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HOUSEKEEPING CONCEPTS FOR MANNED SPACE SYSTEMS

DATA BOOK
VOLUME IIA
WASTE DEFINITION

Prepared For

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Prepared By
Manned Space Systems

FAIRCHILD HILLER
REPUBLIC AVIATION DIVISION
FARMINGDALE, LONG ISLAND, NEW YORK

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ABSTRACT

This Data Book on Housekeeping Concepts for Manned Space Systems contains parametric data on the waste control aspects of housekeeping for future manned orbital spacecraft. The data is intended for use by the mission planner, the spacecraft conceptual designer, and the equipment designer. The areas investigated include:

- Identification of Waste Products, Rates of Generation and Constraints

  Approximately 220 potential waste sources, i.e., personnel life support functions, subsystem equipments and potential experiments, are identified. Study of these waste sources identified 1500 waste items, their constituents, rates of production and interfacing information for handling and processing.

- Utilization Processes

  Utilization processes are potentially capable of converting waste into useful onboard consumables/expendables in lieu of logistical resupply. Both existing systems and basic processing concepts useful as building blocks are discussed.

- Pretreatment Processes for Disposal

  Conceptual designs and parametric data are presented for treatment of normal organic and potentially pathogenic waste for deactivation or sterilization. Concepts for the compaction and packaging of deactivated wastes are presented.

- Waste Disposal

  Conceptual designs and parametric data are presented for separating wastes from the spacecraft. These include the use of the shuttle with resupply/disposal modules, rocket launch for incineration in the earth's atmosphere or for alternate earth and sun orbits, and overboard jettisoning.

- Waste Control and Housekeeping

  Manual and automated concepts of waste collection, pickup, transfer and sorting for interfacing with utilization or disposal processing equipment are presented. The rationale for preparation of crew task and time line information as influenced by partial and zero gravity is developed. In addition, background human factors information for space flight is discussed.

- Search/Report Computer Program

  Because of the magnitude of the information generated, a computer program with updated and search capabilities was developed, and is presented.

The Data Book is divided into three volumes and, because of the magnitude of the information presented, Volume II is in two books. The contents by volume are as follows:

- VOLUME I - WASTE CONTROL - TASKS AND SYSTEM CONCEPTS

  This volume contains the basic results of the study, except for the backup data on the definition of wastes.

- VOLUME II - WASTE DEFINITION

  These books (IIA and IIB) contain the definition of waste products and the backup information.

- VOLUME III - WASTE CONTROL SEARCH/REPORT COMPUTER PROGRAM

  This volume contains the printouts of the computer stored data.

VOLUME II

WASTE DEFINITION DATA BOOK

CONTENTS

0.0 INTRODUCTION

The data in this volume deals with the definition of waste products that could result from manned spacecraft systems having various combinations of mission activities and subsystems. The definition of the waste is in a form that is meant to enhance the derivation of requirements and constraints on waste control housekeeping routines and equipments for various mission configurations. The definition includes identification of waste types and quantities and deals with small, medium, and large spacecraft presently being considered by the NASA agencies or studied by the aerospace industry. The mission limits include up to 100 men, a 10-year mission duration, a 30-day resupply interval, a 300-nautical mile near earth orbit, and a 55-degree orbit inclination.

0.1 THE PROBLEM

With the successful accomplishment of the Apollo mission and the manned landing on the moon, the United States objectives in space are being broadened. Skylab, the three-man orbiting workshop, will perform scientific, engineering, and medical experiments and will provide a basis for future manned spacecraft. Space stations orbiting the earth with 6 to 12 men aboard, servicing attached and remote manned and unmanned experiment modules, and being supplied by recoverable space shuttles are all part of the scope of near future plans. Longer term plans, which are less definitive, include the establishment of manned orbiting space bases, Lunar colonies, and manned exploration of the neighboring planets. Among all the esoteric skills that have already been developed for space, there is the less glamorous one of housekeeping that must be further broadened as the scope of space projects becomes more extensive.

The magnitude of housekeeping requirements aboard an orbiting space station will, in a very short time, give rise to a situation that is analogous to the polution and solid waste disposal tasks being encountered by the earthbound communities, that is, cope with the waste or be inundated by it.

In order to cope with the anticipated housekeeping trash and waste handling problems, early planning and early development of appropriate waste handling and disposal means are required. Among the first tasks to be undertaken by the planners of future spacecraft to arrive at adequate space age housekeeping provisions and routines is to define the magnitude of the problem that is being attacked. This document, Volume II, "Waste Definition Data Manual", supplies a tool usable in defining the problem.

It is appropriate at this point to define certain key words used repeatedly in this study report.

- Wastes (products, materials) -- are substances as items that are produced in the course of spacecraft operations, and that are no longer useful in their present form. These substances or items can be disposed of, or subsequently processed for utilization in their original function or to supply other consumables required in the operation of the spacecraft or in the performance of its mission.
- Waste Sources -- are the man, activities, subsystems, equipments, or laboratories that produce the various waste items.
- Utilization -- is the reuse of waste either in its original function or in another function after conversion in total or in part.
- Process for Utilization -- includes any processing, i.e., conversion, conditioning, extraction, etc., of waste materials to facilitate utilization.
- Reclamation -- is the special case of processing a waste for reuse in its original function.
- Disposal -- is separation of wastes from the spacecraft.
- Process for Disposal -- includes any processing, i.e., sterilization, drying, compaction, etc., of waste materials to facilitate disposal.

0.2 THE DATA ARRANGEMENT

The waste definition data has been arranged into approximately 220 discrete packages of information and data, each one dealing with a particular facility, group of equipment, or experiment whose operation satisfies some portion of a spacecraft function. The data results from reviewing the facility or group of equipments, establishing an operating rationale, and determining the consumables/expendables and the waste types and quantities that could result from such an operating rationale. Each data package, therefore, generally includes an operational description, a list of consumables/expendables, and a list of wastes.

The individual packages of information are grouped into one of three sections by their governing function:

1.0 Support Life Functions
2.0 Maintain Spacecraft Functions
3.0 Perform Mission Tasks

Each package is assigned a five digit identifying number that is made up of four indents under the above function number 1, 2, or 3. This volume contains these information packages and separates them into the three numbered groups and, in addition, into the first indent subgroups thereunder. The table of contents and the oversized tab sheets separating each section in this book are keyed to those first indent subgroups (i.e., the first two digits of the information package identifying number). The sheet following each sectioning tab sheet presents a table of contents for that section and can be modified, as required, without upsetting the rest of the data book.

The functional requirements and the numbering system used to identify the data packages resulted from a general functional analysis of manned spacecraft and is included in Volume I of this data book and at the end of this section for your convenience.

0.3 DATA UPDATING

The data in this book and its method of presentation reflects the initial efforts to establish a handbook of waste data for future space program planners. Considerable effort went into establishing the data format in order to simplify access to the data and in order to enhance and encourage its use by future planners; however, the major importance of the data presentation methods chosen was the intent to simplify the data updating. It was recognized early in this effort that the concurrent studies undertaken by other contractors to define the space station and other long-term space missions would make new and better data on waste definition available. In light of this expectation, provisions for data updating were incorporated in this data presentation scheme.

Updating of the data book is readily accomplished by updating the specific information in the individual data packages. Each data package is independ of all other data packages. The data is presented on simple formats (which are explained in the following subsections) and can be readily changed at any level of detail from a single waste item to an entire operational description without upsetting any other data or the table of contents.

0.4 THE DATA FORMAT

This document contains the data that resulted form reviewing the different spacecraft facilities and functions from the point of view of the waste, trash, and debris generated. The data is arranged into approximately 220 individual data packages each consisting of A, B, and C sheets identified by a common five digit number.

0.4.1 A-xxxxx = Operational Description

These sheets briefly describe the function of a particular facility or group of equipments. A hypothesized rationale is supplied that becomes the basis of the determination of the material types and quantities expected to flow through the equipments under review. In most cases, a schematic block diagram showing the flow is supplied as well as a listing of selected references from which baseline data has been extracted.

0.4.2 B-xxxxx = Consumables/Expendables List

These sheets tabulate those consumable or expendable materials that result from the rationale given in sheet A. In addition to the generic name of the consumable/expendable, the following information is supplied on these B sheets.

0.4.2.1 How Consumed

This refers to that action to which the material is subjected which consumes it, i.e., eaten, worn, saturated with O_2, failed, etc.

0.4.2.2 Basic Constituents Consumed

This refers to that material characteristic that is no longer available after use. This includes such characteristics as freshness, life, and availability as well as latent heat, chemical potential, and surface area.

0.4.2.3 Quantity Data

This heading does not appear on the Consumables/Expendables sheet. Instead, there are three different heading types, each giving specific quantity data dependent on the basic function being satisfied by the equipment or experiment. These quantity headings are keyed to the basic function and, consequently, to the first digit in the five digit identifying number as follows:

B - 1.xxxx -- Quantity data is supplied for those equipments satisfying the function "Support Life." The quantity data is expressed as the total weight per year in pounds for 12 men, 50 men, and 100 men because the material quantity is sensitive to time and the number of consumers involved.

B - 2.xxxx -- Quantity data is supplied for those equipments satisfying the function "Maintain Spacecraft Functions." The quantity data is expressed as the ten-year total weight in pounds, the daily rate in pounds per day, and the single unit size in pounds per unit because the material quantity for the type of equipment is most sensitive to overall mission life and because the material will most likely be handled in single units.

B - 3.xxxx -- Quantity data is supplied for those equipments satisfying the function "Perform Mission Tasks." The quantity data is expressed as the experiment total in pounds, the daily rate in pounds per day, and the normal batch size handled in pounds because, for the most part, the function will be satisfied by discrete experiments that require special facilities for discrete time periods using or operating on specific batches of materials.

0.4.2.4 Average Density As Received, lbs/cu. ft.

This refers to the packaged density of the consumable, not the density of the basic material constituent. As an example, the dnesity of paper sheet, the density of a package of paper bags, and the density of a crumpled paper sheet are all very different. From a housekeeping point of view, the density that is important to deal with is the as-received density. In the above example, that would be the crumpled paper density for waste handling and the packaged paper density for the handling of consumables/expendables.

0.4.3 C-xxxxx = Wastes Lists

These sheets tabulate those waste materials that result from the use of the equipments under review. These materials can be categorized as wastes, or trash, or debris or could even be reusable; but in this document, all are treated under the common name "Wastes." This includes even those materials that can readily be reutilized by the use of a highly feasible, in-space, processing method (i.e., dishes, clothing wash water, carbon dioxide, etc.). Treating the subject of wastes so broadly results from the fact that all on-board processes for reuse will be in competition with a future shuttle resupply craft that promises to make resupply extremely inexpensive. If this result is achieved, it could become uneconomical to maintain an in-space reprocessing facility and to expend in-space man-hours to revitalize or repair anything. Items that can be returned to earth and that are not routinely handled as part of some other function (i.e., data items, scheduled overhaul items, etc.) will possibly be handled within the scope of housekeeping routines and are, therefore, included in the waste lists. The rationale for these wastes are supplied in the A sheet. In addition to the generic name of the waste item, the following additional information is supplied on these C sheets.

0.4.3.1 Characteristics/State and Attributes

This refers to those characteristics of the waste materials that could be useful or important to the considerations of housekeeping. A breakdown of typical characteristics by general categories follows:

1) State -- The basic state in which the waste material will be handled for housekeeping purposes, i.e., either as a liquid, a gas or as a solid.

2) Attributes -- The waste material/housekeeping interface can be identified by categorizing the material by:

- Material type, i.e., metal, plastic, glass, textile, paper, acid, alkali, oil, water, colloid, suspension, gel, etc.
- Form factor, i.e., flexible, rigid, sheet, rod, tubular, spongy, bulky, loose granuals, sharp, brittle, semiliquid, slurry, highly dense, etc.

- Constraints, i.e., toxic, pathogenic (potentially), contaminated (exposed to pathogens), noxious odor, explosive (with O_2), unstable (auto-decomposition), radioactive, organic (this is a broad category for materials that are nutrients for a wide range of organisms that are not necessarily pathogenic but that could putrify), hot (uncomfortable to the touch), cold (will result in condensation), dusty, smoky condensable (near room temperature), etc.

0.4.3.2 Chemical Composition

This refers to the make-up of the material. It is not a purely academic chemical analysis but is rather a breakdown of the material by common material names, by common compounds, and, in some cases, by the basic elements.

0.4.3.3 Action Required to Reclaim

This refers to those actions necessary to restore the capacity or the original function of the major ingredient of the waste item. (Washing is the prime example here.)

0.4.3.4 Quantity Data

This heading does not appear on the waste list in this form. Instead, there are three different heading types, each giving specific quantity data dependent on the basic function being satisfied by the equipment being reviewed. These quantity heading types are keyed to the basic functions and, consequently, are keyed to the first digit in the five digit series in the same manner as described above for the B sheets (Consumables/Expendables).

C-1.xxxx -- Waste quantities totalized for a year: 12, 50, and 100 men.

C-2.xxxx -- Waste quantities totalized for 10 years, by daily rate and by unit weight.

C-3.xxxx -- Waste quantities totalized by experiment, by daily rate and by batch size.

0.4.3.5 Average Density As Required, lbs/cu.ft.

This refers to the density of the material in the condition that it interfaces with the housekeeping system (i.e., the lighter density of a crumpled paper bag rather than the density of paper itself).

0.4.3.6 Remarks

This column is used for any other comments considered significant by the originator of the data.

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES

BASIC FUNCTION: 1.0 SUPPORT LIFE

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
1.1 Maintain and Monitor Crew Health and Safety	1. Medical Dispensary	1. Routine Examination of Crew Members	1.1.1.1.1	Services: Dispensary
		2. Illness Event	1.1.1.2.1	
	2. Dental Dispensary	1. Routine Examination and Illness Event	1.1.2.1.1	Services: Dispensary
	3. Dispensary Housekeeping	1. Medical	1.1.3.1.1	Services: Maintenance
		2. Dental	1.1.3.2.1	
	4. Personnel Protection	1. Space Suits and Portable Life Support Systems	1.1.4.1.1	Services: Airlocks
1.2 Provide Crew Quarters	1. Provide Furnishings	1. Room Furnishings	1.2.1.1.1	Living Area; Bed Room
	2. Provide Personal Articles	1. Clothing	1.2.2.1.1	Living Area; Bed Room
		2. Bed Linens	1.2.2.2.1	Living Area; Bed Room
		3. Limited Personal Grooming Facility	1.2.2.3.1	Living Area; Bed Room
	3. Rest and Relaxation Provisions	1. Individual Crew Recreation	1.2.3.1.1	Living Area; Recreation Living Area; Study/Library
1.3 Provide Crew Meals	1. Food Storage System	1. Perishable Food Storage		Food Preparation and Service; Storage and Kitchen
		a) Perishable Food Storage - Mechanical	1.3.1.1.1	
		b) Perishable Food Storage - Thermoelectric	1.3.1.1.2	
		c) Perishable Food Storage - Space Radiator	1.3.1.1.3	
		2. Stable Food Storage	1.3.1.2.1	Food Preparation and Service; Storage and Kitchen
	2. Food and Food Preparation	1. Food Reconstitution		Food Preparation and Service; Kitchen and Snack Bar
		a) Food Reconstitution - Rehydration	1.3.2.1.1	
		b) Food Reconstitution - Heating	1.3.2.1.2	
		2. Meal Assembly	1.3.2.2.1	Food Preparation and Service; Kitchen
	3. Meal Service and Dining	1. Meal and Accessory Transport	1.3.3.1.1	Food Preparation and Service; Dining Area
		2. Dining	1.3.3.2.1	Food Preparation and Service; Dining Area and Snack Bar

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 1.0 SUPPORT LIFE (Cont'd)

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
1.3 Provide Crew Meals	4. Housekeeping	1. Debris Collection		
		a) Debris Control - Mechanical	1.3.4.1.1	Food Preparation and Service; Kitchen, Dining Area and Snack Bar
		b) Debris Control - Manual	1.3.4.1.2	
		2. Utensil Cleansing	1.3.4.2.1	Food Preparation and Service; Kitchen
		3. Waste Stowage	1.3.4.3.1	Food Preparation and Service; Kitchen, Dining Area, Snack Bar
1.4 Provide for Crew Hygiene	1. Human Waste Management	1. Fecal and Vomitus Waste Management		
		a) Integrated Vacuum Drying	1.4.1.1.1	Living Area; Bathroom; Services and Dispensary
		b) Automated Bag/Vacuum Drying	1.4.1.1.2	" "
		c) Wet Collection/Processing	1.4.1.1.3	" "
		2. Urine Collection	1.4.1.2.1	" "
	2. Full Body Wash	1. Body Wash		
		a) Shower	1.4.2.1.1	Living Area; Bathroom
		b) Immersion Bath	1.4.2.1.2	Living Area; Bathroom
		c) Automated Sponge Bath	1.4.2.1.3	Living Area; Bathroom
	3. Partial Body Wash and Personal Grooming	1. Hygiene Center	1.4.3.1.1	Living Area; Bathroom
	4. Revitalization of Textiles	1. Laundry	1.4.4.1.1	Services; Laundry
	5. Crew Quarters Housekeeping Capability	1. Vacuum Cleaner	1.4.5.1.1	Services; Maintenance
		2. Surface Washer/Wiper (Automated Mop)	1.4.5.2.1	Services; Maintenance
1.5 Environmental Control/Life Support	1. Atmospheric Gas Supply	1. Supercritical Storage and Supply	1.5.1.1.1	Services; Storage
	2. Atmospheric Control	1. Atmospheric Mixing and Pressure Control	1.5.2.1.1	Services; Storage

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 1.0 SUPPORT LIFE (Cont'd)

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
1.5 Environmental Control/Life Support	3. Atmospheric Temperature and Humidity Control	1. Variable Speed Fan System	1.5.3.1.1	Services; Equipment
	4. Trace Contaminant Removal System	1. Regenerable Charcoal/Catalytic Oxidation System	1.5.4.1.1	Services; Equipment
	5. Bacterial/Particulate Control System	1. Direct Storage Method	1.5.5.1.1	Services; Equipment
		2. Sterilization/Storage Method	1.5.5.2.1	Services; Equipment
	6. Carbon Dioxide Control and Oxygen Generation	1. CO_2 Removal/Concentration Systems	1.5.6.1.1	Services; Equipment
		2. CO_2 Reduction System	1.5.6.2.1	Services; Equipment
		3. Water Electrolysis System	1.5.6.3.1	Services; Equipment
	7. Thermal Transport Circuit	1. Coolant Loop	1.5.7.1.1	Services; Equipment
	8. Water Management	1. Water Reclamation System	1.5.8.1.1	Services; Equipment
		2. Potable Water Storage System	1.5.8.2.1	Services; Equipment

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 2.0 MAINTAIN SPACE CRAFT FUNCTION

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
2.1 Control Spacecraft Orbit Position, Attitude and Motion	1. Nav. Guid, Stabilization and Control	1. Electronic Systems	2.1.1.1.1	Work Area;Communications Extra Vehicular
		2. Mechanical Systems		
		a) Control Moment Gyros	2.1.1.2.1	Work Area; Control
		b) Reaction Jet Control, Mono-Propellant	2.1.1.2.2	Services; Equipment and Extra Vehicular
		c) Reaction-Jet Control, Bi-Propellant	2.1.1.2.3	Services; Equipment and Extra Vehicular
2.2 Provide Electrical and Thermal Power	1. Electric Power	1. Solar Arrays	2.2.1.1.1	Extra Vehicular
		2. Radioisotope Brayton Cycle	2.2.1.2.1	Extra Vehicular
	2. Regulate Power	1. Power Conditioning System	2.2.2.1.1	Services; Power
	3. Distribute Power	1. Power Distribution System	2.2.3.1.1	Services; Power
2.3 Maintain and Repair Space Craft	1. Maintenance Facilities	1. Structural Maintenance	2.3.1.1.1	Services; Maintenance
		2. Avionics Systems Maintenance	2.3.1.2.1	Services; Maintenance
		3. Utilities Maintenance	2.3.1.3.1	Services; Maintenance
2.4 Provide Communication	1. Ship-to-Base Communications	1. To and From Ground - Data Relay Space Satellites	2.4.1.1.1	Work Areas; Communications
		2. To and From Ground - Direct	2.4.1.2.1	Work Areas; Communications
	2. Inter-Vehicular Communications	1. To and From Experiment Modules	2.4.2.1.1	Work Areas; Communications
		2. To and From Space Station Shuttle	2.4.2.2.1	Work Areas; Communications
		3. Extra-Vehicular Communications	2.4.2.3.1	Work Areas; Communications
	3. Intra-Vehicular Communications	1. Onboard Communications	2.4.3.1.1	Work Areas; Communications
2.5 Provide for Data Management	1. Data Collection, Storage and Display	1. Data Management-Electronic	2.5.1.1.1	Work Area; Computer
		2. Data Management - Photographic	2.5.1.2.1	Work Area; Photographic Support
2.6 Provide for Spacecraft Logistics	*			
2.7 Provide for Experiment Support	*			

* These areas not reviewed during the performance of this study due to the lack of definitive plans for future programs.

