

Design, Fabrication, and Certification of Advanced Modular PV Power Systems

Annual Technical Progress Report 8 September 1995 - 7 September 1996

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ANNUAL TECHNICAL PROGRESS REPORT

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EXECUTIVE SUMMARY

Solar Electric Specialties Company (SES) has completed the first year of a two year effort under the auspices of the U. S. DOE PVMaT (Photovoltaic Manufacturing Technology) project. Under Phase 4A1 of the project for Product Driven System and Component Technology, the SES contract "Design, Fabrication and Certification of Advanced Modular PV Power Systems" has the goal to reduce installed system life cycle costs through development of certified (Underwriters or other Laboratories) and standardized prototype products for two of our product lines, MAPPSTM (Modular Autonomous PV Power Supply) and PhotogensetsTM. MAPPS are small DC systems consisting of Photovoltaic modules, batteries and a charge controller and producing up to about a thousand watt-hours per day. Photogensets are stand-alone AC systems incorporating a generator as backup for the PV and a DC-AC inverter and battery charger.

The program tasks for the two-year contract consist of designing and fabricating prototypes of both a MAPPS and a Photogenset that meet Listing requirements using modular concepts that will support development of families of products, submitting the prototypes for Listing, and performing functionality testing at Sandia and NREL. Both the MAPPS and Photogenset will be UL Listed. The MAPPS will also acquire FM (Factory Mutual) Approval for hazardous (incendiary gases) locations.

During the first year (from September 8, 1995 through September 7, 1996) SES researched the UL requirements and established contracts with both UL and FM, designed both a 200 W MAPPS and a 1 kW Photogenset, and began fabrication of the MAPPS. SES also developed the specifications and drawings for the designs, generated a Safety Requirements report summarizing UL and FM requirements and efforts, and developed a manufacturing plan for MAPPS product line development. Some specific accomplishments include development of 1) a lower cost battery/ control enclosure for the MAPPS, 2) an updated MAPPS Installation Manual and 3) a multi-platform Photogenset design. SES is also upgrading the MAPPS manufacturing process specifications and will upgrade the Photogenset manual and process specifications. Finally, the MAPPS and Photogenset families will have performance specifications based on functionality testing at NREL and Sandia.

1.0 INTRODUCTION

1.1 Background and Goals

This report summarizes the activities performed during the first year of a nominal two year effort by the Solar Electric Specialties Company under the auspices of the PVMaT (Photovoltaic Manufacturing Technology) project of the National Photovoltaic Program. The SES contract is funded under Phase 4A1 of the project, Product Driven System and Component Technology, which has the goals to improve the cost-effectiveness and manufacturing efficiency of PV end-products, optimize manufacturing and packaging methods, and generally improve balance-of-systems performance, integration, and manufacturing. The period of performance of the contract is from September 8, 1995 to November 7, 1997. This report covers work performed through September 7, 1996.

The goal of the SES contract, "Design, Fabrication and Certification of Advanced Modular PV Power Systems," is to reduce the installed system life cycle costs through development of certified (Underwriters or other Laboratory) and standardized prototype products for two of our product lines, MAPPSTM and PhotogensetsTM. The MAPPS (modular autonomous PV power supply) systems are used for DC applications up to about a thousand watt-hours. The photogensets are hybrid PV/generator systems for AC applications. SES expects these products to provide the basis for future commercial product lines of standardized, certified, packaged systems.

1.2 Organization of Report

A brief summary of the work breakdown structure of the entire contract plus highlights of the status and accomplishments are included in the first two sections. A more detailed discussion is contained in the rest of the report. A number of deliverables were specified for Phase I and those completed have been provided to NREL. None of the deliverables have been included in this report, but the information and results have been summarized as appropriate. More details can be found in the deliverables.

1.3 Task Descriptions

The contract effort is divide into two phases of one year each plus an additional two months for finalizing reports. The scope of work encompasses seven tasks, four for Phase I and three for Phase II, as described below.

Task 1 - Modular Autonomous Photovoltaic Power Supply (MAPPS) Design

This task consists of product research and the design of a UL-certifiable MAPPS with nominal 200 W PV power and 1 80 amp-hour battery capacity. This includes complete design documentation and a drawing package. The task also included a users' survey of SES customers to determine user preferences in system features and components.



Task 2 - Modular Autonomous Photovoltaic Power Supply (MAPPS) Fabrication

This task consists of the fabrication of the 200 W MAPPS, generation of as-built drawings and development of a manufacturing plan for future product line standardization.

