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**US Army Corps
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Construction Engineering
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USA-CERL TECHNICAL REPORT E-89/01
October 1988

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AD-A201 937

Applications Survey for Remote Photovoltaic Power Systems

by
L. Frantzis
W. P. Teagan

As part of the Federal Photovoltaic Utilization Program, the U.S. Army determined that photovoltaic (PV) systems in the size range of 50 watts to 2 kilowatts are cost effective, reliable, and nearly maintenance free for remote, stand-alone application. The objective of this study was to identify installations having potential PV applications and to determine the load and other system requirements. Recommendations for future activities to promote PV use at Army installations are included.

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As part of the Federal Photovoltaic Utilization Program, the U.S. Army determined that photovoltaic (PV) systems in the size range of 50 watts to 2 kilowatts are cost effective, reliable, and nearly maintenance free for remote, stand-alone applications. The objective of this study was to identify installations having potential PV applications and to determine the load and other system requirements. Recommendations for future activities to promote PV use at Army installations are included.					
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APPLICATIONS SURVEY
FOR
REMOTE PHOTOVOLTAIC POWER SYSTEMS

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Cambridge, MA

For
U.S. Army Construction Engineering Research Laboratory
Champaign, IL

September 1987

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1.0 BACKGROUND AND SUMMARY

Arthur D. Little, Inc. under contract to U.S. Army Construction Engineering Research Laboratory (CERL), investigated potential applications for photovoltaic (PV) systems in selected Army facilities. As part of the Federal Photovoltaic Utilization Program (FPUP) the Army determined that PV systems in the size range of 50W-2kW are cost-effective, reliable, and near maintenance free for remote, stand-alone applications. The main objective of this study was to identify viable candidates for PV applications at seven Army sites in the 50W-2kW size range. To accomplish this task, Arthur D. Little, Inc. selected (in conjunction with CERL) and visited seven Army sites in the U.S. to identify potential PV applications, as well as load and balance of system requirements.

The one day site visits to the following seven Army bases are briefly described in section 2.0:

- Dugway Proving Ground, UT
- Tooele Army Depot, UT
- Fort Ord, CA
- Fort Hunter-Liggett, CA
- Fort Bliss, TX
- Fort Huachuca, NM
- Yuma Proving Ground, NM

The bases were chosen because of their diversity in land size, availability of remote locations, and types of Army activities conducted at the bases. The results of these site visits indicate that there is a significant interest and awareness of PV systems. Many of the sites are already using PV for a variety of applications, which are discussed in section 2.0. PV experience gained at some of the visited sites have already indicated that PV systems are a cost-effective alternative in comparison to grid or diesel power. There is, however, still a strong demand for better education about PV system performance and experience gained at other Army bases.

The key PV applications already in use at the Army bases visited or those that show strong potential for increased use include:

- Mobile "A" Stations;
- Battery Chargers;
- Clearance Lights on Water tanks;
- Global Positioning Systems;
- Mobile Firing Ranges;
- Radio Repeaters;
- Firing Range Gun Positions;
- Range Surveillance Video;
- Microwave Repeaters;
- Remote Data Acquisition;
- Met Towers; and
- Storage Facilities (Igloos).

During the one day site visit to each base, basic power and load requirements for each of these systems were identified, which are described in section 2.0. Table 1 summarizes the typical load and power characteristics of the major PV applications identified. More detailed technical data are provided in the applications survey forms provided in the appendix.

In some instances, the level of detail desired for load and energy requirements of potential PV applications were not available or well defined. A more detailed assessment of the power and load requirements of these systems would require more investigation outside the scope of this study. This study identifies some PV experience gained at seven selected Army bases and provides an overview of strong potential PV applications at these sites.

There is clearly a strong interest in PV systems at the bases selected to visit. Additional education and awareness about the cost-effective economics and successful military performance of PV systems would most likely result in increased PV use at other Army bases.

Table 1

Typical Load and Power Characteristics of
Key Potential PV Army Applications

<u>Application</u>	<u>Volts</u>	<u>Amps</u>	<u>Watts</u>	<u>Watt-hrs/day</u>	<u>Battery Storage (Days)</u>	<u>Approximate Peak PV Watts</u>
"A" Stations	32VDC	2	64	576-768	2-3	125-160
Battery Chargers	12-32VDC	.33	9.6	79	-	17-20
(for emergency power of water wells)						
Clearance Lights (on Water Tanks)	120VAC	2.5-4.2	300-500	3,600-12,000	2	770-2,500
Bugle Recorder	120VAC (could be DC)	9.2	1,100	5,000	1-2	1,100
GPS	120VAC	9	1,080	9,700-13,000	4	2,000-2,800
Mobile Firing Range	12VAC	5	60	390	1-2	80-90
Mobile Generators	varies	varies	300-5000	2,400-40,000	3	500-9,000
Radio Repeaters	120VDC	6	800	7,200	3	1,400-1,600
Battery Chargers (Tank Targets)	NA	NA	NA	NA	NA	NA
Firing Range Gun Position	12VDC	4	48	480	2	100-110
Range Surveillance Video	varies	varies	500-1,000	7,200-19,000	2-3	1,000-3,500
Microwave Towers	32VDC	9.4	300	7,200	2-3	1,500-1,700
Remote Data Acquisition	NA	NA	60-100	1,400-2,400	2-3	300-500
Met Towers	20VDC	2	40	960	3	200-220
Storage Facilities (Igloos)	VDC	NA	60	1,440	2-3	300-320
Microwave Repeaters	VDC	NA	200	4,800	3	1,200-1,600

2.0 SITE VISIT RESULTS

2.1 Dugway Proving Ground, UT

Dugway Proving Grounds is about 60 miles Southwest of Salt Lake City, Utah on 802,000 acres. There are only 156 military and 846 civilian personnel at this site. Mr. Jim Wheeler, who functions as the energy coordinator, was the primary contact at Dugway. Key personnel within the Instrumentation Branch and Optical Data Branch who have a knowledge of remote power needs appropriate for PV in the near term, as shown in Table 2, were also contacted. Both of these branches are within the Material Test Directorate. These senior staff members were highly knowledgeable in the field of PV and very receptive to expanding their range of application at Dugway. They pointed out that Dugway was about 65 miles north to south and encompassed an area about that of Rhode Island. Most of this area had no realistic access to utility power and had to be served by PV or engine generators. As indicated below, power needs at the facility in support of field tests are diverse and provide an excellent opportunity for expanded PV use. These applications fall into several broad areas;

- Weather stations
- Radio Repeater Stations
- Range Surveillance Video Systems
- Microwave Towers
- Water Pumping (special application)

Dugway is already experienced in PV use for some of these applications and increasingly undertakes its own system designs to both reduce costs and to better tailor the systems to their specialized applications. Consequently, they currently purchase panels and install them within systems of their own design. They are also well positioned to undertake needed O&M functions of systems. They were very interested in the possibility of acquiring panels from CERL if they are of modern design with a proven track record of reliability.

PAST EXPERIENCE

Dugway participated in the FPUP program in the late 1970's and early 1980's. This program resulted in two, 3 kw, systems being installed which operated reasonably well with most of the problems being associated with controls and power conditioning rather than the PV panels. Both these applications were for operation of meteorological towers with associated measuring and telemetry equipment. These two sites were disassembled for reasons having nothing to do with their performance or reliability. In one case commercial power was made available to the site due to increasing power needs and in the other case the field testing program required moving the facility to another site.

Table 2

Contacts At Dugway Proving Grounds

- Mr. Jim Wheeler
Energy Coordinator
Tel. (801) 831-5412
- Mr. James Dyer,
Chief, Instrumentation Branch,
Tel. (801) 831-5412
- Mr. Jerald Norrington
Optical Data Branch
Tel. (801) 831-5177

CURRENT APPLICATIONS

The PV panels from the two sites discussed above have been utilized for other smaller scale remote power applications. The most important of these are for powering Micro Meteorological Stations referred to as Mesomet Stations. Currently, about 14 of these sites are powered by PV systems. These stations use about 300 watts of PV panels for undertaking basic weather measurements (wind, temperature, pressure, etc.) and transmitting this data periodically to a receiving station. They expect over a dozen more such applications for PV systems and, in fact, assume the use of PV even if commercial power could be made available in order to increase reliability and standardize designs.

Smaller PV systems are used to operate several smaller systems referred to as SAMS and SODAR. Few details were available on these systems except that power needs were about 50 to 100 watts.

PLANNED APPLICATIONS

Dugway is planning to expand the use of PV beyond those referred to above. Several applications in the initial planning stage are discussed briefly below:

Range Surveillance Video Systems

The Optical Data Branch was particularly interested in using PV for range surveillance video systems. These systems, which are still in the early design phase, will be semi-portable units which perform multiple functions in support of field tests including; optical range surveillance and security surveillance. Eight such units are planning to be used each having PV power needs of 1 to 3 kW. The wide range reflects the preliminary status of designs and associated power needs. Power will be required for several functions such as operation of cameras, temperature control with heaters and fans, and telemetry. They want most of the power to be provided by the PV systems. However, they are willing to consider the use of a backup mobile engine driven generator to ensure minimum capabilities during poor weather and/or particularly high energy demands. This reflects their good understanding of PV systems and the high premium associated with ensuring high reliability under all conditions with the PV system alone. Sandia, however, suggested that a recommendation be made that they use more efficient propane heated thermoelectrics which are standard commercial products for backup power. Implementation of the first systems of this new design is planned for 1988.

Microwave Towers

As part of the Ethenet System, 6 microwave towers will be installed over the next few years. There will be no realistic prospect for commercial power for, at least, three of these sites. Approximate power needs will be 300 watts with a 25% duty cycle per antennae (4 per tower).

Remote Data Acquisition System

Dugway purchased several remote data acquisition systems which included PV panels having an area of about 4' x 8' (about 300 watts). They expect to

install up to 12 such systems using PV systems of their own design. To ensure reliable winter operation they will need to install 12 V electric heaters for the batteries which results in inadequate PV capacity with the current design. They expect, therefore, to increase PV capacity, but had no figures on panel or battery capacity requirements.

Water Pumping

There are several Defense Test Chamber (DTC) facilities located on the proving grounds. One of these near Camelback Mountain needs a water supply for personal hygiene and drinking. One option under consideration is an existing well about 2½ miles from the chamber. The well is at a higher elevation than the DTC so gravity feed would be possible once the water is pumped from the well. The depth of the well was not readily available. They estimate (very roughly) that 200 to 600 gallons per day might be adequate. Assuming a depth of 500 ft, this would correspond to about 400 - 800 watts of PV capacity.

Battery Storage Issues

Mr. James Dyer, Chief of the Instrumentation Branch, emphasized that dealing with used lead acid batteries was becoming an increasingly big problem due to environmental regulations which require that they be drained and all acid accounted for. The difficulty in dealing with battery fluids was, in fact, inhibiting their increased use as large (multi kW) buffer systems for grid connected systems. Consequently he felt that sealed gel type batteries which can be shipped as is (no draining) to disposal sites had definite advantages. The issue of battery O&M, life, and disposal may require additional study as part of a strategy to support more widespread use of PV in Army facilities.

2.2 Tooele Army Depot, UT

Tooele Army Depot is located 35 miles Southwest of Salt Lake City, UT on 44,096 acres of land. There are approximately 80 military and 4,000 civilian personnel at this base. Mr. Nathan Walker, (Telephone 801-833-2891), the Energy Coordinator at Tooele Army Depot, was the major contact. This depot is an equipment repair and storage facility comprised of two sections (Main Depot and southern Annex). The relatively small size of the depot results in almost all areas being served by utility power. This, from their perspective, severely limits the potential for photovoltaics in the near term. Several points raised at the meeting are discussed below:

Storage Facilities ("IGLOOS")

The longer term storage of equipment is in concrete buildings having rounded roofs which are referred to as "Igloos". Recently, Tooele committed to installing 90 additional "Igloos" in an area of the depot which was not heretofore served by utility power. This required installing about 9 miles of utility wire (including that between Igloo structures) at an average cost of \$100,000 per mile.

Each Igloo requires power for lighting and intrusion detection equipment. It is roughly estimated that the power requirements could be served with a PV system having 300 watts of capacity. All the Igloos could, therefore, be supplied with 27,000 watts of PV capacity. A preliminary cost comparison of the two systems (PV vs. Utility extension) would be:

Utility Extension: \$100,000/mile x 9 miles = \$900,000
PV: 27,000 watts x \$25/watt = \$675,000

The \$25/watt cost for a packaged PV unit might be somewhat conservative for a relatively large order represented by 90 units. The above figures indicate that PV would have been very competitive with a grid extension and may have offered advantages of increased security and reliability via autonomous power units.

Unfortunately, the commitment to the grid extension has already been made and new Igloo construction will not occur for another 3-4 years. Mr. Walker suggested three other depots where similar Igloo construction projects are in the planning stages which might represent good PV opportunities.

