sdoc	PO-D026	36	1			AD			CR7 OPERATOR'S MANUAL	1	900301	1	900316				
sdoc	PO-D026	37	1			AD			US-1 RDI/O USER'S MANUAL	1	900301	N	900501				
sdoc	PO-D030	1	1			AD		EWING	OPERATING MANUAL	1	880702	2	880726				046
sdoc	PO-D208	1	1	TDI-EMT1-S1A	AD	P		SOUTHWES	REPLACEMENT FOR SOVONICS DC JUNCTION BOX	2	920424	1	920615			293	309
sdoc	PO-D208	2	1	TDI-EMT1-S1A	AD	V		SOUTHWES	EXTERIOR VIEW	2	920611	1	920615	1			310
sdoc	PO-D208	3	1	TDI-EMT1-S1A	AD	V		SOUTHWES	ELECTRICAL SCHEMATIC	2	920611	1	920615	1			310
sdoc	PO-D208	4	1	TDI-EMT1-S1A	AD	V		SOUTHWES	INTERIOR VIEW (DOOR AND TOP PLATE REMOVED)	2	920611	1	920615	1			310

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----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		----- DOCUMENT SUBMITTAL -----															
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER		OWN	RD	Q	UNIT	-----	DESCRIPTION		SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS	..	XMTL	..#
sdoc	SC-D020	1	1	E1		AD					PLANS, SECTIONS, ELEVATIONS		2	880620	1	880621							
sdoc	SC-D020	2	1	1-3		AD					BEAMS		2	880620	1	880621							
sdoc	SC-D020	3	1	2-3		AD					BEAMS		2	880620	1	880621							
sdoc	SC-D020	4	1	3-3		AD					MISCELLANEOUS		1	880613	1	880614							
sdoc	SC-D020	5	1			AD					WELD PROC. #11 & VARIOUS WELDER CERT. (13 SHEETS)		1	880613	1	880614							
sdoc	SC-D021	1	1			AD			ARRAY		PCU PAD RAIN GAUGE PAD REBARS DETAILS		1	880615	N	880615							
sdoc	SC-D021	2	1			AD			ARRAY		CAISSON TYPE C REBAR DETAILS		1	880615	N	880615							
sdoc	SC-D021	3	1			AD			ARRAY		CAISSON TYPE C LAYOUT SHT K-1		1	880615	N	880615							
sdoc	SC-D027	1	1	61635		AD			DECC		SYSTEM SCHEMATIC DIAG PV POWER CONDITIONER		2	880708	N	880804							
sdoc	SC-D027	2	1			AD			DECC		SIGNAL INTERFACE BETWEEN PCU AND RTU (3 SHEETS)		2	880708	N	880804							
sdoc	SC-D027	3	1			AD			DECC		SYSTEM CONTROL LOGIC OPERATION (6 SHEETS)		2	880708	N	880804							
sdoc	SC-D027	4	1	501-6985		AD			DECC		OUTLINE DETAILS		2	880725	N	880804							
sdoc	SC-D027	5	1	501-6981		AD			DECC		CONTROL PANEL ARRANGEMENT		2	880708	N	880804							
sdoc	SC-D027	6	1			AD			DECC		WIRING INTERFACE		1	880708	N	880804							
sdoc	SC-D027	7	1	501-7046		AD			DECC		PRELIMINARY LAYOUT 25KVA		1	880725	2	880804							
sdoc	SC-D027	8	1	501-6980		AD			DECC		HOUSING, 25KVA PHOTOVOLTAIC		1	880725	2	880804							
sdoc	SC-D027	9	1	570-1084		AD			DECC		ACCEPTANCE TEST PROCEDURE (11 SHEETS)		1	880725	N	880804							
sdoc	SC-D027	10	1	523-1254		AD					INSTALLATION AND OPERATION MANUAL		2	910318	2	910501							238
sdoc	SC-D027	11	1			AD							1	910318									
sdoc	SC-D027	12	1	501-7057		AD	AD	V	DECC	SIZE:C	SCHEMATIC DIAGRAM INTERCONNECT SHEET 1 OF 3		1	911014				A					
sdoc	SC-D027	12	2	501-7057		AD	AD	V	DECC	SIZE:C	SCHEMATIC DIAGRAM INTERCONNECT SHEET 2 OF 3		1	911014				A					

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PVUSA - DAVIS SUPPLIER DOCUMENT REGISTER

-----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		-----DOCUMENT SUBMITTAL-----								
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR	REV S2	COMMENTS..	XMTL.#
sdoc	SC-D027	12	3	501-7057	AD	AD	V	DECC	SCHEMATIC DIAGRAM INTERCONNECT SHEET 3 OF 3	1	911014		A			
sdoc	SC-D031	1	1		AD				ELECTRICAL PARAMETERS OF ASI M660 MODULES	1	880523	N	880630		INFO ONLY	
sdoc	SC-D031	2	1		AD				PROJECT SCHEDULE - ARCO	1	880603	N	M80623		INFO ONLY	
sdoc	SC-D031	3	1		AD				STRUCTURAL CALCULATIONS - ARCO	1	880603	N	880623		INFO ONLY	
sdoc	SC-D031	4	1	016712	AD				DELTRIN SPACER	1	880603	N	880623		INFO ONLY	
sdoc	SC-D031	5	1	016737	AD				MOUNT. PLATE DC INTERFACE JB	1	880603	N	880623		INFO ONLY	
sdoc	SC-D031	6	1	016752	AD				PANEL ELECTRICAL ASSEMBLY	3	900401	N	090525	B	INFO ONLY	
sdoc	SC-D031	7	1	016709	AD				ARRAY GENERAL ARRANGEMENT	3	900401	N	900415	C	INFO ONLY	
sdoc	SC-D031	8	1	016710	AD				STRUCTURAL DETAILS	3	900401	N	900415	C		
sdoc	SC-D031	8	2	016710	AD				STRUCTURAL DETAILS	3	900401	N	900415	C	INFO ONLY	
sdoc	SC-D031	9	1	016711	AD				SUPPORT CHANNEL FOR 10 MODULES	1	880603	N	880623	A	INFO ONLY	
sdoc	SC-D031	10	1		AD				QUALITY PLAN/QUALIFICATION TESTING	1	880609	N	880623	B	INFO ONLY	
sdoc	SC-D031	11	1	016753	AD				SYSTEM SCHEMATIC	2	880720	N	880824	C	INFO ONLY	
sdoc	SC-D031	12	1	016754	AD				D.C. INTERFACE J-BOX ASSY	3	880720	N	880824	D	INFO ONLY	
sdoc	SC-D031	13	1	016755	AD				ENCLOSURE J-BOX	3	880720	N	880824	C	INFO ONLY	
sdoc	SC-D031	14	1	016924	AD				M660 ARRAY CONDUIT LOCATION	3	880808	N	880922	C	INFO ONLY	
sdoc	SC-D031	15	1		AD				QUALIFICATION TEST SCHEDULE	1	880808	N	880822		INFO ONLY	
sdoc	SC-D031	16	1		AD				CERTIFICATION OF COMPLIANCE	1	880919	N	881002		INFO ONLY	
sdoc	SC-D031	17	1		AD				PRODUCT QUALITY & SAEFTY TEST REPORT	1	880808	N	880822		INFO ONLY	
sdoc	SC-D031	18	1		AD				OPERATION AND MAINTENANCE MANUAL.	1	890202	N	890301		INFO ONLY	
sdoc	SC-D032	1	1		AD			UPG	QA/QC PLAN, SCHEDULE, ELECTRICAL	2	880830	1	880926			
sdoc	SC-D032	2	1		AD			UPG	PANEL STRUCTURAL ANALYSIS & ADD.	2	880830	1	880926			

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----DOCUMENT ID NUMBER-----			SUPPLIERS		SUPPLIER		----- DOCUMENT SUBMITTAL -----						
TYPE	MR/CONTRACT	SEQ SHEET	NUMBER.....	OWN	RD	Q UNIT	-----	DESCRIPTION.....	SBMTL	INDATE	S	OUTDAT	SPLR.REV S2 COMMENTS.. XMTL.#
sdoc	SC-D032	3	1	60388		AD	UPG	PANEL MECHANICAL LAYOUT	2	880830	2	880926	
sdoc	SC-D032	4	1	71788		AD	UPG	EMT-1 ARRAY LAYOUT SH 1 OF 2	3	890809	1	890809	
sdoc	SC-D032	5	1			AD	UPG	QUALIFICATION TESTS	1	880830	1	880926	
sdoc	SC-D032	6	1			AD	UPG	HAIL IMPACT TEST SEI REPORT	1	880830	N	880926	
sdoc	SC-D032	7	1			AD	UPG	STRUCTURAL CALCULLCATONS	1	880830	1	880926	
sdoc	SC-D032	8	1			AD	UPG	STRUCTURAL CALCULLCATONS	1	880830	1	880926	
sdoc	SC-D032	9	1	71788		AD	UPG	EMT-1 ARRAY LAYOUT SH 2 OF 2	2	890809	1	890809	
sdoc	SC-D032	10	1	890118		AD	UPG	INTERFACE JUNCTIOND BOX	2	890809	1	890809	
sdoc	SC-D032	11	1	890113		AD	UPG	WIRING DIAGRAM	2	890809	1	900501	
sdoc	SC-D032	12	1			AD	UPG	O&M MANUAL	2	900612	2		
sdoc	SC-D032	12	2			AD	UPG	O&M MANUAL	2	900612	2		
sdoc	SC-D032	12	3			AD	UPG	O&M MANUAL	2	900612	2		
sdoc	SC-D032	12	4			AD	UPG	O&M MANUAL	2	900612	2		
sdoc	SC-D032	12	5			AD	1 UPG	O&M MANUAL	2	900402	2	900612	
sdoc	SC-D033	1	1	1000D13288		AD SIZE:D	ENTECH	ROW INSTALLATION SHEET 1 OF 7	002	910925		C	SBY.36(1)
sdoc	SC-D033	1	2	1000D13288		AD SIZE:C	ENTECH	ROW INSTALLATION SHEET 2 OF 7	002	910925		C	SBY.36(2)
sdoc	SC-D033	1	3	1000D13288		AD SIZE:C	ENTECH	ROW INSTALLATION SHEET 3 OF 7	002	910925		C	SBY.36(3)
sdoc	SC-D033	1	4	1000D13288		AD SIZE:C	ENTECH	ROW INSTALLATION SHEET 4 OF 7	002	910925		C	SBY.36(4)
sdoc	SC-D033	1	5	1000D13288		AD SIZE:C	ENTECH	ROW INSTALLATION SHEET 5 OF 7	002	910925		C	SBY.36(5)
sdoc	SC-D033	1	6	1000D13288		AD SIZE:C	ENTECH	ROW INSTALLATION SHEET 6 OF 7	002	910925		C	SBY.36(6)
sdoc	SC-D033	1	7	1000D13288		AD SIZE:C	ENTECH	ROW INSTALLATION SHEET 7 OF 7	001	910925		C	SBY.36(7)
sdoc	SC-D033	2	1	1000D13350		AD	ENTECH	POST INSTALLATION SBY. 42(1)	1	890820	N		INFO ONLY

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DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		DOCUMENT SUBMITTAL -----									
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER.....	OWN	RD	Q UNIT	-----	DESCRIPTION.....	SBMTL	INDATE	S	OUTDAT	SPLR.REV	S2	COMMENTS..	XMTL.#
sdoc	SC-D033	2	2	1000D13350		AD		ENTECH	POST INSTALLATION SBY. 42(2)	1	890820	N				INFO ONLY	
sdoc	SC-D033	3	1	1000D13352		AD		ENTECH	POST/PIER INTERFACE SBY. 43(1)	1	890820	N				INFO ONLY	
sdoc	SC-D033	4	1	1000D13283		AD SIZE:D		ENTECH	ARRAY ASSEMBLY SHEET 1 OF 4	002	910925		C			SBY.35(1)	
sdoc	SC-D033	4	2	1000D13283		AD SIZE:D		ENTECH	ARRAY ASSEMBLY SHEET 2 OF 2	002	910925		C			SBY.35(2)	
sdoc	SC-D033	4	3	1000D13283		AD SIZE:D		ENTECH	ARRAY ASSEMBLY SHEET 3 OF 4	002	910925		C			SBY.35(3)	
sdoc	SC-D033	4	4	1000D13283		AD SIZE:D		ENTECH	ARRAY ASSEMBLY SHEET 4 OF 4	002	910925		C			SBY.35(4)	
sdoc	SC-D033	5	1	1000D13213		AD		ENTECH	MODULE ASSEMBLY - 22X	1	890820	N	N/R			INFO ONLY	
sdoc	SC-D033	5	2	1000D13213		AD		ENTECH	MODULE ASSEMBLY - 22X	1	890820	N	N/R			INFO ONLY	
sdoc	SC-D033	6	1	NE00D13261		AD		ENTECH	CLEVIS ASSEMBLY & DETAIL	2	900607	5	900815	B			
sdoc	SC-D033	7	1	1000D13267		AD		ENTECH	GUIDE ASSEMBLY	1	890920	N	N/R			INFO ONLY	
sdoc	SC-D033	8	1	1000D13270		AD		ENTECH	AXLE ASSEMBLY & DETAILS	2	900607	5	900815	B			
sdoc	SC-D033	9	1	1000D13271		AD		ENTECH	NORTH-SOUTH BEAM ASSEMBLY & DETAILS	2	900607	3	900815	E			
sdoc	SC-D033	9	2	1000D13271		AD		ENTECH	NORTH-SOUTH BEAM ASSEMBLY & DETAILS	2	900607	5	900815	E			
sdoc	SC-D033	9	3	1000D13271		AD		ENTECH	NORTH-SOUTH BEAM ASSEMBLY & DETAILS	2	900607	5	900815	E			
sdoc	SC-D033	10	1	1000D13272		AD		ENTECH	EAST-WEST BEAM ASSEMBLY & DETAILS	2	900607	5	900815	B			
sdoc	SC-D033	10	2	1000D13272		AD		ENTECH	EAST-WEST BEAM ASSEMBLY & DETAILS	2	900607	5	900815	B			
sdoc	SC-D033	10	3	1000D13272		AD		ENTECH	EAST-WEST BEAM ASSEMBLY & DETAILS	1	900607	5	900815	B			
sdoc	SC-D033	11	1	1000D13273		AD		ENTECH	COLLECTOR AXLE ASSEMBLY - 22X	1	890920	N	N/R			INFO ONLY	
sdoc	SC-D033	12	1	1000D13274		AD		ENTECH	DRIVE BAR ASSEMBLY - 22X	1	890920	N	N/R			INFO ONLY	
sdoc	SC-D033	13	1	1000D13277		AD		ENTECH	CENTER POST/BEARING ASSEMBLY	2	900607	3	900815	A			

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----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		----- DOCUMENT SUBMITTAL -----													
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER		OWN	RD	Q	UNIT	-----	DESCRIPTION		SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS..	XMTL.#
sdoc	SC-D033	14	1	1000D13278		AD				ENTECH	SPACER		1	890920	N	N/R					INFO ONLY
sdoc	SC-D033	15	1	1000D13282		AD				ENTECH	ACTUATOR SCREW COVER		1	890920	N	N/R					INFO ONLY
sdoc	SC-D033	16	1	1000D13284		AD				ENTECH	UPPER YOKE ASSEMBLY		2	900607	5	900815	A				
sdoc	SC-D033	17	1	1000D13285		AD				ENTECH	LOWER YOKE ASSEMBLY		2	900607	1	900815	B				
sdoc	SC-D033	18	1	1000D13287		AD				ENTECH	TILT JACK ASSEMBLY		2	900607	5	900815	B				
sdoc	SC-D033	19	1	1000D13290		AD				ENTECH	CENTER BEARING ASSEMBLY		2	900607	5	900815	B				
sdoc	SC-D033	19	2	1000D13290		AD				ENTECH	CENTER BEARING ASSEMBLY		2	900607	5	900815	B				
sdoc	SC-D033	20	1	1000D13291		AD				ENTECH	CENTER BEARING/AXLE ASSEMBLY		2	900607	5	900815	A				
sdoc	SC-D033	21	1	1000D13292		AD				ENTECH	SUPPORT ASSEMBLY		2	900607	5	900815	D				
sdoc	SC-D033	21	2	1000D13292		AD				ENTECH	SUPPORT ASSEMBLY		2	900607	5	900815	D				
sdoc	SC-D033	22	1	1000D13293		AD				ENTECH	ROLL DRIVE SPLICE		1	890920	N	N/R					INFO ONLY
sdoc	SC-D033	23	1	1000D13294		AD				ENTECH	LIMIT SWITCH DETAILS		1	890920	N	N/R					INFO ONLY
sdoc	SC-D033	24	1	1000D13295		AD				ENTECH	WIRE HARNESS ASSEMBLY		1	890920	N	N/R					INFO ONLY
sdoc	SC-D033	25	1	1000D13296		AD				ENTECH	ROLL LIMIT SWITCH ASSEMBLY		1	890920	N	N/R					INFO ONLY
sdoc	SC-D033	26	1	1000D13326		AD				ENTECH	POST ASSEMBLY		2	900607	3	900815	C				
sdoc	SC-D033	27	1	1000D13333		AD				ENTECH	CENTER POST ASSEMBLY		2	900607	3	900815	A				
sdoc	SC-D033	27	2	1000D13333		AD				ENTECH	CENTER POST ASSEMBLY		2	900607	5	900815	A				
sdoc	SC-D033	27	3	1000D13333		AD				ENTECH	CENTER POST ASSEMBLY		2	900607	5	900815	A				
sdoc	SC-D033	28	1	1000D13351		AD				ENTECH	POST ASSEMBLY IDLER		2	900607	5	900815	A				
sdoc	SC-D033	29	1			AD				ENTECH	PROJECT COMPLETION SCHEDULE		1	890928	3	891013					
sdoc	SC-D033	30	1	1000A12012		AD				ENTECH	PROTECTIVE FINISH SPECS		2	920521	1	920608	B				307
sdoc	SC-D033	31	1	3301QAQC		AD				ENTECH	QA/QC MANUAL		1	890928	3	891013					
sdoc	SC-D033	32	1			AD				ENTECH	CALCULATION BINDER		1	890927	N	N/R					INFO ONLY
sdoc	SC-D033	33	1	1000C13267		AD				ENTECH	GUIDE ASSEMBLY		1	900607	5	900815	C				
sdoc	SC-D033	34	1	1000C13305		AD				ENTECH	BEARING		2	910925			C				
sdoc	SC-D033	35	1	1000D13283		AD		V		ENTECH	ARRAY ASSEMBLY		2	910925	1	911216	C				266
SIZE:D																					
SHEET 1 OF 4																					

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-----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		-----DOCUMENT SUBMITTAL-----					
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sdoc	SC-D033	35	2	1000D13283	AD SIZE:D		V	ENTECH ARRAY ASSEMBLY SHEET 2 OF 4	2	910925	1	911216	C 266
sdoc	SC-D033	35	3	1000D13283	AD SIZE:D		V	ENTECH ARRAY ASSEMBLY SHEET 3 OF 4	2	910925	1	911216	C 266
sdoc	SC-D033	35	4	1000D13283	AD SIZE:D		V	ENTECH ARRAY ASSEMBLY SHEET 4 OF 4	2	910925	1	911216	C 266
sdoc	SC-D033	36	1	1000D13288	AD SIZE:D		V	ENTECH ROW INSTALLATION SHEET 1 OF 7	2	910925	1	911216	C 266
sdoc	SC-D033	36	2	1000D13288	AD SIZE:D		V	ENTECH ROW INSTALLATION SHEET 2 OF 7	2	910925	1	911216	C 266
sdoc	SC-D033	36	3	1000D13288	AD SIZE:D		V	ENTECH ROW INSTALLATION SHEET 3 OF 7	2	910925	1	911216	C 266
sdoc	SC-D033	36	4	1000D13288	AD SIZE:D		V	ENTECH ROW INSTALLATION SHEET 4 OF 4	2	910925	1	911216	C 266
sdoc	SC-D033	36	5	1000D13288	AD SIZE:D		V	ENTECH ROW INSTALLATION SHEET 5 OF 7	2	910925	1	911216	C 266
sdoc	SC-D033	36	6	1000D13288	AD SIZE:D		V	ENTECH ROW INSTALLATION SHEET 6 OF 7	2	910902	1	911216	C 266
sdoc	SC-D033	36	7	1000D13288	AD SIZE:D		V	ENTECH ROW INSTALLATION SHEET 7 OF 7	2	910925	1	911216	C 266
sdoc	SC-D033	37	1	1000D13302	AD			ENTECH DRIVE BAR GUIDE ASSEMBLY	1	900607	5	900815	B
sdoc	SC-D033	38	1	1000D13329	AD			ENTECH BEARING ASSEMBLY	1	900607	5	900815	
sdoc	SC-D033	39	1	1000D13332	AD			ENTECH BEARING/AXLE ASSEMBLY	1	900607	5	900815	
sdoc	SC-D033	40	1	1000D13346	AD			ENTECH GROUNDING STRAPS	1	900607	5	900815	A
sdoc	SC-D033	41	1	1000D13350	AD			ENTECH TILT DRIVE MC SPEC DRAWING	1	900607	3	900815	
sdoc	SC-D033	42	1	1000D13350	AD SIZE:D		V	ENTECH POST INSTALLATION - PVUSA SHEET 1 OF 2	3	920430	1	920608	C 307
sdoc	SC-D033	42	2	1000D13350	AD SIZE:D		V	ENTECH POST INSTALLATION - PVUSA SHEET 2 OF 2	3	920430	1	920608	C 307
sdoc	SC-D033	43	1	1000D13352	AD SIZE:D		V	ENTECH POST PIER INTERF - PVUSA SHEET 1 OF 1	2	910925	1	911216	A 266
sdoc	SC-D033	44	1	1000D13354	AD			ENTECH ROLL DRIVE MTG PLT ASSEMBLY	1	900607	5	900815	
sdoc	SC-D033	45	1	1000D13355	AD SIZE:D		V	ENTECH ROLL DRIVE ASSEMBLY SHEET 1 OF 1	2	910925	1	911216	266

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----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		----- DOCUMENT SUBMITTAL -----											
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sdoc	SC-D033	46	1	1000D13356		AD			ENTECH	COLLECTOR AXLE ASSEMBLY	1	900607	5	900815					
sdoc	SC-D033	47	1	1000D13358		AD		V	ENTECH	ROLL DRIVE GEAR MTR CONT SPEC	2	910925	1	911216	A				266
						SIZE:D				SHEET 1 OF 1									
sdoc	SC-D033	48	1	1000D13369		AD		V	ENTECH	DRIVE BAR ASSEMBLY CTR	2	910925	1	911216	A				266
						SIZE:D				SHEET 1 OF 2									
sdoc	SC-D033	48	2	1000D13369		AD			ENTECH	DRIVE BAR ASSEMBLY CTR	1	900607	5	900815					
sdoc	SC-D033	49	1	1000D13372		AD			ENTECH	ROLL DRIVE ACTUATOR COVER	1	900607	5	900815					
sdoc	SC-D033	49	2	1000D13372		AD			ENTECH	ROLL DRIVE ACTUATOR COVER	1	900607	5	900815					
sdoc	SC-D033	50	1	1000D13374		AD			ENTECH	TILT LIMIT SW BRACKETS	1	900607	5	900815					
sdoc	SC-D033	50	2	1000D13374		AD			ENTECH	TILT LIMIT SW BRACKETS	1	900607	5	900815					
sdoc	SC-D033	51	1	1000D13379		AD			ENTECH	SPACER BOLT ON	1	900607	5	900815					
sdoc	SC-D033	52	1	1000D13380		AD		V	ENTECH	WIRE HARNESS ASSEMBLY	2	910925	1	911216	A				266
						SIZE:D				SHEET 1 OF 1									
sdoc	SC-D033	53	1	1000D13380		AD			ENTECH	WIRE HARNESS ASSEMBLY	1	900607	3	900815					
sdoc	SC-D033	54	1	1000A13435		AD			ENTECH	INSTALLATION PLAN FOR	2	920521	1	920622					314
										ENTECH'S EMT-1 PVUSA SYSTEM									
sdoc	SC-D033	55	1	1000B13382		AD			ENTECH	INTERFACE JUNCTION BOX	2	920521							
sdoc	SC-D033	55	2	1000B13382		AD			ENTECH	INTERFACE JUNCTION BOX	2	920521							
sdoc	SC-D033	55	3	1000B13382		AD			ENTECH	INTERFACE JUNCTION BOX	2	920521							
sdoc	SC-D033	56	1	1000B13385		AD			ENTECH	ONE-LINE ELECTRICAL DIAGRAM	2	920521							
sdoc	SC-D033	57	1	1000B13386		AD			ENTECH	ELECTRICAL DIAGRAM - TRACKING	3	920521	1	920608	C				307
						SIZE:B				CONTROL & AUXILIARY POWER									
										SHEET 1 OF 3									
sdoc	SC-D033	57	2	1000B13386		AD			ENTECH	ELECTRICAL SCHEMATIC-TRACKING	2	920521	1	920608	C				307
						SIZE:B				CONTROL AND AUXILLARY POWER									
										SHEET 2 OF 3									
sdoc	SC-D033	57	3	1000B13386		AD			ENTECH	ELECTRICAL SCHEMATIC-TRACKING	2	920521	1	920608	C				307
										CONTROL & AUXILLARY POWER									
										SHEET 3 OF 3									
sdoc	SC-D033	58	1	1000A13401		AD			ENTECH	OPERATION AND MAINTENANCE OF	2	920521	1	920622					314
										THE ENTECH PVUSA EMT-1									
sdoc	SC-D033	59	1	1000A13400		AD			PRIME	PRODUCT MANUAL	1	910916	2	911029				SBY.58(1)	260
										SBY. D033-58(1)-2									

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sdoc	SC-D033	60	1	1000D13392	AD SIZE:D	V	ENTECH BLOCKING DIODE ASSY SHEET 1 OF 1	1	910925	1	911216	-	266
sdoc	SC-D033	61	1	1000D13349	AD SIZE:D	V	ENTECH TILT DRIVE MOTOR CONTROL SPEC DWG SHEET 1 OF 1	2	920430	1	920608	B	307
sdoc	SC-D033	62	1	1000D13388	AD SIZE:D	V	ENTECH ROLL DRIVE ASS'Y SHEET 1 OF 1	1	911002	1	911216	-	266
sdoc	SC-D033	63	1	1000D13389	AD SIZE:D	V	ENTECH AUX. TILT DRIVE MOTOR SPEC. CONTROL DWG SHEET 1 OF 1	1	911002	1	911216	-	266
sdoc	SC-D033	64	1	1000D13390	AD SIZE:D	V	ENTECH AUXILLARY POWER BOX SHEET 1 OF 1	1	911002	1	911216	-	266
sdoc	SC-D033	65	1	1000D13391	AD SIZE:D	V	ENTECH CAMLOK/WIRE ASS'Y SHEET 1 OF 1	2	920430	1	920608	A	307
sdoc	SC-D033	66	1	1000D13413	AD SIZE:D	V	ENTECH CONDUIT RUNS-ABOVE & BELOW GRADE	1	920430	1	920622	-	051392/301 314
sdoc	SC-D033	67	1	1000D13414	AD SIZE:D	V	ENTECH PV MODULE INSTATTATION SHEET 1 OF 2	1	920430	1	920622	-	051392/301 314
sdoc	SC-D033	67	2	1000D13414	AD SIZE:D	V	ENTECH PV MODULE INSTATTATION SHEET 2 OF 2	1	920430	1	920622	-	051392/301 314
sdoc	SC-D033	68	1	1000D13415	AD SIZE:D	V	ENTECH PV MODULE/DIODE ASSY	1	920430	1	920522	-	051392/301 314
sdoc	SC-D033	69	1	1000D13416	AD SIZE:D	V	ENTECH PV MOUNTING PLATE & BRACKET	1	920430	1	920622	-	051392/301 314
sdoc	SC-D033	70	1	1000D13394	AD SIZE:D	V	ENTECH MODULE LOCATION/SERIAL NUMBER	1	920611	1	920622	-	314
sdoc	SC-D033	71	1	1000D13395	AD SIZE:D	V	ENTECH INSTRUMENTATION DIAGRAM	1	920611	1	920622	-	314
sdoc	SC-D033	72	1	1000C13383	AD SIZE:C	V	ENTECH ROLL MOTOR BRACKET	1	920619	1	920622	-	314
sdoc	SC-D033	73	1	1000C13384	AD SIZE:C	V	ENTECH BRACKET, CONTROL BOX	1	920619	1	920622	-	314
sdoc	SC-D033	74	1	1000D13448	AD SIZE:D	V	ENTECH INTERFACE JUNCTION BOX FOUNDATION	1	920619	1	920622	-	314
sdoc	SC-D034	1	1		AD		SOVONICS COVER SHEET	3	890502	1	890629	-	