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 3.0 PERFORM MISSION TASKS

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
3.1 Astronomy, Astrophysics and Celestial Mechanics Studies and Tasks	1. Astronomy and Astrophysics	1. Plasma Physics (FPE 5.7)		
		a) Ionospheric Spacecraft Wake Experiment	3.1.1.1.1 VOID (See 3.2.1.1.1)	
		2. Grazing Incidence X-Ray Telescope (FPE 5.1)		
		a) Polarization of X-Radiation	3 1.1 2 1	Remote Module
		b) Curved Crystal X-Ray Spectrometer	3.1.1.2.2	Remote Module
		c) High Resolution Studies of X-Ray Sources	3.1.1.2.3	Remote Module
		d) Maximum Sensitivity X-Ray Detector	3.1 1 2.4	Remote Module
		3. High Energy Stellar Astronomy (FPE 5.5)		
		a) X-Ray Imaging	3.1.1.3.1	Remote Module
		b) Bragg Spectrometer	3.1.1.3.2	Remote Module
		c) Spark Chamber, Nuclear Emulsion Gamma-Ray	3.1.1.3.3	Astronomy Module
		d) Nuclear Gamma-Ray Spectrometer	3.1.1.3.4	Astronomy Module
		4. UV Stellar Survey (FPE 5.4)		
		a) Schmidt Image Converter Stellar Spectrograph	3.1.1.4.1	Astronomy Module
3.2 Physics and Chemistry Studies and Tasks	1. Physics	1. Plasma Physics (FPE 5.7)		
		a) Plasma Wake Experiments	3.2.1.1.1	Work Area: Laboratory and Remote Satellite
		b) Cyclotron Harmonic Wave Transmission Experiment	3.2.1.1.2	Work Area: Laboratory and Remote Satellite
		2. Cosmic Ray Physics (FPE 5.8)		
		a) Interaction Physics Experiments (Bay 1)	3.2.1.2.1	Work Area: Airlock and Attached Module
		b) High Energy Primary Cosmic Ray Experiment (Bays 2 and 3)	3.2.1.2.2	Work Area: Airlock and Attached Module
	2. Chemistry	1. Unit Separation Processes in Space	3.2.2.1.1	Work Area: Laboratory
		2. Industrial Microbiological Applications in O G		Work Area: Laboratory
		a) A Vaccine Satellite Program	3.2.2.2.1	

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 3.0 PERFORM MISSION TASKS (Cont'd)

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
3.3 Agriculture and Animal Husbandry	1. Plant Crops	1. Rapid Lettuce Growth	3.3.1.1.1	Work Area: Agricultural Study Area, Remote Dockable Module
		2. No Waste Food (Radish/Cabbage)	3.3.1.2.1	Work Area: Agricultural Study Area, Remote Dockable Module
		3. Increased CO_2 on Food Plants	3.3.1.3.1	Work Area: Agricultural Study Area, Remote Dockable Module
	2. Animal Crops	1. Japanese Quail (Colinus)	3.3.2.1.1	Work Area: Animal Housing
3.4 Biological Sciences and Biotechnology Studies	1. Micro Biology Experiment (BIO C)(FPE 5.25)	1. The Role of Gravity in General Cellular Function		Work Area: BIO-Laboratory
		a) General Growth Behavior and Reproduction in Cells	3.4.1.1.1	
		b) Maintenance of Normal Growth and Reproduction in Free Cells	3.4.1.1.2	
		c) Mineral Metabolism in Cells	3.4.1.1.3	
		2. Genetic Stability in Free Cells	3.4.1.2.1	Work Area: BIO-Laboratory
		3. The Role of Gravity in Tissue Function		Work Area: BIO-Laboratory
		a) Animal Tissue Development	3.4.1.3.1	
		b) Plant Tissue Development	3.4.1.3.2	
		4. Development in the Animal Embryo	3.4.1.4.1	Work Area: BIO-Laboratory
		5. Host-Parasite Relationships	3.4.1.5.1	Work Area: BIO-Laboratory
		6. Biorythms in Microorganisms	3.4.1.6.1	Work Area: BIO-Laboratory
		7. Weightlessness and Molecular Reactions in Vitro	3.4.1.7.1	Work Area: BIO-Laboratory
	2. Invertebrates Experiments (BIO F)(FPE 5.26)	1. The Invertebrate Organism and Its Life Cycle	3.4.2.1.1	
		2. The Role of Gravity in Morphogenesis	3.4.2.2.1	
		3. The Role of Gravity in Invertebrate Metabolism	3.4.2.3.1 VOID (See 3.4.2.1.1)	
		4. The Role of Gravity in Aging in Invertebrates	3.4.2.4.1	

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 3.0 PERFORM MISSION TASKS (cont'd)

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
3.4 Biological Sciences and Biotechnology Studies (continued)	2. Invertebrates Experiments (BIO F)(FPE 5,26)	5. Genetic Phenomina in Invertebrates		Work Area: BIO-Laboratory
		a) Mutability in Adult Drosophila	3.4.2.5.1	
		b) Radiation Repair Mechanisms in Chromosomes	3.4.2.5.2	
		6. Biorythmicity in Invertebrates		Work Area: BIO-Laboratory
		a) Circadian Rythms in Invertebrates	3.4.2.6.1	
		b) Biorythmicity in Fiddler Crabs	3.4.2.6.2	
		7. Behavior Influences in Invertebrates		Work Area: BIO-Laboratory
		a) Behavior Influences in Bees	3.4.2.7.1	
		b) Orientation and Geosensing in Spiders	3.4.2.7.2	
	3. Small Vertebrates Experiments (BIO D) (FPE 5.9)	1. The Role of Gravity in Cardiovascular Function	3.4.3.1.1	Work Area: BIO-Laboratory/ Animal Housing
		2. The Life Cycle of Rodents		Work Area: BIO-Laboratory/ Animal Housing
		a) Pregnancy and Growth in the Mammalian Organism	3.4.3.2.1	
		b) Physiology and Behavior Through One Generation	3.4.3.2.2	
		c) Turnover of Mineralized Tissue	3.4.3.2.3	
		d) Metabolic Adaptation of the Mammalian Organism	3.4.3.2.4	
		3. Immune Responses of Mammals		Work Area: BIO-Laboratory/ Animal Housing
		a) Mobile Cells and Muco Proteins	3.4.3.3.1	
		b) Production and Persistance of Circulating Anti-Bodies	3.4.3.3.2	
		4. Embryogenesis and Development in Amphibia	3.4.3.4.1	Work Area: BIO-Laboratory/ Animal Housing
		5. Growth and Metabolism in Reptiles	3.4.3.5.1	Work Area: BIO-Laboratory/ Animal Housing
		6. Influence of Gravity on Behavior in Mammals	3.4.3.6.1	Work Area: BIO-Laboratory/ Animal Housing
		7. Influence on Bicrythms of Animals	3.4.3.7.1	Work Area: BIO-Laboratory/ Animal Housing
		8. The Role of Gravity in Hibernation	3.4.3.8.1	Work Area: BIO-Laboratory/ Animal Housing

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 3.0 PERFORM MISSION TASKS (Cont'd)

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
3.4 Biological Sciences and Biotechnology Studies (continued)	4. Plant Specimens (BIO E) (FPE 5.10)	1. Plant Responses from 0 to 1 G	3.4.4.1.1	Work Area, Agricultural Study Area or Remote Dockable Module
		2. Pea Seedling Growth in Orbit	3.4.4.2.1	Work Area, Agricultural Study Area or Remote Dockable Module
		3. Plant Morphogenesis Under Weightlessness	3.4.4.3.1	Work Area, Agricultural Study Arer or Remote Dockable Module
		4. Effect of Weightlessness on Gamotogenesis and Morphogenesis of Pteris Gametophytes	3.4.4.4.1	Work Area, Agricultural Study Area or Remote Dockable Module
		5. Role of Auxin Mediated Reactions in the Developing Wheat Seedling in O G	3.4.4.5.1	Work Area, Agricultural Study Area, Remote Dockable Module
		6. Role of Gravitational Stress in Land Plant Evolution	3.4.4.6.1	Work Area, Agricultural Study Area or Remote Dockable Module
		7. Effect of Geophysical Factors on Circadian Rhythms in Plants	3.4.4.7.1	Work Area, Agricultural Study Area or Remote Dockable Module
		8. Algae, Duckweed in 0 G	3.4.4.8.1	Work Area, Agricultural Study Area or Remote Dockable Module
	5. Primates	1. Physiology of Chimpanzees in Orbit	3.4.5.1.1	Work Area, Animal Housing
		2. Hemodynamics and Metabolic Effects on Monkeys	3.4.5.2.1	Work Area, Animal Housing
3.5 Biotechnology and Human Research	1. Biomedical Research (FPE 5.13)	1. Neurophysiology		Work Area: Medical Laboratory
		a) Effect of Head Movement During Rotation	3.5.1.1.1	
		b) Sensitivity of Otolith and Semi-Circular Canal Mechanisms	3.5.1.1.2	
		c) Effect of Altered Day-Night Cycles, Effect on Litter Size, and on EEG of Cats	3.5.1.1.3	
		d) Human Vestibular Function	3.5.1.1.4	
		2. Cardiovascular		Work Area: Medical Laboratory
		a) Changes in Circulatory Response to Exercise	3.5.1.2.1	
		b) Effect of Blood Distribution on Arterial Pressure Control Systems	3.5.1.2.2	
		c) Alterations in Venous Compliance Due to the Absence of Hydrostatic Pressure	3.5.1.2.3	
		d) Cardiac Dynamics	3.5.1.2.4	

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 3.0 PERFORM MISSION TASKS (Cont'd)

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
3.5 Biotechnology and Human Research (continued)	1. Biomedical Research (FPE 5.13) (continued)	2. Cardiovascular (cont'd)		Work Area: Medical Laboratory
		e) Intraocular Arterial Blood Pressure	3.5.1.2.5	
		f) Cardiac Output. Direct versus Indirect	3.5.1.2.6	
		g) Use of a LBNP Device to Prevent C.V. Deconditioning	3.5.1.2.7	
		h) Use on an On-Board Centrifuge to Prevent C.V. Deconditioning	3.5.1.2.8	
		i) Use of Occlusive Cuffs to Prevent C.V. Deconditioning	3.5.1.2.9	
		j) C.V. Response to Shock Therapy	3.5.1.2.10	
		k) Sensitivity of the Carotid Sinus-Arterial Pressure Control Loop	3.5.1.2.11	
		l) Peripheral Arterial Reactivity	3.5.1.2.12	
		m) Changes in Blood Volume and Distribution	3.5.1.2.13	
		n) Carotid Baroreceptor Electrical Activity in Primates	3.5.1.2.14	
		3. Respiration		Work Area: Medical Laboratory
		a) Pulmonary Mechanics	3.5.1.3.1	
		b) Respiratory Control	3.5.1.3.2	
		c) Blood and Ventilatory Gas Exchange	3.5.1.3.3	
		d) Lung Cleaning in Rats	3.5.1.3.4	
		e) Induced Pulmonary Infection in Mice	3.5.1.3.5	
		f) Recovery Rate from Non-Infectious Trauma in Rats	3.5.1.3.6	
		4. Gastrointestinal		Work Area: Medical Laboratory
		a) G.I. Motility and pH	3.5.1.4.1	
		b) Intestinal Absorption	3.5.1.4.2	
		c) Indices of Renal Function	3.5.1.4.3	
		d) Renal Calculus Formation in Rats	3.5.1.4.4	
		e) Renal Infection in Rats	3.5.1.4.5	
		5. Metabolism and Nutrition		Work Area: Medical Laboratory
		a) Energy Metabolism	3.5.1.5.1	
		b) Carbohydrate and Fat Metabolism	3.5.1.5.2	
		c) Protein Metabolism	3.5.1.5.3	
		d) Fluid and Electrolyte Balance	3.5.1.5.4	
		e) Mineral Metabolism	3.5.1.5.5	
		f) Bioassay of Body Fluids	3.5.1.5.6	

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 3.0 PERFORM MISSION TASKS (Cont'd)

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
3.5 Biotechnology and Human Research (continued)	1. Biomedical (FPE 5.13)(continued)	6. Musculoskeletal		Work Area: Medical Laboratory
		a) Bone Density	3.5.1.6.1	
		b) Fracture Healing in Animals	3.5.1.6.2	
		c) Calcium Mobilization	3.5.1.6.3	
		d) Muscle Mass and Strength	3.5.1.6.4	
		e) Induction of Pressure Atrophy	3.5.1.6.5	
		f) Electromyography as an Index of Deconditioning	3.5.1.6.6	
		g) Specimen Mass Measurement	3.5.1.6.7	
		7. Endocrinology		Work Area: Medical Laboratory
		a) Endoctrine Function and Stress Physiology	3.5.1.7.1	
		b) Temperature Regulation Mechanisms	3.5.1.7.2	
		c) Adrenal and Parathyroid Functions in Rats	3.5.1.7.3	
		d) Gonad Histopathology	3.5.1.7.4	
		8. Hematology		Work Area: Medical Laboratory
		a) Leukocyte Replication	3.5.1.8.1	
		b) Blood Cell Dynamics - Erythrocyte	3.5.1.8.2	
		c) Leukocyte Dynamics	3.5.1.8.3	
		d) Platelet Dynamics	3.5.1.8.4	
		e) Leukocyte Mobilization in Mice after Chemical Challenge	3.5.1.8.5	
		f) Maximum Rate of Erythrocyte Production in Rats	3.5.1.8.6	
		g) Wound Healing	3.5.1.8.7	
		h) Blood Coagulation and Hemostatic Function	3.5.1.8.8	
		i) Cytogenetic Studies	3.5.1.8.9	
		j) Blood Volume and Red Cell Life Span	3.5.1.8.10	
		9. Microbiology and Immunology		
		a) Microbiological Evaluation of Surfaces	3.5.1.9.1	All Surfaces
		b) Microbial Profiles of Crew Members	3.5.1.9.2	Work Area: Microbiology Laboratory
		c) Air Sampling for Microorganisms	3.5.1.9.3	All Areas
		d) Immunological Survey of Crew Members	3.5.1.9.4	Work Area: Medical Laboratory
	2. Man-Systems Integration (FPE 5.14)	1. Space Systems Human Factors		Work Area: Laboratory
		a) Restraint and Fine-Force Generation	3.5.2.1.1	
		b) Restraint and Gross Force Generation	3.5.2.1.2	
		c) Psychomotor Functions	3.5.2.1.3	
		d) Volume and Layout of Crew Work and Rest Areas and Modifications	3.5.2.1.4	

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 3.0 PERFORM MISSION TASKS (Cont'd)

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
3.5 Biotechnology and Human Research (continued)	2. Man-Systems Integration (FPE 5.14) (continued)	e) Interior Design	3.5.2.1.5	All Areas
		f) Clothing	3.5.2.1.6	Ad Lib
		g) Interpersonal Factors	3.5.2.1.7	Work Area:Communications
		h) Recreation	3.5.2.1.8	Living Area: Recreation
		2. EVA/IVA Technology		
		a) Orientation, Stability and Restraint	3.5.2.2.1	Ad Lib
		b) Personnel Translation	3.5.2.2.2	E.V.A. + Ad Lib
		c) Mass Translation	3.5.2.2.3	Ad Lib
		d) Protective Clothing and Advanced Space Suit Assembly Development	3.5.2.2.4	EVA
		e) IVA Suit (Partial Pressure)	3.5.2.2.5	Work Area: Laboratory Work Area: Airlock
		3. Maintenance and Maintainability		
		a) Accessibility	3.5.2.3.1	Various Areas
		b) Maintenance and Repair in Zero G	3.5.2.3.2	All Areas
		4. Behavior		
		a) Intrapersonal Factors	3.5.2.4.1	Work Area: Psychology Laboratory
		b) Visual Function	3.5.2.4.2	Work Area: Psychology Laboratory
		c) Communications and Recording	3.5.2.4.3	Work Area: Psychology Laboratory Work Area: Control
		d) Kinesthetic Function	3.5.2.4.4	Work Area: Psychology Laboratory Work Area: Control
		e) Orientation Senses	3.5.2.4.5	Work Area: Psychology Laboratory Work Area: Control
		f) Chemical Sense Function	3.5.2.4.6	Work Area: Psychology Laboratory Work Area: Control
		g) Somesthetic Function	3.5.2.4.7	Work Area: Psychology Laboratory Work Area: Control
		h) Intellectual Function	3.5.2.4.8	Work Area: Psychology Laboratory Work Area: Control
		i) Higher Mental Function	3.5.2.4.9	Work Area: Psychology Laboratory Work Area: Control
		j) Auditory Function	3.5.2.4.10	Work Area: Psychology Laboratory Work Area: Control