1. Yumatilla Depot, Hermaston, OR
2. Fort Wingate, Gallup, N.M.
3. Flagstaff Depot, Flagstaff, AZ

Microwave Repeater Station

There are preliminary plans for building a microwave repeater station on one of the mountains on (or adjacent) to the depot. The facility would require about 200 watts of continuous power (1200 - 1600 watts of PV). This could be a good PV application; however, the station would probably not be built for another 3 - 4 years.

Electricity Use

Electricity currently costs about \$2 million per year with about one third the bill being demand charges. Electricity use is increasing in large part due to the increased use of computers. Little of the electric demand is due to air conditioning since "swamp" coolers or simply open windows are used in most residential and work areas.

2.3 Fort Ord, CA

Fort Ord is located a few miles north of Monterey, CA on 28,000 acres. There are approximately 22,000 military and 4,600 civilian personnel at this base. The primary contact was Mr. Rod White, Energy Coordinator, (408) 385-2403.

Fort Ord felt that there were no potential applications for PV because all power needs were in close proximity to grid power. No survey forms, therefore, were filled out for this site. The staff at Fort Ord, however, need to be provided more information regarding actual costs of running wires underground, dropping wire through a transformer and the associated switchgear as compared to PV system costs. If more than 200 ft. of wiring is required for a particular application, grid connected power is not necessarily the cheapest option. Often, a PV system would prove to be more economically attractive for many small-scale power needs. This type of cost information and comparison would be very valuable to many other easily accessible grid connected Army bases that do not clearly understand the benefits and cost-effectiveness of PV power for small-scale applications.

2.4 Fort Hunter-Liggett, CA

Fort Hunter-Liggett is about 60 miles south of Fort Ord and is where field maneuvers take place. Facility staff at Hunter-Liggett report to Fort Ord.

PV are in extensive use at Hunter-Liggett and other promising applications are under consideration. The primary points of contact are identified in Table 3. Bruce Coons at Instrumentation Command is a civilian employee with responsibilities for providing instrumentation and telemetry equipment for field maneuvers which take place over an area of about 88,000 acres.

CURRENT APPLICATIONS

PV are already used for two functions-both of which are described briefly below:

Range Measuring Systems

The core of the range measuring systems at Fort Hunter-Liggett consists of 50 "A Stations" which are placed on hilltops scattered throughout the base. Through a process of triangulation these stations monitor the movement of tanks and other vehicles being used in a field maneuver (the vehicles have small transmitters placed on them). The A stations were purchased as a packaged unit (including the PV system) from General Dynamics. The price got too high and now they do their own engineering and purchase panels for installation into the PV system. They are in the process of replacing panels on some the older systems in order to increase output using the same area. The new panels are being supplied by Solarex and use the polycrystalline material having a high packing density due to their square shape. The systems using the older panels with 3 inch wafers had about 49% less output per unit area and resulted in power shortages - particularly during cloudy weather or when night maneuvers were taking place. The area of solar cells per unit is about 8 square feet corresponding to a peak

Table 3

Contacts at Fort Hunter-Liggett

- Mr. Peter Anderson
Facility Manager
Fort Hunter-Liggett
Jolon, CA.
Tel. (408) 385-2514
- Mr. Bruce Coons
Instrumentation Command
Fort Hunter-Liggett
Tel. (408) 385-5911
-2810
- Mr. Feckter
Chief, Meteriological Command
Fort Hunter-Liggett
Tel. (408) 385-2519

output of about 80 watts using the newer panels. Battery storage capacity is about 800 watt-hrs corresponding roughly to 2 days of panel output during sunny weather.

Other bases which use similar A Station equipment to monitor field maneuvers include Fort Bliss, Yuma Proving Ground, and Fort Irwin.

Remote Weather Stations

There are six small remote weather stations now operating using PV to provide power for the sensors and for telemetry of the data. These units use a single PV panel having an area of about 4.5 square feet (18" x 3'). The head of the Meteorological group was not in and so little information was available on these systems. Apparently, however, there are no plans for additional systems of this type.

PLANNED OR POTENTIAL APPLICATIONS

Hunter-Liggett is planning to install 2 field shower facilities which troops can utilize while on extended field maneuvers. These facilities will need minimal lighting, a circulating pump, and a pump for the wells (estimated to be 100 to 200 feet deep). These sites will be 10 to 20 miles from the grid so either PV or engine generator power will be used. They estimate that 1000 to 2000 gallons of water will be required per day when in use. No estimates of power needs have yet been made. Based on the minimal information available, the following power might be required:

Circulating Pump - 50 to 100 watts
Lighting - 100 to 200 watts
Well Pump - 500 to 1000 watts

It appears, therefore, that each of these facilities could be served by a PV system with a capacity of about 700 to 1500 watts.

The possibility of using a solar water heating system to further reduce logistics problems was also discussed and is being seriously considered.

2.5 Fort Bliss, TX

Fort Bliss is located in El Paso, TX on 125,000 acres. There are 20,500 military and 8,000 civilian personnel at this site.

The staff at Fort Bliss are extremely interested in using PV for many of their remote applications. There was a significant consensus that their climate, range activities and insolation levels would be ideal for such applications. The major barrier for their more widespread use has been a lack of information and education about the status of PV systems. Many times the staff at Fort Bliss were not even aware that there were PV systems already being used in some applications on the base. The key contacts made at Fort Bliss are shown in Table 4 and a brief description of potential PV applications at their base are discussed below.

Table 4

Contacts at Fort Bliss

- Mr. Emilio Escandon
Chief of Energy Conservation Branch
Tel. (915) 568-6627
- Mr. Tony Esparza
Automatic Controls Mechanic
Tel. (915) 568-6627
- Mr. Archa Hall, Deputy
Directorate and Communications
Manager of Information Management
USA ISC
Building 56 ASNB-BLI
Fort Bliss, TX 79916-5900
Tel. (915) 568-4823
- Mr. Alejandro Estorga
Technical Director
Air Defense Board
USA RAB ABD
Attn: ATZC-D
Fort Bliss, TX 79916-5400
Tel. (915) 568-5500 or 3000
- Mr. Javier Montez
Chief of Analysis and
Test Support Division
Tel. (915) 568-5501 or 3355
- Dr. Denny Keith
Chief of Data Acquisition Branch
USAR ADABD
Attn: ATATZC-DTD
Fort Bliss, TX 79916-5400
Tel. (915) 569-4682
- Major Howard
Attn: Range Command
Building 9500, McGregor Range
USA ADA CENFB
Fort Bliss, TX 79916
Tel. (915) 569-9427
- Mr. Bob Tibuni (at White Sands)
ARMTE
Commander
USA WSMR
Attn: STEWS-TE-AM
WSMR, NM 88002
Tel. (505) 678-1010 or 1875

Fort Bliss has very high electricity rates and unreliable grid power in remote areas. Staff at the base also complained of expensive fuel and noisy power that result from the use of diesel or gasoline generators in the field. Mr. Escandon, Chief of the Energy Conservation Branch was not aware of any use of PV power systems at their base. He was, however, very interested in using PV power for: water pumping stations, tower lights for elevated water storage tanks, water tank cathodic protection, and battery chargers for standby power for water pumps.

Battery Chargers

At 19 sites at Fort Bliss, there could be a need for battery chargers to power 60-90 hp gasoline and diesel engines that are used as an emergency power supply for water wells. Currently, there are six 24V, eight 12V, four 32V, and one 6V batteries being used for standby power for the water pumping systems. The trickle charge of these batteries averages 2-3W and full charge runs at about 10W. The duration of the peak demand is roughly one hour once a week. The roof of the water tower buildings are 14'x 20' so the array could be roof mounted. The average watt-hour(Whr) load demand is about 79 Whrs per day. The load would not require battery storage. there is a concern, however, of damage to the system at four of the sites which would be located on the fringe of town. The PV systems might be target practice for rocks and BB guns.

Clearance Lights

The 19 sites described have two clearance lights of 500W each which are currently powered by the "unreliable and expensive" grid system. The lights must be on 11 hrs per day seven days a week from 7PM to 6AM. Each sight currently requires 11,000 Whr/day. Mr. Escandon's hope is that a PV system would allow these sites to be grid free and provide more reliable and cheap power. One PV system could possibly be used to power the battery chargers and the two clearance lights. The PV system would have to be sized for approximately 2,000 - 2,400 Wp to meet this lighting power load.

Water Pumping Stations

There are eight water pumping stations at Fort Bliss that are currently being powered in remote locations by the grid. There is interest in converting the Dona Ana Range Camp water pumping station into a PV powered system. Currently there are two 50 hp wells at 440VAC, one of which requires a booster pump at 10 hp. Both pumps are operated at the same time for a total of 110 hp. The peak load demand for each well 38KW and 45KW with the booster pump. Although this size is much larger than the scope of this study, it should be mentioned as a future potential interest. The details for the system are described in section 3.0.

Cathodic Protection

Fort Bliss is in the process of designing to size and replace tank cathodic protection systems in their water tanks. Data requirements for these systems are not available.

"A Stations"

Mr. Montez mentioned that there were seven "A stations" now being powered by PV at Fort Bliss with unattended operation at very remote sites. The systems operate from 8AM-5PM (9 hours) seven days of the week. Electricity from these systems are used to receive and transmit information which helps to measure target distances for testing defense weapons typically using manned aircraft as targets. Three to four more "A stations" are being planned for PV with power requirements of about 64W (32V and 2Amps). Nellis AFB is also expected to be using PV systems for similar applications.

Mr. Denny Keith, Chief of Data Acquisition, mentioned that Fort Bliss wants to add additional features/data packages on the both "A" and "C" stations. Video capabilities were mentioned as one desired feature that is expected to be needed. Currently, the PV system powers a transmitter, receiver, and data unit. They would like the added capability to remotely turn the unit off and on.

Television Cameras

Mr. Keith also identified the need for 100W television cameras which would be used for surveillance. They are expecting a need for ten units which would have unattended operation. More detailed data for the expected systems were not available.

Global Positioning Systems (GPS)

By 1991 it is expected that there will be 18 satellites in orbit that will help calculate where an object or person is to within 3 ft. This will help facilitate many military training activities. The power requirements for the telemetry and computer equipment is not available. A rough number given was 150-200W. Mr. Keith also suggested calling the Range Measurement Systems Group at Fort Irwin, as they do a great deal of this type of work.

2.6 Fort Huachuca, NM

Fort Huachuca is located 60 miles Southeast of Tucson, AZ on 73,000 acres. There are approximately 6,500 military and 4,400 civilian personnel.

Many of the contacts made at Fort Huachuca were very interested in learning more about PV systems and their potential applications at their base. Their primary interests were for firing range activities, portable radios, Global Positioning Systems (GPS) and mobile power for conducting performance and acceptance tests of various military equipment. The contacts made at this site are identified in Table 5. A brief discussion of these various applications and their power requirements are discussed below.

PLANNED OR POTENTIAL APPLICATIONS

Firing Range Activities

Mr. Charles Whitaker, Range Control Officer, identified several remote power needs for PV systems. Battery chargers are needed for automatic tank target systems (ATTS) which are used only three days per month 24 hrs per

Table 5

Contacts at Fort Huachuca

- Mr. Tom Cochran
Chief of Contract Management Division
Fort Huachuca, AZ 85613-6000
Tel. (602) 538-1442
- Mr. Dana R. Harriman
Facility Manager/Environmental Quality Controls
U.S. Army Electronic Proving Ground
Attn: STEEP-LD
Fort Huachuca, AZ 85613-6000
Tel. (602) 538-6901
- Mr. Bruce Johnson
Lead Mechanical Engineer
Tel. (602) 538-3130
- Mr. Randy White
Electrical Engineer
Tel. (602) 538-2344
- Mr. Charles Whitaker, Commander
Range Control Officer
U.S. Army Garrison
Attn: ASH-PTMS-TR
Fort Huachuca, AZ 85613-6000
Tel. (602) 538-8947 or 8951
- Master Sargent Zander
8/40th Tank Battallion
Tel. (602) 538-6618 or 6619
- Captain Scholtz
Chief of Training Division
Attn: ASH-PTMS-T
Fort Huachuca, AZ 85613-6000
Tel. (602) 538-5512 or 3844

day. There are about 30 ATTS systems which would benefit from the use of PV for battery charging. The power requirements for these battery chargers was not available.

Fort Huachuca is also planning to buy gasoline and diesel generators for approximately 16 Heat Sensor Targets. The contact person for these applications who would be interested in PV systems for these applications is Master Sergeant Zander, identified in Table 5.

Mr. Whitaker was also extremely interested in using PV for setting up mobile firing ranges. Currently, there are approximately 10-30 motors being powered for Pistol Combat Range activity at one practice match. These targets are now only stationary targets connected to the grid which makes them less challenging to users due to the lack of variety in placement of the targets. The motors currently used for these firing ranges are typically 12VAC motors with DC relays, and five amp fuses, averaging 60W each. These ranges are in use roughly two times per week by MPs, Law Enforcement, Security, and Customs personnel. The duty cycle is between 5-8 hours per day (70% during the day and 30% during the evening). These power requirements would require a PV system sized for 100 Wp for each motor. Schematics of the current motors being powered for these activities are shown in Figure 1. The targets are M31A1 units.