Task 3 - Design of 1 kW Photogenset

This task consists of product research and the design of a UL-certifiable Photogenset with nominal 1 kW PV power and 4 kW inverter. This includes complete design documentation and a drawing package.

Task 4 - Safety Certification

This task consists of research into certification issues and determination of the requirements for certification “Listing” of the systems by UL or other certifying laboratories. It includes submission of both the MAPPS and Photogenset designs for verification by UL and the submission of the fabricated MAPPS to UL for certification and UL Listing. The task also includes development of a safety requirements report on the results of the research.

Task 5 - Fabrication of 1 kW Photogenset

This Phase II task consists of the fabrication of the 1 kW Photogenset, generation of as-built drawings and documentation of the manufacturing process. It also includes assessment of the fabrication process for ease of manufacturing and production scale-up.

Task 6 - Safety Certification

This task is a continuation of the Task 4 activities into Phase II. It consists of submittal of the fabricated Photogenset to UL for certification and UL Listing. It also includes a final report on the safety certification results.

Task 7 - Functionality Testing

This task consists of functionality testing of the 200 W MAPPS and the 1 kW Photogenset at NREL and Sandia. It includes development of the test criteria and protocol, the testing, and the generation of test reports.

2.0 SUMMARY OF PHASE I STATUS AND ACCOMPLISHMENTS

2.1 Task 1 Modular Autonomous Photovoltaic Power Supply (MAPPS) Design This task was completed by the end of the third quarter.

User Survey

The User Survey was completed early in the contract. Since the survey was not a deliverable and the results were published only in one of the monthly reports, we have included the results below. There were only 10 responses to the survey out of 37 sent out. It is not possible to make any sweeping conclusions based on the low sample size; however, some trends could be noted.

1. All respondents claimed confidence in their PV systems, would recommend PV to others and were satisfied with the power available.
2. The majority either maintain the systems themselves or have the installers maintain them. (Some responded Yes to both themselves and installer.) Only one has the system maintained by other than self or the installer.
3. Nine respondents admitted they did not conduct a cost analysis to decide whether to install a PV system or connect to the grid. The other respondent did not respond on this item.
4. In keeping with the above, seven respondents felt there was not adequate information available to compare costs.
5. The majority also claimed they would like to have more metering.

Design of MAPPS

The design of 200 W PV MAPPS system was completed on schedule. As part of this effort we developed a new, reduced volume, lower cost, battery enclosure. We researched the development of a new charge controller with several manufacturers who all expressed concerns about developing a controller to our specifications without any guarantee of a large sales volume. We are continuing to pursue this issue and have had many discussions with controller manufacturers concerning developing new controllers that satisfy all our needs and are UL Listed. Taking the Listing requirements into consideration, we opted to go with UL Listed and Recognized components and use conduit for array connections. We had many discussions with battery manufacturers and made them aware of the PV industry's need for more parameter data including cycle life information. We also documented the MAPPS performance requirements and design parameters and developed a complete set of drawings for the 200 W MAPPS which were submitted as a contract deliverable. The block diagram of the MAPPS is included herein.

2.2 Task 2 Modular Autonomous Photovoltaic Power Supply (MAPPS) Fabrication This task was started mid-way through the third quarter and is expected to be complete in mid-October 1996.

Fabrication of MAPPS

The fabrication of the 200 W MAPPS has not yet been completed. We are currently awaiting delivery of the new Battery enclosure we designed for our new MAPPS product line. We have contracted with a manufacturer, negotiated the final fabrication drawings and expect delivery of the enclosure by the end of the first month of Phase II. The enclosure will then be sent to UL for evaluation including a rain spray test. The MAPPS fabrication will be completed as soon as possible after that. The drawing package will be updated with as-built changes as needed.

Process Specifications

We are updating our manufacturing process specifications to satisfy the requirements of the Listing evaluation and the follow-up inspections. The specifications were near completion at the end of Phase I, but are awaiting completion of MAPPS fabrication for manufacturing evaluation.

Installation Manual

We have updated our installation manual to satisfy Listing evaluation requirements and to make them amenable to cover a family of products. The manual will be finalized after fabrication is completed.

Modularity and Standardization

We have divided the MAPPS into subassemblies and identified candidate components for each of the subassemblies for different sizes of MAPPS. This effort will continue throughout the contract; however, upon completion of the MAPPS fabrication, we will complete a manufacturing plan for future MAPPS product line standardization which will further guide the effort.

