CHAPTER 7

SELECTION OF BATTERY FOR PHOTOVOLTAIC SYSTEM

Solar photovoltaic system designers should work closely with the sales and application engineers of representative battery manufacturers to make a wise selection of the battery type for the storage sub-system. These discussions can be most rewarding when each party has a summary of the subsystem requirements. A form useful for this purpose is given at the end of this chapter.

Photovoltaic systems can require batteries with a wide range of capabilities. Classifications of service requirements can help identify the optimum battery type for each application. The following classifications are helpful:

A. <u>Shallow Cycle Service</u>

Most cycles are less than 20% depth, but a small number may be as deep as 50 percent of 5-hour rated 25°C capacity.

B. <u>Deep Cycle Service</u>

Most cycles are in the range of 60-80%, but an occasional cycle may be 100% of rated 5-h 25°C capacity.

C. Standby Service versus Cycle Service

Standby service ranges from 2-12 cycles per year with the remaining service time on float at a predetermined voltage at ambient temperature.

Deep or shallow cycle service is repetitive cycling on a fairly predictable regime with as many as 200-500 cycles per year and 1-2 cyc1es per day.

Combinations of the above classifications are common in photovoltaic system service:

I. Shallow Cycle-Standby (few shallow cycles, mainly float)

II. Shallow Cycle-Deep Cycle - Float-Stand (float occurs after shallow cycles and high insolation periods while discharge stand occurs during long black-outs).

III. Deep Cycle-Standby (few deep cycles, mainly float)

IV. Deep Cycle - Little Float (predominantly deep cycling)

Pure lead and lead-calcium type lead-acid batteries are normally recommended for service types I and III above. Life may vary from 2-3 years in the case of thin plates, 6-10 years with medium thickness plates and 17-22 years with plates of 0.25-0.35 inch thickness. These cells are usually assembled with an effective microporous separator
but with a minimum retainer system.

When an effective retainer system is added to the pure lead or lead-calcium cells, then the cells can be placed in deep cycle service - category type IV - although the service life will be only moderate compared to the cycle life of a lead-antimony cell of the same capacity.

Pasted plate lead-antimony cell designs with thick plates (0.25- 0.35 inches), effective microporous separators and proper active material retainers give excellent life on deep cycle regimes. When higher ampere rates are required, the number of plates is increased, plate thickness is decreased, and service life is reduced.

The tubular positive battery also gives excellent life on deep discharge cycle service.
In addition, the tubular positive plate design increases effective plate area and gives very good high current rate performance.

Maintenance (addition of water to cells) will be greater in lead-antimony cells than in lead-calcium cells unless the reserve acid in each cell is increased in the cell design used for solar applications where low maintenance is known to be an important requirement.

Category II service requires a lead-antimony battery because of the variety of service conditions and the possibility of very deep discharges followed by discharged stands.

Requirements for low maintenance can be met by a pure lead battery provided the charge - discharge rates are very low and within the range of the thick plate, charge retaining, pure lead cell designs. These cells can be occasionally deep discharged and then restored to full capacity by a low rate (75h minimum) recharge.

Lead-calcium batteries with oxygen-hydrogen recombination devices in their vents are excellent for low maintenance applications, but their deep cycle life is more limited at today's state-of-the-art than lead-antimony cells.

A reliable automatic watering accessory which enables a lead-antimony battery to meet the low maintenance requirement is becoming a viable alternative for the solar PV system designer to consider. A collection of additional data on the various types of lead-acid batteries and on the pocket-plate nickel-cadmium battery is given in the appendix as an aid to the system 'designer in selecting the battery type and size most suitable to each application specification.

To assist the battery manufacturer's applications engineer in assessing application requirements, it is recommended that the application data form be completed and submitted along with any request for technical information or pricing made to a manufacturer by the solar system engineer.

APPLICATION DATA SUMMARY FORM

SOLAR PHOTOVOLTAIC BATTERY SUBSYSTEM

1. Array vs. Load Power Estimates

Month of Year	Max. Array Power - kW	Useful Array Power - kW	Total Load Power - kW
Jan.	__________	__________	__________
Feb.	__________	__________	__________
Mar.	__________	__________	__________
Apr.	__________	__________	__________
May	__________	__________	__________
June	__________	__________	__________
July	__________	__________	__________
Aug.	__________	__________	__________
Sept	__________	__________	__________
Oct.	__________	__________	__________
Nov.	__________	__________	__________
Dec.	__________	__________	__________
Estimated Annual. Energy - kWh			
• Array Output	__________	__________	
• Load			__________

