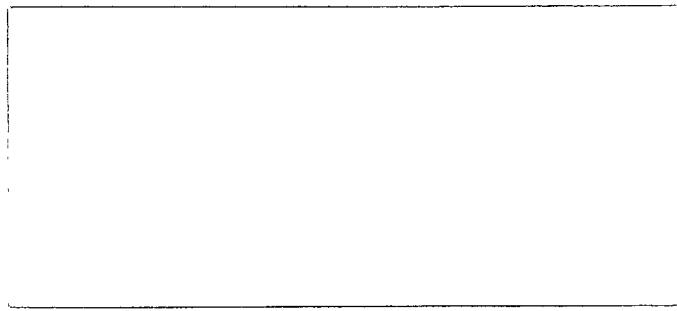
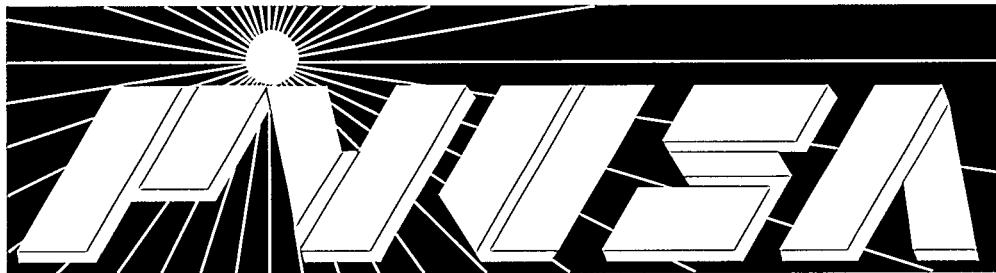


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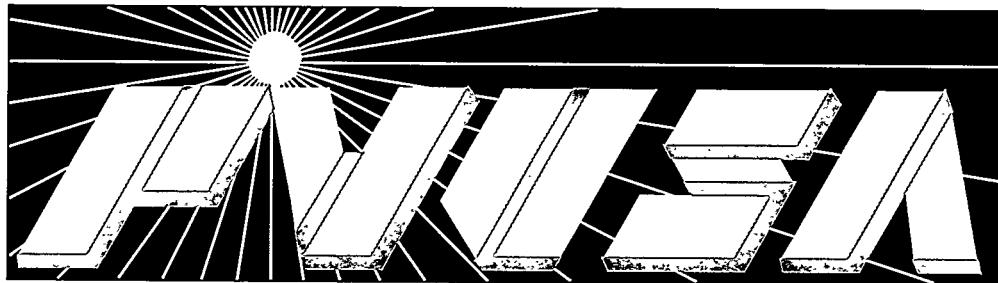
Photovoltaics for Utility Scale Applications



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**PVUSA Procurement,
Acceptance, and Rating Practices
for Photovoltaic Power Plants**

September 1995

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**PVUSA PROCUREMENT,
ACCEPTANCE, AND RATING PRACTICES
FOR PHOTOVOLTAIC POWER PLANTS**

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ABSTRACT

This report is one in a series of PVUSA reports on PVUSA experiences and lessons learned at the demonstration sites in Davis and Kerman, California, and from participating utility host sites. During the course of approximately 7 years (1988-1994), 10 PV systems have been installed ranging from 20 kW to 500 kW. Six 20-kW emerging module technology arrays, five on universal project-provided structures and one turnkey concentrator, and four turnkey utility-scale systems (200 to 500 kW) were installed.

PVUSA took a very proactive approach in the procurement of these systems. In the absence of established procurement documents, the project team developed a comprehensive set of technical and commercial documents. These have been updated with each successive procurement. Working closely with vendors after the award in a two-way exchange provided designs better suited for utility applications.

This report discusses the PVUSA procurement process through testing and acceptance, and rating of PV turnkey systems. Special emphasis is placed on the acceptance testing and rating methodology which completes the procurement process by verifying that PV systems meet contract requirements. Lessons learned and recommendations are provided based on PVUSA experience.

Other complimentary PVUSA topical reports document:

- Construction and safety experience
- Five-year assessment of EMTs
- Validation of the Kerman 500-kW grid-support PV plant benefits
- Balance-of-System designs and costs
- PVUSA instrumentation and data analysis techniques
- Experience with power conditioning units and power quality

EXECUTIVE SUMMARY

Photovoltaics for Utility Scale Applications (PVUSA) is a national cooperative research and development project that is dedicated to acquiring information through field installation and testing of photovoltaic (PV) technologies in utility-scale applications. The project provides the information to utilities and other participants. This report evaluates and documents PV system acquisition, focusing on the processes of procurement, system acceptance, and establishing the system power rating.

Procurement is a specialty dealing with the identification of sources of supplies for systems and components, solicitation of bids, selection of award, and establishing and administering contracts and purchase orders for delivery. The processes of field inspection, acceptance testing, and rating are a natural extension of the procurement process. These activities must be integrated, since the acceptance and rating activities simply complete the procurement cycle by verifying that the equipment purchased in fact meets the utility's specified requirements, and generates the power needed. The procurement agreement must have provisions for acceptance and establishing a rating, and may call for penalties or incentives for ratings that fall below or exceed the contracted value. While procurement of PV systems is largely a routine process, utility purchase of large scale grid-connected PV systems is relatively new and there are unique considerations. This report examines the acquisition experience at PVUSA, summarizes lessons learned, and provides recommendations.

From 1988 through 1994 the PVUSA project acquired six 20-kW nominal systems and three larger utility-scale (US) systems for the Davis, California site. The 20-kW systems demonstrated new PV module technologies and are referred to as Emerging Module Technologies (EMT) systems. There were three competitively bid procurements of EMT systems designated EMT-1, EMT-2, and EMT-3.

The larger US systems are comprised of more mature technologies intended to demonstrate the performance characteristics of large, grid-connected systems. There were two competitively bid procurements of US systems designated US-1 and US-2. Lessons learned from initial procurements for the Davis site (US-1) were applied in the acquisition of a 500-kW utility scale PV plant for grid support, sited near Kerman, California (US-2). The 500-kW Kerman plant has been analyzed as a typical example for discussion of large PV system acquisition; some aspects of the acquisition of EMT arrays are also addressed.

PROCUREMENT PLANNING

Initial planning for a PV system acquisition involves identification of roughly 40 purchases that are necessary for a typical 500-kW PV plant, and assessment of the procurement lead times. Generally the competitively bid turnkey PV system will require the longest schedule. Pre-award activities require about 4 months, followed by about 9 months of post award activity by the PV system vendor and the project engineering team before system completion. Acceptance inspection and testing require about 1 week, followed by a period of parallel testing and startup that could be completed in less than a week, but may take up to several weeks depending on startup problems encountered.

SOLICITATION OF BIDS, SELECTION, AND ADMINISTRATION OF SUBCONTRACTS

This report focuses on the procurement of turnkey PV systems since most other purchases are routine. The first pre-award task is solicitation of competitive bids. The process begins with the development of PV system requirements by the project engineering staff. These requirements are provided to the procurement specialist for solicitation of bids. For improved flexibility, separate requirements documents should be prepared covering: specification of technical requirements, scope of work, schedule of required milestones, estimated budget, special conditions, and suggested sources of supply.

The procurement specialist incorporates the requirements from the engineering staff into a draft subcontract and adds appropriate commercial conditions. Since new PV systems may contain components not proven in the field, it is important to include contract conditions which restrict the use of unproven components, and provide for termination due to non-performance, or when the suppliers must delay delivery indefinitely in order to complete additional research and development. For example, the Kerman bid solicitation imposed limitations on types of modules and inverters.

The bid solicitation package typically includes: a bid invitation letter, instructions to the bidders (including selection criteria), a format for the proposal, description of the technical content required in the bid, and a draft subcontract as described above. Bids are solicited from prequalified bidders which have responded acceptably to pre-bid inquiries. The solicitation should include enough bidders to assure at least three competitive and acceptable bids. The PVUSA selection criteria is the basis for final selection and award of subcontracts.

The engineering staff and procurement supplier quality representatives support the procurement specialist throughout the fabrication and delivery phase of the contract by clarifying technical issues and verifying the product quality in the supplier's shop.

ACCEPTANCE INSPECTION AND TESTING

Once the PV system is delivered and installed, the acceptance inspection, testing, and startup take place to verify that the contractor has delivered the system specified. The overall acceptance process is carried out in phases. Certain checks and tests can be completed before the system is connected to the grid. Once these are complete the utility performs preparallel checks to verify that the system can be safely connected to the grid. After obtaining permission to connect to the grid, full power performance testing and rating can be completed.

Prior to connection to the grid, the following checks, verifications, and tests are completed:

- Engineering documentation checked complete
- Construction checked complete
- Perform Field Wet Resistance Test (FWRT)
- Perform I-V curve trace
- Check remote signal indications (including inverter signals)
- Preparallel checks to verify readiness for preparallel inspection

PREPARALLEL INSPECTION AND STARTUP

After the preceding checks are complete, the system startup takes place in conjunction with the preparallel inspection by the utility. These preparallel inspections are typical of those conducted for an independent power producer (IPP), and include polarity checks, protective relay functions, and metering.

Once connected to the grid, the PV system startup can be completed by checking all modes of operations and shutdown functions in accordance with the owner's startup plan.

When startup is complete, the system is observed during a 30-day conditioning period under normal operating conditions to verify reliability of operation. Upon successful completion of the 30-day conditioning period, the system is accepted by PVUSA.

ESTABLISHING THE SYSTEM POWER RATING

The final activity is to establish the power rating of the PV system. The power output is of course dependent on the solar irradiance and ambient conditions, therefore there must be agreement within the subcontract relative to the conditions under which the system will be rated. PVUSA test conditions (PTC) have been established for rating of all PVUSA systems and are defined as follows:

- 20°C ambient temperature
- 1 m/s wind speed at 10 meters above grade
- 1,000 W/m² global plane-of-array irradiance for flat plates
- 850 W/m² direct normal irradiance for concentrators

Ratings under these conditions are generally lower (roughly 10%) than ratings under the standard test conditions (STC) commonly used in the PV industry. PVUSA believes that ratings under PTC are a better indicator of the actual power output that a utility would receive from a PV system.

Since the PVUSA rating conditions are seldom encountered simultaneously, data is collected over a 30-day rating period, when conditions are close to PTC, and linear regression analysis is applied to establish a rating. This methodology generally provides ratings with less than 5 percent error at the 95 percent confidence level. Contractual provisions may or may not allow for an instrument error (typically 5%) to be added to the calculated system rating, when this rating is used as a basis for final payment. PVUSA has issued contracts both with and without such an allowance.

There is with each completed PV installation a continuing procurement activity to monitor the system for failures or defects and to resolve issues under the contract provisions covering warranty and correction of defects. The manufacturers general system warranty of 2 years from the time of acceptance was augmented for Kerman by an additional 3 year warranty for the modules. In general, warranty work for the power conditioning units (PCUs) has been a more frequent occurrence than warranty replacement of failed PV modules.

LESSONS LEARNED AND RECOMMENDATIONS

The lessons learned and recommendations from the PVUSA's experience emphasize many fundamentals of procurement and good project execution: detailed planning and coordination, use of experienced personnel

throughout the acquisition process with clear division of responsibility, careful control of procurement documents, and fair competitive practices throughout the bid solicitation, evaluation, and contract award processes.

The unique concerns relative to PV module acquisition for EMT arrays are generally related to the developmental nature of PV system components. PVUSA has attempted to apply standard utility requirements to a PV industry that is still developing its standard products. The most fundamental lesson is to anticipate supplier difficulties in delivering developmental products, and to tailor the acquisition process to encourage procurement of prequalified components. The process must include clear subcontract "off ramps" so that when new product development problems are encountered, the subcontract may be terminated in an equitable fashion.

The EMT planning and procurement documents should reflect the schedule uncertainties. For example, time should be allowed to run PV module qualification tests several times if needed, to satisfactorily qualify modules; on the other hand, the subcontract should allow termination at no cost if the qualification of modules cannot be completed within a specified schedule. In some cases, a careful review of the manufacturer's QA plans, and shop visits by an inspector to verify that the manufacturer is following the approved plan will result in a quality product which benefits both the manufacturer and the buyer.

PVUSA utility system acceptance experience highlights the necessity for field construction personnel to monitor the installation process. In particular, attention must be paid to procedures, implementation, and quality control of mechanical tightness of all connections including conductors, junction box covers, module fasteners, and structural members. During construction, the project should maintain liaison with the utility in preparation for preparallel inspections and testing, and rehearse these inspections to avoid delays. The PCU is generally the most critical startup item. The field startup personnel should be trained by the PCU manufacturer and the manufacturer should provide written startup procedures and be present, or in ready communication, during startup.

During the 30-day conditioning period, the full range of system controls should be exercised and all problems documented. High irradiance due to cloud enhancement has caused PCU operation problems during certain months (e.g. at the Kerman, California site, PCU malfunctions are more frequent in the spring months when cloud enhancement is most extreme). This effect may not be apparent depending on

the time of year when the 30-day conditioning period is conducted; modifications may be necessary later under warranty.

Key recommendations relative to establishing the system power rating are: to assure the radiometers are clean, and essential instruments are calibrated before the data collection; avoid collecting data for rating during the winter (particularly for single-axis tracking systems); screen data to limit the data set to conditions near PTC when practical; and remove anomalous data points to reduce spread in the uncertainty.

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GLOSSARY

AEP	Annual Energy Produced
BOS	Balance-of-system. All equipment and associated labor not part of the actual PV array, such as the support structure, power conditioning unit, and utility grid interconnection equipment
DAS	Data acquisition system
DDR	Design Document Registration
DOD	U.S. Department of Defense
EMT	Emerging module technology
FWRT	Field wet resistance test
IJB	Interface junction box
IPP	Independent Power Producer
IQT	Interim Qualification Tests
I/R	Infrared
I-V	Current-voltage
NIP	Normal incidence pyroheliometer
O&M	Operation and maintenance
PCU	Power conditioning unit. Contains a dc-to-ac inverter, system protection and control, and maximum power-tracking circuits
PG&E	Pacific Gas and Electric Company
POA	Plane of array
PSP	Precision spectral pyranometer
PTC	PVUSA test conditions, defined as 1,000 W/m ² POA irradiance for flat-plate modules, 850 W/m ² direct normal irradiance for concentrators, 20°C ambient temperature, and 1 m/s wind speed
PV	Photovoltaic
PVUSA	Photovoltaics for Utility Scale Applications
QA/QC	Quality assurance/quality control
SC	PVUSA Steering Committee
STC	Standard test conditions, defined as 1,000 W/m ² POA irradiance for flat plate modules, 850 W/m ² direct normal irradiance for concentrators, 25°C or 28°C cell temperature, and air mass 1.5 spectrum
TRC	PVUSA Technical Review Committee
US	Utility scale

Section 1

INTRODUCTION

This section provides general background information about the PVUSA project, and describes the roles of various project participants in the acquisition of PV systems. Photovoltaics for Utility Scale Applications (PVUSA) is a national public-private partnership that is assessing and demonstrating the viability of utility-scale photovoltaic (PV) electric generating systems. This report documents PVUSA experience in the overall procurement process for a PV system, with special emphasis on acceptance and rating activities.

PVUSA offers utilities the hands-on experience needed to evaluate and utilize maturing PV technology, provides manufacturers with a test bed for their products, and encourages technology improvement and cost reductions in PV modules and balance-of-system (BOS) components. The project also facilitates the communication between utilities, government laboratories, and the PV industry that is necessary for successful development and commercialization of utility PV systems. Pacific Gas & Electric (PG&E) leads the PVUSA Project Team, which manages daily activities and facilitates technology transfer.

The project consists of emerging module technology (EMT) arrays and utility-scale (US) systems. EMTs are state-of-the-art PV module technologies that have not been extensively field-tested. The 20-kW nominal size of the arrays was selected to demonstrate ease of manufacture and allow a statistically credible evaluation, while minimizing risks associated with a new technology. US systems are vendor-optimized turnkey PV systems that use mature module technologies, and have the potential to produce low cost energy while meeting operation and maintenance (O&M), power quality, reliability, and lifetime requirements necessary for utility applications. The US systems selected for demonstration are nominally 200 kW or larger. They are expected to capture much of the economies of scale of larger systems, and provide realistic evidence of meeting system installation, and protection and grid interaction requirements, with acceptable capital costs, system performance, and O&M costs. These systems incorporate innovative BOS designs that are expected to lead to cost-effective approaches for utility applications. They also provide both the project participants and the PV industry with experience in commercial procurement and construction practices.

PVUSA has installed nine systems to date at Davis, California; six EMT and three US systems. A utility-scale system has been constructed at Kerman, California, on a selected feeder to allow detailed study of impact of PV on the local grid. This grid-support system allows verification of several potential benefits of

distributed PV, as well as information on the operational and power quality aspects of an unattended PV plant on a high-impedance distribution line.

Since the Kerman PV system is more typical of a commercial PV plant, it is the primary source of information for this report. The report provides an overview of the procurement process as applied by PVUSA to the acquisition of PV systems and components for PV plants. An important aspect of the procurement cycle for PV systems is testing and acceptance by the utility. PVUSA, in developing four utility-scale systems, has developed a series of standard procedures and tests appropriate to the PV technology that might be useful to utilities interested in acquiring PV systems.

Both PG&E, as the owner, and Bechtel, as the general contractor, procured equipment and services for PVUSA. However, Bechtel had the primary responsibility for procurement, and this report reflects procurement practice and organization at Bechtel. Bechtel procurement practices have been developed over a long history of heavy construction for utility clients. These practices provided the basis for PVUSA procurements. This report should be helpful to any procurement organization in highlighting the specific issues relating to procurement of PV systems.

Procurement is a multidiscipline function embracing planning, purchasing, subcontracting, expediting, supplier quality surveillance, traffic, and logistics. On the PVUSA Project, procurement is a continuous process beginning with project planning and proceeding without intermission through bidding, evaluation, selection, and administration. The process further includes acceptance testing, rating, and correction of defects during warranty, and ends with the retirement of records when all aspects of procurement on the project are completed. All parts of the PVUSA organization take part in the process including engineering, procurement, construction, Bechtel and PG&E project management and administration, and the PVUSA Technical Review Committee (TRC) and Steering Committee (SC).

Section 2

PLANNING

This section describes the planning process for acquisition of a PV system. It establishes the magnitude of the procurement in dollars and number of separate purchases, suggests duration for each step of a PV system procurement, and shows how these activities are integrated into the overall PV system acquisition.

PROJECT PLANNING

PVUSA procurement activities included acquiring PV systems and the materials, supplies, tools, equipment, and site services necessary to support installing and operating PV systems at the Davis and Kerman sites. Procurement for the PVUSA site at Davis involved a wide range of PV systems and infrastructure typical of PV demonstration and test bed activities. The Kerman 498-kW grid-support PV system is typical of a commercial installation undertaken by utilities.

An outline of the number and types of systems to be fielded was prepared to plan the approximate number and magnitude of orders and subcontracts that would be generated during the life of the project. Plans were based on extensive analyses that described each significant item of equipment and subcontract activity in fairly accurate detail. Table 2-1 is a summary of the number and value of purchases planned for the Kerman grid-support system.

Table 2-1
Procurements for
Kerman 498-kW PV System

Description	No. of Orders	Value (\$000)
Site equipment and services	2	6
Buildings	3	50
Site work - Civil	4	180
Electrical	18	72
Mechanical	4	24
Office supplies, services	4	14
Photovoltaic system	1	4,819
DAS, Met, SCADA, transformers, switchgear, relays, interconnection*	7	188

*Equipment ordered directly by utility.

Initially, procurement concentrated on site development subcontracts and long-lead equipment purchases including surveys, soils testing, grading, drainage, fencing, utilities, buildings, and other infrastructure. Next, procurement assisted in preparing the documents that would be included in solicitations for the PV system. Later, the work was divided between monitoring the progress of PV subcontractors and equipment suppliers, and acquiring office supplies, testing and measuring equipment, and other goods and services in support of the continuing operation at the site.

Specific items were requisitioned by the Project Engineer or Site Superintendent and were acted on by procurement according to the plan and requisition. A petty cash account was used to purchase many field consumables, and credit cards were used for fuels and vehicle services.

PERFORMANCE SCHEDULE PLANNING

An overall schedule for accomplishing various phases of the project helped to establish interfaces between planning, engineering, procurement, construction, installation, and administration. An established schedule allowed procurement to time-phase activities that were derived from the general plan. The project used timetables incorporating information developed by procurement on lead time, delivery, and the various steps of the acquisition process. The procurement, acceptance, and rating activities span the total project, as shown in Figure 2-1, which is a typical PV project schedule.

Procurement tasks may be generally categorized as pre-award and post-award tasks. Table 2-2 shows activities during the pre-award phase involving solicitation, offer, and award. These pre-award tasks are usually accomplished within about 16 weeks as shown on the schedule, Figure 2-1. Table 2-3 shows activities that take place during the post-award performance period involving manufacture, delivery, installation, testing, acceptance, warranty service, and claims processing. Post-award activities require from 3 to 14 months. Figure 2-1 shows a typical duration of about 9 months for post award-tasks.

The post-award tasks and ranges for duration shown on Table 2-3 were typical for PV suppliers on PVUSA. The activities may be conducted in sequence, or in the case of long-lead purchases, in parallel. The duration of an activity depends primarily on its degree of complexity. Designs may be standard or require extensive engineering. Purchases may be off-the-shelf or made-to-order. Fabrication may be conducted in the seller's plant or by purchasing all or part of the elements from subcontractors. The

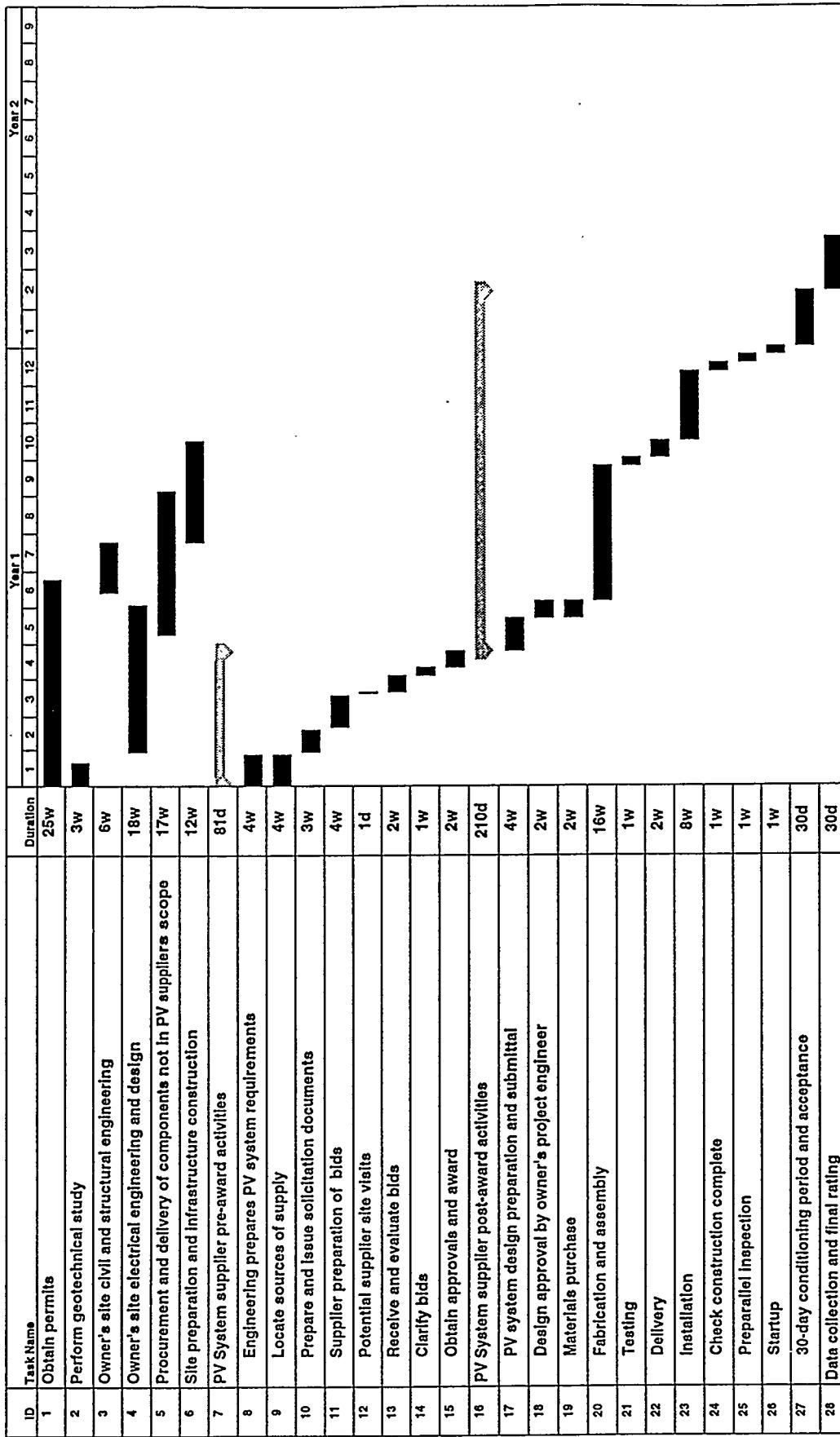


Figure 2-1 Typical Schedule for Commercial 500-kW PV Power Generation Facility

Table 2-2
Timetable for the PVUSA Procurement Process

Pre-Award

Tasks	Duration
Engineering prepares and submits a PV system requisition to procurement; procurement reviews scope, specifications, budget, schedule, deliverables, inspections, tests, shipping instructions, and other requirements contained in the requisition.	This cycle can be very rapid or can take up to several weeks if there is more than one iteration.
Locate sources of supply and determine qualifications.	Sources for common goods and services are readily available. Sources for engineered or specialty items may take weeks to locate and qualify.
Prepare solicitations documents.	Standard bid packages for purchases are available. Subcontract bid packages are specific and will take from several days to several weeks to prepare depending on the complexity of the acquisition and the number of reviewers and iterations.
Request bids from a selected group of qualified sources.	Quotes for small orders can be taken over the phone; larger orders for commercial items can be bid in 2 weeks. Major equipment or subcontracts with a potential for lower-tier suppliers or subcontractors will be bid in 4 to 6 weeks.
Include site visits and prebid conferences if appropriate.	If site/supplier visits are planned, 2 weeks are added to the bidding cycle.
Receive and evaluate bids.	Responsive bids for commercial components are evaluated on the date received. Engineered items and systems take several days, and the evaluation is usually followed by a presentation for approval by project management.
Clarify bids and request best and final offers, if appropriate.	Clarifications can be concluded rapidly or can take a protracted amount of time depending on the complexity of the issue. Best and final offers are called for in 2 weeks after all technical issues are resolved.
Obtain approvals and award.	Local approvals are obtained promptly. Client approvals, if required, can take up to 30 days.

sequence of fabrication may involve manufacturing, assembly, coatings, testing, and a number of separate operations, each of which consumes a discrete amount of time.

Table 2-3
Timetable for the PVUSA Procurement Process
Post-Award

Task	Duration
Design	2 to 8 weeks for seller to complete basic design; as-built drawings and manuals will come later.
Design approval	1 to 8 weeks for PVUSA approval, depending on the number of drawings and their complexity.
Materials purchase	1 to 4 weeks to purchase materials; delivery of components may extend into the fabrication period.
Fabrication	1 to 6 months, depending on both long-lead-time materials and the manufacturing cycle.
Assembly	1 week to 2 months, assuming that assembly overlaps fabrication.
Testing	1 week for final testing after manufacture and assembly.
Delivery	2 weeks for transport of equipment from factory to jobsite.
Installation	1 to 8 weeks, assuming system sizes from 20 kW to 500 kW and construction done in parallel with manufacture.
Acceptance	1 month after seller's testing is complete and the system is made available for acceptance.
Final Rating	1 month after acceptance provided sunlight and other conditions are adequate.
Warranty	1 or more years covering all or part of the system.

The element of delay became a significant component of project administration. Although PVUSA clearly announced its intention to exclude research and development (R&D) as a part of the procurement, suppliers were faced with major problems requiring additional R&D as an adjunct to performing their subcontract. These problems, although not within the scope of the subcontract being conducted for PVUSA, delayed work on the project while the technical obstacles were overcome.

For example, testing of modules should be routine unless the modules are developmental. PVUSA required that all modules be qualified in accordance with the Interim Qualification Tests (IQT). This testing, if not

already complete, requires about 6 weeks and may need to be repeated if unsuccessful. Because of this schedule uncertainty, only prequalified modules should be procured for utility-scale systems.

COST PLANNING

A financial plan was used to provide order-of-magnitude values for the goods and services to be acquired. From this information the project developed data showing the various accounts and the cash flow needed to acquire goods and services. Procurement contributed information on lead times during the scheduling process and developed progress payment procedures. This input helped to establish cash flow needs consistent with the funding available to the project. The project manager prepared and maintained detailed budgets for the project. The budgets included input from procurement based on quotations and comparable records of purchase orders and subcontract values. Experience indicates that the cost of procurement labor and procurement-related activities such as inspection and expediting is generally about five percent of the cost of the item procured. This cost does not include engineering or project management labor.

GENERAL DESCRIPTION OF PROCUREMENT ACTIVITIES

A log was prepared that contained descriptions of materials, equipment, subcontracts, and services acquired. Eventually, every acquisition was entered in the log to form a complete history of procurement activities. The log is used to record purchases, sources of supply, and commitment values. It may include milestone dates to provide a vehicle for tracking performance. The database readily provides information forming the basis for reports of every nature associated with procurement functions.

Appendix A is a commitment register that lists the purchases and subcontracts awarded for the Kerman grid-support system exclusive of items ordered by the utility.

Section 3

BIDDING

This section describes the solicitation of bids for PV systems (i.e. not site development or interconnection). The solicitation process begins with the preparation of requirements documents by the project engineering staff. These requirements are incorporated into the bid solicitation package by the procurement specialist who then administers the preparation of the bidder's list and solicitation of bids, and follows up with clarification of requirements in response to questions from bidders.

PREPARATION OF REQUIREMENTS

The project engineering staff developed specifications, a scope of work, submittal requirements, test descriptions, a desired schedule, an estimate of cost, and other special instructions for PV system procurement on the PVUSA Project. Other project disciplines, including construction and procurement, reviewed this information before engineering prepared a purchase requisition. Engineering incorporated comments received from procurement in the documents at the draft stage, helping to clarify procurement issues and reduce the time required later to prepare subcontracts for placement.

The elements which should be provided by the engineering staff to the procurement specialists for PV system procurement are as follows:

- Specification – A detailed and precise description of the technical requirements to be met.
- Scope – A detailed and precise description of what the supplier is contracted to do to achieve the requirements of the specification. Deliverables are listed here including the principal items of work, drawings, reports, test results, options, services, etc.
- Schedule – A detailed list of milestones leading to completion. All deliverables are listed. Additional milestones may be listed if they are significant or considered to be useful for measurement of progress.
- Budget – An estimate of project funds required for the work. An engineer's estimate is required, particularly for cost type subcontracts, or contracts where adequate competition may not be available.
- Special conditions – A detailed list of additional requirements including key individuals involved in the work, a description of the overall project, the location of the site and other information that may be of interest to the supplier. For example, price incentives were incorporated to compensate for success or failure in meeting target system ratings, and liquidated damages were incorporated as an incentive to meet schedule.

- Suggested sources of supply – In many instances the technical staff has valuable knowledge about prospective sources of supply. This information is included in the requirement documents provided with a requisition.

The basic document developed by the PVUSA engineering team to acquire PV systems was the “specification” which included most of the above elements in a single document. Although the overall approach was successful, the intermingled specification, scope, schedule, terms, and conditions were reported to be unwieldy by several sources in response to bid requests issued by PVUSA. The document has, however, been used as the basis for procurement specifications for several non-PVUSA procurements.

SOLICITATION PACKAGE DEVELOPMENT

The requirements developed by the engineering staff are submitted to the procurement specialist in a requisition and incorporated into a draft subcontract, and this draft “agreement” becomes part of the bid solicitation package. A complete bid solicitation package includes:

- An invitation letter briefly describing the goods or services to be acquired, establishing the date when proposals are due, and providing the name, address, and phone number of the person to contact with respect to the solicitation.
- An instructions to bidders section describing the project, pre-award activity, desired qualifications, a description of the contents of the technical proposal that will portray the approach to be taken, and the equipment that will be provided in compliance with the specification; a Form of Proposal to be completed and submitted including price, schedule, exceptions and alternatives; the signature of a person authorized to bind the offeror; and other aspects of the procurement including the criteria to be used in selecting an offer for award.
- A complete draft subcontract to fully appraise offerors of the terms under which acquisition will be made. The draft includes the subcontract schedule which is a collection of the key points of the agreement such as pricing, special conditions, etc. Certain portions of the subcontract schedule are blank. These blanks are compiled into the Form of Proposal which is filled in by the bidder and signed to complete the subcontract. The more generic “general conditions” are included to cover routine provisions for business practices, labor rules, subcontract changes, and government procurement-required clauses, etc. The technical specifications, drawings, etc. are included as attachments.