2.3 Task 3 Design of 1 kW Photogenset

The design of the 1 kW Photogenset was completed by the end of the fourth quarter and the design documented as a contract deliverable. This documentation includes a description and drawing package suitable for use in fabrication by SES. The Photogenset is a multi-platform design that includes both a trailer and a skid mounted enclosure. Although the photogenset could be fabricated as currently designed, a number of Listing issues have been identified as discussed in Task 4 below. Therefore, we expect the design will be revised to satisfy Listing requirements upon resolution of these issues. The block diagram of the Photogenset is included herein.

2.4 Task 4 Safety Certification

This task was started in the third quarter of the contract and will be completed upon submission of the fabricated MAPPS to UL. During this task we obtained the technical



and administrative requirements for UL and FM Listing including the follow-up inspection requirements. We also obtained Listing fees and follow-up inspection fees as well as labeling requirements and fees. The designs of the 200 W MAPPS and the 1 kW Photogenset were submitted to UL for evaluation. The MAPPS design was also sent to Factory Mutual (FM) for evaluation for hazardous locations. As a result of these evaluations, we have established contracts with both UL and FM for certification of the MAPPS. Based on their comments, we expect no problems due to use of UL Listed and FM approved components. A one-time rain spray test will be performed by UL on the battery enclosure since it is a custom NEMA-3R design. The use of conduit for module interconnections was required for FM approval.

The UL evaluation of the Photogenset design uncovered a number of issues because of the complexity of the system and the lack of UL Listed stationary generators and inverterchargers. Therefore, the design would need to be significantly modified or special UL Listing would have to be done on non-UL Listed components. As a result we are investigating several alternatives: 1) obtaining certification through another laboratory such as ETL Testing Laboratory, 2) using a UL Listed inverter with separate charger and a UL Listed RV generator, and 3) obtaining UL Listing on non-Listed generators and inverters. The research is continuing but it is clear that whatever the final solution the cost of obtaining certification of the Photogenset will be at least twice that of the MAPPS certification.

A detailed discussion of the certification requirements and issues is contained in a Safety Requirements Report submitted as a contract deliverable.

2.5 Overall Phase I Status

Phase I included 18 official milestones and 7 deliverables. By the end of Phase I SES completed 14 milestones and submitted 5 deliverables. The remaining 4 milestones and 2 deliverables will be completed by mid-October 1996.

3.0 TASK EFFORTS AND ACTIVITIES

3.1 Administrative Activities

On October 17, 1995 SES hosted a Kick Off meeting for our NREL Technical Monitoring team at SES's main office in Willits, CA. Discussions covered the following topics:

- Objectives of the project
- Scope of Work
- Tasks proposed
- Work plan
- Milestones and schedules
- Deliverables and schedules
- Demonstration of SES's current working hardware
- SES's manufacturing capabilities and plans
- Current status of project

In October 1995, the second month of the project, we created a Gantt chart to better monitor our progress of Milestones and Deliverables. This chart is updated weekly and helps maintain emphasis on the Milestones and Deliverables.

An Annual Program Review Meeting was held August 22, 1996 at the NREL offices in Golden, CO. It consisted of an open meeting providing an overview for NREL employees and a closed meeting for the contract Technical Monitoring Team. The closed meeting included a review of status and accomplishments, key issues, and Phase II plans.

The SES staff engaged in the performance of this contract consists of:

- | | |
|-----------------------------------|--|
| Glen Minyard, SES Production Mgr. | Project Manager and Principal Investigator |
| Tim Lambariski, Production Engr. | Asst. Project Mgr. and Lead Engineer |
| Barbara Payne, Production Admin. | Administrative Assistant |
| Mike Ashmore, Sales Engineer | Technical Consultation |
| James Padula, President | Technical Consultation |
| Scott Williams, Sales Engineer | Technical Consultation |

The SES staff is augmented by the following contractors:

- | | |
|-------------------------------------|---|
| John Hannestad, Professional EE | Electrical Engineering |
| Ben Worcester, CAD Draftsman | Drawing Support |
| Jim Bird, Industrial Engineer | Production Controls and Quality Assurance |
| John Wiles, SWTDI, Electrical Engr. | Codes, Certification and PV Design |
| Chris Eberspacher, Unisun | PV Applications and Markets |

Mr. Wiles is a PV design expert at the Southwest Technology Development Institute at New Mexico State University. Mr. Eberspacher is a PV utilization expert at Unisun.