2. Standby Battery Charging Equipment

Power - kW

2.1 Power Source: (check) ac grid _______diesel electric generator ________

2.2 Power Rating: ______ kW.

2.3 Current Rating: ______ A.

2.4 Type Regulation: (check one)

2.4.1 Constant Current Type ____

2.4.2 Constant Potential Type ____

2.4.3 Modified Constant Potential Type ____

2.4.4 Other- ___________________________

Describe: ____

____

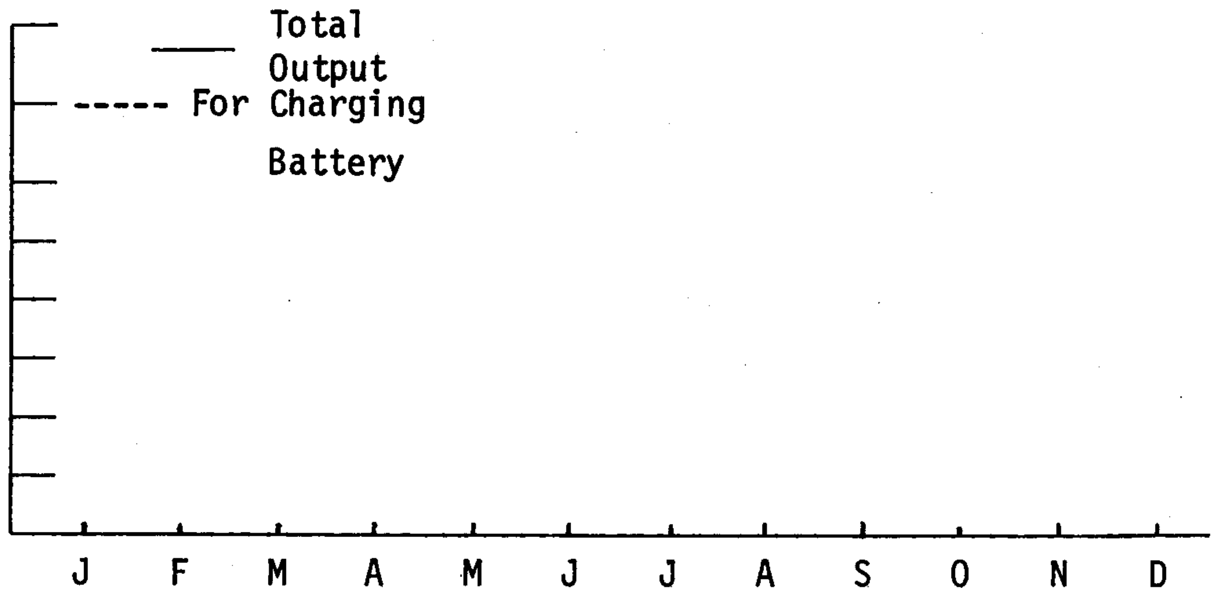
3. Photovoltaic Array Power Characteristics

3.1 Voltage: minimum volts __________ maximum volts ___________

3.2 Current for charging battery: maximum amperes __________________

3.3 Power: minimum kW __________ maximum kW ____________

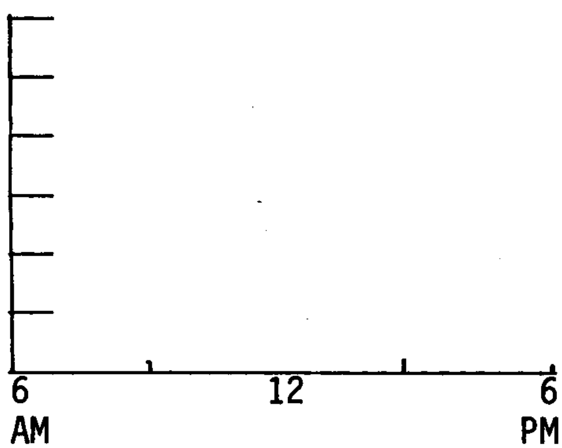
3.4 Power profile; average kW each month during year