Table 3-1 lists the contents of a typical bid solicitation package. The bid solicitation packages prepared by PVUSA contained detailed instruction to bidders on the information to be incorporated in their offers.

Table 3-1
Summary of Typical Bid Solicitation Package

- Invitation Letter
 - Invites a proposal or quotation
 - Establishes a due date
 - Identifies the point of contact
- Instructions to Bidders
 - Instructions
 - Bidder information and site visit
 - Preproposal conferences
 - Technical proposal instructions
 - Commercial proposal instructions (including Form of Proposal)
 - Bidder qualifications
 - Selection criteria
 - Representations and Certifications
 - Type of organization
 - Employer identification
 - Parent company notifications
 - Place of performance
 - Authorized negotiators
 - Selection Criteria
- Draft Subcontract
 - Agreement
 - Identifies the parties
 - Provides identification
 - Lists associated documents
 - May include a synopsis of scope, schedule, and price
 - Evidences acceptance
 - Subcontract Schedule
 - Statement of work with references to technical specification for details
 - Items and prices (blank draft to be completed based on form of proposal information)
 - Delivery schedule including key milestones
 - Performance requirements (e.g. progress payment, incentives, key personnel provisions, etc.)
 - Administration
 - Inspection and acceptance
 - Packing and marking
 - Special conditions
 - General Conditions
 - Business practices
 - Records and reporting
 - Labor and work rules
 - Site and environmental conditions
 - Changes, termination, disputes
 - Socioeconomic clauses
 - Data, patents, copyright
 - Attachments
 - Specifications
 - Drawings
 - Standards
 - Others as appropriate

Array and system solicitations and construction solicitations included an invitation to visit the site. Pre-proposal conferences were scheduled to provide familiarity with engineering and construction aspects of the work, and to acquaint prospective bidders with the project and requirements of the solicitation. Many portions of the bid solicitation package reflect good business practices and are routinely included for procurement of a wide range of equipment and services.

Firm, fixed-price contracts are the most appropriate vehicle for acquiring goods and services in most cases. Fixed-price incentive subcontracts were used for PV systems and major components to emphasize critical schedule or performance goals. Materials, supplies, and equipment were acquired under fixed-price purchase orders.

Site services were acquired under various types of subcontracts. Certain site craft services were hired on a time-and-materials basis when continuing requirements were anticipated without advance knowledge of the work to be performed. Open orders were issued for supply items where it was possible to competitively establish catalog pricing.

Appendix B is a sample PVUSA bid solicitation package for a turnkey PV system showing how many of the elements are expressed in an actual solicitation. The provisions unique to procurement of a PV system were mainly contained in the subcontract schedule, the general conditions, and the selection criteria.

Subcontract Schedule

The following describes elements of the subcontract schedule that were specific to the acquisition of PV systems:

- A statement of work established the level of performance in kilowatts for PVUSA Test Conditions to be achieved by the PV system contractor, and then referred to the technical specification for detailed information.
- A form of proposal required certain commercial and technical data to be submitted and was used to identify items and prices that established the offeror's price for his goods and services. This resulted in receipt of consistent offers that could be directly compared and evaluated fairly. Options were included in items and prices for spare parts, on-site services of seller's technical representative, and optional systems.

- Key milestones were included in the period of performance to track engineering, major system components, construction, and field testing prior to acceptance.
- Progress payments were offered to minimize total system cost. Progress payments provisions offered in the subcontract were based on measurable performance. Measurement was required to be objective. The process of establishing verifiable progress reduced the probability of making advance payments for unperformed work.
- Performance incentives included in the payment provision provided an important element of protection, in that deficiencies in system ratings and changes to system design were offset by retention held against progress payments. Incentives were initially offered for over- and under-performance of the US systems. Later contracts, including Kerman, required that performance achieve the target value with incentives offered for performance in excess of the target value.
- A schedule incentive was included in the Kerman contract providing daily price incentives for early installation and daily assessments for late completion.
- A key personnel provision was included in the contract to guarantee the availability of professionals deemed necessary for the successful performance of the work. Key personnel provisions required that critical individuals remain on the project or that they be replaced by individuals of equal qualifications as measured by PVUSA. This feature enabled PVUSA to insist that capable individuals remain in charge of the work.
- Certain facilities and utilities were provided to contractors to minimize cost. These included water, a storage area with parking, access roads, and perimeter fencing.
- All permits were provided by PVUSA.
- Work rules were established at the jobsite and licensing laws were identified. A memorandum of understanding was required of each contractor with respect to construction work of PVUSA, recognizing the established relationship between PVUSA's construction manager and the local building trades.
- Appropriate elements of the offeror's proposal were incorporated by reference in the contract document.

General Conditions

Terms and conditions initially selected for use in the EMT subcontract documents were primarily those found in standard orders for commercial products and for construction. Remedies for delays included termination and liquidated damages clauses. In general, these remedies failed for the initial PVUSA procurement of EMT systems because of difficulties in product development. In some cases the PV modules were not developed and ready for sale at the time the subcontract was issued. Efforts to expedite subcontracts were not effective under these conditions and there were no alternative sources for these proprietary products. When unable to successfully complete qualification tests, for example, no further

work could be performed under the subcontract until the technical difficulties were resolved through additional, independent R&D by the supplier. This temporarily suspended work on the PVUSA subcontract until the problem could be resolved.

PVUSA involvement in these R&D activities continued since the project team, and particularly the TRC, had valuable pertinent knowledge. The resulting desire to aid in resolving technical difficulties tended to extend the subcontracts rather than terminate them when it was apparent that significant additional work would be necessary to produce acceptable PV modules.

The later development of subcontract terms and conditions for a third EMT procurement and a second US procurement attempted to resolve the dilemma caused by a supplier's inability to continue performance. Successful module qualification and adequate demonstration were made prerequisites for continuing the work. Not until modules were qualified and successfully demonstrated were suppliers allowed to continue with manufacture and deployment of their product. This approach proved to be in the best interests of all parties. Suppliers selected for PVUSA that failed to meet the qualification step of the subcontract were not allowed to proceed with the remaining activities of the subcontract. This avoided a protracted effort to resolve the technical difficulties in product development that was not intended to be part of the scope of the subcontract.

The success of incorporating pass-fail conditions (often referred to as off-ramps) in the subcontracts was a major step toward resolving the dilemma between the attempt to demonstrate new technology and to meet conditions favorable to the needs of utilities. The phased procurement approach offered an opportunity to evaluate new developments without undue exposure to delay and failure.

The following describes additional specific conditions that are considered particularly relevant to PV system contracts:

- Stringent safety provisions were included because of the hazards associated with PV and the lack of general awareness of these unique hazards.
- A warranty covered correction of non-conformities of design, material, workmanship and title, and further covered sound construction practices 2 years from the date of acceptance. An additional warranty covered factory repair or replacement of defective PV devices for a period of 3 years following the end of the 2-year period.

- A detailed acceptance procedure was included in the technical specification.
- Intellectual property rights clauses of the code of federal regulation were included as a requirement of the cooperative agreement between PVUSA and the Department of Energy.

Selection Criteria

Selection criteria were developed to identify meaningful yardsticks for suppliers to use in tailoring their offers to meet the requirements of PVUSA. Weighted selection criteria provided an objective method of ranking competitive offers. Scaled values were assigned to each selection criteria and the total of those values provided a measure of direct comparison.

Selection criteria was an important element of PV acquisitions due to the emerging nature of photovoltaic technology and the limited experience accumulated by suppliers, integrators, and the utilities in placing PV technology in a utility environment. Product qualification and product performance were identified as key technical selection criteria. The ability to manage projects and meet schedule were also identified as an important part of the selection process. Appendix C lists selection criteria used in the EMT, US, and Kerman solicitations.

Prequalification was a preliminary part of the selection, conducted prior to the actual bidding process and selection for award. It is a useful tool in limiting the field of bidders to those who can demonstrate an ability to perform. Module qualification was a prerequisite for being allowed to participate in the bidding process for providing utility scale PV systems. This was in contrast to the earlier EMT procurements where module qualification was included in the scope of subcontracts providing contractors some compensation towards defraying the cost of performing specific qualification tests.

PREPARATION OF THE BIDDERS LIST AND SOLICITATION OF BIDS

Sources of photovoltaic development and manufacture known to PVUSA were listed to establish a database of prospective firms to furnish the EMT PV arrays and associated systems. Sources derived from private and governmental publications were added to the list. A request for an expression of interest was sent to each of the listed firms prior to each major PV acquisition, giving them a description of the project, inviting them to express their interest in participating, and asking for a list of their qualifications. In this way the prospective offerors were able to do advance planning for the acquisitions to follow. Similar source lists were prepared for manufacturers of balance-of-system components, specifically inverters.

The EMT contractors accepted the responsibility of installing their product at the Davis site, but failed to meet the requirement to be registered as a licensed contractor in the State of California. In the requirement of the solicitation, it was understood that firms without the required license at the time of award would obtain all appropriate licenses prior to installation of their product. On occasion, it was necessary to revise an EMT contract by deleting field installation work, thereby changing the concept of EMT to a purchase arrangement rather than a contract to furnish and install. This is a cost-effective remedy at a manned facility where site personnel are available to perform or supervise the work. Otherwise, the failure of a contractor to obtain the proper licenses would be a costly and time consuming problem.

Very few qualifying constraints were imposed on prospective bidders for utility scaleable systems, and no pre-qualification constraints were placed on emerging technology array suppliers. PVUSA wanted every firm involved in the area of photovoltaic technology to have the fullest opportunity to participate. Competition was free and open, with further participation narrowed according to the qualifications demonstrated in any response received. Suppliers of commercial products were considered qualified on the strength of their product history. Formal bid lists were prepared for all major equipment requirements and construction activities, providing a fair degree of competition.

A request for proposal comprised of the aforementioned bid package elements was issued to each of the PV firms that expressed interest in participating on the PVUSA project.

Clarification of Requirements

Prospective PV system bidders were invited to seek clarification of any question concerning a solicitation. Later, solicitations were tailored to incorporate lessons learned in earlier bidding cycles. A primary goal was to establish uniform procurement practices that could be applied as guidelines on similar projects conducted by others.

Queries received from prospective PV offerors were answered by repeating the question and providing a response. Both were sent to every firm on the list of invitees. This approach ensured that all participants received the same complete information and had a competitive advantage.

A site visit was scheduled so prospective offerors could examine the PVUSA facilities and the area in which their equipment would be installed. Furnishing various items under PVUSA control was cost effective. Available utilities and facilities were shared.

Geological investigations were conducted at the jobsite by PVUSA and a summary of the geotechnical report was included in the solicitation, together with an offer to provide the full report if requested. The availability of soils information, on which suppliers were not allowed to rely, stemmed from a desire that such investigations be included in a system contractor's generic responsibility. PVUSA assumed that future systems contracts would be on independent sites where advance soils information would not be available. Although offerors were not allowed to rely on soils data for systems at Davis, it was later decided that PVUSA would stand behind the soil data for the Kerman site.

Site inspections provided direct knowledge of conditions to offerors. Pre-bid meetings allowed an exchange of information related to the project and fostered a meaningful question and answer session. Proposal instructions were structured to obtain comparative offers from all interested parties. System descriptions were invited from which reviewers could determine advancements in technologies of interest. Detailed information on an offeror's qualifications, experience on similar projects, and the qualifications of sub-tier participants allowed an evaluation of strengths and weaknesses. Offerors were invited to express confidence in their product by identifying attractive terms of warranty.

These interchanges between PVUSA and potential suppliers set the stage for subsequent communications and extensive monitoring activities conducted by the project during the performance of subcontracts.

Section 4
SELECTION

This section briefly describes the selection process used by the PVUSA project for awarding subcontracts to PV suppliers in competitive bidding.

EVALUATION OF BIDS

Bids were evaluated on the basis of selection criteria set forth in the solicitation documents. (See Appendix C.) Pertinent facts were first listed in an evaluation form, followed by an evaluation of each offer against these criteria, noting any noncomplying features. Additional clarification was conducted where needed, being mindful not to introduce bias into the evaluation process.

Bid evaluations for the purchase of EMT arrays or US systems were first conducted by the project team. Input from each discipline (engineering, construction, procurement, and management) were consolidated. These data were then provided to the TRC to consider in ranking the bids.

Bid evaluations for services and other non-PV equipment were performed by the Bechtel project team.

PREPARATION OF RECOMMENDATIONS

Evaluations and objective conclusions for EMT arrays and US systems were documented by the TRC in a meeting preceding the SC meeting. The TRC then presented its findings to the SC, reviewing the selection criteria and making a recommendation of the arrays or systems that were considered in the best technical and commercial interests of PVUSA.

Recommendations for purchases and subcontracts other than EMT arrays and US systems were submitted directly to PG&E by the Bechtel project team for approval by the PVUSA project manager. The recommendation letter serves to document the file on such issues as negotiations and competition.

SELECTION (EMT AND US SYSTEMS)

The SC convened to review the TRC's recommendation and make a selection. Selection was based on the chosen criteria, and direction was then given by the SC to the project team.

In certain instances the SC required that additional requirements be placed on suppliers. These requirements were generally tied to the level of confidence that a supplier could meet the requirements of the specification or schedule.

NEGOTIATION AND AWARD (EMT AND US SYSTEMS)

Negotiations were conducted with each supplier selected by the SC to incorporate additional requirements, resolve remaining exceptions and clarifications, and establish a performance schedule for the subcontract. Negotiations were also conducted to establish progress payment schedules.

Section 5
ADMINISTRATION

This section describes administration and control of the procurement process after subcontract award, and includes contract changes, claims, disputes, close out, and records retention.

ADMINISTRATION AND CONTROL

A summary of contract requirements is prepared soon after award of a subcontract for use by the administrator in monitoring compliance with terms of the subcontract. The schedule for expediting activity and field inspections is considered at that time, and plans for these activities are included in the file. Progress reports are required from each supplier, and information from these reports and other direct contacts are included in the data provided by procurement to be considered at regular project action item meetings. Progress payments are monitored to assure that the amounts to be paid coincide with measurable progress by the supplier and amounts prescribed by the subcontract documents. Submittals are monitored against contract requirements. Submittal records are maintained by the project engineer. The administration process is shared by various members of the project team depending on the subject being monitored. Technical matters are the purview of engineering, field matters are the purview of construction, and contractual matters and general administration are the purview of procurement.

When major deviations from plan are experienced, the circumstances are evaluated and the plan is adjusted accordingly. Identification of prospective deviations is a key element in the administration of ongoing work.

Detailed schedules developed early in the planning phase changed dramatically with time. This was a result of forces unique to emerging technology more than any other factor. The inability to achieve projected results caused the delay and cancellation of work; a condition not normally expected. However, important lessons were learned in monitoring outside activities. PV supplier projections are usually optimistic unless the process is broken down into its finite elements so that individual steps can be evaluated. Factory surveillance was found to be invaluable, particularly at the critical initial stages of product testing and manufacture.

Several factors were observed that affected a supplier's schedule performance, resulting in significant delays. For example, changes to system design after design submittal were not always supported by

adequate field testing and documented performance. These failures point out the need to properly assess an offeror's project control procedures and the individuals proposed to conduct these activities.

Inspection procedures and rights to conduct quality surveillance at manufacturing facilities provided a necessary window into progress and performance in conjunction with reports and final delivery. Testing and progress reports supplemented PVUSA's ability to monitor performance and increased the expectation of compliance.

System suppliers were in many instances unable to obtain warranties from their subsuppliers equivalent to the warranty offered to PVUSA. Under these circumstances the system supplier incurred additional cost in furnishing warranty service to PVUSA that was required to be purchased by them from the subsupplier. Delays were encountered while the system supplier negotiated with subsuppliers for parts or services. In addition, failures that could be attributed to more than one component of a system required extensive analysis before the problem was actually pinned down and corrective action taken.

CHANGES, CLAIMS, AND DISPUTES

In every instance where a supplier questioned the direction given by PVUSA, the situation was fully documented. These issues were predominantly resolved through a continued interchange with the supplier. However, in those instances where a claim was formally made, thorough documentation invariably resulted in a means for mutual agreement and settlement. Changes were made in a timely manner when appropriate, thus allowing work to continue uninterrupted.

Termination provisions included in PVUSA subcontracts were found to be inappropriate for the developmental nature of PV technology. Remedies set forth in the provisions were found to be unenforceable, as performance was controlled by the one-of-a-kind nature of the systems acquired. In particular, delays in performance could only be rectified by actions of the seller and not as provided in the clause. This observation led to the concept of phased procurement in which off-ramps were included to remedy a failure to achieve intermediate milestones.

CONTRACT CLOSEOUT

Closure

After the PV system has been constructed, tested, and rated (as described in Sections 6 and 7), and when all contractual actions are completed, the files are closed. Closure includes a final review to ensure that all transactions have been completed, final amendments are written, final releases have been received when appropriate, and final invoices have been paid. Property records are maintained in conjunction with commitment records, and these records are closed by transfer of custody or disposal as directed by the PVUSA Project Manager. Conclusion of the warranty period marks the final entry in the procurement file.

Retention

After the contract is completed, records are sent to permanent records storage for the number of years prescribed by the contract or by company policy, whichever is longer. The period of records storage varies depending on the legal nature of the documents. Generally, records are kept for a period not less than 3 years after final payment. Longer periods apply to records associated with claims or disputes.

Section 6

ACCEPTANCE

This section addresses the four stages of the PVUSA acceptance process for turnkey PV systems including:

- Verification that all engineering documentation and construction is complete
- Completion of a preparallel inspection and start-up
- Completion of a 30-day conditioning period
- Completion of a 30-day performance rating period (The actual methodology for establishing the power rating is covered in detail in Section 7.)

OVERVIEW

Acceptance is an incremental process involving a number of inspections and tests carried out before and during initial start-up and operation of the system as shown in the block diagram, Figure 6-1. These activities may be broken down into four stages, according to sequence and the organizations involved. Appendix D is an excerpt from the Kerman technical specification giving another description of the acceptance process and more details on individual acceptance tests.

1. The process begins with the PV system supplier providing written notice that the system is complete and is offered for acceptance. Certain inspections are completed by the project to verify that engineering documentation and construction are complete. If these inspections are satisfactory, PVUSA takes custody of the system and performs checks to confirm that electrical circuits meet requirements, and that the system is ready for a preparallel inspection. With acceptance of construction, a major milestone is complete, resulting in a payment to the seller as agreed in the subcontract.
2. Next, utility technicians perform the preparallel inspection and verify that the system may be safely connected to the utility grid and started up. After permission to parallel is received, the joint owner/contractor team conducts the start-up.

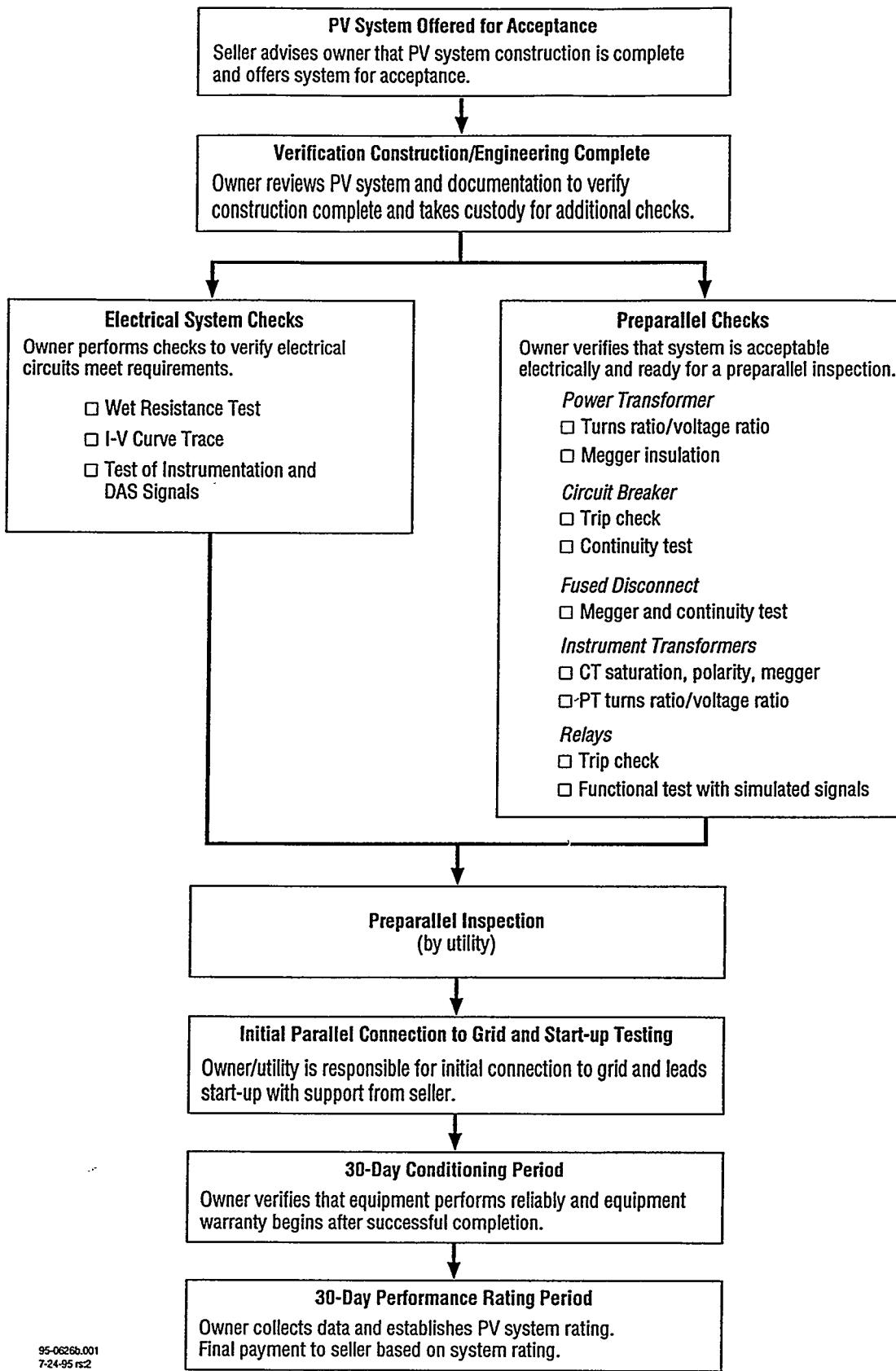


Figure 6-1 PVUSA Field Acceptance Test Block Diagram

3. The owner operates the system for a 30-day conditioning period to verify reliable and proper operation. The supplier maintains the system and is responsible for correction of any system discrepancy noted during the conditioning period. The warranty period is started upon successful completion of this stage.
4. Finally, the owner operates the system for a 30-day data collection period, and calculates the performance rating for the system. The 30-day performance period may be delayed if the weather is not optimal for establishing an accurate power rating. Under the PVUSA subcontract the final payment to the supplier is contingent upon the power rating established.

If for any reason the system fails to pass one of these stages, the supplier must repair or modify the system so that the acceptance process can continue. In an extreme case, the owner may return custody to the seller for additional work until the system is ready to be offered again for acceptance.

A fundamental issue during the acceptance process is system custody. Under some contractual arrangements, the owner takes custody of the system after the first stage when construction is complete, even though acceptable operation has not been demonstrated. In this case the owner would be responsible for start-up of the completed system and would have total control over the system and the utility interface. Generally, key suppliers and subcontractors would be retained by the owner to support start-up.

An alternate contractual relationship could provide for a joint start-up effort, where the seller agrees to retain custody until the system is verified to operate safely and effectively. In this case the prospective owner/utility and seller develop start-up tests and procedures, the utility operates the switches for tests which cause an interaction with the utility grid, but the seller monitors each step. In the latter case, the responsibility and liability for damage could be less clear.

On the PVUSA project, custody transferred to PVUSA at the construction complete stage (before start-up), however, the equipment sellers were present during start-up and were responsible for the proper operation and repair of equipment they supplied. Procurement documents should clearly define the point in time of title or custody transition from seller to owner.

The following sections describe the activities carried out in each of the four stages of acceptance. The methodology used to calculate the power rating in the final stage of acceptance is described in Section 7.

VERIFICATION OF ENGINEERING AND CONSTRUCTION COMPLETE

To start the acceptance process, the PV supplier must notify the owner in writing that construction work is complete and that the system is ready for acceptance. The owner's objective at this point is to be sure the physical work (construction) and paper work are completed so that start-up and final acceptance may proceed without delay or damage to the system.

Engineering Documents

Engineering document requirements (supplier submittals) are defined in the PVUSA technical specification. (Appendix E lists those used for the Kerman system.) A list showing each document required, quantity, kind of copy (reproducible/other), and schedule is included. Supplier documents are recorded, upon submittal, in a design document registration (DDR), which provides a complete list of all supplier documentation and easy access to information concerning the status of each document. The PV system cannot start the acceptance process until all the required engineering documentation has been submitted and meets requirements for quality and completeness. Incomplete engineering design documents are logged in an engineering punch list.

Changes may be required to the system during start-up and testing. The supplier is then required to correct all drawings or material that may be needed to reflect the system configuration at the time of successful completion of the operational test. This includes a final (as-built) operation and maintenance manual.

Construction Inspection for Completeness

Surveillance and monitoring of the construction activities of turnkey PV systems suppliers starts with the mobilization of the workforce and its arrival on site. Construction is routinely monitored for compliance with safety programs, workmanship, equipment, and materials. Quality control (QC) tags may be used to mark construction work not in compliance with the requirements of the contract. The following items are typically reviewed to verify construction complete:

- Records of inspection and cable test results
- Conformance to technical specifications and drawings
- Reports on concrete cylinder breaks, materials certification
- Grounding system test results
- Torque verification (if applicable)

- Tracking operation verification (if applicable)
- QC log
- Testing to confirm "construction complete"

A check of all engineering and construction records is performed to confirm that the construction has been completed in accordance with requirements. Incomplete construction items are logged in a construction punch list. Incomplete deliverables, if any, are dealt with as individual items. Clearance of all punch lists and open items is necessary prior to acceptance of the system as "construction complete."

Supplier tests during construction are frequently monitored for procedures, instruments used, readings obtained, and anything having bearing on the validity of the results recorded (e.g., concrete slump tests, megger insulation tests). If results are marginally acceptable, then PVUSA may repeat the test to obtain an independent verification. After verification that construction is complete, PVUSA takes custody of the PV system and conducts additional inspection and tests.

Field Wet Resistance Test

The field wet resistance test (FWRT) is also known as a "wet megger test" since a battery-operated insulation tester or megger is the primary source of the dc voltage applied during the test while the array is being sprayed with water.

During the FWRT a soft spray of water (simulating rain) is used to wet the front and back sides of the array. Typically, an aqueous surfactant is added to the water to reduce the surface tension, and promote penetration of any openings in the insulation in turn indicating a short to the ground. Megger readings are rarely marginal and usually show near zero resistance (a dead short to the ground) when a fault exists. Faults are usually caused by loose junction box covers, cracked junction boxes, connectors not designed for outdoor use, leaking diode cases, cracked module glass, pinholes in module backsheets, and nicked or cut wiring insulation. Faults are sometimes single and isolated but can also be generic, pointing to poor QC in either the manufacturing or construction processes of the system supplier.

Single faults are tagged with a colored ribbon at their location and logged in the construction punch list. Multiple or generic faults need to have the root cause identified (e.g., breakdown in factory, field QC program, or shipping) and may require wholesale replacement of components. Some repairs are simple,

such as tightening a junction box lid, but others, such as adding a sealant, may require a demonstration that the repair will last the 20 years specified in the contract.

The required repairs and/or component replacements are followed by retesting. When the FWRT results are acceptable, the insulation testing is complete.

I-V Curve Trace

A measurement of the open circuit voltage of each source circuit is taken and recorded using a calibrated dc voltmeter. The measured current and voltage (I-V) characteristics of each source circuit are then taken and recorded graphically using an I-V curve tracer. Prior to measurement of I-V curves, source circuits must be isolated from all equipment by providing a break in the circuit and ensuring all surge arrestors are disconnected.

The I-V curves are reviewed for evidence that each source circuit operates as designed. Failed modules will show up as "humps" on the curve. A comparison of curves from different source circuits may show differences which indicate problems. These I-V curves, taken at the time of system construction, can serve also as a baseline for evaluating long-term performance trends.

Checking Remote Signal Indications

The system supplier is required to furnish a number of instrument signals and to wire them to a terminal strip in an interface junction box (IJB) furnished by the project. These signals are for the PVUSA data acquisition system (DAS). All signals are fed into a Campbell data logger. Voltage signals are checked for accuracy; dry contacts are checked for function. Typical signals for the project DAS are as follows:

Inverter dc Input (per Inverter) Signals. These signals are 0 - 5 Volts dc.

- dc voltage – pole-to-pole for two-wire systems, or pole-to-ground for three-wire systems
- dc current – positive, negative, and neutral (if three-wire)

Inverter Status (per Inverter) Signals. These signals are by dry contact.

- System on (run mode)

- System in shutdown mode
- System in standby mode
- PCU overtemperature
- Array dc ground fault (dc ground current exceeds trip levels)
- Smoke detected
- System trouble (group alarm)
- Synchronization error shutdown

Irradiance Signal. The irradiance signal is a millivolt signal from a pyranometer or a pyrheliometer in the plane of array.

Temperature. The module temperatures are sensed with a Type T thermocouple located on the backs of three modules in the array field.

PREPARALLEL INSPECTION AND START-UP

Preparallel inspection is required by the utility that owns the distribution system to which the PV system will be paralleled. For PVUSA this is PG&E.

PG&E has defined a comprehensive set of testing and inspection requirements for third party – independent power producers (IPPs). PVUSA is treated as an IPP by the PG&E region responsible for the grid connection. These PG&E requirements were developed principally for connecting large rotating machines, and some interpretation and adaptation have been necessary for PVUSA PV systems.

Utility procedures vary but usually require any power producer of greater than 100 kW to complete three specific steps to establish priority to interconnect to the utility system (and usually prior to any construction). Since there may be competition for available capacity in certain areas, it is important that a power producer complete these three steps:

1. Provide a complete project description and proof of site control.
2. Request a detailed interconnection study.

3. Provide a project fee escrow account which is refundable when the project becomes operational.

Additional detail is provided in Figure 6-2, which is a reproduction of a PG&E interconnection flowchart from Section 1 of its *Power Producers Interconnection Handbook*.

Utilities typically require IPPs to formally request preparallel inspection. This request is made sufficiently far in advance of the scheduled inspection so that utility requests for fees, information packages, power purchase, or other requirements can be accommodated in the project schedule.