In conjunction with powering the motors for the firing ranges, power would be needed for three red blinking lights that are used as markers for night firing. Typically, these are on for three hours during each night firing. The power requirements for these lights was not available. The lights are now powered by batteries.

Portable Radios

During military operations, portable PRC77 radios are used which are powered by expensive batteries. They are used between 5 - 7 hours per day, 7 days per week. Their actual power requirements were not available from Mr. Whitaker. His boss, Captain Scholtz, who has more detailed data was not available, but is identified in Table 5. Eight of these radios are needed for firing range activities alone and require 12VDC. Each unit is used between 5 - 24 hours for each operation.

Global Positioning Systems (GPS)

Mr. Dana Harriman is responsible for testing all electronics for the Army and is based in Fort Huachuca. The five satellites NASA was to put in orbit have been delayed by 3 - 5 years. Fort Huachuca, in the interim, is planning to install mock satellites on mountaintops. Three systems would be needed for mountain applications and one would be needed for a First Aid Station location in the desert.

The mountain applications are planning to be used in the San Pedro Valley. Each satellite would require 1000 W at each position. Pretest of these systems is expected by October 1987. Within one year, it is expected the system will expand and be taken to Sulphur Springs area in AZ for additional practice activities. The GPS is a \$5 billion project that will be getting high visibility.

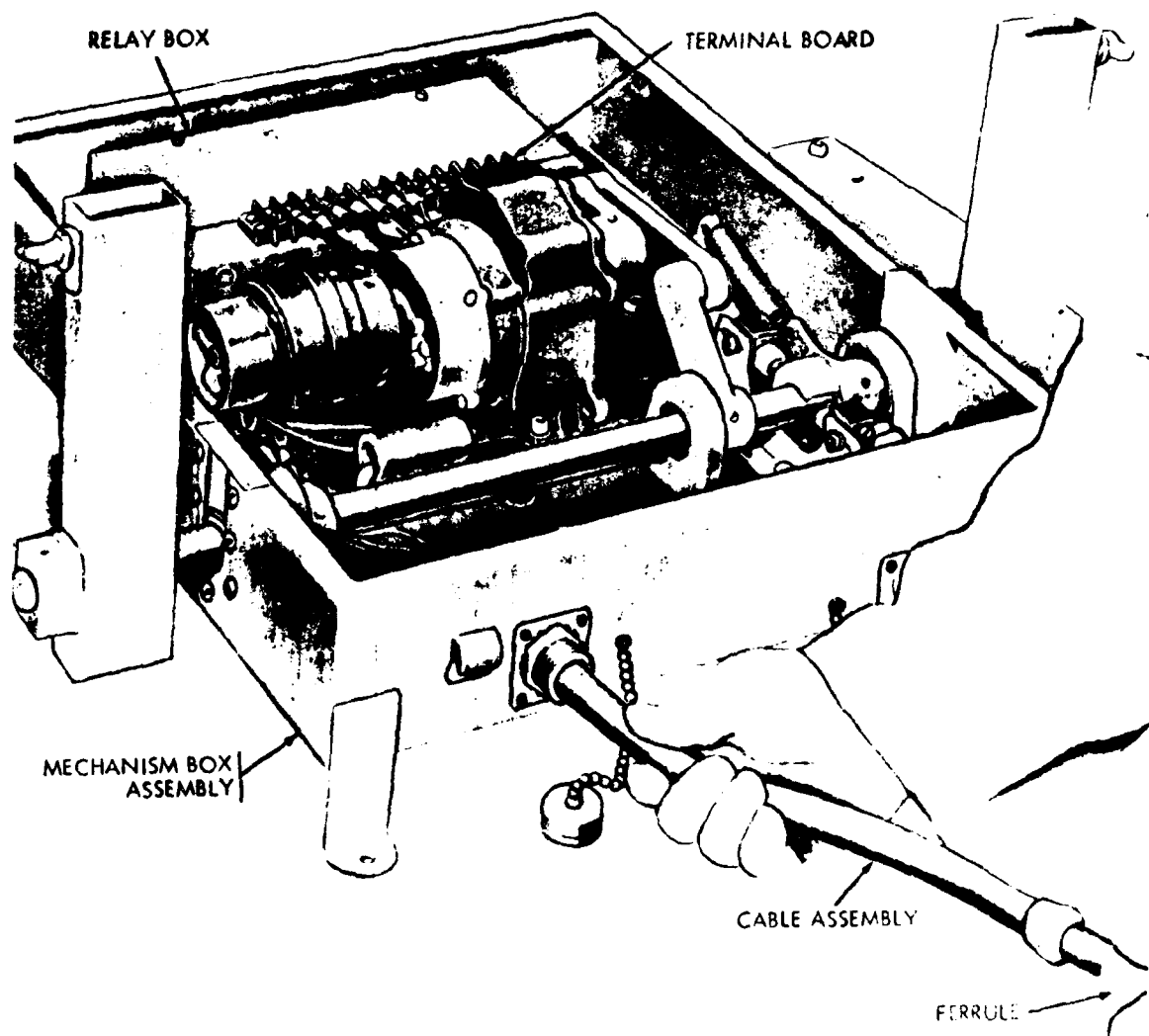


Figure 1 Schematic of Target Holding Mechanism

Radio Repeater Sites

At TV Hill in Fort Huachuca, there are radio repeater sites powered by the grid with backup generator power. The backup generators require manual starts on a regular basis which requires personnel to go up into the mountains. This is an expensive and time consuming process in order to insure reliability during the storm season. Power requirements are about 800 W maximum, for mostly DC power (120V at 6 amps) for each of three repeater sites at TV Hill. Hours of operation are from 7 a.m. - 4 p.m. per day for radio communication in the Southwest U.S. The load is very critical.

Unfortunately, Fort Huachuca has to overcome the somewhat bad experience of an existing PV system that's located in a desert between Yuma and Fort Huachuca at Mount Ottman. They have had many problems with the PV system powering a signal generator with a 125 - 150 W continuous power requirement.

Mobile Generators

Mr. Harriman identified a tremendous need for PV powered mobile generators. Next year alone 150 people will be in field operations where no power is available. Data are currently being gathered on the type and amount of power likely to be needed.

In Arizona, 6,000 separate sites have also been surveyed where generators will be needed at different times of the year. There is a constant need for mobile power. Mr. Harriman also needs mobile power to conduct performance and acceptance tests on military equipment. Four to 12 mobile trailers are needed with power capabilities from 300W - 50kW. The duty cycle for these tests are approximately three days per week, eight hours per day of AC power, 60 Hz.

2.7 Yuma Proving Ground, AZ

Yuma Proving Ground is located 31 miles Northeast of Yuma, AZ on approximately 1,000,000 acres of land. There are 350 military and 950 civilian personnel. The primary contact was Mr. Jack Nixon who is an Energy Engineer at the base. Overall, Yuma Proving Ground is very receptive to using PV for various remote applications and already has several systems in use which will be discussed below. Again, there was a strong desire by several individuals for more education and information related to experience of others gained in specific applications and the cost benefit of using PV systems for larger applications that require air conditioning. The contacts for Yuma Proving ground are listed in Table 6 and a brief summary of potential applications are discussed below.

CURRENT APPLICATIONS

There are at least five telemetry units scattered throughout the Yuma Proving Ground that are powered by PV systems. They range in power from about 1-5 kW. At Whites Peak, there are 6-7 PV systems which power a microwave repeater system, three radio repeater stations, and an A station. The microwave repeater system requires 24V and 3amps (75W) and has remote control capabilities which add an additional 50W of required power. Two days of battery storage is also provided. The three radio repeater stations require less than 50W of continuous power. Power requirements for the A stations were not available. The total power provided by PV systems at Whites Peak is thought to be between 2-3kW with 12 and 24V systems.

There are currently two PV trailers being used by the material test directorate for powering remote telemetry stations. One system powers a motions detector and the other is used for combat related activity (which was classified information).

PV systems are also used at Yuma Proving Ground to power four ground transmitters in military shelters, Figure 2. These units have been in operation since 1976 and were installed by General Dynamics. Each PV system has an output of 80W of DC power. The duty cycle is about four hours a day for six days of the week.

Ten to twelve Position Location Systems are powered by PV, Figure 3. They are positioned on mountain tops for laser operations. The systems are on 24 hours per day for 7 days of the week. These "A stations" activities, shown in Figure 4, are in very remote areas. Typical power requirements are 26VDC and 3.6 amps (about 80W). Radios associated with these operations require 10W of power. More detailed data is provided in Table 7.

PLANNED OR POTENTIAL APPLICATIONS

"A" Stations

Yuma Proving Ground is planning on installing another 10-15 A stations which could be powered by PV. Some of the larger laser sites however, have heavy air conditioning demands (approximately 20kW). It is the belief of



DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORY, CORPS OF ENGINEERS
P.O. BOX 4005
CHAMPAIGN, ILLINOIS 61820-1305

REPLY TO
ATTENTION OF:

CECER-IM

22 November 1988

MEMORANDUM FOR: Defense Logistics Agency, ATTN: DTIC-FDAC (Mr. H. R. Proctor), Cameron Station, Alexandria, VA 22304-6145

SUBJECT: Reproducibility of Report--USA-CERL Technical Report E-89/01

1. Enclosed is a copy on loan of the subject report. After processing, please return to the undersigned.
2. Reference DTIC-FDAC letter, 4 November 1988, SAB.