TABLE 0.0-1. SPACECRAFT FUNCTIONS AND WASTE SOURCES (Cont'd)

BASIC FUNCTION: 3.0 PERFORM MISSION TASKS (Cont'd)

FUNCTIONAL REQUIREMENT	SUBSYSTEM OR LABORATORY	EQUIPMENT OR EXPERIMENT (WASTE SOURCES)	OPERATIONAL DESCRIPTION DOCUMENT NUMBER	LOCATION BY SPACECRAFT AREA
3.6 Space Manufacturing Studies and Tasks	1. Materials Melting (FPE 5.16)	1. Minimum Batch Size	3.6.1.1.1	Work Area: Melting Laboratory
	2. Materials Processing (FPE 5.16)	1. Medium Batch Size	3.6.2.1.1	Work Area: Melting Laboratory
	3. Pre-Production Materials Processing (FPE 5.24)	1. Pre-Production Lots	3.6.3.1.1	Work Area: Laboratory
	4. Production Materials Processing (FPE 5.24)	1. Manufacturing and Processing Facility	3.6.4.1.1	Work Area: Laboratory
3.7 Earth Surveys	1. Earth Resources and Meteorology (FPE 5.11)	1. Agriculture/Forestry and Geography Experiments	3.7.1.1.1	Earth Observations Laboratory
		2. Geology/Minerology Experiments	3.7.1.2.1	Earth Observations Laboratory
		3. Hydrology/Water Resources Experiments	3.7.1.3.1	Earth Observations Laboratory
		4. Meterology Experiments	3.7.1.4.1	Earth Observations Laboratory
		5. Oceanography Experiments	3.7.1.5.1	Earth Observations Laboratory
3.8 Advanced Technology and Engineering Operations		NOTE: These areas not reviewed during the performance of this study due to lack of definite plans for future programs		
3.9 Lunar and Interplanetary Mission Support	1. Lunar Missions	1. Astronomical Investigations	3.9.1.1.1	Work Area: Laboratory and Storage
		2. Geological Explorations	3.9.1.2.1	Work Area: Laboratory and Storage
3.10 Military Sciences		NOTE: Not further reviewed due to classified nature of material		

SUPPORT LIFE FUNCTIONS

MONITOR AND MAINTAIN CREW HEALTH AND SAFETY

TABLE OF CONTENTS

Doc. No. A-1.1.1.1.1
Sheet No. 1
By: G. Greenstein
Date: 20 July 1970

OPERATIONAL DESCRIPTION

TITLE: Routine Examination of Crew Members (Medical Dispensary)

OBJECTIVE:

To maintain and monitor crew health and safety.

RATIONALE:

Approximately 10% of the crew will be monitored each week. The major portion of the wastes produced from the routine examination of crewmembers will be produced by the experiments conducted in the aerospace medical laboratory. The results of these experiments will be used as an indicator of the overall health of each crewmember. The only wastes produced by the routine examination will be from the results of the throat examinations and the maintenance of sanitary conditions in the facility.

EQUIPMENT USED:

Tongue depressors (10)	0.1 lb./week
Thermometers (10)	0.25 lb./week
Sheets (10)	1.3 lbs./week

REFERENCES:

Experiment Program For Extended Earth Orbital Missions, Revision No. 1, September 1, 1969, NASA OMSF.

Definition of Space Flight Medical Kits: A Rationale, Brooks Air Force Base, Texas, AMD TR 67-1, May 1967.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-1.1.1.1.1 Sheet No. 1
Operational Description No. A-1.1.1.1.1
Subsystem Medical Dispensary
By: G. Greenstein Date: 20 July 1970

Title: Routine Examination of Crew Members

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
1 - Tongue Depressor	Contaminated	Balsa	0.52	2.60	5.20	0.3	Must be inactivated
2 - Thermometers	Contaminated	Borosilicates	1.30	6.50	13.0	241.92	Must be inactivated
3 - Sheets	Contaminated	Cellulose	7.76	38.80	77.60	6.07	Must be inactivated

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.1.1.1.1 Sheet No. 1
Operational Description No. A- 1.1.1.1.1
Subsystem Medical Dispensary
By: G. Greenstein Date: 20 July 1970

Title: Routine Examination of Crew Members

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
1 - Tongue Depressor	Solid Wood Contaminated	Balsa	N/R	0.52	2.60	5.20	0.3	
2 - Thermometers	Solid Glass Contaminated	Borosilicates	Sterilize	1.30	6.50	13.0	241.92	
3 - Sheets	Solid Paper Contaminated	Cellulose	N/R	7.76	38.80	77.60	6.07	
4 - Packaging Material	Solid Paper And Plastic Contaminated	Cellulose And Polyethylene	Reuse As Is	0.52	2.60	5.20	0.08	

Doc. No. A-1.1.1.2.1
Sheet No. 1
By: G. Greenstein
Date: 20 July 1970

OPERATIONAL DESCRIPTION

TITLE: Illness Event (Medical Dispensary)

OBJECTIVE:

To maintain and monitor crew health and safety

RATIONALE:

To anticipate the waste products produced from this experiment the following assumptions were made:

a. Three members of the crew per day will receive medications for skin rashes.

b. Three members of the crew per day will receive medications for possible cold infections.

c. Data will be received from other laboratory facilities necessitating no duplications of equipment. The wastes produced from these facilities will not be included in the analysis of the waste products produced from this facility.

d. In case of serious illness the crew member will receive limited care and will be returned to earth for subsequent treatment.

e. Medications will be renewed on a daily basis.

EQUIPMENT USED:

Medication tubes (3)	0.06 lb./day
Spray bottles	0.06 lb./day
Medication bottles	0.02 lb./day
Disposable face masks (3)	0.03 lb./week
Pill boxes (3)	0.06 lb./day
Band aids (3)	0.003 lb./week
Dressings and adhesives	0.02 lb./3 months
Catheter (2)	0.1 lb./mission
Antiseptic solution	0.6 lb./month

Splint (2)	0.2 lb./mission
Gloves (1 pair)	0.02 lb./week
Eye patches (3)	0.006 lb./week

REFERENCES:

Experiment Program for Extended Earth Orbital Missions, Revision No. 1, September 1, 1969, NASA OMSF.

Definition of Space Flight Medical Kits: A Rationale, Brooks Air Force Base, Texas, AMD TR 67-1, May 1967.

Use of the Ben Franklin Submersible as a Space Station Analog, Volume II Psychology and Physiology OSR-70-8, Contract NAS 8-30 172.

Study of Housekeeping Concepts For Manned Space

Doc. No. B- 1.1.1.2.1 Sheet No. 1
Operational Description No. A-1.1.1.2.1
Subsystem Medical Dispensary
By: G. Greenstein Date: 20 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Illness Event

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Medication Tubes	Material used up	Antibiotics and polystyrene	7.30	14.60	21.90	10.36	None
Spray Bottles	Material used up	Antibiotics and polystyrene	1.72	12.00	21.90	56.80	None
Disposable Face Masks	Contaminated	Cellulose	3.65	7.30	10.95	0.7	Must be inactivated
Pill Boxes	Material used	Antibiotics and polystyrene	7.30	14.60	21.90	22.46	None
Medication Bottles	Material used up	Antibiotics and polystyrene	0.40	4.00	7.30	10.36	None
Band Aids	Contaminated	Cellulose and polyvinyl	0.026	0.078	0.156	0.3	Must be inactivated
Dressings and Adhesives	Contaminated	Cellulose and plastic	-	0.02	0.08	6.07	Must be inactivated
Catheter	Contaminated	Polyvinyl	-	-	0.05	8.26	Must be inactivated
Antiseptic Solution	Material used up	Iodine and borosilicates	0.06	0.18	0.72	5.64	Must be inactivated
Splint	Contaminated	Steel	-	-	0.1	490.0	Must be inactivated
Gloves	Contaminated	Polyethylene	0.24	0.60	1.04	0.7	
Eye Patches	Contaminated	Cellulose	0.04	0.4	1.03	0.7	

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 1.1.1.2.1 Sheet No. 1
Operational Description No. A- 1.1.1.2.1
Subsystem Medical Dispensary
By: G. Greenstein Date: 20 July 1

TABLE III. WASTES

Title: Illness Event

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Medication Tubes	Solid Plastic Contaminated	Polystyrene	N/R	3.65	7.30	10.35	5.20	
Spray Bottles	Solid Plastic Contaminated	Polystyrene	N/R	0.48	8.00	14.60	41.47	
Disposable Face Masks	Solid Paper Contaminated	Cellulose	N/R	3.65	7.30	10.95	0.7	
Pill Boxes	Solid Plastic Contaminated	Polystyrene	N/R	3.65	7.30	10.35	11.40	
Medication Bottles	Solid Plastic Contaminated	Polystyrene	N/R	0.20	2.00	3.65	5.20	
Band Aids	Solid Plastic and Paper Contaminated	Plastic and Cellulose	N/R	0.026	0.078	0.156	0.3	
Dressings and Adhesives	Solid Plastic and Paper Contaminated	Cellulose and Plastic	N/R	-	0.02	0.08	6.07	
Catheter	Solid Plastic Contaminated	Polyvinyl	N/R	-	-	0.05	8.26	
Antiseptic Solution	Solid Glass Contaminated	Borosilicates	N/R	0.04	0.12	0.48	4.52	
Splint	Solid Metal Contaminated	Steel	Sterilize	-	-	0.1	4.90	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.1.1.2.1 Sheet No. 2
Operational Description No. A-1.1.1.2.1
Subsystem Medical Dispensary
By: G. Greenstein Date: 20 July 1970

TABLE III. WASTES

Title: Illness Event

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Gloves	Solid Plastic Contaminated	Polyethyrene	N/R	0.24	0.60	1.04	0.7	
Eye Patches	Solid Paper Contaminated	Cellulose	N/R	0.04	0.4	1.03	0.7	
Packaging	Solid Paper Contaminated	Cellulose	Reuse as is	0.75	2.0	3.65	.08	

Doc. No. A-1.1.2.1.1
Sheet No. 1
By: G. Greenstein
Date: 20 July 1970

OPERATIONAL DESCRIPTION

TITLE: Routine Examination and Illness Event (Dental Dispensary)

OBJECTIVE:

To maintain and monitor crew health and safety.

RATIONALE:

Approximately 10% of the crew members will be monitored each week. Standard dental equipment will be used. Examinations will be brief and will involve a minimal amount of equipment. The major problem of dental hygiene during aerospace missions will be stimulation of the gums. Since the problem of decay will be minor, particularly in flights of short duration, (less than six months) because of dietary adjustments that can be made to minimize the growth of organisms that produce tooth decay, there will be no need for tooth filling machinery. For this analysis the following assumptions will be made:

a. There will be one serious case of tooth decay once per year for 12 men.
b. There will be a tooth broken twice for a 12 man-year period.
c. Only emergency tooth extractions will be done onboard the vehicle (3 times per 12 man-year period).

EQUIPMENT USED:

Head rest covering	0.02 lb./each	Used routinely
Dental probe	0.05 lb./each	Used routinely
Dental mirror	0.10 lb./each	Used routinely
Extraction pliers	0.2 lb./each	See notes a, b, & c above
Scalpel	0.06 lb./each	See notes a, b, & c above
Drug and bottle	0.06 lb./+.30 lb.ea.	"
Anaesthetic and bottle	0.06 lb./+.30 lb.ea.	"
Dressing pad	0.002 lb./each	"
Syringe	0.013 lb./each	"

Doc. No. A-1.1.2.1.1
Sheet No. 2
By: G. Greenstein
Date: 20 July 1970

REFERENCES:

Sanitation and Personal Hygiene During Aerospace Missions MRL TDR 62-68 Life Support Systems Laboratory, Wright-Patterson Air Force Base, June 1962.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B- 1.1.2.1.1 Sheet No. 1
Operational Description No. A- 1.1.2.1.1
Subsystem Dental Dispensary
By: G. Greenstein Date: 20 July 1970

Title: Routine Examination and Illness Event

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Dental Probe	Contaminated	Steel	3.1	13.0	26.0	490.0	Must be Inactivated
Dental Mirror	Contaminated	Steel and Borosilicates	6.2	26.0	52.0	490.0	Must be Inactivated
Extraction Pliers	Contaminated	Steel	0.6	2.6	5.2	490.0	Must be Inactivated
Scalpel	Contaminated	Steel	0.18	0.75	1.5	490.0	Must be Inactivated
Drug and Bottle	Used Up	Drug and Borosilicates	0.36	1.5	3.0	83.37	None
Anaesthetic and Bottle	Used Up	Anaesthetic and Borosilicates	0.36	1.5	3.0	83.37	None
Dressing Pad	Contaminated	Cellulose	0.012	0.05	0.1	0.3	Must be Inactivated
Syringe	Contaminated	Polystyrene	0.078	0.32	0.65	35.6	Must be Inactivated
Head Rest Covering	Contaminated	Cellulose	1.24	5.2	10.4	6.07	Must be Inactivated

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.1.2.1.1 Sheet No. 1
Operational Description No. A-1.1.2.1.1
Subsystem Dental Dispensary
By: G. Greenstein Date: 20 July 1970

TABLE III. WASTES

Title: Routine Examination and Illness Event

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Dental Probe	Solid Metal Contaminated	Steel	Sterilize	3.1	13.0	26.0	490.0	
Dental Mirror	Solid Metal Contaminated	Steel	Sterilize	6.2	26.0	52.0	490.0	
Extraction Pliers	Solid Metal Contaminated	Steel	Sterilize	0.6	2.5	5.0	490.0	
Scalpel	Solid Metal Contaminated	Steel	Sterilize	0.18	.75	1.5	490.0	
Drug and Bottle	Solid Glass Contaminated	Borosilicates	N/R	0.30	1.25	2.50	52.57	
Anaesthetic Bottle	Solid Glass Contaminated	Borosilicates	N/R	0.30	1.25	2.50	52.57	
Dressing Pad	Solid Gauze Contaminated	Cellulose	N/R	0.012	0.05	0.1	0.3	
Syringe	Solid Plastic Contaminated	Polystyrene	N/R	0.078	0.32	0.65	35.6	
Head Rest Covering	Solid Paper Contaminated	Cellulose	N/R	1.25	5.2	10.4	6.07	
Tooth	Solid Bone Diseased	Calcium	N/R	-	-	Negligible	Negligible	

Doc. No. A-1.1.3.1.1
Sheet No. 1
By: G. Greenstein
Date: 22 July 1970

OPERATIONAL DESCRIPTION

TITLE: Medical (Dispensary Housekeeping)

OBJECTIVE:

The medical dispensary will be cleaned on a daily basis. Reusable equipment will be wrapped in cloths and placed in the autoclave. Contaminated material and empty medication containers will be placed in trash hampers. These hampers will be emptied daily and the contents of the trash hampers will be autoclaved. Specially designed wipes will be available to clean up any spillage and all the patient areas. These wipes will be impregnated with a bactericide.

EQUIPMENT USED:

	Trash hampers (2)	4.0 lbs./each
*	Autoclave used for both dental and medical dispensary at the same time (2)	1.0 lb./day - (once for contaminated material and once for reusable.)
	Disposable bags for trash hampers (2)	0.06 lb./day
*	Wipes impregnated with bactericide (4)	0.24 lb./day
*	Autoclave wrapping cloths	0.02 lb./day

* - 50 and 100 men spacecraft result is same waste rate, 12 men size approximately 1/3 the rate is assumed.

REFERENCES:

Experimental Program for Extended Earth Orbital Missions Revision Dated September 1968, NASA Office of Manned Space Flight.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B- 1.1.3.1.1 Sheet No. 1
Operational Description No. A-1.1.3.1.1
Subsystem Dispensary Housekeeping
By: G. Greenstein Date: 22 July 1970

Title: Medical Dispensary Housekeeping

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Trash Hamper	Contaminated	Polystyrene				0.35	None
Trash Hamper Bags	Contaminated	Polyethylene	3.0	10.95	21.90	0.08	Must be Inactivated
Wipes	Contaminated	Cellulose and Bactericide	24.00	87.60	175.20	10.37	Must be Inactivated
Autoclave Cloths for Wrapping Instruments	Wrapping Material	Cellulose	2.0	7.0	14.0	6.07	Must be Inactivated
Water	Steam Condensate Escaping	H_2O	50.0	183.0	366.0	62.0	Possible Escape of Noxious Odors

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C- 1.1.3.1.1 Sheet No. 1
Operational Description No. A-1.1.3.1.1
Subsystem Dispensary Housekeeping
By: G. Greenstein Date: 22 July 1970

Title: Medical Dispensary Housekeeping

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Trash Hamper	Solid Plastic Contaminated	Polystyrene	Reuse As Is				0.35	
Trash Hamper Bags	Solid Plastic Contaminated	Polyethylene	N/R	3.0	10.95	21.40	0.69	
Wipes	Solid Gauze and Bactericide Contamined	Cellulose	N/R	24.0	87.60	175.20	10.37	
Autoclave Cloths for Wrapping Instruments	Solid Cloth Contaminated	Cellulose	Reuse As Is	2.0	7.0	14.0	6.07	
Autoclave Waste Water	Vapor Steam 250°F	H_2O and Impurities	Condense, Strain	50.0	183.0	366.0	62.0	
Packaging Material	Solid Plastic Contaminated	Polyethylene	Reuse As Is	2.0	7.30	14.60	.08	

Doc. No. A-1.1.3.2.1
Sheet No. 1
By: G. Greenstein
Date: 22 July 1970

OPERATIONAL DESCRIPTION

TITLE: Dental (Dispensary Housekeeping)

OBJECTIVE:

To maintain and monitor crew health and safety.