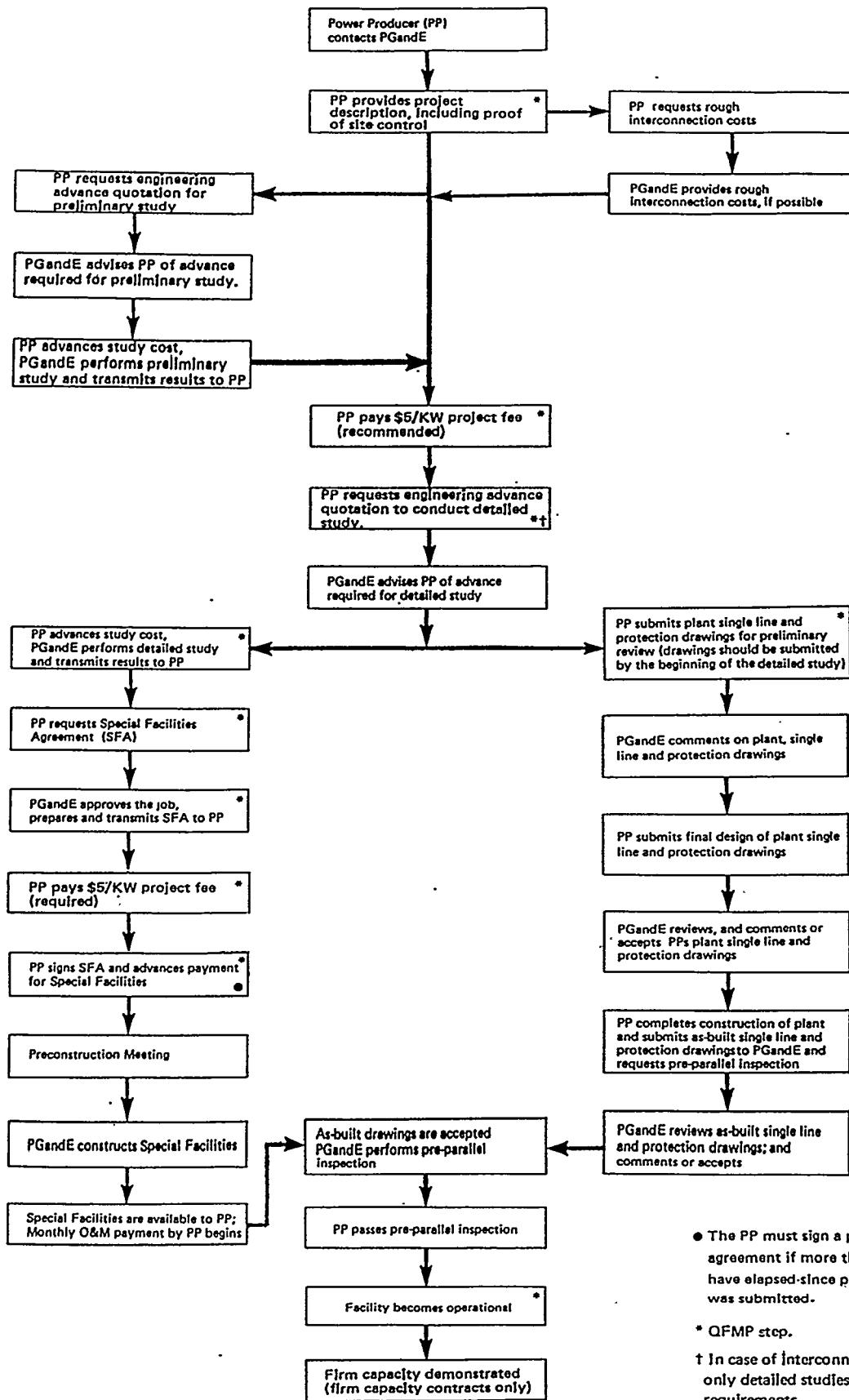
Once the preparallel inspection requirements are known and a date agreed to, the project can perform some of the planned preparallel tests in advance as a check (as shown in Figure 6-1). This is done to minimize the potential for a schedule delay should the utility find unacceptable conditions and require remedial actions and a second inspection. The preparallel inspection is performed by utility technicians, and if successful, the PV owner is granted permission to parallel and conduct start-up testing.

Start-up Process

Since most of the start-up process is concerned with the operation of the PCU, the manufacturer may desire to perform initial checks or tests prior to start-up and further acceptance testing. The manufacturer's representative should be present or should be available for telephone consultation during start-up. The owner is in charge of start-up and responsible for all activity including insurance, and personnel assignments/responsibilities during start-up.

The start-up should be conducted in accordance with a start-up test procedure prepared in advance by the owner. This document can be prepared by the owner or delegated to others. The procedure should cover fundamental operation in accordance with specifications and be tailored to the capabilities of the system. Review and concurrence by the supplier is recommended prior to initiating tests. Appendix F is a sample start-up test procedure which includes the following sections:

- Section 1 Introduction and description of responsibilities
- Section 2 Tests on initial operation and safety
- Section 3 Readiness of the dc generating system



- The PP must sign a power purchase agreement if more than 6 months have elapsed since project description was submitted.

* QFMP step.

† In case of interconnection studies, only detailed studies meet QFMP requirements.

Figure 6-2 PG&E Interconnection Flowchart

Section 4 Readiness of the ac grid connection

Section 5 Sample start-up test procedure

Prior to start-up, the appropriate responsible persons and all individuals in the start-up team should be identified. Results, signatures, and dates should be recorded at each step of start-up to provide a complete record. When the procedure is successfully completed, the PV array will be on-line with its peak or automatic power tracking control in operation and all signal circuits verified and operational.

Incomplete Start-up

Equipment does not always function acceptably during start-up. Should start-up have to be suspended for investigation and/or repair, the circumstances should be recorded and the system turned back to the PV supplier for correction. Start-up may resume after correction is complete.

Since holdups may be minor (blown fuse) or major (equipment damage) the decision of when to resume testing and at what stage or level will be made by the owner.

Completion of Start-up

When start-up is complete and the system is up and operating, copies of the annotated record of the start-up procedure should be retained by the owner, the PV system supplier, and the PCU manufacturer as documentation.

30-DAY CONDITIONING PERIOD

Under PVUSA procurement conditions the operating PV system is required to undergo a 30-day (cumulative) conditioning exposure following start-up, for three purposes:

1. To furnish the buyer with an opportunity to check the quality of the ac power output. The check will be for compliance to the requirements of the technical specification. These requirements, as a minimum, reflect the performance criteria set by the utility. The utility criteria address the harmonic content, power factor, and voltage fluctuations allowed on a generating system connected to the utility grid.
2. To demonstrate system reliability the test is for 30 cumulative, not consecutive, days; the intent is to assess, subjectively, system operability. A 30-day test requiring 95 percent availability over 30 consecutive days is an alternative. In particular, stable operation of the PCU is required over the 30 days during which the PCU response to internal and remote control signals and the transmission of data will be demonstrated; all components

of the system must operate properly. No data are collected for rating purposes, but the DAS is calibrated during the 30 days.

3. The 30 days furnishes a "light soak" period for modules subject to significant initial degradation.

During the 30 days, the PV supplier will perform any and all required modifications or maintenance on its system. The PV supplier will typically be required to give the owner 24 hours advance notice if clearance of the grid connection is required.

Should significant malfunctions develop during the 30 days, then the "clock" is stopped while the PV supplier makes repairs. Such suspension and resumption will occur at the sole discretion of the owner.

System Acceptance

When the 30-day conditioning test is completed satisfactorily, the owner formally accepts the operating PV system by furnishing written notification of acceptance signed by an authorized person. This is a major milestone and initiates the warranty period.

30-DAY PERFORMANCE RATING PERIOD

Once the PV system has successfully completed the 30-day conditioning period, it should be fully operational and generating power consistent with the requirements of the purchase agreement. However, final payment may depend on the power rating established for the system.

The 30-day performance rating period is a time set aside for the owner to collect data for the purpose of rating the system. At the conclusion of this period the owner will finally determine if the PV system output meets the power rating required in the purchase agreement. If the output falls short, the supplier may be required to provide additional PV panels to meet contract requirements or the final payment may be adjusted to compensate for the shortfall in system power rating. The rating procedure is described in Section 7.

Section 7

SYSTEM RATING

This section describes the process used by PVUSA to rate the power output of PV systems and modules.

NEED FOR RATING

A rigorous PV system rating process is necessary to establish a consistent basis for evaluating PV module and overall system power output and efficiency. For US systems purchased under turnkey contracts, the overall system performance is of primary interest. US systems receive an overall system ac output rating measured at the grid interconnection level of 12.47 kV. EMT systems receive dc ratings since the objective of these demonstrations is to compare PV module output and efficiency. Depending on the contract provisions, final payment for an accepted PV system may depend on the output rating.

SYSTEM RATING METHOD

The power output of a PV system changes greatly depending on irradiance and other weather factors. Therefore, it is important to establish a consistent set of reference conditions for rating system power. The reference conditions used with the PVUSA rating method are referred to as PVUSA test conditions (PTC). PTC are practical to measure in the field and yield ratings that are more indicative of field performance and more conservative than ratings based on the standard test conditions (STC) favored by manufacturers. PTC are defined as:

- 20°C ambient temperature
- 1 m/s wind speed at 10 meters above grade
- 1,000 W/m² global plane-of-array irradiance for flat-plates
- 850 W/m² direct normal irradiance for concentrators

Given the above reference conditions, there are several ways to rate the power output of a PV system. Power measurements using conventional utility revenue meters, special power testing instruments, current-voltage (I-V) curve tracers, or dedicated data acquisition systems can all be used. However, each of these types require that measurements be taken under conditions identical to the reference conditions, or that the measured results under the given conditions be scaled accurately to represent what the output would be

under the reference conditions. The uncertainty using these rating techniques can be as little as $\pm 3\%$ when conducted properly under favorable conditions, but $\pm 5\%$ to $\pm 10\%$ is more likely.

PVUSA applies a regression modeling technique for rating PV systems in which numerous quality-screened measurements are used to achieve uncertainties on the order of $\pm 3\%$. These measurements are provided by a data acquisition system with calibrated instruments which records a statistically large number of 10-minute average observations. The following parameters are measured:

- POA irradiance as measured by a precision spectral pyranometer (PSP) for flat-plate arrays and a normal incidence pyroheliometer (NIP) for concentrator arrays
- Ambient temperature (measured at the site meteorological station)
- Wind speed (measured at the site meteorological station 10 meters above grade)
- System power output (measured at the 12.47 kV utility interface between the contractor's PV system and the PVUSA facility for US systems; dc power is measured for EMTs)

Instruments must be calibrated periodically to ensure that data are being recorded accurately. Instruments calibrated and frequency of calibration are shown in Table 7-1.

Table 7-1
Calibration Checks

System	Subsystem	Procedure Reference	Frequency
Davis			
DAS	Data loggers	Campbell Scientific	3 years
	Weather station	PVUSA	Biannual
EMT Metering	ac/dc metering	PVUSA	Annual
	Inverters	DECC/Helionetics	Annual
US-1 Metering	Power/energy	PVUSA	Annual
	Inverters	Manufacturers	Annual
Main 12-kV Bus Metering	Power/energy	PVUSA	Annual
	Energy	PG&E	Annual
Kerman			
DAS	Data loggers	Westronic/Harris	Annual
	Weather station	PVUSA	Annual
Low Voltage metering	Power/energy	Westronic/Harris	Annual
	Inverters	Westronic/Harris	Annual
12-kV Bus Metering	Power	Westronic/Harris	Annual
	Energy	Westronic/Harris	Annual

To model the instantaneous output of a system under ambient conditions, PVUSA uses a simple model (Equation 7-1) to predict PV power as a function of POA irradiance, ambient temperature, and wind speed. The model has two principal uses: to calculate the expected power under PTC, which establishes the system rating and final system payment, and to track variations in the PTC rating over longer periods.

Equation 7-1

$$\text{Power} = I_{\text{POA}} * (A + B * I_{\text{POA}} + C * T_{\text{amb}} + D * W)$$

Where:

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

A linear regression is performed on test data to determine the constants A, B, C, and D. With these constants known, the rating is calculated by evaluating Equation 7-1 at the PTC values for each variable.

The useful range of Equation 7-1 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.

Equation 7-2 represents another measure of performance which describes power as a function of POA irradiance and module temperature. This equation is not used in PVUSA's rating procedure, but is commonly used by PV manufacturers to describe performance under STC defined as:

- 25°C cell temperature
- Air mass 1.5 spectrum

- 1000 W/m² POA irradiance

A linear regression is performed to determine constants K1 and K2, and the expected power can then be calculated.

Equation 7-2

$$\text{Power} = I_{\text{POA}} * (K1 + K2 * T_{\text{mod}})$$

Where:

T_{mod} = module temperature (°C)

K1, K2 = regression constants

Equation 7-3 describes the back-of-module temperature as a function of irradiance, ambient temperature, and wind speed. It is not used explicitly in the rating procedures, but is used to calculate supplementary performance information. It is also the starting point from which Equation 7-1 is derived. Equation 7-1 results from substituting Equation 7-3 into Equation 7-2 and simplifying. Equation 7-3 is used to obtain estimates of T_{mod} under PTC.

Equation 7-3

$$T_{\text{mod}}, ^\circ\text{C} = C1 * I_{\text{POA}} + C2 * T_{\text{amb}} + C3 * W$$

Where:

C1, C2, C3 = regression constants

DATA SET

A balanced and well distributed data set may be obtained by requiring that a portion of the irradiance observations be at least as great as the reference irradiance (1000 W/m² for flat-plate systems or 850 W/m² direct normal irradiance for concentrators). A threshold of 10 kWh/m² of insolation at or above the reference irradiance is recommended to ensure that an adequate input data set is available for calculating

PTC ratings. Depending on location, data collected during winter months may not be adequate (particularly for single-axis tracking systems). A 30-day performance rating period is generally sufficient to collect data.

To reduce error contributed by transient or nonuniform sky conditions, data are excluded if the plane-of-array (POA) observations differ by more than 10 percent from a site reference pyranometer, when such a reference is available.

In order to preserve a basic assumption that prediction errors are unbiased and randomly distributed, all observations at irradiances below 500 W/m^2 are discarded from the input data set. For some ratings, the minimum irradiance threshold may be as high as 750 W/m^2 , depending on the temperature and wind speed distributions. The lower irradiance observations are discarded because plots of prediction error (residuals) vs. irradiance usually show a distinct fanning-out pattern at progressively lower irradiances whenever the data set has a concentration of observations at high irradiances (which is often the case). As the residual plots should not have any identifiable patterns, keeping the lower irradiance observations in the regression data set invalidates the random error assumption.

The residual plots are also examined for obvious anomalous observations that can skew the regression results. Determining whether an outlying observation is anomalous can be somewhat subjective, but points that lie much beyond three standard deviations can usually be omitted.

After calculating an initial rating, Equation 7-1 is used to backcast the measured power at each data point. Then, a plot of predicted versus measured power is viewed to identify any anomalous points. Table 7-2 shows the computed coefficients for all of the PVUSA systems rated to date.

When insufficient data are available due to poor irradiance conditions, an interim rating may be provided based on available data. A final rating is provided later based on data that does meet requirements.

Table 7-2
Power Equation Coefficients for EMT and US Systems

System	Coefficient	Coefficient	Coefficient	Coefficient	PTC Rating	r^2
	A	B	C	D		
SSI (Arco) EMT-1	21.69	-1.202	-0.094	0.167	18.7 ± 0.7 kW dc	0.99
Solarex EMT-1	17.07	-0.5480	-0.045	0.109	15.7 ± 0.5 kW dc	0.99
Sovonics EMT-1	17.43	-0.3350	0.013	-0.014	17.3 ± 0.7 kW dc	0.99
UPG EMT-1	15.71	-1.545	0.081	-0.045	15.7 ± 0.3 kW dc	0.98
ENTECH EMT-1	25.60	-5.651	-0.066	0.328	16.5 ± 0.5 kW dc	0.92
APS US-1	563.2	-39.00	-2.370	2.750	479 ± 13 kW ac	0.97
IPC US-1	282.1	-70.15	-0.898	1.582	196 ± 3 kW ac	0.97
SSI US-1	82.39	-10.05	-0.310	0.888	67 ± 2 kW ac	0.92
SSI US-2 Kerman	701.1	-142.2	-3.384	6.412	498 ± 6 kW ac	0.97
Maui EMT-1 Host	19.96	-2.642	0.056	0.079	18.5 ± 1 kW dc	0.99
Austin US-1 Host	22.83	-3.416	-0.081	0.124	17.9 ± 0.6 kW ac	0.94
SMUD Host	287.8	-58.68	-1.161	1.505	207 ± 6 kW ac	0.96
Astropower EMT-2	19.34	-1.644	-0.033	0.164	17.1 ± 0.6 kW dc	0.98
NREL/NYPA	14.17	-0.2732	-0.061	0.198	12.9 ± 0.7 kW ac	0.90

r^2 = Regression coefficient of determination: 1 = perfect correlation, less than 0.9 = suspect

ERROR ALLOWANCE

PVUSA characterizes the statistical uncertainty in the power rating using a 95% confidence interval. This means that 95% of the points in a system rating data set, when used with the fitted model, will yield a predicted power within the range shown in Table 7-2. Rating uncertainties for the 95% confidence interval are typically in the range of $\pm 2\%$ to $\pm 5\%$ depending on the spread in the data set collected for each system.

The rating uncertainty from the statistical point of view must be considered in conjunction with the instrument accuracy for the required measurements. For example, PSPs have a typical accuracy of $\pm 3\%$, and other instruments are typically calibrated to $\pm 1\%$. The combined instrument uncertainty of $\pm 3\%$ to $\pm 5\%$ is consistent with the observed $\pm 2\%$ to $\pm 5\%$ statistical uncertainty for the 95% confidence interval.

Based on these considerations, PVUSA Technical Specifications typically have allowed the addition of 5% to the calculated system output when evaluating whether or not the system delivers the power specified in the contract. However, no allowance for error in rating was allowed for the Kerman system and the final contract settlement was based on the rating of 498 kW, although the system was designed to be 500 kW. The terms for establishing and using the system rated power should be delineated in the purchase agreement.

SYSTEM PERFORMANCE AFTER RATING

PVUSA systems are rated based on data taken after a 30-day conditioning period and usually on a clean array with little or no module soiling since PV suppliers usually exercise their right to clean arrays before data are collected. Power output can be expected to drop over time due to both soiling and a degree of module degradation which can range up to 20 percent or more over an anticipated 20-year life, depending on the module technology. Additionally, some cell technologies may be sensitive to seasonal spectral changes.

POWER PROFILE VALUE

Two power output measurements can be made. First is the peak power output at defined test conditions as described in this section. Second is the annual energy produced (AEP). Output is metered so that kWh output is recorded. Bidders for the Kerman PV plant were requested to furnish in their proposals power profile calculations of the hourly plant output as data to be used in bid evaluations. The PVUSA request was detailed in Section 4.0 of the Kerman RFP instructions to bidders (Appendix B). Section 4.0 also included the Kerman data on which the bidders' calculations were based.

The value of grid support PV systems, such as Kerman, to utilities is a complex matter; refer to PVUSA Topical Report "The Value of Photovoltaics in the Distribution System - The Kerman Grid-Support Project," prepared by Tom Hoff and Howard Wenger. (PG&E R&D Report 007.5-94.15, issued June 15, 1995.)

Section 8

WARRANTY AND CORRECTION OF DEFECTS

PVUSA contracts provided for the warranty to start after successful completion of the 30-day conditioning period of observation.

Warranty provisions selected for PVUSA subcontracts were very stringent. The supplier was required to resolve all issues in the field. Later revisions to the warranty clause specified that PVUSA would communicate with the supplier when a failure occurred, and the supplier would provide instructions for local corrective action. This allowed timely correction of many small problems without the added expense of sending a supplier representative to the field. The risk of PVUSA actions interfering with warranty was resolved by language that allowed supplier-directed support, and the thorough documentation of telephone direction preserved the original warranty. Contract language should clearly state when warranty is to take effect; upon receipt or when placed in service.

Warranty periods varied with the commodity. PV devices were selected to a certain extent on the basis of the period of warranty coverage. Warranty provisions for the Davis and Kerman systems are shown on Table 8-1. PV devices are customarily warranted for a number of years. Construction and components manufactured to order are customarily warranted for 1 year after equipment is first operated. Commercial products sold in substantial quantities customarily carry the manufacturer's standard warranty which may vary from 3 months to 1 year from the date of delivery to the end user.

Table 8-1
PVUSA
Synopsis of Warranty Provisions in PV Contracts

Subcontract 19271-XX	Supplier	Date of Array Final Acceptance	General Warranty ⁽¹⁾	Module Warranty	Special Provisions
D31	SSI (ARCO) (EMT-1)	1/6/89	12 months	Under general	12 months on corrective work (from its acceptance)
D32	UPG (EMT-1)	12/14/89	60 months	Under general	
D34	Sovonics (EMT-1)	9/12/89	12 months	Under general	12 months on corrective work (from its acceptance)
D35	SOLAREX (EMT-1)	11/19/90	12 months	Under general - module removal/shipping costs borne by PVUSA	12 months on corrective work (from its acceptance) and ⁽¹⁾
D33	ENTECH (EMT-1)	4/5/91	12 months	Under general	12 months on corrective work (from its acceptance)
D96	AstroPower (EMT-2)	11/18/94	2 years	Additional 3 years after general warranty	
D100	SSI (US-1)	1/23/91	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 ⁽²⁾ on power output (.85 of accepted rating)
D215	SSI Kerman	6/15/93	2 years	Additional 3 years after general warranty	

(1) 10-year limited commercial warranty

(2) From final acceptance

Section 9

RECOMMENDATIONS

Following are recommendations and lessons learned based on PVUSA's experience with the procurement, acceptance, and rating activities.

PV-SPECIFIC PROCUREMENT

It is important to distinguish whether PV systems and components offered and purchased are developmental or fully commercialized. Currently many PV systems and components are developmental and selecting these systems presents special issues. Since it is inevitable that developmental systems must be purchased as the PV industry grows, the following lessons learned and recommendations are offered:

Procurement of Developmental Systems

- Allow sufficient schedule contingency and flexibility relative to your requirement date when purchasing a developmental system. Add incentives to achieve critical schedule milestones.
- Contracts which pay only for delivered items will offer some protection against failure to deliver.
- Contracts for which there is a risk of failure to perform should have clear "off ramps" to facilitate termination with minimal impact (e.g., no termination costs).
- For PV modules not already qualified to the IQT, allow suppliers the time to perform qualification tests and to repeat tests. Ability to readily achieve module qualification can not be assumed.
- Require a QA/QC plan, review and approve the plan, then insist that the supplier meet the requirements established in the plan.
- Send shop inspectors to check on supplier's progress, and to monitor product quality versus the QA/QC plan. This will uncover potential noncompliance before the product is delivered.
- Shop tests of high power components such as PCUs are highly recommended since there is not a long history of production and use of these units. New PCU designs should undergo prototype testing and correction of design deficiencies at a field installation since many of the conditions causing operating problems in the field cannot be duplicated in the shop (e.g., cloud enhancement impact on PCU operation, inadequate compensation for solar gain, sensitivity to grid transients, harmonic suppression, continuous power source equivalent to PV array).

Procurement of any PV Components or Systems

- In most cases the owner should take responsibility for soil test data so that suppliers can offer lowest pricing on what they know best – the equipment – and do not need to include contingency for uncertainty or differing site conditions.
- Previous installations of identical or similar components should be visited or researched. PVUSA EMTs and utility-scale systems are good sources of information on system and component performance.
- The contract should clearly delineate the required system output under various conditions. For example, if the array is expected to be soiled for long periods of time and the owner needs full output under these conditions, the system should be designed with the appropriate margin.
- The commitment of the manufacturer to long-term spare parts supply and technical support should be required. Technology changes in the PV industry can quickly make equipment obsolete, and when equipment is no longer produced, spare parts may become expensive to manufacture.

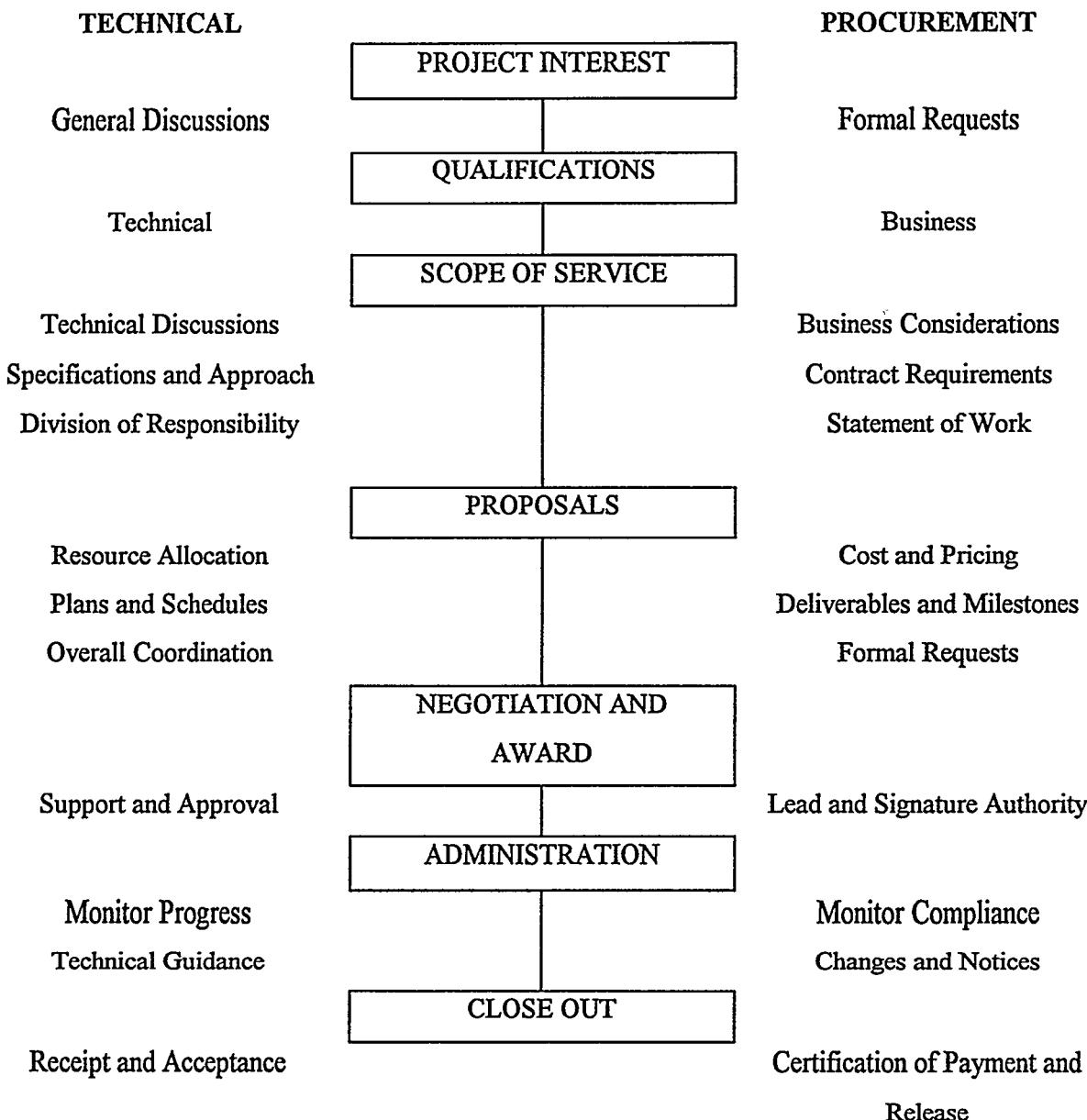
GENERAL PROCUREMENT

The following generic procurement recommendations are part of good procurement practice and equally applicable to procurement of PV systems.

- Establish a document control scheme for procurement. Consolidate records into official files. Create master records for each procurement activity and file these records in a repository accessible to the individual responsible for administration. When different administrators are assigned to office and field activities, organize their separate files in a formal manner designed to allow consolidation when the project is complete. Do not allow duplication or lax filing habits for official records. Duplicate working records should be marked as copies so that they can be recycled when no longer required.
- Make a concentrated effort to extract commercially significant information from technical data, and place this information in the official procurement file. Ensure that technical personnel are equipped to recognize important commercial information.
- Establish a division of responsibility matrix to show which discipline has responsibility for various activities on the project. An example of such a matrix, Table 9-1, shows the technical and procurement relationships to supplier contacts. Each element of the relationship has unique responsibilities that must be considered during supplier contacts.

For example, a request for an expression of interest by a supplier must provide the supplier with a description of the project and identify the element of the project in which the supplier can participate. A technical description is not sufficient to allow the supplier to gauge its interest. A certain amount of information must be provided regarding commercial terms to properly establish the prospective relationship. These separate elements must be provided correctly to avoid later misunderstandings. The same concept

Table 9-1
Supplier Party Contacts



is applicable to determining a supplier's qualifications. It is not enough to evaluate technical background, experience, and capabilities. One must also consider financial and commercial strengths and weaknesses in determining if a source of supply is fully qualified.

- For major systems, assign a full-time project representative trained in the discipline of procurement commencing at the outset and continuing throughout the project.
- For crucial components, plan to visit suppliers prior to award and at selected intervals during the work to verify that critical operations have been performed and conducted successfully. The added expense of such visits must be weighed against the probability of delays and the potential for developmental component failure.
- Carefully review selection criteria so that meaningful elements are chosen; include strict conformance as a requirement of the order. Think in terms of the features that are important and require offerors to explain these features fully. Choose criteria that can be objectively quantified, leaving little chance to subjectivity. For example, system output is objective and forms a proper basis for selection, but prior experience is subjective and should be considered only as a means of determining that an offer will be accepted for evaluation.
- Make sure that the bid list is fairly prepared. Don't preselect prospective offerors for award. Avoid discussions with prospective offerors other than to learn about their qualifications and experience. Do not discuss the solicitation requirements or any aspect of the work.
- In a competitive solicitation, do not introduce unfair advantage by allowing one bidder to correct a failing that others have not been advised was a criteria for selection. In the ranking process, stick precisely to the selection criteria.
- Coordinate administration between the various disciplines to avoid direction being given by an unauthorized party.
- Examine the failure mechanism before selecting terms and conditions. Consider module qualification as pass-fail selection criteria.
- Add a stipulation in warranty for spare parts including replacement modules. If some components fail frequently, suppliers will thereafter maintain a suitable number of spares at the jobsite to be used for replacement. This will allow prompt replacement while parts are sent to the factory for servicing or new parts are ordered.

ACCEPTANCE AND RATING

Recommendations are offered for each of the phases of the acceptance process.

Construction Completeness

- Monitor the PV suppliers' construction activity throughout the process. Pay particular attention to compliance with PV safety procedures, testing (concrete tests, electrical insulation tests), and calibration of tools such as torque wrenches.

- Monitor adherence to construction procedures and tolerances, particularly mechanical tightness of all connections including conductors, electrical boxes, modules fasteners, and structural members.
- Monitor labor hours and equipment used on change order activity.

Preparallel and Start-up Testing

- Prepare a coordinated schedule and define a clear chain of command in the start-up process. Document all phases. Start-up is one of the most critical activities in PV system installation and has the highest potential for occurrence of failure, damage, or delays. The number of parties involved requires a high level of coordination.
- Maintain constant liaison (contact) with the utility during the construction period to ensure that the utility requirements for the electrical interface are understood and complied with.
- To the extent possible, perform your own preparallel testing as a rehearsal for the utility testing. This will minimize surprises and possible schedule delays.
- Obtain familiarity and training with the PCU before and during the start-up process. This is critically important due to the role of the PCU in the system. Witnessing the PCU factory testing is a good opportunity to become familiar with the PCU design, controls, displays, protection, and test procedures.
- Require the PV supplier to furnish a PCU start-up procedure as soon as the factory testing is complete. Be aware that the factory testing is done with limited dc power input and full power testing will probably not occur until field start-up.
- Require the PCU manufacturer's technical representative to be present during start-up.
- Establish sufficient confidence to allow unattended system operation at the conclusion of start-up tests.

30-day Conditioning Period

- Conduct power quality testing during the 30-day period.
- Operate at the maximum power point and exercise the controls and operation of the system.
- Document all abnormal occurrences during the 30 days.
- If possible conduct an infrared (IR) scan to detect hot spots or problem areas with the PV modules. Alternately, measurements of dc current can be made for each module string as an additional check of the PV array health.
- Ensure that calibration documentation is in place for all relevant instruments.

Performance Data Gathering

- Encourage the PV supplier to wash the array prior to the data gathering period.
- Clean the radiometers (PSP or NIP) prior to gathering data and monitor cleanliness during the test period.
- Encourage the PV supplier to be cognizant of and/or monitor the process.
- Avoid collecting data for rating systems, particularly one-axis tracking systems, in winter. Site conditions will dictate timing, but generally April through October will provide acceptable data.
- If using the PVUSA performance model, limit data set to times with irradiance of 750 w/m² or higher if possible. The tightness of the regression, r^2 , should be greater than 0.95
- Recalculate the expected performance with the existing data set after coefficients are determined and plot the error as a check to see if the error is random. If error does not appear random, something may be skewing the data set.