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-----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		-----DOCUMENT SUBMITTAL -----										
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sdoc	SC-D034	1	2		AD		2			SOVONICS MODULE DETAILS	3	890502	1	890629				
sdoc	SC-D034	1	3		AD					SOVONICS ARRAY LAYO9UT	3	890502	1	890629				
sdoc	SC-D034	1	4		AD					SOVONICS PANEL DETAIL	3	890502	1	890629				
sdoc	SC-D034	1	5		AD					SOVONICS TYPICAL STRING WIRING	1	890502	1	890629				
sdoc	SC-D034	1	6		AD					SOVONICS IJB & JB DETAIL	1	890502	1	890629				
sdoc	SC-D034	1	7		AD					SOVONICS PANEL DETAIL	1	890502	1	890629				
sdoc	SC-D034	2	1		AD					SOVONICS SHOP DRAWING	2	880726	1	880823				
sdoc	SC-D034	3	1		AD					SOVONICS QA/QC PLAN (7 SHEETS)	2	880726	N	880823				
sdoc	SC-D034	4	1		AD					SOVONICS SCHEDULE (2 SHEETS)	1	880429	1	880623				
sdoc	SC-D034	5	1		AD					SOVONICS STRUCTURAL DRAWING AND CALCULATIONS (5 SHEETS)	2	880726	1	880823				
sdoc	SC-D034	6	1		AD					SOVONICS QUALIFICATION TESTS (6 SHEETS)	1	880429	N	880623				
sdoc	SC-D034	7	1		AD					SOVONICS VALUE OF ELECTRICAL PARAMETERS (5 SHEETS)	2	880726	1	880823				
sdoc	SC-D034	8	1		AD					SOVONICS LETTER FROM SOVONICS-RESPONSE TO COMMENTS	1	880726	1	880823				
sdoc	SC-D034	9	1		AD					SOVONICS TEMP TEST FOR BYPASS DIODES & JB	1	880726	1	880823				
sdoc	SC-D034	10	1		AD					SOVONICS HAIL TEST INSTRUCTIONS TO GEORGIA POWER	1	880726	1	880823				
sdoc	SC-D034	11	1		AD					SOVONICS OPERATION & MAINTENANCE MANUAL	1	890811	N	890811				
sdoc	SC-D035	1	1		AD					SOLAREX MODULE SPECIFICATION	1	880614	N	880718			INFO ONLY	
sdoc	SC-D035	2	1	5783-301	AD					SOLAREX PANEL ASSEMBLY & MOUNTING DETA DETAIL [INCLUDED IN O&M MANUAL D35-20(1)-2]	4	890820	N	890918			INFO ONLY	
sdoc	SC-D035	3	1		AD					SOLAREX STRUCTURAL CALCULATIONS	2	880920	N	881102			INFO ONLY	
sdoc	SC-D035	4	1		AD					SOLAREX SUMMARY INSPECTION & TEST PLAN	3	880916	N	880921			INFO ONLY	
sdoc	SC-D035	5	1		AD					SOLAREX PROJECT MASTER SCHEDULE	1	880614	N	880718			INFO ONLY	
sdoc	SC-D035	6	1	D-5783-101	AD					SOLAREX SITE FOUNDATION ELECTRICAL PLAN [INCLUDED IN O&M MANUAL - D35-20(1)-2]	3	890828	N	890918			INFO ONLY	

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sdoc	SC-D035	7	1	D-5783-302	AD			SOLAREX STRUCTURAL MOUNTING DETAILS [INCLUDED IN O&M MANUAL - D35-20(1)-2]	3	890828	N	890918				INFO ONLY	
sdoc	SC-D035	8	1	D-5783-401	AD			SOLAREX GENERAL SYSTEM & ELECTRICAL LAYOUT [INCLUDED IN O&M MANUAL D35-20(1)-2]	3	890828	N	890918				INFO ONLY	
sdoc	SC-D035	9	1	D-5783-402	AD			SOLAREX ELECTRICAL DETAILS [INCLUDED IN O&M MANUAL - D35-20(1)-2]	3	890828	N	890918				INFO ONLY	
sdoc	SC-D035	10	1	D-5783-403	AD			SOLAREX ELECTRICAL SCHEMATICS J-BOXES (INCLUDED IN O&M MANUAL - D035-20(1)-2]	3	890828	N	890918				INFO ONLY	
sdoc	SC-D035	11	1	B-10902-00	AD			SOLAREX LABEL ID & SERIAL	1	881222	N	890123				INFO ONLY	
sdoc	SC-D035	12	1	B-11108-00	AD			SOLAREX MODEL NO. LABELS	1	881222	N	890123				INFO ONLY	
sdoc	SC-D035	13	1	B-11991-00	AD			SOLAREX LABEL CAUTION MAX. OVERCURRENT	1	881222	N	890123				INFO ONLY	
sdoc	SC-D035	14	1	P-D-11898-00	AD			SOLAREX MBWB 00900 MBF/62/12V/CBL	1	881222	N	890123	1			INFO ONLY	
sdoc	SC-D035	15	1	SK-081489-01	AD			SOLAREX MODULE [INCLUDED IN O&M MANUAL - D35-20(1)-2]	1	890828	N	890918				INFO ONLY	
sdoc	SC-D035	16	1	D-5783-309	AD			SOLAREX PLATE, J-BOX MTG/TRAY HANGER [INCLUDED IN O&M MANUAL - D35-20(1)-2]	1	890828	N	890918				INFO ONLY	
sdoc	SC-D035	17	1	D-5783-312	AD			SOLAREX PANEL ASSY. LEFT [INCLUDED IN O&M MANUAL - D35-20(1)-2]	1	890828	N	890918				INFO ONLY	
sdoc	SC-D035	18	1	D-5783-313	AD			SOLAREX PANEL ASSY. RIGHT [INCLUDED IN O&M MANUAL - D35-20(1)-2]	1	890828	N	890918				INFO ONLY	
sdoc	SC-D035	19	1		AD			SOLAREX QA ENVIRONMENTAL TEST REPORT	1	891013	N	891013				INFO ONLY	
sdoc	SC-D035	20	1	20927	AD			SOLAREX O & M MANUAL	4	910425	1						237
sdoc	SC-D035	21	1		AD			SOLAREX STRUCTURAL ANALYSIS - PANEL	1	891204	N	891207				INFO ONLY	
sdoc	SC-D035	22	1		AD			SOLAREX QA/QC PLAN	1	891204	N	891207				INFO ONLY	
sdoc	SC-D038	1	1		AD			COLLINS BILL OF MATERIAL	1	880907	N	880912					
sdoc	SC-D038	2	1	B32938	AD			COLLINS OUTLINE EMT-1 FEEDER PANEL ASCO/DELTA	1	880907	N	880912					

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sdoc	SC-D038	2	2	B32938			AD		COLLINS SCHEMATIC EMT-1 FEEDER PANEL ASCO/DELTA	1	880907	N	880912				
sdoc	SC-D043	1	1				AD		EPPLEY PSP & NIP SPECIFICATION (2 SHEETS)	1	880617	1	880717				
sdoc	SC-D046	1	1				AD		QUALIMET METEOROLOGICAL INSTRUMENT MANUAL	1	880712	1	880712				
sdoc	SC-D047	1	1				AD		EPPLEY INSTRUCTION MANUEL FOR SOLAR TRACKER	1	880617	1	880717				
sdoc	SC-D047	2	1				AD		EPPLEY AUTOMATIC SOLAR TRACKER INSTRUCTION MANUAL	1	880617	1	880717				
sdoc	SC-D049	1	1				AD		ADVANCED INSTALLATION & REFERENCE MANUAL	1	880802	1	880802				
sdoc	SC-D072	1	1				AD		BASLER INSTRUCTION MANUAL - 59N	1	880310	1	880313				
sdoc	SC-D072	2	1				AD		BASLER SERVICE MANUAL - 59N	1	880310	1	880313				
sdoc	SC-D072	3	1				AD		BASLER INSTRUCTION MANUAL - 81 O/U	1	880310	1	880313				
sdoc	SC-D072	4	1				AD		BASLER SERVICE MANUAL - 81 O/U	1	880310	1	880313				
sdoc	SC-D081	1	1	D-89-7806-01			AD		EPP 12KV FAULT INTERRUPTER SW SUP. BY 9-1	1	890524	N	890524				
sdoc	SC-D081	2	1	D-89-7806-02			AD		EPP 12KV FAULT INTERRUPTER CONTROL WIRING AND CONNECTIONS SBY. 9(1)	2		1	890928			1	
sdoc	SC-D081	3	1	D-89-7806-03			AD		EPP 12KV SWITCHGEAR - METERING COMPARTMENT SBY. 9(1)	2		1	890928			1	
sdoc	SC-D081	4	1	BM-89-7806			AD		EPP BILL OF MATERIAL SBY. 9(1)	2		1	890928			1	
sdoc	SC-D081	5	1	NP-89-7806			AD		EPP NAMEPLATE ENGRAVING CHART SBY. 9(1)	2		2	890928			1	
sdoc	SC-D081	6	1	S275-20-1			AD		EPP FAULT INTERRUPTERDS	1			890525				
sdoc	SC-D081	7	1	7910			AD		EPP INSTRUMENT TRANSFORMER-INDOOR VOLTAGE	1			890525				
sdoc	SC-D081	8	1	A-89-7806			AD		EPP INTERLOCK DATA SHEET	1		1	890928				
sdoc	SC-D081	9	1	S.O.89-7806			AD		EPP MANUAL FOR INDOOR 12,470 VOLT SWITCHGEAR	1		5	900117				

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-----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		-----DOCUMENT SUBMITTAL-----									
TYPE	MR/CONTRACT....	SEQ	SHEET	NUMBER.....	OWN	RD	Q UNIT	-----	DESCRIPTION.....	SBMTL	INDATE	S	OUTDAT	SPLR.REV	S2	COMMENTS..	XMTL.#
sdoc	SC-D088	1	1		AD				WELL WATER PUMP MANUAL	1	890524	1	890524				
sdoc	SC-D095	1	1		AD			PHOTON	DETAILED SCHEDULE	1	890630	N	890724			INFO ONLY	
sdoc	SC-D095	2	1		AD			PHOTON	QA/AC PLAN	1	890630	N	890724			INFO ONLY	
sdoc	SC-D095	3	1		AD			PHOTON	CALCULATION OF WIRING LOSSES	1	890630	N	890724			INFO ONLY	
sdoc	SC-D095	4	1		AD			PHOTON	"S" CHANNEL ANALYSIS	1	890630	N	890724			INFO ONLY	
sdoc	SC-D095	5	1		AD			PHOTON	COVER SHEET	1	890630	N	890724			INFO ONLY	
sdoc	SC-D095	6	1	101-400-W003-D	AD			PHOTON	IJB SCHEMATIC	3	900827	N	900904	B		INFO ONLY	
sdoc	SC-D095	7	1	101-400-W001-D	AD			PHOTON	ONE LINE DIAGRAM	3	900827	N	900904	B		INFO ONLY	
sdoc	SC-D095	8	1	101-100-L001-D	AD			PHOTON	FIELD LAYOUT	3	900827	N	900904	B		INFO ONLY	
sdoc	SC-D095	9	1	101-100-L002-D	AD			PHOTON	BUILDING BLOCK LAYOUT	3	900827	N	900904	A		INFO ONLY	
sdoc	SC-D095	10	1	101-200-A003-D	AD			PHOTON	PANEL DETAIL	3	900827	N	900904	C		INFO ONLY	
sdoc	SC-D095	11	1	101-400-A001-D	AD			PHOTON	CONDUIT DETAIL	3	900827	N	900904	B		INFO ONLY	
sdoc	SC-D095	12	1	101-200-P001-B	AD			PHOTON	"S" CHANNEL DETAIL	1	890630	N	890724			INFO ONLY	
sdoc	SC-D095	13	1	101-200-P002-B	AD			PHOTON	LONG-EDGE SUPPORT	1	890630	N	890724			INFO ONLY	
sdoc	SC-D095	14	1	101-400-A002-D	AD			PHOTON	IJB LAYOUT (MOUNTING)	2	900827	N	900904			INFO ONLY	
sdoc	SC-D095	15	1	BGS-400-W002-D	AD			PHOTON	INTERFACE JUNCTION BOX LAYOUT (INTERNAL)	2	900827	N	900904	A		INFO ONLY	
sdoc	SC-D096	1	1		AD			ASTRO	QA/QC PLAN (8 SHEETS)	1	891117	N	891120			INFO ONLY	
sdoc	SC-D096	2	1		AD			ASTRO	PARAMETERS OF DC SYSTEM (5 SHEETS)	1	891117	N	891120			INFO ONLY	
sdoc	SC-D096	3	1		AD			ASTRO	DESIGN DESCRIPTION (14 SHEETS)	1	891117	N	891120			INFO ONLY	
sdoc	SC-D096	4	1	201	AD			ASTRO	SITE PLAN	2	900331	N	900416	B		INFO ONLY	
sdoc	SC-D096	5	1	202	AD			ASTRO	CONDUIT DIAGRAM	2	900331	N	900416	B		INFO ONLY	
sdoc	SC-D096	6	1	203	AD			ASTRO	SUB ARRAY TRIPLE PANEL J-BOXES	2	900331	N	900416	B		INFO ONLY	
sdoc	SC-D096	7	1	204	AD			ASTRO	IJB LAYOUT	2	900331	N	900416	B		INFO ONLY	
sdoc	SC-D096	8	1	205	AD			ASTRO	MODULE DETAIL	2	900331	N	900416	A		INFO ONLY	
sdoc	SC-D096	9	1	206	AD			ASTRO	TRIPLE PANEL MECHANICAL DETAIL	2	900331	N	900416	A		INFO ONLY	

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TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS..	XMTL.#
sdoc	SC-D096	10	1	207				AD	ASTRO	SINGLE LINE ELECTRICAL	2	900331	N	900416	A	INFO ONLY	
sdoc	SC-D096	11	1	208				AD	ASTRO	INSTRUMENTATION THERMOCOUPLE J-BOXES	2	900331	N	900416	A	INFO ONLY	
sdoc	SC-D096	12	1	209				AD	ASTRO	TRIPLE PANEL WIRING DIAGRAM	2	900331	N	900416	B	INFO ONLY	
sdoc	SC-D096	13	1	210				AD	ASTRO	TRIPLE PANEL MOUNTING DETAIL	2	900331	N	900416	A	INFO ONLY	
sdoc	SC-D097	1	1					AD	SIEMENS	SCHEDULE (11 SHTS)	3	900204	N	900319		INFO ONLY	
sdoc	SC-D097	2	1					AD	SIEMENS	MODULE ELECTRICAL PARAMETERS	1	890712	N	890802		INFO ONLY	
sdoc	SC-D097	3	1	017585				AD	SIEMENS	SYSTEM SCHEMATIC - C30	2	910110	N	910311	1		234
sdoc	SC-D097	4	1	017586				AD	SIEMENS	D.C. INTERFACE J-BOX	2	910110	N	910311	1		234
sdoc	SC-D097	4	2	017586				AD	SIEMENS	D.C. INTERFACE J-BOX	2	910110	N	910311	1		234
sdoc	SC-D097	5	1	90-049				AD	SIEMENS	QUALITY PLAN/QUALITY TEST PLAN	1	891103	N	900522		INFO ONLY	
sdoc	SC-D097	6	1					AD	SIEMENS	STRUCTURAL CALCULATIONS	1	900207	N	900312		INFO ONLY	
sdoc	SC-D097	7	1	017670				AD	SIEMENS	LAMINATE ASSY W/PRINER	2	910110	N	910311	A		234
sdoc	SC-D097	8	1	017671				AD	SIEMENS	LAMINATE ASSY, C30	2	910110	N	910311	B		234
sdoc	SC-D097	9	1	017672				AD	SIEMENS	CIRCUIT ASSEMBLY	1	900207	N	900312	1	INFO ONLY	
sdoc	SC-D097	10	1	017673				AD	SIEMENS	CIRCUIT PLATE	2	910110	N	910311	A		234
sdoc	SC-D097	11	1	017669				AD	SIEMENS	MODULE ASSEMBLY	2	910110	N	910311	A		234
sdoc	SC-D097	11	2	017669				AD	SIEMENS	MODULE ASSEMBLY	2	910110	N	910311	A		234
sdoc	SC-D097	11	3	017669				AD	SIEMENS	MODULE ASSEMBLY	2	910110	N	910311	A		234
sdoc	SC-D097	12	1	017589				AD	SIEMENS	GENERAL ARRANGEMENT	2	910110	N	910311	2		234
sdoc	SC-D097	13	1	017590				AD	SIEMENS	SUPPORT CHANNEL FOR 8 MODULES	2	910110	N	910311	3		234
sdoc	SC-D097	14	1	017767				AD	SIEMENS	PANEL ASSEMBLY	2	910110	N	910311	2		234
sdoc	SC-D097	14	2	017767				AD	SIEMENS	PANEL ASSEMBLY	2	910110	N	910311	2		225
sdoc	SC-D097	15	1	017768				AD	SIEMENS	J-BOX ASSEMBLY	2	910110	N	910311	2		234
sdoc	SC-D097	16	1	017619				AD	SIEMENS	MOUNTING PLATE 52"X43" FOR SAFETY SWITCHES	1	910110	N	910311	1		234
sdoc	SC-D097	17	1	017587				AD	SIEMENS	PANEL, ENCLOSURE, 33'X45" FOR DC INTERFACE J-BOX	1	910110	N	910311	1		234

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TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR.REV S2 COMMENTS..	XMTL.#
sdoc	SC-D097	18	1	017588			AD	SIEMENS ENCLOSURE (J-BOX) (48X36X8) NEMA TYPE 4	1	910110	N	910311	1	234
sdoc	SC-D098	1	1	801000			AD	CHRONAR SITE LAYOUT	4	901026	1	901026	C	
Stat:DEL Comment:MOVE TO D101-50														
sdoc	SC-D098	2	1	801001			AD	CHRONAR ARRAY LAYOUT	3	900601	1	900621	B	
sdoc	SC-D098	3	1	801002			AD	CHRONAR FOUNDATION LAYOUT	1	890710	N	890811		INFO ONLY
sdoc	SC-D098	4	1	801003			AD	CHRONAR FRONT PIER FOUNDATIONS	4	901019	1	901026	F	208
sdoc	SC-D098	5	1	801004			AD	CHRONAR PV-PANEL ARRAY - INTERIOR ISOMETRIC GEN. ARRANGEMENT	4	901019	1	901026	E	208
sdoc	SC-D098	5	2	801004			AD	CHRONAR STRUCTURAL FRAMING - INTERIOR SIDE ELEVATION	4	901019	1	901026	E	208
sdoc	SC-D098	5	3	801004			AD	CHRONAR PANEL ARRAY - PLANFORM FOR INTERIOR	4	901019	1	901026	C	208
sdoc	SC-D098	5	4	801004			AD	CHRONAR STRUCTURAL FRAME BRACING - INTERIOR	3	900601	1	900612	B	
sdoc	SC-D098	6	1	801005			AD	CHRONAR PV-PANEL ARRAY - PERIMETER	4	901019	1	901026	E	208
sdoc	SC-D098	6	2	801005			AD	CHRONAR STRUCTURAL FRAMING- PERIMETER	4	901019	1	901026	E	208
sdoc	SC-D098	6	3	801005			AD	CHRONAR PANEL ARRAY - PLANFORM FOR PERIMETER	4	901019	1	901026	C	208
sdoc	SC-D098	6	4	801005			AD	CHRONAR STRUCTURAL FRAME BRACING - PERIMETER	3	900601	1	900621	B	
sdoc	SC-D098	7	1	801006			AD	CHRONAR PCU FOUNDATION	3	900601	3	900621	B	
sdoc	SC-D098	8	1	801007			AD	CHRONAR PV PANEL ASSEMBLY	4	901019	1	901026	D	208
Comment:RENUM. DAPS-8(1)														
sdoc	SC-D098	9	1	801008			AD	CHRONAR EARTH ANCHOR DETAILS	4	901019	1	901026	E	208
sdoc	SC-D098	10	1	801009			AD	CHRONAR BRIDGING/BRACING CLIP	4	901019	1	901026	A	208
sdoc	SC-D098	10	2	801009			AD	CHRONAR STRUCTURAL FRAME JOIST AND BRIDGING PERIMETER	1	901019	1	901026	E	208
sdoc	SC-D098	10	3	801009			AD	CHRONAR STRUCTURAL FRAME JOIST AND BRIDGING INTERIOR	1	901019	1	901026	E	208
sdoc	SC-D098	11	1	801010			AD	CHRONAR STRUCTURAL FRAME - STRAP BRACING PARTS	3	900601	1	900621	B	

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TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR	REV S2	COMMENTS..	XMTL.#
sdoc	SC-D098	12	1	801011			AD	CHRONAR STRUCTURAL FRAME - MISCELLANEOUS PARTS	4	901019	1	901026	E			208
	Comment:MOVED TO D101-65															
sdoc	SC-D098	13	1	801012			AD	CHRONAR PANEL CHANNELS	4	901019	1	901026	C			208
sdoc	SC-D098	14	1	801013			AD	CHRONAR STRUCTURAL FRAME - REAR POST	4	901019	1	901026	C			208
sdoc	SC-D098	15	1	801013			AD	CHRONAR WIRING LAYOUT	1	890711	N	890811			INFO ONLY	
sdoc	SC-D098	16	1	801031			AD	CHRONAR WIRE, ASSEMBLY - SERIES PANEL STRING	3	900601	3	900621	B			
sdoc	SC-D098	17	1	801032			AD	CHRONAR WIRE, ASSEMBLY - STRING POSITIVE BUS W/DIODE	3	900601	3	900621	A			
sdoc	SC-D098	18	1	801033			AD	CHRONAR WIRE, ASSEMBLY - STRING NEGATIVE BUS W/DIODE	3	900601	1	900621	A			
sdoc	SC-D098	19	1	801034			AD	CHRONAR POSITIVE SECTION HARNESS	3	900601	3	900621	B			
sdoc	SC-D098	20	1	801035			AD	CHRONAR NEGATIVE SECTION HARNESS	3	900601	3	900621	B			
sdoc	SC-D098	21	1	801036			AD	CHRONAR TRENCH LOCATION	1	890710	N	890811			INFO ONLY	
sdoc	SC-D098	22	1	801037			AD	CHRONAR WIRE LIST	3	900601	3	900621	B			
sdoc	SC-D098	23	1	801038			AD	CHRONAR ELECTRICAL CONFIGURATION	3	900601	3	900621	B			
sdoc	SC-D098	24	1	801040			AD	CHRONAR METER PANEL	3	900601	3	900621	B			
sdoc	SC-D098	25	1	801041			AD	CHRONAR MAIN DISCONNECT CIRCUIT	3	900601	3	900621	B			
sdoc	SC-D098	26	1	801042			AD	CHRONAR 125 KVA INVERTER CIRCUIT	3	900601	3	900621	B			
sdoc	SC-D098	27	1	801043			AD	CHRONAR CENTRAL PROCESSING CIRCUIT 256204	3	900601	3	900621	B			
sdoc	SC-D098	28	1	801044			AD	CHRONAR SWITCH CABINET CIRCUIT	4	900601	3	900621	B			
sdoc	SC-D098	29	1	801045			AD	CHRONAR SYSTEM DIAGRAM 256205	4	900601	3	900621	B			
sdoc	SC-D098	30	1	410108			AD	CHRONAR EUREKA MODULE	1	890711	P	890811				
sdoc	SC-D098	31	1				AD	CHRONAR SCHEDULE - PVUSA - US-1	2	891227	N	890220				
sdoc	SC-D098	32	1				AD	CHRONAR QA/QC PLAN	2	891227	N	890220				
sdoc	SC-D098	33	1	801014			AD	CHRONAR BOLT LIST	2	900601	1	900621	C			
sdoc	SC-D098	34	1	801019			AD	CHRONAR SCHEDULE	1	891227	N	900220				
sdoc	SC-D098	35	1	801020			AD	CHRONAR ARRAY FIELD PLAN	2	900601	1	900621	B			

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TYPE	MR/CONTRACT	SEQ SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR.REV S2 COMMENTS.. XMTL.#
sdoc	SC-D098	35	2 801020	AD			CHRONAR ARRAY SECTION WIRING	2	900601	3	900621	B
sdoc	SC-D098	35	3 801020	AD			CHRONAR CONTAINER UTIL - INSTALLATION & DETAILS	2	900601	3	900612	B
sdoc	SC-D098	35	4 801020	AD			CHRONAR CONTAINER UTIL - INSTALLATION & DETAILS	2	900601	3	900621	B
sdoc	SC-D098	35	5 801020	AD			CHRONAR DC UTILITY POLES - ETC.	2	900601	3	900621	B
sdoc	SC-D098	35	6 801020	AD			CHRONAR DC UTILITY POLES - ETC.	2	900601	3	900621	B
sdoc	SC-D098	35	7 801020	AD			CHRONAR ELEVATION - POLES & WIRING	2	900601	3	900621	B
sdoc	SC-D098	35	8 801020	AD			CHRONAR ROW CABLE LOCATION	2	900601	3	900621	B
sdoc	SC-D098	35	9 801020	AD			CHRONAR CENTER AISLE CABLE LOCATION	2	900601	N	900621	B
sdoc	SC-D098	35	10 801020	AD			CHRONAR TYPICAL ROW HANGER	2	900601	3	900621	B
sdoc	SC-D098	35	11 801020	AD			CHRONAR FIELD GROUNDING	2	900601	3	900621	B
sdoc	SC-D098	35	12 801020	AD			CHRONAR PART & ITEM NUMBERS	2	900601	3	900621	B
sdoc	SC-D098	36	1 801024	AD			CHRONAR CABLE SUSPENSION ANGLE	1	891227	N	900220	A VOIDED
Comment:VOIDED												
sdoc	SC-D098	37	1 801025	AD			CHRONAR CONCRETE PIER INSTALLATION	3	901019	1	901026	E 208
Comment:MOVED TO D101-64												
sdoc	SC-D098	38	1 801026	AD			CHRONAR FIELD INSTRUMENTATION	2	900601	3	900621	B
sdoc	SC-D098	38	2 801026	AD			CHRONAR FIELD INSTRUMENTATION	2	900601	3	900621	B
sdoc	SC-D098	39	1 801027	AD			CHRONAR DRAWING TREE	1	891227	N	900220	
sdoc	SC-D098	40	1 801039	AD			CHRONAR FIELD THERMOCOUPLE J-BOX WIRING	2	900607	3	900621	B
sdoc	SC-D098	41	1	AD			CHRONAR STRUCTURAL STABILITY CHECK	2	901019	1	901026	208
sdoc	SC-D098	42	1	AD			CHRONAR CALCULATIONS- FRONT FOUNDATION PIER (3 SHEETS)	2	900601	3	900612	
sdoc	SC-D098	43	1	AD			CHRONAR STRUCTURAL ANALYSIS (4 SHEETS)	1	900420	N	900501	
sdoc	SC-D098	44	1 801048	AD			CHRONAR ZEE BRACKET	1	900601	1	900621	A
sdoc	SC-D098	45	1 801049	AD			CHRONAR SOIL ANCHOR TEST LOCATION	1	900601	3	900621	A
Comment:RENUM. DAPS-9(1)												
sdoc	SC-D098	46	1 801050	AD			CHRONAR PHENOLIC BKR TUBE REAR	1	900601	1	900621	A
Comment:RENUM. DAPS-10(1)												