3.2 TASK 1, Modular Autonomous Photovoltaic Power Supply (MAPPS) Design

In the performance of Task 1, SES completed the following milestones and deliverables:

End of First Quarter:

M-1.1.1. Complete user survey of PV system components for the MAPPS System.

M-1.1.2. Complete definition of performance requirements for the MAPPS.

M-1.1.3. Complete preliminary design of MAPPS, including block diagrams.

D-1.1. Deliver list of suppliers contacted for components.

End of Second Quarter:

M-1.2.1. Complete determination of MAPPS components based on user preference and UL requirements.

D-1.2. Deliver list of candidate PV system components, performance requirements and preliminary design for MAPPS.

End of Third Quarter:

M-1.3.1. Complete design of MAPPS to include final drawings.

M-1.3.2. Complete Task I.

D-1.3 Deliver final MAPPS design and drawings.

3.2.1 User Survey

A Users Survey was developed at the beginning of the contract to be sent to SES customers that are currently using systems of the type being addressed in this contract. The survey was mailed on December 6th to 37 SES customers. Initial response was very small, perhaps because it was mailed during the Christmas season. Therefore, we took the opportunity to make several changes and re-mailed it after the new year. In the end we received a total of 10 replies to our survey and that only because we solicited responses by phone from seven of the respondents.

Because of the relatively small number of responses from the survey, it is difficult and may be misleading to draw many inferences or conclusions. We summarized the responses in a spreadsheet and developed some general conclusions. The results have been included in the summary section 2.1 above.

3.2.2 MAPPS Design

As part of the MAPPS development effort, we designed a new enclosure for the batteries and controller. This design changes the aspect ratio, reduces the overall area and reduces the cost of the enclosure. We developed and released an RFQ to a number of enclosure suppliers in order to obtain a vendor for the enclosure. After the winning response was selected (Name of the company is SES proprietary), we issued a contract for the vendor to develop the final fabrication drawings and provide two enclosures. The battery enclosure design developed by SES had to be expanded into a detailed set of drawings for fabrication. All fabrication requirements such as knockouts, hole position and dimensions, corner radius specifications, hinge details and rain abatement gutters had to

be specified. As of the end of Phase I, the fabrication drawings had been completed and accepted by SES and the fabrication was in progress. We expect delivery by the second week in October. Upon successful completion of SES incoming inspection, one enclosure will be sent to UL for a NEMA-3R rain spray test.

RFQ's were also developed and released for a Charge Controller and a Lighting Controller. We were attempting to obtain designs for these components that would satisfy all our needs for a standardized line of MAPPS. However, we were not able to obtain any satisfactory responses to the RFQ's. The respondents either felt their existing units could satisfy enough of our requirements or they were not in a position to redesign their units without either a large fee or a guaranteed large order. We abandoned the attempt to develop the controllers through formal RFQ's and are now working with some of the manufacturers through continuing orders for their products and phone solicitation for changes.

SES has manufactured many different MAPPS systems over the years. In this contract our goal was to develop a UL Listable design that could form the basis for a standardized, low cost, reliable product line. We first developed a preliminary MAPPS design, sent it to both John Wiles at SWTDI and to Underwriters Lab, obtained a detailed report from John Wiles and verbal comments from UL, and finalized our design based on their comments. The final design uses UL Listed and Recognized components with a history of high reliability and a new, lower-cost battery/control enclosure with more room for optional equipment such as lighting control, metering and remote data acquisition.

3.3 TASK 2, Modular Autonomous Photovoltaic Power Supply (MAPPS) Fabrication
In the performance of Task 2, SES is near completion of the following milestones and deliverables:

- M-1.4.1. Complete fabrication of the MAPPS, including a system description and as-built drawings.
- M-1.4.2. Complete Task II.
- D-1.8. Deliver complete, MAPPS documentation including system description and as-built drawings.
- D-1.9. Deliver manufacturing plan for future product line standardization encompassing a MAPPS family of products.

These milestones and deliverables were near completion at the end of Phase I. They were delayed in order to ensure the successful design and fabrication of the new battery/control enclosure and will be completed after delivery of the enclosure.