RATIONALE:

The dental dispensary will be cleaned on a daily basis. Reusable equipment will be wrapped in autoclave cloths, placed in the autoclave and sterilized. Contaminated material will be placed in a trash hamper. The trash hamper inner liner will be removed at the end of each waking day and the contents of the trash hamper will be autoclaved. Impregnated wipes will be used to maintain the sanitary conditions of the facility.

EQUIPMENT USED:

Trash hamper	2.0 lbs./each
* Disposable bags for trash hamper	0.03 lb./day
* Wipes impregnated with bactericide (2)	0.12 lb./day
* Autoclave cloths (5)	0.1 lb./day
Autoclave (wastes are produced from both medical and dental dispensary and are are enumerated in 1.1.3.1.1).	

*For 12 men these will be approximately 1/3 the size required for 50 and 100 men.

REFERENCES:

Experimental Program For Extended Earth Orbital Missions
Revision Dated September 1968, NASA Office Of Manned Space Flight.

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FARMINGDALE, LONG ISLAND, NEW YORK

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B- 1.1.3.2.1 Sheet No. 1
Operational Description No. A- 1.1.3.2.1
Subsystem Dispensary Housekeeping
By: G. Greenstein Date: 20 July 1970

Title: Dental Dispensary Housekeeping

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Trash Hamper	Contaminated	Polystyrene				0.35	None
Trash Hamper Bags	Contaminated	Polyethylene	3.0	10.95	10.95	0.08	Must be Inactivated
Wipes	Contaminated	Cellulose and Bactericide	12.0	43.80	43.80	10.37	Must be Inactivated
Autoclave Cloths Used For Wrapping Instruments	Wrapping Material	Cellulose	12.0	36.5	36.5	6.07	Must be Inactivated

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 1.1.3.2.1 Sheet No. 1
Operational Description No. A- 1.1.3.2.1
Subsystem Dispensary Housekeeping
By: G. Greenstein Date: 20 July 1970

TABLE III. WASTES

Title: Dental Dispensary Housekeeping

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Trash Hamper	Solid Plastic Contaminated	Polystyrene	Reuse as is				0.35	
Trash Hamper Bags	Solid Plastic Contaminated	Polyethylene	N/R	3.6	10.95	10.95	0.08	
Wipes	Solid Gauze and Bactericide Contaminated	Cellulose and Bactericide	N/R	12.0	43.80	43.80	10.37	
Autoclave Cloths/ Wrapping Instruments	Solid Cloth Contaminated	Cellulose	Reuse as is	12.0	36.56	36.50	6.07	
Packaging Material	Solid Plastic Contaminated	Polyethylene	Reuse as is	1.0	3.65	3.65	0.08	

Doc. No. A-1.1.4.1.1
Sheet No. 1
By: P. Cooper
Date: August 1970

OPERATIONAL DESCRIPTION

TITLE: Space Suits and Portable Life Support Systems

1. RATIONALE

This system baseline consists of a Pressure Garment Assembly (PGA) and a Portable Life Support System (PLSS) each designed for a specific wearer. These units are not considered interchangeable except in an emergency. The individual PGA and the basic PLSS are considered to be replaceable with the crew members and, therefore, are not housekeeping problems. The PLSS is assumed to have replaceable or rechargeable modules which result in the consumables/expendables and wastes listed in Tables II and III.

This rationale treats the scheduled or planned EVA tasks such as routine external inspections and repairs, construction or erection of separate structures and transfers to external module.

The rationale on consumables/expendables and waste generation is based on the following guidelines (1):

- EVA occurs with two men at a time for a period of four hours.
- Approximately 1/2% of the available space station hours is consumed by EVA. This works out to 40 hours/month or 5 two man EVA excursions per month for a 12 man station. In that space station, EVA would be occurring for about 3% of the calendar time. For a 50 man station these figures work out to 160 hours/month, 20-two man excursions/month and 11% of the calendar time. For a 100 man station the latter figures would be doubled.
- Water evaporated for heat rejection = 1.75#/man-hr
- Oxygen for breathing (converted to CO_2) = 0.325/man-hr
- Li OH for atmospheric contaminant control = 1.25#/man-hr
- CO_2 removed = 0.39#/man-hr
- Power supply battaries = 1.4#/man-hr
- EVA airlock 232 cu. ft. (2) at 14.7 psia - 31% O_2, 69% N_2
- The PLSS and the space units are essentially personal articles and go up with a man and return to earth with him so that there is no waste directly from this basic equipment.

Doc. No. A-1.1.4.1.1
Sheet No. 2
By: P. Cooper
Date: August 1970

2. REFERENCES

1. McDonnell Douglas Astronautics Co. MDC GO634, Space Station Preliminary Design Data, Volume 1, Book 3, Crew Systems (July 1970) contract NAS8-25140.

2. North American Rockwell Corp., Space Division MSC-00735, Space Station Design Sheets, Vol. 1, Sections: 4.6 and 4.7, Contract NAS9-9953.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.1.4.1.1 Sheet No. 1
Operational Description No. A-1.1.4.1.1
Subsystem Personnel Protection
By: P. Cooper Date:

TABLE II. CONSUMABLES/EXPENDABLES

Title: Space Suits and P.L.S.S.

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght req'd per year-lbs 12 Man	50 Man	100 Man	Average Density lbs/cu.ft.	REMARKS
Water for Heat Rejection	Evaporated	H_2O, latent heat	840	3,360	6,720	62.4	
Oxygen	Metabolized and expelled	O_2 availability	156	624	1,248	.09	
Li OH	Adsorber of CO_2	Affinity for contaminants	600	2,400	4,800	28.0	
Power Supply (Battery)	Discharged	Chemical Potential	670	2,680	5,360	100.0	
Cabin Air	Vented to space	O_2, N_2	854	3,418	6,836	.07	

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Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.1.4.1.1 Sheet No. 1
Operational Description No. A-1.1.4.1.1
Subsystem Personnel Protection
By: P. Cooper Date: 28 Aug. 1970

TABLE III. WASTES

Title: Space Suits and P.L.S.S.

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght req'd per year-lbs			Average Density lbs/cu.ft.	Index Of Utilization Potential And Remarks
				12 man	50 man	100 man		
Water	Liquid, Vaporized	H_2O	N/R	840	3,360	6,720	62.4	
CO_2	Gas, combined with LiOH	O_2, C	Trap and scrub	187	749	1,498	-	at about 7 mm Hg. partial pressure
Li OH	Solid, Granular, Hydroscopic, Strong Caustic	Li OH	N/R	600	2,400	4,800	28.0	
Power Supply (Battery)	Solid, Dense, Corrosive	Unknown	Recharge	670	2,680	5,360	100.0	

PROVIDE CREW QUARTERS

SECTION 1.2

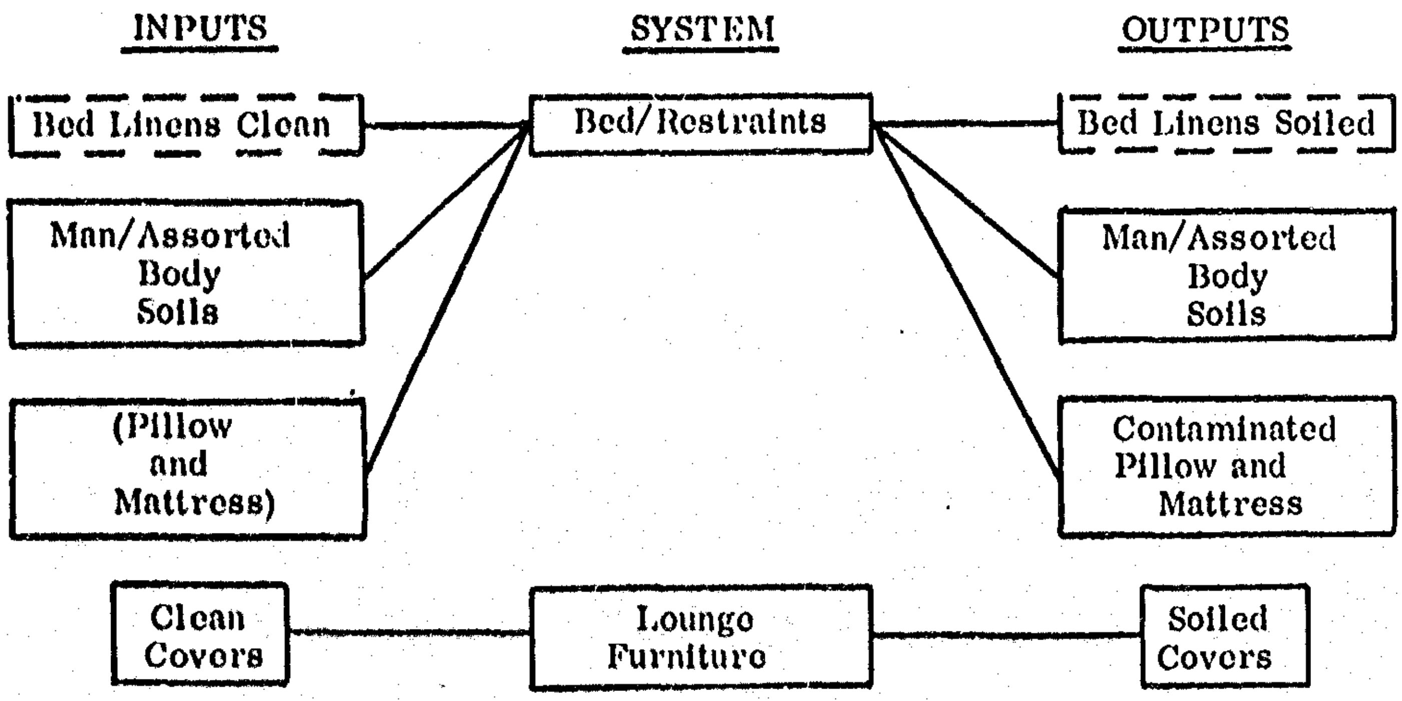
TABLE OF CONTENTS

Doc. No. A-1.2.1.1.1
Sheet No. 1
By: P. Trotta
Date: 16 June 1970

OPERATIONAL DESCRIPTION

TITLE: Room Furnishings

SCHEMATIC BLOCK DIAGRAM:



RATIONALE:

a. Bed/Restraints

This subsystem is designated to define consumables and products other than the normal linen which is considered separately (see Document No. A-1.2.2.2.1. The subsystem consists of any and all sleep fixtures, restraints or supports. Pillows or mattresses, if used in a manner similar to that used on Earth, can be changed or cleaned as the user changes (i.e., new crewman: fresh pillow and mattress,) or if they become contaminated. It is assumed that if pillows and mattresses are used, they will be of the inflatable type and will weigh approximately 1/3 lb. and 1 lb. respectively and will be used for 90 days before replacement.

b. Lounge Furniture

The lounge furniture, if present, is essentially a passive system. Furniture covers, if used, will be the only conceivable consumable and/or waste product. These covers, it is assumed, will not be replaced faster than yearly on the average (including replacements due to accidental contamination). They are assumed to weigh 1 lb. each.

c. Closets, Shelves, Drawers, Clean Materials Hampers

This is essentially a passive system and as such has no consumables in and of itself. Its contents will not be considered as expendables, consumables, products or wastes.

REFERENCES:

Hygiene Systems Analysis Debris Generation and Flow Patterns, FHR #3864, December 30, 1969, FH/RAD

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B- 1.2.1.1.1 Sheet No. 1
Operational Description No. A- 1.2.1.1.1
Subsystem Provide Furnishings
By: P. Trotta Date: 16 June 1970

Title: Room Furnishings

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght req'd per year-lbs			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Pillows (inflatable)	Contaminated in use	External purity	16	67	133	40	Density noted Assumes deflated condition
Mattress (inflatable)	Contaminated in use	External purity	48	200	400	40	Density noted Assumes deflated condition
Lounge Covers	Contaminated in use	Life, freshness	12	50	100	20	

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 1.2.1.1.1 Sheet No. 1
Operational Description No. A- 1.2.1.1.1
Subsystem Provide Furnishings
By: P. Trotta Date: 16 June 1970

TABLE III. WASTES

Title: Room Furnishings

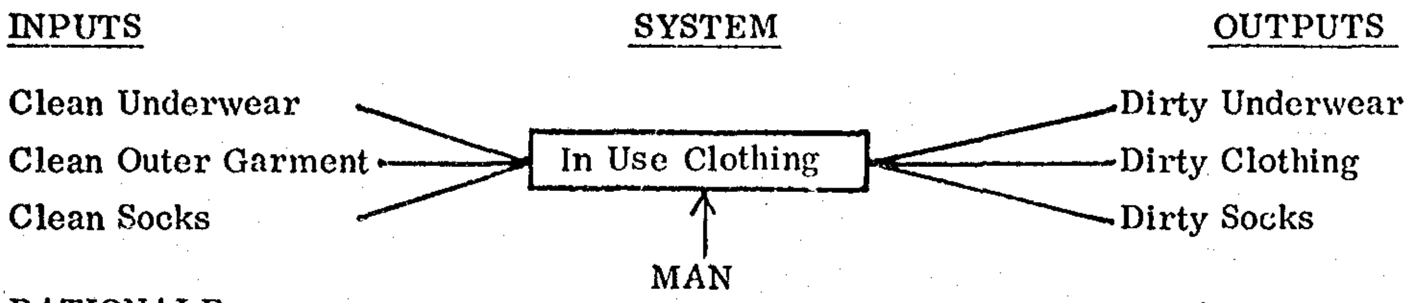
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght req'd per year-lbs 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Used inflatable pillow	Solid, plastic inert, sheet	Teflon	Launder/ Wipe Clean	16	67	133	40	
Used inflatable mattress	Solid, plastic inert, sheet	Teflon	Launder/ Wipe Clean	48	200	400	40	
Worn furniture covers	Solid, plastic sheet, inert	PBI (Poly-benzimidazole) or nylon (polyamide)	None	12	50	100	20	

Doc. No. A-1.2.2.1.1
Sheet No. 1
By: P. Trotta
Date: 15 June 1970

OPERATIONAL DESCRIPTION

TITLE: Clothing

SCHEMATIC BLOCK DIAGRAM



RATIONALE:

Clothing has been considered as a system unto itself for ease of handling. Clean garments constitute the consumables and dirty garments constitute the product or waste. Their individual weights and usage time is as follows:

Article of Clothing	Weight	Usage Period (Days)	LB/MN/DAY
Short sleeve shirt	0.27/shirt	3	0.09
Trousers	0.77/trousers	6	0.13
Jacket (lightweight)	0.62/jacket	90	0.0069
Undershirt	0.17/shirt	2	0.085
Undershorts	0.17/shorts	2	0.085
Socks	0.04/pair	2	0.02
Shoes	0.55/pair	180	0.003
			.4199

REFERENCES:

Preliminary Definition - Integrated Hygiene System Material Provisions, FHR #3871, January 29, 1970 FH/RAD

Hygiene Systems Analysis Debris Generation and Flow Patterns. FHR #3864, December 30, 1969 FH/RAD

Space Station Phase B Definition Design Sheets by Space Division N.A.R. MSC-00735 SD 70-150, Vol. 1, Page 002

Handbook of Garment Selection Criteria for A Space Station, By Austin C. Morris of B. Welson & Co., Inc., Hartford, Conn. NASA CR 102051, N70-15022 (1969-1970)

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.2.2.1.1 Sheet No. 1
Operational Description No. A-1.2.2.1.1
Subsystem Personal Articles
By: P. Trotta Date: 15 June, 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Clothing

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Wght Req'd per year-lbs 12 MAN	50 MAN	100 MAN	Average Density As Received lbs/cu.ft.	REMARKS
Shirt (short sleeve)	Soiled as worn	Freshness	389	1620	3240	15	Density is a function of packing
Trousers	Soiled as worn	Freshness	554	2310	4620	15	
Jacket, Lightweight	Wear and soiling	Life	28	124	248	17	
Undershirt	Soiled as worn	Freshness	367	1530	3060	15	
Undershorts	Soiled as worn	Freshness	367	1530	3060	15	
Socks (pair)	Soiled as worn	Freshness	86	360	720	10	
Shoes (pair)	Wear and soiled	Life	13	56	110	64	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.2.2.1.1 Sheet No. 1
Operational Description No. A- 1.2.2.1.1
Subsystem Personal Articles
By: P. Trotta Date: 15 June, 1970

Title: Clothing

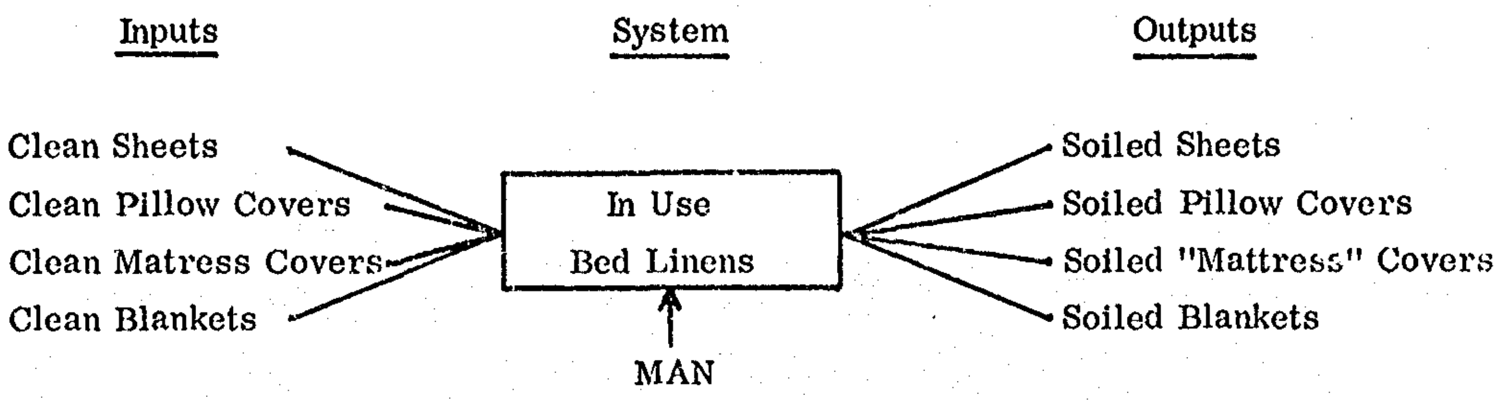
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght req'd per year-lbs			Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
				12 man	50 man	100 man		
Soiled shirt (short sleeve)	Solid, Textile Sheet, Pathogenic	Cellulose H-C-O	Launder	428	1782	3564	17	
Soiled Trousers	" "	Cellulose	Launder	609	2541	5082	17	
Soiled Jacket, Lightweight	" "	Cellulose	Launder	8	34	68	19	
Soiled Undershorts	" "	Cellulose	Launder	440	1836	3672	18	
Soiled Undershirts	" "	Cellulose	Launder	440	1836	3672	18	
Soiled Socks (pair)	" "	Cellulose	Launder	103	432	864	12	
Soiled Shoes (pair)	Solid, plastic, inert, sheet	Flourel soaked doeskin	Clean with solvents	7	28	56	65	

Doc. No.A-1.2.2.2.1
Sheet No. 1
By: P. Trotta
Date: 15 June 1970

OPERATIONAL DESCRIPTION

TITLE: Bed Linens

SCHEMATIC BLOCK DIAGRAM



RATIONALE:

Bed linens are considered as a system unto itself separate from bed/restraints (A 1.2.1.1.1) or laundry (1.4.4.1.1). The inputs consist of the clean items noted above, the outputs are the same items - soiled. Sheets weighing 0.37 lbs each will be replaced every 6 days. Blankets and mattress covers weigh approximately 1.0 lb and 0.7 lb respectively and will be used for approximately 6 months. Pillow cases weigh approximately 0.1 lbs and will be replaced every 6 days with the sheets.