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TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER		OWN	RD	Q	UNIT	-----	DESCRIPTION		SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS..	XMTL.#
sdoc	SC-D098	47	1	801051		AD				CHRONAR	FRONT ANCHOR GROUNDING		1	900601	1	900621	A				
				Comment:RENUM. DAPS-11(1)																	
sdoc	SC-D098	48	1			AD				CHRONAR	ANCHOR TEST REPORT (36 SHEETS)		1	900604	1	900629					
sdoc	SC-D098	49	1			AD				CHRONAR	PVUSA ECN (ECN # 4 TO 33) (31 SHEETS)		1	900604	1	900629					
sdoc	SC-D098	50	1	801100		AD				CHRONAR	CONCRETE CONSTRUCTION SPEC. (13 SHEETS)		1	901019	1	901026					208
sdoc	SC-D098	51	1	801101		AD				CHRONAR	STRUCTURAL STEEL ERECTION SPECIFICATION (10 SHEETS)		1	901019	1	901026					208
sdoc	SC-D098	52	1	801024		AD				CHRONAR	EARTH ANCHOR INSTALLATION		1	901019	1	901026	B				208
				Comment:REV. A VOIDED																	
sdoc	SC-D098	53	1	801058		AD				CHRONAR	WASHER DETAILS		1	901019	1	901026	B				208
sdoc	SC-D098	54	1	801059		AD				CHRONAR	STRUCTURAL FRAME ASS'Y PERIMETER		1	901019	1	901026	B				208
sdoc	SC-D098	55	1	801060		AD				CHRONAR	STRUCTURAL FRAME ASS'Y INTERIOR		1	901019	1	901026	B				208
sdoc	SC-D098	56	1	801061		AD				CHRONAR	ANCHOR BOLT INSPECTION TOOL		1	901019	1	901026	C				208
sdoc	SC-D098	57	1	801062		AD				CHRONAR	ANCHOR BOLT INSTALLATION TOOL		1	901019	1	901026	B				208
sdoc	SC-D098	58	1	801063		AD				CHRONAR	EARTH ANCHOR LOCATION FIXTURE		1	901019	1	901026	A				208
sdoc	SC-D098	59	1	801064		AD				CHRONAR	REAR ANCHOR INSPECTION TOOL		1	901019	1	901026	A				208
sdoc	SC-D098	60	1	801065		AD				APS	DIRECT BURIAL DUCT SYSTEM		1	910506			A				243
				Stat:DEL Comment:MOVE TO SC-DAPS																	
sdoc	SC-D098	61	1	801067		AD				APS	DC GROUNDING SYSTEM		1	910506			A				243
				Stat:DEL Comment:MOVE TO SC-DAPS																	
sdoc	SC-D098	62	1	256202		AD				APS	SWITCH CIRCUIT		1	910506			A				243
				Stat:DEL Comment:MOVE TO SC-DAPS																	
sdoc	SC-D098	63	1	256203		AD				APS	MAINS DISCONNECT & TRANSFORMER CIRCUIT		1	910506			A				243
				Stat:DEL Comment:MOVE TO SC-DAPS																	
sdoc	SC-D098	64	1	256206		AD				APS	PVUSA INSTRUMENTATION		1	910506			A				243
				Stat:DEL Comment:MOVE TO SC-DAPS																	
sdoc	SC-D098	65	1	801050		AD				APS	PHENOLIC BREAKER TUBE REAR ANCHOR TEST POST		1	910506			A				243
				Stat:DEL Comment:MOVE TO SC-DAPS																	
sdoc	SC-D098	66	1	801066		AD				APS	PIPE SUPPORT ASSY		1	910506							243
				Stat:DEL Comment:MOVE TO SC-DAPS																	

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sdoc	SC-D098	67	1 801073	AD		APS	UPPER NEGATIVE ARRAY HARNESS	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	68	1 801072	AD		APS	UPPER POSITIVE ARRAY HARNESS	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	69	1 (801074)	AD		APS	LOWER POSITIVE ARRAY HARNESS	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	70	1 801075	AD		APS	LOWER POSITIVE ARRAY HARNESS	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	71	1 801076	AD		APS	POSITIVE BUS CONNECTION HARNESS	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	72	1 F11077	AD		APS	NEGATIVE BUS CONNECTION HARNESS	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	73	1 801071	AD		APS	ARRAY WIRING	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	73	2 801071	AD		APS	ARRAY WIRING DETAILS	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	74	1 801079	AD		APS	TRANSFORMER, DISCONNECT, IJB GROUND PREPARATIONS	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	74	2 801079	AD		APS	TRANSFORMER, DISCONNECT, IJB GROUND PREPARATIONS	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	75	1 (801080)	AD		APS	PCU INSTALLATION	1	910506		A		243
	Stat:DEL Comment: MOVE TO SC-DAPS												
sdoc	SC-D098	76	1 801007	AD		APS	PV-PANEL ASSEMBLY	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	77	1 801070	AD		APS	ROW CABLE LOCATIONS & CONNECTIONS	1	910506		B		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	78	1 801049	AD		APS	SOIL ANCHOR TEST LOCATION	1	910506		C		243
	Stat:DEL Comment: MOVE TO SC-DAPS												
sdoc	SC-D098	79	1 801051	AD		APS	FRONT ANCHOR GROUNDING CABLE	1	910506		B		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	80	1 256216	AD		APS	ELECTRICAL CONFIGURATION ONE LINE DIAGRAM	1	910506		A		243
	Stat:DEL Comment:MOVE TO SC-DAPS												
sdoc	SC-D098	82	1 (256201)	AD		APS	125 KVA INVERTER CIRCUIT	1	910506		A		243
	Comment:MOVE TO SC-DAPS												
sdoc	SC-D099	1	1 900368-1	AD		IPC	200 KW SYSTEM, S/L (LATEST DWG 1172-1)	1	890920	N	891031		INFO ONLY
	Stat:SBY Comment:D99-32(1)												

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----DOCUMENT ID NUMBER-----			SUPPLIERS		SUPPLIER		----- DOCUMENT SUBMITTAL -----						
TYPE	MR/CONTRACT	SEQ SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR	REV S2 COMMENTS.. XMTL.#
sdoc	SC-D099	2	1	AD		IPC	QUALITY ASSURANCE PLAN	1	890920	2	891031		
			Comment:ACCEPTABLE AS-IS										
sdoc	SC-D099	3	1	C-002375	AD	IPC	PCU & WINCH PAD LAYOUT AND PIPING DETAILS	6	910911	1	910919	G	RESUBMITTE 256
			Comment:INHOUSE TRANS-211										
sdoc	SC-D099	4	1	C-002441	AD	IPC	TRACKER EAST ELEVATION	4	900806	1	900816	D	
sdoc	SC-D099	5	1	C-002443	AD	IPC	SYSTEM SOUTH ELEVATION TRACKER CENTERLINE	5	920108	1	920218	F	268
				SIZE:C									
sdoc	SC-D099	6	1	B-002495	AD	IPC	PIER LAYOUT	5	910108	1	920218	E	268
				SIZE:B									
sdoc	SC-D099	7	1	B-002444	AD	IPC	PEDESTAL FABRICATION	4	900806	1	900816	C	
sdoc	SC-D099	8	1	C-002500	AD	IPC	DRIVE CABLE WINCH & PIER ASSEMBLY	5	920108	1	920218	F	268
			Comment:THIS WAS B-002500										
				SIZE:C									
sdoc	SC-D099	9	1	B-002496	AD	IPC	CENTER TORQUE TUBE NORTH ELEVATION	5	920108	1	920218	F	268
				SIZE:B									
sdoc	SC-D099	10	1	B-002497	AD	IPC	CENTER TORQUE TUBE EAST ELEVATION	5	920108	1	920218	F	268
				SIZE:B									
sdoc	SC-D099	11	1	B-002442	AD	IPC	INTERIOR TORQUE TUBE EAST ELEVATION	5	920110	1	920218	F	268
				SIZE:B	V								
sdoc	SC-D099	12	1	B-002502	AD	IPC	PANEL MOUNTING ASSEMBLY	5	920108	1	920218	D	268
				SIZE:B									
sdoc	SC-D099	13	1	80000001	AD	IPC	RA 220-8 MODULE	1	900110	5	900228	A	
sdoc	SC-D099	14	1	80000006	AD	IPC	PANEL ASSEMBLY	1	900110	5	900228	B	
sdoc	SC-D099	15	1		AD	IPC	CALCULATION & DESIGN SKETCH, TRACK. PHOTO. SYSTEM (60 SHEETS)	2	900420	1	900517		
sdoc	SC-D099	16	1	C-002538	AD	IPC	SYSTEM PLAN	4	920108	1	920218	D	268
				SIZE:C									
sdoc	SC-D099	17	1	B-002499	AD	IPC	DRIVE CABLE TURNING SHEAVE ASSEMBLY	3	900805	1	900816	D	
sdoc	SC-D099	18	1	B-002498	AD	IPC	TURNBUCKLE ASSEMBLY	4	920108	1	920218	C	268
				SIZE:B									
sdoc	SC-D099	19	1	B-002445	AD	IPC	CENTER TORQUE TUBE FABRICATION	3	900805	1	900816	D	
sdoc	SC-D099	20	1	B-002446	AD	IPC	INTERIOR TORQUE TUBE FABRICATION	3	900805	1	900816	B	

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sdoc	SC-D099	21	1 B-002447	AD		IPC	END TORQUE TUBE FABRICATION	3	900805	1	900816	B
sdoc	SC-D099	22	1 B-002448	AD		IPC	COUNTERWEIGHT BASE FABRICATION	3	900805	1	900816	B
sdoc	SC-D099	23	1 B-002449	AD		IPC	PIVOT BEARING SHAFT FABRICATION	3	900805	1	900816	B
sdoc	SC-D099	24	1 B-002501	AD		IPC	PANEL MOUNTING CLIP FABRICATION DETAIL	4	900815	1	900816	A
sdoc	SC-D099	25	1 1172-1	AD SIZE:C		IPC	ONE-LINE DIAGRAM IPC 200KW CONVERTER SHEET 1 OF 1	8	920626	1	920811	4 AS-BUILT 323
sdoc	SC-D099	26	1 1172-0	AD SIZE:D		IPC	IPC 200KW CONVERTER SCHEMATIC SHEET 1 OF 2	8	920626	1	920811	4 AS-BUILT 323
sdoc	SC-D099	26	2 1172-0	AD SIZE:D		IPC	IPC 200KW CONVERTER SCHEMATIC SHEET 2 OF 2	8	920626	1	920811	4 AS-BUILT 323
sdoc	SC-D099	27	1 1172-2	AD SIZE:D		IPC	CABINET OUTLINE FOR IPC PVUSA US1 CONVERTER SHEET 1 OF 7	6	920108	1	920218	1 268
sdoc	SC-D099	27	2 1172-2	AD SIZE:C		IPC	TRANSFORMER FOR IPC PVUSA US1 CONVERTER SHEET 2 OF 7	6	920108	1	920218	1 268
sdoc	SC-D099	27	3 1172-2	AD SIZE:C		IPC	PT & CT ENCLOSURE FOR IPC PVUSA US1 CONVERTER SHEET 3 OF 7	5	920108	1	920218	1 268
sdoc	SC-D099	27	4 1172-2	AD SIZE:C		IPC	IPC 200KW PVUSA US1 CONVERTER INTERCONNECTION DIAGRAM SHEET 4 OF 7	5	920626	1	920811	2 AS-BUILT 323
sdoc	SC-D099	27	5 1172-2	AD SIZE:D		IPC	IPC 200KW US-1 CONVERTER SHEET 5 OF 7	4	920626	1	920811	2 AS-BUILT 323
sdoc	SC-D099	27	6 1172-2	AD SIZE:D		IPC	IPC 200KW PVUSA US-1 CONVERTER SHEET 6 OF 7	3	920108	1	920218	1 268
sdoc	SC-D099	27	7 1172-2	AD SIZE:D		IPC	IPC 200KW PVUSA US-1 PT AND CT ENCLOSURE LAYOUT SHEET 7 OF 7	4	920626	1	920811	3 AS-BUILT 323
sdoc	SC-D099	28	1	AD		IPC	DESCRIPTION OF CONVERTER (9 SHEETS)	1	900420	3	900503	
		Comment: SBY. 76(2)-1										
sdoc	SC-D099	29	1	AD		IPC	CALCULATION SLAB DESIGN (5 SHEETS)	1	900420	2	900517	
		Comment: SBY. 58(1)-1										

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----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		----- DOCUMENT SUBMITTAL -----													
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER		OWN	RD	Q	UNIT	-----	DESCRIPTION		SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS..	XMTL.#
sdoc	SC-D099	30	1			AD			IPC		DESCRIPTION OF TRANSFORMER & PT, CT CUBICLE		1	900504	3	900601					
				Comment:SBY. 76(2)-1																	
sdoc	SC-D099	31	1	B-002455		AD			IPC		ARRAY SOURCE CIRC. WIRING DIAG		3	920108	1	920218	C				268
				Comment:INHOUSE TRANS.-211				SIZE:B													
sdoc	SC-D099	32	1	B-002456		AD			IPC		ONE-LINE DIAGRAM		3	910911	1	910919	C				256
				Stat:SUP Comment:D99-1(1)-1																	
sdoc	SC-D099	33	1	B-002531		AD			IPC		DC COLLECTION CABINET WIRING DIAGRAM		3	920108	1	920218	C				268
				Comment:INHOUSE TRANS.-211				SIZE:B													
sdoc	SC-D099	34	1	D-002733		AD			IPC		DC COLLECTION CABINET LAYOUT		3	901204	1	901205	C				219
sdoc	SC-D099	35	1	C-002760		AD			IPC		SOURCE CKT LAYOUT CONDUIT & WIRING DETAIL		4	920108	1	920218	D				268
				Comment:THIS WAS B-002760				SIZE:C													
sdoc	SC-D099	36	1	B-002761		AD			IPC		INSTR. LAYOUT SOURCE CKT NO. 3		3	920108	1	920218	C				268
				Comment:INHOUSE TRANS.-211				SIZE:B													
sdoc	SC-D099	37	1	C-002774		AD			IPC		SYSTEM ELECTRICAL PLAN SITE GROUNDING & TRENCH LAYOUT		4	920108	1	920218	D				268
				Comment:THIS WAS PRO02774				SIZE:C													
sdoc	SC-D099	38	1			AD			IPC		ELECTRICAL BILL OF MATERIALS & EQUIPMENT CUT SHEETS (37 SHEETS)		2	901105	2	901127					216
				Comment:SBY. 76(1)-1																	
sdoc	SC-D099	39	1			AD			IPC		GROUNDING SYSTEM DESIGN (8 SHEETS)		1	900601	3	900625					
				Comment:ACCEPTABLE AS-IS																	
sdoc	SC-D099	40	1			AD			IPC		TRACKER BEARING (4 SHEETS)		1	900805	5	900816					
sdoc	SC-D099	41	1			AD			IPC		SPEC. IPC ARRAY STRUCTURAL STEEL ERECTION (9 SHEETS)		1	900805	3	900816					
				Comment:ACCEPTABLE AS-IS																	
sdoc	SC-D099	42	1			AD			IPC		SPEC. DRILLED PIER CONSTR. (6 SHEETS)		1	900805	3	900816					
				Comment:ACCEPTABLE AS-IS																	
sdoc	SC-D099	43	1			AD			IPC		SPEC. DRILLED HOLE CONSTR. (5 SHEETS)		1	900805	3	900816					
sdoc	SC-D099	44	1			AD			IPC		SPEC. SUBGRADE PREPARATION (3 SHEETS)		1	900805	1	900815					
sdoc	SC-D099	45	1			AD			IPC		FACTORY TEST PROCEDURES FOR OMNION 200KW CONVERTER		4	910819	1	910826					254
sdoc	SC-D099	46	1	C-002758		AD			IPC		TRACKER CONTROL SCHEMATIC		4	920108	1	920218	D				268
						SIZE:C															
sdoc	SC-D099	47	1	C-003158		AD			IPC		DC SYSTEM SCHEMATIC & WIRING DIAGRAM		3	920108	1	920218	C				268
						SIZE:C															

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sdoc	SC-D099	48	1	C-003155		AD		IPC	PCU & WINCH PAD GRADING & EQUIPMENT LAYOUT	3	910911	1	910919	C				256
sdoc	SC-D099	49	1	C-003157		AD		IPC	PCU & WINCH PAD EQUIPMENT MOUNTING & CONDUIT DETAILS	4	920108	1	920218	D				268
						SIZE:C												
sdoc	SC-D099	50	1	D-003156		AD		IPC	CONDUIT AND CABLE LAYOUT AND SCHEDULE	4	920108	1	920218	D				268
						SIZE:D												
sdoc	SC-D099	51	1	80000009		AD		IPC	MODULE INTERCONNECTION ASSY	1	901105	1	901116	A			DELETED	212
				Comment:DRAWING DELETED														
sdoc	SC-D099	52	1	80000010-X		AD		IPC	HARNESS ASSEMBLY	1	901105	1	901116	A			DELETED	212
				Comment:DRAWING DELETED														
sdoc	SC-D099	53	1	82000060-X		AD		IPC	PIGTAIL ASSEMBLY	1	901105	1	901116	A			DELETED	212
				Comment:DRAWING DELETED														
sdoc	SC-D099	54	1	246167		AD		IPC	PT/PC METERING ENCLOSURE	1	901204	4	901205	A				219
				Comment:SBY. 27(3),27(7)														
sdoc	SC-D099	55	1	C-003138		AD		IPC	COMPONENT LAYOUT TM3 TRACKER CONTROLLER	3	920108	1	920218	C				268
						SIZE:C												
sdoc	SC-D099	56	1	B-003232		AD		IPC	ANGLE CLIP FABRICATION AND MOUNTING DETAIL	1	901204	1	901205	A				219
sdoc	SC-D099	57	1	GEP-7900D		AD		IPC	GE INSTRUMENT TRANSFORMERS (3 SHEETS)	1	901204	5	901205					219
sdoc	SC-D099	58	1			AD		IPC	PCU PAD DESIGN CALCULATIONS (ANDERSON & DOIG STRUCTURAL ENGINEERS)	1	901204	1	901205					219
sdoc	SC-D099	59	1			AD		IPC	INSTRUMENT TRANSFORMERS FOR METERING	1	910530	1	910611					244
sdoc	SC-D099	60	1	PD-275		AD		IPC	MAIN TRANSFORMER ASSEMBLY	1	910530	1	910611					244
sdoc	SC-D099	61	1	900448		AD		OMNION	PRELIMINARY INSTRUCTION MANUAL OMNION 200KW SERIES 3200	1	910806	3	910822					251
				Comment:SBY. 76(1)-1														
sdoc	SC-D099	62	1	004012		AD		IPC	DAS AND CONTROL WIRING DIAGRAM	3	920626	1	920811	C			AS-BUILT	323
						SIZE:D												
sdoc	SC-D099	63	1	80000013		AD		IPC	RA 440-8 PANEL ASSEMBLY	2	920108	1	920218	-				268
						SIZE:D												
sdoc	SC-D099	64	1	80000015-X		AD		IPC	HARNESS ASSEMBLY	2	920108	1	920218	C				268
						SIZE:D												
				Comment:THIS WAS 80000015														
sdoc	SC-D099	65	1	80000017		AD		IPC	PANEL ASSEMBLY DUAL DIODE	2	920108	1	920218	B				268
						SIZE:D												

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TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER		OWN	RD	Q	UNIT	-----	DESCRIPTION		SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS	..	XMTL	..#
sdoc	SC-D099	66	1	82000070-X		AD				IPC	PIGTAIL ASSEMBLY		2	920108	1	920218			C			268	
				Comment:THIS WAS 82000070		SIZE:D																	
sdoc	SC-D099	67	1			AD		P		IPC	IPC/MOBIL MODULE ELECTRICAL		001	910924	2	911008						259	
				Comment:SBY, 76(1)-1		SIZE:A					PARAMETERS (21 PAGES)												
sdoc	SC-D099	68	1			AD				IPC	IPC/MOBIL QUAL TEST CERTF.		001	910924	1	911008						259	
											(8 PAGES)												
sdoc	SC-D099	69	1			AD				IPC	IPC/MOBIL MODULE FRAME SAGGING		001	910924	1	911008						259	
											DATA												
sdoc	SC-D099	70	1			AD				IPC	IPC BYPASS DIODE DATA SHEETS		001	910924	2	911008						259	
				Comment:SBY, 76(1)-1							(5 PAGES)												
sdoc	SC-D099	71	1	B-004042		AD				IPC	TRACKER CONTROLLER		1	920108	1	920218			A			268	
						SIZE:B					SENSOR LAYOUT												
sdoc	SC-D099	72	1	B-004281		AD				IPC	TRACKER ROW TILT ADJUSTMENT &		1	920108	1	920218			A			268	
						SIZE:B					ATTACHMENT CABLE TENSIONING												
											ASSEMBLY												
sdoc	SC-D099	73	1	B-004282		AD				IPC	TRACKER DRIVE CABLE TENSIONING		1	920108	1	920218			A			268	
						SIZE:B					ASSEMBLY												
sdoc	SC-D099	74	1	80000024		AD				IPC	DIODE POTTING ASSEMBLY		1	920108	1	920218			A			268	
						SIZE:C																	
sdoc	SC-D099	75	1	2107-0		AD				IPC	3200 THREE PHASE BRIDGE		1	920108	1	920218			-			268	
						SIZE:C					ASSEMBLY												
											SHEET 1 OF 1												
sdoc	SC-D099	76	1	VOLUME 1		AD				IPC	O&M MANUAL		2	931025	2	931026			-			400	
						SIZE:A					VOLUME 1 OF 3												
sdoc	SC-D099	76	2	VOLUME 2		AD				IPC	O&M MANUAL		2	931025	2	931026			-			400	
						SIZE:A					VOLUME 2 OF 3												
sdoc	SC-D099	76	3	VOLUME 3		AD				IPC	O&M MANUAL		2	931025	2	931026			-			400	
						SIZE:A					VOLUME 2 OF 3												
sdoc	SC-D099	77	1	002455		AD	ED	V		IPC	ARRAY SOURCE CIRCUIT WIRING		1	920828	1	920902			D			327	
						SIZE:B					DIAGRAM												
sdoc	SC-D099	78	1	004856		AD	ED	V		IPC	ARRAY WIRING HARNESS ASSEMBLY		2	930812	1	930921			C			398	
						SIZE:D					MSEC RA 440-8 PANEL J-BOX												
sdoc	SC-D099	79	1	82000144		AD	ED	V		M.S.E	JUNCTION BOX POSITIVE, 2 HOLES		2	930913	1	930921			B			398	
						SIZE:C					1 INSERT												
sdoc	SC-D099	80	1	82000145		AD	ED	V		M.S.E	JUNCTION BOX NEGATIVE 2 HOLES,		2	930913	1	930921			B			398	
						SIZE:C					1 INSERT												

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sdoc	SC-D099	81	1	80000048			AD	ED	V		M.S.E RQ 440-8 PANEL ASSEMBLY		2	930913	1	930921		C			398
							SIZE:D														
sdoc	SC-D100	1	1	US100002-T89			AD		P		SIEMENS SCHEDULE		1	890719	N	890719					
sdoc	SC-D100	2	1	US100001-T89			AD		P		SIEMENS ONE-LINE DIAGRAM		1	890718	N	890718					
sdoc	SC-D100	3	1	90-049			AD		P		SIEMENS QUALITY & QUALITY TEST PLANT		1	891006	1	891026					
sdoc	SC-D100	4	1				AD		P		SIEMENS STRESS ANALYSIS - PV SUPPORT (24 SHEETS)		1	891113	N	891127					
sdoc	SC-D100	5	1				AD		P		SIEMENS INSTALLATION INSTRUCTION (12 SHEETS)		1	891113	N	891127					
sdoc	SC-D100	6	1	1			AD		V		SIEMENS SITE PLAN SHT. 1		3	900110	N	900228					132
sdoc	SC-D100	7	1	2			AD		V		SIEMENS DETAILS & GENERAL STRUCTURAL NOTES (SHEET 2)		4	940103	2	940106					403
sdoc	SC-D100	8	1	R7100			AD		V		SIEMENS PANEL ASSEMBLY (SHEET 3)		3	940103	1	940106					403
sdoc	SC-D100	9	1	R7100 SHEET 4			AD		V		SIEMENS VERT. SUPPORT POST. TOP VIEW (SHEET 4)		4	920429	1	920626		C		043092/295	317
							SIZE:D														
sdoc	SC-D100	10	1	R7100			AD		V		SIEMENS VERT. SUPPORT POST. ASSEMBLY (SHEET 5)		3	920220	1	920323				920224-273	279
							SIZE:D														
sdoc	SC-D100	11	1	R7100 SHEET 6			AD		V		SIEMENS MAIN SUPPORT BEAM/CBL SUPPORT (SHEET 6)		5	940103	1	940106					403
							SIZE:D														
sdoc	SC-D100	12	1	R7100			AD		V		SIEMENS PV ARRAY PER BEAM (SHEET 7)		3	900110	N	900228					132
sdoc	SC-D100	13	1	R7100			AD		V		SIEMENS MAIN SUPPORT BEAM/CBL SUPPORT (SHEET 8)		2	900110	N	900228					132
sdoc	SC-D100	14	1	R7101			AD		V		SIEMENS CROSSOVER TORQUE ARM (SHEET 9)		2	900110	N	900228					132
sdoc	SC-D100	15	1	R7103			AD		V		SIEMENS BEARING SUPPT PLATE (SHEET 10)		3	900110	N	900228					132
sdoc	SC-D100	16	1	R7104			AD		V		SIEMENS CABLE STANDOFF (SHEET 11)		2	900110	N	900228					132
sdoc	SC-D100	17	1	R7107			AD		V		SIEMENS MAIN SUPPT BEAM ASSY (SHEET 12)		2	900110	N	900228					132
sdoc	SC-D100	18	1	R7108			AD		V		SIEMENS SPINDLE AND SPACER (SHEET 13)		2	900110	N	900228					132
sdoc	SC-D100	19	1	R7109			AD		V		SIEMENS BASE PLATE (SHEET 14)		3	900110	N	900228					132
sdoc	SC-D100	20	1	R7113			AD		V		SIEMENS VERTICAL SUPPT WELD ASSY (SHEET 15)		2	900110	N	900228					132

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----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		-----DOCUMENT SUBMITTAL -----											
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER	OWN	RD	Q UNIT	-----	DESCRIPTION		SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS..	XMTL.#
sdoc	SC-D100	21	1	R7114		AD	V		SIEMENS	SUPPORT CABLE (SHEET 16)	2	900110	N	900228					132
sdoc	SC-D100	22	1	R7119		AD	V		SIEMENS	MOUNTING PAD SPACING (SHEET 17)	3	900110	N	900228					132
sdoc	SC-D100	23	1	R7120		AD	V		SIEMENS	REFLECTORS (SHEET 18)	2	900110	N	900228					132
sdoc	SC-D100	24	1	R7121		AD	V		SIEMENS	HANGER BRACKETS-SOUTHEND (SHEET 19)	2	900110	N	900228					132
sdoc	SC-D100	25	1	R7122		AD	V		SIEMENS	HANGER BRACKETS-NORTHEND (SHEET 20)	2	900110	N	900228					132
sdoc	SC-D100	26	1	R7123		AD	V		SIEMENS	MTG-HANGER BRACKETS & REFLECTORS (SHEET 21)	2	900110	N	900228					132
sdoc	SC-D100	27	1	R7124		AD	V		SIEMENS	RESTRAINING BAR (SHEET 22)	2	900110	N	900228					
sdoc	SC-D100	28	1	017689		AD	V		SIEMENS	SUPPORT CHANNEL FOR 8 MODULES	3	900730	1	900813		2			
sdoc	SC-D100	29	1	017647		AD	V		SIEMENS	MODULE ASSY M54-55W (SHEET 1 OF 2)	2	900608	1	900622		C			
sdoc	SC-D100	29	2	017647		AD	V		SIEMENS	MODULE ASSY M54-55W (SHEET 2 OF 2)	2	900608	1	900622		C			
sdoc	SC-D100	30	1	017648		AD	V		SIEMENS	CIRCUIT ASSY M54-55W	2	900608	1	900622		D			
sdoc	SC-D100	31	1	017649		AD	V		SIEMENS	LAMINATE ASSY M54-55W	3	900730	1	900813		C			
sdoc	SC-D100	32	1	013075		AD	V		SIEMENS	LABEL, IDENTIFICATION	2	900608	1	900622		Y			
sdoc	SC-D100	33	1	017650		AD	V		SIEMENS	BACK FACE SHEET, ASSY	2	900608	1	900622		C			
sdoc	SC-D100	34	1	017651		AD	V		SIEMENS	J-BOX ASSY W/O DIODE	2	900608	1	900622		E			
sdoc	SC-D100	35	1	014234		AD	V		SIEMENS	J-BOX MOLDING	2	900608	1	900622		G			
sdoc	SC-D100	36	1	017664		AD	V		SIEMENS	ENCLOSURE, INSTRUMENTATION	1	900110	N	900228		A			
Comment:DELETED																			
sdoc	SC-D100	37	1	017665		AD	V		SIEMENS	PANEL 17"X13"INSTRUMENTATION	1	900110	N	900228		A			
Comment:OBSOLETE																			
sdoc	SC-D100	38	1	017660		AD	V		SIEMENS	ONE-LINE ELECTRICAL DIAGRAM	11	940103	3	940106					403
				SIZE:D															
sdoc	SC-D100	38	2	017660		AD	V		SIEMENS	ONE-LINE ELECTRICAL DIAGRAM	2	900730	N						
Comment:DELETED																			
sdoc	SC-D100	39	1	017506		AD	V		SIEMENS	PANEL ASSEMBLY	5	910409	1	910430		B			239