Appendix A

PVUSA COMMITMENT REGISTER
FOR KERMAN

PVUSA COMMITMENT REGISTER FOR KERMAN

PO/SC

WBS	PO/SC	DATE	S U P P L I E R	DESCRIPTION	AMOUNT
SPD	D215	04/15/92	Siemens Solar	500 kW system	4,819,452.00
SPK	K001	12/07/92	Central Fence Company	Perimeter fences/gates	38,729.00
SPK	K002	10/13/92	Garcia Paving Company	Roads, test piers, etc.	132,720.08
SPK	K003	10/15/92	Independent Plumbing	Site septic and plumbing	13,693.00
SPK	K004	10/15/92	Fraser Supply	Water well	6,793.68
SPK	K005	09/23/92	Space Leasing Company	10'W x 40'L office trailer	25,625.00
SPK	K006	06/01/92	Hanna & Hanna	Site survey	5,000.00
SPK	K007	06/01/92	Grainger	Tools and misc. supplies	5,000.00
SPK	K008	12/29/92	Patricia Drew	Condo, rent + PG&E/phone	11,460.00
SPK	K009	06/05/92	Souza's Lettering	Caps	255.00
BSK	K010	06/15/92	Graybar Elect. Co.	Service pedestal	1,353.00
SPK	K011	11/04/92	Office Depot	Operations supplies	2,000.00
SPK	K012	10/14/92	Storage Container Co	Cargo container	1,995.00
SPK	K013	11/05/92	Tressler's Office Products	Trailer furniture	929.00
BSK	K014	01/11/93	Kortick Manufacturing	Grounding device	1,651.16
SPK	K015	03/15/93	Bud Manter	Landscaping	4,098.00
SPD	K016	04/15/93	Budget Signs	Front sign (Kerman)	1,000.00
BSK	KE01	12/07/92	Square D Company	15 kV Metal - Enc. Switchgear	25,761.00
BSK	KE02	11/16/92	Ingalls Power Products	48V battery/rack	7,463.00
BSK	KE03	11/10/92	Bitronics, Inc.	Meters	7,404.00
BSK	KE04	10/14/92	Basler Electric	Overvoltage relay	1,340.00
BSK	KE05	07/22/93	Square D Company	Transducer	865.00
BSK	KE06	09/11/92	AVO International	Test switch	109.32
BSK	KE07	08/11/92	Jemtec	Recording meter	2,460.00
BSK	KE08	12/02/92	Ingalls Power Products	Battery charger	2,553.00
BSK	KE09	09/21/92	Gibbons	Buss support	1,320.00
	KE10		Void	Void	
BSK	KE11	12/11/92	Solidstate Controls	UPS	5,675.00
BSK	KE12	10/14/92	GE Supply	15 kV shielded power cable	2,470.65
BSK	KE13	03/01/93	GE Supply	Distribution panelboards	3,215.00
BSK	KE14	11/05/92	Rochester Inst. Systems	Annunciator	2,490.00
BSK	KE15	12/11/92	GE Supply	Cable	2,144.54
DAK	KE16	01/27/93	Anixter Bros.	SCADA cable	2,288.40
BSK	KE17	03/15/93	Steven Engineering	Terminal blocks	496.44
MTN	KE18	06/14/93	Consolidated Electric	Fuses	1,270.02

Appendix B

KERMAN
REQUEST FOR PROPOSAL
(Commercial)

REQUEST FOR PROPOSAL

19271-US-2-K

KERMAN

UTILITY SCALE PHOTOVOLTAIC POWER SYSTEMS

(US-2)

PHOTOVOLTAICS FOR UTILITY SCALE APPLICATIONS

(PVUSA)

BECHTEL CONSTRUCTION COMPANY

JANUARY 1992

RIGHTS IN TECHNICAL DATA

Offerors are cautioned that proposals will be evaluated by a number of individuals from separate organizations and that proposals should be free from proprietary information not adequately protected. The project has executed confidentiality agreements with all persons who will review or have access to proposals received in response to the request. The confidentiality agreement will protect proprietary information supplied by the Offeror.

In the event a proposal will not stand alone without disclosure of proprietary information, such additional proprietary data as is necessary for a complete technical evaluation should be placed in a separate volume, marked with the following legends identifying restrictions applicable to the information it contains (Bechtel reserves the right to reject proposals should the unrestricted information be considered inadequate for the purposes of the entire review team).

Mark the title page with the following legend:

"This proposal includes data that shall not be disclosed outside Bechtel, PG&E or the PVUSA Technical Review committee and shall not be duplicated, used, or disclosed - in whole or in part - for any purpose other than to evaluate this proposal. If, however, a contract is awarded to this offeror as a result of - or in connection with - the submission of this data, Bechtel, PG&E and the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract.

This restriction does not limit the right to use information contained in this data if it is obtained from another source without restriction. The data subject to this restriction are contained in pages (insert number or other identification of pages)."

Mark each page of restricted data with the following legend:

"Use or disclosure of data contained on this page is subject to the restriction on the title page of this proposal."

Any information received by Bechtel in connection with this solicitation will be restricted in the manner provided above.

Offerors requiring further safeguards are invited to contact R. N. Dows by telephone at (415) 768-8503.

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PART A - INSTRUCTIONS TO BIDDER

1.0 GENERAL

These Instructions to Bidders are for use in preparing a proposal on the Proposal Forms prescribed in Part B subject to the Subcontract Documents in Part C.

1.1 Definitions

PVUSA Photovoltaics for Utility Scale Applications is a national public-private research and development project that is assessing and demonstrating the viability of utility scale photovoltaic electric generating systems.

US-2 Utility Scale Photovoltaic Power System-2. US-2 is the second round of PV demonstration systems for PVUSA.

Owner PG&E Research & Development, 3400 Crow Canyon Rd., San Ramon, CA 94583.

Bechtel Bechtel Construction Company, 50 Beale Street, San Francisco, CA 94105.

Bechtel's Procurement Representative

R. N. Dows, Contracts/Purchases Mgr., Bechtel Construction Company, 50 Beale Street, San Francisco, CA 94105, P. O. Box 193965, San Francisco, CA 94119
Telephone: (415) 768-8503, Facsimile: (415) 768-5568.

Construction Site Kerman Jobsite, a site located in Fresno County, California, between the town of Kerman and the City of Fresno.

Site Construction Manager DJ Shipman, P. O. Box 354, Davis, CA 95617, Telephone: (916) 753-0725.

Contractor The Bidder who is awarded a Subcontract to perform the Work as required herein.

1.2 Construction Site Visit and Bidder Information

Prior to preparing its bid, the Bidder should inspect the construction site in order to fully familiarize itself concerning the conditions to be encountered. Arrange to visit the site by writing to the Site Construction Manager with a copy to Bechtel's Procurement Representative. Direct all questions concerning the Request for Proposal to Bechtel's Procurement Representative.

2.0 BIDDER'S PROPOSAL

The scope of work requires that the Contractor design, qualify fabricate, test, ship, install, demonstrate, and start up a fully functional 500 kW ac base or alternate 250 kW ac photovoltaic (PV) system that meets the Specification requirements, Part C, Exhibit B, at the PG&E Grid Support Application (Kerman) Site in Fresno County, California. The PV modules/panels to be proposed shall be the same as those manufactured by APS (US-1), or ENTECH (EMT-1), or Mobil (US-1 IPC), or Siemens (US-1) for the Davis site in Phase 1 of PVUSA, or the previously proven Solarex MSX60 module which also is acceptable. As part of the turnkey system, prices shall be quoted for power conditioning systems based upon the same inverter units manufactured for the Davis US-1 procurement by Bluepoint Associates (Dickerson) or Omnim, or a previously proven Toshiba model which has at least two years of successful operating experience in a United States PV system of at least 100 kW capacity. As part of the turnkey system, prices shall be quoted for a foundation and structural fixed support or tracking system based upon the same design as PVUSA systems provided at Davis by Chronar (technology now controlled by APS) or ENTECH or IPC or Siemens, or some other previously proven fixed tilt or tracking system that shall have at least two years of successful operating experience in a United States PV system of at least 100 kW capacity. Systems designs previously installed at Davis are requested; modifications to these designs can be bid only as an alternate. Other BOS components proposed for Kerman including interconnecting wiring, connectors, circuit protection and diodes shall be as proven at Davis or equivalent unless higher quality is prescribed by the Technical Specifications. Delivery and installation is contemplated by the target date for start of performance testing on May 24, 1993.

The PV system proposed (module/panels, PCU system and foundation and support system) must comprise a complete and operating PV system conforming in all respects to the technical requirements of this RFP.

The Bidder shall comply with the following instructions in preparing its proposal.

- 2.1 Submit a firm fixed price proposal for a 500 kW ac base system and a 250 kW ac alternate system on the Proposal Forms provided in Part B, Bidder's Proposal, including all required attachments, together with a technical proposal (see 4.0). The instructions for preparing the attachments are provided in this Part A and in each attachment. Failure to complete the Proposal Forms in the manner prescribed and without alteration, addition or omission, may be cause for rejection as non-responsive.
- 2.2 Submit twenty-five proposal sets consisting of one unbound reproducible original and the remainder bound copies by certified mail, express carrier, or hand delivered to Bechtel.

- 2.3 Deliver sealed Proposals bearing a label identifying the Request for Proposal Number and addressed to Bechtel's Procurement Representative (see 1. 1 above) on or before the bid closing: 3:00 P.M. PST, March 2, 1992.
- 2.4 Proposals must be firm for a period of 60 days from the date of bid closing. Any proposal which is not complete in every respect may be rejected. All costs incurred by the Bidder in preparing its Proposal shall be borne by the Bidder.
- 2.5 Determine and include all applicable taxes, duties, premiums and all other costs in accordance with the terms and conditions contained in Part C.
- 2.6 Properly sign and date proposals where indicated. Proposals must be signed by an officer authorized to legally bind the Bidder contractually. Properly identify joint venturers or partners, if any. When requested, submit satisfactory evidence of the authority of any signatory on behalf of Bidder.
- 2.7 Should the Bidder find discrepancies in or omissions from the RFP or subcontract documents, or should the intent or meaning appear unclear or ambiguous, or should any other question arise relative to the RFP, notify Bechtel's Procurement Representative immediately. Replies to such notices may be made in the form of addenda to the RFP which will be issued simultaneously to all persons who have obtained the RFP.
- 2.8 Departures from the prescribed Proposal Forms may only be addressed by the Bidder under the Attachment entitled Exceptions and Alterations. In addition, Bidders are encouraged to point out in this Attachment those items in the specifications which it believes would lead to unduly high costs and to propose lower cost alternatives the Bidder believes meet the intent of the specifications.

3.0 PREAWARD BID SCHEDULE

Following issuance of the RFP, any revisions to the original solicitation will be issued as addenda. After proposals are received on the bid closing date, the PVUSA Project Team and Technical Review Committee will evaluate the Proposals and formulate recommendations to the PVUSA Steering Committee. Based on direction from the Steering Committee, Bechtel will meet with certain selected bidders for negotiations. Subcontract award is scheduled on or about the end of March 1992. Bechtel reserves the right to order one or more systems or reject any or all of the proposals at its sole discretion. Bechtel further reserves the right to make no awards.

4.0 TECHNICAL PROPOSAL

Submit a technical proposal, limited to a maximum of 70 pages, typed double-spaced and single-sided consisting of:

4.1 A written description of the photovoltaic PV system being proposed. Address plans for fabrication, installation, and testing of the PV system and its components. Include sketches, drawings, photographs or similar graphics as needed to clarify the written description. Specifically include:

4.1.1 a sketch or drawing showing the proposed layout of the equipment and appropriate dimensions,

4.1.2 a simplified electrical single line drawing,

4.1.3 a calculation showing all system losses including, but not limited to module and source circuit mismatches; soiling, tracking error, and structure deflection; wiring and connector resistances; blocking diode, switch, and fuse voltage drops; PCU efficiency; and transformer losses, and

4.1.4 power profile calculations, including hourly plant output for the proposed 500 kW base and 250 kW alternate systems. The value of the power output profile is based on capturing time dependent (i.e., load dependent) utility benefits based on the following equation:

$$\text{Power Profile Value} = \text{SUM} [(\text{Plant Output}_{\text{PDI}}/500 \text{ kW}) \times \text{WF}_{\text{PDI}}]$$

Where

Power Profile Value = a number between 10 and 20 (a 500 kW two-axis tracking system will result in a value of about 19 to 20; systems with ratings greater than 500 kW can achieve a total Power Profile Value greater than 20, however the maximum value will be limited to 20 for evaluation.

Plant Output_{PDI} = plant output for the *i*th hour based on the Kerman Peak Day weather data shown in Table 1.

WF_{PDI} = Kerman Peak Day weighting factor from Table 2, for the *i*th hour [dimensionless].

NOTE: Do not include soiling losses in the power profile value calculation. A sample calculation of the power profile value is provided in Table 3.

¹For the 250 kW alternate system, substitute 250 kW

Table 1. Kerman Peak Day Weather Data, July 3, 1991 (day 184)
 Kerman Latitude = $36^{\circ}42'$, Longitude = $120^{\circ}04'$

Hour (Pacific Standard Time)	Direct Beam Irradiance (W/sqm)	Global Horizontal (W/sqm)	Ambient Temperature (deg C)	Wind Speed (m/sec)
01:00	0.0	0.0	25.1	1.7
02:00	0.0	0.0	23.8	1.5
03:00	0.0	0.0	23.7	1.4
04:00	0.0	0.0	23.1	1.7
05:00	4.5	0.5	22.6	0.8
06:00	338.5	75.5	21.9	0.9
07:00	597.5	236.0	24.4	1.0
08:00	726.5	432.0	27.4	1.1
09:00	802.0	606.0	30.8	1.2
10:00	840.0	755.5	33.9	1.8
11:00	864.5	837.5	36.2	1.9
12:00	872.0	887.0	38.3	1.7
13:00	877.0	948.5	39.5	2.1
14:00	861.0	932.0	41.0	1.6
15:00	848.0	837.0	41.2	3.4
16:00	807.0	666.0	41.6	3.3
17:00	747.5	474.0	41.1	2.9
18:00	618.0	259.0	40.0	2.2
19:00	363.0	80.0	38.0	1.6
20:00	22.5	1.0	34.1	1.8
21:00	0.0	0.0	31.3	2.4
22:00	0.0	0.0	30.2	1.7
23:00	0.0	0.0	27.8	1.2
24:00	0.0	0.0	27.3	1.5

Figure 1. Kerman Weather Data

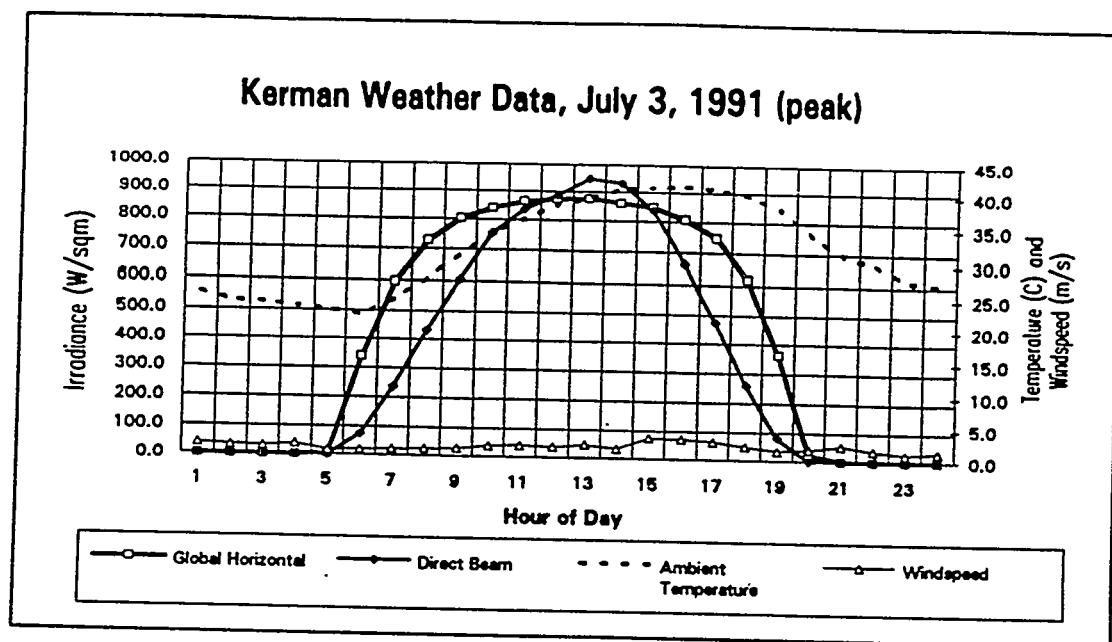


Table 2. Kerman Peak Day Weighting Factors

Time	WF _{PDI}
05:00	0.00
06:00	0.00
07:00	0.06
08:00	0.08
09:00	0.14
10:00	0.29
11:00	0.51
12:00	0.99
13:00	1.93
14:00	3.15
15:00	4.67
16:00	6.31
17:00	2.94
18:00	0.21
19:00	0.06
20:00	0.00

Power Profile Value Sample Calculation

A sample calculation of the power profile value, described in section 4.1.5, is provided in Table 3. The calculation is based on a fixed flat plate 500 kW ac rated plant at PVUSA Test Conditions. Arrays are tilted at 20 degrees and face due south. The total system Power Profile Value is 14.37.

Table 3. Sample Power Profile Value Calculation

Hour	WF _{PDi}	POA ² Irradiance (W/sqm)	Cell Temp. (deg C)	Power Output (kW ac)	Power Profile Value
05:00	0.00	0.0	22.6	0	0.00
06:00	0.00	24.1	22.7	0	0.00
07:00	0.06	97.7	27.6	50	0.01
08:00	0.08	299.7	37.2	157	0.03
09:00	0.14	527.0	48.1	269	0.08
10:00	0.29	725.2	54.1	362	0.21
11:00	0.51	838.9	59.6	410	0.42
12:00	0.99	901.9	63.5	433	0.85
13:00	1.93	953.9	66.2	452	1.75
14:00	3.15	919.6	66.8	435	2.74
15:00	4.67	799.8	60.6	389	3.63
16:00	6.31	583.4	55.7	289	3.65
17:00	2.94	335.3	49.2	168	0.99
18:00	0.21	113.6	43.1	55	0.02
19:00	0.06	25.0	38.7	0	0.00
20:00	0.00	0.0	34.1	0	0.00
Total					14.37

The bidder shall provide the Power Profile Value results in the same format presented in Table 3, including POA irradiance, cell temperature, AC power output, and Power Profile Value.

²POA Irradiance is defined as the plane of array irradiance, and represents the useable radiation component for PV electrical conversion (units: Watts per square meter).

Performance Calculation Methodology and Assumptions

The Bidder shall provide the power output and cell temperature calculation equations, and the method of calculating the plane of array irradiance.

The Bidder shall also provide all loss adjustment factors, including but not limited to those shown in Tables 4 and 5, which are used to calculate:

- (1) AC system rating (at PVUSA test conditions);
- (2) Power Profile Value; and,
- (3) Annual energy production for the energy cost calculation of Section 4.1.5.

Table 4. Power Loss Adjustment Factors

Loss Factors	Factors Assumed by bidder
dc cabling	
Diodes & connections	
Mismatch	
Transformer (daylight hours)	
Tracking Losses ³	
Power Conditioning Unit	
Others (please specify)	
Total	

The Bidder shall provide all energy loss adjustment factors used in the calculation of annual energy production for the energy cost calculation (EC) of Section 4.1.5, including but not limited to those shown in Table 5.

Table 5. Energy Loss Adjustment Factors

Loss Factors	Factors assumed by Bidder
Interarray shading	
Soiling/optical ⁴	
Transformer (night time hours)	
Availability of system	
Others (please specify)	
Total	

³Tracking losses result from inaccurate tracking and tracking strategies which do not track arrays at the minimum angle of incidence.

⁴Assume array field is washed 2 times per year, in May and July.

4.1.5 a derivation of values (AOM, AEP) and a calculation of energy cost based on hourly irradiance, temperature, and wind speed data, the installed cost for the proposed system, and estimated O&M costs. The energy cost is calculated by the following equation:

$$EC = (FCR * TC + AOM) / AEP$$

Where

EC = Energy Cost (in cents/kWh)
FCR = Fixed Charge Rate of 0.13
TC = Total Cost of proposed system, excluding sales tax
AOM = Annual Operating and Maintenance cost
AEP = Annual Energy Produced by the proposed system based on one year's worth of hourly average weather data for Kerman, California, provided on diskette

The total cost, TC, shall be the total cost of the proposed system. The cost of land and similar Owner's costs shall be excluded. An average annual O&M cost, AOM, shall be estimated for the 20 year design life of the proposed system. The proposal shall list materials, labor hours, and labor rates for each O&M item. This estimate shall exclude work performed by the Contractor under warranty, travel to the site, and maintenance of the site grounds. Both the total cost and annual O&M costs shall be in 1992 dollars.

The annual energy produced, AEP (in kWh), shall be based on the irradiance, temperature, and wind speed data provided on diskette and described in Table 6. A Readme file containing a detailed description of the data is contained on the data diskette (see Enclosure 1). The weather data are actual measured hourly average values retrieved from the Kerman weather station for the period January 1, 1991 to December 31, 1991. The energy produced shall be net ac energy delivered at the 12.47 kV output terminals of the proposed PV system. All system losses, such as PCU efficiency and degradation, as well as wiring, mismatch, and shading, shall be taken into account and listed in the proposal (including, but not limited to, the loss factors listed in Tables 4 and 5). Array surface soiling shall be estimated and taken into account in the calculation of both losses and annual O&M.

The Bidder shall also provide monthly energy production and associated results as shown in Table 7, including plane of array insolation, AC energy production, AC system efficiency, and AC capacity factor based on the system capacity at PVUSA Test Conditions.

Table 6. Kerman Hourly Weather Data

Site: Kerman, California	Data: hourly averages at PST	
Latitude: 36°42'	Period: 1/1/1991 - 12/31/1991	
Longitude: 120°04'	Ground albedo: 0.20	
Data	Units	Column Number
Year	calendar	1
Month	calendar	2
Day	calendar	3
Hour	Pacific Standard Time (PST)	4
Global Horizontal Irradiance	Watts per square meter	5
Direct Normal Irradiance	Watts per square meter	6
Ambient Dry Bulb Temperature	degrees C	7
Wind Speed	meters per second	8

Table 7. Annual Energy Performance Results (provided by Bidder)

Month	Plane of Array Insolation (kWh/sqm)	AC Energy Production (kWh ac)	AC System Efficiency (%)	AC Capacity Factor based on PTC rating (%)
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				
Annual				

- 4.2 A written description of QA/QC plans and module qualification testing plans. Indicate whether it is planned to submit previous module test results in lieu of results from tests conducted during the course of the proposed subcontract.
- 4.3 A completed Design Summary Sheet (see Part B, Attachment 9).
- 4.4 Information required by this part 4.0 for the alternate 250 kW system to the extent of departure from the 500 kW base system including a completed Design Summary Sheet.

5.0 SCHEDULE

Submit separate summary bar chart schedules for each of the proposed 500 kW base and alternate 250 kW systems. Develop the schedules in accordance with Part B, Attachment 2, utilizing appropriate legend figures to indicate start and end dates for each milestone activity.

6.0 BIDDER QUALIFICATIONS

Submit with your proposal, information showing qualifications to perform the work, including among other things:

- 6.1 A narrative describing management capability including specific methods to be employed in planning and control over progress of the Work.
- 6.2 The names and resumes of key personnel including the representative who will be responsible for all aspects of the work, the senior individuals responsible for activities in the office and factory, and the senior individual responsible for activities in the field.
- 6.3 An organization chart showing the relationship of this project to Bidder's other work, the relationships between segments of the organization that will participate in the work, and the positions that will be assigned, utilized or filled relative to performance of this project.
- 6.4 A description of facilities and equipment available and expected to be used for performance of the work.

7.0 SUBTIER SUBCONTRACT WORK

Submit a list of the names and addresses of all significant subtier subcontractors, their capabilities, experience, organization, resumes of key personnel, status of collective bargaining agreements and a certified financial statement. State briefly the scope of subtier subcontract work, delineating clearly the interface between the subtier subcontractor's work and the Contractor's work.

8.0 WARRANTY

Submit a description of warranty offered with the proposal, if any, that exceeds the minimum requirements prescribed by the Subcontract document. Extended warranties will be considered an objective measure of product reliability, maintainability and operating cost.

9.0 COLLECTIVE BARGAINING AGREEMENTS

Each Contractor performing work on a PVUSA jobsite is required to first become a signatory to the Memorandum of Understanding for the Photovoltaics for Utility Scale Applications Project (PVUSA) and to perform all work at the project site under the terms of the Memorandum (Attachment B to the draft Subcontract Schedule).

10.0 SUBCONTRACT DOCUMENT

Part C of this Request for Proposal contains the pro forma Subcontract to be awarded to the successful Bidder. Any exceptions to the terms, conditions, exhibits, annexes or their attachments shall be specifically stated in an attachment to Bidder's proposal marked Exceptions (see Part B, Attachment 8) with recommended modifications clearly stated and priced.

11.0 PAYMENT AND PERFORMANCE BONDS

At the option of Bechtel, Contractors may be required to furnish separate Payment and/or Performance Bonds. Evidence of bonding capacity and rate are to be submitted with proposals (see Part B, Attachment 7). If bonds are required they will be purchased at Bechtel's expense.

12.0 SELECTION CRITERIA

Proposals received in response to this RFP will be evaluated and ranked in accordance with the following criteria.

Recommendations for award will be presented jointly by the TRC and PVUSA team to the PVUSA Steering Committee for approval.

<u>Criteria</u>	<u>Points</u>
12.1 Peak load correlation (Power Profile Value, see 4.1.4)	20
12.2 Relative demonstrated experience with proposed modules, based upon previous successful, documented field test data and the ability of modules to pass the PVUSA module qualification test.	15
12.3 Relative capability of bidder's team to meet schedule and performance goals and to backup warranties.	15
12.4 Relative comparison of system design reliability and redundancy (e.g., two PCU's) to avoid single mode failures and to minimize O&M costs. Includes the ability to meet peak power under anomalous conditions such as soiling, tracking accuracy/failure, partially cloudy or hazy conditions, etc.	20
12.5 Additional warranty coverage above the minimum required for modules, dc BOS and structures/trackers, and the PCU and transformer.	10
12.6 Cost per kWh of peak energy (EC, see 4.1.5)	20
	<hr/> 100

PART B - BIDDER'S PROPOSAL

To: Bechtel Construction Company
50 Beale Street
San Francisco, CA 94105

Attn: R. N. Dows
Contracts/Purchases Mgr.

**Subject: REQUEST FOR PROPOSAL NO. 19271-US-2-K
UTILITY SCALE PHOTOVOLTAIC POWER SYSTEMS - KERMAN**

1.0 PROPOSAL

Having carefully examined the documents transmitted by your Request for Proposal No. 19271-US-2-K, dated January 23, 1992, and addenda _____ through _____, we hereby offer to furnish all engineering services, supervision, labor, materials, tools, equipment, supplies, planning, scheduling, insurance, support, and all other items necessary or desired to carry out the Work (unless specifically stated to be furnished by others) in strict accordance with the Subcontract documents, Specifications, and the implied intent thereof. Specifically, we hereby propose to perform the Work set forth in the Subcontract Documents, in the manner described in the Technical Proposal which is attached hereto, and in accordance with the following provisions:

2.0 BID PRICE

We will design, qualify, fabricate, test, ship, install, demonstrate, and startup a fully functional photovoltaic (PV) system that meets requirements of Part C, Exhibit B, Technical Specification.

At the sole option of Bechtel:

(A) One 500 kW ac base system,

OR

(B) one 250 kW ac alternate system.

Site grading, drainage, fencing, roads, interconnecting power, signal and data collection systems, and other necessary site facilities outside of the immediate plot boundaries of the PV system installation will be provided by Owner.

The schedules and prices should reflect time and cost savings inherent in replication and expansion of relevant Davis work, including but not limited to the following areas:

- o Reuse of PVUSA array and PCU systems designs and shop drawings.
- o Module qualification testing.
- o Manufacturing process development and testing.
- o Special jigs, tools and equipment required in the factory and for field erection.
- o Savings from larger raw material and purchased component orders.
- o Advancement along the fabrication and erection learning curves.

3.0 PERIOD OF PERFORMANCE

If awarded the Subcontract for this Work, we agree to start the work promptly after receiving a Notice to Proceed, and will complete the Work, in strict accordance with Part B, Attachment 2, Milestone Schedule.

4.0 ATTACHMENTS

We include as part of this offer our technical proposal and Attachments 1 through 9. We understand that any and all attachments or parts thereof may be incorporated into the final Subcontract Documents.

<u>List of Attachments</u>	<u>Number</u>
Items and Prices	1
Performance Schedule	2
Bidder's Qualifications	3
Subtier Contractors	4
Warranty	5
Collective Bargaining Agreements	6
Bonding capacity and rate	7
Exceptions and Alterations	8
Design Summary Sheet (insert in Technical Volume)	9
Technical Proposal	Separate Vol.

5.0 BIDDER'S WARRANT

By placing the signature of the authorized officer of the Bidder's organization on this form in the space provided below, the Bidder warrants that it has fully informed itself of the terms and conditions under which the Work will be performed, that it is thoroughly familiar with the requirements and specifications and that it will perform all Work in strict accordance therewith. The Bidder further agrees that all terms and conditions listed in Part C of this document are acceptable, subject to the exceptions (if any) set forth in Attachment 8 hereto. Bidder's proposal is firm and irrevocable for a period of 60 days after the bid closing date.

COMPANY _____

SIGNATURE _____ DATE _____

NAME/TITLE _____

CALIFORNIA CONTRACTOR'S LICENSE NO. _____

TELEPHONE NUMBER _____

TELEFAX/TELECOPIER NO. _____

ATTACHMENT 1

ITEMS AND PRICES

Minimum System Power	BASE <u>500 kW ac</u>	ALTERNATE <u>250 kW ac</u>
1. Design - deliver schedule, drawings, calculations, QA/QC plan, Independent Safety Review Plan/ Report.	\$ _____	\$ _____
2. Fabrication of Array Modules - deliver array modules (panels), factory test results, additional modules, and certified qualification test results.	\$ _____	\$ _____
3. Fabrication of Power Conditioning Systems - deliver power conditioning system and factory test results.	\$ _____	\$ _____
4. Construction - fabricate and install foundations, structures, array, additional equipment and instrument brackets.	\$ _____	\$ _____
5. Operations and Maintenance - deliver O&M manuals, special equipment and tools for maintenance.	\$ _____	\$ _____
6. Startup - debug equipment and deliver documentation and notice of completion.	\$ _____	\$ _____
7. Access roads and graveled area within plot boundaries	\$ _____	\$ _____
8. Applicable California Sales Tax	\$ _____	\$ _____
TOTAL PRICE	\$ _____	\$ _____
9. RECOMMENDED SPARE PARTS (exclusive of sales tax)	\$ _____	\$ _____
10. OPTIONAL TECHNICAL REP CONTRACT	LABOR	\$ _____ /Hr Plus Material and Travel at Actual Cost.

ATTACHMENT 2 - MILESTONE SCHEDULE

MILESTONE	1992											1993											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
ENGINEERING																							
Gen. Arrangement																							
Struct. Design																							
Elect. Design																							
PCU Specs.																							
Equipment List																							
O&M MANUAL																							
Draft																							
Final																							
QA/QC PLAN																							
Safety Plan																							
Safety Review Report																							
QUAL. TESTS																							
PCU																							
Mfg. / purchase																							
Test																							
Ship																							
STRUCTURE																							
Material																							
Fabrication																							
ARRAY																							
Module Mfg.																							
Test																							
Pack and Ship																							
INSTALLATION																							
Foundation																							
Structure																							
Array																							
PCU																							
wiring																							
30-DAY CONDITIONING																							
ACCEPTANCE TEST																							

ATTACHMENT 3

REPRESENTATIONS AND CERTIFICATIONS

1.0 THE BIDDER REPRESENTS THAT (CHECK AS APPROPRIATE):

1.1 SMALL BUSINESS: It () is () is not a small business concern. For additional information, call the buyer or see governing regulations of the Small Business Administration (13 CFR part 121).

1.2 DISADVANTAGED BUSINESS CONCERN: It () is () is not a small business concern owned and controlled by socially and economically disadvantaged individuals as found to be disadvantaged by the Small Business Administration as to Section 8(a) of the Small Business Act.

1.3 WOMAN-OWNED BUSINESS: It () is () is not a woman-owned business.

1.4 EQUAL OPPORTUNITY CERTIFICATION: (a) It () has () has not participated in a previous contract or subcontract subject to the Equal Opportunity article herein, or the article originally contained in Section 301 of Executive Order No. 10925, or the clause contained in Section 201 of Executive Order No. 11114; (b) it () has () has not filed all required compliance reports; and that representations indicating submission of required compliance reports, signed by proposed subcontractors, will be obtained prior to subcontract awards; c) it () has () has not developed and placed on file at each establishment affirmative action programs as required by the rules and regulations of the Secretary of Labor (41 CFR 60-1 and 60-2), or; (d) it () has () has not previously had contracts subject to the written affirmative action program required by the rules and regulations of the Secretary of Labor.

1.5 TYPE OF ORGANIZATION: It operates as an () individual, () partnership, () joint venture, () nonprofit organization (), corporation, incorporated in the State of _____.

1.6 EMPLOYER IDENTIFICATION NO. AND PARENT COMPANY:
It () is () is not owned or controlled by a parent company.

Bidder E. I. No.: _____

Parent company Name: _____

Address: _____

Parent E. I. No.: _____

ATTACHMENT 3 (cont'd)

2.0 THE BIDDER, BY SUBMISSION OF THIS OFFER, CERTIFIES THAT:

2.1 CERTIFICATION OF INDEPENDENT PRICE DETERMINATION: (i) The prices in this offer have been arrived at independently, without, for the purpose of restricting competition, any consultation, communication, or agreement with any other offeror or competitor relating to those prices, the intention to submit an offer, or the methods or factors used to calculate the prices offered. (ii) The prices in this offer have not been and will not be knowingly disclosed by the offeror, directly or indirectly, to any other offeror or competitor before bid opening or contract award unless otherwise required by law. (iii) No attempt has been made or will be made by the offeror to induce any other concern to submit or not to submit an offer for the purpose of restricting competition.