Encl

DP Mann
D. P. MANN
Chief, Information
Management Office

Report to

**U.S. Army Construction
Engineering Research Laboratory
September 1987**

Applications Survey for Remote Photovoltaic Power Systems

 **Arthur D. Little, Inc.**

*Requisition No. CERL-ES-85-262
#A028
Reference 59719-07*

Report to
U.S. Army Construction
Engineering Research Laboratory
September 1987

Applications Survey for Remote Photovoltaic Power Systems

 **Arthur D. Little, Inc.**

Requisition No. CERL-ES-85-262
#A028
Reference 59719-07

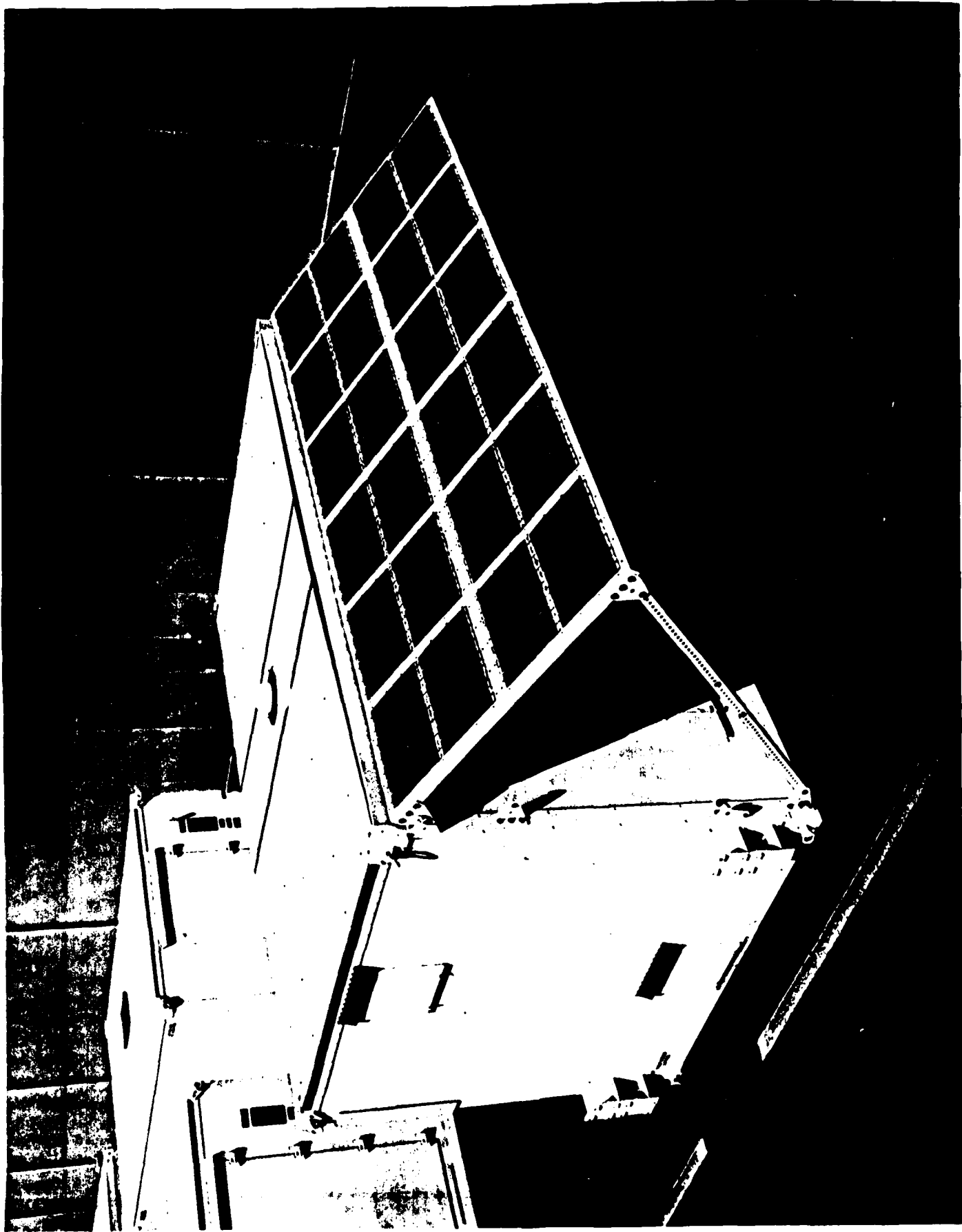


Figure 2 PV Powered Ground Transmitters in Military Shelters

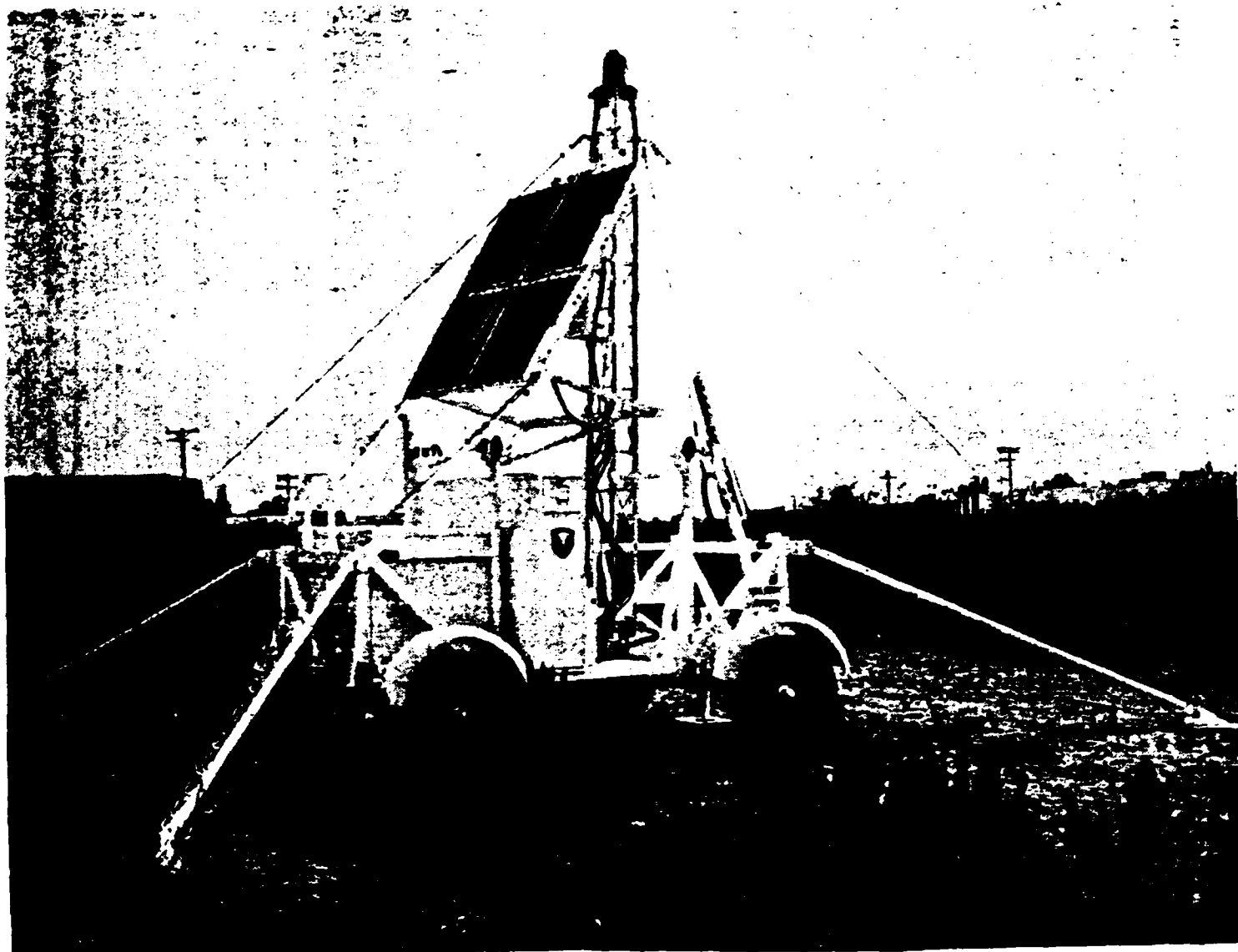


Figure 3 Mobile Micro-A Station

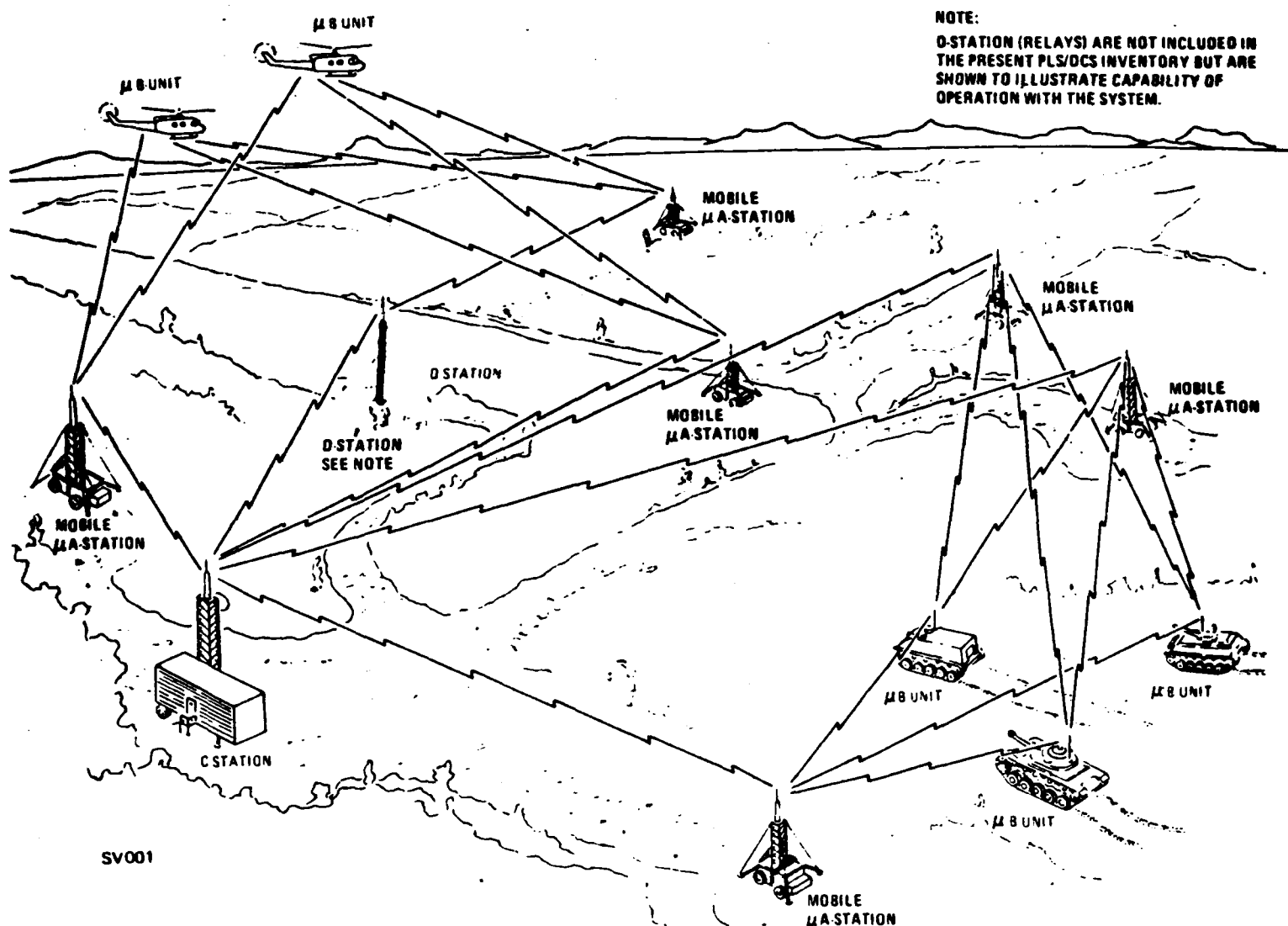


Figure 4 Typical PLS/DCS Deployment

Table 6

Contacts at Yuma Proving Ground

- Mr. Jack Nixon
Energy Engineer
Tel. 602-328-2198
- Mr. Jim Grisham
Energy Division
Tel. 602-328-2937
- Mr. James White
Chief of Communications System Division
Senior Applications Engineer
USA ISC ASNC-TYU-RD
Yuma Proving Ground, AZ 85365
Tel. 602-328-2154
- Mr. Bruce Dobbs
Director of Engineering and Housing
Tel. 602-328-3734 or 3742
- Mr. Bob Morris
(for information on field activities)
Tel. 602-328-3765
- Master Sargent Plaskett
Tel. 602-328-3175
- Mr. Dave Shassetz
Laser Operations Supervisor
Dynalectron
Tel. 602-328-3253
- Mr. Bruce Proctor
Material Test Directorate
Tel. 602-328-3111 or 3066
- Mr. Maurice Evans
Energy Coordinator
Tel. 602-328-3112 or 3156
- Mr. Paul Vukets
Meteorological Services
Tel. 602-328-2467

Table 7

Micro-A Station Leading Particulars

Solar electric generating system	
Solar Array	
Electrical	
Voltage	26 Vdc (attained at approx. 100 mw/sq. cm. insolation)
Current	3.6 amps max. (Proportional with solar insolation; 50% attained at 50 mw/sq. cm. - 100% attained at 100 mw/sq. cm.)
Windloading	In excess of 75 mph
Dimensions	
Height	74 inches
Width	64 inches
Depth	4 inches
Weight	210 pounds
Battery	
Type	Lead calcium grid
Rating	280 ampere-hours at 8 hour discharge rate; 530 ampere-hours at 500 hour discharge rate.
Dimensions	
Height	18 inches
Width	45 1/2 inches
Depth	10 1/4 inches
Weight	740 pounds
Trailer	
Wheelbase	85 inches
Track	78 inches
Turning angle	33°
Dimensions	
Height (in towing config.)	6 feet 10 inches
Width	7 feet 2 inches
Length (towbar extended)	18 feet 2 inches
Length (towbar raised)	13 feet
Weight	4000 pounds

some, therefore, that these larger loads would be better suited to mobile diesel generators. PV power is however, being strongly considered for the majority of these applications.

Met Towers

Three Met Towers, #9, 10, and 12 in CIBOLA Range are powered by the grid, which has had frequent power outages. Yuma is interested in the possibility of using PV for battery charging of the backup power. Very cheap power (roughly \$.01/kWh) is provided by the utility due to the availability of hydropower. There is no real interest in converting from the grid to PV for these applications because of the availability of cheap grid power which is already at these Met stations. Should prices increase, however, these applications would be ideal for PV systems. Each tower requires $\pm$ 15VDC and 2 amps (30W) for computer systems and 5VDC and 2 amps (10W) for other equipment. The air conditioning however, requires 220 VAC and 30 amps (6,600 W).

Firing Range Gun Positions

Gun positions 17 and 20 at Yuma Proving Ground each have a computer system to detect wind speed and direction during and before firing activities. There are four targets on each gun position which require 12 VDC and 4 amps (48W). The units are typically on for 10 hours per day between 7 a.m. and 5 p.m. Grid power is not available; currently these units are being powered by batteries. PV would be a very good power source for this application. A PV system used for this application would require a capacity of approximately 100 Wp.

Microwave Relays

Yuma Proving Ground operations may be expanding to Palomis Mountain where there is no grid power. Mr. White thought there may be a need for 50W-500W of power at this site to power microwave relay systems for both telephone and data transmission.

Thermal Infrared Targets

Detect and recognize operations are conducted at Yuma Proving Ground by tanks and aircraft. Power is needed to heat the thermal panels that are located in very remote locations. Mr. Bob Morris was unavailable to provide the power requirements of the system. Night lighting to help guide the aircrafts are also needed. Currently, they set small fires in cans as a means for aircraft identification. Forward Looking Thermal Sites, are used approximately 30 days per year.

Jamming Units

Jamming units are used in military activities to purposely jam GPS systems to simulate a real potential malfunctioning of equipment. Currently, 3kW engine generators are used. Details about the load and duty cycle requirements were not able to be given.