REFERENCES:

Space Station Phase B Definition Design Sheets by Space Division N.A.R. MSC-00735 SD 70-150 Vol.1, Pages 008.

Hygiene Systems Analysis Debris Generation and Flow Patterns, FHR 3864 December 30, 1969, FH/RAD.

Preliminary Definition - Integrated Hygiene System Material Provisions, FHR #3871, February 2, 1970, FH/RAD.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.2.2.2.1 Sheet No. 1
Operational Description No. A-1.2.2.2.1
Subsystem Personal Articles
By: P. Trotta Date: 15 June 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Bed Linens

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght req'd per year-lbs. 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	REMARKS
Sheets	Soiled as used	Fabric cleanliness	266	1110	2220	30	Density is a function of packing
Blanket	Wear or accidental contamination	Fabric Life and cleanliness	24	100	200	5	
Pillow Cases	Soiled as used	Fabric cleanliness	73.2	305.0	610.0	30	
Mattress Covers	Wear or accidental contamination	Fabric Life and cleanliness	17	70	140	5	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.2.2.2.1 Sheet No. 1
Operational Description No. A- 1.2.2.2.1
Subsystem Personal Articles
By: P. Trotta Date: 15 June 1970

TABLE III. WASTES

Title: Bed Linens

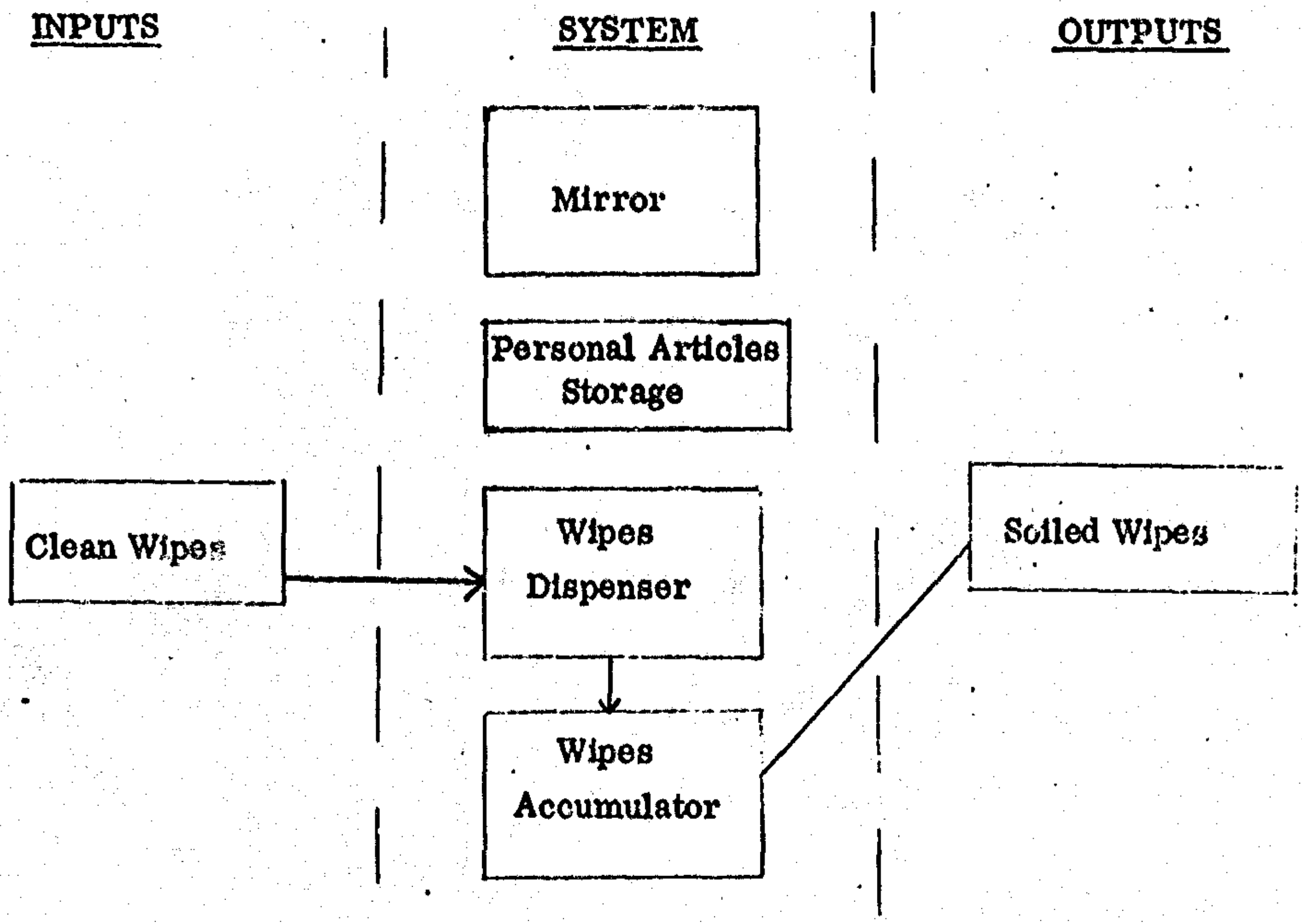
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total weight req'd per year-lbs 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Sheets Soiled	Solid, Fabric, Sheet, Organic Soil	Cellulose	Launder	320	1332	2664	25	Density is a function of packing
Blanket	Solid, Fabric, Sheet, Organic Soil	Cellulose	Dry Clean or Launder	24	100	200	5	Density is a function of packing
Pillow Cases	Solid, Fabric, Sheet, Organic Soil	Cellulose	Launder	73.2	305.0	610.0	25	Density is a function of packing
Mattress Covers	Solid, Fabric, Sheet	Cellulose	Launder	17	70	140	5	Density is a function of packing

Doc. No. A-1.2.2.3.1
Sheet No. 1
By: P. Trotta
Date: 16 June 1970

OPERATIONAL DESCRIPTION

TITLE: Limited Personal Grooming Facility

SCHEMATIC BLOCK DIAGRAM:



RATIONALE:

The personal limited grooming facility is essentially a passive system. It consists of a mirror and storage for any personal grooming aid the crew member would want in his quarters (i.e., comb, brush). It may however, be the location of a wipes dispenser in the crew quarters and as such it will "consume" clean wipes and "produce" soiled wipes at a rate of 10 wipes/day (approx. 4 gm each).

REFERENCES:

Vol. 1 - Preliminary Design Report (Space Station: Hygiene, Waste Management, and Food Subsystems). FHR #3900 June 1, 1970 Fairchild Hiller/RAD.

Design Sheets (Hygiene and Food Management) for MDAC. FHR #3902 June 5, 1970 FH/RAD.

Preliminary Definition - Integrated Hygiene System Material Provisions. FHR #3871 Jan. 29, 1970 FH/RAD.

Hygiene Systems Analysis Debris Generation and Flow Patterns. FHR #3864 Dec. 30, 1969 FH/RAD.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.2.2.3.1 Sheet No. 1
Operational Description No. A- 1.2.2.3.1
Subsystem Provide Personal Articles
By: P. Trotta Date: 16 June 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Limited Personal Grooming Facility

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght req'd per year-lbs 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	REMARKS
Absorbent Paper Wipes	Soiled in use	Papers ability to absorb liquids and debris	38.6	160.8	323.6	7.0	Density is a function of packing

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.2.2.3.1 Sheet No. 1
Operational Description No. A-1.2.2.3.1
Subsystem Provide Personal Articles
By: P. Trotta Date: 16 June 1970

TABLE III. WASTES

Title: Limited Personal Grooming Facility

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght req'd per year-lbs 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Absorbent Wipes 4 gm ea. 10/day	Solid, Paper Pathogenic, Sheet	Cellulose H-C-O	Clean, Dry and disinfect	38.6	160.8	321.6	7.0	Density is a function of packing

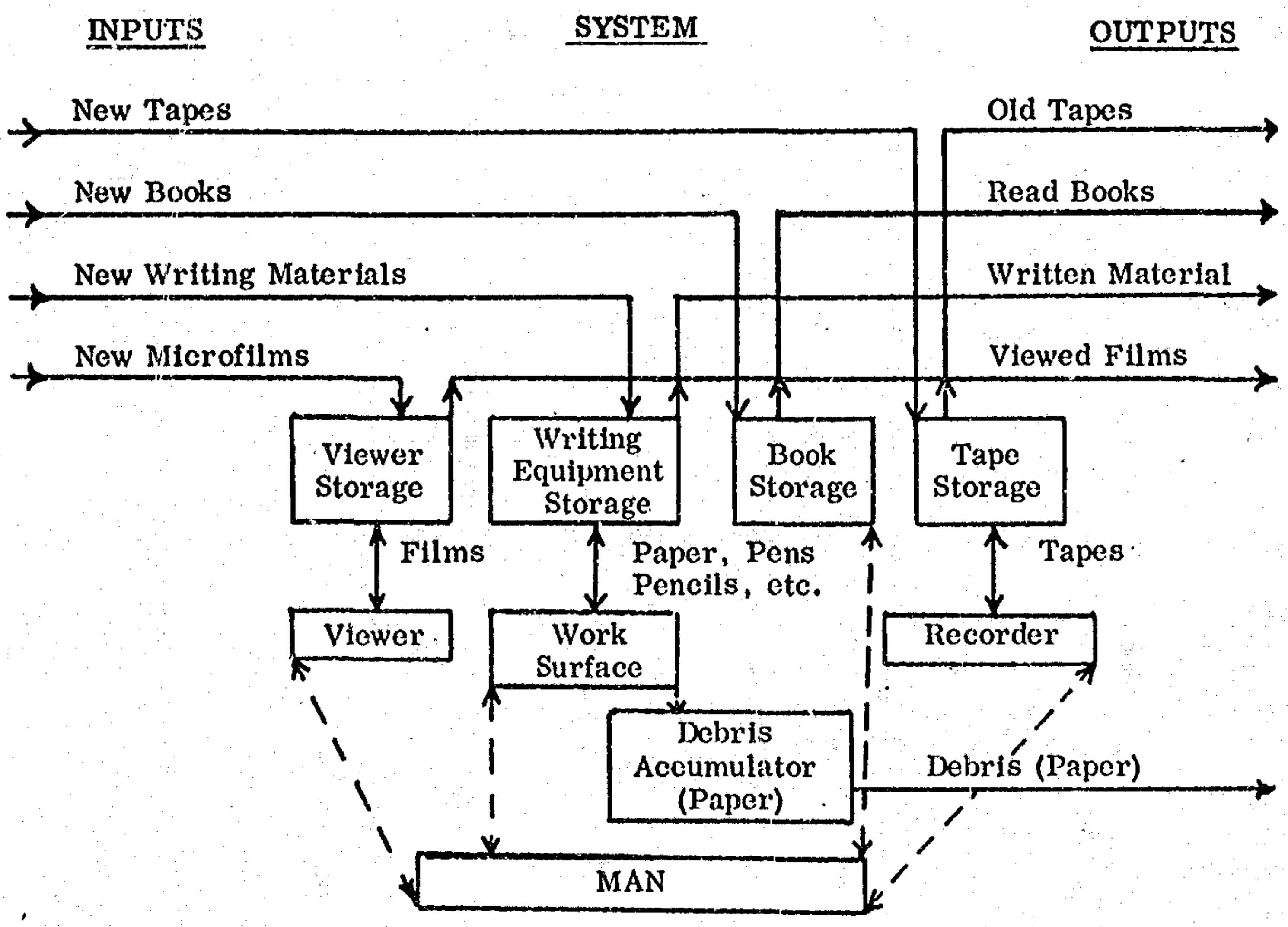
1.2-13

Doc. No. A-1.2.3.1.1
Sheet No. 1
By: P. Trotta
Date: 22 June 1970

OPERATIONAL DESCRIPTION

TITLE: Individual Crew Recreation

SCHEMATIC BLOCK DIAGRAM:



RATIONALE:

The individual crew recreation center may utilize printed books as well as tapes and films as mediums. Recreational reading (or non-music tapes or micro film) will have its utility change as the fraction of crewmembers who have used it compared to those who have not, changes. That is, a change of crew will increase the utility of a book without the book changing in any physical way. (One book is assumed read/man/wk). The crewmember will also use about 10 sheets of writing material/day for personal logs and letters, half of which will be discarded.

REFERENCES:

Hygiene Systems Analysis Debris Generation and Flow Patterns - FHR #3864
December 30, 1969 - FH/RAD

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.2.3.1.1 Sheet No. 1
Operational Description No. A-1.2.3.1.1
Subsystem Rest and Relaxation Provisions
By: J. Trotta Date: 6/22/70

TABLE II. CONSUMABLES/EXPENDABLES

Title: Individual Crew Recreation

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght req'd per year-lbs			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Paper for writing	Written upon	Surface	40	170	350	50	
Books	Read by all	Novelty	52	52	52	50	
Magnetic Tape Cassettes	Listened to by all	Novelty	8	8	8	80	
New Micro Films	Viewed by all	Novelty	5	5	5	80	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.2.3.1.1 Sheet No. 1
Operational Description No. A-1.2.3.1.1
Subsystem Rest and Relaxation Provisions
By: P. Trotta Date: June 22, 1970

Title: Individual Crew Recreation

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght req'd per year-lbs 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Debris (Paper)	Solid, Paper, Sheet, Inert	Cellulose C-H-N	Reprocess	20	85	175	3 - 20	Density is a function of packing
Books (100% Read)	Solid, Paper Sheet, Inert	Cellulose C-H-N	Reprocess	52	52	52	50	
Magnetic Tapes Cassettes	Solid, Plastic Sheet, Inert	Mylar, F_e	Erase and Rerecord	8	8	8	80	
Viewed Micro Films	Solid, Plastic Sheet, Inert	Acetate	Reprocess	5	5	5	80	

PROVIDE CREW FOOD AND DRINK

TABLE OF CONTENTS

Doc. No. A-1.3.1.1.1.
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

TITLE: Perishable Food Storage - Mechanical

SCHEMATIC BLOCK DIAGRAM

IN	SYSTEM FUNCTION	OUT
Food in package	Perishable Food -10°F Freezer	Food in package
Coolant	↓	Water (Frost)
Cabin Air		Coolant
Spares	Perishable Food 40°F and 55°F Refrigerator	Spent Parts
Lights		Lights
Compressor		Seals (Door)
Frozen Food (-10°F 33°F)		Compressor
Dehydro Frozen Food		Frozen Food
Fresh Fruits & Vegetables		Dehydro Frozen Food
		Fresh Fruit & Vegetables

RATIONALE:

The mechanical, compressor operated, refrigerator and freezer act only as transient storage facilities for perishable food items. The freezer subassembly will include a compressor, unloading device, condensor, and an evaporator/separator. The machinery transfers heat from within its compartments and dumps it either directly or indirectly into the ECLSS. Internal freezer volume required for the 12 man food supply 365 days is 147 ft^3. The refrigerator subassembly consists of four (4) insulated compartments capable of storing food at two preselected temperature levels simultaneously. Internal refrigerator volume required for the 12 man food supply for 365 days is 30 ft^3. Internal volumes for crews of greater number will increase linearly.

Doc. No. A-1.3.1.1.1.
Sheet 2
By: L. Peyser
Date: 10 July 1970

Food stored in the system is defined as follows:

Type	Density lb/ft^3	12 Men	50 Men	100 Men
Frozen	56	5,650	23,500	47,000
Dehydro-Frozen	46	2,140	8,900	17,800
*Perishable	15	57	237	474
		7,847	32,637	65,274

*Perishable foods are fresh fuits and vegetables placed on board not as a vital part of the food supply. This amount represents a 30 day supply.

REFERENCES:

Fairchild Hiller Study - FHR 3885 "Food Management Subsystem - Space Station", 2/17/70

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.3.1.1.1 Sheet No. 1
Operational Description No. A-1.3.1.1.1
Subsystem Food Storage System
By: L. Peyser Date: 10 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Perishable Food Storage - Mechanical

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu. ft.	REMARKS
			12 Man	50 Man	100 Man		
Refrigerant in container	Escape to Atmosphere	Freon	10	42	84	120.0 as Liquid	
Lights (2/yr/system) (100 w. bulb .076#)	Burn Out	Life	.152	.608	1.215	8.0	
Compressor & Engine Parts 100 1½ hp	Random Failure	Metals Rubber Teflon	4	8	16	120	
Atmospheric Humidity	Condensed	Water	41	170	340	64	
Food-In Pkg. (Perishable) (45% by dry wt of total)	Removed for Preparation	N.A.	7,847	32,637	65,274	56	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.3.1.1.1 Sheet No. 1
Operational Description No. A-1.3.1.1.1
Subsystem Food Storage System
By: L. Peyser Date: 10 July 1970

Title: Perishable Food Storage - Mechanical

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Freon	gas, inert,	Freon	N/A	10	42	84	120	
Light bulbs	Solid, Fragile, Sharp Pieces	Glass Tungsten Steel	N/A	.152	.608	1.215	8.0	
Spent Parts	Solid, Dense, Small Metal, Plastic	Fe, Cu, Al, Teflon	N/A	4	8	16	120	
Water	Liquid, Frost	H_2O	Condense & Recover	41	170	340	64	1.0
Food in Pkg. (.1% Spoilage)	Solid, Organic Plastic, Sheet, Metal	Polyethylene Aluminum	None	7.8	32.6	65.3	56	Deactivate Bacteria

Doc. No. A-1.3.1.1.2
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

TITLE: Perishable Food Storage - Thermoelectric

SCHEMATIC BLOCK DIAGRAM

IN	SYSTEM FUNCTION	OUT
Food In Pkg	Perishable Food -10°F Freezer	Food In Pkg
Cabin Air	↕	Water (Frost)
Spares	Perishable Food 40°F and 55°F Refrigerator	Spent Parts
Lights		Lights
Seals (Door)		Seals

RATIONALE:

The passive thermoelectric refrigerator and freezer act as transient storage facilities for perishable food items. Adjunct equipments for the system are condensor and evaporator/separator. The system dumps heat either directly or indirectly into the ECLSS. Volume requirements are as for A-1.3.1.1.1.