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TYPE	MR/CONTRACT	SEQ SHEET	NUMBER	OWN	RD	Q	UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR.REV S2 COMMENTS.. XMTL.#
sdoc	SC-D100	40	1	017688	AD	V		SIEMENS INSTRUMENT INTERCONNECT CABLE	1	900110	N	900228	
								Comment:DELETED					
sdoc	SC-D100	41	1	017732	AD	V		SIEMENS PANEL, FAB FOR F.C. J-BOX	2	900608	1	900622	2
sdoc	SC-D100	42	1	017734	SHT. 1	AD	V	SIEMENS I&C DIAGRAM	6	901224	N	910102	8
								Comment:OBSOLETE					224
sdoc	SC-D100	42	2	017734	SHT. 2	AD	V	SIEMENS I&C DIAGRAM	4	901224	N	910102	8
								Comment:OBSOLETE					224
sdoc	SC-D100	42	3	017734		AD	V	SIEMENS I&C DIAGRAM SH 3/4	5	940103	2	940106	B
sdoc	SC-D100	42	4	017734		AD	V	SIEMENS I&C DIAGRAM SH 4/4	4	940103	3	940106	B
								SIZE:D					403
sdoc	SC-D100	43	1	017639	AD	V		SIEMENS FRAME FOR INVERTER	2	900806	N	900813	367
								Comment:OBSOLETE					
sdoc	SC-D100	44	1	017640	AD	V		SIEMENS ASSY, 100KVA INVERTER	2	900806	N	900813	367
								Comment:OBSOLETE					
sdoc	SC-D100	45	1	017641	AD	V		SIEMENS CONCRETE PAD FOR INVERTER	2	900806	N	900813	1
								Comment:OBSOLETE					367
sdoc	SC-D100	46	1	017719	AD	V		SIEMENS D.A.S. J-BOX ASSY	3	900730	N	900813	2
								Comment:OBSOLETE					
sdoc	SC-D100	47	1	017720	AD	V		SIEMENS PANEL FAB. FOR D.C. J-BOX	3	900730	1	900813	
								Comment:OBSOLETE					
sdoc	SC-D100	48	1	017721	AD	V		SIEMENS D.C. J-BOX ASSEMBLY SH 1/2	6	910530	1	910723	B
													247
sdoc	SC-D100	48	2	017721	AD	V		SIEMENS D.C. J-BOX ASSEMBLY SH 2/2	4	910530	1	910723	B
													247
sdoc	SC-D100	49	1		AD	P		SIEMENS CALC. - STRUCTURAL - PV PANELS (10 SHEETS)	1	900604	1	900622	
sdoc	SC-D100	50	1		AD	P		ARCO CALC. - PAD & STRUCTURAL - INVERTER (9 SHEETS)	1	900604	N	900622	
								Comment:OBSOLETE					
sdoc	SC-D100	51	1		AD	P		SIEMENS PRODUCT QUALITY & SAFETY TEST REPORT (72 SHEETS)	1	900604	3	900622	
sdoc	SC-D100	52	1	017771	AD	V		SIEMENS DIODE ASSEMBLY	4	910409	1	910430	B
													239
sdoc	SC-D100	53	1	017772	AD	V		SIEMENS CONDUIT & CABLE SCHEDULE	7	910409	1	910430	B
													239
sdoc	SC-D100	54	1	017795	AD	V		SIEMENS ELECTRICAL DETAILS SH 1/5	7	910711	1	910723	D
													247
sdoc	SC-D100	54	2	017795	AD	V		SIEMENS ELECTRICAL DETAILS SH 2/5	6	910711	1	910723	D
													247

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TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER	OWN	RD	Q	UNIT	-----	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS..	XMTL.#
sdoc	SC-D100	54	3	017795		AD		V	SIEMENS	ELECTRICAL DETAILS SH 3/5	6	910711	1	910723	D				247
sdoc	SC-D100	54	4	017795		AD		V	SIEMENS	ELECTRICAL DETAILS SH 4/5	4	910711	1	910723	D				247
sdoc	SC-D100	54	5	017795		AD		V	SIEMENS	ELECTRICAL DETAILS SH 5/5	4	910711	1	910723	D				247
sdoc	SC-D100	55	1	017797		AD		V	SIEMENS	MTG BRACKET FOR PYRANOMETER	2	910204	1	910228	A				233
sdoc	SC-D100	56	1	017798		AD		V	SIEMENS	CABLE ASSEMBLY INTERCONNECTION	2	910204	1	910228	A				233
sdoc	SC-D100	57	1	017799		AD		V	SIEMENS	THERMOCOUPLE JB A ASSEMBLY	3	910204	1	910228	A				233
sdoc	SC-D100	58	1	017800		AD		V	SIEMENS	CABLE ASSEY - MODULE INTERCONNECT	2	910204	1	910228	A				233
sdoc	SC-D100	59	1	017801		AD		V	SIEMENS	PANEL FOR THERMOCOUPLE J-BOX	3	910204	1	910228	A				233
sdoc	SC-D100	60	1	017857		AD		V	SIEMENS	DC J-BOX ASSEMBLY	2	910204	1	910228	A				233
sdoc	SC-D100	61	1	017858		AD		V	SIEMENS	GENERAL LAYOUT - CIRCUITS	2	910204	1	910228	A				233
sdoc	SC-D100	62	1	017859		AD		V	SIEMENS	DC J-BOX INTERCONNECTION DIAGRAM	6	910409	1	910430					239
sdoc	SC-D100	63	1	017860		AD		V	SIEMENS	CONDUITS - GENERAL LAYOUT	5	910214	1	910228					233
sdoc	SC-D100	64	1			AD		P	SIEMENS	SPEC SHEETS, SHUNTS AND TRANSDUCERS (8 SHEETS)	1	900608	N	900622					
				Comment: INCL IN O&M MANUAL															
sdoc	SC-D100	65	1	017507		AD		V	SIEMENS	PIER LOADS - GEOTECH ATTACH	2	910204	1	910228	A				233
sdoc	SC-D100	66	1	017508		AD		V	SIEMENS	BORING PLAN	2	910204	1	910228	A				233
sdoc	SC-D100	67	1	016712		AD		P	SIEMENS	SPACER, DERLIN	1	900608	1	900622	C				
sdoc	SC-D100	68	1	017886		AD		V	SIEMENS	THREE-LINE DIAGRAM - 51/27 RELAY C PT AND CT CONNECTIONS	4	910409	1	910430					239
sdoc	SC-D100	68	2	017886		AD		V	SIEMENS	THREE-LINE DIAGRAM - 51/27 RELAY C PT AND CT CONNECTIONS	3	910409	1	910430					239
sdoc	SC-D100	69	1	89A3-L-0001		AD		V	SIEMENS	FRAME FOR INVERTER	2	910530	N	910723					247
				Comment: OBSOLETE															
sdoc	SC-D100	70	1	89A3-L-0002		AD		V	SIEMENS	CONCRETE PAD FOR INVERTER	1	900726	N	900813					
				Comment: OBSOLETE															
sdoc	SC-D100	71	1	89A3-L-0009		AD		V	SIEMENS	CONDUIT ENTRANCE/EXIT - 100KVA INVERTER	1	900726	N	900813					
				Comment: OBSOLETE															
sdoc	SC-D100	72	1	89A3-L-0011		AD		V	SIEMENS	DC CONDUIT WIRING	2	910530	N	910723					247
				Comment: OBSOLETE															

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sdoc	SC-D100	73 1	89A3-S-0001	AD	V		SIEMENS	100 KW INVERTER DC CONNECTION	2	901224	N	910102	B	224
		Comment:OBSOLETE												
sdoc	SC-D100	74 1	89A3-T-0001	AD	V		SIEMENS	ASSEMBLY - 100 KW INVERTER	2	910530	N	910723		247
		Comment:OBSOLETE												
sdoc	SC-D100	75 1	60-01564-060-1B	AD	P		SIEMENS	BILL OF MATERIAL & WIRING DIAGRAM	3	940103	1	940106	3	403
sdoc	SC-D100	75 2	60-01564-060-1A	AD	V		SIEMENS	BASE DETAILS	1	910506	1	910723	1	247
sdoc	SC-D100	76 1	60-01564-060-1	AD	V		SIEMENS	UNIT SUBSTATION	4	910502	1	910723	5	247
sdoc	SC-D100	77 1	017637	AD	V		SIEMENS	GENERAL STRUCTURAL NOTES	1	900806	N	900813		367
		Comment:OBSOLETE												
sdoc	SC-D100	78 1	017638	AD	V		SIEMENS	ELECTRICAL EQUIPMENT FOOTING PAD	1	900806	N	900813		367
		Comment:OBSOLETE												
sdoc	SC-D100	79 1	1718.10	AD	P		SIEMENS	CALCULATION - EQUIPMENT PAD - SWITCHGEAR, TRANSFORMER AND IJB (2 SHEETS)	1	900904	1	900914		
sdoc	SC-D100	80 1	017951	AD	V		SIEMENS	FOUNDATION - EQUIPMENT PAD - SWITCHGEAR, TRANSFORMER AND IJB	6	910409	1	910430	C	239
sdoc	SC-D100	81 1	017919	AD	V		SIEMENS	THERMOCOUPLE BOX B ASSEMBLY	2	910204	1	910228	A	233
sdoc	SC-D100	82 1	017920	AD	V		SIEMENS	THERMOCOUPLE BOX C ASSEMBLY	2	910204	1	910228	A	233
sdoc	SC-D100	83 1		AD	P		SIEMENS	O & M MANUAL - INVERTER	2	910502	3	910723		247
sdoc	SC-D100	84 1	017952	AD	V		SIEMENS	SUBSTATION CONDUIT PLAN	5	910530	1	910723	A	247
sdoc	SC-D100	85 1		AD	P		SIEMENS	DATA SHEET - CT1 FOR METERING (DAS) (2 SHEETS)	1	901003	N	901017		
		Comment:INCL IN O&M MANUAL												
sdoc	SC-D100	86 1		AD	P		SIEMENS	DATA SHEET - PT1 FOR METERING (DAS) (2 SHEETS)	1	901003	N	901017		
		Comment:INCL IN O&M MANUAL												
sdoc	SC-D100	87 1		AD	P		SIEMENS	DATA SHEET - CT FOR PROTECTION	1	901003	N	901017		
		Comment:INCL IN O&M MANUAL												
sdoc	SC-D100	88 1		AD	P		SIEMENS	DATA SHEET - PT FOR PROTECTION	1	901003	N	901017		
		Comment:INCL IN O&M MANUAL												
sdoc	SC-D100	89 1		AD	P		SIEMENS	DATA SHEET - T2 AUXILIARY TRANSFORMER (2 SHEETS)	1	901003	N	901017		
		Comment:INCL IN O&M MANUAL												
sdoc	SC-D100	90 1		AD	P		SIEMENS	DATA SHEET - 12.47 KV DISCONN. SW (19 SHEETS)	1	901003	N	901017		
		Comment:INC IN O&M MANUAL												

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sdoc	SC-D100	91	1			AD		P		SIEMENS	DATA SHEET - 12.47 KV FUSE (6 SHEETS)		1	901003	N	901017							
				Comment:INCL IN O&M MANUAL																			
sdoc	SC-D100	92	1			AD		P		SIEMENS	DATA SHEET - CB1/CB2 480V CIRCUIT BREAKERS (33 SHEETS)		1	901003	N	901017							
				Comment:INCL IN O&M MANUAL																			
sdoc	SC-D100	93	1	130225		AD		V		SIEMENS	SPECIFICATION DRAWING		1	901003	5	901026							
sdoc	SC-D100	94	1	017971		AD		V		SIEMENS	METER ENCLOSURE		3	910214	1	910228							233
sdoc	SC-D100	94	2	017971		AD		V		SIEMENS	METER ENCLOSURE		2	910214	1	910228		3					233
sdoc	SC-D100	94	3	017971		AD		P		SIEMENS	PANEL INSTRUMENTS		1	910214	1	910228							233
sdoc	SC-D100	95	1	017979		AD		P		SIEMENS	METERING TRANSDUCER ENCLOSURE		2	910110	1	950131		2					229
sdoc	SC-D100	95	2	017979		AD		P		SIEMENS	METERING TRANSDUCER ENCLOSURE SPECIFICATION SHEETS (3 SHTS)		1	910110	5	950131							229
sdoc	SC-D100	95	3	017979		AD		P		SIEMENS	TRANSDUCER		1	910214	1	910228							233
sdoc	SC-D100	96	1			AD		P		SIEMENS	US-1 OPERATIONS & MAINTENANCE MANUAL, VOLUME 1		2	910502	3	910723							247
sdoc	SC-D100	96	2			AD		P		SIEMENS	US-1 OPERATIONS & MAINTENANCE MANUAL, VOLUME 2		2	910502	3	910723							247
sdoc	SC-D100	97	1	60-01564-060-1C		AD		V		SIEMENS	UNIT SUBSTATION WIRING DIAGRAM		2	910506	1	910723		2					247
sdoc	SC-D100	98	1	018036		AD		V		SIEMENS	METERING WIRING DIAGRAM		2	910409	1	910430		A					239
sdoc	SC-D100	99	1	17860		AD		V			CONDUITS, GENERAL LAYOUT		5	910228	1	910228		A					233
						SIZE:D																	
sdoc	SC-D100	100	1			AD		P		SIEMENS	SITE GROUNDING CALCULATIONS		1	910506	1	910723							247
sdoc	SC-D100	101	1	018078		AD	AD	V		SIEMENS	AC KW TRANSD. WIRING		1	910711	1	910723		A		1			247
sdoc	SC-D100	102	1	018200		AD	AD	P		SSI	LABEL, I.D. M54-55W MODULE SHEET 1 OF 1		1	911210	N			A					264
						SIZE:B																	
sdoc	SC-D100	103	1	R7126		AD		V		SIEMENS	BEARING SUPPORT PLATE (SHEET 24 OF 24)		1	920220	1	920323		A			920224-273		279
						SIZE:D																	
sdoc	SC-D100	104	1	SK 1413		AD		V		SIEMENS	100 KVA INVERTER SHT 1 OF 2		2	920327	N	920413							289
				Comment:OBSOLETE																			
sdoc	SC-D100	104	2	SK 1413		AD		V		SIEMENS	100 KVA INVERTER SHT 2 OF 2		2	920327	N	920413							289
				Comment:OBSOLETE																			

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sdoc	SC-D100	106	1	SK 1414	AD	V	SIEMENS 100 KVA INVERTER 12 FUSE BRIDGE CONFIGURATION SHT 1 OF 1	1	920220	N	1	920220	274
			Comment:OBSOLETE		SIZE:C								
sdoc	SC-D100	107	1	SK 1415	AD	V	SIEMENS 100 KVA INVERTER CONTROL WIRING SHT 1 OF 1	1	920220	N	1	920220	274
			Comment:OBSOLETE		SIZE:C								
sdoc	SC-D100	108	1	SK 1416	AD	V	SIEMENS 100 KVA INVERTER dc SIDE WIRING 1-100 kW SHT 1 OF 1	1	920220	N	1	920220	274
			Comment:OBSOLETE		SIZE:C								
sdoc	SC-D100	109	1	SK 1417	AD	V	SIEMENS 100 KVA INVERTER WIRING ENCLOSURE FOR AC SIDE SHT 1 OF 1	1	920220	N	1	920220	274
			Comment:OBSOLETE		SIZE:C								
sdoc	SC-D100	110	1	SK 1418	AD	V	SIEMENS 100 KVA INVERTER WIRING LOCATIONS SHT 1 OF 1	1	920220	N	1	920220	274
			Comment:OBSOLETE		SIZE:C								
sdoc	SC-D100	111	1	BULLETIN A-30	AD	P	SIEMENS FREE-STANDING NEMA 12 ENCLOSURES SHT 1 OF 1	1	920220	5	920413		289
					SIZE:A								
sdoc	SC-D100	112	1	SK1420	AD	V	SIEMENS SCHEMATIC 100 KVA INVERTER	1	920327	N	920413		289
			Comment:OBSOLETE		SIZE:D								
sdoc	SC-D100	113	1	SK1421	AD	V	SIEMENS CONTROL LOGIC 100KVA INVERTER	1	920327	N	920330		289
			Comment:OBSOLETE		SIZE:D								
sdoc	SC-D100	114	1	SK1422	AD	V	SIEMENS 100KVA INVERTER B.O.M.	1	920327	N	920330		289
			Comment:OBSOLETE		SIZE:D								
sdoc	SC-D100	115	1		AD	P	SIEMENS TEST PROCEDURE FOR DICKERSON INVERTER	1	920327	3	920409		287
sdoc	SC-D100	116	1		AD	P	SIEMENS STUDY & ANALYSIS OF DICKERSON INVERTER	1	920327	2	920330		289
sdoc	SC-D100	117	1	018344	AD	V	SIEMENS 100KVA INVERTER B.O.M.	2	930121	N	930204	B	369
			Comment:OBSOLETE		SIZE:D								
sdoc	SC-D100	118	1	018339	AD	V	SIEMENS 100KVA INVERTER-CONCRETE PAD	2	940103	2	940106		403
					SIZE:D								
sdoc	SC-D100	119	1	018340	AD	V	SIEMENS INVERTER POSITIONED PAD ON CONCRETE PAD	1	930121	1	930204	A	369
					SIZE:D								
sdoc	SC-D100	120	1	018341	AD	V	SIEMENS ENCLOSURE 100KVA INVERTER SHEET 1 OF 2	2	940103	2	940106		403
					SIZE:D								
sdoc	SC-D100	120	2	018341	AD	V	SIEMENS ENCLOSURE 100KVA INVERTER SHEET 2 OF 2	2	940103	1	940106		403
					SIZE:D								

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sdoc	SC-D100	121	1	018342		AD		V	SIEMENS	CONTROL LOGIC 100KVA INVERTER	1	930121	1	930204	C			369
						SIZE:D												
sdoc	SC-D100	122	1	018343		AD		V	SIEMENS	SCHEMATIC 100KVA INVERTER "B"	2	940103	2	940106	D			403
						SIZE:D				SHEET 1 OF 2								
sdoc	SC-D100	122	2	018343		AD		V	SIEMENS	SCHEMATIC 100KVA INVERTER "A"	1	930121	2	930204	C			369
						SIZE:D				SHEET 2 OF 2								
sdoc	SC-D100	123	1	018345		AD		V	SIEMENS	INSTRUMENT WIRING 100KVA	1	930121	1	930204	C			369
						SIZE:D				INVERTER								
sdoc	SC-D101	1	1	256206		AD			APS	PVUSA INSTRUMENTATION	1	910920	3	910923	C			257
sdoc	SC-D101	2	1	256216		AD	ED	V	APS	ELECTRICAL CONFIGURATION	6	930315	1	930421	H			392
						SIZE:D				ONE LINE DIAGRAM								
sdoc	SC-D101	3	1	801049		AD		V	APS	SOIL ANCHOR TEST LOCATION	5	930315	1	930407	I			390
				Comment:K. FERRE/		SIZE:D				SHEET 1 OF 2								
sdoc	SC-D101	3	2	801049		AD		V DAV	APS	SOIL ANCHOR TEST LOCATION	2	930315	1	930407	B			390
				Comment:K. FERRE/		SIZE:D				SHEET 2 OF 2								
sdoc	SC-D101	4	1	801065		AD		V	APS	DIRECT BURIAL DUCT SYSTEM	3	921026	1	921105	F			344
						SIZE:E				SHEET 1 OF 1								
sdoc	SC-D101	5	1	801066		AD			APS	CONDUIT SUPPORT ASS'Y	1	910920	1	910923	C			257
sdoc	SC-D101	6	1	801072		AD		V	APS	UPPER POSITIVE ARRAY HARNESS	4	920501	1	920513	H			302
						SIZE:D												
sdoc	SC-D101	7	1	801073		AD		V	APS	UPPER NEGATIVE HARNESS	4	920501	1	920513	H			302
						SIZE:D												
sdoc	SC-D101	8	1	801074		AD		V	APS	LOWER POSITIVE ARRAY HARNESS	5	920928	1	921001	H			336
						SIZE:D												
sdoc	SC-D101	9	1	801075		AD			APS	LOWER NEGATIVE ARRAY HARNESS	4	920501	1	920513	H			302
						SIZE:C				SHEET 1 OF 1								
sdoc	SC-D101	10	1	801076		AD		V	APS	POSITIVE BUS CONNECTION	4	920501	1	920513	F			302
						SIZE:C				HARNESS								
										SHEET 1 OF 1								
sdoc	SC-D101	11	1	801077		AD		V	APS	NEGATIVE BUS CONNECTION	4	920501	1	920513	F			302
						SIZE:C				HARNESS								
										SHEET 1 OF 1								
sdoc	SC-D101	12	1	801080		AD		V	APS	PCU INSTALLATION	5	920928	1	921001	J			336
				Comment:THIS DWG SUPERCEDE		SIZE:D				SHEET 1 OF 2								
sdoc	SC-D101	12	2	801080		AD		V	APS	PCU INSTALLATION	2	911031	1	911211	B			265
						SIZE:D				SHEET 2 OF 2								

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-----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		-----DOCUMENT SUBMITTAL-----						
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR.REV	S2 COMMENTS.. XMTL.#
sdoc	SC-D101	13	1	801082	AD		V	APS	FIELD INSTRUMENTATION	5	920928	1 921001	F	336
					SIZE:D									
sdoc	SC-D101	13	2	801082	AD		V	APS	FIELD INSTRUMENTATION	5	920928	1 921001	H	336
					SIZE:D				SHEET 2 OF 3					
sdoc	SC-D101	13	3	801082	AD		V	APS	FIELD INSTRUMENTATION	1	920902	1 920917	A	332
					SIZE:D				SHEET 3 OF 3					
sdoc	SC-D101	14	1	801089	AD			APS	TEST STATION MOUNTING ANGLE	1	910920	1 910923	B	257
sdoc	SC-D101	15	1	801090	AD		V	APS	PCU CABLE CONNECTIONS	2	911031	1 911211	C	265
					SIZE:D									
sdoc	SC-D101	16	1	801012	AD		V	APS	PANEL CHANNELS	2	920124	1 920330	G	920205-271 282
sdoc	SC-D101	17	1	801050	AD		V	APS	PHENOLIC BREAKER TUBE REAR	001	910924		C	
					SIZE:B				ANCHOR TEST POST					
sdoc	SC-D101	18	1	801088	AD		V	APS	REAR POST - WITH BREAKER TUBE	001	910924		C	
					SIZE:C									
sdoc	SC-D101	19	1		AD		P	SPAULDIN	GRADE C - SPAULDITE TUBING	001	910925		-	
					SIZE:A				1 PAGE					
sdoc	SC-D101	20			AD		P		ANDERSON CALCULATION EQUIPMENT	001	910925	1 910926	-	258
					SIZE:A				PAD BREAKER TUBE DESIGN					
									(24 PAGES)					
sdoc	SC-D101	21	1	NOT ASSIGNED	AD	AD	P	APS	GROUND RESISTANCE AND CABLE	1	911107	1 911211	-	265
					SIZE:A				PULLING CALCULATIONS					
									10 PAGES					
sdoc	SC-D101	22	1	801067	AD		V	APS	DC GROUNDING SYSTEM	1	911031	1 911211	C	265
					SIZE:E				SHEET 1 OF 1					
sdoc	SC-D101	23	1	801079	AD		V	APS	TRANSFORMER, DISCONNECT, IJB	2	911031	1 911211	E	265
					SIZE:D				GROUND PREPARATIONS					
									SHEET 1 OF 3					
sdoc	SC-D101	23	2	801079	AD		V	APS	TRANSFORMER, DISCONNECT, IJB	3	920501	1 920513	F	302
					SIZE:C				GROUND PREPARATIONS					
									SHEET 2 OF 3					
sdoc	SC-D101	23	3	801079	AD		V	APS	TRANSFORMER, DISCONNECT, IJB	1	911031	1 911211	A	265
					SIZE:D				GROUND PREPARATIONS					
									SHEET 3 OF 3					
sdoc	SC-D101	24	1	801093	AD	AD	V	APS	POSITIVE TEST HARNESS	001	911122		B	263
					SIZE:C				SHEET 1 OF 1					
sdoc	SC-D101	25	1	801094	AD	AD	V	APS	NEGATIVE TEST HARNESS	001	911122		B	263
					SIZE:C				SHEET 1 OF 1					

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TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER		OWN	RD	Q UNIT	-----	DESCRIPTION		SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS..	XMTL.#
sdoc	SC-D101	26	1	801095		AD	AD	V	APS	I-V TEST BOX ASSEMBLY SHEET 1 OF 1		001	911122				A			263
					SIZE:C															
sdoc	SC-D101	27	1	801092		AD		V	APS	SHORTING CABLE SHEET 1 OF 1		1	911031	1	911211		B			265
					SIZE:C															
sdoc	SC-D101	28	1	801096		AD	AD	V	APS	I-V INSTALLATION SHEET 1 OF 1		001	911122				B			263
					SIZE:D															
sdoc	SC-D101	29	1	801097		AD	AD	P	APS	THREADED TERMINAL STUD SHEET 1 OF 1		001	911122	1	911211		A			265
					SIZE:B															
sdoc	SC-D101	30	1	801098		AD	AD	V	APS	CHANNEL BRACKET SHEET 1 OF 1		001	911122				B			263
					SIZE:C															
sdoc	SC-D101	31	01	256605		AD	AD	V	APS	LOGIC DIAGRAM		1	920109							267
					SIZE:C															
sdoc	SC-D101	32	1	801154		AD		V	APS	INTERFACE CONTROL DRAWING SHT 1 OF 1		1	920128	3	920330		A		920205-271	282
					SIZE:A															
sdoc	SC-D101	33	1	801071		AD	ED		APS	SECTION WIRING SHT 1 OF 2		4	921026	1	921105		F			344
					SIZE:D															
sdoc	SC-D101	33	2	801071		AD		V	APS	SECTION WIRING SHT 2 OF 2		2	920902	1	920917		D			332
					SIZE:D															
sdoc	SC-D101	34	1	801007		AD		V	APS	PV-PANEL ASSEMBLY SHT 1 OF 1		1	920127	1	920330		I		920205-271	282
					SIZE:D															
sdoc	SC-D101	35	1	256201		AD		V	APS	125 KVA INVERTER CIRCUIT SHT 1 OF 1		5	921123	1	921216		F			354
					SIZE:D															
sdoc	SC-D101	36	1	256202		AD	ED	V	APS	SWITCH CIRCUIT		4	920902	1	920917		E			332
					SIZE:D															
sdoc	SC-D101	37	1	256203		AD		V	APS	MAINS DISCONNECT & TRANSFORMER CIRCUIT		3	920902				D			
					SIZE:D															
sdoc	SC-D101	38	1	256204		AD		V	APS	CENTRAL PROCESSING CKT.		4	920902	1	920917		E			332
					SIZE:D															
sdoc	SC-D101	39	1	256205		AD	ED	V	APS	SYSTEM DIAGRAM		6	921208	1	921216		G			354
					SIZE:D															
sdoc	SC-D101	40	1	Comment:SBY. D101-76(1)		AD		P	APS	ACCXEPTANCE TEST PROCEDURE FOR MPE-500 SOLAR INVERTER 9 PAGES		1	920124				A		SBY. 76(1)	271
						SIZE:A														
sdoc	SC-D101	41	1			AD		P	APS	PT AND CT DATA SHEETS 8 SHEETS		1	920324	5	920330		-		920324-281	283
					SIZE:A															