Emergency Beacons

Emergency beacons are used to announce and warn military personnel of test firing by a flashing red light. Depending on each mission most of these lights are required for 24 hours per day. The system requires about 1kW of power at 24V. Battery backup is needed.

3.0 RECOMMENDATIONS

As a result of the visits to the seven Army bases, the following are brief recommendations for future activities to promote PV use at Army bases:

- develop information sheets about PV applications showing both the benefits and drawbacks of PV use. Provide a state-of-the-art review of PV use for various military applications.
- quantify the costs of running underground power and other hookup equipment to illustrate when PV systems would be more cost-effective.
- provide information, on an Army base level, showing how and where PV is being used. Present information on the degree of satisfaction with the use of the PV systems at Army bases.
- conduct a cost-benefit analysis of the PV systems relative to different military applications.

The availability of this information and dissemination to the appropriate personnel at each Army base would facilitate technology transfer and provide the necessary information to help increase the use of PV systems at Army bases.

APPENDIX
SITE SURVEY FORMS

The survey forms filled out during each of the seven site visits are presented in this appendix and have been organized by Army base. In some cases, the load information needed was not available. A more detailed assessment would require further investigation, which was out of the scope of this contract. The information provided, however, does indicate that there are many applications that would be very appropriate for PV, especially in the 50 W - 2 kW size range. Some applications, such as mobile generators and range surveillance video, could benefit from larger size PV systems. The load and power requirements of the applications identified, however, would often be an economic alternative to grid or diesel power.

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: DUGWAY PROVING GROUND, UT Date: 7/20/87

Ref. #:

Type of Application: RANGE SURVEILLANCE VIDEO Number of Sites: 8
POC: MR. JERALD NORRINGTON Phone: 801-831-5177
Organization/Branch: OPTICAL DATA BRANCH
Person Completing Report: DR. PETER TEAGAN

Site Data

Latitude: 40°46'

What are the soil conditions?
(Sandy, rocky, clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)

SEMI PORTABLE UNITS

What is the maximum snow accumulation?
NA

What is the site accessibility? NA
____ Excellent (Paved road to the site)
____ Good (Dirt road, not consistently able to handle trucks)
____ Fair (May require 4 wheel drive transportation)
____ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
____ Ocean environment (Salt water spray/immersion)
____ Coastal environment (Salt water spray only)
✓ Desert environment (Airborne sand and dirt)
____ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?

Month: DEC Insol. (~~Worst Case~~): 570
BTU/Ft²

What are the temperature characteristics of the site, by month?

Average hi: 76.7°F Month: JUL
Average lo: 28°F Month: JAN
20 year hi: ? 20 year lo: ?

Is special protection required against:

____ Perching or nesting birds
____ Rodents/Small animals
____ Large animals
____ Fungus
____ Insects
____ Theft
____ Vandalism

Is the site in an area of high seismic activity? NO

Load Characteristics

Nominal voltage required: _____ AC DC

If AC, what frequency is required?
_____ Hertz +/- _____ %

What range of voltage is tolerable?

Hi: _____ volts

Lo: _____ volts

What is the peak load demand?

_____ Amperes

500-1000 Watts

_____ Volt-Amperes reactive

What is the duration of the peak demand?

_____ Instantaneous

_____ Seconds

_____ Minutes

_____ Hours

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?

7,200-19,000 Watt hours per day,

_____ Ampere-hours per day

_____ Continuous (24 hours per day)
amperes, or watts

70 Daytime load (% of total)

30 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

_____ Ampere hours @ _____ volts, or

3 Days autonomy (Sunless operation)

IF BACKUP GENERATOR 0 DAYS

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. No

Are there any other special considerations for the PPS? Should be

semi-portable

IF BACKUP GENERATOR AVAILABLE

What is the pattern of load demand:

Load is the same everyday: VARIES

8-24 Hrs per day

Load pattern is weekly as follows:

Load is seasonal (annual cycle):

Load repeats as follows:

What type of equipment is being powered? _____

How critical is the load?

☒ Load is extremely critical, must be maintained at all times.

☒ Load is critical, but occasional, short-term failure is tolerable.

_____ Load is not very critical. System should support the load _____ % of the time.

How will the solar array be mounted:

Ground: _____

Roof: _____

Pole: _____

Other: Trailer

Any special instrumentation required:

Any special control systems required?

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: DUGWAY PROVING GROUND, Date: 7/20/87
UT Ref.: _____

Type of Application: MICROWAVE TOWERS Number of Sites: 6
POC: MR. JAMES DYER Phone: 801-831-5412
Organization/Branch: INSTRUMENTATION BRANCH
Person Completing Report: DR. PETER TEAGAN

Site Data

Latitude: 40°46'

What are the soil conditions?
Sandy, rocky, clay, etc.

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)
NO LIMITS

What is the maximum snow accumulation?
NA

What is the site accessibility?
☐ Excellent (Paved road to the site)
☒ Good (Dirt road, not consistently able to handle trucks)
☒ Fair (May require 4 wheel drive transportation)
☒ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
☐ Ocean environment (Salt water spray/immersion)
☐ Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
☐ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?
Month: DEC Insol. (kWh/m²/day): 570
BTU/ft²

What are the temperature characteristics of the site, by month?
Average hi: 76.7°F Month: JUL
Average lo: 26°F Month: JAN
20 year hi: NA 20 year lo: NA

Is the site in an area of high seismic activity? NO

Is special protection required against:
☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism

Load Characteristics

Nominal voltage required: _____ AC/DC

If AC, what frequency is required?
_____ Hertz +/- _____ %

What range of voltage is tolerable?

Hi: _____ volts

Lo: _____ volts

What is the peak load demand?

_____ Amperes

300 Watts - 500 W

_____ Volt-Amps reactive

What is the duration of the peak demand?

_____ Instantaneous

_____ Seconds

_____ Minutes

_____ Hours

If the peak demand is a motor starting load, what horsepower is the motor? NO

What is the total load demand?

7,200-12,000 Watt hours per day, or

_____ Ampere-hours per day

_____ Continuous (24 hours per day) amperes, or watts

50 Daytime load (% of total)

50 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

_____ Ampere hours @ _____ volts, or

3 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. _____

Are there any other special considerations for the PPS? _____

What is the pattern of load demand? Load is the same everyday: _____

24 HOURS PER DAY

Load pattern is weekly as follows:

25% DUTY CYCLE PER ANTENNAE (4 per tower)

Load is seasonal (annual cycle): _____

Load repeats as follows: _____

What type of equipment is being powered? 6 microwave towers

part of Ethernet System

How critical is the load?

_____ Load is extremely critical, must be maintained at all times.

☒ Load is critical, but occasional, short-term failure is tolerable.

_____ Load is not very critical. System should support the load _____ % of the time.

How will the solar array be mounted:

Ground: ☒ _____

Roof: _____

Pole: _____

Any special instrumentation required: _____

Any special control systems required? _____

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: DUGWAY PROVING GROUND, UT Date: 7/20/87
Key: _____

Type of Application: REMOTE DATA ACQUISITION Number of Sites: 12
POC: MR. JAMES DYER Phone: 801-831-5412
Organization/Branch: INSTRUMENTATION BRANCH
Person Completing Report: DR. PETER TEAGAN

Site Data

Latitude: 40°46'

What are the soil conditions?
(Sandy, rocky, clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)

What is the maximum snow accumulation? NA

What is the site accessibility?
☐ Excellent (Paved road to the site)
☐ Good (Dirt road, not consistently able to handle trucks)
☒ Fair (May require 4 wheel drive transportation)
☒ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
☐ Ocean environment (Salt water spray/immersion)
☐ Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
☐ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?
Month: DEC Insol. (4 hrs 15 min day): 570
BTU/ft²

What are the temperature characteristics of the site, by month?
Average hi: 76.7°F Month: JUL
Average lo: 28°F Month: JAN
20 year hi: NA 20 year lo: NA

Is the site in an area of high seismic activity? NO

Is special protection required against:
☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism
☒ DUST

Load Characteristics

Nominal voltage required: 12 AC/DC

If AC, what frequency is required?
____ Hertz +/- ____%

What range of voltage is tolerable?
Hi: _____ volts
Lo: _____ volts

What is the peak load demand?

____ Amperes
~~60-100~~ Watts
____ Volt-Amps reactive

What is the duration of the peak demand?

____ Instantaneous
____ Seconds
____ Minutes
____ Hours

If the peak demand is a motor starting load, what horsepower is the motor? NO

What is the total load demand? -

~~1400-2400~~ Watt hours per day,
____ Ampere-hours per day
____ Continuous (24 hours per day)
____ amperes, or watts
____ Daytime load (% of total)
____ Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

____ Ampere hours @ ____ volts, or
3 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. NOT LIKELY

Are there any other special considerations for the PPS? _____

What is the pattern of load demand?
Load is the same everyday: _____

24 HOURS PER DAY
Load pattern is weekly as follows: _____

Load is seasonal (annual cycle): _____

Load repeats as follows: _____

What type of equipment is being powered? _____

How critical is the load?

____ Load is extremely critical, must be maintained at all times.
☒ Load is critical, but occasional, short-term failure is tolerable.
____ Load is not very critical. System should support the load ____% of the time.

How will the solar array be mounted:

Ground: ☒
Roof: _____
Pole: _____

Any special instrumentation required: _____

Any special control systems required? _____

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: TOOELE ARMY DEPOT, UT Date: 7/20/87

Key: _____

Type of Application: STORAGE FACILITIES-IGLOOS Number of Sites: 10
POC: MR. NATHAN WALKER Phone: 801-333-2811
Organization/Branch: ENERGY COORDINATOR
Person Completing Report: DR. PETER TEAGAN

Site Data

Latitude: ~40° 40'

What are the soil conditions?
(Sandy, rocky, clay, etc.)

What are the dimensions of the land
available for the solar array?
(Attach site plan if available.)
NA

What is the maximum snow accumu-
lation? _____

What is the site accessibility?
☐ Excellent (Paved road to the site)
☒ Good (Dirt road, not consistently
able to handle trucks)
☐ Fair (May require 4 wheel drive
transportation)
☐ Poor (Helicopter or animal trans-
portation required)

Are there any special environmental
conditions?
☐ Ocean environment (Salt water
spray/immersion)
☐ Coastal environment (Salt water
spray only)
☒ Desert environment (Airborne sand
and dirt)
☐ Jungle environment (High tempera-
ture and condensing humidity)

What is the daily average insolation
for the worst-case month?
Month: DEC Insol. ($\text{Watts/m}^2/\text{day}$): 570
BTU/Ft²

What are the temperature character-
istics of the site, by month?
Average hi: 60°F Month: JULY
Average lo: 28°F Month: JAN
20 year hi: NA 20 year lo: NA

Is the site in an area of high
seismic activity? NO

Is special protection required
against:
☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism

Load Characteristics

Nominal voltage required: _____ AC DC

If AC, what frequency is required?
_____ Hertz +/- _____ %

What range of voltage is tolerable?

Hi: _____ volts

Lo: _____ volts

What is the peak load demand?

_____ Amperes

~ 60 Watts or 300 W (PV)

_____ Volt-Amps reactive

What is the duration of the peak demand?

_____ Instantaneous

_____ Seconds

_____ Minutes

☒ Hours

If the peak demand is a motor starting load, what horsepower is the motor? NO

What is the total load demand?

~ 1440 Watt hours per day,

_____ Ampere-hours per day

_____ Continuous (24 hours per day) amperes, or watts

50 Daytime load (% of total)

50 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

_____ Ampere hours @ _____ volts, or

2-3 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. YES, DIMENSIONS

NOT AVAILABLE

Are there any other special considerations for the PPS? ALREADY

COMMITTED TO EXTENDING UTILITY

LINE TO 90 IGLOO SITES

What is the pattern of load demand? Load is the same everyday: _____

YES AT 24 HRS PER DAY
Load pattern is weekly as follows: _____

Load is seasonal (annual cycle): _____

Load repeats as follows: _____

What type of equipment is being powered? LIGHTING AND INTRUSION DETECTORS

How critical is the load?

☒ Load is extremely critical, must be maintained at all times.

☒ Load is critical, but occasional, short-term failure is tolerable.

_____ Load is not very critical. System should support the load _____ % of the time.

How will the solar array be mounted:

Ground: ☒ (OR on TOP OF IGLOO)

Roof: _____

Pole: _____

Any special instrumentation required: _____

Any special control systems required? _____

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: TOOELE ARMY DEPOT, UT Date: 7/20/87

Ref. #:

Type of Application: MICROWAVE REPEATER STATION Number of Sites: 1
POC: MR. NATHAN WALKER Phone: 801-833-2891
Organization/Branch: ENERGY COORDINATOR
Person Completing Report: DR. PETER TEAGAN

Site Data

Latitude: ~ 40°40'

What are the soil conditions?
(Sandy rocky, clay, etc.)

What are the dimensions of the land
available for the solar array?
(Attach site plan if available.)
NA

What is the maximum snow accumu-
lation?