REFERENCES:

Fairchild Hiller Study FHR 3885. Food Management Subsystem - Space Station 2/17/70.

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.3.1.1.2 Sheet No. 1
Operational Description No. A-1.3.1.1.2
Subsystem Food Storage System
By: L. Peyser Date: 10 July 1970

TABLE III. WASTES

Title: Perishable Food Storage - Thermoelectric

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Light bulbs	Solid, Fragile, Sharp, Pieces	Borosillicate Tungsten Steel	Pulverize	.152	.608	1.215	8	As pulverized
Water	Liquid, Frost	H_2O	Condense & Recover	41	170	340	64	1.0
Food in Pkg .1% Spoilage	Solid, Organic, Plastic, Sheet, Metal	Polyethylene Aluminum	None	7.8	32.6	65.3	56	Deactivate Bacteria

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-1.3.1.1.2 Sheet No. 1
Operational Description No. A-1.3.1.1.2
Subsystem Food Storage System
By: L. Pevser Date: 10 July 1970

Title: Perishable Food Storage - Thermoelectric

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Lights 2/yr/system 100 W Bulb .076#	Burn Out	Tungsten	.152	.608	1.215	8.0	As Packaged
Atmospheric Humidity	Condensed	Water	41	170	340	64	
Food in Pkg. (Perishable) (45% by dry wt. of total)	Removed to Preparation	NA	7,790	32,400	64,800	56	

Doc. No. A-1.3.1.1.3
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

TITLE: Perishable Food Storage - Space Radiator

SCHEMATIC BLOCK DIAGRAM

IN	SYSTEM FUNCTION	OUT
Food in Pkg	Perishable Food -10°F Freezer	Food in Pkg
Cabin Air	⇕	Water
Spares	Perishable Food 40°F and 55°F Refrigerator	Spent Parts
Lighting	↓	Lighting
Seals	To Preparation	Seals

RATIONALE:

The passive space radiator refrigerator freezer acts as transient storage. The subassembly will include a condensor, and an evaporator/separator. The system dumps heat directly to the space radiator. Volume requirements are as for A.1.3.1.1.1.

REFERENCES:

Fairchild Hiller Study - FHR 3885. Food Management Subsystem - Space Station 2/17/70.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.3.1.1.3 Sheet No. 1
Operational Description No. A-1.3.1.1.3
Subsystem Food Storage System
By: L. Peyser Date: 10 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Perishable Food Storage - Space Radiator

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Lights	Burn Out	Tungsten	.152	.608	1.215	8.0	As Pkgd.
Atmospheric Humidity	Condensed	Water	41	170	340	64	
Food in Pkg. 45% by dry wt. of total	Remove to preparation	NA	7,970	32,400	64,800	56	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.3.1.1.3 Sheet No. 1
Operational Description No. A-1.3.1.1.3
Subsystem FoodStorage System
By: L. Peyser Date: 10 July 1970

Title: Perishable Food Storage - Space Radiator

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Light Bulbs	Solid, Glass Fragile Sharp, Pieces	Borosilicate Tungsten Steel	Pulverize	.152	.608	1.215	8	As Pulverized
Water	Liquid, Frost	H_2O	Condense & Recover	41	170	340	64	1.0
Food in Pkg. (.1% Spoil)	Solid, Organic Plastic, Sheet, Metal	Polyethylene Aluminum	None	7.8	32.6	65.3	56	Deactivate Bacteria

Doc. No. A-1.3.1.2.1
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

TITLE: Stable Food Storage

SCHEMATIC BLOCK DIAGRAM

IN	SYSTEM FUNCTION	OUT
Food In Package	Stable Food	Food In Package
Spares Lights	Storage Structure	Spent Parts Lights

RATIONALE:

The stable food storage structures are unsealed compartments subject to ambient temperature, pressure, and humidity. The structure acts as transient storage facilities for dried and thermostabilized food.

Food stores in the structure are defined as follows:

Type	Density lb/ft^3	Packaged Weight		
		12 Men	50 Men	100 Men
Dry	50	1,245	5,200	10,400
Freeze-Dried	10	1,245	5,200	10,400
Thermostabilized	56	5,875	24,500	49,000
Total		8,365	34,900	69,800

REFERENCE:

Fairchild Hiller Study - FHR 3885,"Food Management Subsystem - Space Station," 17 February 1970.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.3.1.2.1 Sheet No. 1
Operational Description No. A-1.3.1.2.1
Subsystem Food Storage System
By: L. Peyser Date: 10 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Stable Food Storage

Consumable/Expendable. ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	REMARKS
Food in pkg.	Removed to preparation	Food	8,365	34,900	69,800	41.6	
Lights (2/yr/system)	Burn out	Tungsten	.152	.608	1,215	8.0	as pkgd.

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.3.1.2.1 Sheet No. 1
Operational Description No. A-1.3.1.2.1
Subsystem Food Storage System
By: L. Peyser Date: 10 July 1970

Title: Stable Food Storage

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Food in pkg. .1% of total	Solid, Organic, Plastic Sheet	Food, Polyethylene	Physical separation of constituents	8.4	34.9	69.8	41.6	Deactivate bacteria
Light Bulbs	Solid, Glass, Fragile, Sharp, Pieces	Borosilicates Tungsten Steel	Pulverize	.152	.608	1.215	8	

OPERATIONAL DESCRIPTION

TITLE: Food Reconstitution (Rehydration)

SCHEMATIC BLOCK DIAGRAM

IN	SYSTEM FUNCTION	OUT
Food In Package (Dry)	Food Rehydration	Rehydrated Food In Package
Water (For Reconstitution)	↓	Dry Food In Package
Water (For Drinking)	Meal Assembly	Drinking Water

RATIONALE:

Dehydrated food products; i.e., freeze dried, powder, ground, and dehydro-frozen, are rehydrated with hot or cold water prior to being assembled onto a meal tray. Water quantities are derived as follows: (Man per day quantities)

Beverage rehydration	1000 ml	2.2#	4 beverages of 250 ml each
Drinking water	1045 ml	2.3#	
Food reconstitution	455 ml	1.0#	

The waste factor assigned to inpackage food reconstitution is 0.5%.

REFERENCE:

Fairchild Hiller Study FHR 3885 -"Food Management Subsystem - Space Station," 17 February 1970.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-1.3.2.1.1 Sheet No. 1
Operational Description No. A-1.3.2.1.1
Subsystem Food and Food Prep.
By: L. Peyser Date: 10 July 1970

Title: Food Reconstitution (Rehydration)

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	REMARKS
Water 1.0#/Man/Day	Rehydration of Dehydrated Food	H_2O	4,380	18,250	36,500	62	
2.2#/Man/Day	Rehydration of Dehydrated Beverages	H_2O	9,620	40,000	80,000	62	
Dry Food In Package Package .214#/#Food Food .75#/Man/Day	Reconstituted (Rehydration)	Food & Package	4,630	19,300	38,600	36.2	
Water (Drinking) 2.3# 1000 ml	Drinking	H_2O	10,074	42,000	84,000	62	

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 1.3.2.1.1 Sheet No. 1
Operational Description No. A- 1.3.2.1.1
Subsystem Food and Food Prep.
By: L. Pevser Date: 10 July 1970

TABLE III. WASTES

Title: Food Reconstitution (Rehydration)

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Food In Package .5%	Solid, Organic, & Plastic Sheet	Food, Polyethlene	None	45.5	188	375	56	
Water Spilled & Not Drunk 10%	Liquid Water	H_2O	Recycle	1007	4,200	8,400	62	1.0

Doc. No. A-1.3.2.1.2
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

TITLE: Food Reconstitution (Heating)

IN	SYSTEM FUNCTION	OUT
Frozen and Wetpack Food in Packages	Heat to 180°F	Warmed Food in Package
	Hold @ 140°F	Cooked Food in Package
	Chill 45°F	Prepared Food in Package
Trays		Trays
Handling Equipments		Spoiled Food Package

RATIONALE:

Stable wet pack, perishable frozen, and dehydro-frozen foods may require heat reconstitution prior to serving. This is accomplished with ovens, warmers, and chillers. Ovens are combination microwave-forced air convertion for quickest warm-up. The chiller is an adjunct to the refrigerator. Possible consumables result from random failure of the 7 pound magnitron which has an estimated useful life of three to five thousand hours.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-1.3.2.1.2 Sheet No. 1
Operational Description No. A-1.3.2.1.2
Subsystem Food and Food Prep.
By: L. Pevser Date: 10 July 1970

Title: Food Reconstitution (Heating)

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	REMARKS
Precooked Food in Pkg. Include frozen, wetpak and dehydro frozen	Warmed or Chilled or Cooked	Food and Pkg	13,650	57,000	114,000	56	
Magnitron tube Spares	Random failure	Usefullness	2.1	4.2	7.0	100	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.3.2.1.2 Sheet No. 1
Operational Description No. A- 1.3.2.1.2
Subsystem Food and Food Prep.
By: L. Peyser Date: 10 July 1970

TABLE III. WASTES

Title: Food Reconstitution (Heating)

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Spoiled Food in Pkg. (1% of total)	Solid - Food	Organic Plastic	N/R	136.5	570	1,140	56	
Magnitron Tube	Solid Glass Envelope intact	Borosilicates, Fe, Cu, Ni, W	N/R	2.1	4.2	7.0	100	

Doc. No. A-1.3.2.2.1
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

TITLE: Meal Assembly

SCHEMATIC BLOCK DIAGRAM

IN	SYSTEM FUNCTION	OUT
Tray (meal) Tray (accessory) Food in Pkg Accessory Components: Napkins Dining Utensils Condiments Wipes	Unpackage food items and place meals on tray ↓ Set Up Accessory Tray ↓ Transport	Pkg Food Wipes Trays Dining Utensils Condiments Assembled Meal

RATIONALE:

Primary menu items, i.e., meat, vegetable, and starch, are unpackaged and placed onto an individual meal tray. Secondary menu items, i.e., beverage, bread, cereal, dessert, salad, sandwich, and soup, are assembled onto group service trays. Maximum number of group service trays per six man meal service will be two. Cloth towels weighing .125 pound each will be utilized for collection of spilled food and water, and they will be consumed at the rate of four per day per 12 man crew. Trays weigh 0.5 pound each and are consumed at the rate of 18 per day for the twelve man crew. Dining utensils are consumed as follows:

(1) Tongs, 1.15 oz each
(2) "Spork" 1.0 oz each
2.5 oz each per man per meal

Total 7.5 oz per man per day = .47 lb.
Drinking devices weigh 4 oz = .25 lb each with attached flexible ends. Ends are designed for 1 year useful life.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.3.2.2.1 Sheet No. 1
Operational Description No. A-1.3.2.2.1
Subsystem Food and Food Prep.
By: L. Peyser Date: 10 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Meal Assembly

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Packaging	Food Unpkgd	Polyethylene Aluminum	2,920	12,200	24,400	120	Must be bacterially inactivated
Wipes (towel) 41 days .125 lb ea / 12 man crew	Utilized Daily	Cloth (cotton)	184	775	1,650	100	Wash
Trays (meal) (.5 lb ea)	Utilized daily	Plastic	6,600	27,200	54,400	125	
Dining Utensils	Utilized daily	Aluminum	225	937	1,874	250	Pkgd density
Drinking Utensils	Utilized	Plastic	1,195	4,560	9,120		
Trays (Accessory)	Utilized	Plastic	1,065	2,130	4,260	125	

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FARMINGDALE, LONG ISLAND, NEW YORK

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.3.2.2.1 Sheet No. 1
Operational Description No. A-1.3.2.2.1
Subsystem Food and Food Prep.
By: L. Peyser Date: 10 July 1970

Title: Meal Assembly

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Packaging	Solid, Flexible	Polyethylene Alum. Foil	Wash	2,920	12,200	24,400		
Attached Food .5% overall	Solid, Organic, Semi-Liquid	Food	N/R	14.5	61.0	122.4		
Wipes (towel) 4/day/12 man crew 10% waste	Solid, Cloth	Cotton	Re-weave	18	77	165	100	1.0 use as rags
Flex drinking device tips	Solid Flex.	Hypalon rubber	Wash	.37	1.56	3.12	20	
Spilled Food 3%	Solid, Organic, Semi-Liquid	Food	N/R	87.0	366	730	56	

Doc. No. A-1.2.3.1.1
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

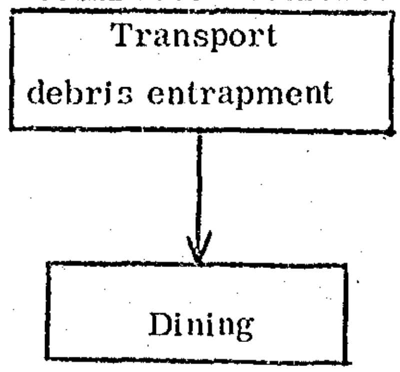
OPERATIONAL DESCRIPTION

TITLE: Meal and Accessory Transport

SCHEMATIC BLOCK DIAGRAM

IN	OUT
Assembled meal	Assembled meal
Tray (meal)	Tray (meal)
Tray (accessory)	Tray (accessory)
Airflow	Airflow
Disinfectant sol	Spilled food
	Disinfectant sol

SYSTEM FUNCTION



RATIONALE:

Meal and accessory trays will be transported from the assembly area to the dining area by means of a man or mechanical conveyor system. The area through which the tray travels must provide spill control such that any item ejected from a tray is entrapped and can be collected.

Expected spillage is < .5% of total transported food. Total transported assembled meals for the 12 man crew is 20,000 lb/yr.

Filters for collection will be metalic grids for entrapment -- food debris must removed daily -- filters should be cleansed weekly with disinfectant.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-1.3.3.1.1 Sheet No. 1
Operational Description No. A-1.3.3.1.1
Subsystem Meal Service and Dining
By: L. Peyser Date: 10 July 1970

Title: Meal and Accessory Transport

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	REMARKS
Assembled meals	Transported	Food	20,000	83,300	166,600	56	
Disinfectant sol	Utilized	Liquid	52	220	440	64	
Package for disinfectant	Emptied	Polyethylene	1.75	7.0	14.0	57	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTE

Doc. No. C-1.3.3.1.1 Sheet No. 1
Operational Description No. A-1.3.3.1.1
Subsystem Meal Service and Dining
By: L. Peyser Date: 10 July 1970

Title: Mean and Accessory Transport

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Spilled food	Solid, liquid saturated, organic	Food	N/R	100	460	920	56	Possible use as animal food
Disinfectant sol	Liquid chemical	BAC solution	N/R	52	220	440	64	
Package for disinfectant	Solid, plastic molded container	Polyethylene	N/R	1.75	7.0	14.0	57	

Doc. No. A-1.3.3.2.1
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

TITLE: Dining

IN

Man

Meal

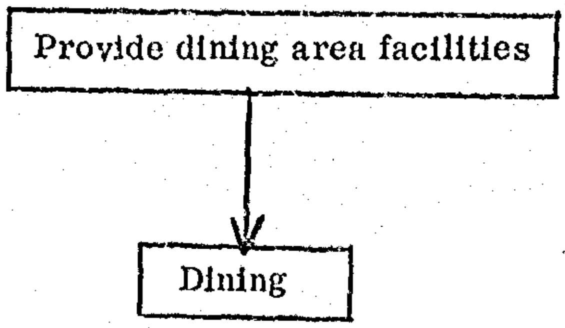
Pkg. 1

Tray (meal)

Tray (accessory)

Utensils

SYSTEM FUNCTION



OUT

Man

Food Waste

Pkg. Waste

Tray with Food & Pkg Wastes

Tray with left over Accessories

Accessory Pkg
Napkins

Soiled Utensils

RATIONALE:

Dining is accomplished in the seated position. Man and tray restraints are provided. Food and trays will be held in place by means of laminar air flow or electrostatic forces. Primary concern will be not for dining technique but rather for spill control as outlined in A 1.3.4.1.1.

Food wastes are based upon food rejection due to personal dislike and selection capability data generated for in house food management studies. Napkins are consumed at the rate of three per day per man. They are linen and washable. They weigh 15 gm (.03#) each. Initial supply will be six per man with expected attrition to be 30% per year or 2 per man-per year. Spares can be utilized as washable wipes as required.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.3.3.2.1 Sheet No. 1
Operational Description No. A-1.3.3.2.1
Subsystem Meal Service and Dining
By: L. Peyser Date: 10 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Dining

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	REMARKS
Assembled Meal	Eaten	Food	20,000	83,300	166,600	56	
Dining Utensils	Utilized	Usefulness	225	937	1,874	100	Wash
Drinking Utensils	Utilized	Usefulness	1,195	4,560	9,120	40	Wash
Meal Tray	Utilized	Usefulness	6,600	27,200	54,400	125	Wash
Accessory Tray	Utilized	Usefulness	1065	2,130	4,260	125	Wash
Napkins	Utilized	Cloth	146	607	1,214	30	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C- 1.3.3.2.1 Sheet No. 1
Operational Description No. A-1.3.3.2.1
Subsystem Meal Service and Dining
By: L. Peyser Date: 10 July 1970

Title: Dining

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Uneaten Food	Solid, organic	Food	N/R	2,780	11,600	23,200	56	
Napkins (-linen)	Solid linen soiled torn	fibre-acetate	Wash, reweave	42	175	350	70	
Spilled Food	Solid, organic	Food	N/R	100	460	920	56	

Doc. No. A-1.3.4.1.1
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

TITLE: Debris Control - Mechanical

SCHEMATIC BLOCK DIAGRAM

IN	SYSTEM FUNCTION	OUT
Liquid < Droplet	Collect	Air
Solid particulate mass	↓	Package of Debris
Semi Solid		
Air	Transfer to stowage	
Debris Package	Compactor	Squeegee
Squeegee		

RATIONALE:

Automatic collection of liquid and solid debris in the zero g environment is accomplished by an airflow plenum chamber device in the areas where meals are assembled, transported, and eaten.