3.3.1 MAPPS Fabrication

At the end of Phase I, the fabrication of the 200 W MAPPS was awaiting the delivery of the new battery enclosure. The final drawing package was not completed in time for

fabrication and delivery before the end of Phase I. Two enclosures are expected to be delivered early in the second week of October. Following incoming inspection one enclosure will be sent to UL. At that time we will make a decision whether to fabricate the MAPPS using the second enclosure or wait for the return of the enclosure sent to UL. An “as-built” drawing package will be produced after the MAPPS fabrication. This package may contain modifications to the design based on experience gained during the fabrication and assembly.

3.3.2 Process Specifications

As part of this task we are developing new production process specifications to standardize and streamline the in-plant assembly process. This will ensure that each order for a MAPPS will be filled using the same high quality standards and consistency of production which are required to satisfy UL follow-up inspection requirements. These process specs are awaiting final fabrication to verify their utility and efficiency and recommend any changes that may be needed to perfect them. Our industrial engineering consultant will observe the fabrication of the MAPPS with a view to improving our assembly procedures.

3.3.3 Installation Manual

Also part of this task was the drafting of a new Installation Manual for MAPPS which is constructed in modular form with a product line in mind so that the same format can be used for all manuals. To accommodate new products and options we will only need to replace the appropriate pages with no reformatting or page renumbering.

3.3.4 Future Product Line Standardization

We are also developing a proprietary manufacturing plan to accommodate future product line standardization encompassing a family of MAPPS products. We have broken the MAPPS systems into subassemblies so that the product line can be developed along principles of modularity and standardization. Three basic subassemblies will be employed: PV Array Subassembly, Control System Subassembly, and Battery Subassembly. A non-proprietary Manufacturing Plan document will be delivered after the fabrication is completed allowing us to incorporate lessons learned during the fabrication.

3.4 TASK 3, Design of 1 kW Photogenset

In the performance of Task 3, SES completed the following milestones and deliverables:

End of Second Quarter:

M-1.2.3. Complete survey of components for 1 kW Photogenset and identify components and suppliers.

End of Third Quarter:

M-1.3.3. Complete prototype design for Photogenset.

End of Fourth Quarter:

M-1.4.3 Complete final design and drawings of the 1 kW Photogenset.

M-1.4.4. Complete Task III

D-1.5. Deliver list of candidate PV system components for 1 kW Photogenset

D-1.7. Deliver preliminary design and drawings for 1 kW Photogenset.

SES started the development of the 1 kW Photogenset by reviewing existing Photogenset designs. The next step was to develop a computer model for the Photogenset components so that a trade-off study could be performed to determine the optimum battery capacity and PV to Generator ratio. Manufacturers were contacted to obtain the latest data on battery capacity and cycle life versus discharge rate, generator maintenance and repair costs, fuel consumption rates and costs of various equipment. We also developed load and weather data for several locations. The analyses were performed using both the Siemens Stand-Alone System sizing program and the System-Spec program. Based on our analyses we have specified the battery to be approximately 1000 A-H and the generator to be 6.5 kW.

A major effort has also been expended in determining the enclosure for the Photogenset power processing equipment. We began by contacting manufacturers of portable and wheeled containers. We settled on a multi-platform design which has the option for employing either a transportable container or a cargo trailer.

In the electrical design of the Photogenset, we first developed a preliminary design which was sent to UL for comment and to solicit a quote for Listing evaluation. We also engaged John Wiles to address the issues involved in reliability of various battery types for Photogenset usage and for UL certification. John provided us with a report and UL provided us with verbal comments both of which were used to develop the final design. Although the final design is complete and suitable for fabrication, we expect some modifications will be made because of problems with UL Listing as discussed below under Task 4.

As part of this task we also began to review the requirements for remote data acquisition and transmission. We have reviewed literature on available remote monitoring and telemetry systems both in the telecommunications market and in remote commercial applications. We have also reviewed the products being offered by other PV systems suppliers. Prior to determining the direction of our development in this arena, we have decided to engage an expert in data acquisition and telemetry for consultation on technology availability, manufacturers and cost. We will continue this effort outside the development of the basic UL Listed Photogenset with the goal of completing the effort by the end of Phase II.

3.5 TASK 4, Safety Certification

In the performance of Task 4, SES completed the following milestones and deliverables:

End of Third Quarter:

M-1.3.4. Submit MAPPs design meeting safety and performance requirements to UL for verification.

End of Fourth Quarter:

M-1.4.6. Submit prototype 1 kW Photogenet designs for UL verification.