2.2 CERTIFICATION OF NONSEGREGATED FACILITIES: The offeror certifies that it complies with the nonsegregated facilities requirements of 41 CFR, Part 60-1, as amended, and agrees to the terms of the equal opportunity and affirmative action compliance programs, small business/small disadvantaged business/labor surplus area, veterans employment and geographical distribution requirements.

2.3 CERTIFICATION OR DISCLOSURE OF OWNERSHIP OR CONTROL BY A FOREIGN GOVERNMENT THAT SUPPORTS TERRORISM: Except as listed in below, the offeror certifies that no country identified by the Secretary of State as having repeatedly provided support for acts of international terrorism (i. e., Cuba, Iran, Libya, Iraq, Syria or South Yemen) has a significant interest in the offeror or in the entity which has mined, produced, or manufactured the product to be furnished under any contract resulting from this solicitation.

Firm/Country: _____

The foregoing representations, Part 1.0, and Certifications, Part 2.0, are made in connection with _____ (Solicitation/Subcontract/Order No.)

Company: _____

By: _____

Title: _____ Date: _____

Duns No. _____

ATTACHMENT 4

SUBTIER CONTRACTORS

If awarded a Subcontract, the Bidder proposes to employ the following major subtier subcontractors and suppliers. If no subtier subcontract work is proposed, the Bidder shall so state. If it is planned to use major subtier subcontractors but they are not yet selected, the Bidder shall so indicate. Bidder shall provide information with its proposal for named major subtier subcontractors and suppliers that is sufficient to allow Bechtel's determination of responsibility. Information that is provided in response to Part 7.0 of the Instructions to Bidder is considered sufficient.

NAME/ADDRESS

SPECIALTY

Bechtel approval must be obtained prior to awarding major subcontractors that have not been identified in the manner prescribed above pursuant to General Condition GC-35.

ATTACHMENT 5

ADDITIONAL WARRANTY

In addition to the warranty provisions set forth in the subcontract document, the bidder offers the following extended warranty for goods or services performed which are included in the prices stated in Attachment 1, Items and Prices:

() as indicated below. () additional coverage is not available.

ATTACHMENT 6

COLLECTIVE BARGAINING AGREEMENTS

I _____ (Bidder's authorized signature) acknowledge that any contractor performing construction services at the PVUSA, Kerman, California, jobsite shall become signatory to and perform all work at the project site under the terms of a Memorandum of Understanding similar to the one for Davis set forth in Attachment B to the Subcontract Schedule.

It is Bechtel's and Owner's intent to negotiate a similar Memorandum of Understanding to that set forth in Attachment B to the pro forma Subcontract with the cognizant building trades in the Fresno Area for work to be performed at the Kerman site. Contractors will be required to sign such an agreement at least 30 days before start of site work.

ATTACHMENT 7

BONDING CAPACITY AND RATES

Bechtel reserves the right, at its option and expense, to require payment and/or performance bonds in connection with performance of all or part of the work. Bidder offers the following information with respect to the provision of bonds:

Bonding Agent: Name _____

Address _____

Phone _____

Bonding Capacity/Rate _____

ATTACHMENT 8

EXCEPTIONS AND ALTERNATIVES

A. EXCEPTIONS

Bidder takes exception to the following (with the understanding that any exception to the form of proposal, specification, terms and conditions may be considered nonresponsive, and Bechtel may at its option reject and return any nonresponsive proposal):

() no exceptions to the Request for Proposal and attachments
() exceptions specifically listed as follows
() see exceptions listed on attached pages #__ through #__.

B. RECOMMENDATIONS

Bidder recommends the following improvements expected to result in cost savings to PVUSA.

{ } no exceptions to the Request for Proposal and attachments
{ } exceptions specifically listed as follows
{ } see exceptions listed on attached pages #__ through #__.

ATTACHMENT 9

DESIGN SUMMARY SHEET
(Submit separate forms for 500 kW and 250 kW systems)

1. Cell Type (e.g., Cz-Si, a-Si, etc.): _____
2. Module Design (e.g., 57X point focus, unframed glass laminate):

3. Module Overall Dimensions:
_____ inches wide _____ inches long _____ inches deep
4. Module Power at PTC** (stabilized): _____
5. Module Efficiency based on Items 3 & 4 above: _____ percent
6. Net module area excluding frame: _____ square meters
7. Module Efficiency based on Items 4 & 6 above: _____ percent
8. Panel Design (e.g., steel rails supporting 12 framed modules):

9. Panel Overall Dimensions:
_____ inches wide _____ inches long _____ inches deep
10. Structure Type (e.g., fixed tilt, 2-axis tracking): _____
11. Structure Design (e.g., steel frame, concrete foundations):
If tracking, describe the tracking strategy, accuracy, and maximum rotation angle capability of the tracking system

ATTACHMENT 9

DESIGN SUMMARY SHEET (cont'd)
(Submit separate forms for 500 kW and 250 kW systems)

12. dc System

(All values at PTC** unless stated otherwise)	<u>Module</u>	<u>Panel</u>	<u>Source Circuit</u>	<u>Array Field</u>
Maximum Power Voltage, STC*	_____	_____	_____	_____ vo
Maximum Power Current, STC*	_____	_____	_____	_____ am
Open Circuit Voltage, STC*	_____	_____	_____	_____ vo
Short Circuit Current, STC*	_____	_____	_____	_____ am
Series	_____ cells	_____ modules	_____ panels	
Parallel	_____ cells	_____ modules	_____ panels	_____ sou circuits

Nominal operating cell temperature (NOCT) _____ °C

Voc @ 0.2 kW/m², Tair = -7 °C _____ volts

Isc @ 1.2 kW/m², Tair = 46 °C _____ amps

Net dc power at PTC** (sum of module power-losses) _____ kW

13. Power Conditioner Manufacturer: _____

14. PCU Description (e.g., self-commutated, 2 parallel GTO
bridges) and number of PCU's:

15. PCU Efficiency: _____ percent at _____ kW ac full load

16. System Rated ac Power at PTC** : _____ kW

17. Calculated System Energy (AEP): _____ kWh/year and
cost of energy (EC) _____ ¢/kWh under conditions
described in Part 4.1.5 of the Instructions to Bidder.

ATTACHMENT 9
 DESIGN SUMMARY SHEET (cont'd)
 (Submit separate forms for 500 kW and 250 kW systems)

PV PARAMETERS

Module (Stabilized) PTC** STC*

V_{mp} = _____

I_{mp} = _____

V_{oc} = _____

I_{sc} = _____

Overall Area = _____ m²

Aperture = _____ m²

Current temp. coefficient = _____ amps/°C

Voltage temp. coefficient = _____ volts/°C

Internal resistance (series) = _____ ohms

Curve correction factor = _____ ohms/°C

Efficiency temperature coefficient = _____ %/°C

PV module cover transmissivity = _____ %

PV cell absorptivity = _____ %

* STC = Standard Test Conditions

Flat Plate

1000 W/m² POA irradiance
 25°C cell temperature
 1.5 Air Mass Spectrum

Concentrators

850 W/m² DN irradiance
 25°C cell temperature
 1.5 Air Mass Spectrum

** PTC = PVUSA Test Conditions

Flat-Plates

1000 W/m² POA irradiance
 20°C ambient temperature
 1 m/s wind speed (at 10
 meters above grade)

Concentrators

850 W/m² DN irradiance
 20°C ambient temperature
 1 m/s wind speed (at 10
 meters above grade)

Ambient temperature and wind speed are measured at the PVUSA
 meteorological tower.

PART C - SUBCONTRACT 19271-SC-(TBD)

This Subcontract is entered into as of the day of _____, 1992, between Bechtel Construction Company (Bechtel) and

(Contractor).

All work specified below, which is a portion of the work and services to be performed as a part of the Photovoltaics for Utility Scale Applications (PVUSA) project by Bechtel for Pacific Gas & Electric Company (Owner) under Contract Z19-5-526-87, will be performed by the Contractor in accordance with the provisions of this Subcontract, consisting of the following documents which by their descending order shall also establish the Subcontract Order of Precedence:

Subcontract Agreement
Schedule
Exhibit "A" - General Conditions
Exhibit "B" - Specification

1. **WORK TO BE PERFORMED:** Contractor shall install a turnkey photovoltaic power system at the PVUSA jobsite, all as described in the Schedule, General Conditions, and Specification.

2. **COMPENSATION:** As full consideration for the satisfactory performance by Contractor, Bechtel shall pay to Contractor compensation in the manner prescribed in the Schedule and with the payment provisions of this Subcontract.

BECHTEL CONSTRUCTION COMPANY

(CONTRACTOR)

Authorized

Authorized

Signature: _____

Signature: _____

Name: R. N. Dows

Name: _____

Title: Contracts/Purchases Mgr.

Title: _____

Date: _____

Date: _____

ADDRESS/PHONE

PO Box 193965

San Francisco, CA 94119

(415) 768-8503

CALIFORNIA CONTRACTOR'S LICENSE NO.

452324

SCHEDULE

ARTICLE I STATEMENT OF WORK

Contractor shall perform the work set forth in Exhibit "B", Technical Specification US-2.

Contractor's system shall achieve a Minimum System Power of _____ kW ac at PVUSA test conditions (for Flat-plates: 1000 W/m² POA irradiance, 20°C ambient temperature and 1 m/s wind speed at 10m above grade, or for Concentrators: 850 W/m² DN irradiance, 20°C ambient temperature and 1 m/s wind speed at 10m above grade) as measured in accordance with Appendix C of Exhibit B, Specification. Ambient temperature and wind speed are measured at the PVUSA meteorological tower at the Kerman site.

ARTICLE II ITEMS AND PRICES

1. Design - deliver schedule, drawings, calculations, QA/QC plan safety review plan/report. \$ _____
2. Fabrication of Array Modules - deliver array modules (panels), factory test results, additional modules, and certified qualification test results. \$ _____
3. Fabrication of Power Conditioning System - deliver power conditioning system and factory test results. \$ _____
4. Construction - fabricate and install foundations, structures, array, additional equipment and instrument brackets. \$ _____
5. Operations and Maintenance - deliver O&M manuals, special equipment and tools for maintenance. \$ _____
6. Startup - debug equipment and deliver documentation and notice of completion. \$ _____
7. Access roads and gravel area \$ _____
8. Applicable California Sales Tax \$ _____
- TOTAL PRICE \$ _____
9. SPARE PARTS (exclusive of California Sales Tax) \$ _____
10. OPTIONAL TECH REP. LABOR CONTRACT \$ _____ /Hr Plus Material and Travel at actual cost

ARTICLE III PERIOD OF PERFORMANCE

The Contractor shall commence work promptly upon notice to proceed and shall perform the work to meet the following Milestones:

<u>MILESTONE</u>	<u>SCHEDULE</u>	
	<u>START</u>	<u>COMPLETE</u>
Engineering		
general arrangement	_____	_____
structural design	_____	_____
electrical design	_____	_____
PCU specification	_____	_____
equipment list	_____	_____
safety provisions	_____	_____
O&M manual		
draft	_____	_____
Final	_____	_____
Performance Schedule	_____	_____
QA/QC plan	_____	_____
Safety Review Plan	_____	_____
Qualification tests (if required)	_____	_____
(Note: 30 calendar days are required for Bechtel review of Drawings and other submittals prior to commencement of fabrication/construction)		
PCU mfg./purchase		
test	_____	_____
ship	_____	_____
Array material purchase	_____	_____
Structure mfg./purchase	_____	_____
Safety Review Report*	_____	_____
Array		
module manufacture	_____	_____
test	_____	_____
assemble and pack	_____	_____
ship	_____	_____
Contractor's Site Safety Program	_____	_____
Construction		
install foundation	_____	_____
install structure	_____	_____
install array	_____	_____
install wiring	_____	_____
Install PCU	_____	_____
30-day conditioning	_____	_____
Acceptance Test, parallel approval	_____	_____
Turnover	_____	_____

* May be submitted in sections as reviews (of individual components or sub-systems) are completed

ARTICLE IV INVOICES, PAYMENT AND INCENTIVES

Invoices shall be prepared by Contractor and submitted for Bechtel's approval covering the amount and value, as set forth in a schedule of payments that is mutually agreed upon by Bechtel and Contractor, of items satisfactorily completed by Contractor up to the date of such invoice.

The schedule of payments shall be structured to reasonably allocate the Total Price, see Article II, which has been first reduced by twenty percent (20%), an amount equal to the reserve for performance measurement described below.

Incremental payments shall be due and payable upon receipt of approved invoices.

Final payment, which shall be comprised of the reserve noted above, shall become due and payable by Bechtel at such time as final acceptance tests are completed and the desired performance level is attained.

Any amounts otherwise payable under the contract may be withheld, in whole or in part, if:

- (a) Any claims are filed against Contractor by Bechtel or third parties, or if reasonable evidence indicates the probability of filing any such claims; or
- (b) Contractor is in default of any contract condition; or
- (c) There is reasonable doubt that this contract can be completed within the time specified or for the balance then unpaid.

Bechtel will pay such withheld payments if Contractor:

- (a) pays, satisfies or discharges any claim of Bechtel, Owner, or third party against Contractor arising out of or in any way connected with the contract; or
- (b) cures all defaults in the performance of the contract.

If claims filed against Contractor connected with performance under this contract are not promptly removed by Contractor after receipt of written notice from Bechtel to do so, Bechtel may remove such claims and deduct all costs in connection with such removal from withheld payments or other monies due, or which may become due, to Contractor. If the amount of such withheld payment or other monies due Contractor under the contract is insufficient to meet such costs, or if any claim against Contractor is discharged by Contractor after final payment is made, Contractor and its surety or sureties, if any, shall promptly pay Bechtel all costs incurred thereby regardless of when such claim arose or whether such claim imposed a lien upon the Project or the real property upon which the

Project is situated.

Upon receipt by Contractor of Bechtel's written notice of Final Acceptance of its work under this contract, Contractor shall prepare an invoice for Bechtel's approval of the amount and value of all work satisfactorily completed under this contract. Unless otherwise specified by applicable law, Bechtel shall, within thirty calendar days following final acceptance and after submittal of such invoice, pay to Contractor the amount then remaining due, provided that, Contractor shall have furnished Bechtel and Owner for itself, its contractors, immediate and remote, and all material suppliers, vendors, laborers and other parties acting through or under it, waivers and releases of all claims against Bechtel or Owner arising under or by virtue of this contract, except such claims, if any, as may with the consent of Bechtel and Owner be specifically excepted by Contractor from the operation of the release in stated amounts to be set forth therein.

No payments of invoices or portions thereof shall at any time constitute approval or acceptance of the work under this contract, nor be considered to be a waiver of Bechtel or Owner of any of the terms of this contract.

Performance Incentive Adjustment

Performance will be measured against the Minimum System Power shown in Article I, Statement of Work, for peak ac power output.

For the purpose of determining performance incentives for the Kerman installation, Measured ac performance is defined as 100 percent of the 30 days measured data regression rating. There will be no allowance for instrument measurement error.

There will be a contract price increase at the rate of 1/2% for each 1% (or portion) the measured performance exceeds the Minimum System Power, to a maximum addition of 4% of the Total Price as shown in Article II (equivalent to 8% over the Minimum System Power).

In the event measured performance is less than the Minimum System Power, the Contractor shall, on a schedule agreeable to Owner, install additional components necessary to bring measured performance up to the Minimum System Power.

Schedule Incentive Adjustment

Performance against schedule will be continuously monitored during the Subcontract period from commencement to completion. Completion will occur upon satisfactory accomplishment of the work, specifically as described in the Technical Specification at subpart 8.0 (acceptance testing, construction complete, thirty day conditioning period) and Appendix F (pre-parallel acceptance testing).

Target completion is scheduled 14 months after award.

The Contractor shall earn an incentive in the amount of two thousand dollars (\$2000) per calendar day for each day completion is achieved in advance of the target completion date set forth above up to a maximum of 60 days (but see Article XIX).

The amount of two thousand dollars (\$2,000) per calendar day will be assessed against Contractor for each day Contractor fails to achieve completion beyond the target completion date set forth above, up to a maximum of 120 days (but see Article XIX).

Schedule incentives are independent of performance incentives. In the event that nominal supplemental installations are required to increase measured performance to the Minimum System Power, both positive and negative schedule incentives shall be adjusted to the proportion of Minimum System Power actually attained at the date ready for acceptance testing.

ARTICLE V RELEASE OF INFORMATION

Contractor agrees not to divulge to third parties, without the written consent of Owner or Bechtel, any information obtained from or through Owner or Bechtel in connection with the performance of this Subcontract unless; (i) the information is known to Contractor prior to obtaining the same from Owner or Bechtel; (ii) the information is, at the time of disclosure by Contractor, then in the public domain; or (iii) the information is obtained by Contractor from a third party who did not receive same, directly or indirectly from Owner or Bechtel and who has no obligation of secrecy with respect thereto.

Contractor further agrees that it will not, without the prior written consent of Owner or Bechtel, disclose to any third party any information developed or obtained by Contractor in the performance of this contract except to the extent that such information falls within one of the categories described in (i), (ii) or (iii) above.

If so requested by Owner or Bechtel, Contractor further agrees to require its employees to execute a nondisclosure agreement prior to performing any services under this contract.

ARTICLE VI KEY PERSONNEL

A. CONTRACTOR

It having been determined that the employees whose names appear below, pursuant to Article GC-3 of the General Conditions, or persons approved by Bechtel as persons of substantially equal abilities and qualifications, are necessary for the successful performance of this contract, the Contractor agrees to assign such employees or persons to the performance of the work under this contract and shall not reassign or remove any of them without the

consent of Bechtel. Whenever, for any reason, one or more of the aforementioned employees is unavailable for assignment for work under the contract, the Contractor shall, with the approval of Bechtel, replace such employee with an employee of substantially equal abilities and qualifications.

<u>Name</u>	<u>Title</u>

B. BECHTEL

Bechtel designates the following individuals to represent and act for Bechtel pursuant to Article GC-4 of the General Conditions:

<u>Name</u>	<u>Title</u>
Engineering: E. J. Gough	Project Engineering Mgr.
Construction: D. J. Shipman	Site Construction Manager
Buyer: R. N. Dows	Project Procurement Mgr.

ARTICLE VII INSURANCE REQUIREMENTS

Unless otherwise specified in this contract, the Contractor shall, at its sole expense, maintain in effect at all times during the performance of work insurance coverage with limits not less than those set forth below with insurers and under forms of policies satisfactory to Bechtel. The Contractor shall deliver to Bechtel no later than ten (10) days after award of the contract but in any event prior to commencing work on the site Certificates of Insurance, IDENTIFIED ON THEIR FACE AS TO PROJECT NAME AND THE SUBCONTRACT NUMBER TO WHICH APPLICABLE, as evidence that policies providing such coverage and limits of insurance are in full force and effect, which Certificates shall provide that not less than thirty (30) days advance notice will be given in writing to Bechtel prior to cancellation, termination or material alteration of said policies of insurance.

A.	<u>Minimum Coverage</u>	<u>Amounts and Limits</u>
(a)	Workers' Compensation	Statutory requirements at location of work
(b)	Employer's Liability	To extent included under Workers' Compensation Insurance policy

*(c) Comprehensive General Liability

(i) Bodily Injury \$5,000,000 each occurrence

(ii) Property Damage \$5,000,000 each occurrence

*(d) Comprehensive Automobile Liability (owned, hired and non-owned)

(i) Bodily injury \$5,000,000 each person
\$5,000,000 each occurrence

(ii) Property Damage \$5,000,000 each occurrence

* Combined single limit policies are acceptable provided the combined single limit of each policy for bodily injury and property damage liability is not less than \$5,000,000 each occurrence. These policies may contain an aggregate limit not less than the occurrence limit. The required limits may be satisfied by a combination of a primary policy and an excess or umbrella policy.

B. Neither Owner nor Bechtel is maintaining any insurance on behalf of Contractor covering against loss or damage to the work or to any other property of Contractor unless otherwise specifically stated herein and as may be described by appendix hereto. In the event Contractor maintains insurance against physical loss or damage to Contractor's construction equipment and tools, such insurance shall include an insurer's waiver of rights of subrogation in favor of Owner and Bechtel.

C. The policy of insurance which affords Comprehensive General Liability shall contain a provision or endorsement stating that such insurance:

- (a) applies to the liability assumed by Contractor under this contract, subject to all of the terms and conditions of such insurance;
- (b) does not contain any exclusions as to loss or damage to property caused by explosion or resulting from collapse of buildings or structures or damage to property underground, commonly referred to by insurers as the "XCU" hazards;
- (c) includes Owner and Bechtel as additional insured as regards their liability arising out of operations performed for Owner and Bechtel by Contractor under this contract;
- (d) states that it is primary insurance as regards Owner and Bechtel as additional insured and contains a cross liability or severability of interest clause.

- D. The requirements contained herein as to types and limits, as well as Bechtel's approval of insurance coverage to be maintained by Contractor are not intended to and shall not in any manner limit or qualify the liabilities and obligations assumed by Contractor under the contract.
- E. The Certificates of Insurance must provide clear evidence that Contractor's Insurance Policies contain the minimum limits of coverage and special provisions prescribed in Sections A, B & C above.
- F. The Contractor shall deliver the original of the initial Certificates of Insurance, and any notices of Cancellation, termination or alteration of such policies to:

Bechtel Construction Company
P.O. Box 193965
San Francisco, CA 94119
Attention: R. N. Dows
Reference: 19271-SC-(TBD)

and one copy of each such documents shall be delivered to:

PVUSA Construction Management Office
Bechtel Construction Company
P.O. Box 354
Davis, CA 95617

ARTICLE VIII BECHTEL-FURNISHED UTILITIES AND FACILITIES

(i) Utilities: The utilities listed below will be furnished by Bechtel without cost to Contractor during onsite construction activities of Contractor, that all such utilities will be furnished at outlets existing on the site and Contractor shall, at its expense, extend such utilities from said outlets to points of use and at completion of all work remove all materials and equipment used for such extensions.

NONE

(ii) Facilities: The facilities listed below will be furnished by Bechtel. Such facilities may be used by Contractor without charge therefor, provided that any such use will be subject to written approval of Bechtel.

- (a) Storage and working area, unimproved
- (b) Parking area, unimproved
- (c) Access roads to PV subcontractor's plot boundary
- (d) Site perimeter fencing and gates

ARTICLE IX BECHTEL-FURNISHED MATERIALS AND EQUIPMENT

Bechtel will furnish no materials or equipment to Contractor except to the extent specified elsewhere in the Subcontract.

ARTICLE X BECHTEL-FURNISHED PERMITS

The clause entitled Permits of Exhibit "A", General Conditions, notwithstanding, Bechtel will without cost to the Contractor, furnish the permits listed below. The Contractor shall, in accordance with said Clause provide all other permits. All such Bechtel-furnished permits are available for examination at the project office of Bechtel during regular business hours.

- (a) Land Use Permit, Fresno County, California

ARTICLE XI CONTRACTOR-FURNISHED DRAWINGS

Review and permission to proceed by Bechtel as stated in this Special Condition does not constitute acceptance or approval of design details, calculations, analyses, test methods, certificates or materials developed or selected by the Contractor and does not relieve Contractor from full compliance with contractual obligations.

Where drawings are required for: (a) fabrication of Contractor furnished equipment, (b) installing Contractor-furnished material or equipment, or (c) planning and performance of the work under the contract.

DRAWINGS SHALL BE SUBMITTED IN REPRODUCIBLE FORM BY AND AT THE EXPENSE OF THE CONTRACTOR BEFORE FABRICATION, INSTALLATION OR PERFORMANCE IS COMMENCED, ALLOWING AT LEAST THIRTY (30) CALENDAR DAYS FOR REVIEW BY BECHTEL.

All drawings submitted for this purpose which are reviewed by Bechtel, shall form a part of the contract. Such drawings shall include, but not be limited to, matchmarks, erection diagrams and other details, such as field connections for proper installation, erection of the equipment, and performance of the work. All drawings submitted shall be "D" size, 22" x 34".

Drawings of a specific piece of equipment shall identify components with the manufacturer's part number or reference drawing number clearly indicated. If reference drawing numbers are used, the review date of such drawings shall be included.

Drawings shall indicate design dimensions. The sequence of submission of all drawings shall be such that all information is available for reviewing each drawing when it is received.

Bechtel will conduct a review of Contractor's drawings and a reproducible drawing marked with one of the following notations will be returned to the Contractor.

1. Work may proceed.	
2. Work may proceed.	Submit Final Drawings.
3. Revise and Resubmit.	Work may proceed subject to incorporation of changes indicated.
4. Revise and Resubmit.	Work may not proceed.
5. Review not required.	Work may proceed.

Although work may proceed on receipt of a drawing with a Code 3 notation the Contractor must incorporate the changes indicated, resubmit and obtain a Code 1 or 2 notation before release for shipment can be granted.

During construction, the contractor shall maintain a mark-up set of drawings that reflects the "as-built" status of the installation. Prior to system acceptance, Contractor shall submit a complete set of "as-built" drawings for final review and acceptance.

ARTICLE XII PERFORMANCE BONDS

If directed by Bechtel, within ten days after execution of the contract, Contractor shall furnish to Bechtel evidence of a performance and material and labor payment bond for all work under the contract in an amount equal to 100% of the contract value by a company or corporation acceptable to Bechtel.

Contractor shall vary the value of such bonds as necessary and called for by the bonding company to equal price adjustments made pursuant to the clause entitled "CHANGES".

ARTICLE XIII PRICING OF ADJUSTMENTS

When costs are a factor in any determination of a price adjustment pursuant to the "Changes" clause, or any other provision of this contract, such costs shall be in accordance with Part 31 of the Federal Acquisition Regulations in effect on the date of this Subcontract.

ARTICLE XIV CONTRACTORS LICENSING LAW

All Contractors and Subcontractors are required to be licensed in accordance with California State Law.

ARTICLE XV JOBSITE WORK RULES AND REGULATIONS

Contractors, Subcontractors, and their employees are required to adhere to jobsite work rules and regulations (Attachment "A") and shall become signatory to the Memorandum of Understanding for the Photovoltaics for Utility Scale Applications Project (PVUSA) (Attachment "B") as negotiated for the Kerman site.

ARTICLE XVI LINES AND GRADES

Bechtel has established bench marks describing a base line which are located in the general building area at the PVUSA Kerman site.

These survey control points are indicated on the site plan.

ARTICLE XVII BUY AMERICAN

The Contractor shall deliver only unmanufactured end products mined or produced in the United States or an end product manufactured in the United States if the cost of its articles, materials, and supplies mined or produced in the United States and incorporated directly into the end product exceeds 50 percent of the cost of all its components, except those for which the Owner determines the cost to be unreasonable.

ARTICLE XIX DELAYED COMPLETION

During the winter rainy season, frequent periods of weather-related interruptions to construction work are probable. For this reason, weather will not be considered as a force-majeure (beyond control of the Contractor) for construction delays which may be experienced between the dates of November 15 and March 31 of any years, insofar as completion incentives are concerned.

Except as stated above for weather-related delays occurring between November 15 and March 31 of any years, delays shall be governed in the manner set forth in General Condition GC-30.

ARTICLE XX CONTRACTOR'S PROPOSAL

Appropriate elements of Contractor's proposal will be incorporated in this article of the final subcontract document.

ATTACHMENT A
JOBSITE WORK RULES AND REGULATIONS

WORKING HOURS: The work week shall start with the first shift on Monday and conclude with the third shift on Sunday. Eight (8) hours per day shall constitute a standard work day between the hours of 7:00 AM and 3:30 PM with one-half (1/2) hour unpaid lunch period. All employees will be at their work location (tool box or physical location off work task) at starting time and will work until the authorized quitting time at the end of the shift. Loitering in the change house or other late-starting and early quitting habits will be subject to disciplinary action. Conditions as set forth above (starting and quitting times, lunch and work locations) will apply to all shifts.

LEAVING PROJECT: Whenever an employee leaves the project at other than normal quitting time, it is his or her responsibility to notify the immediate supervisor, e.g. foreman, general foreman or superintendent.

DRINKING COFFEE/SMOKING DURING WORKING HOURS: There will be no recognized or organized coffee breaks, smoke breaks, or rest periods during working hours. However, when working conditions permit, workers will be permitted to have personal thermos bottles, the contents of which may be consumed during working hours at their assigned locations. There will be no lunch wagons permitted on the project.

PERSONAL PROTECTION EQUIPMENT: Hard hats are mandatory on this project. They must be worn at all times. Long sleeve shirts are recommended. Other protective equipment must be worn where required.

RAFFLES SELLING OR GAMBLING: Employees must not bring onto this project items for sale or raffle to other employees. Gambling is not allowed.

SOLICITING FOR DONATIONS: Any solicitation for donations must have prior approval from the Bechtel Construction Manager.

ALL VEHICLES ID CONTAINERS: Tool boxes, carry-all boxes, lunch boxes are subject to inspection on demand, with employee present. Any employee refusing to obey this regulation will be banned from the jobsite.

PARKING LOT: The parking lot is a convenience for employees. Neither the Owner nor Bechtel will be held responsible for any damage to, or theft from vehicles.

FIRST AID: All accidents and injuries must be reported to the employee's supervisor and the Bechtel Site Office immediately, even if the injuries may be considered minor.

PROHIBITED ACTS: Employees engaging in prohibited acts are subject to being banned from the jobsite. Prohibited acts include, but are not limited to:

1. Theft of Project, Contractor or personal property. Employee will be subject to prosecution.
2. Violation of Safety or Security Rules. Failure to adhere to Project tagging procedures at all times.
3. Willful or negligent damage or mutilation of project property.
4. Possessions, consumption, or being under the apparent influence of alcohol, illegal or non-prescribed drugs on the Project.
5. Acts of sabotage.
6. Possession of firearms or lethal weapons on the Project.
7. Making or stating false claims or falsifying any reports or records.
8. Assault on supervisory personnel.
9. Fighting on the jobsite.
10. Failure to use sanitary facilities.
11. Sleeping on jobsite.
12. Engaging in horseplay.
13. Eating, drinking and/or smoking in any area where such is prohibited.
14. Gambling, selling items or holding raffles.
15. Possession of camera(s) on jobsite without written authorization from the Bechtel Construction Manager.
16. Operating motor vehicle or equipment on jobsite in unsafe manner.
17. Refusing to submit to lunch box or vehicle inspection.
18. Refusal to accept work assignment.
19. Insubordination.
20. Poor or irregular attendance/including excessive tardiness.
21. Leaving work place or Project without supervisor's authorization.

22. Unsatisfactory work.
23. Misuse of tools, equipment or facilities; this includes sanitary facilities.
24. Interfering with the work of any other employee on the Project.
25. Leaving work place for drinking coffee.

ATTACHMENT B

SAMPLE MEMORANDUM OF UNDERSTANDING
FOR THE
PHOTOVOLTAICS FOR UTILITY SCALE APPLICATIONS PROJECT (PVUSA)

This Memorandum of Understanding is entered into by and between Bechtel Construction Inc. (Construction Manager) and signatory contractors and subcontractors engaged in the construction of the PVUSA project, (Employer(s)) and the signatory local building and construction trade unions affiliated with the Sacramento-Sierras Building and Construction Trades Council, (Union(s)).

I. SCOPE

1. This Memorandum of Understanding shall apply to construction work contracted to the Employer by the Owner.
2. It is understood and agreed that Pacific Gas and Electric Company, Electric Power Research Institute, California Energy Commission and the U.S. Department of Energy, are not party to this Memorandum of Understanding. It is further understood that this Memorandum of Understanding shall not apply to any work performed by the Owner on the Project site including calibration, testing, operations, and/or maintaining facilities and/or equipment.

II. NO WORK STOPPAGES AND NO LOCKOUTS

1. During the term of this Memorandum of Understanding, there shall be no strikes, sympathy strikes, pickets, refusals to work, walkoffs, or slowdowns of any kind, or threats of any kind to engage in such conduct by the local unions or by individual employees on the PVUSA project against any employer on the project.
2. There shall be no lockouts or threats of lockouts by the employer.
3. Any employee who violates this Article shall be subject to immediate discharge, and will not be eligible for rehire on the PVUSA project.
4. Nothing in this Memorandum shall be construed as to limit or restrict the right of the union or the employer to pursue any and all remedies available to them under the law in the event of a violation of this Memorandum.

III. GRIEVANCE PROCEDURE

Grievances arising out of the use and interpretation of this Memorandum of Understanding shall be handled in accordance with the following procedure:

Step 1

Individual grievances shall be discussed and, if possible, settled at the project between representatives of the Union and the Employer.

Step 2

If no agreement can be reached in Step 1, the grieving party shall, within three working days off the alleged violation, submit the grievance in writing to the other party. The Business Manager of the Union and the Site Manager of the Employer shall meet within three days of receipt off the written grievance for the purpose of resolving such grievance.