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----DOCUMENT ID NUMBER-----			SUPPLIERS		SUPPLIER			----- DOCUMENT SUBMITTAL -----				
TYPE	MR/CONTRACT	SEQ SHEET	NUMBER		OWN RD Q UNIT	-----	DESCRIPTION.....	SBMTL	INDATE	S	OUTDAT	SPLR.REV S2 COMMENTS.. XMTL.#
sdoc	SC-D101	42	1	801118	AD SIZE:D	V	APS	SIGN PLATE ASSEMBLY	1	920501	1 920612	051292/300 308
sdoc	SC-D101	43	1	801119	AD SIZE:D	V	APS	SIGN PLATE INSTALLATION	2	920902	1 920917	B 332
sdoc	SC-D101	44	1	801122	AD SIZE:D	ED V	APS	I-V TEST BOX ASS'Y W/BUS WIRE CONN.	1	920501	1 920610	051292/300 308
sdoc	SC-D101	45	1	801123	AD SIZE:D	ED V	APS	I-V TEST BOX INST'L W/BUS CABLES	1	920501	1 920610	051292/300 308
sdoc	SC-D101	46	1	801167	AD SIZE:A	P	APS	APS LABEL, PVUSA	1	920501	1 920610	051292/300 308
sdoc	SC-D101	47	1		AD SIZE:P		APS	SAFETY AND HEALTH POLICY	2	920914	1 920917	- 332
				CODE:A								
sdoc	SC-D101	48	1		AD SIZE:A	P	APS	OCCUPATIONAL INJURY AND ILLNESS PREVENTION PROGRAM	1	920526	1 920623	- 052692/305 315
sdoc	SC-D101	49	1		AD SIZE:A	P	APS	ACCIDENT PREVENTION PLAN	1	920526	1 920623	- 052692/305 315
sdoc	SC-D101	50	1	801000	AD SIZE:D	V	APS	SITE LAYOUT	1	920602	1 920622	- 060292/306 313
				Comment: SUPERSEDED D098-1								
sdoc	SC-D101	51	1	801171	AD SIZE:D	V	APS	TRANSFORMER PAD LAYOUT	1	920602	1 920622	A 060292/306 313
sdoc	SC-D101	52	1	801172	AD SIZE:D	V	APS	TOP ASSEMBLY	2	920902	1 920917	C 332
				Comment: SUPERSEDED D098-35								
sdoc	SC-D101	53	1	801184	AD SIZE:D	ED V	APS	PCU INTERFACE WIRE LIST AND LOCATION SHEET 1 OF 3	3	920928	1 921001	C 336
sdoc	SC-D101	53	2	801184	AD SIZE:D	ED V	APS	PCU INTERFACE WIRE LIST AND LOCATION SHEET 2 OF 3	3	920928	1 921001	C 336
sdoc	SC-D101	53	3	801184	AD SIZE:D	ED V	APS	PCU INTERFACE WIRE LIST AND LOCATION SHEET 3 OF 3	2	920902	1 920917	B VOIDED 332
				Comment: VOIDED 9/28/92								
sdoc	SC-D101	54	1	801081	AD SIZE:D	V	APS	TOP LEVEL PCU ASS'Y SHEET 1 OF 3	2	920902	1 920917	B 332
sdoc	SC-D101	54	2	801081	AD SIZE:D	V	APS	TOP LEVEL PCU ASS'Y SHEET 2 OF 3	2	920902	1 920917	B 332
sdoc	SC-D101	54	3	801081	AD SIZE:D	V	APS	TOP LEVEL PCU ASS'Y SHEET 3 OF 3	2	920902	1 920917	B 332

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TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR	REV S2	COMMENTS..	XMTL.#
sdoc	SC-D101	55	1	801099	AD SIZE:D	V	APS	SIGN, DECAL, FIRE EXTING., & FIRST AID KIT INSTALL. SHEET 1 OF 2	2	920902	1	920917	B			332
sdoc	SC-D101	55	2	801099	AD SIZE:D	V	APS	SIGN, DECAL, FIRE EXTING., & FIRST AID KIT INSTALL. SHEET 2 OF 2	1	920702	1	920702	A			318
sdoc	SC-D101	56	1	801157	AD SIZE:D	V	APS	PLENUM INSTALLATION	2	920902	1	920917	B			332
sdoc	SC-D101	57	1	801103	AD SIZE:A	P	APS	ELECTRICAL CONNECTOR MATING PROCEDURE	2	920914	1	920917	C			332
sdoc	SC-D101	58	1	801104	AD SIZE:A	P	APS	HANDLING OF EUREKA PHOTOVOLTAIC MODULES AND PANELS	1	920702	1	920702	B			318
sdoc	SC-D101	59	1	801105	AD SIZE:A	P	APS	FIELD ELECTRICAL WIRING SEQUENCE	2	920914	1	920917	C			332
sdoc	SC-D101	60	1	801106	AD SIZE:A	P	APS	SAFETY RULES APS' PVUSA POWER STATION	1	920702	1	920702	B			318
sdoc	SC-D101	61	1	801107	AD SIZE:A	P	APS	FIELD REPAIR OF ELECTRICAL CONNECTOR PROCEDURE	3	921026	1	921105	C			344
sdoc	SC-D101	62	1	D3146	AD SIZE:D	B	MALTON	MES 100 SERIES 600A PADMOUNT SWITCHGEAR 15KV 95KV BIL P/N MES105	1	920818	1	921216	B			354
sdoc	SC-D101	63	1		AD SIZE:A	P	APS	APS FIELD WET RESISTANCE TEST	1	920818	1	920917	-			332
				Comment:DATE AUG 3, 1992												
sdoc	SC-D101	64	1	801025	AD SIZE:D	CD V	APS	CONCRETE PIER INSTALLATION	1	920902	1	920917	G			332
				Comment:SUPERSEDED D098-37												
sdoc	SC-D101	65	1	801011	AD SIZE:D	CD V	APS	MISCELLANEOUS PARTS	1	920902	1	920917	F			332
				Comment:SUPERSEDED D098-11												
sdoc	SC-D101	66	1	801188	AD SIZE:D	ED V	APS	SECTION WIRING (ROW 1 THRU 4 AND 5 WEST ONLY] SHEET 1 OF 2	2	921026	1	921105	B			344
sdoc	SC-D101	66	2	801188	AD SIZE:D	ED V	APS	SECTION WIRING (ROW 1 THRU 4 AND 5 WEST ONLY] SHEET 2 OF 2	1	920902	1	920917	A			332
sdoc	SC-D101	67	1	801108	AD SIZE:A	ED P	APS	ARRAY FIELD SHORTING PROCEDURE	1	920914	1	921008	A			337
sdoc	SC-D101	68	1	801110	AD SIZE:A	ED P	APS	ARRAY FIELD TROUBLE SHOOTING AND REPAIR PROCEDURE	2	921026	1	921105	B			344

---DOCUMENT ID NUMBER----	SUPPLIERS	SUPPLIER	DOCUMENT SUBMITTAL
TYPE MR/CONTRACT...SHEET NUMBER...	OWN RD & UNIT	DESCRIPTION	SBMTL INDATE S QUIDAT SPLR.REV S2 COMMENTS..XMTL.#

336	sdcc SC-D101	69	1	AD	ED P	APS	CALCULATION FOR SEA VAN HOLD DOWN CONNECTION	1	920928	1	921001	-	
336	sdcc SC-D101	70	1	AD	ED P	APS	TRANSFORMER NAMEPLATE DATA (LIMITED)	1	920928	1	921001	-	
344	sdcc SC-D101	71	1	AD	ED V	APS	ELECTRICAL CONFIGURATION ONE LINE TEST DIAGRAM	1	921026	1	921105	A	
344	sdcc SC-D101	72	1	AD	ED V	APS	ROW CABLE LOCATIONS & CONNECTIONS	1	921026	1	921105	E	
	sdcc SC-D101	73	1	AD	ED P	APS	DESIGN OF DIAGNOSTIC LED'S	1	921026			-	DELETED
365	sdcc SC-D101	74	1	AD	ED P	APS	CALIBRATION PROCEDURE FOR DC SIGNALS 6 PAGES	2	921209	1	930129	B	REVIEW
354	sdcc SC-D101	75	1	AD	ED P	APS	PROVIDE ACCURACY OF DC VOLTAGE AND CURRENT INPUT SIGNALS	1	921026	-	921216	-	DELETED
337	sdcc SC-D101	76	1	AD	P	APS	ACCEPTANCE TEST PROCEDURE (ATP) FOR THE MODEL 500-256-1 500KW POWER CONDITIONER	3	920928	1	921008	-	
	sdcc SC-D101	77	1	AD	V	APS	SITE LAYOUT	1	920602				DELETED
	sdcc SC-D101	78	1	AD	V	APS	PVUSA HTOP ASSEMBLY	1	920602			S	DELETED
	sdcc SC-D101	79	1	AD	V	APS	TRANSFORMER PAD LAYOUT	1	920602			A	DELETED
	sdcc SC-D101	80	1	AD	V	APS	SITE LAYOUT	1	920602				DELETED
	sdcc SC-D101	81	1	AD	P	APS	OPERATION AND MAINTENANCE FOR APS PV-1 SOLAR SYSTEM VOLUME 1 OF 2	4	930315	1	930421	5	392
	sdcc SC-D101	81	2	AD	P	APS	OPERATION AND MAINTENANCE FOR APS PV-1 SOLAR SYSTEM VOLUME 2 OF 2	1	921224	2	921224	3	355
	sdcc SC-D101	82	1	AD	P	APS	OPERATION AND MAINTENANCE MAN VOLUME 2 OF 2	1	921217			3	URS REVIEW 355
	sdcc SC-D101	83	1	AD	P	APS	OPERATION AND MAINTENANCE FOR APS PV-1 SOLAR SYSTEM VOLUME 1 OF 1	2	921217			3	URS REVIEW 355

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TYPE	MR/CONTRACT	SEQ SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR.REV	S2 COMMENTS.. XMTL.#
sdoc	SC-D101	84	1	801049	AD	V DAV	APS	SOIL ANCHOR TEST LOCATION	1	930204		A	XMTL-368
			Comment:K. FERRE'	REVIEW	SIZE:D			SHEET 1 OF 2					
sdoc	SC-D101	84	2	801049	AD	V DAV	APS	SOIL ANCHOR TEST LOCATION	1	930204		A	920204-368
			Comment:K. FERRE'	REVIEW	SIZE:D			SHEET 2 OF 2					
sdoc	SC-D101	85	1	256999	AD	ED V	APS	PCU SHUTDOWN CIRCUIT	1	930315	1 930421	A	392
					SIZE:D								
sdoc	SC-D102	1	1		AD		LATHAM	TRUSS CALCULATIONS & DRAWINGS	1	890721	N 890721		
								(5 SHEETS)					
sdoc	SC-D103	1	1	2-3027	AD		MALCOM	FOUNDATION PADS	1	890728	N 890731		
sdoc	SC-D103	2	1	W6041B	AD		MALCOM	MIX DESIGN	1	890801	1 890802		
sdoc	SC-D121	1	1	2-09100	AD		ASCO	BILL OF MATERIAL	1	900122	P 900126		
sdoc	SC-D121	2	1	B3342701	AD		ASCO	OUTLINE EMT-2 FOR PNL	1	900122	P 900126		
sdoc	SC-D121	2	2	B3342701	AD		ASCO	SCHEMATIC EMT-2 FOR PNL	2	900213	1 900213		
sdoc	SC-D123	1	1	CLE-202031	AD		DAVIS	CURRENT TRANSDUCER MANUAL	1	891006	1 891009		
sdoc	SC-D123	2	1	CLE-201031	AD		DAVIS	CURRENT TRANSDUCER MANUAL	1	891006	1 891009		
sdoc	SC-D123	3	1	CLE-20800	AD		DAVIS	WATT/VAR TRANSDUCER MANUAL	1	891006	1 891009		
sdoc	SC-D123	4	1		AD		DAVIS	CERTIFICATE OF COMPLIANCE	1	891030	1 891030		
sdoc	SC-D124	1	1	YD-08787-001-N	AD		DAVIS	INSTRUCTION MANUAL FOR J.E.M.	1	891130	1 891201		
sdoc	SC-D124	2	1	YD-09494-001-N	AD		DAVIS	EXJ-11, SUPPLEMENT TO J.E.M.1	1	891130	1 891201		
								USER MANUAL					
sdoc	SC-D124	3	1	YD-09493-001-N	AD		EXJSET	INSTRUCTION MANUAL	1	910822	5 910822		252
sdoc	SC-D211	1	1		AD	A	SOLAR	DATA SHEETS (DESIGN SUMMARY	1	920323	5 920323		920323-272 277
					SIZE:A			SHEETS)					
								2 PAGES					
sdoc	SC-D211	2	1		AD		SOLAR	QUALITY ASSURANCE/QUALITY	1	920408	3 920501		040992-288 296
								CONTROL PROGRAM					
sdoc	SC-D211	3	1		AD		SOLAR	OVERALL CPM AND CHART SCHEDULE	1	920408	3 920501		040992-288 296
sdoc	SC-D211	4	1		AD		SOLAR	DETAIL CPM AND CHART SCHEDULE	1	920408	2 920501		040992-288 296
								FOR NEGOTIATING CONTRACT FOR					
								1KW ARRAY					
sdoc	SC-D211	5	1		AD		SOLAR	DETAIL CPM AND CHART SCHEDULE	1	920408	2 920501		040992-288 296
								FOR MODULE QUALIFICATION TESTS					

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TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER	OWN	RD	Q UNIT	DESCRIPTION	SBMTL	INDATE	S	OUTDAT	SPLR	REV S2	COMMENTS..	XMTL.#
sdoc	SC-D212	1	1		AD		P	SUNPOWER VALUE PARAMETERS AS NOTED ON P. 21 OF THE CONTRACT, 1.13.1	1	920323	3	920323			920323-280	280
					SIZE:A			1 PG								
sdoc	SC-D212	2	1		AD			SUNPOWER DESIGN SUMMARY SHEET	1		3	920429			040992-284	294
sdoc	SC-D212	3	1		AD			SUNPOWER CORPORATE QUALITY MANUAL	1	920615						320
sdoc	SC-D212	4	1		AD			SUNPOWER DRIVE SAFETY FACTOR REQUIREMENT FOR DESIGN WINDS LOADS	1	920615						320
sdoc	SC-D212	5	1		AD			SUNPOWER WIND PRESSURE PREDICTIONS FOR MIRROR MODULES	1	920615						320
sdoc	SC-DAPS	1	1	256201	AD			APS 125 KVA INVERTER CIRCUIT	001	910506	3	910515	A			
				Comment:MOVED TO D101-35												
sdoc	SC-DAPS	2	1	256202	AD			APS SWITCH CIRCUIT	001	910506	3	910515	A			
				Comment:MOVED TO D101-36												
sdoc	SC-DAPS	3	1	256203	AD			APS MAINS DISCONNECT & TRANSFORMER CIRCUIT	001	910506	3	910515	A			
				Comment:MOVED TO D101-37												
sdoc	SC-DAPS	4	1	256204	AD			APS CENTRAL PROCESSING CKT.	001	910506	3	910515	A			
				Comment:MOVED TO D101-38												
sdoc	SC-DAPS	5	1	256205	AD			APS SYSTEM DIAGRAM	001	910506	3	910515	A			
				Comment:MOVED TO D101-39												
sdoc	SC-DAPS	6	1	256206	AD			APS PVUSA INSTRUMENTATION	003	910819						253
				Comment:CHGD TO D101-1(1)												
sdoc	SC-DAPS	7	1	256216	AD			APS ELECTRICAL CONFIGURATION ONE LINE DIAGRAM	003	910819						253
				Comment:CHGD TO D101-2(1)												
sdoc	SC-DAPS	8	1	801007	AD			APS PV-PANEL ASSEMBLY	002	910709	1	910802	F			248
				Comment:MOVED TO D101-34												
sdoc	SC-DAPS	9	1	801049	AD			APS SOIL ANCHOR TEST LOCATION	003	910819						253
				Comment:CHGD TO D101-3(1)												
sdoc	SC-DAPS	10	1	801050	AD			APS PHENOLIC BREAKER TUBE REAR ANCHOR TEST POST	002	910709	4	910802	B			248
				Comment:CHGD TO D101-17(1)												
sdoc	SC-DAPS	11	1	801051	AD			APS FRONT ANCHOR GROUNDING CABLE	002	910709	1	910802	C			248
sdoc	SC-DAPS	12	1	801065	AD			APS DIRECT BURIAL DUCT SYSTEM	003	910819						253
				Comment:CHGD TO D101-4(1)												
sdoc	SC-DAPS	13	1	801066	AD			APS SUPPORT ASS'Y	003	910819						253
				Comment:CHGD TO D101-5(1)												

PVUSA
PVUSA - DAVIS SUPPLIER DOCUMENT REGISTER

----DOCUMENT ID NUMBER-----				SUPPLIERS		SUPPLIER		----- DOCUMENT SUBMITTAL -----													
TYPE	MR/CONTRACT	SEQ	SHEET	NUMBER		OWN	RD	Q	UNIT	-----	DESCRIPTION		SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS..	XMTL.#
sdoc	SC-DAPS	14	1	801067		AD			APS		DC GROUNDING SYSTEM		002	910709	3	910802	B				248
				Comment:CHGD TO D101-22(1)																	
sdoc	SC-DAPS	15	1	801070		AD			APS		ROW CABLE LOCATIONS AND CONNECTIONS		002	910709	3	910802	C				248
sdoc	SC-DAPS	16	1	801071		AD			APS		ARRAY WIRING		002	910709	1	910802	B				248
				Comment:MOVED TO D101-33																	
sdoc	SC-DAPS	16	2	801071		AD			APS		ARRAY WIRING DETAILS		002	910709	1	910802	B				248
sdoc	SC-DAPS	17	1	801072		AD			APS		UPPER POSITIVE ARRAY HARNESS		003	910819							253
				Comment:CHGD TO D101-6(1)																	
sdoc	SC-DAPS	18	1	801073		AD			APS		UPPER NEGATIVE ARRAY HARNESS		003	910819							253
				Comment:CHGD TO D101-7(1)																	
sdoc	SC-DAPS	19	1	801074		AD			APS		LOWER POSITIVE ARRAY HARNESS		003	910819							253
				Comment:CHGD TO D101-8(1)																	
sdoc	SC-DAPS	20	1	801075		AD			APS		LOWER NEGATIVE ARRAY HARNESS		003	910819							253
				Comment:CHGD TO D101-9(1)																	
sdoc	SC-DAPS	21	1	801076		AD			APS		POSITIVE BUS CONNECTION HARNESS		003	910819							253
				Comment:CHGD TO D101-10(1)																	
sdoc	SC-DAPS	22	1	801077		AD			APS		NEGATIVE BUS CONNECTION HARNESS		003	910819							253
				Comment:CHGD TO D101-11(1)																	
sdoc	SC-DAPS	23	1	801079		AD			APS		TRANSFORMER, DISCONNECT, 1JB GROUND PREPARATIONS		002	910709	3	910802	B				248
				Stat:DEL Comment:CHGD TO D101-23(1)																	
sdoc	SC-DAPS	23	2	801079		AD			APS		TRANSFORMER, DISCONNECT, 1JB GROUND PREPARATIONS		002	910709	2	910802	B				248
				Comment:CHGD TO D101-23(2)																	
sdoc	SC-DAPS	24	1	801080		AD			APS		PCU INSTALLATION		003	910819							253
				Stat:DEL Comment:CHGD TO D101-12(1)																	
sdoc	SC-DAPS	25	1	801082		AD			APS		FIELD INSTRUMENTATION		003	910819							253
				Comment:CHGD TO D101-13(1)																	
sdoc	SC-DAPS	25	2	801082		AD			APS		FIELD INSTRUMENTATION		003	910819							253
				Comment:CHGD TO D101-13(2)																	
sdoc	SC-DAPS	26	1	801087		AD			APS		HOLD DOWN DOG		001	910709	3	910802	A				248
sdoc	SC-DAPS	27	1	801088		AD			APS		REAR POST - WITH BREAKER TUBE		001	910709	4	910802	A				248
				Comment:CHGD TO D101-18(1)																	
sdoc	SC-DAPS	28	1	801089		AD			APS		TEST STATION MOUNTING ANGLE		002	910819							253
				Comment:CHGD TO D101-14(1)																	

C-42

PVUSA
PVUSA - DAVIS SUPPLIER DOCUMENT REGISTER

-----DOCUMENT ID NUMBER-----			SUPPLIERS		SUPPLIER		-----DOCUMENT SUBMITTAL -----															
TYPE	MR/CONTRACT	SEQ SHEET	NUMBER		OWN	RD	Q	UNIT	-----	DESCRIPTION		SBMTL	INDATE	S	OUTDAT	SPLR	REV	S2	COMMENTS	..	XMTL	#
sdoc	SC-DAPS	29	1	801090		AD			APS	PCU CABLE CONNECTIONS		002	910819									253
				Comment:CHGD TO D101-15(1)																		
sdoc	SC-DAPS	30	1	801012		AD			APS	PANEL CHANNELS		1	910819									253
				Comment:CHGD TO D101-16(1)																		
sdoc	SC-DAPS	31	1			AD			SPAULDIN	GRADE C -SPAULDITE TUBING		1	910822									
				Comment:CHGD TO D101-24(1)					G													
sdoc	SC-DM-001	1	1			AD				GOULDS PUMPS DATA SHEETS		2	871026	1	871026							
sdoc	SC-DO-001	1	1			AD				SUBMITTAL OF PROPOSED GRADATIO		1	871002	1	871026							
										N 1/2" MAX.												
sdoc	SC-DO-001	2	1			AD				CONCRETE MIX DESIGN		1	871026	1	871026							
sdoc	SC-DO-001	3	1			AD				STORM DRAIN/REBARS		1	871029	N	871030							
sdoc	SC-DO-001	4	1			AD				SUMP CONCRETE STRUCTURE REBARS		2	871001	1	871005							
sdoc	TSC-D217	1	1			AD	P		PPPL	REPORT OF A SAFETY REVIEW FOR		2	920416		920417	4						291
						SIZE:A				PVUSA AT DAVIS JOB SITE												

Appendix D
GENERAL REFERENCE FIGURES

GENERAL REFERENCE FIGURES

Figure	Page
D-1 Artist rendition	D-1
D-2 Site plan	D-2
D-3 Physical layout, ARCO (now SSI) EMT-1 PV system (drawing 016924) Bechtel D31-014 (1)	D-3
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D-5 Physical layout, Sovonics EMT-1 PV system (drawing Sov-PVUSA-OM1) Bechtel D34-01-3 (3)	D-5
D-6 Physical layout, UPG EMT-1 PV system (drawing 071788) Bechtel D32-4-3 and D32-9-2	D-6
D-7 Physical layout, ENTECH EMT-1 PV system (drawing 1000D13283) Bechtel D33-35 (1-4)-2	D-7
D-8 Physical layout, ENTECH EMT-1 PV system (drawing 1000D13288) Bechtel D33-36 (1-7)-2	D-8
D-9 Physical layout, SSI US-1 PV system (drawing 017795) Bechtel D100-54-6	D-9
D-10 Physical layout, IPC US-1 PV system (drawing 002538) Bechtel D99-16-4	D-10
D-11 Physical layout, APS US-1 PV system (drawing 801172) Bechtel D101-52-2	D-11
D-12 Main single-line diagram (drawing 478561)	D-12
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D-14 EMT-2 single-line diagram (drawing 478563)	D-14

PHOTOVOLTAICS FOR UTILITY SCALE APPLICATIONS (PVUSA)

(ARTIST'S CONCEPT) DAVIS SITE

PACIFIC GAS AND ELECTRIC COMPANY

FIGURE #2

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D

C

B

A

⑥ MODULES NUMBERED 1 THRU 10 FROM TOP TO BOTTOM TYPICAL FOR EACH PANEL.

5. ABOVE GROUND CONDUIT
UNDER GROUND CONDUIT

③ CARLON 1" PVC EXPANSION JOINTS TYPICAL 4- PLACES.

② BACKFILL USING ORIGINAL MATERIAL EXCLUDING ROCKS > 1 1/2" DIA; COMPACT TO 90% DENSITY, USING ENGINEERING APPROVED EQUIPMENT IN 12" LIFTS.

① OBTAIN LOCATION OF BURIED GROUND CONDUCTORS FROM BECHTEL PRIOR TO TRENCH EXCAVATION.

NOTES: UNLESS OTHERWISE SPECIFIED

D-3

SYSTEM CONFIGURATION LINE

AS VIEWED FROM FRONT
APPROX. SCALE: 1/8" = 1'

SIDE ELEVATION, EAST VIEW

APPROX. SCALE: 1/2" = 1'

ARRAY LAYOUT AND NOMINAL DIMENSIONS

See Exhibit 2-2 For Typical Panel Detail

True
N

TOTAL SYSTEM APERTURE* AREA = 13,920 Ft.²
MODULE APERTURE* AREA = 5280 FT.²

*Aperture in this case is total area of the array including inter-row spacing. Module area is frame

WIRE SIZES
AWG Stranded, Copper
Type Direct Burial

2

4

STRINGS

A, B, C, D

E, F, G, H

D34-01-3(3)

Drawing No.
SOV-PVUSA-0M1

FIGURE #5

APPLICATION		DO NOT SCALE DRAWING		SCALE 3/16"=1'	
USED ON	MEET ASSY	ISSUED	SIZE	DWG NO.	SHEET 1 OF 2
		CHECKED	DATE	071788	
MATERIAL		DRAWN	APPROVALS	PVUSA EMT-1 ARRAY LAYOUT	
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE IN INCHES FRACTIONS DECIMALS ANGLES		C. BOOT		UTILITY POWER GROUP 9410 DE SOTO AV. CHATSWORTH, CA. 91311	
CONTRACT NO.		19271-SC-D32			
PARTS LIST					
QTY	RECD	PLANT NO.	DESCRIPTION	MATERIAL	
19271-SC-D32-12-(3)1					

D32-4-3
D32-9-2

ROW 1

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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B

ROW 2

C

ROW 3

D

REV	DATE	DESCRIPTION	APPROVED
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96			
97			
98			
99			
100

FIGURE #8

FIGURE #7

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C

B

A

Row A-1-1+

Row A-2-1+

Row A-2-1-

Row A-1-1-

Row B-1-1-

DETAIL 'M'
SEE SHT. 4

① ⑦

② ⑧

② ⑧

① ⑦

① ⑦

J-BOX A-1+

J-BOX A-2+

J-BOX A-2-

J-BOX A-1-

J-BOX B-1-

P SEE SHT. 4

② ⑥

N SEE SHT. 4

② ⑦

INVERTER 'A'

TRANSFORMER
AND SWITCHGEAR

DETAIL 'D'
(SEE SHT. 3)

(SHT. 4)

(SHT. 3)

(SHT. 2)

DETAIL 'M'
SEE SHT. 4

Row A-1-2+

Row A-2-2+

Row A-2-2-

Row A-1-2-

Row B-1-2-

Row

POLARITY SIGNS INDICATE
SOURCE CIRCUIT. POLARITY
LOCATED IN ROWS.

REMOVE EXISTING GRAVEL
IN THIS AREA

E 9401.00

APPROX. GRADE
ELEV. = 33.38

DRIVE WINCH
REFER TO IPC DWG. B-002500.