What is the site accessibility?
☐ Excellent (Paved road to the site)
☒ Good (Dirt road, not consistently
able to handle trucks)
☐ Fair (May require 4 wheel drive
transportation)
☐ Poor (Helicopter or animal trans-
portation required)

Are there any special environmental
conditions?
☐ Ocean environment (Salt water
spray/immersion)
☐ Coastal environment (Salt water
spray only)
☒ Desert environment (Airborne sand
and dirt)
☐ Jungle environment (High tempera-
ture and condensing humidity)

What is the daily average insolation
for the worst-case month?
Month: DEC Insol. ($\text{kWhr/m}^2/\text{day}$): 570
BTU/ft²

What are the temperature character-
istics of the site, by month?
Average hi: 60°F Month: JULY
Average lo: 25°F Month: JAN
20 year hi: NA 20 year lo: NA

Is the site in an area of high
seismic activity? NO

Is special protection required
against:
☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism
☐ Tactical activities

Load Characteristics

Nominal voltage required: _____ AC DC

If AC, what frequency is required?
_____ Hertz +/- _____ %

What range of voltage is tolerable?
Hi: _____ volts
Lo: _____ volts

What is the peak load demand?
_____ Amperes
200 Watts or 1200-1600W of PV
_____ Volt-Ampe reactive

What is the duration of the peak demand?
_____ Instantaneous
_____ Seconds
_____ Minutes
24 Hours

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?
4600 Watt hours per day,
_____ Ampere-hours per day
_____ Continuous (24 hours per day) amperes, or watts
50 Daytime load (% of total)
50 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:
_____ Ampere hours @ _____ volts, or
3 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. _____

Are there any other special considerations for the PPS? _____

What is the pattern of load demand?
Load is the same everyday: YES
24 HRS PER DAY
Load pattern is weekly as follows: _____

Load is seasonal (annual cycle): _____

Load repeats as follows: _____

What type of equipment is being powered? _____

How critical is the load?

_____ Load is extremely critical, must be maintained at all times.
☒ Load is critical, but occasional, short-term failure is tolerable.
_____ Load is not very critical. System should support the load _____ % of the time.

How will the solar array be mounted?
Ground: ✓
Roof: _____
Pole: _____

Any special instrumentation required: _____

Any special control systems required? _____

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT HUNTER - LIGGETT, CA

Date: 7/22/87

Key: _____

"A" STATIONS

Type of Application: RANGE MEASURING SYSTEMS Number of Sites: ?

POC: MR. BRUCE COONS Phone: 408-385-5911

Organization/Branch: INSTRUMENTATION COMMAND

Person Completing Report: DR. PETER TEAGAN

Site Data

Latitude: 36°

What are the soil conditions?

Sandy, rocky, clay, etc.

What are the dimensions of the land available for the solar array?

(Attach site plan if available.)

ON MOUNTAIN TOPS

What is the maximum snow accumulation?

What is the site accessibility?

☐ Excellent (Paved road to the site)

☐ Good (Dirt road, not consistently able to handle trucks)

☐ Fair (May require 4 wheel drive transportation)

☒ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?

☐ Ocean environment (Salt water spray/immersion)

☒ Coastal environment (Salt water spray only)

☐ Desert environment (Airborne sand and dirt)

☐ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?

Month: DEC Insol. (Worst Case): ~600
BTU/ft²

What are the temperature characteristics of the site, by month?

Average hi: ~81°F Month: JUL

Average lo: ~45°F Month: JAN

20 year hi: NA 20 year lo: NA

Is special protection required against:

☐ Perching or nesting birds

☐ Rodents/Small animals

☐ Large animals

☐ Fungus

☐ Insects

☐ Theft

☐ Vandalism

Is the site in an area of high seismic activity? FAULT

Load Characteristics

Nominal voltage required: _____ AC DC

If AC, what frequency is required?
_____ Hertz +/- _____ %

What range of voltage is tolerable?
Hi: _____ volts
Lo: _____ volts

What is the peak load demand?
_____ Amperes
80 Watts (PV)
_____ Volt-Amps reactive

What is the duration of the peak demand?
_____ Instantaneous
_____ Seconds
_____ Minutes
_____ Hours

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?
_____ Watt hours per day, or
_____ Ampere-hours per day
_____ Continuous (24 hours per day) amperes, or watts
_____ Daytime load (% of total)
_____ Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:
_____ Ampere hours @ _____ volts, or
2 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. NO

Are there any other special considerations for the PPS? _____

What is the pattern of load demand?

Load is the same everyday: _____

DEPENDS ON FIELD MANEUVERS

Load pattern is weekly as follows: _____

Load is seasonal (annual cycle): _____

Load repeats as follows: _____

What type of equipment is being powered? RANGE MEASURING EQUIPMENT

How critical is the load?

_____ Load is extremely critical, must be maintained at all times.

☒ Load is critical, but occasional, short-term failure is tolerable.

_____ Load is not very critical. System should support the load _____ % of the time.

How will the solar array be mounted:

Ground: ☒ _____

Roof: _____

Pole: _____

Any special instrumentation required? _____

Any special control systems required? _____

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT BLISS Date: 8/12/87
EL PASO, TX Ref. #:

Type of Application: "A STATIONS" Number of Sites: 24
POC: DR. DENNY KEITH Phone: 915-569-4652
Organization/Branch: DATA ACQUISITION
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 31° 48'

What are the soil conditions?
(Sandy, rocky, clay, etc.)

What are the dimensions of the land
available for the solar array?
(Attach site plan if available.)
UNLIKELY TO BE SIZE LIMIT

What is the maximum snow accumula-
tion? 2 INCHES

What is the site accessibility?
☐ Excellent (Paved road to the site)
☐ Good (Dirt road, not consistently
able to handle trucks)
☒ Fair (May require 4 wheel drive
transportation)
☒ Poor (Helicopter or animal trans-
portation required)

Are there any special environmental
conditions?
☐ Ocean environment (Salt water
spray/immersion)
☐ Coastal environment (Salt water
spray only)
☒ Desert environment (Airborne sand
and dirt)
☐ Jungle environment (High tempera-
ture and condensing humidity)

What is the daily average insolation
for the worst-case month?
Month: DEC Insol. ($\text{kWh/m}^2/\text{day}$): 1030.7
 BTU/ft^2

What are the temperature character-
istics of the site, by month?
Average hi: 80.5°F Month: AUG
Average lo: 43.6°F Month: JAN
20 year hi: 113°F 20 year lo: 17°F

Is the site in an area of high
seismic activity? ON A FAULT,
BUT NO ACTIVITY

Is special protection required
against:
☐ Perching or nesting birds
☒ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism
☐ Tactical activities

Load Characteristics

Nominal voltage required: 32 ~~AC~~ DC

If AC, what frequency is required?
____ Hertz +/- ____ %

What range of voltage is tolerable?
Hi: _____ volts
Lo: _____ volts

What is the peak load demand?
2 Amperes
64 Watts
____ Volt-Amps reactive

What is the duration of the peak demand?
____ Instantaneous
____ Seconds
____ Minutes
____ Hours

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?
576 Watt hours per day, or
____ Ampere-hours per day
____ Continuous (24 hours per day)
amperes, or watts
100 Daytime load (% of total)
____ Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:
____ Ampere hours @ _____ volts, or
2-3 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. Unlikely

Are there any other special considerations for the PPS? MUST BE
MOBILE AND UNATTENDED
OPERATION

What is the pattern of load demand:
Load is the same everyday: _____

Load pattern is weekly as follows:
8AM - 5PM (9 HOURS) PER
DAY SEVEN DAYS PER WEEK
Load is seasonal (annual cycle):
____ NO _____

Load repeats as follows: _____

What type of equipment is being powered? RANGE MEASURING
SYSTEMS

How critical is the load?
☒ Load is extremely critical, must be maintained at all times.
☒ Load is critical, but occasional, short-term failure is tolerable.
____ Load is not very critical. System should support the load ____ % of the time.

How will the solar array be mounted:
Ground: _____
Roof: _____
~~Free~~ ✓ ON TRAILOR

Any special instrumentation required:

Any special control systems required?

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT BLISS, TX

Date: 8/12/87
Ref.: _____

BATTERY CHARGERS FOR EMERGENCY
POWER SUPPLY FOR WATER WELLS

Type of Application: BATTERY CHARGERS Number of Sites: 19
POC: EMILIO ESCANDON Phone: 915-528-6627
Organization/Branch: ENERGY CONSERVATION
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 31° 48' (3947 ELEVATION) What are the soil conditions?
(Sandy) (rocky) clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)
NO SIZE LIMIT

What is the maximum snow accumulation?
2 INCHES MAX FOR 24 HRS.

What is the site accessibility?
☐ Excellent (Paved road to the site)
☒ Good (Dirt road, not consistently able to handle trucks)
☐ Fair (May require 4 wheel drive transportation)
☐ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
☐ Ocean environment (Salt water spray/immersion)
☐ Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
☐ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?
Month: DEC. Insol. (kWh/m²/day): 1030.7
BTU/ft²

What are the temperature characteristics of the site, by month?
Average hi: 80.5°F Month: AUG
Average lo: 43.6°F Month: JAN
20 year hi: 113°F 20 year lo: 17°F

Is the site in an area of high seismic activity? ON A FAULT,
BUT NO ACTIVITY

Is special protection required against:
☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☒ Vandalism
☐ Tactical activities

Load Characteristics

Six 24V
eight 12V
four 32V
one 6V

Nominal voltage required: _____ AC (DC)

If AC, what frequency is required?
_____ Hertz +/- _____ %

What range of voltage is tolerable:

Hi: 32 volts

Lo: 6 volts

What is the peak load demand?

1/3 Amperes

26 Watts

_____ Volt-Amps reactive

What is the duration of the peak demand?

_____ Instantaneous

_____ Seconds

_____ Minutes

1 Hours

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?

79 Watt hours per day, or

_____ Ampere-hours per day

_____ Continuous (24 hours per day)
amperes, or watts

40 Daytime load (% of total)

60 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

_____ Ampere hours @ _____ volts, or

_____ Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. ROOM AVAILABLE, IF NEEDED

Are there any other special considerations for the PPS? VANDALISM IN SUMMER (ROCKS THROWN) & VERY HIGH WINDS (60-70 mph) 6 TIMES/YR

What is the pattern of load demand:

Load is the same everyday: _____

ONCE PER WEEK

Load pattern is weekly as follows:

ONE START PER WEEK - SAME

EACH WEEK

Load is seasonal (annual cycle):

NO

Load repeats as follows: _____

What type of equipment is being powered? 6V GASOLINE ENGINES (12)
and DIESEL ENGINES (6)
60-90 hsp

How critical is the load?

_____ Load is extremely critical, must be maintained at all times.

☒ Load is critical, but occasional, short-term failure is tolerable.

_____ Load is not very critical. System should support the load _____ % of the time.

How will the solar array be mounted:

Ground: _____

Roof: ON ROOF OF WATER TOWER Bldg (14'x20')

Pole: _____

Any special instrumentation required:

Any special control systems required?

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT BLISS Date: 8/12/87
EL PASO, TX Ref. #:

CLEARANCE LIGHTS ON ELEVATED WATER TANKS

Type of Application: CLEARANCE LIGHTS Number of Sites: 19
POC: EMILIO ESCANDON Phone: 915-568-6627
Organization/Branch: ENERGY CONSERVATION
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 31°48'

What are the soil conditions?
(Sandy) (rocky), clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)
NO SIZE LIMIT

What is the maximum snow accumulation?
2 INCHES MAX

What is the site accessibility?
Excellent (Paved road to the site)
☒ Good (Dirt road, not consistently able to handle trucks)
Fair (May require 4 wheel drive transportation)
Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
Ocean environment (Salt water spray/immersion)
Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?
Month: DEC. Insol. (kWh/m²/day): 1030.7
BTU/FT²

What are the temperature characteristics of the site, by month?
Average hi: 80.5°F Month: AUG
Average lo: 43.6 Month: JAN
20 year hi: 113°F 20 year lo: 17°F

Is the site in an area of high seismic activity? ON A FAULT,
BUT NO ACTIVITY

Is special protection required against:
Perching or nesting birds
Rodents/Small animals
Large animals
Fungus
Insects
Theft
☒ Vandalism
Tactical activities

Load Characteristics

Nominal voltage required: 120 (AC) DC

If AC, what frequency is required?
60 Hertz +/- 1.6%

What range of voltage is tolerable:

Hi: _____ volts
Lo: _____ volts +/- 10%

What is the peak load demand?

4.2 Amperes
500 Watts
____ Volt-Amps reactive (RESISTIVE
LOAD)

What is the duration of the peak demand?

____ Instantaneous
____ Seconds
____ Minutes

24 Hours CONSTANT

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?