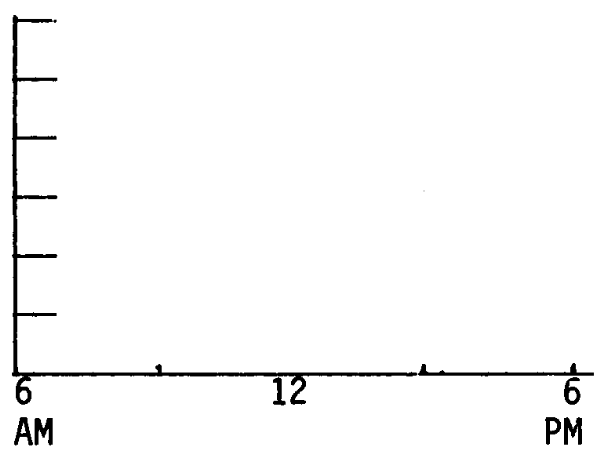
3.5 Expected daily power output: —— Total

---- For charging battery

Maximum Power Output kW



Minimum Power Output kW



3.5.1 Expected zero power time per day: minimum hours ________________

3.5.2 Maximum zero insolation period expected:

hours _____________ ; number periods per year _______________.

4. System and Equipment Loads on Battery

4.1 System voltage window:

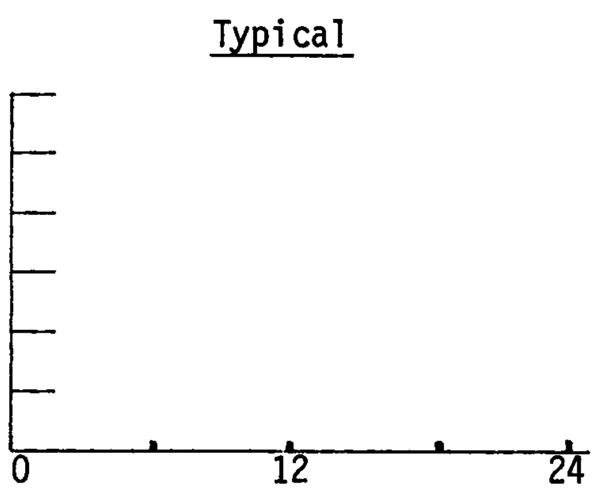
Minimum, bottom of discharge ______ volts

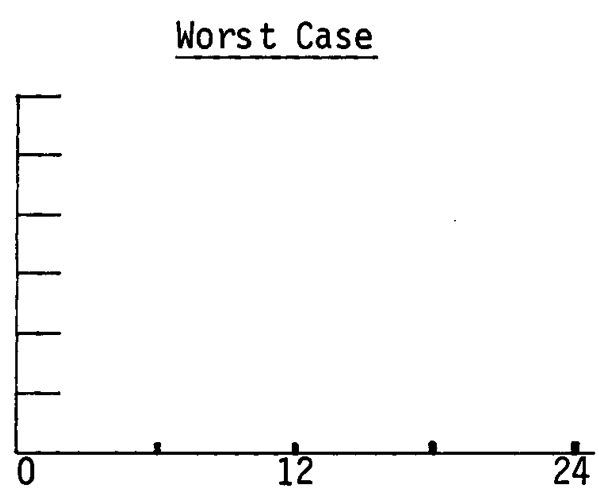
Maximum, top-of-charge _________ volts

4.2 Maximum Discharge current __________ A

4.3 Battery energy storage requirement __________ kWh

4.4 Typical and worst case battery daily load profile: kW versus time





4.5 Type of Equipment Loads on Batteries

	Test	Unit	Appliance (1)	(2)	(3)	Total
4.5.1	Load	watts	_______	________	_______	_______
4.5.2	Current, mean	A	_______	________	_______	_______
4.5.3	Duration	h	_______	________	_______	_______
4.5.4	Number per day	ea	_______	________	_______	_______
4.5.5	Number per week	ea	_______	________	_______	_______
4.5.6	Number per year	ea	_______	________	_______	_______
4.5.7	Average energy output per day	kWh	_______	________	_______	_______
4.5.8	Total energy output per year	kWh	_______	________	_______	_______
4.5.9	Total energy input needed per year	kWh	_______	________	_______	_______

5. Environmental Requirements

5.1 Temperature extremes: minimum ____°C

maximum ____°C

5.2 Desired battery life, years _________

5.3 Vibration and shock:

____

____

6. Maintenance Schedule Permitted:

____

____

Water addition every _____ months.

7. Space Allocations and Ventilation

7.1 Battery Space and Battery Room Dimensions

Dimension	Battery Space	Battery Room
Floor Area:	_________ ft^2	_________ ft^2
Dimensions:		
L	_________ ft	_________ ft
W	_________ ft	_________ ft
H	_________ ft	_________ ft
Volume	_________ ft^3	_________ ft^3

Ventilation required: ____________________ CFM

8. Other Information:

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