Step 3

If no agreement can be arrived at in Step 2, the grievance shall be referred to an International Representative of the union and a management representative of the Employer for resolution. If no agreement is reached at this Step, it is agreed that the grievance shall be referred to an arbitration committee under Step 4 of this procedure.

Step 4

If no agreement is reached in Step 3, the issue shall be submitted within ten (10) calendar days to an arbitration committee comprised of two members appointed by the Union, two members appointed by the Employer, and a fifth member selected by these four from a list off five submitted by the American Arbitration Association. The majority decision of the Arbitration Committee will be binding upon both parties. Such decision shall neither add to nor subtract from the terms of this Memorandum. Any costs incurred by arbitration will be borne equally between the signatory Union(s) involved and the Contractor. The conduct off any arbitration proceedings, including the selection off the third member, shall be under the rules off the American Arbitration Association.

IV. JURISDICTIONAL DISPUTES

1. There will be no strikes, work stoppages, picketing, refusals to work, walkoffs, or any other interferences or disruptive activity with the work because of a jurisdictional dispute.
2. The Contractors and Subcontractors will hold jurisdictional mark-up meetings with representatives of the unions involved in order to attempt to reach agreement on jurisdictional work assignments. Jurisdictional assignments made at the mark-up meeting will be considered tentative to give the Unions reasonable time to respond. If no response is received within the time frame set at the mark-up meeting, the assignments will be considered final.

Should a jurisdictional dispute arise on a piece of equipment after the mark-up meeting, the unions agree to notify the specific contractor as soon as practical to present their contesting claims. This presentation is to be made prior to work starting on the disputed piece of equipment. The specific contractor has the obligation of presenting to the unions all of the pertinent data, drawings, opinions, or descriptions that are available at the time of subject notice. If the parties are unable to reach agreement, the specific contractor shall make a clear assignment on the work for which he has responsibility. Any disputes shall be resolved under Paragraph 4 below.

4. Work shall be assigned by the specific contractor responsible for the work and performed in accordance with the agreements and decisions of record rendered under the Plan for Settlement of Jurisdictional Disputes in the Construction Industry. All Jurisdictional disputes will be settled in accordance with the Procedural Rules and Regulations of the Plan except that jurisdictional disputes affecting any non-participant union(s) shall be referred to the applicable international union(s). The specific contractor shall make every sincere effort to assign work to the proper crafts in accordance with past practices, agreements and decisions of record.

V. SUBCONTRACTING

1. The Employer agrees that neither he nor any of his subcontractors will subcontract any work to be done on the project except to a person, firm or corporation party to this Memorandum. Any contractor or subcontractor working on the project covered by this Memorandum, shall as a condition to working on said project, become signatory to and perform all work at the project site under the terms of this Memorandum. In accordance with their applicable national or local union agreements, the contractors and subcontractors signatory hereto, agree to be bound by and pay into the legally established local fringe benefit funds contained and referenced in said agreements.
2. The furnishing of materials, supplies or equipment and the delivery thereof, shall be in no case considered subcontracting.

VI. DURATION

This Memorandum of Understanding shall become effective March 18, 1988, and shall continue in full force and effect until the completion of the PVUSA Project.

Contractor

Signature

GENERAL CONDITIONS

GC-1 ENTIRE AGREEMENT

This contract embodies the entire agreement between the Bechtel and Contractor and supersedes all other writings. The parties shall not be bound by, or be liable for any statement, representation, promise, inducement or understanding not set forth herein. No amendments or modifications of any of the terms or conditions shall be valid unless reduced to writing and signed by both parties.

GC-2 INDEPENDENT CONTRACTOR

Contractor represents that it is fully experienced, properly qualified, registered, licensed, equipped, organized, and financed to perform the work under this contract. Contractor shall act as an independent contractor and not as the agent of Bechtel or Owner in performing this contract, maintaining complete control over its employees and all of its suppliers and lower-tier contractors. Nothing contained in this contract or any lower-tier contract award by Contractor shall create any contractual relationship between any such supplier or lower-tier contractor and either Bechtel or Owner. Contractor shall perform its work hereunder in accordance with its own methods subject to compliance with the contract.

GC-3 AUTHORIZED REPRESENTATIVES

Before starting work, Contractor shall designate in writing an authorized representative acceptable to Bechtel to represent and act for Contractor and shall specify any and all limitations of such representative's authority. Such representative shall be present or be represented at the jobsite at all times when contract work is in progress. During periods when work is suspended, arrangements shall be made for an authorized representative acceptable to Bechtel for any emergency work that may be required. All communications given to the authorized representative by Bechtel in accordance with this contract shall be binding upon Contractor. Bechtel shall designate in writing one or more representatives to represent and act for Bechtel and to receive communications from Contractor. Notification of changes of authorized representatives for either Bechtel or Contractor shall be provided in advance, in writing, to the other party.

GC-4 NOTICES

Any notices provided for hereunder shall be in writing and served by registered mail to the address shown on the face of the contract agreement form or as such address may have been changed by written notice.

GC-5 SUBCONTRACT INTERPRETATION

All questions concerning interpretation or clarification of this contract or the acceptable performance thereof by Contractor, shall be immediately submitted in writing to the Bechtel Buyer for resolution. All determinations, instructions, and clarifications of Bechtel shall be final and conclusive unless determined by a court of competent jurisdiction to have been fraudulent or capricious, or arbitrary, or so grossly erroneous as necessarily to imply bad faith, or not supported by substantial evidence. At all times Contractor shall proceed with the work in accordance with the determinations, instructions, and clarifications of Bechtel. Contractor shall be solely responsible for requesting instructions or interpretations and shall be solely liable for any costs and expenses arising from its failure to do so.

GC-6 STANDARDS AND CODES

Wherever references are made in the contract to standards or codes in accordance with which work under the contract is to be performed, the edition or revision of the standards or codes current on the effective date of this contract shall apply unless otherwise expressly stated. In case of conflict between any referenced standards and codes and any contract documents, the latter shall govern.

GC-7 LAWS AND REGULATIONS

Contractor and its employees and representatives shall at all times comply with applicable laws, ordinances, statutes, rules or regulations in effect at the time work under this contract is performed.

If during the term of this contract there are changed or new laws, ordinances, statutes, rules or regulations not known or foreseeable at the time of signing this contract which become effective and which affect the cost or time of performance of this contract, Contractor shall immediately notify the Bechtel Buyer in writing and submit detailed documentation of such effect in terms of both time and cost of performing the contract. Upon concurrence by Bechtel as to the effect of such changes an equitable adjustment in compensation and time of performance will be made.

If Contractor discovers any discrepancy or inconsistency between this contract and any law, ordinance, statute, rule, regulation, order or decree, Contractor shall report the same immediately, in writing, to the Bechtel Buyer who will issue such further instructions as may be necessary.

GC-8 PERMITS

Except as otherwise specified, Contractor shall procure and pay for all permits and inspections other than inspections performed by Bechtel, and shall furnish any bonds, security or deposits required to permit performance of its work hereunder.

GC-9 TAXES

Contractor shall pay all taxes, levies, duties and assessments of every nature due in connection with work under the contract and shall make any and all payroll deductions required by law, and hereby indemnifies and holds harmless Bechtel and Owner from any liability on account of any and all such taxes, levies, duties, assessments and deductions.

GC-10 LABOR, PERSONNEL AND WORK RULES

Contractor shall, to the extent permissible under applicable law, comply with the provisions of Bechtel's collective bargaining agreements which apply to work performed under this contract. Contractor shall pay rates of wages and shall observe hours of work and other economic terms and conditions of employment equivalent to those paid and observed by Bechtel, all of which shall be subject to Bechtel's approval.

Contractor shall employ only competent and skilled personnel to perform the work. Contractor shall remove from the jobsite any personnel of Contractor determined to be unfit or to be acting or working in violation of any provision of this contract. Contractor shall comply with and enforce jobsite work rules.

GC-11 COMMERCIAL ACTIVITIES

Neither Contractor nor its employees shall establish any commercial activity or issue concessions or permits of any kind to third parties for establishing commercial activities on the jobsite or any other lands owned or controlled by Owner.

GC-12 PUBLICITY AND ADVERTISING

Contractor shall not make any announcement, take any photographs, or release any information concerning this contract, or the project, or any part thereof to any member of the public, press, business entity, or any official body unless prior written consent is obtained from Bechtel.

GC-13 SAFETY

Contractor shall be fully and solely responsible for conducting all operations under this Subcontract at all times in such a manner as to avoid the risk of bodily harm to persons and damage to property. Contractor shall continually and diligently inspect all work, materials and equipment to discover any conditions which might involve such risks and shall be solely responsible for discovery and correction of any such conditions.

Contractor shall comply with Bechtel's Project Safety Action Plan, in addition to maintaining a safety program in accordance with Contractor's established practices and CAL OSHA requirements. Contractor shall have sole responsibility for implementing its safety program. All of Contractor's obligations under General Conditions Clause entitled INDEMNITY, hereof, apply to any liability arising in connection with or incidental to Contractor's performance or failure to perform as provided in this General Conditions Clause entitled SAFETY.

Neither Owner nor Bechtel shall be responsible for supervising the implementation of Contractor's safety program, and neither Owner nor Bechtel shall have responsibility for the safety of Contractors' or its sub-contractors' employees.

Contractor's failure to correct an unsafe condition after notice thereof shall be grounds for an order to suspend the affected operations until the unsafe condition is corrected and, if the violation continues, termination of this contract for such failure.

Contractor shall appoint a qualified and competent safety representative who by experience, training and instruction is familiar with the operations to be performed and the hazards involved and who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary or dangerous to employees and who is authorized to take prompt corrective measures to eliminate them. Contractor shall participate in periodic safety meetings with Bechtel. Contractor shall instruct its personnel on the requirements of Contractor's safety program and shall coordinate with other contractors on safety matters.

Contractor shall furnish safety equipment and enforce the use of such equipment by its employees.

Contractor shall maintain accurate accident and injury reports and shall furnish Bechtel a monthly summary of injuries and manhours lost due to injuries.

GC-14 DISCOVERY OF CONFLICTS, DISCREPANCIES, ERRORS OR OMISSIONS

In case of conflict or discrepancies, errors or omissions among the various contract documents, the latter shall be submitted immediately by Contractor to the Bechtel Buyer for decision and such decision shall be final. Any work affected by such conflicts, discrepancies, errors or omissions which is performed prior to Bechtel's determination shall be at Contractor's risk.

GC-15 SITE CONDITIONS AND NATURAL RESOURCES

Contractor shall have the sole responsibility for satisfying itself concerning the nature and location of work and the general and local conditions, including but not limited to the following:

- (a) Transportation, access, disposal, handling and storage of materials
- (b) Availability and quality of labor, water, electric power and road conditions
- (c) Climatic conditions and seasons
- (d) Physical conditions at the jobsite and the project area as a whole
- (e) Topography and ground surface conditions
- (f) Equipment and facilities needed preliminary to and during the performance of Contractor's work.

The failure of Contractor to acquaint itself with any applicable conditions will not relieve Contractor of the responsibility for properly estimating either the difficulties or the cost of successfully performing Contractor's obligations under this contract.

Where Bechtel or Owner has made investigations of subsurface conditions in areas where work is to be performed under this contract, such investigations are made by Bechtel and Owner for the purpose of study and design. If the records of such investigation are included in the contract documents, the interpretation of such records shall be the sole responsibility of the Contractor. Neither Bechtel nor Owner assumes any responsibility whatsoever in respect to the sufficiency or accuracy of such investigations, the records thereof, or of the interpretations set forth and there is no warranty or guarantee, either express or implied, that the conditions indicated by such investigations or records thereof are representative of those existing throughout such areas, or any part thereof, or that unforeseen developments may not occur, or that materials other than, or in proportions different from, those indicated may not be encountered.

GC-16 DIFFERING SITE CONDITIONS

Contractor shall promptly notify Bechtel in writing before proceeding with any work which Contractor believes constitutes a differing site condition with respect to; (1) subsurface or latent physical conditions at the jobsite differing materially from those indicated in this contract, or (2) previously unknown physical conditions at the jobsite, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in this contract. The Bechtel Buyer will, as promptly as practicable, investigate such conditions and make a determination. If Bechtel determines that such conditions do materially so differ and cause an increase or decrease in Contractor's cost of or the time required for performance of any part of any work under the contract, an adjustment will be made and the contract modified in writing accordingly. No claim of Contractor under this clause will be allowed unless Contractor has given the required notice.

GC-17 SURVEY CONTROL POINTS AND LAYOUTS

Contractor shall complete the layout of all work and shall be responsible for all requirements necessary for the execution of any work in accordance with the locations, lines, and grades specified, subject to such modifications as Bechtel may require as work progresses.

If Contractor or any of its lower-tier contractors or any of their representatives or employees move or destroy or render inaccurate any survey control point, such control point shall be replaced by Bechtel at Contractor's expense. No separate payment will be made for survey work performed by Contractor.

GC-18 CONTRACTOR'S WORK AREA

All Contractor's work areas on the jobsite will be assigned by Bechtel. Contractor shall confine its operations to the areas so assigned. Should Contractor find it necessary or advantageous to use any additional off-site area for any purpose whatever, Contractor shall, at its expense, provide and make its own arrangements for the use of such additional off-site areas.

GC-19 CLEANING UP

Contractor shall, at all times, keep its work areas in a neat, clean and safe condition.

Upon completion of any portion of its work, Contractor shall promptly remove from the work area all its equipment, construction plant, temporary structures and surplus materials not be used at or near the same location during later stages of work.

Upon completion of the contract work and prior to final payment, Contractor shall at its expense satisfactorily dispose of all rubbish, and remove all plant, buildings, equipment and materials belonging to Contractor. Contractor shall leave the premises in a neat, clean and safe condition.

In event of Contractor's failure to comply with the foregoing, Bechtel will accomplish same at Contractor's expense.

GC-20 COOPERATION WITH OTHERS

Bechtel, Owner, other contractors and other subcontractors may be working at the jobsite during the performance of this contract and Contractor's work or use of certain facilities may be interfered with a result of such concurrent activities. Bechtel reserves the right to require Contractor to schedule the order of performance of its work in such a manner as will minimize interference with the work of any of the parties involved.

GC-21 ENVIRONMENTAL CONDITIONS

Throughout performance of its work, Contractor shall conduct all operations in such a way as to minimize impact upon the natural environment and comply with all laws, regulations and rules applicable to jobsite. Contractor shall provide:

- (a) Dust control of all excavations, material sites, roads, and disposal areas within its assigned work areas of responsibility
- (b) Suitable equipment, facilities and precautions to prevent the discharge of contaminants which may pollute the atmosphere, any body of water, or land areas, or which may harm fish or other wildlife
- (c) maintenance of existing irrigation drainage control features to prevent, during the construction period, water entering upon the site from adjacent lands.

GC-22 RESPONSIBILITY FOR WORK, SECURITY AND PROPERTY

- (a) Work in Progress, Materials and Equipment - Contractor shall be responsible for and shall bear any and all risk of loss of or damage to work in progress, all materials delivered to jobsite and all materials and equipment until completion and final acceptance of work under this contract.
- (b) Delivery, Unloading and Storage - Contractor's responsibility for materials and plant equipment required for the performance of the contract shall include:

- (1) Receiving and unloading
- (2) Storing in a secure place and in a manner subject to Bechtel's review. Outside storage of materials and equipment subject to degradation by the elements shall be in weather tight enclosures provided by Contractor
- (3) Delivering from storage to construction site all materials and plant equipment as required

(c) Security - Contractor shall at all times conduct all operations under the contract in a manner to avoid the risk of loss, theft, or damage by vandalism, sabotage or any other means to any work, materials, equipment or other property at the jobsite. Contractor shall continuously inspect all work, materials and equipment to discover and determine any conditions which might involve such risks and shall be solely responsible for discovery, determination and correction of any such conditions.

Contractor shall comply with the Project Security Program for the jobsite. Contractor shall cooperate with Bechtel on all security matters and shall promptly comply with any project security arrangements established by Bechtel or Owner. Such compliance with these security requirements shall not relieve Contractor of its responsibility for maintaining proper security for the above noted items, nor shall it be construed as limiting in any manner Contractor's obligation to comply with all laws and regulations and to undertake reasonable action to establish and maintain secure conditions at the jobsite.

(d) Property - Contractor shall plan and conduct its operations so as not to:

- (1) Enter upon lands in their natural state unless authorized by Bechtel
- (2) Damage, close or obstruct any utility installation, highway, road or other property until permits therefor have been obtained.
- (3) Disrupt or otherwise interfere with the operation of any pipeline, telephone, electric transmission line, ditch or structure unless otherwise specifically authorized by this contract.
- (4) Damage or destroy cultivated and planted areas, and vegetation such as trees, plants, shrubs, and grass on or adjacent to the premises which, as determined by the Bechtel, do not interfere with the performance of this contract. This includes damage arising from performance of work through operation of equipment or stockpiling of materials.

Contractor shall not be entitled to any extension of time or compensation on account of Contractor's failure to protect all materials, equipment and environment as described herein. All costs in connection with any repairs or restoration necessary or required by reason of unauthorized obstruction, damage or use shall be borne by Contractor.

GC-23 CONTRACTOR'S PLANT, EQUIPMENT AND FACILITIES

Contractor shall provide and use for its work hereunder only such construction plant and equipment as are capable of producing the quality and quantity of work and materials required by the contract and within the time or times specified in the contract schedule.

GC-24 ILLUMINATION

When any work is performed at night or where daylight is obscured, Contractor shall, at its expense, provide artificial light sufficient to permit work to be carried on efficiently, satisfactorily and safely, and to permit thorough inspection. During such time periods the access to the place of work shall also be clearly illuminated. All wiring for electric light and power shall be installed and maintained in a first-class and safe manner.

GC-25 USE OF BECHTEL'S CONSTRUCTION EQUIPMENT OR FACILITIES

Where Contractor requests Bechtel and Bechtel agrees to make available to Contractor certain equipment or facilities belonging to Bechtel for the performance of Contractor's work under the contract the following shall apply:

- (a) Equipment or facilities will be charged to Contractor at agreed rental rates.
- (b) Bechtel will furnish a copy of the equipment maintenance and inspection record, and these records shall be maintained by Contractor during the rental period.
- (c) Contractor shall assure itself of the condition of such equipment and assume all risks and responsibilities during its use. Contractor shall hold Bechtel harmless against any damages or claims that may arise from use of the equipment.
- (d) Bechtel and Contractor shall jointly inspect such equipment before its use and upon its return. The cost of all necessary repairs or replacement for damage other than normal wear shall be at Contractor's expense.

GC-26

INSPECTION, QUALITY SURVEILLANCE, REJECTION OF MATERIALS
AND WORKMANSHIP

All materials and equipment furnished and work performed shall be properly inspected by Contractor at its expense, and shall at all times be subject to quality surveillance and quality audit by Bechtel, Owner, or their authorized representatives who shall be afforded full and free access to the shops, factories or other places of business of Contractor and its lower-tier contractors and suppliers for such quality surveillance or audit. Contractor shall provide safe and adequate facilities, drawings, documents and samples as requested, and shall provide assistance and cooperation including stoppage of work to perform such examination as may be necessary to determine compliance with the requirements of this contract. Any work covered prior to any quality surveillance or test by Bechtel or Owner shall be uncovered and replaced at the expense of Contractor. Failure of Bechtel or Owner to make such quality surveillance or to discover defective design, materials or workmanship shall not relieve Contractor of its obligations under this contract nor prejudice the rights of Bechtel thereafter to reject or require the correction of defective work in accordance with the provisions of this contract.

If any work is determined by Bechtel or Owner to be defective or not in conformance with this contract, Contractor will be notified in writing and shall, at Contractor's expense, immediately remove and replace or correct such defective work. In the event that Contractor fails to promptly comply with the above, Bechtel shall have the right to accomplish the corrective work at Contractor's expense.

GC-27

TESTING

Unless otherwise provided in the contract, testing of materials or work shall be performed by Contractor at its expense and in accordance with contract requirements. Should tests in addition to those required by the contract be desired by the Bechtel, Contractor will be advised in ample time to permit such testing. Such additional tests will be at Bechtel's expense.

Contractor shall furnish samples as requested and shall provide reasonable assistance and cooperation necessary to permit tests to be performed on materials or work in place including reasonable stoppage of work during testing.

GC-28

EXPEDITING

The material and equipment furnished and work performed under this contract shall be subject to expediting by Bechtel or its representatives who shall be allowed full and free access to the shops, factories and other places of business of Contractor and its lower-tier contractors and suppliers for expediting purposes. As

required by Bechtel, Contractor shall provide detailed schedules and progress reports for use in expediting and shall cooperate with Bechtel in expediting activities.

GC-29 PROGRESS

Contractor shall give Bechtel full information in advance as to its plans for performing each part of its work. If at any time, Contractor's actual progress is inadequate to meet the requirements of this contract, Bechtel may so notify Contractor who shall thereupon take such steps as may be necessary to improve its progress. If within a reasonable period as determined by Bechtel, Contractor does not improve performance to meet the currently approved Subcontract Construction Schedule, Bechtel may require an increase in Contractor's labor force, the number of shifts, overtime operations, additional days of work per week and an increase in the amount of construction plant, all without additional cost to Bechtel. Neither such notice by Bechtel nor Bechtel's failure to issue such notice shall relieve Contractor of its obligation to achieve the quality of work and rate of progress required by this Subcontract.

Failure of Contractor to comply with Bechtel's instructions may be grounds for determination by Bechtel that Contractor is not prosecuting its work with such diligence as will assure completion within the times specified. Upon such determination, Bechtel may terminate, in accordance with the applicable provisions of this contract, Contractor's right to proceed with the performance of the Subcontract.

GC-30 DELAYS AND EXTENSION OF TIME

If Contractor's performance of this Subcontract is prevented or delayed by any unforeseeable cause, existing or future, which is beyond the reasonable control and without the fault or negligence of Contractor, Contractor shall, within twenty-four hours of the commencement of any such delay, give to Bechtel written notice thereof and within seven days of commencement of the delay the anticipated impact of the delay on performance of work. Within seven days after the termination of any such delay, Contractor shall file a written notice with Bechtel specifying the actual duration of the delay. Failure to give any of the above notices shall be sufficient ground for denial of an extension of time. If Bechtel determines that the delay was unforeseeable, beyond the control and without the fault or negligence of Contractor, Bechtel will determine the duration of the delay and will extend the time of performance of this contract accordingly.

GC-31 CHANGES

Bechtel may, at any time, without notice to the sureties, if any,

by written change notice, make any change in the work within the general scope of this contract, including but not limited to changes:

- (a) in the drawings, designs or specifications;
- (b) in the method or manner of Contractor's work;
- (c) in Owner or Bechtel furnished facilities, equipment, materials, services or site;
- (d) directing acceleration or deceleration in the performance of Contractor's work.

If at any time Contractor believes that other acts or omissions of Bechtel constitute a change to the work not covered by a change notice, Contractor must within ten calendar days submit in writing a change notice request explaining in detail the basis for the request. Bechtel will either issue a change notice or deny the request in writing.

If the Contractor intends to assert a claim for an equitable adjustment under this article, it must, within ten calendar days after receipt of written change notice, submit to the Bechtel Buyer a written statement setting forth the nature, schedule impact and monetary extent of such claim in sufficient detail to permit thorough analysis and negotiation.

If any change under this clause causes an increase or decrease in the Contractor's cost of, or the time required for, the performance of any part of the work under this contract whether or not changed by any order, an equitable adjustment shall be made and the contract modified by amendment accordingly. Contractor shall not be entitled to and neither Owner or Bechtel shall be liable to Contractor or its contractors of any tier, in tort (including negligence) or in contract except as specifically provided herein, for increased costs in connection with any changes or delays in the work.

No claim by the Contractor for an equitable adjustment hereunder shall be allowed unless the required notice has been given within ten (10) calendar days as specified. In no case shall a claim by Contractor be considered if asserted after final payment under this contract. Nothing in this clause shall excuse Contractor from proceeding with the contract as changed.

GC-32 WARRANTY

Contractor warrants that all goods shall be free from liens and defects in design, material, workmanship, and title, and shall conform in all respects to the terms of this subcontract, and shall be new and of the best quality, and further warrants that all workmanship shall be in accordance with sound construction

practices acceptable to Bechtel. If at any time prior to two (2) years from the date of acceptance it appears that the goods or services, or any part thereof, do not conform to these warranties or to the specifications, and Bechtel so notifies Contractor within a reasonable time after its discovery, Contractor shall promptly correct such nonconformity to the satisfaction of Bechtel, at Contractor's sole expense; failing which Bechtel may reject or revoke acceptance, and cover by making any reasonable purchase of goods in substitution for those rejected and the Contractor will be liable to Bechtel for any excess cost for such similar goods or services; or Bechtel may proceed to correct Contractor's nonconforming work by the most expeditious means available the costs of which shall be for Contractor's account; or Bechtel may retain the nonconforming goods and an equitable adjustment reducing the price to reflect the diminished value of such nonconforming goods will be made by written revision. Contractor's liability hereunder shall extend to all damages proximately caused by the breach of any of the foregoing warranties, including incidental damages, such as removal, inspection, costs of return or warehousing. Contractor shall not be liable for consequential damages such as loss of profit, loss of use or production, and costs of capital. No implied warranty of merchantability or of fitness for purpose shall apply.

Contractor further warrants that all PV devices (modules, panels or other readily detachable factory manufactured units) shall be free from defects in design, materials and workmanship and shall conform in all respects to the terms of this subcontract for an additional period. If at any time during three (3) years following the system warranty described above it appears that the PV devices do not conform to these warranties or to the specifications, and Bechtel so notifies Contractor within a reasonable time after its discovery and returns the devices to Contractor's plant at Bechtel's expense, Contractor shall promptly correct such nonconformity by repairing or replacing the defective device at Contractor's option and return the repaired or replacement units to the jobsite at Contractor's sole expense.

GC-33 INDEMNITY

Contractor hereby releases and shall indemnify, defend and hold harmless Owner, Bechtel and their subsidiaries and affiliates and the officers, agents, employees, successors and assigns and authorized representatives of all the foregoing from and against and all suits, actions, legal or administrative proceedings, claims, demands, damages, liabilities, interest, attorney's fees, costs and expenses of whatsoever kind or nature, including those arising out of injury to or death of Contractor's employees, whether arising before or after completion of the work hereunder and in any manner directly or indirectly caused, occasioned, or contributed to in whole or in part, or claimed to be caused, occasioned or contributed to in whole or in part, by reason of any act, omission, fault or negligence whether active or passive of

Contractor, its contractors or of anyone acting under its direction or control or on its behalf in connection with or incidental to the performance of this contract. Contractor's aforesaid release, indemnity and hold harmless obligations, or portions or applications thereof, shall apply even in the event of the fault or negligence, whether active or passive, or strict liability of the parties released, indemnified or held harmless to fullest extent permitted by law, but in no event shall they apply to liability caused by the willful misconduct or sole negligence of the party released, indemnified or held harmless.

GC-34 PATENT INDEMNITY

Contractor hereby indemnifies and shall defend and hold harmless Bechtel, Owner, and their representatives from and against all claims, actions, losses, damages, and expenses, including attorney's fees incurred as a result of or in connection with any claim, whether rightful or otherwise, that any equipment, material, or process or any part thereof furnished by Contractor under this agreement constitutes an infringement of any patent. If use of any part of such equipment, material, or process is limited or prohibited, Contractor shall, at its sole expense, procure the necessary licenses to use the infringing equipment, material or process, or with Bechtel or Owner's prior written approval, replace same with substantially equal but non-infringing equipment, materials, or processes or modify same to be non-infringing; provided that any such substituted or modified equipment, materials, or processes shall meet all the requirements, and be subject to all the provisions of this contract, and that such replacement or modifications shall not modify or relieve Contractor of its obligations under this contract. The aforementioned obligation shall not apply to any equipment, material, or processes, the detailed design of which (excluding rating and/or performance specifications) has been furnished in writing by Bechtel or Owner.

GC-35 ASSIGNMENTS AND SUBCONTRACTS

Any assignment of this contract or rights hereunder, in whole or part, without the prior written consent of Bechtel shall be void, except that upon ten (10) days written notice to Bechtel, Contractor may assign monies due or to become due under this contract, provided that any assignment of monies shall be subject to proper set-offs in favor of Bechtel and any deductions provided for in this contract. Contractor shall not contract with any third party for the performance of all or any portion of the work without the advance written approval of Bechtel. Lower-tier contracts must include provisions to secure all rights and remedies of Bechtel provided under this contract, and must impose upon the lower-tier contractor all of the general duties and obligations required to fulfill this contract including but not limited to the following Articles:

Assignment and Subcontracts

Indemnity

Warranty

Laws and Regulations

Inspection, Quality Surveillance, Rejection of Materials and Workmanship Expediting

Responsibility for Work, Security and Property

Labor, Personnel and Work Rules

Safety

Unpriced copies of all purchase and contract agreements are to be provided to Bechtel upon request.

No assignment or contract will be approved which would relieve Contractor or its sureties of their responsibilities under this contract.

GC-36 SUSPENSION

Bechtel may by notice in writing to Contractor, suspend at any time the performance of all or any portion of work to be performed under the contract. Upon receipt of such notice, Contractor shall, unless the notice requires otherwise:

- (a) immediately discontinue work on the date and to the extent specified in the notice;
- (b) place no further orders or contracts for material, services, or facilities with respect to suspended work other than to the extent required in the notice;
- (c) promptly make every reasonable effort to obtain suspension upon terms satisfactory to Bechtel of all orders, contracts and rental agreement to the extent they relate to performance of suspended work;
- (d) continue to protect and maintain the work including those portions on which work has been suspended; and
- (e) take any other reasonable steps to minimize costs associated with such suspension.

As full compensation for such suspension, Contractor will be reimbursed for the following costs, reasonably incurred, without duplication of any item, to the extent that such costs directly result from such suspension of work:

- (f) a standby charge to be paid to Contractor during the period of suspension of work, which standby charge shall be sufficient to compensate Contractor for keeping, to the extent required in the suspension notice, its organization and equipment committed to the work on a standby basis;

- (g) all reasonable costs associated with mobilization and demobilization of Contractor's plant, forces and equipment; and
- (h) an equitable amount to reimburse Contractor for the cost of maintaining and protecting that portion of work upon which performance has been suspended.

Upon receipt of notice to resume suspended work, Contractor shall immediately resume performance under the contract to the extent required in the notice. If the Contractor intends to assert a claim for equitable adjustment under this clause, it must, within ten calendar days after receipt of notice to resume work, submit to the Bechtel Buyer a written statement setting forth the schedule impact and monetary extent of such claim in sufficient detail to permit thorough analysis.

No adjustment shall be made for any suspension to the extent that performance would have been suspended, delayed, or interrupted by any Contractor's non-compliance with the requirements of this contract.

GC-37 TERMINATION FOR DEFAULT

Notwithstanding any other provisions of this contract, Contractor shall be considered in default of its contractual obligations under this contract if it:

- (a) performs work which fails to conform to the requirements of this contract;
- (b) fails to meet the contract schedule or fails to make progress so as to endanger performance of this contract;
- (c) abandons or refuses to proceed with any or all work, including modifications directed pursuant to the clause entitled "CHANGES";
- (d) fails to fulfill any of the terms of this contract; or
- (e) becomes insolvent or files or has filed against it a petition for rearrangement, composition or compromise with its creditors under any applicable law.

Upon the occurrence of any of the foregoing, Bechtel shall notify Contractor in writing of the nature of the failure and of Bechtel's intention to terminate the contract for default. If Contractor does not cure such failure within three (3) calendar days from receipt of notification, or sooner if safety to persons is involved, or if Contractor fails to provide satisfactory evidence that such default will be corrected, Bechtel may without notice to Contractor's sureties, if any, terminate in whole or in part Contractor's right to proceed with work by written notice and

prosecute the work to completion by contract or by any other method deemed expedient. Bechtel may take possession of and utilize any materials, plant, tools, equipment, and property of any kind furnished by Contractor and necessary to complete the work.

Contractor and its sureties, if any, shall be liable for all costs in excess of the contract price for such terminated work reasonably and necessarily incurred in the completion of the work as scheduled, including cost of administration of any contract awarded to others for completion.

Upon termination for default, Contractor shall:

- (f) immediately discontinue work on the date and to the extent specified in the notice and place no further purchase orders or contracts to the extent that they relate to the performance of work terminated;
- (g) inventory, maintain and turn over to Bechtel all materials, plant, tools, equipment, and property furnished by Contractor or provided by Bechtel for performance of work;
- (h) promptly obtain cancellation upon terms satisfactory to Bechtel of all purchase orders, lower-tier contracts, rentals, or any other agreements existing for performance of the terminated work or assign those agreements to Bechtel as directed;
- (i) cooperate with the Bechtel in the transfer of information and disposition of work in progress so as to mitigate damages;
- (j) comply with other reasonable requests from Bechtel regarding the terminated work; and
- (k) continue to perform in accordance with all of the terms and conditions of the contract such portion of work that is not terminated.

