CHAPTER 1

INTRODUCTION

1-1. Purpose

The purpose of this publication is to provide guidance for facilities engineers in selecting, installing, and maintaining an uninterruptible power supply (UPS) system after the decision has been made to install it. This technical manual (TM) TM 5-693 has been prepared to provide generic guidance to agencies responsible for the selection, installation, and maintenance of UPS systems at Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) facilities. Although it is written mainly for C4ISR facilities, which require a higher level of reliability, it could also be utilized as a reference in similar applications.

1-2. Scope

The process for identifying the need for an UPS system, selecting, installing, and maintaining the UPS system are covered. Covered are: theory and principles of static and rotary UPS systems, design and selection of UPS, installation and testing of UPS, maintenance and operation of UPS systems, principles of static and rotary UPS, UPS system rating and sizing selection, operations/maintenance, batteries, troubleshooting, harmonic distortions, grounding, checklists, and acceptance testing.

1-3. References

A complete list of references is contained in appendix A. The design, installation, and maintenance of UPS systems should follow the latest industry and commercial codes and standards as detailed in the references.

1-4. Principles and configurations

An UPS system is an alternate or backup source of power with the electric utility company being the primary source. The UPS provides protection of load against line frequency variations, elimination of power line noise and voltage transients, voltage regulation, and uninterruptible power for critical loads during failures of normal utility source. An UPS can be considered a source of standby power or emergency power depending on the nature of the critical loads. The amount of power that the UPS must supply also depends on these specific needs. These needs can include emergency lighting for evacuation, emergency perimeter lighting for security, orderly shut down of manufacturing or computer operations, continued operation of life support or critical medical equipment, safe operation of equipment during sags and brownouts, and a combination of the preceding needs.

a. Static UPS. A static UPS is a solid-state system relying solely on battery power as an emergency source. A static UPS consists of a rectifier, inverter, and an energy storage device, i.e., one or more batteries. The inverter in the static UPS also includes components for power conditioning. Modern static UPS systems are constructed with ratings ranging from about 220 VA to over 1 MVA. Static UPSs ranging from 220 VA to 1 MVA are constructed without paralleling internal components. UPS with output higher than 1 MVA are built with some parallel internal components, which result in decreasing reliability. Figure 1-1 shows a simple

static UPS. Design, installation, and maintenance requirements should follow the latest version of applicable codes and standards from recognized industry and commercial groups.

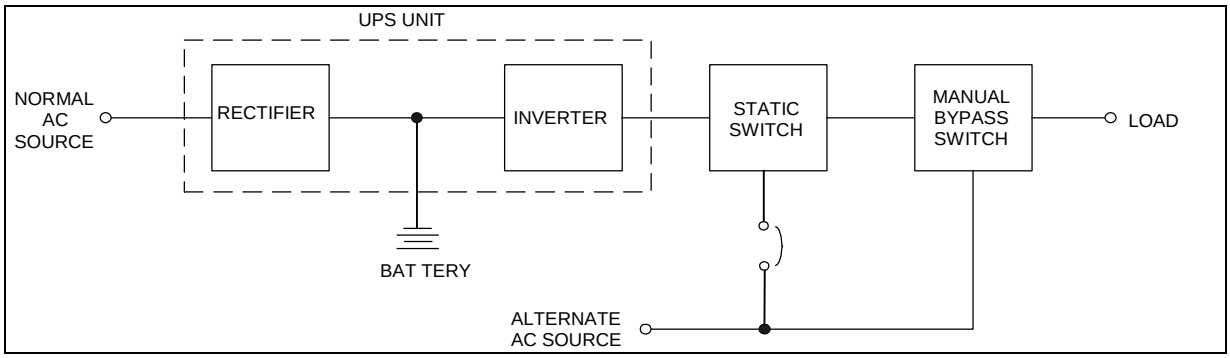

Figure 1-1. Simple version of a static UPS

b. Rotary UPS. A rotary UPS is a system that uses a motor-generator (M-G) set in its design. Figure 1-2 illustrates a simple rotary UPS. Unlike static units, the basic parts may vary between manufacturers for rotary units. Rotary units are mainly designed for large applications, 125 kVA or higher. Some reasons for selecting a rotary UPS over a static UPS are to provide higher efficiency, superior fault clearing capability, capability of supplying currents for high inrush loads, and isolation from harmonic distortion generated by non-linear loads in the line. Rotary UPS bearings must be replaced periodically. Although this might make reliability between the two types debatable, bearing failure is highly predictable with stringent routine testing. Rotary units produce more heat than do static units due to their M-G sets. They are more costly for small capacities but become competitive with static units around 300 kVA. Rotary units provide complete electrical isolation where the static UPS is limited by the static switch. Extremely high voltages or rapidly rising voltages can pass through the static switch and damage critical loads.