Filters will pass air and entrap liquid, and solid wastes. These wastes will be collected from the filter surface by means of a scraping and vacuum device.

Debris packages will not be reusable because of difficulty of unpackaging at the compactor.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.3.4.1.1 Sheet No. 1
Operational Description No. A-1.3.4.1.1
Subsystem Housekeeping
By: L. Peyser Date: 10 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Debris Control - Mechanical

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	REMARKS
Debris package	Utilized	Polyethylene	10.9	43.7	87.4	50	
Package tie	Tie seal pkg.	Plastic Choke	2.55	9.50	19.0	26	Reusable
Scraper (squeegee)	Utilized	Hypalon rubber	.4	.8	1.6	69	Washable
Vacuum cleaner tips	Utilized	Hypalon rubber	.8	1.6	3.2	69	Washable

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C- 1.3.4.1.1 Sheet No. 1
Operational Description No. A-1.3.4.1.1
Subsystem Housekeeping
By: L. Peyser Date: 10 July 1970

Title: Debris Control – Mechanical

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Filter Unit, clogged	Solid, organic, debris, sharp	Teflon, aluminum	Reverse flush	2.6	10.8	21.6	5	
Debris pkg. filled with debris	Solid flex container filled	polyethylene	-	10.9	43.7	87.4	50	
Package tie, reusable	Solid, plastic ribbon	Teflon	Remove from debris pkg	2.55	9.50	19.0	26	
Scraper, worn	Solid, plastic	Hypalon rubber	-	.4	.8	1.6	69	
Collected Food Waste	Solid, organic	Food	-	100	460	920	56	Use as animal food
Vacuum cleaner tips, worn	Solid, plastic	Rubber	N/R	.8	1.6	3.2	69	

Doc. No. A-1.3.4.1.2
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

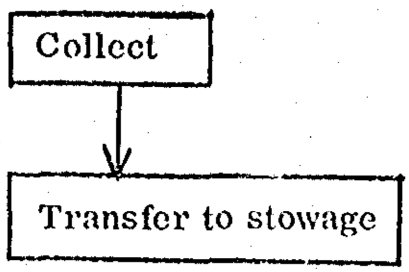
TITLE: Debris Control - Manual

SCHEMATIC BLOCK DIAGRAM

IN

Liquid
Solid
Semi Solid
Air
Wipes
Packaged Food
Utensils, Cooking & Eating
Gloves

SYSTEM FUNCTION



OUT

Air
Wipes
Cartons of Debris
Packaged Food
Utensils, Cooking & Eating
Gloves

RATIONALE:

There will be in any food preparation, assembly, and dining areas, spills and waste food collection requirements. The spoiled food is removed by hand from the process stream. This may be in the form of hand pick up or wipe. Waste food will be scraped from utensils into cartons and transfered by hand to waste storage facilities.

Wipes will be paper weighing .01# each. Saturated with water their weight increases four times.

Study of Housekeeping Concepts For Manned Space

Doc. No. B- 1.3.4.1.2 Sheet No. 1
Operational Description No. A- 1.3.4.1.2
Subsystem Housekeeping
By: L. Pevser Date: 10 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Debris Control - Manual

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	REMARKS
Wipes	Utilized	Paper	12.8	51.7	103.4	6.87	
Bags	Utilized	Polyethylene	10.9	43.7	87.4	50	
Gloves	Utilized	Polyethylene	11	44	88		
Scraper (Squeegee)	Utilized	Rubber Hypalon	.4	.8	1.6	69	Washable
Vacuum cleaner tips	Utilized	Rubber Hypalon	.8	1.6	3.2	69	Washable

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.3.4.1.2 Sheet No. 1
Operational Description No. A-1.3.4.1.2
Subsystem Housekeeping
By: L. Peyser Date: 10 July 1970

TABLE III. WASTES

Title: Debris Control - Manual

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Wipes	Solid, paper, wet, soiled	Organic	N/R	51.2	235	412	55	
Bags of wasted food	Solid, flexible, filled	Polyethylene Food wastes	N/R	3,165	13,251	26,500	56	
Gloves	Solid, flexible, sheet	Polyethylene	Wash	11	44	88	26	
Scraper	Solid, plastic, rod	Rubber hypalon	Wash	.4	.8	1.6	69	
Nozzle, Vacuum Pickup	Solid, plastic, tubular	Rubber hypalon	Wash	.8	1.6	3.2	69	

Doc. No. A-1.3.4.2.1
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

TITLE: Utensil Cleansing

SCHEMATIC BLOCK DIAGRAM

IN	SYSTEM FUNCTION	OUT
	Remove Debris	Food debris
Cooking Utensils	Wash	Water
Eating Utensils	Dry	Air
Food Debris		Utensils (Clean)
Wash Water		
Rinse Water		
Air		
Surfactant (detergent)		

RATIONALE:

Eating and drinking utensils will be manually scraped prior to placement into the dishwasher. In the dishwasher, water jets with detergent will remove remaining debris. The debris will be collected and removed, water will be filtered, sterilized, and recycled. Utensils will be removed dry and stored until next usage.

Wash water will be consumed at the rate of 8 pounds per pound of equipment washed. Detergent will be consumed at the rate of .38 pounds per 80 pounds of water.

Study of Housek[illegible] [illegible]cepts For Manned Space

TABLE II. [illegible]BLES/EXPENDABLES

Doc. No. B-1.3.4.2.1 Sheet No. 1
Operational Description No. A-1.3.4.2.1
Subsystem Housekeeping
By: L. Peyser Date: 10 July 1970

Title: Utensil Cleaning

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Eating Utensils	Used	Freshness	225	937	1874	100	
Drinking Utensils	Used	Freshness	1,195	4,560	9,120	40	
Meal Tray	Used	Freshness	6,600	27,200	54,400	125	
Accessory Tray	Used	Freshness	1065	2130	4260	125	
Water	Utilized	Freshness	8520	17,000	34,000	62	
Surfactant (Detergent)	Utilized	Detergency	40.5	81.0	162	67	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.3.4.2.1 Sheet No. 1
Operational Description No. A- 1.3.4.2.1
Subsystem Housekeeping
By: L. Peyser Date: 10 July 1970

Title: Utensil Cleaning

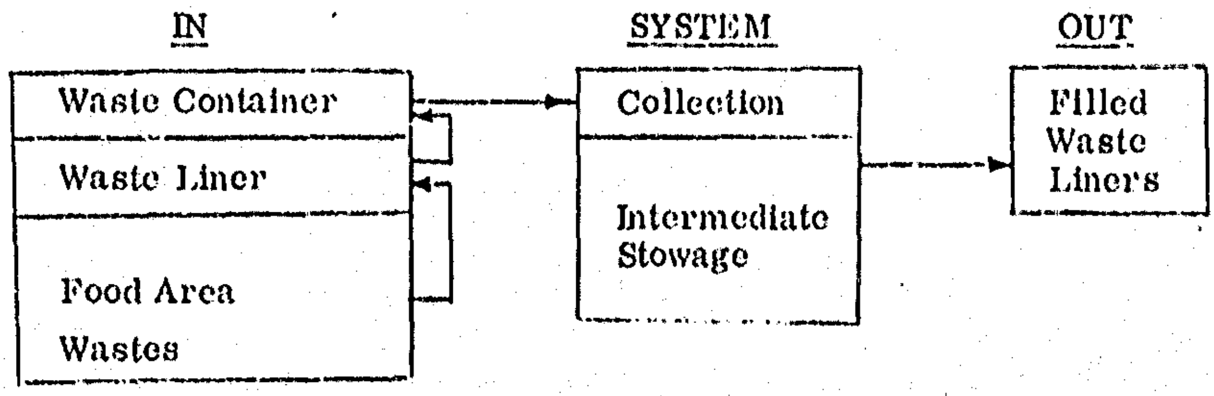
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Food Debris	Solid Water Saturated	Organic	N/R	278	1160	2320	56	
Detergent	Liquid in solution	Sulfonates	N/R	40.5	81.0	162	67	
Water	Liquid saturated Food and detergent	H_2O	Filter, Boil	8520	17,000	34,000	62	

Doc. No. A-1.3.4.3.1
Sheet No. 1
By: L. Peyser
Date: 10 July 1970

OPERATIONAL DESCRIPTION

TITLE: Waste Stowage

SCHEMATIC BLOCK DIAGRAM



RATIONALE:

Wastes from all areas of the Food Management subsystem are collected in individual, lined, containers strategically located on those areas. It is assumed that only the liners are consumed and not the containers proper. The liners which have an average capacity of about 5 cu.ft. each are assumed to be completely filled with uncompressed waste and then compressed manually to about 75% capacity for transportation. The empty bags are assumed to weigh 0.25 pounds each (average for 5 cu.ft. capacity). it is assumed that the average is made up of small bags and large bags as required for the daily tasks.

	Total Weight Rec'd Per Year (lbs)			Lbs/cu.ft Uncompressed Density
	12 Man	50 Man	100 Man	
Wasted Food in Packages	198	825	1650	56
Packaging	2920	12200	24400	30
Wipes	51	235	412	30
Waste Food	2967	12426	24850	56

Total Volumes Collected in a Year:

12 man: 156 cu. feet
50 man: 650 cu. feet
100 man: 1300 cu. feet

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.3.4.3.1 Sheet No. 1
Operational Description No. A- 1.3.4.3.1
Subsystem Housekeeping
By: L. Peyser Date: 10 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Food Waste Stowage

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Stowage Containers	Filled	Space	*	*	*	-	* Reuse as is
Stowage Liners	Filled	Freshness	8	32.5	65	65.0	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.3.4.3.1 Sheet No. 1
Operational Description No. A-1.3.4.3.1
Subsystem Housekeeping
By: L. Peyser Date: 10 July 1970

TABLE III. WASTES

Title: Food Waste Stowage

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
				12 Man	50 Man	100 Man		
Filled Waste Liners	Solid, Plastic Sheet, Organic	Teflon + Food Wastes	Empty, Wash	8	32.5	65	50.0	

PROVIDE FOR CREW HYGIENE

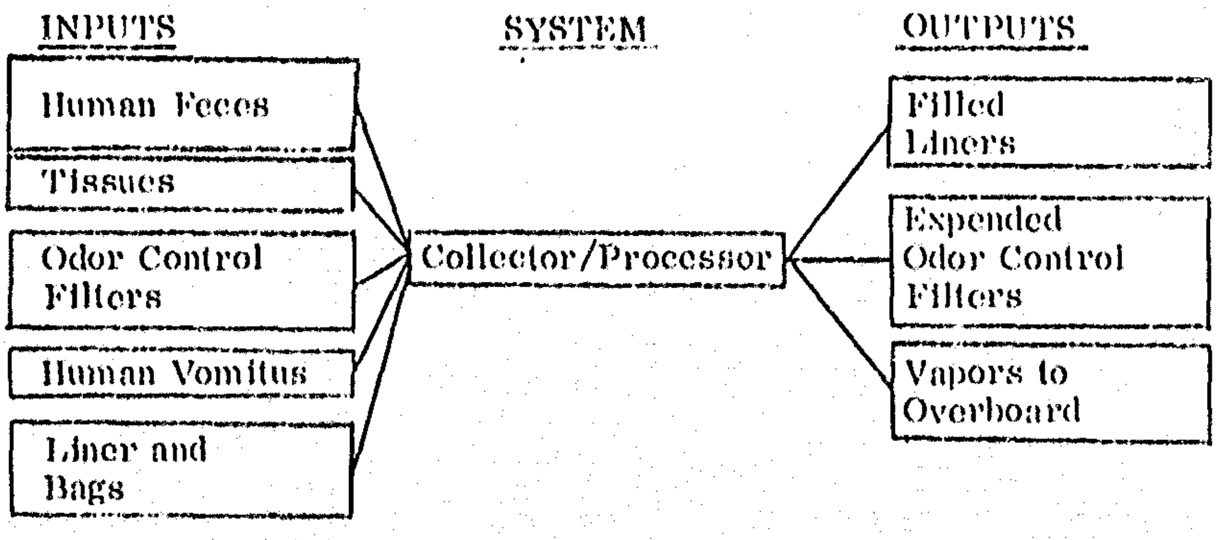
TABLE OF CONTENTS

Doc No. A-1.4.1.1.1
Sheet No. 1
By: W. Ford
Date: 17 July 1970

OPERATIONAL DESCRIPTION

TITLE: Integrated Vacuum Drying (Fecal and Vomitus Waste Management)

SCHEMATIC DIAGRAM



RATIONALE

The integrated vacuum drying fecal/vomitus waste collection and processing system directly collects the human feces and is along with soiled conventional toilet tissue, exposed to space vacuum for drying and de-activation. The system is also used as an optional convenience for similar collection and processing of human vomitus.

Defecation is directly into a lined collector/processor and the soiled tissue is collected similarly by the same collector. After defecation, the collector/processor is exposed to space vacuum and ambient cabin heat until all gaseous matter is drawn off. The gaseous matter may be either condensed out or allowed overboard. The liners which contain the debris are capable of holding the waste from 35 man days or approximately 7.6 lbs each. The liners containing the dried and inert residue must then be stored on board, returned to earth or placed in extra-earth orbit.

Vomitus disposal is handled either by initial placement in a specially designed bag with subsequent placement in the collector/processor or by directing the vomitus directly into the feces collector/processor. In both cases, the vomitus is processed concurrently with the feces.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.4.1.1.1 Sheet No. 1
Operational Description No. A-1.4.1.1.1
Subsystem Human Waste Management
By: W. Ford Date: 17 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Integrated Vacuum Drying

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year (lbs)			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Toilet Tissue	Soiled	Cleanliness	75.4	314.3	628.6	64	
Filters (Odor Control)	Filled	Volume	51.9	216.3	432.5	85	
Liners	Filled	Volume	21.9	91.2	182.5	64	
Bags	Filled	Volume	14.4	60.0	120.0	64	
Filters (Bacteria Control)	Filled	Volume	2.6	10.8	21.6	5	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.4.1.1.1 Sheet No. 1
Operational Description No. A-1.4.1.1.1
Subsystem Human Waste Management
By: W. Ford Date: 17 July 1970

TABLE III. WASTES

Title: Integrated Vacuum Drying

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year (lbs) 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Filters (Odor Control)	Solid, Metalic/ Granular Pathogenic	Activated Charcoal	Purify Charcoal	51.9	216.3	432.5	85	
Filters (Bacteria Control)	Solid, Teflon Sheet, Pathogenic	Teflon	Purify Clean	2.6	10.8	21.6	5	
Waste Container (Filled)								
Bags	Solid, Plastic Sheet, Pathogenic	Teflon	Empty/ Clean					
Liners	Solid, Plastic Sheet, Pathogenic	Teflon	Empty/ Clean					
Tissue	Solid, Paper Sheet, Pathogenic	Cellulose	N/R	940	3915	7795	64	
Feces	Solid Bulk Pathogenic	Bacteria	N/R					
Vomitus	Semi-liquid, Organic, Bulk, Pathogenic	Protein H_2O - HCL	N/R					
Vaporized Products	Gas Corrosive, Wet	Methane, Ammonia H_2O, N	N/R	1022	4258	8550	0	

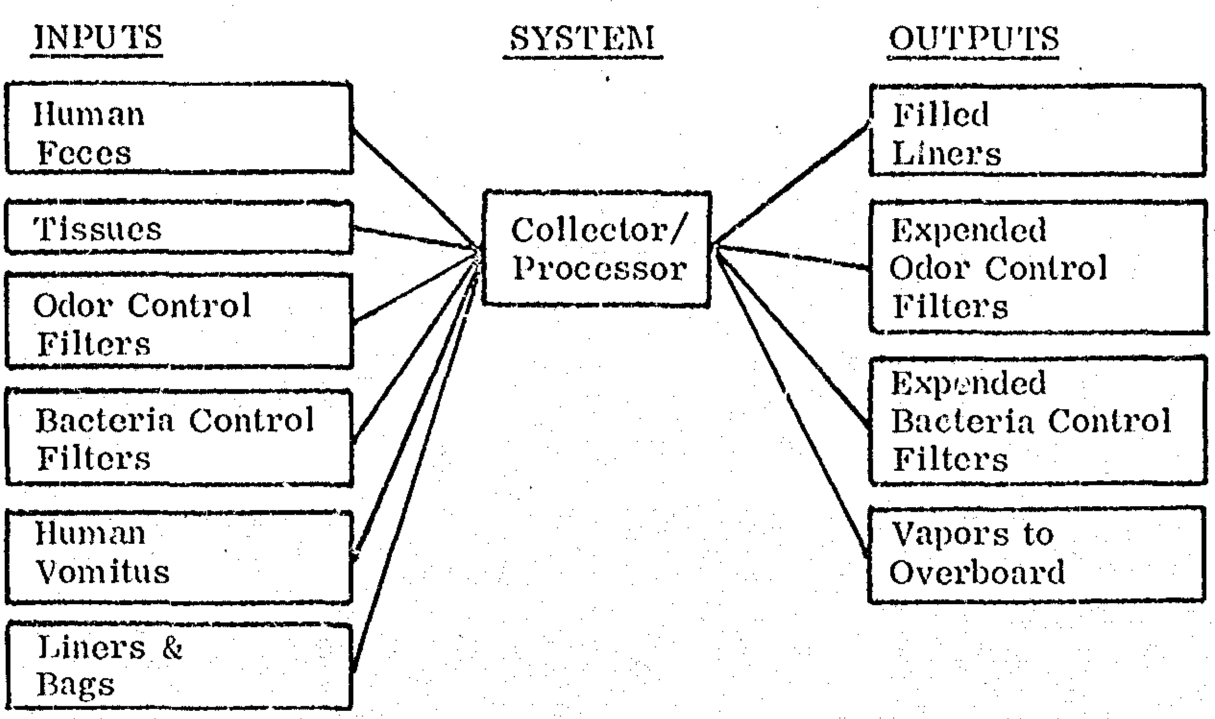
(Values 940, 3915, 7795 and 64 are bracketed for Bags, Liners, Tissue, Feces and Vomitus together.)