TRACKER ROW #T1

#T2

#T3

REFER TO IPC DWG. B-002442
FOR TYPICAL ELEVATION IN THIS AREA

#T4

#T5

#T6

REFER TO IPC DWG. B-002405
FOR OVERALL PIER LAYOUT

#T7

#T8

#T9

#T10

#T11

50 PANELS TYPICAL PER ROW

41'-0"

SHOAVE CENTERLINE

DITCH CENTERLINE

DITCH

NATURAL GRADE SLOPE 0.5%

NOTES:

1. REFER TO B-002495 FOR PIER LAYOUT AND DIMENSIONS.
2. REFER TO PWUSA DRAWING NO. 478565 FOR ELECTRICAL TRENCH AND RACEWAY LAYOUT IN THIS AREA.
3. REFER TO C-003155 FOR PCU AND WINCH PAD GRADING AND EQUIPMENT LAYOUT.

D99-16-4

AS-BUILT

FIGURE #10

REVISION DATE B - 10APR80 C - 18JUL80 D - 05DEC91				Integrated Power Corporation ROCKVILLE, MARYLAND USA			
SCALE 1" = 40'		APPROVED BY <i>[Signature]</i>		DRAWN BY GEF			
DATE 02 FEB 90		REV BY CRH					
SYSTEM PLAN							
PWUSA US-1				DATE 002538			
				REV D

+

+

+

+

DETAIL "A"

PCU, TRANSFORMER, DISCONNECT & IJB

MODULE

10	08	06
09	07	

DETAIL

TYPICAL MOD

7 13/16' (REF)

1-12'-4 13/16" (REF)

↑
NORTH

[illegible][illegible]

ABLE CONNECTIONS

[illegible][illegible]

NUMBERS

04 02
5 03 01

8

7

6

5

4

3

2

1

'B'

E LAYOUT

2-19-3-04 (219304)

ROW -
SECTION -
PANEL -
MODULE -

SEE DWG. #80100 FOR
SITE LAYOUT

UNLESS OTHERWISE SPECIFIED		DO NOT SCALE DWG		LIST OF MATERIALS ON PANELS USE!	
DWGS. IN INCHES OR IN [MM]		SIGNATURES		DATE	
DEC.TOL. XXXX		DRY D.LAWRENCE		5/19/92	
FAC.TOL.± ANG.TOL.±		DSON DE			
MATERIAL		CHD 5/14/92		ADVANCED PHOTOVOLTIC SYSTEMS P.O. BOX 7093 PRINCETON, N.J. 08543-7093	
		CHD			
		CHD			
FINISH				PVUSA TOP ASSEMBLY	
APPD		5/14/92		PVUSA, DAVIS, CA	
		SCALE		SHT	
		NTS		OF 1	
				801172	
				REV	
				C	

FIGURE #11

- 47856
47856
PO-D8
SC-D1
SC-D9
SC-D1
49269
47855
49269
PO-D8
49269
47853
47857

1. SURGE SUPPRESSION DEVICES ON BOTH AC AND DC SYSTEMS ARE NOT SHOWN. REFER TO APPROPRIATE VENDOR DRAWING FOR LOCATIONS AND RATING.
2. METER AND RELAY DEVICES LISTED IN THE DEVICE TABLE ARE PIVISA FURNISHED DEVICES ONLY. REFER TO VENDOR DRAWINGS FOR VENDOR FURNISHED DEVICES.
3. DEVICE NUMBERS SHOWN FOR BREAKERS, DISCONNECT SWITCHES, ETC. ARE ASSIGNED BY PIVISA AND WILL NOT NECESSARILY MATCH THE INDICATED DEVICES. THESE DEVICE NUMBERS ONLY SHALL BE THE SPECIFIC NUMBERS USED FOR OPERATING PURPOSES.
4. THE IPC SYSTEM MAY BE ISOLATED FROM THE BUS BY DISCONNECTING THE ELBOW CONNECTION FROM THE HIGH-VOLTAGE TRANSFORMER BUSGING AND INSERTING IT INTO THE STANDOFF PORN BUSGING. CONNECTIONS MUST BE MADE UNDER CONDITIONS USING AN INSULATED "HOT STIC

[illegible]

PROTECTIVE RELAY CABINET RBO1

DEVICE TABLE (NOTE 2)

DEVICE (PVUSA)	FUNCTION	RATING/RANGE	MFR	MFR. TYPE OR MODEL	CAT. No	REF. DWG. No	REMARKS
21/59-1	SYST. OVER/UNDER VOLTAGE	55-160V	BASLER	BEI-21/59	ASF 441 BOND	(1)	SWAT TRIP
42-1,2	COMB. STARTER, STORM WTR. PUMPS	NEHA SIZE 3	—	—	—	—	—
50/51-1	INST./TIME PHASE O.C. RELAY	—	HUGHES-EDISON	—	—	—	—
50/51N-1	INST./TIME NEUT. O.C. RELAY	—	HUGHES-EDISON	—	—	—	—
SIC-111, 117, 121, 131	OVER CURRENT/VOLT. CONT., RELAY	0.5-12A 40-160V	BASLER	BEI-51/21C	LIE-21P8000	—	SELECTABLE EM 15S, NO. 101118
52-1	CIRCUIT BREAKER, MAIN 480V	400A	SQUARE D	LAL	3600	—	—
52-2	CIRCUIT BREAKER, SUMP PUMPS	100A	SQUARE D	—	—	—	—
52-3	CIRCUIT BREAKER, VISITORS TRAILER	40A	SQUARE D	—	—	—	—
52-4	CIRCUIT BREAKER, LTG.	100A	SQUARE D	—	—	—	—
52-5	CIRCUIT BREAKER, SPARE	20A	SQUARE D	—	—	—	—
SW # 12489	VAC. BRKR, 12.47KV MAIN FEEDER	600A	HUGHES-EDISON	CME	—	(11)	ELECTRONIC TRIP
52-7	CIRCUIT BREAKER, EMT-1 FEEDER	175A	SQUARE D	MEL	236LS1G	(8)	SWAT TRIP
52-8	CIRCUIT BREAKER, EMT-2 FEEDER	175A	SQUARE D	MEL	236LS1G	(9)	SWAT TRIP
59N-1	12KV FOR GROUND FAULT OVER VOLT.	0-12V	BASLER	BEI-59H	ASE-E1J-0527	(7)	DEFINITE TIME
810/U-1	SYST. OVER/UNDER FREQUENCY	40-100% 120V	BASLER	BEI-810/U	1X-E1J-470P	(7)	DEFINITE TIME
ATD	CURRENT TRANSDUCER	0-6.5A	SQUARE D	CLE	CLE-20231	—	12KV, US-1 EMT-1, EMT-2
KWH7	WATT HOUR AND VAR HOUR	25-135V	SCIENTIFIC COLUMBUS	JEM-1	JEM603-T-F	—	12KV, US-1 EMT-1
VTD	VOLTAGE TRANSDUCER	0-180V	SQUARE D	CLE	CLE-201031	—	12KV, US-1 EMT-1
W/VTD	WATT/VAR TRANSDUCER	0-10A	SQUARE D	CLE	CLE-208004	—	12KV, US-1 EMT-1, EMT-2
PO NODE	POWER QUALITY ANALYZER	—	BHI	8010	—	—	—

```
PRG NAME: 478562.DAY  TYPE F PROJ: ENTN
```

CONTRACTOR: VEGA ENGINEERING INC

[illegible]

TABLE OF DEVICES

DEVICE NO.	FUNCTION	RATING	MFR	TYPE	CATALOG OR REF. DWG.	REMARKS
25	SYNCHRONISM CHECK RELAY	—	DECC	—	—	SEE NOTE 1
26	INVERTER OVER TEMPERATURE	—	DECC	—	—	—
27/59	UNDER/OVER VOLTAGE RELAY	—	DECC	—	—	—
51V	OVERCURRENT WITH VOLTAGE CONTROL RELAY	—	DECC	—	—	—
81 U/O	UNDER/OVER FREQUENCY RELAY	—	DECC	—	—	—
51	FUSED DISCONNECT SWITCH, PCU OUTPUT	600VAC, 60AMP	G.E.	TH3362	—	45AMP FUSE
52	FUSED DISCONNECT SWITCH, PCU AUX.	600VDC, 30AMP	G.E.	TH3361	—	12 AMP FUSE
52	ARRAY DC GROUND FAULT INDICATOR	—	DECC	—	—	—
GF1	ARRAY MAIN DISCONNECT SWITCH	600VDC, 30AMP	SO D	HU	HU-364RB	NEUTRAL IS SWITCHED
DCSW	PV ARRAY MAIN DC CIRCUIT BREAKER	100A, 250V	SO D	FAL	FAL-34100	SOLAREX PV CIRCUIT
52-E201 THRU 52-E304	SOURCE CIRCUIT-CIRCUIT BREAKER	25A, 500V	HEINEMANN	GH6	GH6-23-1	SOVONICS PV CIRCUIT
89-E101 AND 89-E102	SOURCE CIRCUIT DISCONNECT SW.	60A, 600V	G.E.	THN	THN2262DC	ARCO PV CIRCUIT
89-E201 THRU 89-E214	SOURCE CIRCUIT DISCONNECT SW.	5A, 250V	ELECTRO SWITCH	—	101102AA-2A-CODE 5	SOLAREX PV CIRCUIT
89-E401	PV ARRAY MAIN DC DISCONNECT SW.	100A, 250V	SO D	—	M223	UPG PV CIRCUIT
89-E501 THRU 89-E503A	SOURCE CIRCUIT DISCONNECT SW.	60A, 600V	SO D	—	H262	ENTECH PV CIRCUIT

LEGEND

- ↑ DRAWOUT OR RACKOUT DEVICE
- ⏏ CONTACTOR
- 1-3B TRANSducer, THREE-PHASE, 3-ANALOG OUTPUT TO DATA ACQUISITION SYSTEM
- A - CURRENT
W - WATT
KWHR - KILOWATT-HOUR
- ⏏ GROUND
- ⏏ FUSED DISCONNECT SWITCH
- MOV, METAL OXIDE VARISTOR

NOTE

1. DEVICE FUNCTION THAT IS INCORPORATED IN THE PCU PROTECTIVE CIRCUIT, NOT A PROTECTIVE RELAY AS SYMBOLIZED.

DWG. NO.

478561
INC. SC-031-11
ES, SOLAREX SC-035-10
CONNECT BOX, P.O. 0208-3-111
R GROUP SC-032-11
ENTECH INC. SC-033-56-111

REVISIONS	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			

REVISIONS	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			

ELECTRICAL - 480V SINGLE LINE
METER & RELAY DIAGRAM
EMERGING MODULE TECHNOLOGY #1
PVUSA DAVIS
DEPARTMENT OF ENGINEERING
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

478562
5

POWER CONVERSION UNIT #6

PCU #6

AUXILIARY POWER
TRANSFORMER
5KVA, 480/120V.
AND DIST. PNL.
(FOR CONTROL &
LINE SENSING)

5-CKT-BRKR
FEEDERS FROM DIST.
PANEL TO BE USED
BY PC&E

30KVA, 3Ø, 60HZ
H.V. 480V
L.V. 480V

INVERTER

CONTACTOR $\overline{\text{T}}$

1-3/C, #2/0 AWG.
1-1/C #6 AWG.

DCSW6
MAIN DC
DISC. SWITCH
(3-POLE, 200A, 600VDC)
(TYPICAL)

FUTURE
JB #6

FUTURE
PHOTOVOLTAIC
ARRAYS
20KW

UNIT
DESCR:
EXT: 243-9305
REV. BY:
DATE:
CONTRACTOR: V

```

PRJ NAME: 478563.DAY TYPE F PROJ: ENT2

```

DATE: _____
CONTRACTOR: VEGA ENGINEERING INC.

No.	Date	Description
		REVIEW

REVISED

TABLE OF DEVICES

DEVICE NO.	FUNCTION	RATING	MFR	TYPE	CATALOG OR REF. DWG.	REMARKS
25	SYNCHRONISM CHECK RELAY	—	DECC	—	—	SEE NOTE 1
26	INVERTER OVER TEMPERATURE	—	DECC	—	—	—
27/59	UNDER/OVER VOLTAGE RELAY	—	DECC	—	—	—
51V	OVERCURRENT WITH VOLTAGE CONTROL RELAY	—	DECC	—	—	—
81 U/O	UNDER/OVER FREQUENCY RELAY	—	DECC	—	—	—
S1	FUSED DISCONNECT SWITCH, PCU OUTPUT	600VAC, 60AMP	G.E.	TH3362	—	45 AMP FUSE
S2	FUSED DISCONNECT SWITCH, PCU ADR.	600VDC, 30AMP	G.E.	TH3361	—	12 AMP FUSE
GFI	ARRAY DC GROUND FAULT INDICATOR	—	DECC	—	—	SEE NOTE 1
DCSW	ARRAY MAIN DISCONNECT SWITCH	600VDC, 30AMP	SG D	HJ	HJ-364RB	NEUTRAL IS SWITCHED

LEGEND

NOTE

1. DEVICE FUNCTION THAT IS INCORPORATED IN THE PCU PROTECTIVE CIRCUIT, NOT A PROTECTIVE RELAY AS SYMBOLIZED.

REFERENCES

DWG. NO.

1. MAIN SINGLE LINE DIAGRAM 478561

NO.	DATE	DESCRIPTION	CHWSPEC	DWN	CHG	SUPP	APPROVED BY	NO.	DATE	DESCRIPTION	CHWSPEC	DWN	CHG	SUPP	APPROVED BY
1	11-15-77	REVISION PER AS - BUILT						2	11-15-77	ISSUED FOR CONSTRUCTION - SC-01091					

ELECTRICAL - 480V SINGLE LINE
METER & RELAY DIAGRAM
EMERGING MODULE TECHNOLOGY #2
PVUSA DAVIS
DEPARTMENT OF ENGINEERING
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

PROJECT NO.	478561
DWG. LIST	063117
SHEET NO.	1
TOTAL SHEETS	1

Appendix E
FIELD WET RESISTANCE TEST

FIELD WET RESISTANCE TEST

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NOTE:

BARS IN RH MARGIN INDICATE REVISED TEXT

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FIELD WET RESISTANCE TEST

1. INTRODUCTION

The Field Wet Resistance Test (FWRT) consists of spraying a conductive water solution on a portion of an installed PV system and measuring the leakage resistance between the PV dc circuit and ground.

2. OBJECTIVE

The Field Wet Resistance Test is a test of the insulation on an installed PV system. It is conducted to detect leakage paths to ground that may lead to system malfunction or result in damage to the modules and other parts of the system. The FWRT also confirms the results of factory Quality Control inspections of the modules.

The FWRT can indicate whether portions of the high voltage dc circuit are exposed due to damaged modules (e.g., cracked glass, punctured cover materials), damaged wiring, unsealed connectors or other possible leakage current paths. However, it should be noted that modules and systems successfully passing the FWRT may become damaged a short time after the test and become unsafe to touch. Thus, passing the FWRT does not relieve personnel from following established electrical safety procedures. The test is not intended to measure the leakage resistance of the modules, although an allowable leakage resistance is used in determining the pass/fail criterion for the test.

3. BACKGROUND

Concern over the insulation of PV circuits from their surroundings dates to the first uses of solar cells. Space craft applications led to testing that included use of a wet sponge to form a contact in testing for dielectric breakdown and pinholes in insulating materials [1]. JPL's Low-Cost Silicon Solar Array (LSSA and later LSA) Project for terrestrial applications developed testing methods that include dielectric breakdown and insulation resistance tests to ensure electrical safety for personnel. Criteria for passing these tests included no signs of arcing at 1500 V_{dc} and a leakage resistance greater than 100 M Ω between the cells and module frame or mounting structure [2,3]. Later JPL and SERI versions [4,5] revised the leakage resistance to a leakage current $\leq 50 \mu\text{A}$, but the tests were still performed with the module dry. In work for JPL, Bechtel proposed covering modules with a conductive solution for both the breakdown and resistance tests [6]. This was incorporated into both the module qualification tests and field wet resistance test for the first (and subsequent) PVUSA procurement specification [7]. The commercial advent of amorphous silicon power modules led to the development of a corrosion susceptibility test in which leakage resistance was measured as the modules were thoroughly wet [8]. The SERI Interim Qualification Test also included this test [9]. The process of refining these tests is still continuing and efforts are underway to develop IEEE/ASTM Standards.

The major difference between the above cited qualification tests and the FWRT is that the qualification tests measure one module while the field test measures many electrically active modules. Additionally, the meter reading represents a number of leakage paths that include the several modules and wiring in the section under test. With the factory tests, one module (usually with the terminals shorted) is measured and leakage resistance can be read directly on a meter. With the FWRT, the meter reading must be corrected to account for the voltage of the several modules under test.

4. PASS/FAIL CRITERION

The pass/fail criterion is that each module, when thoroughly wet, shall have a leakage current less than 50 μA at twice the system voltage to ground plus 1000 volts. In implementing the FWRT, this is translated into an equivalent resistance:

$$R_{\text{LEAKAGE}} = \frac{2 \cdot V_{\text{SYSTEM}} + 1000}{50 \cdot 10^{-6}} \quad (1)$$

where:

R_{LEAKAGE} is the equivalent allowable minimum leakage resistance of one module, and
 V_{SYSTEM} is the operating voltage between the dc system and ground.

5. METHODOLOGY

For the FWRT, a number of modules are disconnected and isolated from the rest of the PV system to form a test section. It has generally been found convenient to use a series-connected string of modules such as a half a source circuit or monopole for the test section. A megohmmeter (megger) is connected in series between one side (pole) of this test section and ground. The positive terminal of the megger is connected to the negative terminal of the test section. As a result, the first module (connected to the megger) is at the megger voltage with respect to ground. The second module is at the megger voltage plus the first module's open-circuit voltage. The series-connected modules in the test section are at progressively higher voltages to ground, with the last module being at the megger voltage plus the test section open-circuit voltage to ground. At the higher voltages, a module will have a higher leakage current since the module leakage resistance is (assumed to be) constant.

Meggers are customarily not used to measure the resistance of circuits that contain active voltage sources, such as modules in sunlight, and are calibrated for their own internal voltage sources. Thus, in the field wet resistance test, a means must be used to account for the fact that the modules are at voltages above the megger voltage and to translate the megger scale reading into leakage resistance. Equation 2 gives the allowable minimum megger reading, R_M , for the allowable single-module leakage resistance given by Equation 1. The derivation of Equation 2 is in Appendix A.

$$R_M = \frac{2 \cdot V_{MEGGER} \cdot R_{LEAKAGE} / N - V_{OC} \cdot R_{MEGGER}}{2 \cdot V_{MEGGER} + V_{OC}} \quad (2)$$

where:

- R_M is the allowable minimum megger reading for the section under test,
- $R_{LEAKAGE}$ is the leakage resistance or allowable leakage resistance per module,
- V_{MEGGER} is the open-circuit voltage of the megger,
- R_{MEGGER} is the internal resistance of the megger,
- V_{OC} is the open-circuit voltage of section under test, and
- N is the number of modules in the test section.

A separate and individual calculation is required for each photovoltaic system to be tested. In practice, the allowable megger reading, R_M , is reduced by 10 percent as an allowance for leakage currents through wiring and other areas of the circuit. Also, R_M is plotted as a function of V_{OC} so as to account for temperature effects and the actual V_{OC} measured in the field at the time of the test. The internal resistance of the megger used at PVUSA changes with the scale used, which is taken into account by separate lines on the graph, one for each measured R_{MEGGER} .

The number of modules to be tested at one time, N , is limited by the fact that calculated pass/fail acceptance level of resistance to ground should not be much less than 100,000 ohms for the megger used.

In continuing efforts to refine module qualification testing and develop standards, the PV industry has debated whether the pass/fail allowable module resistance or leakage current should be normalized to module area or perimeter. For the variety of modules installed in the PVUSA Project, this would produce some variation in the pass/fail criterion that has been previously used. However, it would not have affected the outcomes of the field wet resistance tests. In all such tests at PVUSA to date, the installed systems have either passed or failed the FWRT by a significantly wider margin.

6. EQUIPMENT

The equipment listed below has been used by PVUSA in performing the FWRT. Other similar equipment and models might also be used.

- High-impedance megohmmeter (megger)
- Wetting solution (water and surfactant)
- Conductivity meter
- Tank/pump/sprayer unit to wet the array
- Protective goggles, rubber gloves, rubber boots, oilskin slicker
- Data sheet to record resistance readings and other data
- Tools as needed to disconnect and reconnect the array wiring

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6.1 Megger

The megger used by PVUSA is the model 400-2 manufactured by Simpson. This megger has three ranges: 0 to 0.4 M Ω , 0.01 to 5 M Ω and 2 to 200 M Ω . It includes test leads. Further data on this unit are shown in Appendix B. The unit is battery operated and spare batteries should be kept in reserve.

Key parameters for this unit are an open-circuit voltage (V_{MEGGER}) of 665 volts_{DC} and internal resistances (R_{MEGGER}) of 0.15 M Ω for the 0 to 0.4 M Ω scale and 0.25 M Ω for the 0.01 to 5 M Ω and 2 to 200 M Ω scales. These parameters are used in Equation 2 and would change if a different megger were to be used.

6.2 Wetting Solution

The wetting solution used by PVUSA at the Davis Site is well water with a surfactant (detergent) added to decrease the surface tension of the water so as to improve its "sheeting" action and its ability to penetrate small cracks in insulation. The wetting solution used by PVUSA is 1 part in 500, approximately 1/4 ounce of Liqui-nox detergent per 1 gallon of water or 3 pints of Liqui-nox per 250 gallons of water. This dilution has been found to produce adequate sheeting action.

Liqui-nox detergent is manufactured by Alconox, Inc. (catalog #C6308-2). This product contains no phosphates and is nontoxic. The manufacturer's Material Safety Data Sheet indicates that there are no ingredients which appear on OSHA hazardous products lists and the product may be handled with normal industrial hygiene and safety practices for industrial chemicals. Further information on Liqui-nox is in Appendix B. If other surfactants are used, they should be checked for toxicity, biodegradability, etc. before use.

6.3 Conductivity Meter

PVUSA uses a conductivity meter to verify the quality of the well water. Water with a conductivity of 6000 micro-siemens/m (1 $\mu\text{S} = 1/10^6$ ohms) and above should not be used. The conductivity meter used by PVUSA is a Cole-Palmer model #1481-55. It is powered by a 9-volt battery. It has ranges of 199.9 to 1999 μS and 19.99 to 199.9 μS , with an accuracy of $\pm 1\%$ full scale, ± 1 digit. The meter is calibrated against a standard calibration solution (Cole-Palmer #1481-52) which has a conductivity value of 12.88 $\mu\text{S}/\text{cm}$ at 25 °C.

6.4 Sprayer

A means is needed to bring the wetting solution into the array field. PVUSA uses a 500-gallon capacity water trailer (Aqua Trans Model #WT 550-c) to mix, store and transport the wetting solution. The water trailer is towed behind a pickup truck and is equipped with a 50-foot filler hose (with fire hydrant fitting) and a 100-foot one-inch hose with nozzle and fittings. The water trailer has a gasoline powered pump to deliver the contents. A

car wash wand (with a Borden water pressure gage) is attached to the one- inch hose. The spray pattern is adjustable and a shutoff valve is used to control flow.

In addition, a small spray bottle or garden sprayer and visual inspection are occasionally used to precisely locate faulted/damaged areas which have caused a FWRT fail condition.

6.5 Personnel Protection

The low concentration of wetting agent is not harmful; it is many times weaker than household detergents in common use. However, protective gear is worn as a protection against the possibility of electrical shock. Gloves with a 1000-volt rating (ASTM D120 Class 0 Type 1) must be worn to touch any part of the array or structure and to connect/disconnect the megger or source circuit wiring. Other equipment for protection of personnel includes a hard hat, protective goggles, rubber boots, and slicker.

6.6 Pass/Fail and Test Data

For convenience, PVUSA practice has included preparing a graph of Equation 2 for the PV system to be tested. The graph incorporates the pass/fail criterion of Equation 1, the characteristics of the megger, and the planned number of modules per test section. The one remaining element in Equation 2, open-circuit voltage, is the independent variable on the graph and is measured in the field as part of the test to determine the pass/fail reading on the megger. A representative graph is shown in Figure 1, below.

Figure 1 Representative Graph of Pass/Fail Megger Reading Versus Voltage

In addition, it has been found convenient to use a form to record data from the test. The data form also aids in insuring that all elements of the test are performed. A representative data form is shown on the next page.

Portions of the data are not essential to the FWRT, but are recorded to provide information that would be difficult to retrieve at a later date should questions arise. As indicated on the form, PVUSA practice includes attaching a printout from the on-site Data Acquisition System (DAS) to provide meteorological data.

7. SAFETY

The human body is about five times more tolerant of direct current (dc), such as generated by photovoltaic modules, than it is of alternating currents (ac). Voltages below 25 volts dc are generally considered safe to touch. Depending on the person and conditions (e.g., wet hands), 50 to 100 volts dc may cause a severe shock.

Photovoltaic modules are always energized when they are exposed to light. Even dim light on an overcast day can result in the full voltage being present on the modules and system. There is no way to completely de-energize a photovoltaic system except by covering the entire system or waiting for night. Even if the module or circuit terminals are shorted, there is still a possibility of having the full open-circuit voltage across an undetected break in the wiring or elsewhere. The modules may become damaged during shipping or installation. Previous experience has shown that such damage can expose internal electrical parts to the point where personnel contact is possible, particularly if the module is wet. The wires and terminals in junction boxes will have the pole to ground and pole to pole voltages present at any time there is light on the modules.

Modules and systems successfully passing the wet megger test may still be damaged at some time after the test and become unsafe. Because of this possible shock hazard, the area should be posted with signs warning of "DANGER - HIGH VOLTAGE", and workers and visitors alike should be warned not to touch the module surfaces or wiring.

Attention to Safety Plans and Procedures (with special emphasis on training, protective equipment and coordination with the site safety officer) cannot be overemphasized. These items must be reviewed and understood by personnel involved prior to the start of the FWRT.

Tests should be conducted under the direction of an identified test engineer or technician. Only personnel involved in the tests should be permitted to be in the test area. If necessary, barriers and warning tapes should be erected to keep observers at a safe distance. Only authorized personnel should make the required terminations. The person spraying the water should be provided with rubber gloves, rubber boots, and slicker as a protection against the possibility of electrical shock.

8. TEST PROCEDURE

The FWRT consists of two parts, preparation and implementation.

8.1 Preparation

Preparation includes evaluating the arrays to be tested in order to determine the number of modules per test section and the connections to be broken/made. For the Simpson megger used at PVUSA, the number of modules per test section should be such as to keep the allowable reading above about 100,000 ohms. Also, the number of modules should be such that it is possible to keep all of the modules in the test section wet at the same time. For testing to date at PVUSA, it has been convenient to make the test sections a monopole; a positive pole to neutral and negative pole to neutral.

It also has been found convenient to calculate and produce a graph of pass/fail megger readings ahead of time. (The pass/fail criterion may also be calculated in the field.) Pre-test activities also include ensuring the availability of personnel, requisite tools, surfactant concentrate (e.g., Liqui-nox), spare batteries for the megger and all other items needed to perform the test. It has been found desirable to have three people conduct the FWRT; for wetting the modules, one to operate the megger and one to record data.

Weather is difficult to plan. The preferred condition is a dry day (no precipitation), with little or no wind and an overcast sky. Rain tends to dilute the wetting agent and also makes it difficult to find the location of specific faults (pin holes, loose box covers, etc.). Wind and/or sun will dry the array too fast. Winds also make the spraying process more difficult to control.

8.1 Implementation

Site electrical safety rules must be followed during the FWRT.

Implementing the FWRT consists of the following steps:

1. Assemble the requisite equipment and personnel at the array to be tested.
2. Measure and record the conductivity of the water to be used. Add the surfactant to the water. Using a hose to complete the filling of the water trailer will provide mixing action. Measure and record the conductivity of the spray solution.
3. Measure and record the site meteorological conditions and/or arrange for the data to be measured by the site Data Acquisition System.
4. Clear all nonessential personnel from the array area. No one should touch the modules or arrays during the testing.