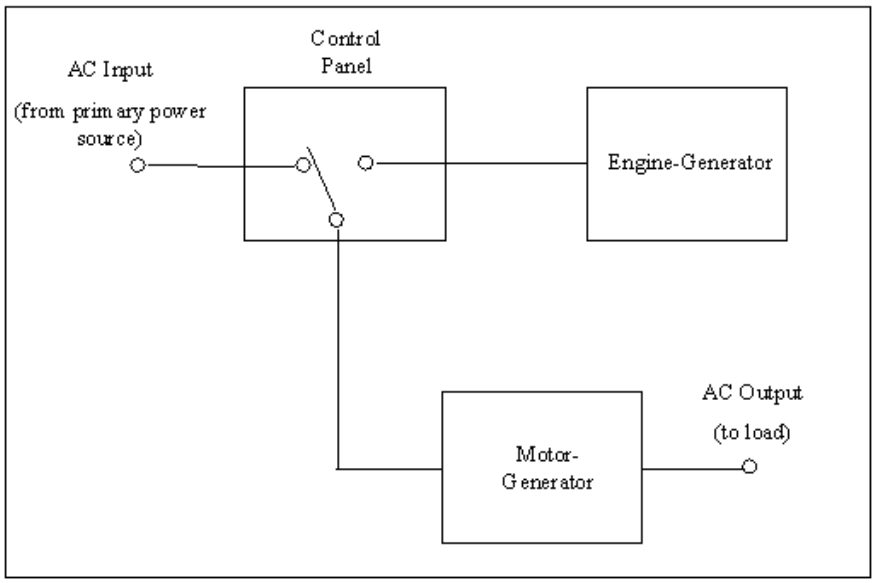

Figure 1-2. Rotary UPS (shown with primary power on)

1-5. Design criteria and selection

The UPS selection process involves several steps as discussed briefly here. These steps are discussed in further detail in chapter 3.

a. Determine need. Prior to selecting the UPS it is necessary to determine the need. The types of loads may determine whether local, state, or federal laws mandate the incorporation of an UPS. An UPS may be needed for a variety of purposes such as lighting, startup power, transportation, mechanical utility systems, heating, refrigeration, production, fire protection, space conditioning, data processing, communication, life support, or signal circuits. Some facilities need an UPS for more than one purpose. It is important to determine the acceptable delay between loss of primary power and availability of UPS power, the length of time that emergency or backup power is required, and the criticality of the load that the UPS must bear. All of these factors play into the sizing of the UPS and the selection of the type of the UPS.

b. Determine safety. It must be determined if the safety of the selected UPS is acceptable. The UPS may have safety issues such as hydrogen accumulation from batteries, or noise pollution from solid-state equipment or rotating equipment. These issues may be addressed through proper precautions or may require a selection of a different UPS.

c. Determine availability. The availability of the selected UPS must be acceptable. The criticality of the loads will determine the necessary availability of the UPS. The availability of an UPS may be improved by using different configurations to provide redundancy. It should be noted that the C4ISR facilities require a reliability level of 99.9999 percent.

d. Determine maintainability. The selected UPS must be maintainable. Maintenance of the unit is important in assuring the unit's availability. If the unit is not properly cared for, the unit will be more likely to fail. Therefore, it is necessary that the maintenance be performed as required. If the skills and resources required for the maintenance of the unit are not available, it may be necessary to select a unit requiring less maintenance.

e. Determine if affordable. The selected UPS must be affordable. While this is the most limiting factor in the selection process, cost cannot be identified without knowing the other parameters. The pricing of the unit consists of the equipment cost as well as the operating and maintenance costs. Disposal costs of the unit should also be considered for when the unit reaches the end of its life.

f. Re-evaluate steps. If these criteria are not met, another UPS system must be selected and these steps re-evaluated.

1-6. Installation and testing

The installation and testing of the UPS is critical to its proper operation. These items are discussed in greater detail in chapter 4.

a. Features. The UPS shall be installed with all necessary features. Features such as alarms, indicators, control devices, and protective devices are installed to assist in the safe operation of the unit. Power and control components such as meters, indicating lights, control switches, push buttons, and potentiometers are typically located in a nearby cabinet. Batteries are typically installed on battery racks. The design of the racks varies based on the available space and number of batteries.

b. Location. The UPS shall be installed on a level surface with sufficient clearance to allow for ventilation and access to maintenance panels. Static UPSs require environments with a controlled atmosphere where the temperature, humidity, and dust levels are carefully maintained. The batteries of the UPS require ventilation of the room to prevent hydrogen buildup. Rotary UPSs are suitable for placement in industrial environments.

c. Protection. The UPS power distribution system shall be designed to provide short circuit protection, isolate branch faults, and isolate critical loads from sources of harmonics, surges, and spikes. This is achieved using panelboards, circuit breakers, and fuses. The UPS system is grounded to ensure the safety of the operating personnel. Shielding of the control cables shall be achieved by running power cables in bonded metal enclosures separately from the control cable's enclosures.

d. Testing and startup. Testing and startup shall be performed to ensure the component's operation once energized. Acceptance testing should be performed on all equipment. Testing records on test forms should be kept for comparison to later routine maintenance tests. The possible failures of the equipment drawn out from the test results should be discussed and corrective action implemented. Test equipment used should be in accordance with the manufacturer's recommendation.

1-7. Maintenance

Maintenance of the UPS consists of preventive and corrective maintenance. Preventive maintenance consists of a scheduled list of activities. Performing these activities keeps the UPS in good working order and helps to prevent failures. Corrective maintenance is performed as a result of a failure. Corrective maintenance fixes the problem and gets the unit working again. Maintenance is covered in chapter 5.