M-1.4.7. Complete safety requirements assessments for Safety Requirements Report.

D-1.6. Deliver preliminary safety requirements report for MAPPs and 1 kW Photogenet.

The following milestones were near completion at the end of Phase I. They were delayed in order to ensure the successful design and fabrication of the new battery/control enclosure and will be completed after delivery of the enclosure.

M-1.4.5. Submit prototype MAPPs meeting safety and performance requirements to UL for certification.

M-1.4.8. Complete Task IV.

3.5.1 Determination of Listing Requirements

The results of our investigation into safety issues, code compliance and safety certification Listing are discussed in detail in the Safety Requirements Report submitted as deliverable D-1.6.

We began this effort by contacting Tom Lundveit, Underwriters Laboratories, Northbrook IL, to discuss our plans and obtain information on submitting products for UL Listing. We provided Mr. Lundveit with company literature and a preliminary design of the 200 W MAPPs to obtain a quote on the Listing evaluation. Mr. Lundveit provided us with product submittal and documentation requirements.

In conjunction with this effort, we contacted other PV suppliers who have UL Listed components to obtain their experience with the UL Listing process and its requirements. We also discussed the UL Listing process with John Wiles and obtained some documentation from him on issues related to code compliance and UL Listing of PV components. We also obtained copies of various UL Standards:

UL 1741	Power Conditioning Units for use in Residential Photovoltaic Power Systems
UL 1778	Uninterruptible Power Supply Equipment
UL 50	Enclosures for Electrical Equipment
UL 1236	Battery Chargers
UL 508A	Industrial Control Panels

3.5.2 Listing of MAPPS

Mr. Steve Jochurns was assigned by UL as our evaluation engineer. Subsequently, he provided us with a quote for the evaluation along with an Application for Evaluation. We also received a Follow-Up Services Agreement outlining the follow-up inspection requirements. Based on this information we established a contract with UL for the Listing evaluation of the MAPPS.

Communication with UL revealed that a new subcategory would be initiated for our products. We were concerned about the lack of a UL standard for complete PV systems; however, they informed us the issues were sufficiently well-understood that no standard was needed prior to evaluation and no additional cost would be incurred because of the lack of a formal standard.

Subsequently we initiated contact with Factory Mutual Research Corporation (FM) to obtain information on FM Approval of products for hazardous locations. These relate to locations where combustible gasses, dusts and fibers are to be found as defined in NEC Article 500. They provided us with a quote, an application for investigation and the requirements for submittal of products and documentation. Based on this information we established a contract with FM for Class I, Division 2 Approval evaluation of the MAPPS.

The MAPPS design has already had significant review and scrutiny by UL and FM. The UL Listing evaluation will begin as soon as our new battery enclosures are delivered assuming they pass incoming inspection. At this point we will send one enclosure to UL for a one-time, NEMA-3R rain spray test. The fabricated MAPPS will be sent to UL after the rain spray test is completed. At that time, we will decide whether to fabricate a second MAPPS for FM evaluation or to wait for the return of the first fabricated unit.

3.5.3 Listing of Photogenset

With the intention of establishing a contract for UL Listing of the 1 kW Photogenset, we sent the detailed design to UL for review and to obtain a quote. UL identified several issues relating to the complexity of the system and the lack of UL Listing on stationary generators and inverterchargers. There are no UL Listed stationary generators, but a standard, UL 2200, is being developed. However, no manufacturers are as yet signed up for Listing of their stationary generators. There are CSA Listed stationary generators, but UL will have to perform an evaluation and may require some testing. There are UL Listed RV generators, but they may require some evaluation for our application.

There are no off-the-shelf UL Listed inverters with built in chargers. The Trace inverter/charger is ETL rather than UL Listed so that a considerable effort will be required to obtain Listing with this inverter. We are researching the availability, cost and features of other inverter options.

Because of the problems and unknowns associated with obtaining a UL Listing on the Photogenet, UL has proposed performing an initial scoping evaluation to determine the extent and cost required for the Listing evaluation. The results of this initial evaluation would apply directly to the Listing effort and reduce the subsequent cost. However, that cost is as yet unknown.

As a result of these problems, we began to pursue Listing of the Photogenet with the ETL Testing Laboratory. We have subsequently obtained a quote from ETL with submittal and documentation requirements for safety listing of the Photogenet. ETL has stated they will accept the CSA Listing of the stationary generators; however, in spite of this the cost is much higher than the initial evaluation cost for the Photogenet. At this point, we can not determine which Listing will be more cost-effective; however, we have time yet before the planned fabrication of the Photogenet to refine our information and make our decision.

