CHAPTER I

INTRODUCTION, SUMMARY AND GOALS OF HANDBOOK

Harnessing energy from the sun to perform useful work is becoming more and more urgent, perhaps one of the most important priorities for this century. The direct conversion of the sun's insolation to electrical current is no longer a scientific curiosity but a practical way to generate auxiliary power for electrical devices in remote locations and areas with high utility rates.

Photovoltaic systems composed of solar photovoltaic cells in modules, voltage control circuits and batteries for energy storage are frequently the major power source for navigational aids, village electrical power, water pumping, communication devices, TV stations and homes.

The major purpose of this handbook is to collect some of the essential information needed by the photovoltaic system designer as an overview of the requirements for the battery energy storage subsystem and its charge control equipment.

This handbook provides technical data to enable the photovoltaic system designer to select the battery type and size best suited to meet the needs for each application and to predict how the battery subsystem will operate under each set of conditions.

Brief descriptions are given of four types of lead-acid batteries and one type of nickel-cadmium battery available from commercial sources.

Discharge characteristics are given for each battery type, and the effects of discharge rate, discharge depth and operating temperature are illustrated with tables of data and graphs. Optimum charging methods are recommended to meet operating requirements and to extend life. The effects of cell design and operating conditions on battery life are outlined to aid the solar PV system designer in battery selection.

Remote solar PV installations require battery subsystems with minimum maintenance due to the extreme costs associated with transporting personnel and parts by helicopter to each site. Minimum maintenance requirements are therefore recommended for each battery type, and safety precautions advised for personnel who install and maintain the systems.

Estimates are given of battery purchase prices based on GSA (General Services Administration) approved catalog prices for late 1980. Delivered energy costs are calculated in dollars per kilowatt-hour for single discharges at various rates from the l-hour to the 500-hour rate. Energy storage costs are estimated using cycle lives consistent with actual test and operational experience in non-solar PV system applications. This battery life-cycle cost covers all cycles during the life of the battery and has units of dollars per kilowatt-hour per cycle.

The relative economic viability of each of the four types of lead-acid batteries and one type of nickel-cadmium battery can be compared under a variety of test conditions.

The operation of four types of voltage regulator circuits is explained.
A comparison of the characteristics of each circuit is made to aid the designer in selecting a circuit most favorable to each application. The impact of their charge control on the battery is given in terms of the trade-off of initial vs. long term performance, voltage control vs. life, energy storage efficiency and maintenance.

Finally, the process of engineering a particular battery into a solar photovoltaic system is described in terms of the minimum essential information required by the designer to match a battery design to a given solar PV system design.

Technical information on batteries which are commercially available is collected in the appendix so that the designer can become aware of their performance characteristics.
Using this data and the handbook, the solar PV system designer should be able to work intelligently with the battery manufacturer technical representatives to select the optimum battery type, a capacity to assure adequate energy storage, and a cell design to provide the required years of wet life.