5. Isolate the circuit(s) to be tested. Depending on the design of the PV system, this may involve opening source circuit switches, taking out removable links, or disconnecting bolted connections or connectors. All poles of the circuit to be tested (plus, minus and neutral) must be isolated. Disconnect positive and negative monopoles from each other. Ground connections among module frames, panels, array structures and system/earth ground must be left in place.

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It has been found convenient to so isolate all of the sections to be tested in a day (or half day) prior to the start of spraying the array structures.

6. Verify that MOVs or similar voltage surge protection devices are disconnected and are not part of the isolated circuits. If such devices are connected, they must be disconnected, as they would invalidate the tests and may be damaged by the test voltages.
7. Set the megger on a voltage scale. Connect the positive lead of the megger to the positive point of the circuit under test and connect the negative lead of the megger to negative point of the circuit under test.
8. Measure and record the open-circuit voltage of the circuit under test.

An open-circuit voltage reading that is substantially less than expected is an indication of a problem that should be identified. The test should proceed only after the problem has been identified and remedied.

9. Use the open-circuit voltage reading to determine the pass/fail megger reading using Equation 2 or a graph of Equation 2 (such as illustrated by Figure 1).
10. Disconnect the megger and set it on an ohm scale. Connect the positive lead of the megger to the negative point of the section of modules under test and connect the negative lead of the megger to earth ground (i.e., the array structure metal). The positive terminal of the test section of modules is left unconnected and protected so that it will not become wet and interfere with the test.

Depending on the circuit under test, it may be required to connect the negative lead of the megger to the positive point of the circuit under test, leave the circuit's negative terminal unconnected, and connect the positive lead of the megger to earth ground.

11. Measure and record the dry leakage resistance reading after the capacitive charging effect has subsided (perhaps 30 seconds). Also note any jumps in the reading which may indicate arcing.

The dry resistance reading should be higher than 500,000 ohms. If the circuit under test has a substantially lower resistance, it very likely won't pass the subsequent wet test. Further testing of any low-resistance circuit may be

postponed until the problem is identified and corrected. Alternatively, wet resistance testing may continue to attempt to locate the defect more precisely (see Step 13).

It may be convenient to measure and record the open-circuit voltages and dry resistances of several circuits to be tested at this point, before proceeding with the wet resistance testing.

12. Thoroughly wet the back (away from the sun) side of the circuit under test. A gentle rain-simulating spray should be used, which is equivalent to a diffuse spray from a low pressure garden hose. The surfactant added to the water assures that it will penetrate small crevices; it is not necessary to use a forceful stream.

The spray rate may be measured and recorded, if this is of interest. Spray into a graduated container for one minute before starting the wet-down process.

The person holding the hose should start spraying at one end of the circuit under test and wet one panel at a time while standing under adjacent dry panels.

Care should be taken not to get water into the interior of the interface junction boxes, the power conditioning unit, the megger, or similar items which are not under test. Also, try to avoid wetting adjacent modules and panels, as this would interfere with subsequent Step 11 dry resistance measurements.

13. While the entire test section is wet, measure and record the wet leakage resistance reading after the capacitive charging effect has subsided (perhaps 30 seconds). Also note any jumps in the reading and the area being sprayed at that time to provide an indication of the location of defects.

When such defects are found, practice has been to attempt to locate the defect more precisely by watching the megger reading while spraying small areas of the circuit under test. It has been found convenient to use a small garden sprayer or spray bottle (filled from the water trailer) for this purpose.

14. Repeat steps 12 and 13, while wetting the front (sun) side of the circuit under test.
15. Repeat steps 7 through 14 for the other test section circuits to be tested. Observe appropriate polarities for the megger connection.
16. Wiring disconnected for the testing should be replaced. Circuits found to have defects may be left isolated, pending repairs.
17. The spray may leave a thin residual film. If necessary, this may be rinsed from the face of the modules after completing the test.

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If the wet leakage resistances are above the pass/fail criterion for each circuit tested, the PV system has successfully passed the FWRT. If the wet leakage resistance of any of the circuits tested is below the pass/fail criterion, the PV system has failed FWRT. The defect(s) must be corrected and the repaired portions of the system will then be re-tested.

In practice, it has been found that all of the circuits tested either pass or fail the FWRT by a wide margin. For most of the failures, it has been possible to precisely locate the defect with the FWRT. Defects found include pinholes (or larger holes) in module laminate materials due to manufacturing and material problems, and other holes very likely caused during field installation. Defective wiring, pottant, junction boxes and other items have also been detected by the FWRT. X

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Appendix A
DERIVATION OF EQUATIONS FOR
THE FIELD WET RESISTANCE TEST

Appendix A

DERIVATION OF EQUATIONS FOR THE FIELD WET RESISTANCE TEST

The Field Wet Resistance Test, FWRT, includes use of a megohmmeter (megger) to measure the resistance between ground and the dc circuit of several series-connected modules (e.g., half a source circuit or monopole). Ordinarily, meggers are not used to measure the resistance of circuits that contain active voltage sources, such as modules in sunlight, and are calibrated for their own internal voltage sources. The active sources in the circuit under test must be taken into account and an equation must be used to translate scale readings on the megger into leakage resistances.

In practice, the FWRT procedure has been to calculate an allowable (pass/fail) megger reading for use in the field. The pass/fail criterion is that a module, when thoroughly wet, have a leakage current less than 50 μA at twice the system voltage to ground plus 1000 volts. This is converted into an equivalent resistance:

$$R = \frac{2 V_{\text{SYSTEM}} + 1000}{50 \cdot 10^{-6}} \quad (\text{A-1})$$

where:

R is the equivalent leakage resistance of a module, and

V_{SYSTEM} is the operating voltage between the dc system and ground.

Equation A-2 gives the allowable megger reading, R_M , for the allowable single-module leakage resistance given by Equation A-1.

$$R_M = \frac{2 V_{MO} \frac{R}{N} - V_{OC} R_i}{2 V_{MO} + V_{OC}} \quad (\text{A-2})$$

where:

R is the leakage resistance or allowable leakage resistance per module,

V_{MO} is the open-circuit voltage of the megger,

R_i is the internal resistance of the megger, and

V_{OC} is the field-measured open-circuit voltage of N series-connected modules.

The derivation of Equation A-2 follows.

During the FWRT, the modules being tested are disconnected from the rest of the PV system and are open circuited. For purposes of the FWRT, each module is represented as a voltage source, V , with a leakage resistance to ground, R . The leakage currents are assumed to be equally distributed on both module terminals, as indicated by the module equivalent circuit shown in Figure A-1.

Figure A-1 Equivalent Circuit

Additional assumptions include:

- all of the modules have identical open-circuit voltages and leakage resistances,
- the current through a module during the test is negligibly small so that the module can be considered to have open-circuit voltage across its terminals,
- the modules and measurement system exhibit linear behavior for the parameter values experienced during the FWRT, and
- the resistance of the sheet of water used to wet the modules and of the connections among components of the ground circuit (module frames, array structure, etc.) is negligibly small compared to the module leakage resistances.

The megger is connected between one side of the series string of modules and ground. The positive terminal of the megger is connected to the negative terminal of the series-connected modules. As a result, the first module (connected to the megger) is at the megger voltage with respect to ground. The second module is at the megger voltage plus the module open-circuit voltage. The modules along the series-connected string are at progressively higher voltages to ground, with the last module being at the megger voltage plus the circuit voltage to ground. At a higher voltage to ground, a module has a higher leakage current. The equivalent circuit for the megger and series string of N modules under test is shown by Figure A-2.

Figure A-2 FWRT Measurement Equivalent Circuit

The parallel connection of two adjacent leakage resistances of $2R$ is combined into a single resistance, R , except for the two end modules (1 and N).

As indicated by Figure A-2, the megger is assumed to be a voltage source, with an internal resistance. The megger open-circuit voltage, V_{MO} , and internal resistance, R_I , must be measured prior to the FWRT and calculation of an allowable megger reading from Equation A-2.

With conventional use, the megger-produced voltage, V_M , across an unknown resistance and current, I_M , through this resistance result in a megger scale reading that gives the correct (calibrated) value for the resistance being measured. For the FWRT, the effect of the active elements (PV modules) on V_M and I_M must be determined and the allowable

leakage resistance per module, R , must be related to the resistance indicated on the megger scale.

Because of previous work [6], loop equations for Figure A-2 were solved to obtain the desired relationship. Other methods can be used to obtain the same result.

Referring to Figure A-2, the equation for the first loop is given by Equation A-3:

$$V_M = 2 R I_M - 2 R I_1 \quad (\text{A-3})$$

Rearranging gives:

$$R I_1 = R I_M - V_M / 2 \quad (\text{A-4})$$

The second loop results in Equation A-5:

$$V = -2 R I_M + 3 R I_1 - 2 R I_2 \quad (\text{A-5})$$

Substituting $R I_1$ from Equation A-4 into Equation A-5 and rearranging gives:

$$R I_2 = R I_M - 3/2 V_M - V \quad (\text{A-6})$$

The third loop results in Equation A-7:

$$V = -R I_1 + 2 R I_2 - R I_3 \quad (\text{A-7})$$

Substituting $R I_2$ from Equation A-6 into Equation A-7 and rearranging gives:

$$R I_3 = R I_M - 5/2 V_M - 3 V \quad (\text{A-8})$$

The fourth loop results in Equation A-9:

$$V = -R I_2 + 2 R I_3 - R I_4 \quad (\text{A-9})$$

Substituting $R I_3$ from Equation A-8 into Equation A-9 and rearranging gives:

$$R I_4 = R I_M - 7/2 V_M - 6 V \quad (\text{A-10})$$

The fifth loop results in Equation A-11:

$$V = -R I_3 + 2 R I_4 - R I_5 \quad (\text{A-11})$$

Substituting $R I_4$ from Equation A-10 into Equation A-11 and rearranging gives:

$$R I_5 = R I_M - 9/2 V_M - 10 V \quad (\text{A-12})$$

Continuing this process results in the general Equation A-13 for the Kth loop:

$$R I_K = R I_M - \frac{(2K-1)}{2} V_M - \frac{K(K-1)}{2} V \quad (\text{A-13})$$

The last (Nth) loop results in Equation A-14:

$$V = -R I_{N-1} + 3 R I_N \quad (\text{A-14})$$

Using Equation A-13 with $K = N-1$ in Equation A-14 gives:

$$V = -RI_M + \frac{2(N-1)-1}{2}V_M + \frac{(N-1)(N-2)}{2}V + 3RI_M - \frac{3(2N-1)}{2}V_M - \frac{3N(N-1)}{2}V \quad (A-15)$$

which simplifies to:

$$0 = 2RI_M - 2NV_M - N^2V \quad (A-16)$$

There are N series-connected modules. Each has an open-circuit voltage of V . To correct for temperature variations, the open-circuit voltage of the series string, V_{oc} , is measured as part of the FWRT and $V_{oc} = NV$. Substituting this into Equation A-16 and rearranging yields:

$$V_M = \frac{NV_{oc}}{2R/R_M + 2N} \quad (A-17)$$

As mentioned, the megger is constructed and calibrated so that a voltage of V_M is produced across a connected external resistance, a current of I_M flows through the resistance and R_M is measured (indicated) on the megger scale. That is:

$$R_M = V_M / I_M \quad (A-18)$$

Further, the megger is assumed to be a voltage source, with an internal resistance. The megger has an open-circuit voltage of V_{MO} and internal resistance of R_I that are measured and known (for the megger used in the FWRT). Examination of the first (left) branch of the circuit in Figure A-2 shows that:

$$V_M = V_{MO} - I_M R_I = \frac{V_{MO} R_M}{R_M + R_I} \quad (A-19)$$

Setting Equation A-17 equal to Equation A-19 gives:

$$\frac{NV_{oc}}{2R/R_M + 2N} = \frac{V_{MO} R_M}{R_M + R_I} \quad (A-20)$$

Multiplying gives:

$$(R_M + R_I)NV_{oc} = (2R/R_M + 2N)V_{MO}R_M \quad (A-21)$$

Collecting coefficients of R_M and dividing yields:

$$R_M = \frac{2V_{MO} \frac{R}{N} - V_{oc} R_I}{2V_{MO} + V_{oc}} \quad (A-22)$$

which is the result sought. R_M is the reading on the megger scale when the leakage resistance for each of the N series-connected identical modules is R . The open-circuit voltage of the N series-connected modules, V_{oc} , is measured during the FWRT. V_{MO} and R_I are characteristics of the megger, which are determined prior to the FWRT.

Appendix B
MEGGER AND SURFACTANT DATA

Simpson

MODEL 401

MODEL 400-2

MODEL 401 1000VDC BATTERY-OPERATED INSULATION TESTER

- Test Insulation to 1000VDC
- Four Switchable Test Voltages — Neon Range Selection Indication
- Makes Continuity Checks
- Measures AC/DC Voltage Up to 1000V

Model 401 is the precise instrument for insulation tests. Battery-saver pushbutton operation uses battery only during actual measurements. Light-up probe illuminates measuring point to provide quick visual insulation checkout. **SPECIFICATIONS.** Accuracy: Resistance ranges $\pm 1.5\%$ fs length. Voltage Ranges: $\pm 1.5\%$ fs. Supply: Six 1.5V batteries. Rated voltage 9V. Continuity Testing: Lamp operating point: In the range of 100 to 1000 Ω . Open circuit voltage: Approximately 5VDC. Internal Resistance: Approximately 1K Ω . Dimensions: 9.6x5.5x4.13" (245x140x105mm). Weight: 4.9 lbs. (2.2kg). Complete with batteries, permanently connected leads, carrying strap and manual. 919-0401. Type 12502.

MODEL 400-2 BATTERY-OPERATED INSULATION TESTER

Tests insulation to 500VDC and measures AC/DC voltage to 600V. Model 400-2 tests continuity in low resistance circuits. It has a special "Indicator" probe that illuminates the measuring point for quick visual checkout. Battery-saver pushbutton operation uses battery only during actual measurements. **SPECIFICATIONS.** Resistance Ranges: (1) 0 to 0.4M Ω , open circuit voltage 665V, internal resistance 0.25M Ω . (2) 0.01 to 5M Ω , open circuit voltage 665V, internal resistance 0.15M Ω . (3) 2 to 200M Ω , open circuit voltage 665V, internal resistance 0.15M Ω . Accuracy: $\pm 1.5\%$ of fs length. Voltage Range: 0 to 600V AC/DC. Internal Resistance: Approximately 0.2m Ω . Continuity Range: 0-4 Ω . Open circuit voltage approximately 5VDC. Supply: Six 1.5V batteries. Rated voltage 9V. Size: 5.6x4.6x3.2" (141x117x90mm). Weight: 3.5 lbs. (1.65kg). Complete with batteries, permanently attached three-foot connecting leads, carrying strap and manual. 919-0402. Type 12509.

ALCONOX, Inc.

215 PARK AVENUE, SO.
NEW YORK, N. Y. 10003

Tel. 473-1300 • Area Code 212

Cable Address: "ALCONOXINC NEW YORK"

★ DETERGENTS FOR LABORATORIES ★ HOSPITALS ★ INDUSTRY

FAX: 212-353-1342

TECHNICAL INFORMATION BULLETIN # 4 - LIQUI-NOX

LIQUI-NOX®

Phosphate free

The perfect liquid detergent.

LIQUI-NOX has all the advantages of powdered Alconox with the added convenience of a liquid. It was developed to meet the many requests for a detergent that was free from phosphates. Its superior qualities have prompted many of our LIQUI-NOX users to refer to this detergent as "the perfect liquid detergent".

LIQUI-NOX is a special formulation of anionic and non-ionic detergents and wetting agents. It has high cleaning power, yet it is mild (pH 8.0-8.6). Whether you use it in hot or cold water or in soft or hard water, LIQUI-NOX is completely soluble. Its fast wetting action and high foaming power provides aggressive detergency for the spotless cleaning of glass, metal, rubber, plastic and hard-surface materials. Among its many special uses, LIQUI-NOX is ideal for E.E.G. laboratories, (write for full details) respiratory equipment and phosphate research cleaning. Like its powdered counterpart, Alconox, LIQUI-NOX can be used safely on metal instruments.

"Where Perfection Depends On Cleanliness — Cleanliness Depends on ALCONOX Detergents"

XX

LIQUI-NOX CHEMICAL DESCRIPTION & TECHNICAL DATA

LIQUI-NOX consists of a balanced blend of linear alkyl aryl sulphonates, sodium xylene sulphonates, and alkanolamide, and a nonylphenoxypoly (ethyleneoxy) ethanol. All of these materials are biodegradeable. There are no phosphates present. LIQUI-NOX is a special formulation of anionic and non-ionic detergents and wetting agents.

ALL ALCONOX PRODUCTS ARE BIODEGRADABLE

Material Safety Data Sheet
May be used to comply with
OSHA's Hazard Communication Standard,
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY (As Used on Label and List)

LIQUI-NOX

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name

ALCONOX, INC.

Emergency Telephone Number

(212) 473-1300

Address (Number, Street, City, State, and ZIP Code)

215 PARK AVENUE SOUTH

Telephone Number for Information

(212) 473-1300

NEW YORK, NEW YORK 10003

Date Prepared

JULY 1, 1987

Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))

OSHA PEL

ACGIH TLV

Other Limits
Recommended

% (optional)

THERE ARE NO INGREDIENTS IN LIQUI-NOX WHICH APPEARED ON THE OSHA STANDARD
29 CFR 1910 SUBPART Z.

Section III — Physical/Chemical Characteristics

Boiling Point

214°F

Specific Gravity (H₂O = 1)

1.075

Vapor Pressure (mm Hg.)

NO DATA

Melting Point

N.A.

Vapor Density (AIR = 1)

NO DATA

Evaporation Rate

(Butyl Acetate = 1)

NO DATA

Solubility in Water

COMPLETELY SOLUBLE IN ALL PROPORTIONS

Appearance and Odor

YELLOW LIQUID - PRACTICALLY ODORLESS

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)

NONE (CLEVELAND OPEN CUP)

Flammable Limits

LEL

N.A.

UEL

N.A.

Extinguishing Media

WATER, DRY CHEMICAL, FOAM, CO₂, SAND/EARTH

Special Fire Fighting Procedures

FOR FIRES INVOLVING THIS MATERIAL, DO NOT ENTER WITHOUT

PROTECTIVE EQUIPMENT AND SELF CONTAINED BREATHING APPARATUS.

Unusual Fire and Explosion Hazards

NONE

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid	NONE
	Stable	XX		

Incompatibility (Materials to Avoid) NONE

Hazardous Decomposition or Byproducts SO₂ MAY BE RELEASED ON BURNING

Hazardous Polymerization	May Occur		Conditions to Avoid	NONE
	Will Not Occur	XX		

Section VI — Health Hazard Data

Route(s) of Entry: Inhalation? NO Skin? YES Ingestion? YES

Health Hazards (Acute and Chronic) SKIN CONTACT MAY PROVE LOCALLY IRRITATING.
INGESTION MAY CAUSE DISCOMFORT AND/OR DIARRHEA.

Carcinogenicity: NTP? NO IARC Monographs? NO OSHA Regulated? NO

Signs and Symptoms of Exposure PROLONGED SKIN CONTACT MAY CAUSE DRYING AND/OR CHAPPING.

Medical Conditions Generally Aggravated by Exposure NONE

Emergency and First Aid Procedures

EYES-FLUSH WITH PLENTY OF WATER FOR 15 MINUTES. SKIN-FLUSH WITH WATER.
INGESTION-DRINK LARGE QUANTITIES OF WATER. GET MEDICAL ATTENTION FOR DISCOMFORT

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled

MATERIAL FOAMS PROFUSELY. RECOVER AS MUCH AS POSSIBLE WITH ABSORBENT MATERIAL AND RINSE REMAINDER TO SEWER. MATERIAL IS COMPLETELY BIODEGRADABLE

Waste Disposal Method

SMALL QUANTITIES MAY BE DISPOSED OF IN SEWER. LARGE QUANTITIES SHOULD BE SOAKED UP WITH ABSORBENT MATERIAL AND DISPOSED OF ACCORDING TO LOCAL ORDINANCES

Precautions to Be Taken in Handling and Storing

NONE REQUIRED -VISCOSITY OF MATERIAL INCREASES AT VERY LOW TEMPERATURES.

Other Precautions

NO SPECIAL REQUIREMENTS OTHER THAN THE GOOD INDUSTRIAL HYGIENE AND SAFETY PRACTICES EMPLOYED WITH ANY INDUSTRIAL CHEMICAL.

Section VIII — Control Measures

Respiratory Protection (Specify Type)

Ventilation	Local Exhaust	NORMAL	Special	N.A.
	Mechanical (General)	N.A.	Other	N.A.

Protective Gloves RECOMMENDED Eye Protection RECOMMENDED

Other Protective Clothing or Equipment NOT REQUIRED

Work/Hygienic Practices NO SPECIAL PRACTICES REQUIRED

Appendix F
PVUSA GROUND MEGGER PROCEDURE

PVUSA GROUND MEGGER PROCEDURE

This procedure provides for periodic testing of site grounding at PVUSA Davis, required due to site soil conditions. The test sites are located on the attached site plan. Record ground megger readings at the following locations:

Site	Location	Ohms
1	APS row 5 structure to ground	_____
2	APS row 1 structure to ground	_____
3	APS switchgear \ PVUSA to ground	_____
4	Siemens Row 7 structure to ground	_____
5	Siemens Row 5 structure to ground	_____
6	Siemens Row 1 structure to ground	_____
7	Siemens switchgear \ PVUSA to ground	_____
8	Siemens IJB to ground	_____
9	IPC switchgear \ PVUSA to ground	_____
10	IPC row 11 to ground	_____
11	IPC row 3 to ground	_____
12	EMT 1 ARCO structure to ground	_____
13	EMT 1 ARCO PCU \ PVUSA to ground	_____
14	Entech structure to ground	_____
15	Entech PCU \ PVUSA to ground	_____
16	EMT 2 structure to ground	_____
17	EMT 2 structure to ground	_____
18	EMT 2 PCU \ PVUSA to ground	_____
19	EPRI structure to ground	_____
20	EPRI trailer \ PVUSA to ground	_____
21	Pump switchgear \ PVUSA to ground	_____
22	Pumps to ground	_____
23	PG&E tracker structure to ground	_____

Completed by _____ Date _____

Appendix G
SOIL ANCHOR CORROSION TESTING DATA

TEST 1: Current measured between the anode and the anchors.
(all readings in milliamps)

TEST SITE							
	1	2	3	4	5	6	7
Anchor 1	0.015	0.573	0.472	1.921	0.013	0.001	0.241
Anchor 2	0.320	0.840	0.631	1.261	0.377	0.001	0.365
Anchor 3	0.209	0.337	0.597	0.601	0.081	0.001	0.097
Anchor 4	0.052	0.918	1.102	0.609	0.110	0.001	0.013
GN	58.58	58.48	59.34	59.22	60.31	0.06	61.72

TEST 2: Current measured between the anchors and ground with anode grounded. (all readings in milliamps)

TEST SITE							
	1	2	3	4	5	6	7
Anchor 1	0.001	0.050	0.027	0.923	0.002	0.002	0.002
Anchor 2	0.037	0.135	0.068	0.196	0.059	0.006	0.028
Anchor 3	0.015	0.032	0.030	0.123	0.027	0.003	0.010
Anchor 4	0.003	0.046	0.325	0.205	0.043	0.001	0.001

The above measurements were taken with a Fluke 45
DVM on the 100 ma range.

Testing completed on July 27, 1993.

Calculation Sheet

Testers: D. E. Gilroy (M&OS) Date 8/24/92 Calc No. _____ Rev No. _____
 Project PVUSA - Davis Job No. 19271-000 Checked _____ Date _____
 Subject Initial Soil Anchor Corrosion Rate Tests Sheet No. 1 of 7

		TEST SITE						
		1	2	3	4	5	6	7
1)	Pipe to Soil vs CSE (Open Circuit) (Vg)							
	Anchor #1	-0.286*	-0.508	-0.478	-0.692	-0.553*	-0.158*	-0.396*
	#2	-0.258	-0.430	-0.411	-0.643	-0.347*	-0.224*	-0.378*
	#3	-0.476	-0.464	-0.589	-0.616	-0.602*	-0.166*	-0.113*
	#4	-0.315	-0.315	-0.765*	-0.397	-0.608*	-0.223*	-0.370*
	Ground	-0.248	-0.279	-0.295	-0.279	-0.283	-0.257	-0.283
	Zinc Anode	-1.110	-1.090	-1.100	-1.030	-1.030	-0.999	-1.050
2)	Current w/Zinc Anode (Individual) (ma)							
	Anchor #1	0.000	0.031	0.065	0.320	0.000	0.000	0.150
	#2	0.020	0.006	0.035	0.240	0.013	0.000	0.011
	#3	0.004	0.015	0.080	0.190	0.070	0.000	0.000
	#4	0.012	0.020	0.450	0.220	0.070	0.000	0.000
	Ground	7.110	7.540	3.750	0.960	4.800	1.000	1.000
3)	Current When Bonded to Ground (No Anode) (ma)							
	Anchor #1	0.000	0.008	0.016	1.000	0.000	0.000	0.060
	#2	0.002	0.001	0.005	0.380	0.010	0.000	0.001
	#3	0.001	0.005	0.028	0.280	0.050	0.000	0.000
	#4	0.001	0.001	1.00	0.400	0.050	0.000	0.000
4)	Pipe to Soil vs CSE With All Anchors Shorted to Ground (Vg)							
	Without Anode	-0.246	-0.277	-0.295	-0.282	-0.282	-0.255	-0.275
	With Anode	-0.249	-0.283	-0.295	-0.283	-0.284	-0.255	-0.275
	Delta	-0.003	-0.006	0.000	-0.001	-0.002	0.000	0.000
	I Anode (ma)	7.130	7.530	3.750	1.100	4.840	1.020	1.100

* = Perimeter & Corner Anchors $\cong 9 \text{ ft}^2$
 Others $\cong 5 \text{ ft}^2$

Appendix H
TROUBLESHOOTING

TROUBLESHOOTING

A. US-1 (APS)

The US-1 APS system has a fixed flatplate monopolar array. The array is connected to four 125-kW inverters located in the inverter enclosure in the middle of the second row of modules. Each inverter is powered from one row of modules, plus one fourth of the northern row. The open-circuit voltage for the array is 570 Vdc, and the operating voltage is fixed at 360 V typical. The operating voltage is adjustable using a potentiometer located on the front panel of each inverter.

System operation may be monitored from meters located on the front panels of the inverters or from the data acquisition computer in the DAS room of the I&C building. To verify that the system is operating properly, check that the dc voltages for each inverter are at the operating voltage (360 Vdc). The voltage will be zero or 570 Vdc (open-circuit voltage) when the unit is shut down. The operating current will vary according to the amount of irradiance available. When all four inverters are operating, verify that the total power output of the system is approximately 428 kW at PVUSA STC.

If you find a problem, monitor the front panel of the inverters and control panel as the diagnostics will provide more information about the nature of the problem. Detailed explanations of the diagnostics, troubleshooting, safety, and repair procedures are in the APS system O&M Manual in the US-1 section of the Reference Library.

B. US-1 (IPC)

The US-1 IPC system has a one-axis active tracking, bipolar array connected to a single 200-kW inverter east of the array. The open-circuit voltage of the array is ± 485 Vdc pole-to-neutral or 970 Vdc pole-to-pole. The operating voltage varies between ± 330 and ± 395 Vdc pole-to-neutral by a peak power tracking system, which adjusts the voltage to maximize power. The inverter may also be operated in a constant voltage mode. In this mode, normally used for testing, the voltage may be adjusted with the potentiometer located inside the inverter. Peak power tracking mode is the normal operating mode.

System operation is best monitored from the data acquisition computer located in the DAS room in the I&C building. To ascertain that the system is operating properly, verify that the positive and negative dc operating voltages are within a few volts of each other and the output power is approximately 198 kW at PVUSA STC. If you find a problem with the system, monitor the LCD on the front panel of the inverter as the diagnostics will provide more information about the nature of the problem. A voltage imbalance of 10 Vdc or more between the positive and negative monopoles under clear sky conditions indicates a problem with the array. Check the operating current of each source circuit with a clamp-on ammeter. After you find the source circuit, visually inspect it for cracked glass or hot spots on the modules. The tracking system is computer-controlled and is normally reliable and accurate. If the position of the tracker is off, you may have to reset the clock. Detailed explanations of the diagnostics, troubleshooting, safety, and repair procedures are in the IPC system O&M Manual in the US-1 section of the Reference Library.