12,000 Watt hours per day, or
100.8 Ampere-hours per day
____ Continuous (24 hours per day)
amperes, or watts
50 Daytime load (% of total)
50 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

____ Ampere hours @ _____ volts, or
2 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. YES

Are there any other special considerations for the PPS? VANDALISM IN
SUMMER AND VERY HIGH
WINDS SIX TIMES PER YEAR

What is the pattern of load demand:
Load is the same everyday: YES

Load pattern is weekly as follows:

Load is seasonal (annual cycle):

Load repeats as follows:

What type of equipment is being powered? CLEARANCE LIGHTS

How critical is the load?

____ Load is extremely critical, must be maintained at all times.
☒ Load is critical, but occasional, short-term failure is tolerable.
____ Load is not very critical. System should support the load ____% of the time.

How will the solar array be mounted:

Ground: _____
Roof: ON ROOF OF WATER TOWER
Pole: _____

Any special instrumentation required:
INVERTER IF USE SAME
AC LIGHTS.

Any special control systems required:

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT HUACHUCA Date: 8/13/87
SIERRA VISTA, NM Rel. #: _____

Type of Application: BUGLE PA and LIGHTS Number of Sites: 1
POC: MR. TOM COCHRAN Phone: 602-538-1442
Organization/Branch: CONTRACT MANAGEMENT
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 31°30

What are the soil conditions?
(Sandy, rocky, clay, etc.)

What are the dimensions of the land
available for the solar array?
(Attach site plan if available.)
NO SIZE LIMITS

What is the maximum snow accumu-
lation? 8 INCHES

What is the site accessibility?
☒ Excellent (Paved road to the site)
☐ Good (Dirt road, not consistently
able to handle trucks)
☐ Fair (May require 4 wheel drive
transportation)
☐ Poor (Helicopter or animal trans-
portation required)

Are there any special environmental
conditions?
☐ Ocean environment (Salt water
spray/immersion)
☐ Coastal environment (Salt water
spray only)
☒ Desert environment (Airborne sand
and dirt)
☐ Jungle environment (High tempera-
ture and condensing humidity)

What is the daily average insolation
for the worst-case month?
Month: DEC Insol. (Worst day): 1100
BTU/FT²

What are the temperature character-
istics of the site, by month?
Average hi: 92°F Month: JUNE
Average lo: 28°F Month: JAN
20 year hi: ? 20 year lo: ?

Is the site in an area of high
seismic activity? NO

Is special protection required
against:
☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism
☒ HIGH WINDS
☒ LIGHTNING

Load Characteristics

Nominal voltage required: 120 AC DC What is the pattern of load demand:
BUT COULD CONVERT TO DC SYSTEM Load is the same everyday: YES

If AC, what frequency is required?

60 Hertz +/- %

Load pattern is weekly as follows:

What range of voltage is tolerable?

Hi: 125 volts

Lo: 105 volts

Load is seasonal (annual cycle):

What is the peak load demand?

 Amperes

1100 Watts

 Volt-Amps reactive

Load repeats as follows:

What is the duration of the peak demand?

 Instantaneous

 Seconds

✓ Minutes (FOUR TIMES PER DAY) - PA

4 Hours (LIGHTS)

What type of equipment is being

powered? A PUBLIC ADDRESS
SYSTEM (BUGLE) AND LIGHTS

If the peak demand is a motor starting load, what horsepower is the motor? NO

How critical is the load?

 Load is extremely critical, must be maintained at all times.

✓ Load is critical, but occasional, short-term failure is tolerable.

 Load is not very critical. System should support the load % of the time.

What is the total load demand?

5000 Watt hours per day, or

 Ampere-hours per day

N/A Continuous (24 hours per day) amperes, or watts

30 Daytime load (% of total)

70 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

80 Ampere hours @ volts, or

1-2 Days autonomy (Sunless operation)

How will the solar array be mounted:

Ground: ✓

Roof:

Pole:

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. YES, CHLORINE

ROOM NEARBY (8'x10' FLOOR AREA)

Are there any other special considerations for the PPS?

Any special instrumentation required:

Any special control systems required?

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT HUACHUCA Date: 8/13/87
SIERRA VISTA, NM Ref. #:
GLOBAL POSITIONING SYSTEM (GPS)

Type of Application: MOCK SATELLITE ON MOUNTAIN TOPS Number of Sites: 4
POC: MR. DANA HARRIMAN Phone: 602-538-6901
Organization/Branch: US ARMY ELECTRONIC PROVING GROUNDS (STEEP-LO)
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 31°30

What are the soil conditions?
(Sandy, rocky, clay, etc.)
(Sandy, rocky)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)
NOT AVAILABLE AT THIS TIME

What is the maximum snow accumulation?
12 INCHES

What is the site accessibility?
☐ Excellent (Paved road to the site)
☐ Good (Dirt road, not consistently able to handle trucks)
☐ Fair (May require 4 wheel drive transportation)
☒ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
☐ Ocean environment (Salt water spray/immersion)
☐ Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
☐ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?
Month: DEC Insol. (44 hr / day): 1100
BTU/FT²

What are the temperature characteristics of the site, by month?
Average hi: 85°F Month: JULY
Average lo: 10°F Month: JAN
20 year hi: ? 20 year lo: ?

Is the site in an area of high seismic activity? NO

Is special protection required against:
☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism
☒ HIGH WINDS
☒ LIGHTNING

Load Characteristics

Nominal voltage required: 120 AC/DC

If AC, what frequency is required?
60 Hertz $\pm 0.5\%$

What range of voltage is tolerable?
Hi: 125 volts
Lo: _____ volts

What is the peak load demand?
9 Amperes
1080 Watts
1.6kV Volt-Amps reactive

What is the duration of the peak demand?
____ Instantaneous
____ Seconds
☒ Minutes
____ Hours

If the peak demand is a motor starting load, what horsepower is the motor? NO

What is the total load demand?
____ Watt hours per day, or NO SURE
____ Ampere-hours per day
____ Continuous (24 hours per day) amperes, or watts
80 Daytime load (% of total)
20 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:
____ Ampere hours @ _____ volts, or
4 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. NO

Are there any other special considerations for the PPS? MUST BE
PORTABLE

What is the pattern of load demand?
Load is the same everyday: YES
(80% DAY / 20% NIGHT)
Load pattern is weekly as follows: _____

Load is seasonal (annual cycle):
SAME YEAR AROUND

Load repeats as follows: _____

What type of equipment is being powered? _____

How critical is the load?
☒ Load is extremely critical, must be maintained at all times.
____ Load is critical, but occasional, short-term failure is tolerable.
____ Load is not very critical. System should support the load ____% of the time.

How will the solar array be mounted:
Ground: ☒
Roof: _____
Pole: _____

Any special instrumentation required: _____

Any special control systems required? _____

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT HUACHUCA Date: 8/13/87
SIERRA VISTA, NM Ke1.#: _____

Type of Application: MOBILE FIRING RANGES Number of Sites: 30 MOTORS
POC: MR. CHARLES WHITAKER Phone: 602-535-8947
Organization/Branch: RANGE CONTROL
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 31°30

What are the soil conditions?
(Sandy, rocky, clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)
NO SIZE LIMITS

What is the maximum snow accumulation?
8 INCHES

What is the site accessibility?
Excellent (Paved road to the site)
☒ Good (Dirt road, not consistently able to handle trucks)
Fair (May require 4 wheel drive transportation)
Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
Ocean environment (Salt water spray/immersion)
Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?
Month: DEC Insol. (kWh/m²/day): 1100
BTU/FT²

What are the temperature characteristics of the site, by month?
Average hi: 92°F Month: JUNE
Average lo: 28°F Month: JAN
20 year hi: ? 20 year lo: ?

Is the site in an area of high seismic activity? NO

Is special protection required against:
Perching or nesting birds
Rodents/Small animals
Large animals
Fungus
Insects
Theft
Vandalism
☒ BULLETS
☒ LIGHTNING
☒ HIGH WINDS

Load Characteristics

Nominal voltage required: 12V DC
For Motors DC RELAYS

If AC, what frequency is required?
____ Hertz +/- ____%

What range of voltage is tolerable?

Hi: _____ volts

Lo: _____ volts

What is the peak load demand?

5 Amperes

60 Watts

____ Volt-Amps reactive

What is the duration of the peak demand?

____ Instantaneous

____ Seconds

____ Minutes

____ Hours

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?

390 Watt hours per day, or

____ Ampere-hours per day

____ Continuous (24 hours per day)
amperes, or watts

____ Daytime load (% of total)

____ Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

____ Ampere hours @ _____ volts, or

1-2 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. UNLIKELY

Are there any other special considerations for the PPS? _____

What is the pattern of load demand?

Load is the same everyday: NO

5-8 HRS PER DAY

Load pattern is weekly as follows:

TWO DAYS PER WEEK

Load is seasonal (annual cycle):

NO

Load repeats as follows:

NO PATTERN

What type of equipment is being powered?

MOTORS FOR M31A1

TARGETS

How critical is the load?

____ Load is extremely critical, must be maintained at all times.

☒ Load is critical, but occasional, short-term failure is tolerable.

____ Load is not very critical. System should support the load ____% of the time.

How will the solar array be mounted:

Ground: ☒

Roof: _____

Pole: _____

Any special instrumentation required:

REMOTE CONTROL MIGHT
BE DESIRED

Any special control systems required? _____

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT HUACHUCA Date: 8/13/87
SIERRA VISTA, NM Ref. #:
POWER ELECTRONIC TESTING EQUIP

Type of Application: MOBILE GENERATORS Number of Sites: 6,000
POC: MR. DANA HARRIMAN Phone: 602-538-6901
Organization/Branch: US ARMY ELECTRONIC PROVING GROUND
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 31°30

What are the soil conditions?
(Sandy, rocky, clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)
TRAILOR SIZE

What is the maximum snow accumulation?
8-12 INCHES

What is the site accessibility?
☐ Excellent (Paved road to the site)
☐ Good (Dirt road, not consistently able to handle trucks)
☒ Fair (May require 4 wheel drive transportation)
☒ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
☐ Ocean environment (Salt water spray/immersion)
☐ Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
☐ Jungle environment (High temperature and condensing humidity)
☒ MOUNTAINS

What is the daily average insolation for the worst-case month?
Month: DEC Insol. (kWh/m²/day): 1100
BTU/FT²

What are the temperature characteristics of the site, by month?
Average hi: 92°F Month: JUNE
Average lo: 28°F Month: JAN
20 year hi: _____ 20 year lo: _____

Is the site in an area of high seismic activity? NO

Is special protection required against:
☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism
☒ DUST
☒ HIGH WINDS
☒ LIGHTNING

Load Characteristics

VARIES

Nominal voltage required: A (AC) DC

If AC, what frequency is required?

60 Hertz +/- %

What range of voltage is tolerable?

Hi: volts

Lo: volts

What is the peak load demand?

 Amperes

300 Watts - 50 kW

 Volt-Amps reactive

What is the duration of the peak demand?

 Instantaneous

 Seconds

 Minutes

 Hours

VARIES

If the peak demand is a motor starting load, what horsepower is the motor?

What is the total load demand?

2400 - Watt hours per day, or to 400 kWh

 Ampere-hours per day

 Continuous (24 hours per day)

amperes, or watts

 Daytime load (% of total)

 Nighttime load (% of total)

What is the pattern of load demand?

Load is the same everyday:

8 HRS PER DAY

Load pattern is weekly as follows:

3 DAYS PER WEEK

Load is seasonal (annual cycle):

NO

Load repeats as follows:

What type of equipment is being powered? PERFORMANCE & ACCEPTANCE

TEST EQUIPMENT AND REMOTE

POWER (STILL UNDEFINED)

How critical is the load?

☒ Load is extremely critical, must be maintained at all times.

☒ Load is critical, but occasional, short-term failure is tolerable.

 Load is not very critical. System should support the load % of the time.

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

 Ampere hours @ volts, or

2 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available.

Are there any other special considerations for the PPS?

MUST BE PORTABLE

How will the solar array be mounted:

Ground:

Roof:

Pole:

ON TRAILOR

Any special instrumentation required?

Any special control systems required?

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT HUACHUCA Date: 8/13/87
SIERRA VISTA, NM Ke1.#: _____

Type of Application: RADIO REPEATERS/BACK-UP POWER A Number of Sites: 3
POC: MR. DANA HARRIMAN Phone: 602-538-6901
Organization/Branch: US ARMY ELECTRONIC PROVING GROUND (STEAP-LO)
Person Completing Report: LISA FRANTZ

Site Data

Latitude: 31°30

What are the soil conditions?
(Sandy, rocky, clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)

NOT AVAILABLE

What is the maximum snow accumulation?
12 INCHES

What is the site accessibility?
☐ Excellent (Paved road to the site)
☐ Good (Dirt road, not consistently able to handle trucks)
☐ Fair (May require 4 wheel drive transportation)
☒ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
☐ Ocean environment (Salt water spray/immersion)
☐ Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt) MOUNTAINS
☐ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?

Month: DEC Insol. (kWh/m²/day): 1100
BTU/FT²

What are the temperature characteristics of the site, by month?

Average hi: 85°F Month: JULY
Average lo: 10°F Month: JAN
20 year hi: ? 20 year lo: ?

