

APOLLO PLSS - A CRITERION FOR SPACE BACK PACK EQUIPMENT

Fred H. Goodwin
Hamilton Standard
Division of United Aircraft Corporation
Windsor Locks, Connecticut

Abstract

This paper covers the Portable Life Support System (PLSS), used to support the astronauts during the six lunar surface excursions of the Apollo Program. It reviews the basic requirements imposed on the system, describes the system and its capability, reviews overall program performance and discusses the significant experience gained which can be applied to life support system programs of the future.

The PLSS supplies the astronaut with breathing oxygen, controls suit pressure, reprocesses the recirculated gas by removing carbon dioxide, trace contaminant gases, and excess moisture, and removes heat resulting from the astronaut's metabolism, leaks into the system from the environment, and inefficiencies or exothermic chemical reactions within the PLSS. A communications system affords the astronaut the ability to communicate with other astronauts or, via relay through the LM, with ground control. Nine channels of telemetry are transmitted. Emergency provisions to supplement the basic capability of the PLSS are briefly discussed.

I. Introduction

The Apollo Portable Life Support System (PLSS) program had its beginning in October, 1962 when the National Aeronautics and Space Administration awarded Hamilton Standard a contract for the development and production of portable life support equipment for astronaut use during extravehicular activity (EVA).

This paper covers the basic requirements imposed on the portable equipment; describes the equipment and its capability; summarizes its use to date; and discusses experience gained during the conduct of the PLSS program.

II. Basic Requirements

To provide himself with a suitable protective environment while outside the LM during lunar surface excursions, the astronaut carries on his back a compact assembly of various environmental control devices, which, when joined together, form the PLSS (see Figure 1). This package supplies the man with breathing oxygen, controls suit pressure, reprocesses the recirculated gas by removing carbon dioxide, odors, some trace contaminant gases, and excess moisture, controls system temperature by rejecting excess heat, and provides for warnings of certain malfunctions, voice communication, and telemetry of essential data. The

heat rejection system must accommodate, in addition to the metabolic load and heat generated by the functioning PLSS components, heat gained from or lost to the lunar environment through the system insulation. Table I presents a summary of the requirements for the PLSS used on Apollo 9 through 14, and requirements for the extended life version of the PLSS which was used for Apollo 15, 16 and 17.

An emergency oxygen supply, called the Oxygen Purge System (OPS), is mounted on top of the PLSS and can be manually actuated, if needed, to supply breathing oxygen, control suit pressure, remove contaminants and cool the astronaut, in the event these functions in the PLSS are impaired. A high oxygen flow is introduced directly into the oro-nasal area and vented to ambient through a suit-mounted purge valve.

An umbilical assembly called the Buddy Secondary Life Support System (BSLSS) enables two astronauts to share the liquid cooling capacity of a single PLSS should the other become disabled.

Multiple extravehicular activities (EVA's) were made on most of the missions. Therefore, provisions for recharging PLSS expendables such as oxygen, water, contaminant removal cartridges and power supplies from the LM were made. There was no requirement to recharge the OPS.

III. System Description

Figure 2 shows a schematic of the -6 PLSS. Gas enters the suit ventilation distribution system and picks up heat, moisture, and metabolic by-product contaminants as it passes through the suit adjacent to the man's body. This warm, moist, contaminated gas then is transported to a contaminant control package, which consists of an activated charcoal bed for absorption of trace contaminant gases, and a lithium hydroxide bed, which reacts with carbon dioxide to form lithium carbonate. By-products of this chemical reaction are heat and moisture, which are added to that already carried by the recirculating gas stream. The gas stream then enters a heat exchanger where the heat is given up, and the excess moisture in the stream is condensed. Upon leaving the heat exchanger, or sublimator, as it is called, free water is removed from the gas stream by an elbow water separator, and transferred to the backside of the sublimator feedwater reservoir diaphragm. The stream then goes to a centrifugal fan which supplies the energy to overcome the pressure drop in the suit PLSS system. The fan is driven by an electric motor which draws its power from a silver-zinc battery. Some