C. US-1 (SSI)

The US-1 SSI system has a one-axis passive tracking, bipolar array connected to a 100-kW inverter located in the middle of the array. The open-circuit voltage is 820-Vdc pole-to-pole, and the operating voltage is fixed and follows the ac voltage. The transformer taps are changed seasonally, resulting in 610 Vdc in summer and 670 Vdc in winter (Refer to the SSI O&M Manual for voltages under various conditions). System operation is best monitored from the data acquisition computer in the DAS room in the I&C building. To ascertain that the system is operating properly, verify that the dc operating voltages are within a few volts of each other. The operating currents will vary according to the amount of irradiance available, but all the currents should be within a few amps of each other. The output power is approximately 67 kW at PVUSA STC. If you find a problem with the system, monitor the display located on the front panel of the inverter as the diagnostics will provide more information about the nature of the problem. An array problem can be located by checking the operating current of each source circuit with a clamp-on ammeter. After you find the source circuit, visually inspect it for cracked glass or hot spots on the modules. The tracking system is a passive device controlled by solar heating of the actuator tubes, and it typically lags six degrees off the optimum position during clear, sunny weather. Detailed explanations of the diagnostics, troubleshooting, safety, and repair procedures are found in the SSI system O&M Manual in the US-1 section of the Reference Library.

D. EMT-1

The EMT-1 systems supplied by SSI, Solarex, Sovonics, and UPG are fixed flatplate arrays. The system supplied by ENTECH is a two-axis tracking concentrator. Each array is connected to its own 25-kW DECC inverter. The inverters for all EMTs are the same model. **Caution:** Although the inverters are all the same model, control boards or other components are not necessarily directly interchangeable between units. Consult the manufacturer prior to interchanging inverter parts. See Section XIV for DECC/Helionetics contact. The systems' operating voltages vary between ± 120 and ± 185 Vdc pole-to-neutral by a peak power tracking system, which adjusts the voltage to maximize power. The voltage may be adjusted with the potentiometer located inside the front window of the inverter for testing, but the peak power tracking mode is the normal operating mode. System operation is best monitored from the data acquisition computer located in the DAS room in the I&C building. To ascertain that the system is operating properly, verify that the positive and negative dc operating voltages are within a few volts. If you find a problem with the system, monitor the LED located on the front panel of the inverter as the diagnostics will provide more information about the nature of the problem. A voltage imbalance of 10 Vdc or more between the positive and negative monopoles under clear sky conditions generally indicates a problem with the array. The ENTECH tracking system is computer-controlled. If the position of the tracker is off, you may have to reset the clock or calibrate the controller. Information about each EMT array can be found in the O&M manual for the particular system in the EMT-1 section of the Reference Library. Detailed explanations of the PCU diagnostics, troubleshooting, safety, and repair procedures are found in the DECC/Helionetics O&M Manual in the EMT-1 section of the Reference Library.

Appendix I
WARRANTY PROVISIONS

PVUSA Synopsis of Warranty Provisions in PV Contracts (11)

Subcontract 19271-XX	Supplier	Date of Array Final Acceptance	General Warranty (1)	Module Warranty	Special Provisions
D31	ARCO (EMT-1)	1/6/89	Expired 12 months	Under general	12 months on corrective work (from its acceptance)
D32	UPG (EMT-1)	12/14/89	60 Months	Under general	
D33	ENTECH (EMT-1)	4/5/91	Expired 12 Months	Under general	12 months on corrective work (from its acceptance)
D34	ECD (EMT-1)	9/12/89	Expired 12 months	Under general	12 months on corrective work (from its acceptance acceptance)
D35	Solarex (EMT-1)	11/19/90	Expired 12 months	Under general-module removal/shipping costs borne by PVUSA	12 months on corrective work (from its acceptance) and (2)
D96	AstroPower (EMT-2)	Open	2 years	Additional 3 years after general warranty	
D98	APS (US-1)	12/16/92	2 years	Additional 3 years after general warranty	
D99	IPC (US-1)	4/19/93	2 years	Under general	5 years (1) on power output (.85 of accepted rating)
D100	SSI (US-1)	7/26/94	Canceled general; 2 years-PV only	Additional 3 years after general warranty (to 7/26/99)	Additional 3 years on all PV devices only (to 7/26/99)
D215	SSI	6/15/93	2 years	Additional 3 years after general warranty	

(1) From final acceptance

(2) Ten-year limited commercial warranty

(3) No active contract

Appendix J
PV PARAMETERS

PV PARAMETERS FOR PVUSA SYSTEMS

19271	PV Supplier	Technology	FP Module/Conc. Panel (STC)						SOURCE CIRCUIT (PTC)				ARRAY FIELD (PTC)					
				Out-side Area	Aper-ture Area										[3]	[4]	Out-side Area	[5]
			[1]			Watts	VOC	ISC	# of	# of	VOC (2)	ISC	# of	ISC	kW	kW		Array
			Eff. %	m ²	m ²	PMax	Volts	Amps	Modules	Panels	Volts	Amp	Src Cts	Amps	Rated PVUSA	Meas. PVUSA	m ²	Eff. % Meas.
D31	ARCO EMT-1	Microgridded Crystalline Silicon	14.1	.426	.394	60.14	22.2	3.6	200	20	405.6	36.4	2	72.77	19.2 dc	18.7 dc	170.4	11.1
D32	UPG EMT-1	Tandem Junction Amorphous Silicon	3.7	.095	.075	4.06	1.76	6.88	384	32	460	5.0	13	75.0	20.8 dc	15.7 dc	474.24	3.3
D33	ENTECH EMT-1	Linear Concentrator, Silicon Cells	18.0	---	2.79	428	19.4	24.4	20	---	470	18	3	74.4	21.5 dc	16.5 dc	---	11.3
D34	ECD EMT-1	Tandem Junction Amorphous Silicon	3.7	.414	.384	16.5	1.7	21.0	300	30	470	18	4	70.0	20.8 dc	17.3 dc	496.8	3.5
D35	SOLAREX EMT-1	Bifacial Poly-Silicon	10.5	.54	.48	57.0	20.8	3.75	24	56	480	3.82	14	53.5	20.8 dc	15.7 dc	181.44	8.6
D95 •	PHOTON EMT-2	Cadmium Sulfide/ Cadmium Telluride	6.32	.374	.319	23.63	40.2	.94	72	12	446	5.62	13	73.1	18.7 dc	--- dc	350.06	
D96	Astro-Power EMT-2	Polycrystalline Silicon Film on Ceramic Substrate	7.6	.95	.91	72.3	19.1	5.46	312	26 triples	419.45	71	1	71	19.3 dc	--- dc	296.4	
D97 *	SSI (ARCO) EMT-2	Copper Indium Diselenide	7.35	.50	.44	36.74	23.6	2.54	176	22	469	20.29	4	81	19.4 dc	--- dc	352	
D98	APS US-1	Flat-plate Fixed Amorph. Silicon, Magna Power PCU	4.06	1.23	1.16	50	57.5	1.8	2,400	240	575	388	4	1,555	400.36 ac	479 ac	11,808	4.2
D99	IPC US-1	Flat-plate, 1-axis Tracking, Mobil Solar Silicon, Omnion PCU	9.97	2.21	2.08	220.3	10.2	30.8	100	50	901	31.18	11	343	180	196 ac	2,431	8
D100	SSI (ARCO) US-1	Flat-plate, 1-axis Tracking, Crystalline Silicon, Dickerson PCU	12.9	.426	.377	55.09	7.26	10.34	496	62	820.6	41.78	8	334.22	174.3 ac	--- ac	1,690.37	

(1) Based on outside area • Contract Canceled

(2) Pole to Pole

(3) Contract

(4) ± 4% for Calibration error

(5) $\frac{kWp [4]}{m^2} \times \frac{100}{1}$

Appendix K
ROUTINE MAINTENANCE SCHEDULES

ROUTINE MAINTENANCE SCHEDULES

Routine maintenance activities for the various PV systems and general site maintenance are described in this appendix. The activities are grouped by system and frequency. A procedure number is assigned to each group of activities, and the procedures are filed in subject file ROUTINE MAINTENANCE.

A. Monthly Maintenance

1. US-1 APS (DMP-001)
 - a. Check PCU container window filters and clean or replace as required.
 - b. Test emergency lights.
2. US-1 IPC (DMP-002)
 - a. Check metal oxide varistor (MOV) fuses F38-F42.
 - b. Check inverter air filters and clean or replace as required.
 - c. Reset tracker clock and check sensor alignment.
3. EMT-1 ENT (DMP-003)
 - a. Inspect array.
 - b. Check tracker alignment, verify that wind sensor is operating, and reset clock if required.
 - c. Check tracker battery voltage and add water if required.
4. Balance-of-Plant (DMP-004)
 - a. Check out and run pump on water wagon.
 - b. Charge lift batteries and add water as required.
 - c. Charge Fortrax battery.
 - d. Verify operation of security system.
 - e. Check all site fire extinguishers.
 - f. Lubricate site sump pumps during winter or rain periods.

B. Quarterly Maintenance

1. US-1 APS (DMP-005)
 - a. Adjust PCU operating limits.
2. EMT-1 ENT (DMP-006)
 - a. Check tracker gear motor oil and add or replace oil as required.
 - b. Lube tilt and roll drive bearings.

3. BOP (DMP-007)

- a. Check field safety boxes.
- b. Walk down perimeter fence.

C. Semi-Annual Maintenance

1. US-1 APS (DMP-008)

- a. Inspect array for cracks, burned cells, hot spots, broken or loose wire.
- b. Test smoke detector.
- d. Test PCU.

2. US-1 IPC (DMP-009)

- a. Verify neutral ground on switch 89-122.
- b. Check source circuit open-circuit voltage.
- c. Inspect array j-boxes and conduit for moisture or corrosion.
- d. Inspect array for cracks, burned cells, hot spots, broken or loose wire.
- e. Check source circuit short-circuit current.
- f. Check source circuit leakage.
- g. Verify no inter-row shading.
- h. Tighten electrical connections in dc collection and field boxes.

3. US-1 IPC (DMP-010) Tracker

- a. Check for moisture or corrosion.
- b. Tighten cable and conduit clamps.
- c. Operate winch in both directions.
- d. Inspect winch frame.
- e. Inspect sensors for corrosion.
- f. Inspect disk brakes.
- g. Inspect winch drum and sheaves.
- h. Check sensor cables.
- i. Verify bolt torque of winch motor attachment bolts.
- j. Inspect structure for corrosion.
- k. Inspect drive cable and turnbuckle.
- l. Verify support structure ground.
- m. Check oil level and quality and add or replace oil as required.
- n. Check enclosure gasket.
- o. Inspect and tighten I/O terminals.

4. US-1 SSI (DMP-011)
 - a. Inspect array for cracks, burned cells, hot spots, broken or loose wire.
 - b. Inspect transformer and change taps.
 - c. Inspect tracker cylinders for fluid leakage.
 - d. Clean plastic covers and reflectors.
 - e. Lubricate bearings.
5. EMT-1 ENT (DMP-012)
 - a. Inspect array for cracks, burned cells, hot spots, broken or loose wire.
 - b. Adjust module tracking as required.
 - c. Adjust PCU start-up voltage for seasonal wakeup.
 - d. Calibrate tracker controller.
 - e. Lubricate gear box.
6. EMT-1 SSI (DMP-013)
 - a. Inspect array for cracks, burned cells, hot spots, broken or loose wire.
 - b. Adjust PCU start-up voltage for seasonal wakeup.
7. EMT-1 SX (DMP-014)
 - a. Inspect array for cracks, burned cells, hot spots, broken or loose wire.
 - b. Adjust PCU start-up voltage for seasonal wakeup.
 - c. Tighten support bolts.
8. EMT-1 SOV (DMP-015)
 - a. Inspect array for cracks, burned cells, hot spots, broken or loose wire.
 - b. Adjust PCU start-up voltage for seasonal wakeup.
9. EMT-1 UPG (DMP-016)
 - a. Inspect array for cracks, burned cells, hot spots, broken or loose wire.
 - b. Adjust PCU start-up voltage for seasonal wakeup.
10. BOP (DMP-017)
 - a. Clean I&C building and Visitor's Center.
 - b. Grade or repair site roads as required.
 - c. Conduct weed control.
 - d. Inspect roads, drainage, dikes.
 - e. Check flammables cabinet.
 - f. Inspect and maintain UPS.
 - g. Test rubber gloves and hot stick.

D. Annual Maintenance

1. US-1 APS (DMP-018)

- a. Inspect and maintain switch 89-131.
- b. Inspect and maintain switch 89-132.
- c. Inspect and maintain switch 89-133.
- d. Inspect and maintain switch 89-134.
- e. Inspect and maintain switch 89-135.
- f. Inspect and maintain auxiliary panel.
- g. Calibrate JEM meter.
- h. Calibrate PCU.
- i. Wet megger array.
- j. Take I-V curves.
- k. Soil anchor corrosion test.

2. US-1 IPC (DMP-019)

- a. Inspect and maintain switch 89-121.
- b. Inspect and maintain switch 89-122.
- c. Tighten inverter connections.
- d. Calibrate JEM meter.
- e. Wet megger array.
- f. Take I-V curves.

3. US-1 SSI (DMP-020)

- a. Inspect and maintain switch 89-111.
- b. Inspect and maintain switch 89-1110.
- c. Inspect and maintain switch 89-1111.
- d. Inspect and maintain switch 89-1112.
- e. Inspect and maintain switch 89-1113.
- f. Inspect and maintain switch 89-116.
- g. Inspect and maintain switch 89-117.
- h. Inspect and maintain switch 89-118.
- i. Inspect and maintain switch 89-119.
- j. Inspect and maintain auxiliary panel.
- k. Tighten inverter connections.
- l. Check orientation of reference cell.
- m. Check inverter air filters and clean or replace as required.
- n. Calibrate JEM meter.
- o. Wet megger array.
- p. Take I-V curves.

4. EMT-1 ENT (DMP-021)
 - a. Tighten support bolts and connections.
 - b. Wet megger array.
5. EMT-1 SSI (DMP-022)
 - a. Tighten support bolts and connections.
 - b. Wet megger array.
6. EMT-1 SOV (DMP-023)
 - a. Tighten support bolts and connections.
 - b. Wet megger array.
7. EMT-1 UPG (DMP-024)
 - a. Tighten support bolts and connections.
 - b. Wet megger array.
8. EMT-1 SX (DMP-025)
 - a. Tighten support bolts and connections.
 - b. Wet megger array.
9. BOP (DMP-026)
 - a. Maintain site flood control sump.
 - b. Clean storage shed.
 - c. Align gates and lubricate locks.
 - d. Replace emergency light batteries.
 - e. Ground megger test.
 - f. Maintain Fortrax battery (check the charge and the battery liquid).
 - g. Inspect first aid kits.
 - h. Inspect and maintain breaker 42-1.
 - i. Inspect and maintain breaker 42-2.
 - j. Inspect and maintain east pump.
 - k. Inspect and maintain west pump.
 - l. Paint Visitor's Center deck.

E. Two-Year Maintenance

1. EMT-1 PCU (DMP-027)
 - a. Inspect EMT-1 ENT PCU.
 - b. Inspect EMT-1 SX PCU.
 - c. Inspect EMT-1 SOV PCU.
 - d. Inspect EMT-1 SSI PCU.
 - e. Inspect EMT-1 UPG PCU.
 - f. Inspect EMT-2 PCUs (three).
2. US-1 IPC (DMP-028)
 - a. Replace tracker oil.

F. Three-Year Maintenance

1. US-1 APS (DMP-029)
 - a. Inspect and maintain breaker 52-131.
 - b. Inspect and maintain breaker 52-132.
 - c. Inspect and maintain breaker 52-133.
 - d. Calibrate protective relays.
2. US-1 IPC (DMP-030)
 - a. Inspect and maintain breaker 52-121.
 - b. Calibrate protective relays.
3. US-1 SSI (DMP-031)
 - a. Inspect and maintain breaker 52-111.
 - b. Inspect and maintain breaker 52-112.
 - c. Calibrate protective relays.
4. BOP (DMP-032)
 - a. Inspect and maintain breaker 52-1.
 - b. Inspect and maintain breaker 52-2.
 - c. Inspect and maintain breaker 52-3.
 - d. Inspect and maintain breaker 52-4.
 - e. Inspect and maintain breaker 52-5.
 - f. Inspect and maintain breaker 52-7.
 - g. Inspect and maintain breaker 52-8.
 - h. Inspect and maintain switch 12489.
 - i. Calibrate protective relays.
 - j. Send safety grounds out for testing.

G. Five-Year Maintenance

1. US-1 SSI (DMP-033)
 - a. Tighten instrumentation connections.
 - b. Replace inverter fans.
2. US-1 IPC (DMP-034)
 - a. Service TR-121 oil and test, add, or replace as required.

H. Maintenance Instructions

1. Document all maintenance activities on the PVUSA O&M Report and Inspection Sheet. See sample sheet and instructions for completing the form on the following pages.
2. Submit a hard copy to the O&M data entry personnel for database input and filing.
3. The routine maintenance activities are scheduled as tasks in the Schedule + program, which is included in Windows for Workgroups and is used by Davis site personnel. The date each activity is due appears on the task list. When an activity is checked as completed, the task is removed from the list and saved in the file. Repetitive tasks (monthly, daily, etc.) are automatically rescheduled and added to the task list on the new due date. Completed tasks may be exported for use in a database as required.

PVUSA O&M REPORT AND INSPECTION SHEET

Log #	Date:	Start Time:	Stop Time:
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Site:

☐ EMT-1 ENT	☐ EMT-1 SX	☐ EMT-2 EPRI	☐ MAUI	☐ US2-KERMAN
☐ EMT-1 SOV	☐ EMT-1 UPG	☐ I.C BLDG	☐ US1-IPC	☐ Other_____
☐ EMT-1 SSI	☐ EMT-1 EPRI	☐ US1-APS	☐ US1-SSI	

Type of Maintenance:

☐ Planned-Preventive

☐ Unplanned-Failure Related

☐ Research Related

Description of Event:

☐ BOS Failure	☐ Erosion Problem	☐ Inverter Failure	☐ Pump Failure	☐ Routine Inspect.	☐ Sych. Error
☐ Clearance	☐ Exchange Equip.	☐ Line Disturbance	☐ PV Sys. Problem	☐ Routine Maint.	☐ Vegetation Problem
☐ DAS Problem	☐ Facility Improvement	☐ Module Failure	☐ PV Workshop	☐ Security Problem	
☐ DAS Upgrade	☐ FWRT	☐ Non-Routine Maint.	☐ Read Meters	☐ Safety Problem	

☐ Other: _____

Action Taken:

☐ Adjust	☐ Disconnect	☐ Modify	☐ Procurement	☐ Other: _____
☐ Calibrate	☐ Inspect	☐ Repair	☐ Supervise/Buddy	_____
☐ Clean/Wash	☐ Install	☐ Replace	☐ Test	_____
☐ Connect	☐ Load	☐ Reset	☐ Warranty	_____

System Involved

System:

☐ DAS

☐ PCU

☐ PV Module

☐ Support Structure

☐ Other: _____

AC Electrical:

☐ Circuit Brkr.

☐ Fuse

☐ Inverter

☐ Relaying

☐ 12kV Transf.

☐ Other: _____

DC Electrical:

☐ Blocking Diode

☐ Bypass Diode

☐ Bypass Diode

☐ Combiner Box

☐ Fuse

☐ Interconnect

☐ Movistor

☐ Switch

☐ Other: _____

Tracker:

☐ Actuator/Seal

☐ Bearings

☐ Clock

☐ Controller

☐ Lubricate

☐ Motor Drive

☐ Receiver

☐ Sensor

☐ Stow

☐ Wake-up

☐ Winch

☐ Other: _____

Site:

☐ Buildings

☐ Drainage

☐ Fences

☐ Erosion Ctrl.

☐ Pest Ctrl.

☐ Pumps

☐ Roads

☐ Security

☐ Veggie Ctrl.

☐ Other: _____

Site DAS:

☐ Computer

☐ Datalogger

☐ MD9

☐ Pyranometer

☐ Sensor

☐ Software

☐ Thermocouple

☐ Transducer

☐ Weather Sta.

☐ Wiring

☐ Other: _____

Downtime

Problem Occurred: Date: Time:	Downtime Hours: Partial System: Whole System:	Present Status: <div style="display: flex; justify-content: space-between;"> <div>☐ Whole system On</div> <div>☐ Partial system Off</div> <div>☐ Whole system Off</div> </div>
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Materials and Labor

PVUSA WBS: ☐ BSD ☐ KEY-2 ☐ BSK ☐ KEY-2K ☐ DAS ☐ MTN ☐ DASK ☐ SAF ☐ EMT-2 ☐ SAFK ☐ EMT-3 ☐ SPD ☐ EVA ☐ SPK ☐ KEY-1 ☐ ____	Work Done by: ☐ BEV ☐ DJS ☐ DLM ☐ KOB ☐ PAH ☐ RSR ☐ TUT ☐ ____	Materials/Parts Used: <div style="border: 1px solid black; height: 40px;"></div>	Materials Cost: <div style="border: 1px solid black; height: 40px;"></div>
		Major Equipment Used: <div style="border: 1px solid black; height: 40px;"></div>	Equipment Cost: <div style="border: 1px solid black; height: 40px;"></div>

Total Force:	Hours per Person:	Work Complete: ☐ Yes ☐ No	Labor Cost:	Total Cost:
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INSTRUCTIONS FOR COMPLETING O&M REPORT AND INSPECTION SHEETS

LOG #: Leave blank, assigned at time of entry into database.

DATE: Date O&M activity was started.

START TIME: Time O&M was started (PST).

STOP TIME: Time O&M was completed (PST).

SITE: ☐ Check appropriate box for site where O&M was performed. *Other* may be used for site maintenance on areas other than PV system (e.g., *other* Davis for road, ditch, vegetation, or drainage maintenance).

TYPE OF MAINTENANCE: (check only one)

- ☐ *Planned-Preventive:* Includes all scheduled or planned O&M activities that were not research-related or did not result from system failure. System downtime could result from this type of maintenance, but should not have occurred prior to this maintenance.
- ☐ *Unplanned-Failure Related:* Includes all O&M activities that resulted from a system failure. The system failure includes any system required for the operation of the system at full potential power, but does not include research-related activities.
- ☐ *Research Related:* Includes O&M activities associated with research activities that are not required for PV system operations. Examples of research-related activities include data acquisition, meteorological station, solar instrumentation, computers, and special tests.

DESCRIPTION OF EVENT: (check only one)

- ☐ *BOS Failures:* Includes the failure of any balance-of-system commodity, except the inverter, movistors, fuses, or ground fault.
- ☐ *Clearance:* Identifies that a "tag out" clearance was initiated and/or removed.
- ☐ *DAS Problem:* Includes research-related DAS problems and/or SCADA.
- ☐ *DAS Upgrade:* Includes activities to upgrade the existing DAS and/or SCADA.

- ☐ *Erosion Problem:* Includes activities associated with the remediation or repair of site erosion problems.
- ☐ *Movistor Failure:* Includes failure of a movistor.
- ☐ *Facility Improvement:* Includes any modification or improvement to existing non-PV facility.
- ☐ *FWRT:* Includes only the actual performance of the test.
- ☐ *Inverter Failure:* Includes all inverter failures, except for ground fault, blown fuse, or synchronization error.
- ☐ *Line Disturbance:* Includes facility or PV problems associated with line-side (feeder) problems.
- ☐ *Module Failure:* Includes only module failures or commodities permanently attached (e.g., wiring and junction boxes), which will require a module repair or replacement.
- ☐ *Non-Routine Maintenance:* Includes emergency, unscheduled, or unplanned non-PV facility maintenance activities.
- ☐ *Pump Failure:* Includes any problem/failure associated with site pumps (well or storm).
- ☐ *Storm Damage:* Includes all damage resulting from inclement weather, earthquakes, or non-electrical fires. Note: Use ☐ *Other* to further detail event/damage.
- ☐ *PV Workshop:* Use to capture worker hours for technology transfer.
- ☐ *Read Meters:* Use to capture operations cost for meter reading; not required when meter reading is done by non-PV staff.
- ☐ *Routine Inspection:* Use to capture costs associated with routine inspections.
- ☐ *Routine Maintenance:* Includes all weekly, monthly, quarterly, and annual routine facility maintenance (includes PV routine maintenance).
- ☐ *Security Problem:* Includes any O&M costs associated with security problems (e.g., security system, fence, door, or window repairs).
- ☐ *Safety Problem:* Use to capture costs associated with a safety problem, such as emergency repairs or safety modifications, safety equipment, or personnel safety problems.
- ☐ *Synch. Error:* Includes only synchronization errors that occur during PCU start-up/operations.

- ☐ *Vegetation Problem:* Use to capture costs associated with vegetation removal, disking, mowing, or spraying.
- ☐ *Blown Fuse:* Use to capture costs associated with the replacement of fuses (ac/dc).
- ☐ *Ground Fault:* Includes maintenance activities associated with known ground faults.
- ☐ *Other:* Use to further describe event. Enter description of events for which no box exists. Enter equipment number (e.g., inverter #3, source circuit #4).

ACTION TAKEN: (check only one)

- ☐ Check the most significant action that was taken to resolve the event. If more than one action was taken, list additional actions under the subheading ☐ *Other*.

SYSTEM INVOLVED: (check only one)

- ☐ *DAS (Data Acquisition System):* Use for all data acquisition-related O&M activities.
- ☐ *PCU (Power Conditioning Units):* Use to collect costs associated with O&M of inverters.
- ☐ *PV Module:* Includes all maintenance activities associated with the inspection or replacement of PV module(s).
- ☐ *Support Structure (BOS):* Includes all other systems not specifically listed and which are essential for the production and distribution of PV-generated electricity.
- ☐ *Other:* Includes all systems not required for the PV-generated electricity, including security, cathodic protection, well water, storm water, and septic systems.

SUBSYSTEM(S) INVOLVED: (check only one)

- ☐ Check the box under each subheading which best describes the subsystem involved. If more than one subsystem was involved, use ☐ *Other* to indicate additional information. It is not necessary for each subheading to have an entry (e.g., ac electrical, dc electrical, tracker).

DOWNTIME:

Problem Occurred: Enter data and time (if known) when the outage or event being addressed actually began. This block may not apply to planned preventive maintenance.

Downtime Hours: Enter the number of hours (daylight) that the PV system was partially or wholly unavailable for energy production.

Present Status: ☐ check the box that indicates the status of the PV system after the O&M work was performed. "Partial System Off" indicates that part of the system is out of service at the completion of the work done on this form.

MATERIALS AND LABOR: (check only one)

PVUSA WBS: ☐ Check the box which indicates the cost code used for the work performed on this O&M report. For system work under warranty, charge to System WBS (e.g., EMT-3). After warranty, charge only to MTN for non-research work.

Work Done By: ☐ Check the box adjacent to the initials of the person performing the task described on the O&M log form. If more than one person or the person's initials are not indicated, list additional initials on the bottom blank.

Materials/Parts Used: List all materials/parts (non-consumables) used to perform the listed task, including warranty materials/parts.

Major Equipment Used: List any specialized equipment or rental equipment required to perform the task. It is not necessary to list hand tools or non-specialized tools.

Material Cost: List actual non-consumable material costs (if known), including warranty/parts costs. Estimate if costs are unknown.

Equipment Cost: List rentals or specialized equipment purchased. Estimate if costs are unknown.

Total Force: List the total PVUSA work force (either full or part time) required to perform the task, including support for warranty repairs.

Hours Per Person: Enter hours to the nearest 15 minutes. Hours per person times total force should equal total time expended.

Work Completed: If this O&M report completes the necessary work required to address the event, check yes; otherwise, check no.

Labor Cost: No entry required because the database will calculate.

Total Cost: No entry required because the database will calculate.