Is the site in an area of high seismic activity? NO

Is special protection required against:

☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism

☒ DUST ACCUMULATION
☒ LIGHTNING
☒ HIGH WINDS

Load Characteristics

Nominal voltage required: 120 AC DC

If AC, what frequency is required?

 Hertz +/- %

What range of voltage is tolerable?

Hi: volts

Lo: volts

What is the peak load demand?

6 Amperes

800 Watts

 Volt-Amps reactive

What is the duration of the peak demand?

 Instantaneous

 Seconds

 Minutes

7 Hours

If the peak demand is a motor starting load, what horsepower is the motor?

What is the total load demand?

7200 Watt hours per day, or

 Ampere-hours per day

 Continuous (24 hours per day) amperes, or watts

100 Daytime load (% of total)

 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

 Ampere hours @ volts, or

3 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. NO

Are there any other special considerations for the PPS?

What is the pattern of load demand?

Load is the same everyday: YES

Load pattern is weekly as follows:

9 HRS PER DAY / SEVEN
DAYS PER WEEK (7AM-4PM)

Load is seasonal (annual cycle):

NO

Load repeats as follows:

What type of equipment is being powered? RADIO REPEATERS

AT TV HILL

How critical is the load?

☒ Load is extremely critical, must be maintained at all times.

 Load is critical, but occasional, short-term failure is tolerable.

 Load is not very critical. System should support the load % of the time.

How will the solar array be mounted:

Ground: ☒

Roof:

Pole:

Any special instrumentation required?

Any special control systems required?

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT HUACHUCA Date: 8/13/87
SIERRA VISTA, NM Rel. #: _____

BATTERY CHARGERS FOR

Type of Application: AUTOMATIC TANK TARGET SYST. Number of Sites: 30
POC: MR. CHARLES WHITAKER Phone: 602-538-8947
Organization/Branch: RANGE CONTROL
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 31°30

What are the soil conditions?
Sandy ~~rocky~~ clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)
NO SIZE LIMITS

What is the maximum snow accumulation?
8 INCHES

What is the site accessibility?
Excellent (Paved road to the site)
☒ Good (Dirt road, not consistently able to handle trucks)
☒ Fair (May require 4 wheel drive transportation)
Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
Ocean environment (Salt water spray/immersion)
Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?
Month: DEC Insol. (Worst day): 1100
BTU/FT²

What are the temperature characteristics of the site, by month?
Average hi: 92°F Month: JUNE
Average lo: 28°F Month: JAN
20 year hi: ? 20 year lo: ?

Is the site in an area of high seismic activity? NO

Is special protection required against:
Perching or nesting birds
Rodents/Small animals
Large animals
Fungus
Insects
Theft
Vandalism
☒ HIGH WINDS
☒ LIGHTNING

Load Characteristics

Nominal voltage required: _____ AC/DC

If AC, what frequency is required?
_____ Hertz +/- _____ %

What range of voltage is tolerable?

Hi: _____ volts

Lo: _____ volts

What is the peak load demand?

_____ Amperes NOT AVAILABLE

_____ Watts

_____ Volt-Amps reactive

What is the duration of the peak demand?

_____ Instantaneous

_____ Seconds

_____ Minutes

24 Hours

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?

_____ Watt hours per day, or

_____ Ampere-hours per day

_____ Continuous (24 hours per day)

_____ amperes, or watts

_____ Daytime load (% of total)

_____ Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

_____ Ampere hours @ _____ volts, or

_____ Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. _____

Are there any other special considerations for the PPS? _____

What is the pattern of load demand?

Load is the same everyday: NO

Load pattern is weekly as follows:

THREE DAYS PER MONTH

24 HRS PER DAY

Load is seasonal (annual cycle):

NO

Load repeats as follows: _____

What type of equipment is being powered? _____

How critical is the load?

_____ Load is extremely critical, must be maintained at all times.

☒ Load is critical, but occasional, short-term failure is tolerable.

_____ Load is not very critical. System should support the load _____ % of the time.

How will the solar array be mounted:

Ground: ☒ _____

Roof: _____

Pole: _____

Any special instrumentation required: _____

Any special control systems required? _____

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: FORT HUACHUCA Date: 8/13/87
SIERRA VISTA, NM Key: _____

Type of Application: WATER TOWER WARNING LIGHTS Number of Sites: 1
POC: MR. TOM COCHRAN Phone: 602-538-1442
Organization/Branch: CHIEF CONTRACT MANAGEMENT DIV.
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 31° 35'

What are the soil conditions?
(Sandy, rocky) clay, etc.

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)
NOT SURE OF DIMENSIONS

What is the maximum snow accumulation?
8 INCHES

What is the site accessibility?
☒ Excellent (Paved road to the site)
☐ Good (Dirt road, not consistently able to handle trucks)
☐ Fair (May require 4 wheel drive transportation)
☐ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
☐ Ocean environment (Salt water spray/immersion)
☐ Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
☐ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?
Month: DEC Insol. (kWh/m²/day): 1100
BTU/ft²

What are the temperature characteristics of the site, by month?
Average hi: 92° Month: JUNE
Average lo: 28° Month: JAN
20 year hi: ? 20 year lo: ?

Is the site in an area of high seismic activity? NO

Is special protection required against:
☐ Perching or nesting birds
☐ Rodents/Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism
☒ HIGH WINDS
☒ LIGHTNING

Load Characteristics

Nominal voltage required: 120 AC DC What is the pattern of load demand?

CURRENTLY, POSSIBLE TO USE DC SYSTEM Load is the same everyday: YES

If AC, what frequency is required?

60 Hertz +/- %

TWELVE HRS / DAY

Load pattern is weekly as follows:

What range of voltage is tolerable?

Hi: 125 volts

Lo: 105 volts

Load is seasonal (annual cycle):

What is the peak load demand?

 Amperes

300 Watts

 Volt-Ampe reactive

Load repeats as follows:

What is the duration of the peak demand?

 Instantaneous

 Seconds

 Minutes

12 Hours

What type of equipment is being powered? WARNING LIGHTS

If the peak demand is a motor starting load, what horsepower is the motor? NO

How critical is the load?

 Load is extremely critical, must be maintained at all times.

✓ Load is critical, but occasional, short-term failure is tolerable.

 Load is not very critical. System should support the load % of the time.

What is the total load demand?

3600 Watt hours per day, or

 Ampere-hours per day

 Continuous (24 hours per day) amperes, or watts

 Daytime load (% of total)

100 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

80 Ampere hours @ volts, or

 Days autonomy (Sunless operation)

How will the solar array be mounted:

Ground:

Roof:

Pole:

RECOMMEND ON TOP OF TANK

Any special instrumentation required:

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. NONE

Are there any other special considerations for the PPS?

Any special control systems required?

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: YUMA PROVING GROUND Date: 8/14/87
YUMA, AZ Ref. #:

Type of Application: FIRING RANGE GUN POSITIONS Number of Sites: 2 (8 targets)
POC: MR. PAUL VUKETS/DR. PAT EASTON Phone: 602-328-2467 or 678-1066
Organization/Branch: METEOROLOGICAL SERVICES
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 32° 80'

What are the soil conditions?
(Sandy, rocky, clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)

NO SIZE LIMITS

What is the maximum snow accumulation?
0 INCHES

What is the site accessibility?

- ☐ Excellent (Paved road to the site)
☐ Good (Dirt road, not consistently able to handle trucks)
☒ Fair (May require 4 wheel drive transportation)
☐ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?

- ☐ Ocean environment (Salt water spray/immersion)
☐ Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
☐ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?

Month: DEC Insol. (~~Worst~~ day): 1000.1
BTU/F²

What are the temperature characteristics of the site, by month?

Average hi: 107°F Month: JULY
Average lo: 68°F Month: JAN
20 year hi: 118°F 20 year lo: 27°F

Is special protection required against:

- ☐ Perching or nesting birds
☒ Rodents / Small animals
☐ Large animals
☐ Fungus
☐ Insects
☒ Theft
☒ Vandalism
☒ LIGHTNING
☒ HIGH WINDS

Is the site in an area of high seismic activity? NO, BUT ON
FRINGE OF FAULT

Load Characteristics

Nominal voltage required: 12V AC DC

If AC, what frequency is required?
____ Hertz +/- ____ %

What range of voltage is tolerable:

Hi: _____ volts

Lo: _____ volts

What is the peak load demand?

4 Amperes

48 Watts

____ Volt-Amps reactive

What is the duration of the peak demand?

____ Instantaneous

____ Seconds

____ Minutes

10 Hours (7AM - 5PM)

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?

480 Watt hours per day, or

____ Ampere-hours per day

____ Continuous (24 hours per day)

____ amperes, or watts

100 Daytime load (% of total)

____ Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:

____ Ampere hours @ ____ volts, or

2 Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. ?

Are there any other special considerations for the PPS? _____

What is the pattern of load demand?

Load is the same everyday: _____

10 HRS PER DAY / SEVEN DAYS / WEEK

Load pattern is weekly as follows: _____

Load is seasonal (annual cycle): _____

Load repeats as follows: _____

What type of equipment is being

powered? COMPUTER SYSTEM TO

DETECT WIND SPEED & DIRECTION

(NOW BATTERY POWERED)

How critical is the load?

____ Load is extremely critical, must be maintained at all times.

☒ Load is critical, but occasional, short-term failure is tolerable.

____ Load is not very critical. System should support the load ____ % of the time.

How will the solar array be mounted:

Ground: ☒ _____

Roof: _____

Pole: _____

Any special instrumentation required: _____

Any special control systems required? _____

USA-CERL PHOTOVOLTAIC POWER SYSTEM
CANDIDATE APPLICATION SURVEY

Installation: YUMA PROVING GROUNDS Date: 8/14/87
YUMA, AZ Ref. #:

Type of Application: "A STATIONS" Number of Sites: 15
POC: MR. JACK NIXON / JAMES WHITE Phone: 602-328-8198 and 2154
Organization/Branch: ENERGY ENGINEER (DEH) and COMMUNICATIONS SYSTEM
Person Completing Report: LISA FRANTZIS

Site Data

Latitude: 32° 50

What are the soil conditions?
(Sandy) (rocky, clay, etc.)

What are the dimensions of the land available for the solar array?
(Attach site plan if available.)

varied

What is the maximum snow accumulation?
0 INCHES

What is the site accessibility?
☐ Excellent (Paved road to the site)
☒ Good (Dirt road, not consistently able to handle trucks)
☒ Fair (May require 4 wheel drive transportation)
☐ Poor (Helicopter or animal transportation required)

Are there any special environmental conditions?
☐ Ocean environment (Salt water spray/immersion)
☐ Coastal environment (Salt water spray only)
☒ Desert environment (Airborne sand and dirt)
☐ Jungle environment (High temperature and condensing humidity)

What is the daily average insolation for the worst-case month?

Month: DEC Insol. (~~Worst Case~~ Worst Case): 1000.1
BTU/FT²

What are the temperature characteristics of the site, by month?

Average hi: 107°F Month: JULY
Average lo: 68°F Month: JAN
20 year hi: 118°F 20 year lo: 27°F

Is the site in an area of high seismic activity? NO

Is special protection required against:

☐ Perching or nesting birds
☒ (Rodents) Small animals
☐ Large animals
☐ Fungus
☐ Insects
☐ Theft
☐ Vandalism

☒ LIGHTNING

Load Characteristics

Nominal voltage required: 240V AC DC

If AC, what frequency is required?
____ Hertz +/- ____ %

What range of voltage is tolerable?
Hi: _____ volts
Lo: _____ volts

What is the peak load demand?
3.6 Amperes
80 Watts RADIOS WITH UNITS 10W
____ Volt-Amps reactive

What is the duration of the peak demand?
____ Instantaneous
____ Seconds
____ Minutes
____ Hours

If the peak demand is a motor starting load, what horsepower is the motor? _____

What is the total load demand?
1920 Watt hours per day, or
____ Ampere-hours per day
____ Continuous (24 hours per day) amperes, or watts
50 Daytime load (% of total)
50 Nighttime load (% of total)

Balance of System Considerations

Is there a specified amount of energy storage? If so, please list:
280 Ampere hours @ _____ volts, or
____ Days autonomy (Sunless operation)

Will a building be available to house batteries and electronics? If so, give dimensions and attach building plan if available. NOT SURE
BUT UNLIKELY

Are there any other special considerations for the PPS? _____

What is the pattern of load demand?
Load is the same everyday: _____

24 HRS PER DAY
Load pattern is weekly as follows:
7 DAYS PER WEEK

Load is seasonal (annual cycle):
NO

Load repeats as follows: _____

What type of equipment is being powered? POSITION LOCATION
SYSTEMS

How critical is the load?

☒ Load is extremely critical, must be maintained at all times.
☒ Load is critical, but occasional, short-term failure is tolerable.
____ Load is not very critical. System should support the load ____ % of the time.

How will the solar array be mounted:
Ground: _____
Roof: _____
~~Post~~: ON TRAILOR

Any special instrumentation required? _____

Any special control systems required? _____