If, after termination pursuant to this clause, it is determined for any reason that Contractor was not in default, the rights and obligations of the parties shall be the same as if the notice of termination had been issued pursuant to the clause entitled "OPTIONAL TERMINATION."

GC-38 OPTIONAL TERMINATION

Bechtel may, at its option, terminate for convenience any work under the contract in whole or, from time to time, in part, at any time by written notice to Contractor. Such notice shall specify the extent to which the performance of work is terminated and the effective date of such termination.

Upon receipt of such notice Contractor shall:

- (a) immediately discontinue work on the date and to the extent specified in the notice and place no further orders or lower-tier contracts for materials, services, or facilities, other than as may be required for completion of such portion of work that is not terminated;
- (b) promptly obtain cancellation upon terms satisfactory to Bechtel of all purchase orders, lower-tier contracts, rentals, or any other agreements existing for the performance of the terminated work or assign those agreements to Bechtel as directed;
- (c) assist Bechtel in the maintenance, protection, and disposition of work in progress, plant, tools, equipment property, and materials acquired by Contractor or furnished by Bechtel under this contract; and
- (d) complete performance of the work which is not terminated.

Upon any such termination, Contractor shall waive any claims for damages including loss of anticipated profits, on account thereof, but as the sole right and remedy of Contractor, Bechtel shall pay in accordance with the following:

- (e) all amounts due and not previously paid to Contractor for work completed in accordance with the contract prior to such notice of termination, and for work thereafter completed as specified in such notice;
- (f) reasonable administrative costs of settling and paying claims arising out of the termination of work under lower-tier contracts or purchase orders;
- (g) reasonable costs incurred in demobilization and the disposition of residual material, plant and equipment; and
- (h) a reasonable profit on items (f) and (g) of this paragraph.

Contractor shall submit within 30 days after receipt of notice of termination, a proposal for an adjustment to the contract price including all incurred costs described herein. Bechtel shall review, analyze, and verify such proposal, and negotiate an equitable adjustment, and the contract shall be amended in writing accordingly.

Those provisions of the contract that by their very nature survive final acceptance under the contract shall remain in full force and effect after such termination.

GC-39 FINAL INSPECTION AND ACCEPTANCE

When Contractor considers all work under this contract to be complete and ready for acceptance, Contractor shall notify Bechtel in writing. Contractor's notification shall include documentation of field testing required by the contract together with a complete set of "as-built" drawings defining the system offered for acceptance. Bechtel, with Contractor's cooperation, will conduct such inspection and tests as may be reasonably required to satisfy Bechtel that the work conforms to all of requirements of the contract. If all or any part of the work does not conform to contract requirements, Bechtel shall notify Contractor of such non-conformance and Contractor shall take corrective action in accordance with the clause entitled "INSPECTION, QUALITY SURVEILANCE, REJECTION OF MATERIALS AND WORKMANSHIP" and the nonconforming work reinspected until accepted. Bechtel's written acceptance shall be final and conclusive except with regard to latent defects, fraud or such gross mistakes as amount to fraud, or with regard to Bechtel's right under the clause entitled "WARRANTIES."

GC-40 NON-WAIVER

Failure by Bechtel to insist upon strict performance of any terms or conditions of this contract, or failure or delay to exercise any rights or remedies provided herein or by law, or failure to properly notify Contractor in the event of breach, or the acceptance of or payment for any goods or services hereunder, or the review or failure to review designs shall not release Contractor from any of the warranties or obligations of this contract and shall not be deemed a waiver of any right of Bechtel to insist upon strict performance hereof or any of its rights or remedies as to any prior or subsequent default hereunder nor shall any termination of work under this contract by Bechtel operate as a waiver of any of the terms hereof.

GC-41 EQUAL EMPLOYMENT OPPORTUNITY

Contractor is aware of, and is fully informed of Contractor's obligations under Executive Order 11246 and, where applicable, shall comply with the requirements of such Order and all orders, rules, and regulations promulgated thereunder unless exempted therefrom.

Without limitation of the foregoing, Contractor's attention is directed to 41 Code of Federal Regulations (CFR), Section 60-1.4, and the clause entitled "Equal Opportunity Clause" which, by this reference, is incorporated herein.

Contractor is aware of and is fully informed of Contractor's responsibilities under Executive Order No. 11701 "List of Job Openings for Veterans" and, where applicable, shall comply with the requirements of such Order and all orders, rules and regulations

promulgated thereunder unless exempted there from.

Without limitation of the foregoing, Contractor's attention is directed to 41 CN Section 60-250 et seq. and the clause therein entitled "Affirmative Action Obligations for Contractors and Contractors for Disabled Veterans and Veterans of the Vietnam Era", which by this reference, is incorporated herein.

Contractor certifies that segregated facilities, including but not limited to washrooms, work areas and locker rooms, are not and will not be maintained or provided for Contractor's employees. Where applicable, Contractor shall obtain a similar certification from any of its contractors, vendors, or suppliers performing work under this Subcontract.

Contractor is aware of and is fully informed of Contractor's responsibilities under the Rehabilitation Act of 1973 and, where applicable, shall comply with the provisions of the Act and the regulations promulgated thereunder unless exempted there from.

Without limitation of the foregoing, Contractor's attention is directed to 41 CFR Section 60-741 and the clause therein entitled "Affirmative Action Obligations of Contractors and Contractors for Handicapped Workers" which by this reference, is incorporated herein.

In addition to the foregoing, Contractor will assist minority business enterprises to obtain business opportunities by identifying and encouraging minority suppliers, contractors and subcontractors to participate to the extent possible consistent with their qualifications, quality of work and obligations of the Contractor under this Subcontract.

GC-42 CLAUSES INCORPORATED BY REFERENCE

This Subcontract incorporates the following CFR clauses by reference, with the same force and effect as if they were given in full text. Upon request, their full text can be made available.

The following terms shall have the meaning indicated for clauses listed in this article.

Contracting Officer: The person with the authority to enter into, administer and terminate subcontracts is the Bechtel procurement representative assigned to the Contract.

Government: The rights and obligations of Government, other than in its sovereign capacity, shall extend to Bechtel pursuant to the authority of the Contract.

<u>CLAUSE TITLE</u>	<u>TEXT REFERENCE</u>
Authorization and Consent (MAR 11, 1988)	10 CFR 600.33(b)(5)
Notice and Assistance Regarding Patent Copyright Infringement (MAR 11, 1988)	10 CFR 600.33(b)(6)
Reporting of Royalties (MAR 11, 1988)	10 CFR 600.33(c)(2)
Additional Technical Data Requirements (APR 1984)	48 CFR 952-227-73
Rights in Technical Data (Long Form) (APR 1984)	48 CFR 952.227-75
Nondiscrimination in Federally Assisted Programs (45 FR 40514, June 13, 1990)	10 CFR 1040
Price Reduction for Defective Cost or Pricing Data (APR 1988)	52.215-22
Subcontractor Cost or Pricing Data (APR 1985)	52.215-24
Patent Rights - Retention by the Contractor (Long Form)	52.227-12
Inspection of Services (APR 1984)	52.246-5

Appendix C
SELECTION CRITERIA

Selection Criteria

EMT-1 (First Procurement)

Criteria	Weight (%)
The proposed PV collector technology has good potential for meeting energy cost goals for complete PV systems (under 12 cents/kWh by the early 1990s and 6 cents/kWh by the year 2000 in 1987 dollars). Required technology improvements and reliability can be attained. Barriers to commercialization can be overcome.	30
The proposed PV collector hardware offers greater efficiency, reliability, and warranty than similar PV technologies.	25
The bidder is capable of satisfactorily performing the work proposed within the time frame required.	25
The proposed QA/QC program is adequate.	10
The proposal clearly and succinctly describes the hardware and all of the above items.	10
Total	100

Note:

Although proposed cost is not included in the technical evaluation criteria, it will be considered in the award of the contract.

Selection Criteria

EMT-2 (Second Procurement)

Minimum Acceptance Criteria
A prototype of the proposed module has been adequately tested and its efficiency and performance have been demonstrated.
The module can be fabricated in quantity to meet the schedule.
The bidder can carry out the work as proposed.
The QC/QC plan is adequate.
A minimum performance warranty is offered.
The proposal is thorough, complete, and responsive.
Ranking Criteria
The bid price is competitive.
The proposed technology is judged to be suitable for long-term energy cost goals or is a worthwhile intermediate step, and the module/array is a significant improvement over existing technologies and/or the efficiency is higher than similar technologies.
The dc subsystem and the module/array designs are conducive to low O&M costs, and will perform as proposed.

Selection Criteria

EMT-3 (Third Procurement)

Criteria	Weight (%)
The proposed technology is judged to be suitable for long-term energy cost reduction or is a worthwhile intermediate step, and the module/array is a significant improvement over existing technologies and/or the efficiency is higher than similar technologies.	20
Bidder can carry out work as proposed, including fabrication of modules in a quantity sufficient to meet the schedule with adequate QA/QC.	20
A prototype of the proposed module has been adequately tested and its efficiency and performance have been demonstrated and documented.	20
The dc subsystem and the module/array designs are conducive to low O&M costs, and will perform as proposed.	15
The bid price is competitive.	15
A minimum warranty is offered.	5
The proposal is thorough and complete.	5
Total	100

Selection Criteria

US-1

Minimum Acceptance Criteria

The proposed modules have been successfully field tested.

The proposed PV system can be installed by October 1, 1990.

The minimum warranty is offered on all hardware.

The proposal is thorough and complete.

The proposal offers the optional system sizes requested.

The proposed PV system meets U.S. origin criteria in Article XVII of the schedule.

The offeror is capable of performing the work as proposed.

Ranking Criteria

System costs on an energy-produced basis, \$/kWh.

The system design is consistent with low O&M costs and high reliability.

The system is suitable for long-term energy cost goals or is a worthwhile intermediate step, and shows improvement in system efficiency, system cost, or BOS innovation over existing systems.

Note:

Manufacturers have indicated that system costs will range from \$5 to \$10 per watt. To be successful, bids must be at the low end of this range.

Selection Criteria

Kerman

Criteria	Weight (%)
Peak load correlation.	20
Relative demonstrated experience with proposed modules, based upon previous, successful, documented field test data and the ability of modules to pass the PVUSA module qualification test.	15
Relative capability of bidder's team to meet schedule and performance goals and to backup warranties.	15
Relative comparison of system design reliability and redundancy (e.g., two PCUs) to avoid single mode failures and to minimize O&M costs. Includes the ability to meet peak power under anomalous conditions such as soiling, tracking accuracy/failure, partially cloudy or hazy conditions, etc.	20
Additional warranty coverage above the minimum required for modules, dc BOS and structures/trackers, and the PCU and transformer.	10
Cost per kWh of peak energy.	20
Total	100

Appendix D

FIELD ACCEPTANCE TESTING

PV TURNKEY SYSTEMS

INTRODUCTION

This document is a replication of Appendix F of the Kerman Technical Specification. It defines the field acceptance testing process to be carried out after the Kerman PV plant has been accepted as construction complete. See Section 2 for a description of construction completeness.

FIELD ACCEPTANCE TESTING US-2 PV TURNKEY SYSTEMS

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ILLUSTRATIONS

- A PREPARALLEL INSPECTION (Extract from PG&E's White Book)
- B FIELD ACCEPTANCE TEST - BLOCK DIAGRAM
- C FIELD WET RESISTANCE TEST
- D SYSTEM ACCEPTANCE TEST - SCHEDULE OF MILESTONES

1.0 GENERAL

1.1 The objectives of this field testing are three-fold:

- 1) To determine that the system is functionally operative and meets the requirements delineated in the Technical Specification;
- 2) To verify that the system as installed is safe for personnel as well as equipment; and
- 3) To verify that the system meets the interconnection requirements for paralleling to the grid.

1.2 Utility power (12.47 kV) will be available only after Owner has verified and conducted the necessary tests and the preparallel inspection performed by PG&E has been passed (Illustration A).

1.3 Sequence of milestones and responsibilities are as follows. (See also Illustration B.)

- a) Contractor completes dc array installation and notifies Bechtel in writing. Owner and Bechtel will perform the Wet Resistance Test outlined in 4.1. (Illustration C). Contractor will be notified of pass/fail results and Contractor shall rework deficiencies.
- b) When Contractor considers all work under this contract to be complete and ready for acceptance, Contractor shall notify Bechtel in writing.
- c) Bechtel inspects the PV system and verifies that all required documentation has been fulfilled. Bechtel also performs safety checks such as measuring the PV system's resistance value to ground.
- d) Owner will conduct the tests outlined in Section 4.2 through 4.5; also see 1.5 below.
- e) Owner notifies Contractor that the system is ready for paralleling to the utility distribution circuit (Grid).
- f) Owner will conduct test on initial operation per Section 5.1. Assistance or presence of the Contractor is required for the initial operation tests.
- g) Upon successful completion of all the above tests, up to and including 5.1, Owner will notify Contractor that the system can be connected unattended to the grid.

- h) 30-day exposure conditioning period commences. Power quality test will be performed by Owner, Section 5.2.
- i) Upon completion of the 30-day conditioning period, Owner will collect data for 30 days as a basis for performance rating.
- j) After satisfactory completion of all the field acceptance tests delineated herein, Owner will notify Contractor and Bechtel in writing.

1.4 Factory certified test reports shall be submitted by Contractor to Bechtel for major equipment such as transformers, fused disconnect switch, power conditioning units, drive motors, tracking controllers, instrument transformers, etc. Contractor shall deliver these reports per Appendix G.

1.5 Certain tests (designated by *) must be performed by Owner and results forwarded to PG&E regional operating office 10 working days prior to pre-parallel inspection.

1.6 Electrical cables and wires will be tested by Contractor for continuity and insulation. Records shall be maintained by Contractor and submitted to Bechtel prior to offering the system for acceptance under GC-39.

1.7 Contractor shall maintain during construction a current set of all construction drawings/documents marked to reflect any field modifications. These will be used as reference for field testing. All drawings/documents affected by field modifications shall be updated to "as-built" condition and submitted to Bechtel prior to offering the system for acceptance under GC-39.

1.8 Contractor shall submit the reports/certifications as listed in the Technical Specification, Section 6.4.7 per Appendix G.

2.0 CODES AND STANDARDS

The equipment, material and components shall be tested and performed in accordance with the applicable standards, requirements and guides of the following:

- American National Standards Institute (ANSI)
- National Electrical Safety Code (NESC)
- Institute of Electrical and Electronics Engineers (IEEE)
- National Electrical Manufacturer's Association (NEMA)
- Insulated Cable Engineers Association (ICEA)
- Underwriters Laboratory (UL)

3.0 SCOPE

Acceptance tests shall include but not be limited to inspections and tests involving insulation, continuity, grounding, transformer turns ratio, polarity, hi-pot, meggering, instrument calibration, relay settings, I-V curves, functional system operation and demonstration of protective features and alarms. Performance tests such as output voltage and current harmonics, power factor and overcurrent will also be done.

An inspection will be conducted to insure that the installed system is built in a workmanlike manner and consistent with industry practice. Torque verification on bolted connections will be randomly performed. Finish or corrosion protection on structure will be checked for condition and damage repair. For tracking array systems, proper operation and performance to manufacturer's standard will be demonstrated by the contractor.

For power conditioning unit(s) (PCUs) or inverters, the Contractor shall demonstrate operation to manufacturer's standard, meeting the requirements in the Kerman US-2 Technical Specification.

Results of all tests will be documented and copies furnished to both Owner and Contractor.

4.0 TESTING PRIOR TO PARALLELING

Before start-up of the system is attempted, testing as outlined in the succeeding paragraphs shall be completed satisfactorily. The following paragraphs do not attempt to detail the procedure of each item of inspection, test or calibration. The method and extent will be agreed between Owner and Contractor by referring to the manufacturer's instruction, data sheets, specification, drawings, etc.

4.1 Field Wet Resistance Test

A wet resistance test will be conducted by the Owner and Bechtel on the installed PV array per Technical Specification Section 7.4 and as detailed on Illustration C of this appendix.

4.2 Major Equipment

The asterisk (*) indicates test to be performed solely by Owner. The tests so designated involve some equipment furnished by Owner.

4.2.1 Isolation Transformer *

The transformer shall be tested on the final operating tap, where a multi-tap type transformer is used. A 2,500 Volt dc or 1,000 Volt dc megger shall be used to prove the insulation of the transformer, winding-to-winding and each winding-to-ground. All ratios will be proven either by performing a

turns ratio test or a voltage ratio test. Transformers containing insulating oil shall be tested for dielectric strength.

4.2.2 Circuit Breaker *

All circuit breakers operated by protective relays (51C) shall demonstrate tripping at 70% of nominal control voltage. A micro-ohm test should be performed on all the circuit breakers. If this is not possible, a simple continuity check is acceptable.

4.2.3 Fused disconnect *

A megger test (using 2,500 or 1,000 Volt dc megger) shall be performed on the fused disconnect in the following manner:

Disconnect open - each pole-to-ground, pole 1 to 2, pole 3 to 4, pole 5 to 6.

Disconnect closed - pole 1 to ground, pole 3 to ground, pole 5 to ground; and if in a common enclosure, pole 1 to 3, pole 3 to 5, pole 5 to 1.

A micro-ohm test should be performed on the fused disconnect. If this is not possible, a simple continuity check is acceptable.

4.2.4 Instrument Transformers *

Current Transformers and Circuits:

- A saturation test should be made on all current transformers. If this is not possible, a manufacturer's curve is acceptable.
- The ratio of all current transformers have to be proven either by using current (primary to secondary) or voltage (secondary to primary).
- The current transformer circuits have to be checked for proper connections and continuity by applying primary or secondary current and reading in the relays (injection testing to verify relay operation).
- A single phase burden check will be made on the phase with the highest burden.
- A megger check of the total circuit with the ground wire lifted will be done to prove that only one ground point exists.

Potential Transformers:

- A 2,500 Volt dc or 1,000 Volt dc megger shall be used to prove the insulation of the transformer, winding-to-winding and each winding-to-ground. All ratios will be proven either by performing a turns ratio test or a voltage ratio test.

4.2.5 Relays *

- All relays must be field tested on site in accordance with paragraph 3.4 of the Power Producer's Handbook (See Appendix B). Settings will be determined and made by PG&E.

Trip checks of all required relays must be witnessed by the Owner's protection representative. This may require injecting a signal to trigger the relay. Jumping the studs on the relay is not acceptable. This is done to prove that the relay will handle the trip current of the breaker and also proves relay targeting.

Voltage restraint overcurrent relays must have a load check made. (Phase relation between voltage and current).

4.2.6 Cables and Buses

All buses and cables (operated at above 600 Volts) have to be meggered or Hi-Pot tested phase-to-phase and phase-to-ground after installation.

4.2.7 Power Conditioning Unit (PCU)

The following tests are intended to compliment factory tests.

After the PCU(s) and necessary accessory equipment/devices are installed in their final configuration, the Owner will:

- Perform a visual inspection on wiring, components, enclosure, etc.
- Verify emergency stop and other controls (as possible).
- Check all adequacy of grounding.

4.3 Data Acquisition Interface

Owner shall verify that all signals to the DAS are available and properly terminated in the US-2 IJB. Also simulate signals from the DAS Interface Junction Box to the PCU(s) and verify the system's consequent operation (as possible).

The Owner will verify the calibration of the instrumentation and compare the results with the manufacturer's specification (e.g., transducer manufacturer specification sheets).

4.4. Array I-V Curve

An I-V curve of each source circuit and entire array, as practical, will be done by Owner. I-V curve(s) will be used as information to determine possible problems, if any (e.g., spikes on the curve or fill factor outside expected limits of the particular PV technology).

4.5. Conclusion to Test Prior to Paralleling

The Owner will notify the Contractor, after completion of all necessary pre-parallel tests and inspection to the satisfaction of the Owner and PG&E Operations, to arrange for initial parallel operation.

5.0 TEST ON INITIAL OPERATION

Prior to initial start-up tests, testing as described in the previous sections shall have been satisfactorily completed.

5.1 Initial Start-up

The test will consist of demonstrating proper functional operation of the control and protective features under normal and abnormal conditions. The tests shall include but not limited to the following:

- Local operation and controls
- Remote reset and disable control
- Simulate the daily "wake-up" and "sleep" operation
- Loss of utility, three-phase
- Over/Undervoltage
- Over/Underfrequency
- Loss of control power
- Simulation of abnormal conditions (as practical) and corresponding PCU response such as orderly shutdown
- Loss of dc, or solar array(s)
- Tracker stow (if applicable)
- Run on

A test procedure will be developed by Owner and agreed by Contractor prior to testing.

5.2 Power Quality and System Operation

Power quality measurements/tests will be performed by Owner at the Owner furnished 12.47 kW outdoor switchgear. The tests will include but not be limited to:

- Harmonic Distortion: Limits per Technical Specification, Section 6.6.14
 - Current \leq 5% THD
 - \leq 3% Single
 - Voltage \leq 3% THD
 - \leq 1% Single
- Power Factor: Shall be 0.95 lagging or higher at a power level above 20% or rated power.
- Operation with other PCUs in parallel.
- An infrared camera will be used to scan the array field (while under load or shorted) to identify possible defects (e.g., loose terminations tend to be hotter than average).
- Dc injection into the 12.47 kV output of the PV system, this should be less than 0.5%.
- Phase current balance at 50% and 100% load.

SECTION 6

PREPARALLEL INSPECTION

The following is PG&E's procedure for performing preparallel inspection. It is important that all time constraints be adhered to for PG&E to provide you with timely service. Figure 6-1 shows a simplified flow chart of the requirements of parallel operation.

6.1 RELAY TEST REPORTS

The test reports must be received by PG&E a minimum of 10 working days prior to performing a preparallel inspection, and two copies should be sent to PG&E. Written verification of receipt for the test report will be returned to the power producer. Discrepancies in the relay coordination with PG&E relays will be handled via the phone and followed up in writing.

Test reports should include but are not limited to the following:

6.1.1 Providing Insulation (a 2,500 Volt dc megger is preferred, but a 1,000 Volt dc is acceptable).

1. All transformers connected to the primary bus have to be meggered winding to winding and each winding to ground.
2. All circuit breakers connected to the primary bus have to be meggered in the following manner. Breaker open - each pole to ground, pole 1-2, pole 3-4, pole 5-6. Breaker closed - pole 1-ground, pole 2-ground, pole 3-ground and if the poles are in common tank or cell, pole 1-2, pole 2-3, pole 3-1.
3. All busses and cables have to be meggered or Hi-Pot tested phase to phase and phase to ground.
4. The generator(s) have to be meggered or Hi-Pot tested phase to phase and phase to ground.

6.1.2 Proving Ratios

All ratios of transformers connected to the primary bus have to be proven either by using a turns ratio tester or a voltage ratio test. The main transformer has to be tested on the final operating tap (Tap furnished by PG&E).

6.1.3 Circuit Breakers

1. A minimum to trip at 70% nominal voltage has to be performed on all circuit breakers that are operated by PG&E required relays.
2. A micro-ohm test should be performed on all circuit breakers. If this is not possible, a simple continuity checks is acceptable.
3. A speed shot test is required and should be consistent with PG&E's testing procedure.

6.1.4 Current Transformer and Current Circuits

1. A saturation check should be made on all current transformers. If this is not possible, manufacturer's curve is acceptable.
2. The ratio of all current transformers has to be proven either by using current (primary to secondary) or voltage (secondary to primary).
3. The current transformer circuits have to be checked for proper connections and continuity by applying primary or secondary current and reading in the relays.
4. A single phase burden check has to be made on the phase with the highest burden.
5. A megger check of the total circuit with the ground wire lifted has to be done to prove that only one ground exists.

6.1.5 Relays

All relays must be field tested on site to the specifications outlined in Section 3.

6.2 PREPARALLEL TEST

All preparallel tests should be scheduled to begin at 9:00 a.m. Monday through Friday only. Functional tests will be performed by the power producer and all tests observed by PG&E as outlined below. The Project developer will provide all test equipment and qualified personnel to perform the required tests. PG&E will be there strictly as an observer.

6.2.1. Required Tests

The following functional tests will be performed after the equipment has been energized but before the generator is paralleled with PG&E's system.

1. Check that each protective relay trips the appropriate generator breaker and/or main breaker.
2. When first energized, check that proper secondary potential is applied to all voltage and frequency relays.
3. Check the synchronizing meter and equipment with the paralleling breaker closed and the generator off line. The equipment should show an "in-phase" condition.
4. Check the generator phase rotation (PG&E's phase rotation is A-C-B).

The following load tests may be done when the generator first picks up load.

1. Check for correct load current in all relay current coils.
2. Verify operation of the generator at .90 PF lag and .95 PF lead at the generator's rated output.
3. Verify operation of the generator at 95% and 105% from nominal voltage at the generator's rated output.
4. Load check all differential relays. The load current must balance to zero in all differential relays.

Direction check all impedance and directional relays by doing the following:

1. Bring up load on the plant and/or generator.
2. Verify direction of power flow.
3. Measure the phase angle between the current and potential applied to the relay.
4. Observe the correct action of the directional contacts according to direction of power flow.
5. Verify the operation of the generator at 0.90 PF Lag and at 0.95 PF lead while delivering rated (or contract) output.
6. Verify the operation of the generator at 0.95 and 1.05 per unit voltage while delivering rated (or contract) output.

On projects where the generation has a rated output in excess of 100 kW, the power producer will reimburse PG&E its estimate of the cost for performing the parallel inspection.

6.2.2 It is the power producer's responsibility to assure that all relays and other protective devices are adjusted and working properly prior to the preparallel inspection. In the event that problems arise with equipment during test, the PG&E representative may elect to cancel the test and reschedule for another time.

Typically, preparallel inspections can be performed within a normal working day. PG&E will dedicate one full working day to observe the test. In the event that a test cannot be completed by 6:00 p.m. the day of the test, the PG&E representative may cancel the remainder of the test and reschedule it for another time.

6.3 PARALLEL OPERATION

During the preparallel test, the PG&E representative will contact the designated switching station and obtain clearance for parallel operation. At PG&E's discretion, when the test is passed the power producer may be allowed to operate in parallel with PG&E for testing purposes only. This should not be mistaken as an official release for parallel operation. Once permission is granted, the power producer may then operate in accordance with the Operating Agreement (Appendix G) previously executed for a maximum of 14 days. At the end of the 14-day period, if the power producer has not received written permission from PG&E to operate in parallel, they must isolate from PG&E until written permission is received.

Written permission to parallel will be sent to the power producer via U.S. First Class Mail. This will be sent after PG&E has verified that all proper contracts and documents have been executed and are in place, the preparallel test has been passed and all other outstanding issues have been resolved including right-of-way, deeds of conveyance, insurance verification, operating agreements, interim solution agreement, if applicable, and PG&E has received final copies of the single line diagram and elementary diagrams that show "as-built" changes made during construction as well as a completed finalized generator data sheet.

Firm capacity performance testing cannot begin until after written permission from PG&E to parallel has been received by the power producer.

FIGURE 6-1
Simplified Flow Chart of Preparallel Test Procedure

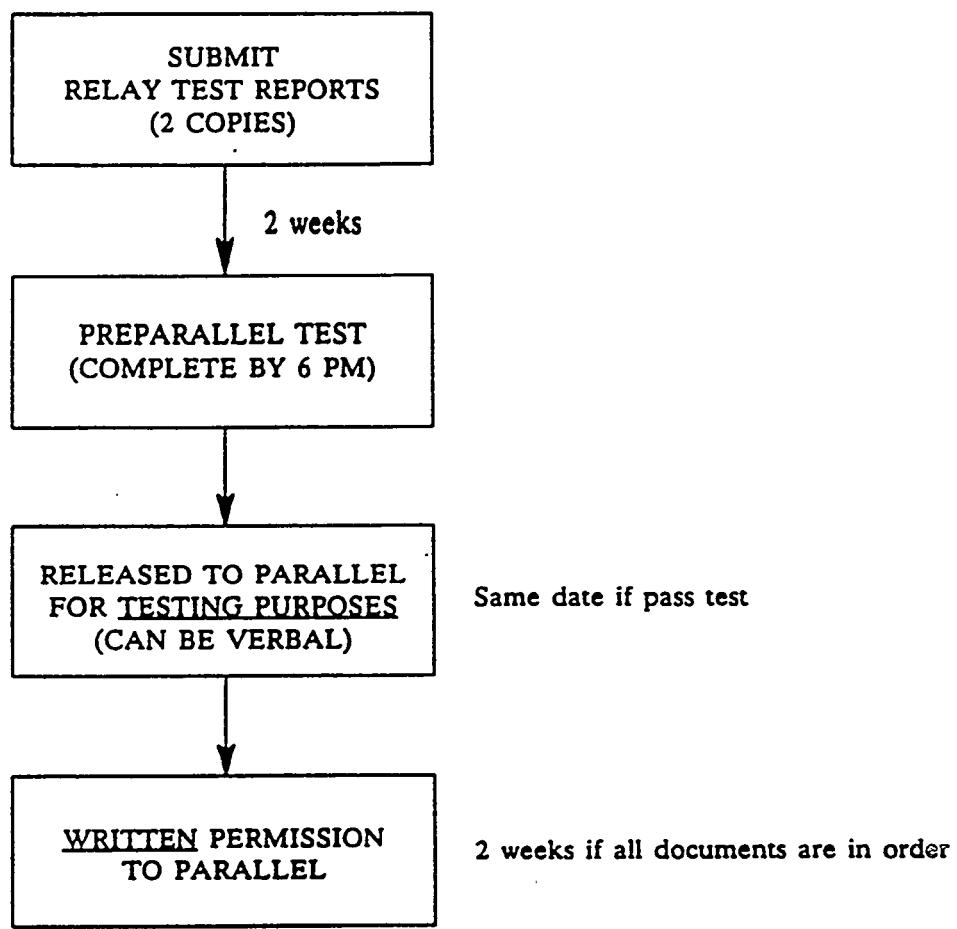


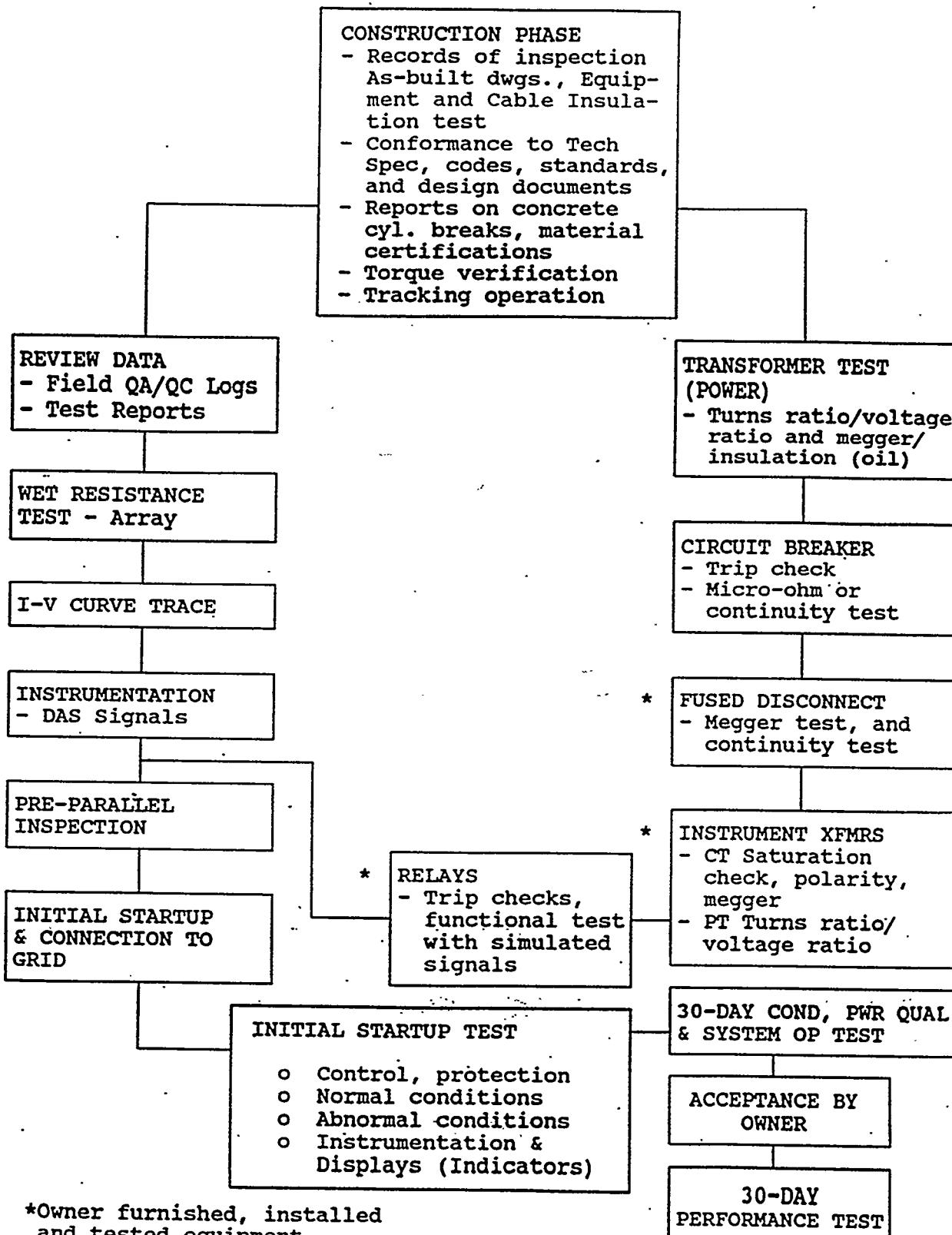
ILLUSTRATION A

TECHNICAL SPECIFICATION
APPENDIX F

(Rev. 4/90)

ILLUSTRATION B

PVUSA FIELD ACCEPTANCE TEST BLOCK DIAGRAM



*Owner furnished, installed and tested equipment.