TASK 1 M 1.3.1
PRELIMINARY DESIGN OF M.A.P.P.S.
LINE BLOCK DIAGRAM OF SYSTEM LAYOUT

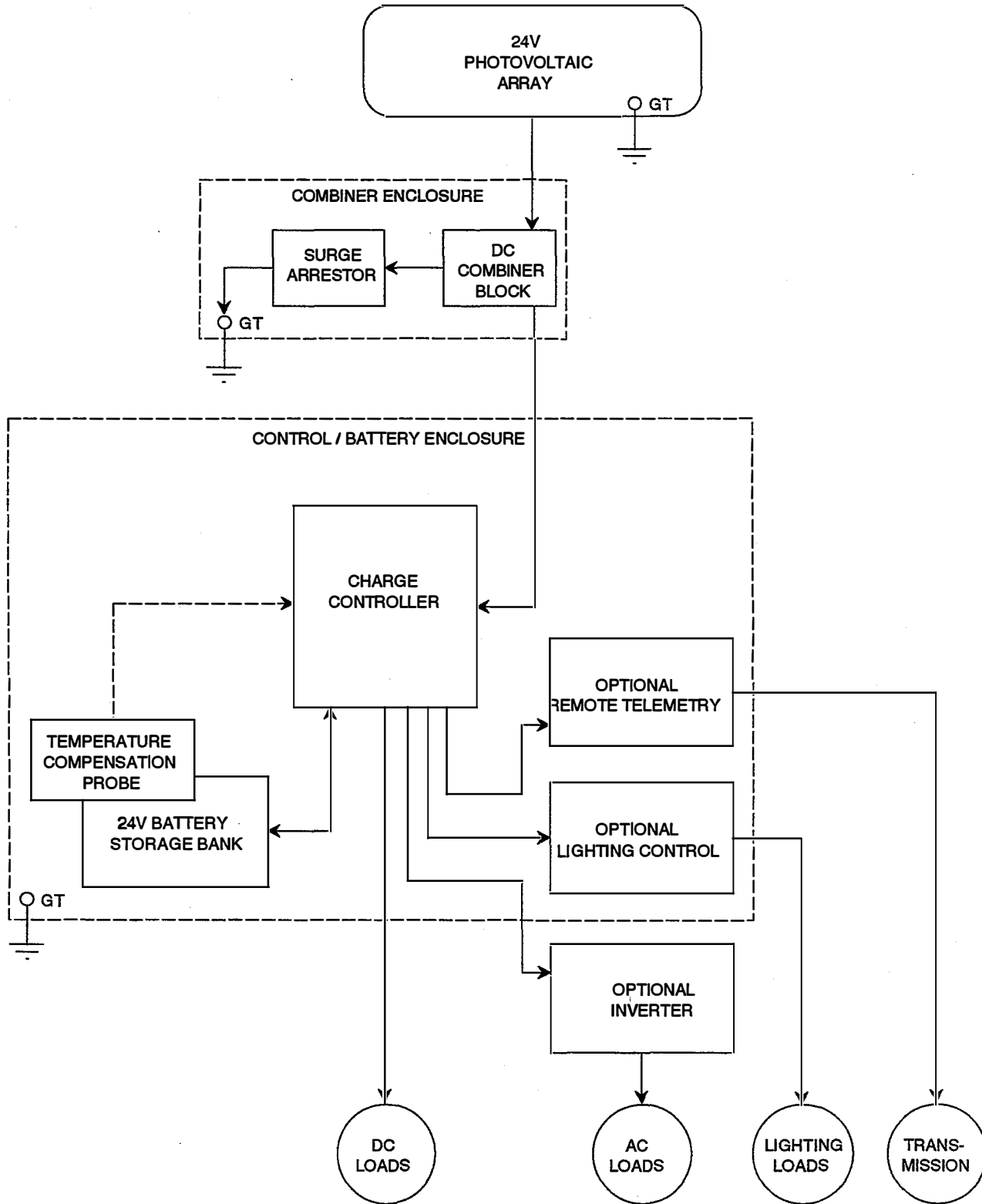
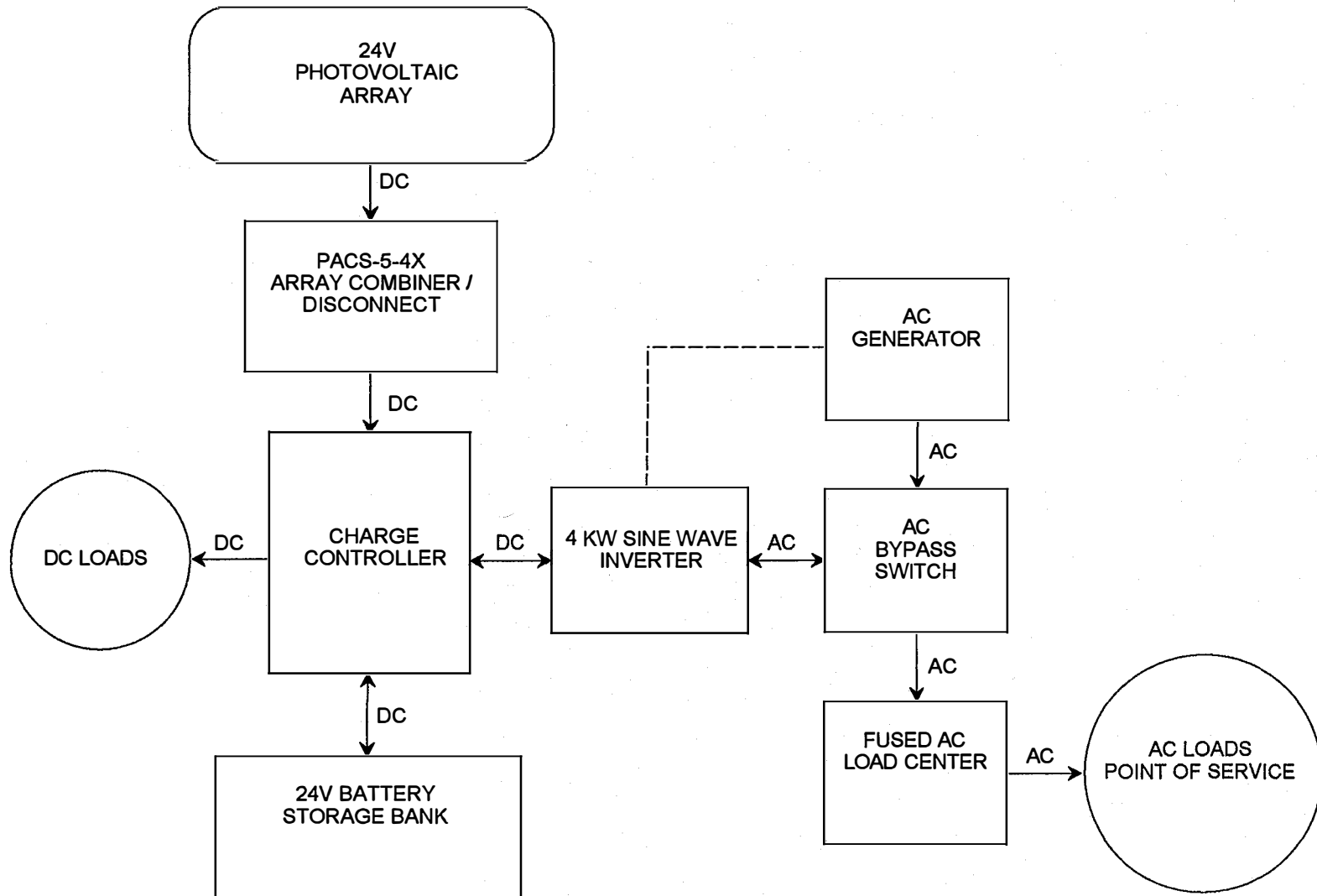


Figure 1.3.1 - 2





**SOLAR ELECTRIC
SPECIALTIES CO.**

WILLITS, CALIFORNIA USA

SCALE: NONE	CUSTOMER: N.R.E.L.	JOB NO: -
NOTES:		STOCK NO: -
DRAWN BY: BEN WORCESTER	PROJECT NAME: AC / 24VDC PHOTOGENSET SYSTEM	REVISION NO: -
CHECKED BY: GLEN MINYARD	DRAWING TITLE: ONE LINE BLOCK DIAGRAM	DRAWING NO: NRL-D170.DFT
DATE DRAWN: 05-JULY-08		PAGE 2 OF 4

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