OBJECTIVE: The primary objective of this test is to provide reasonable verification of the electrical safety of the modules and dc system as installed. A secondary objective is to provide some measure of assurance that the modules will survive the site environment.

CRITERION: Leakage currents should be less than .50 microamperes per module at twice the system operating voltage (to ground) plus 1000 volts.

BACKGROUND: This wet resistance test essentially repeats the wet hi-pot test conducted as part of the module qualification tests.

TEST PROCEDURE:

NOTE THAT EVEN IN DIM LIGHT, THE dc SYSTEM MAY HAVE AN OPEN CIRCUIT VOLTAGE OF UP TO ____ VOLTS dc POLE TO GROUND (WHEN GROUNDED) AND ____ VOLTS POLE TO POLE. THE ____ VOLTS dc IS A SEVERE SHOCK HAZARD THE POLE TO POLE VOLTAGE MAY BE LETHAL. APPROPRIATE CAUTION MUST BE USED WHEN WORKING ON THIS SYSTEM AND THE PVUSA SITE SAFETY PROCEDURES SHALL BE FOLLOWED.

1. Assemble the equipment at the array. Check ground continuity from panel frames to ground.
2. Verify that the contractor has not yet connected the MOVs or similar voltage surge protection devices. If such devices are connected, they must be disconnected as they would invalidate the tests and possibly be damaged by the test voltages. Open circuit the both poles (+ and -) connections to ground.
3. Open all of the source circuit switches.
4. Clear all nonessential personnel from the array area. No one should touch the modules or array during the high voltage testing.
5. Check that all string diodes are conducting. This step may be omitted if step 10 is carried out.
6. Connect the positive lead of the megger to the negative lead of the section. Connect the negative lead of the megger to ground.
7. Record the leakage resistance reading after the capacitive charging effect has subsided (perhaps 30 seconds). Also note any jumps in the reading which may indicate arcing.
8. Thoroughly wet all surfaces of the test section to which the megger is connected. Wet the module fronts first, then the backs. Be careful not to get water into the interior of the interface junction box, the power conditioning unit, the

megger or similar items which are not under test.

9. Measure the resistance, as in step 7, while the modules are wet to determine the wet leakage resistance.
10. Repeat steps 6 through 9 for the negative of the section circuit, except appropriately reverse the polarities in step 6 (i.e., connect the megger positive to ground and the megger negative to the section positive (see Figure 2). This step may be omitted if step 5 is carried out.
11. Repeat steps 6 through 10 for the other source circuits or segments of source circuits.
12. Notify and submit to Bechtel results of the tests.

If the wet leakage resistance is above the allowable wet leakage resistance for each test section, the dc system has successfully passed the test; any wiring disconnected for the testing should be replaced by Contractor; and the contractor may complete its installation work.

If leakage resistance is substantially lower for any test section, the contractor must correct the defective section and the corrected section will be re-tested.

EQUIPMENT (to be provided by PVUSA):

Simpson model 400-2 high impedance megohmmeter (megger)

Tank/pump/sprayer unit to wet the array

Oilskin slicker

Rubber gloves

Water and wetting agent: For example the wetting solution will be 1/4 ounce of Liqui-nox detergent (or approved equal) per 1 gallon of water (1 part in 512).

Procedure Accepted

Date

PVUSA _____

CONTRACTOR _____

NOTES:

1. Liqui-nox MSDS (Material Safety Data Sheets) and toxicity have been reviewed for any EPCRA (Emergency Planning and Community Right to Know Act) and OSHA (Occupational Safety Hazards Act) requirements. No action is required.
2. Each tank of the wetting agent will be checked for conductivity/resistivity.
 - 2.1 If a conductivity meter is used, the conductivity should not exceed 22,222 micro-siemens-meter at 22°C (77°F).
 - 2.2 If resistivity is measured, the resistance should not be below 4,500 ohm-cm @ 22°C (77°F).
3. When a single series string of _____ modules is tested, the open circuit voltage (pole-to-pole) is _____ volts with up to _____ amps of current available. All safety precautions shall be observed.

SYSTEM ACCEPTANCE TESTS - SCHEDULE AND MILESTONES

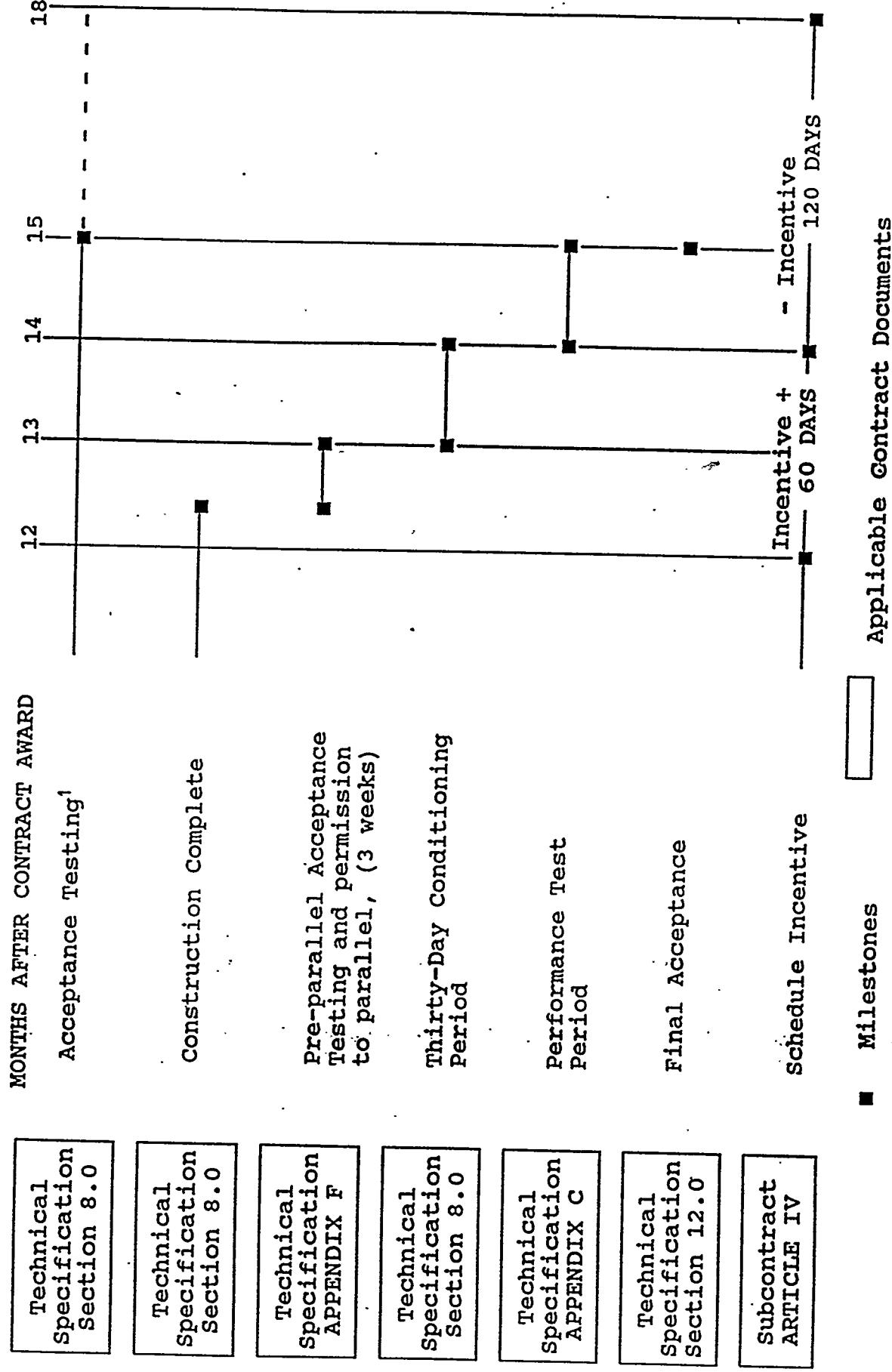


ILLUSTRATION D

¹The Owner may perform certain acceptance tests prior to construction complete as systems or commodities become available for testing.

Appendix E
ENGINEERING DOCUMENT REQUIREMENTS

INTRODUCTION

This document is a reproduction of Appendix G of the Kerman Technical Specification. This is a typical Bechtel document for the control of engineering documents submitted by contractors.

ENGINEERING DOCUMENT REQUIREMENTS								
1. DOCUMENT CATEGORY NUMBER	2. SPECIFICATION PARAGRAPH REFERENCE	3. DOCUMENT DESCRIPTION	4. PERMISSION TO PROCEED REQUIRED		5. SUBMITTAL SCHEDULE	6. QUANTITY REQUIRED		7. KIND OF COPIES
			YES	NO		INITIAL	FINAL	
1.1	11.6.1	OUTLINE DIM, SERVICES & FDN/HTG DETS	X		F	1	1	R
1.2	11.6.2	ASSEMBLY DWGS	X		F	1	1	R
1.3	6.4.8 11.6.3	SHOP DET DWGS	X		F	1	1	R
1.4	11.6.3 11.6.4 11.6.5	WIRING DIAGS	X		F	1	1	R
1.5	11.6.6	CONT LOGIC DIAGS	X		F	1	1	R
2.0	9.0	PARTS LIST & COST	X		S	1	1	R
3.0	11.6.9	COMP DATA SHEET	X		30	1	1	R
4.1	11.6.10	ERECL/INSL	X		S	1	1	R
4.2	9.0 11.4	OPERATING	X		S	1	3	R
4.3	9.0 11.4	MAINTENANCE	X		S	1	3	R
4.4	11.6.11	SITE STOR & HDLG	X		S	1	1	R
5.0	11.5	SCHEDULE (CPM)	X		30	1	1	R
6.0	11.2.1	QA MNL/PROC	X		30	1	1	R
33.0	11.2.2	INDEPENDENT DESIGN REVIEW OUTLINE	X		30	1	1	R
33.0	11.2.2	INDEPENDENT DESIGN REVIEW REPORT	X		60*	1	1	R
12.0	6.4.8	WLDG PROC & QUAFL	X		F	1	1	R
25.0	6.4.8 11.6.12	INSPECTION REPORTS	X		A	1	1	R
26.1	6.4.8	CERTIFICATION OF COMPLIANCE	X		S	1	1	R
26.2	7.2, 7.3 11.3.1	ELEC TEST PROC	X		S	1	1	R
30.0	7.2, 7.3 11.3.1 11.3.2	FACTORY TEST REPORT	X		S	1	1	R
31.0	11.2	MOULE QUAFL TEST REPORT	X		F	1	1	R
32.0	6.11	SAFETY CALCS	X		D	1	1	R
34.0	6.11.1	SAFETY PROGRAM		X	I*	1	1	R
35.0	6.11.2	FIRE PREVENTION PROGRAM		X	I*	1	1	R

ENGINEERING DOCUMENT CATEGORY DEFINITION

G-321-E - SUP A

(E) Engineering Documents. This term comprises procedures, drawings, specifications, QA plans, prototype qualification test reports and other similar documents that require Bechtel permission to proceed prior to fabrication, or prior to use of the document on the design, fabrication, installation or other work progress. The term is also applied to price lists, and instructions for erection/installation, operation, maintenance and site storage and handling.

A. DEFINITION OF TERMS

(Note: Standard abbreviated titles follow the category definitions).

Supplier - This is a comprehensive term and includes seller, vendor, contractor, subcontractor, subsupplier, etc.

Original - The initial document of which copies are made; i.e., handwritten copy, typed copy, printed matter, tracings, drawings and photographs.

Reproducible - A master copy which can be legibly duplicated by either microreproduction, diazo or electrostatic process. Diazo sepia may be submitted, only if they meet and satisfy Bechtel microfilming requirements.

Microfilm - Film containing an image reduced in size from the original and capable of being enlarged to a clear reproduction of the original.

Permission to Proceed Required - Bechtel review required prior to use of documents in the design, fabrication, installation or other work processes.

Initial - The first submittal of a document in accordance with the schedule mutually agreed to by Bechtel and the supplier.

Final - The submittal that reflects the required resolution of review comments or the complete submittal required. Drawings submitted as final shall show Bechtel's job title, job number, procurement document number, line equipment, tag or code number and the manufacturer's serial number(s).

B. SUBMITTAL

In column 5, Bechtel Engineering will place the following codes where applicable:

F - Before Fabrication	I - Before Installation
W - With Shipment	S - Before Shipment
P - Before Final Payment	D - Before Design
A - Before Acceptance	

or

Expressed in calendar days after notice of award.

In column 7, Bechtel Engineering to place the following letter as applicable.

M - Microfilm
R - Reproducible
O - Original

In column 8, supplier to indicate its schedule if different from one shown, and agreed with by Bechtel.

C. DOCUMENT CATEGORY NUMBERS AND ABBREVIATED DESCRIPTIONS

Engineering Documents are identified as follows:

1.0 DRAWINGS (DWG)

- 1.1 Outline Dimensions, Services, Foundations and Mounting Details (OUTLINE DIM, SERVICES & FDN/MTG DETS) - Drawings providing external envelope, including lugs, centerlines(s), location and size for electrical cable, conduit, fluid and other service connections, isometrics and details related to foundations and mountings.
- 1.2 Assembly Drawings (ASSEMBLY DWG) - Detailed drawings indicating sufficient information to facilitate assembly of component parts of an equipment item..
- 1.3 Shop Detail Drawings (SHOP DET DWGS) - Drawings which provide sufficient detail to facilitate fabrication manufacturer or installation. This includes pipe spool drawings, internal piping and wiring details, cross-section details and structural and architectural details.

- 1.4 Wiring Diagrams (WIRING DIAGS) - Drawings which show schematic diagrams, equipment internal wiring diagrams and interconnection wiring diagrams for electrical items.
- 1.5 Control Logic Diagrams (CONT LOGIC DIAGS) - Drawings which show paths which input signals must follow to accomplish the required responses.
- 1.6 Piping and Instrumentation Diagrams (P&IDs) - Drawings which show piping systems scheme and control elements.

2.0 PARTS LIST AND COST - Sectional view with identified parts and recommended spare parts for one year's operation or specified with unit cost.

3.0 COMPLETED BECHTEL DATA SHEETS (COMP DATA SHT) - Information provided by a supplier on data sheets furnished by Bechtel.

4.0 INSTRUCTIONS

- 4.1 Erection/Installation (ERE/CINSTL) - Detailed written procedures, instructions and drawings required to erect or install material or equipment.
- 4.2 Operating - Detailed written instructions describing how an item should be operated.
- 4.3 Maintenance - Detailed written instructions required to disassemble, reassemble and maintain items or systems in operating condition.
- 4.4 Site Storage and Handling (SITE STOR & HDLG) - Detailed written instructions which defined the requirements and time period for lubrication, rotation, heating, lifting or other handling requirements to prevent damage or deterioration during storage and handling at jobsite. This includes return shipping instructions.

5.0 SCHEDULES: ENGINEERING AND FABRICATION/ERECTION (SCHED) (ENRG & FAB EREC) - Bar charts or critical path method diagrams which detail - Bar charts or critical path method diagrams which detail the chronological sequence of activities.

6.0 **QUALITY ASSURANCE MANUAL/PROCEDURES (QA MNL/PROC)** - The document(s) which describe(s) the planned and systematic measures that are used to assure that structures, systems and components will meet the requirements of the procurement documents.

7.0 **SEISMIC DATA REPORT** - The analytical or test data which provides data and demonstrates suitability of material, components or system in relations to conditions imposed by the stated seismic criteria.

8.0 **ANALYSIS AND DESIGN REPORT (ANAL & DSGN RPRT)** - The analytical data (stress, electrical loading, fluid dynamics, etc.) which demonstrates that an item satisfied specified requirements.

9.0 **ACOUSTIC DATA REPORT (ACST DATA RPRT)** - The noise, sound and other acoustic vibration data required by the procurement documents.

10.0 SAMPLES

10.1 **Typical Quality Verification Documents (TYP QUAL VERIF DOC)** - A representative data package which will be submitted for the items furnished as required in the procurement documents.

10.2 **Typical Materials Used (TYP MAT USED)** - A representative sample of the material to be used.

11.0 **MATERIAL DESCRIPTION (MAT DESCRT)** - The technical data describing a material which a supplier proposes to use. This usually applies to architectural items, e.g., metal siding, decking, doors, paints and coatings.

12.0 **WELDING PROCEDURES AND QUALIFICATIONS (WLDG PROC & QUALF)** - The welding procedure, specification and supporting qualification records required for welding, hard facing, overlay, brazing and soldering.

13.0 **MATERIAL CONTROL PROCEDURES (MATERIAL CONT PROC)** - The procedures for controlling issuance, handling, storage and traceability of materials such as weld rod.

- 14.0 REPAIR PROCEDURE (REPAIR PROC) - The procedures for controlling material removal and replacement by welding, brazing, etc., subsequent thermal treatments and final acceptance inspection.
- 15.0 CLEANING AND COATING PROCEDURES (CLNG & CTG PROC) - The procedures for removal of dirt, grease or other surface contamination and preparation and application of protection coatings.
- 16.0 HEAT TREATMENT PROCEDURES (HEAT TR PROC) - The procedures for controlling temperature and time at temperature as a function of thickness, furnace atmosphere, cooling rate and method, etc.
- 19.0 UT- ULTRASONIC EXAMINATION PROCEDURES (UT PROC) - Procedures for detection of presence and certain characteristics of discontinuities and inclusions in materials by the use of high frequency acoustic energy.
- 20.0 RT - RADIOGRAPHIC EXAMINATION PROCEDURES (RT PROC) - Procedures for detection of presence and certain characteristics of discontinuities and inclusions in materials by x-ray or gamma ray exposure of photographic film.
- 21.0 MT - MAGNETIC PARTICLE EXAMINATION PROCEDURES (MT PROC) - Procedures for detection of surface (or near surface) discontinuities in magnetic materials by distortion on an applied magnetic field.
- 22.0 PT - LIQUID PENETRANT EXAMINATION PROCEDURES (PT PROC) - Procedures for detection of surface discontinuities in materials by application of a penetrating liquid in conjunction with suitable developing techniques.
- 23.0 EDDY CURRENT EXAMINATION PROCEDURES (EDDY CUR EXAM PROC) for detection of surface discontinuities in material by distortion of an applied electromagnetic field.
- 24.0 PRESSURE TEST - HYDRO, AIR, LEAK, BUBBLE OR VACUUM TEST PROCEDURES (PRESS TEST - HYDRO, AIR BUBBLE - VAC TEST PROC) - Procedures for performing hydrostatic or pneumatic structural integrity and leakage tests.

25.0 INSPECTION PROCEDURE (INSPECTION PROC) - Organized process followed for the purpose of determining that specified requirements (dimensions, properties, performance results, etc.) are met.

26.0 PERFORMANCE TEST PROCEDURES (PRFM TEST PROC) - Tests performed to demonstrate that functional design and operational parameters are met.

26.1 Mechanical Tests (MECH TEST) - e.g., pump performance data, valve stroking, load, temperature rise, calibration, environmental, etc.

26.2 Electrical Tests (ELEC TEST) - e.g., impulse, overload, continuity, voltage, temperature rise, calibration, saturation, loss, etc.

27.0 PROTOTYPE TEST REPORT (PROTO TYP TEST REPORT) - Report of a test which is performed on a standard or typical example of equipment or item, and is not required for each item produced in order to substantiate the acceptability of equal items. This may include tests which result in damage to the item(s) tested.

28.0 PERSONNEL QUALIFICATION PROCEDURES (PERSONL QUAL PROC) - Procedures for qualifying welders, inspectors and other special processes personnel.

29.0 SUPPLIER SHIPPING PREPARATION PROCEDURE (SPLR SHPNG PREP PROC) - The procedure used by a supplier to prepare finished materials or equipment for shipment from its facility to the jobsite.

30.0 FACTORY TEST REPORT performed on major pieces of equipment such as breakers, transformers, PCU, etc.

31.0 MODULE QUALIFICATION TEST REPORT

32.0 SAFETY CALCULATION

33.0 INDEPENDENT DESIGN REVIEW

34.0 CONTRACTORS SAFETY PROGRAM

35.0 CONTRACTORS FIRE PREVENTION AND PROTECTION PROGRAM

Appendix F

SAMPLE START-UP TEST PROCEDURE FOR A PV SYSTEM

INTRODUCTION

This document is a sample test procedure for a turnkey PV System based on start-up test procedures used for the Kerman PV plant. Illustration A (Pages F-5 through F-12) is directed to start-up of the PCU which is about 90 percent of the total start-up process.

SAMPLE START-UP TEST PROCEDURE FOR A PV SYSTEM

1.0 GENERAL

1.1 Definition

The start-up phase is defined as the period between the completion of construction and release to operations (on-line or commercial operation). Completion of construction implies that all installation work is finished and has been subjected to insulation and other testing, and that the settings and function of the protective devices have been checked. Additionally, the system dc open circuit voltages have been checked, and the responsible utility entity has given permission to parallel to the grid at minimum power levels.

1.2 Responsibilities

Start-up is the responsibility of the Owner who has notified acceptance of the system, in writing, to the buyer. The conduct of the start-up procedure may be delegated to others but remains the responsibility of the Owner for insurance purposes.

Utility companies typically place an electrical engineer in charge of the start-up of PV systems. Assistance may be employed from subcontractor personnel; a technical representative from the PCU manufacturer should either be physically present or should be available for consultation by telephone.

The personnel present and their responsibilities should be clearly identified in the start-up test procedure. Sign-off signatures are required on the test record at various stages; these may be either the signature of the utility engineer in charge or the PCU manufacturer's representative if responsibility has been delegated.

Safety of personnel is a primary concern during start-up and a safety meeting should be conducted prior to the start-up. Safety procedures should be reviewed and a

check made of test equipment, safety equipment and personnel training and readiness.

The test procedure should list all test equipment to be used and, where relevant, calibration history.

2.0 READINESS OF THE DC GENERATING SYSTEM

Prior to start-up, the dc array has successfully passed the FWRT, and I-V curves have been taken of the open circuit voltages of each source circuit. The dc ground fault protection system has been checked and is functioning. All protective devices (such as MOVs) are in place following the FWRT. All dc disconnects are closed and dc voltage is present at the input terminals of the PCU.

3.0 READINESS OF AC GRID CONNECTION

Also, prior to start-up, the responsible utility has completed its preparallel inspection and has given permission for the PV system to be paralleled to the grid. All protective and metering devices are functional and all ac disconnects are closed. Ac voltage is present at the output terminals of the PCU.

4.0 SAMPLE START-UP TEST PROCEDURE

Illustration A is a sample start-up test for Kerman which focuses on functionality for acceptance purposes. This document is furnished for illustration only. The PCU manufacturer should furnish a detailed step-by-step start-up procedure during the construction phase of the project which should be incorporated into the project start-up test procedure for the system. Not covered in **Illustration A** are system checks and tests conducted as part of certifying construction completion. Also not covered are provisions for stopping the test procedure in the event that equipment malfunctions require repair by the supplier.

PCU and System Warranty

The warranty provisions of the contract become effective following the Owner's notification of the PV systems acceptance as an operational PV System. This notification follows successful completion of start-up and subsequent successful completion of a 30-day conditioning period. During the start-up testing, the array and PCU are the property of the Owner. Assuming that only approved supplier procedures are followed, repairs during start-up, if required, are the responsibility of the supplier.

ILLUSTRATION A **SAMPLE START-UP TEST PROCEDURE**

This test is to be performed only after all tests required prior to are completed satisfactorily and permission for generation (parallel operation) has been granted by the PG&E regional office. This test is intended to verify functional operation of the photovoltaic system under actual generation condition (to verify compliance with the contract). Included are local and remote controls, protective devices (those not previously covered), alarms, abnormal operating conditions, and data channels. Accuracy, calibration, and power quality are not included as they are covered separately.

This procedure contains the basic steps which should be performed on all systems. They may be augmented for each system depending on the features and design of that particular system.

This procedure should be done with the assistance or in the presence of the turnkey contractor. The equipment manufacturer's field service engineer should be present or, at least, available by telephone for consultation.

Any comments, deviations from the test or items to be addressed should be noted below each step.

* **WARNING** *
* *

Safety is of primary concern with any electrical power equipment. During normal operation, these units operate from voltages and generate voltages that are LETHAL. Prudent adherence to ELECTRICAL SAFETY PROCEDURES is essential. Tests must be conducted by a minimum of two persons at all times.

Test equipment required:

Multimeter, DVM or DMM (two each)

Oscillograph

Heat Gun

Reference Thermometer

Pyranometer

System

Section

1.1.1 Local Operations and Controls

♦ Initial Test Conditions:

Acceptable Parameter Ranges

Irradiance: Min _____ Max _____ W/sq.meter

DC Voltage: Min _____ Max _____ Volts (Open Circuit)
(pole-to-pole) Volts (Operating)

AC Voltage: Min _____ Max _____ Volts
(low side of transformer)

Initial Values (system off-line)

Date/Time: _____

Irradiance: _____ W/sq.meter

Ambient Temperature: _____

Wind: _____ Mph

Initials

Date

DC Voltage (pole-to-pole): _____ Volts

AC Voltage (line-to-line): _____ Volts

Transformer Tap setting: _____ Volts

♦ Emergency Stop Interlock:

Activate Emergency stop switch and place RUN/STOP switch to RUN position. Verify that unit cannot be started. Note annunciator or other display status.

	<u>Initials</u>	<u>Date</u>
♦ Local Startup:		

Locally clear emergency stop if this is a maintained switch. Note change in annunciator status display. Turn the local RUN/STOP switch to the RUN position to initiate unit start-up.

List chronologically below the significant actions, steps, or states which will occur in the process of coming on line. These will be specific for each vendor. As appropriate, indicate the expected the observed elapsed times from initiation. (Include for example, contactor closures, charging cycles, self-check cycles, firing initiation, loading ramp rate.)

Note Annunciator or other display status.

Start-up sequence verified

Measure and record the following parameters while the system is on-line. Operating values (system on-line)

Time: _____

Irradiance: _____

AC Voltage (line-to-line): _____

AC Current _____

Measurement Location: _____

AC kVA Output (calculated): _____

Initials

Date

♦ Local Shutdown:

List chronologically below the significant actions, steps, or states which will occur in the process of going off-line to the standby or shutdown mode. These will be specific for each vendor. As appropriate, indicate the expected and observed elapsed time from initiation.

Shutdown sequence verified _____

♦ Emergency Stop:

Restart unit. Shutdown unit using EMERGENCY STOP switch.

Display: _____

♦ Manual Operation:

If the inverter has a manual operating mode, (e.g., constant voltage), place unit in manual control and verify stable operation throughout the range. Record operating range.

Minimum _____

Maximum _____

♦ Peak Power tracking:

Briefly describe the peak power tracking scheme below. Place the inverter in manual mode and determine peak power. Detune the setting and switch to automatic and record operating point.

Manual peak power _____

Automatic peak power _____

Initials Date

1.1.2 Remote Control and Data Interface

◆ PCU Run status: _____

With the unit in operation verify "PCU RUN" Status to DAS

◆ Disable: _____

Stop unit by REMOTE DISABLE (contact closure) and verify unit shutdown and proper indication. Upon removal of the REMOTE DISABLE signal (contact open), the system shall automatically restart (provided all other conditions are acceptable).

Display: _____

◆ Reset: _____

With inverter in the shutdown (tripped) mode, reset unit via remote reset function.

Display: _____

◆ Data Interface:

DC Voltage: _____

Using a DVM, measure and record the actual dc pole-to-pole voltage and corresponding signal from each signal conditioning unit.

Source Circuit Ident.	Spec. Ratio (Actual/ Signal)	Primary Value	Signal Value
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

DC Current: _____

Using a clamp-on ammeter, measure and record the actual dc source circuit current. Using a DVM, measure the corresponding signal from each signal conditioning unit.

Source Circuit	Spec. Ratio (Actual/ Signal)	Primary Value Shunt	Signal Value
<u>Bus</u>	_____	_____	_____
<u>1</u>	_____	_____	_____
<u>2</u>	_____	_____	_____
<u>3</u>	_____	_____	_____
<u>4</u>	_____	_____	_____

Thermocouples:

Using a reference thermometer with digital display, measure and record the back-of-module temperature for each thermocouple. Read and record the corresponding temperature as registered on the IJB data logger.

Thermocouple	DAS Channel	Ref. Temp.	Measured Temp. (DAS)
<u>1</u>	_____	_____	_____
<u>2</u>	_____	_____	_____
<u>3</u>	_____	_____	_____
<u>4</u>	_____	_____	_____
<u>5</u>	_____	_____	_____

1.1.3 Tests for Abnormal Conditions

For each test also verify "TROUBLE" alarm contact closure.
(After each test, unit must be reset.)

	<u>Initials</u>	<u>Date</u>
◆ Ground Fault:	_____	_____
Simulate array dc ground fault by injecting signal(s) to the sensor. Verify that unit trips and "ground fault" contact closes for remote indications.		
Remove signal and verify that ground fault sensor resets to normal state.		
Set Point _____ Observed _____		
Observed _____		
◆ Smoke Alarm:	_____	_____
Verify unit trip when SMOKE is injected into the unit or contacts are jumpered activating the SMOKE ALARM. Also trips ac circuit breaker. Requires control power to be toggled off and reset of smoke detector.		
◆ Door Interlock:	_____	_____
Open door to activate mechanical interlock and verify unit trip.		
◆ PCU Overtemperature:	<u>Initials</u>	<u>Date</u>
Using heat source (heat gun, etc.), apply heat to unit sensor(s), verify unit trip. Monitor temperature with a reference thermometer and record temperature at trip.		
◆ Single Phasing:	_____	_____
This test will determine the response by the PCU logic upon detected loss of one phase voltage. To simulate single phasing of the inverter, lift one of the phase voltage sensing leads.		
Record Response: _____		

♦ Run On:

By interrupting connection to the ac grid during system operation, the inverters are placed in a situation where they may "run-on" by phasing back and possibly cross feeding if multiple inverters are involved.

Connect an oscillograph or other events recorder to monitor line side ac voltage and PCU ac contactor status. Initial test shall be conducted with no other US systems on-line. Trip ac potential by appropriate device (e.g., 12-kV disconnect or 12-kV interrupter). Record clearing times and/or any abnormal responses. Attach Oscillograph printout if available. If multiple inverters are used, testing shall include, as a minimum: 1) one individual PCU, and 2) all PCUs operating in parallel.

Equipment _____

Ac contactor clearing time _____

Remarks _____

Initials

Date

♦ Automatic Restart:

The PCU is designed to automatically restart after certain transient conditions. Under these conditions, the PCU is not tripped (shutdown) but goes into standby mode. Record below conditions under which this should occur and verify proper restart.

Insufficient Irradiance:

◆ Loss of Array:

With PCU operating, open dc disconnect(s) to
interrupt array input. Record PCU response.

1.1.4 "Wakeup" and "Sleep"

This test will require use of the DAS.

Arrange to have the DAS monitor global irradiance, array dc voltage and status of PCU (such as run status contact or ac contactor status). DAS sampling rate should be no less than at 30 second intervals. Record irradiance in the plane of the reference cell (if used) and PVUSA site pyranometer.

◆ Wakeup:

Record irradiance and dc voltage at time of system initiation. (Initiation means logical permission to start, not actual power generation.)

Design _____ W/m² _____ Volts (p-p)

Observed _____ W/m² _____ Volts (p-p)

Observed _____ W/m² (Site pyranometer, indicate type) _____

Initials Date

◆ Sleep:

Record irradiance at the time the system separates from the utility.

Design _____ W/m²

Observed _____ W/m²

Observed _____ W/m² (Site pyranometer, indicate type) _____