Doc. No. A-1.4.1.1.2
Sheet No. 1
By: W. Ford
Date: 14 August 1970

OPERATIONAL DESCRIPTION

TITLE: Automated Bag with Vacuum Drying (Fecal and Vomitus Waste Management)

SCHEMATIC DIAGRAM



RATIONALE

The automated bag with vacuum drying fecal/vomitus waste collection and processing system collects the human feces in a bag which has been previously positioned automatically. The bag is sealed after fecal collection and insertion of the soiled tissue and is drawn down into the processing chamber by cabin air.

The chamber is then exposed to space vacuum and ambient cabin heat for drying. The liners containing the dried and inert residue are stored on board, returned to earth or placed in extra earth orbit. The liners which contain the debris are capable of holding the waste from 35 man days or approximately 7.6 lbs each.

Vomitus disposal is handled by either initial placement in a specially designed bag with subsequent placement in the collector/processor or by directing the vomitus directly into a fecal collection bag. In either case, the vomitus is processed concurrently with the feces.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.4.1.1.2 Sheet No. 1
Operational Description No. A-1.4.1.1.2
Subsystem Human Waste Management
By: W. Ford Date: 14 August 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Automated Bag with Vacuum Drying

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year (lbs)			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Toilet Tissue	Soiled	Cleanliness	75.4	314.3	628.6	64	
Filters (Odor Control)	Filled	Volume	51.9	216.3	432.5	85	
Liners	Filled	Volume	21.9	91.2	182.5	64	
Bags	Filled	Volume	452.4	1885.0	3770.0	64	
Filters (Bacteria Control)	Filled	Volume	2.6	10.8	21.6	5	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C- 1.4.1.1.2 Sheet No. 1
Operational Description No. A- 1.4.1.1.2
Subsystem Human Waste Management
By: W. Ford Date: 14 August 1970

Title: Automated Bag with Vacuum Drying

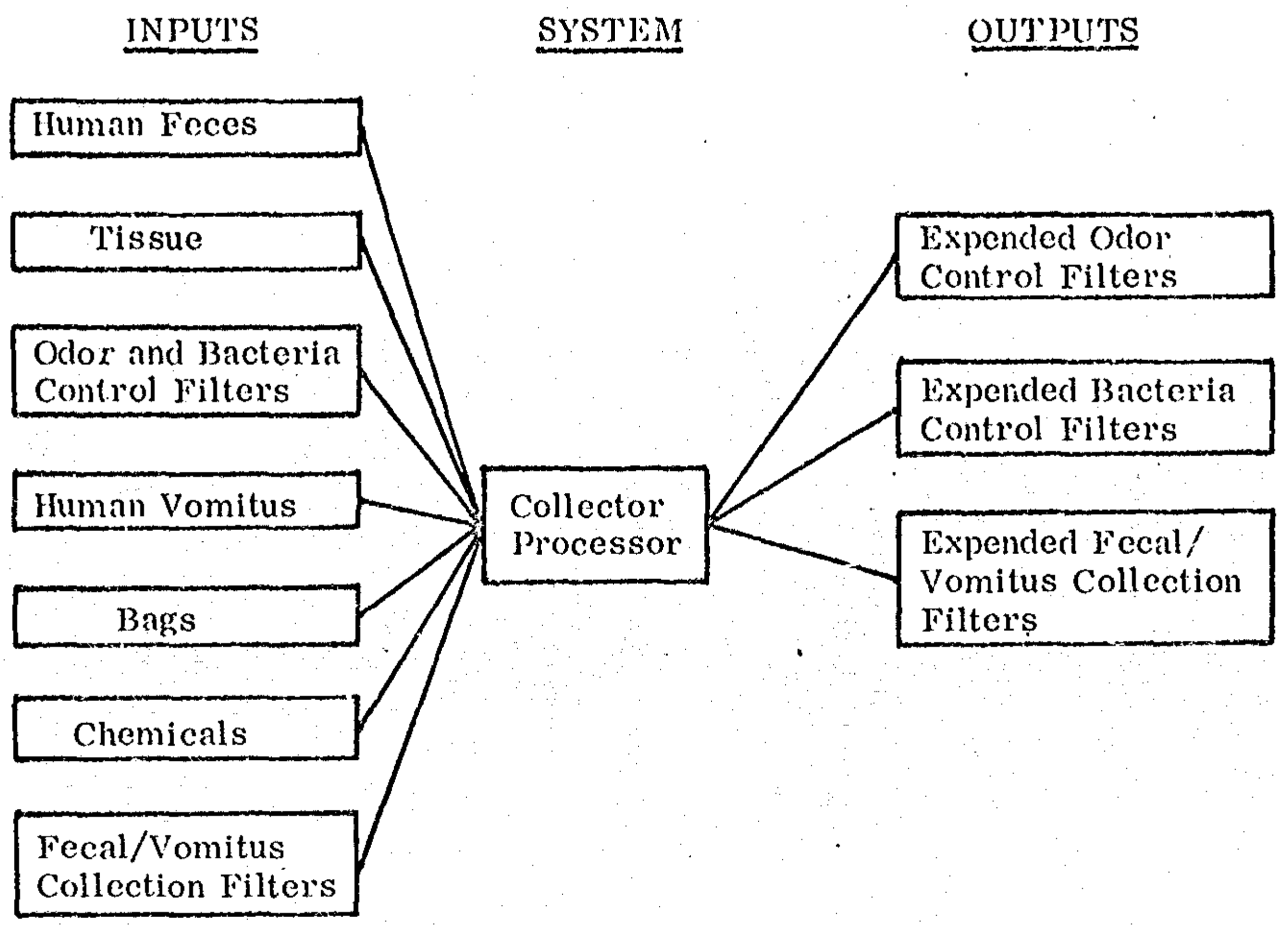
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year (lbs) 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Filters (Odor Control)	Solid Metalic/ Grannular Pathogenic	Activated Charcoal	Purify Charcoal	51.9	216.3	432.5	85	
Waste Container (Filled)								
Bags	Solid, Plastic Sheet, Pathogenic	Teflon	Empty, Clean					
Liners	Solid, Plastic Sheet, Pathogenic	Teflon	Empty, Clean					
Toilet Tissue	Solid, Paper Sheet, Pathogenic	Cellulose	Clean	1387	5742	11450	64	
Feces	Solid, Organic, Bulk, Pathogenic	Organics/ Bacteria	N/R					
Vomitus	Semi-liquid, Organic, Bulk, Pathogenic	Protein HCL, H_2O Food	N/R					
Filters (Bacteria Control)	Solid Teflon Sheet Pathogenic	Teflon	Purify, Clean	2.6	10.8	21.6	5	

Doc. No. A-1.4.1.1.3
Sheet No. 1
By: W. Ford
Date: 14 Aug. 1970

OPERATIONAL DESCRIPTION

TITLE: Wet Collection and Processing (Fecal and Vomitus Waste Management)

SCHEMATIC DIAGRAM



RATIONALE

The wet collection and processing system for human feces and vomitus is a chemical deactivation system utilizing a deactivating solution such as formaldehyde. The solids are filtered out of the solution after they have been diced up and deactivated. The filters are replaced as necessary and then stored for return to earth or placement in extra-earth orbit. Cabin air is drawn through the seat pulling the feces into the processor. The air is then filtered and returned to the cabin. Additional chemicals are added to the solution as necessary.

Vomitus is handled either by initial placement in a specially designed bag with subsequent insertion into the feces processor or by vomiting directly into the processor. In both cases, the vomitus is processed concurrently with the feces.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.4.1.1.3 Sheet No. 1
Operational Description No. A-1.4.1.1.3
Subsystem Human Waste Management
By: W. Ford Date: 14 Aug. 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Wet Collection and Processing

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year (lbs)			Average Density As Received lbs/cu.ft.	REMARKS
			12 men	50 men	100 men		
Chemicals	Absorbed	Deactivation	55.5	231.0	462.0	32	
Bags	Filled	Volume	14.4	60.0	120.0	64	
Filters (Odor Control)	Filled	Volume	51.9	216.3	432.6	85	
Tissues	Solid	Cleanliness	75.4	314.3	628.6	64	
Filters (Bacteria Control)	Filled	Volume	2.6	10.8	21.6	5	
Filters (Fecal and Vomitus Collector)	Filled	Volume	240	1000	2000	5	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.4.1.1.3 Sheet No. 1
Operational Description No. A-1.4.1.1.3
Subsystem Human Waste Management
By: W. Ford Date: 14 Aug. 1970

TABLE III. WASTES

Title: Wet Collection and Processing

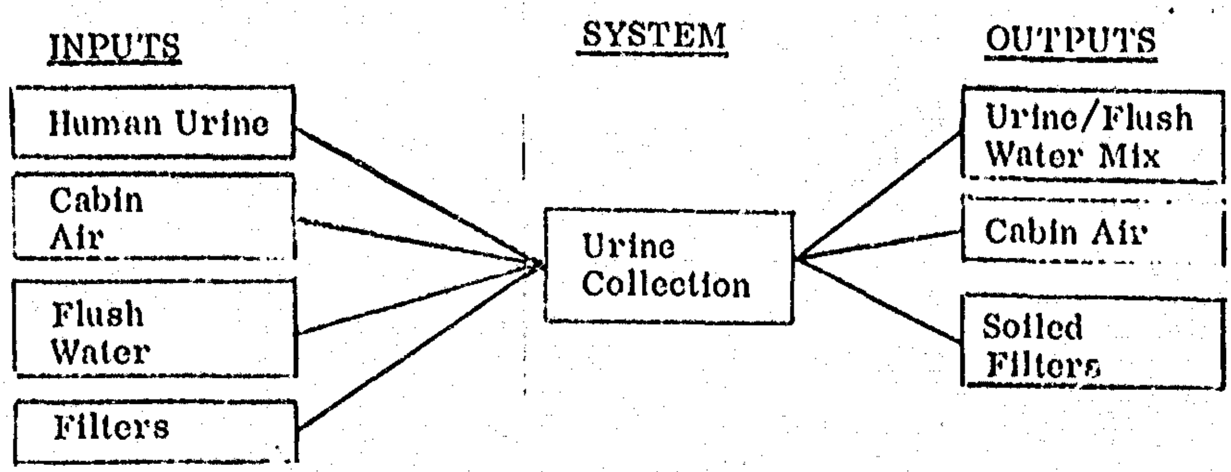
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year (lbs) 12 men	50 men	100 men	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Filters (Odor Control)	Solid, Metalic/ Granular, Pathogenic	Activated Charcoal	Purify Filter Element	51.9	216.3	432.6	85	
Filters (Bacteria Control)	Solid, Teflon Sheet Pathogenic	Teflon	Purify, Clean	2.6	10.8	21.6	5	
Waste Container (Filled)								
Bags	Solid, Plastic Sheet, Pathogenic	Teflon	Empty, Clean					
Chemicals	Liquid, Caustic	Various	Isolate					
Tissue	Solid, Paper Sheet, Pathogenic	Cellulose	Clean	2000	8333	16666	64	
Feces	Solid, Organic Bulk, Pathogenic	Bacteria	N/R					
Vomitus	Semi-liquid Organic Bulk, Pathogenic	Protein HCL. H_2O	N/R					
Filters, Fecal and Vomitus Collector	Solid Sheet (Bulk) Pathogenic	Cellulose	Purify, Clean	240	1000	2000	5	

Doc. No. A-1.4.1.2.1
Sheet No. 1
By: W. Ford
Date: 13 August 1970

OPERATIONAL DESCRIPTION

TITLE: Urine Collection

SCHEMATIC DIAGRAM



RATIONALE

The urine collection system concerns only the collection of human urine and its transportation to the water reclamation system where the water is recovered for re-use.

Operation of the system is initiated by opening the cover of the urinal horn. This activates a blower which draws cabin air down through the horn. The crewman urinates directly into the horn. The urine is carried through the horn and into a liquid/air separator by the flow of cabin air. The flush water button is pushed and flush water washes down the sides of the horn and tubing as it is drawn into the liquid/air separator by the cabin air flow. The cabin air is filtered by bacteria and odor control filters and returned to the cabin. The urine/flush water mixture is then separated from the trapped air by the liquid/air separator and the liquid delivered to the H_2O reclamation system for processing.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.4.1.2.1 Sheet No.
Operational Description No. A-1.4.1.2.1
Subsystem Human Waste Management
By: W. Ford Date: 13 August 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Urine Collection

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year (lbs)			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Filters	Filled	Volume	25.9	108.2	216.2	85	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.4.1.2.1 Sheet No. ____
Operational Description No. A-1.4.1.2.1
Subsystem Human Waste Management
By: W. Ford Date: 13 August 1970

TABLE III. WASTES

Title: Urine Collection

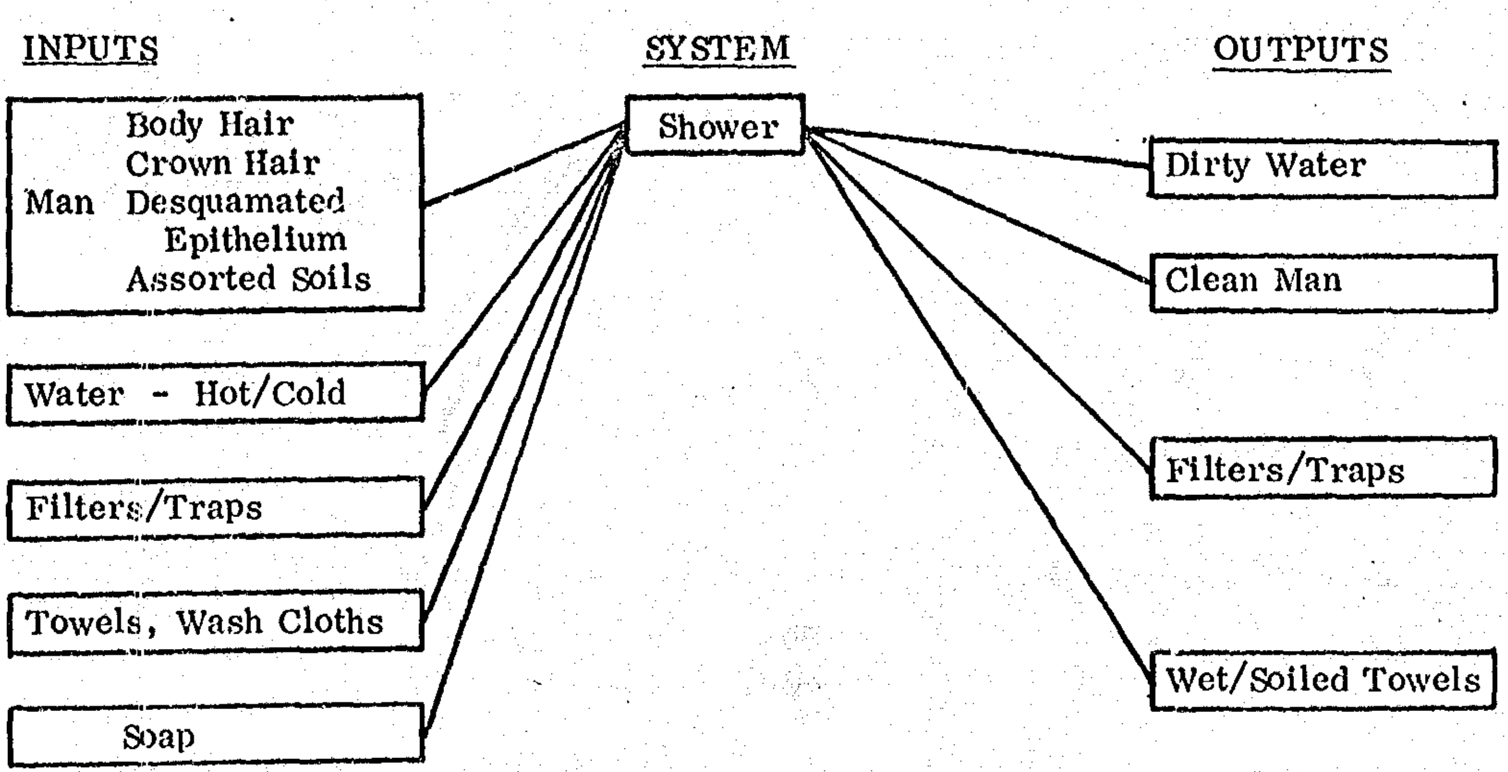
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year (lbs)			Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
				12 man	50 man	100 man		
Filters	Solid Metalic/ Grannular Pathogenic	Activated Charcoal	Purify Filter Element	25.9	108.2	216.4	85	

Doc. No. A-1.4.2.1.1
Sheet No. 1
By: P. Trotta
Date: 17 June 1970

OPERATIONAL DESCRIPTION

TITLE: Shower

SCHEMATIC BLOCK DIAGRAM



RATIONALE:

The zero-gravity shower is a cylindrical enclosure approximately 36 inches in diameter and 84 inches high. The man enters the shower naked and is restrained by foot stirrups while the mixture of air and water impinge upon his body. Water is introduced from a fixed (or hand-held) shower head. The spray is carried laterally along the cylinder axis and out the end by the air stream. A water collector/blower is utilized for the removal of local accumulations of water and to aid in drying. Temperatures and flow rates are controlled by the crewman. A wash cloth is provided for local area washing within the shower, and toweling may be required for final drying.

The shower system uses up filters and debris traps as it removes clogging debris and soils from the recirculating water or from the water being returned to the water management system. The other consumables and expendables are those listed in Table I and are related to shower usage.

TABLE I

SHOWER RATIONALE

A. Showers taken 3 times/week/man

B. Water Usage - 20 lbs/shower

C. Soap Usage - .044 lbs/shower

D. Filters/Traps - Good for 6 shower usages before clogging. Replaceable elements weigh 0.5 lb each

E. Towels weigh 0.25 lbs each, once/shower

F. Wash Cloths weigh 0.08 lbs each, once/shower

REFERENCES:

Vol. I Preliminary Design Report (Space Station: Hygiene, Waste Management, and Food Subsystems). FHR #3900, June 1, 1970 Fairchild Hiller/RAD

Design Sheets (Hygiene and Food Management) for MDAC. FHR #3902 June 5, 1970, Fairchild Hiller/RAD

Preliminary Definition - Integrated Hygiene System Material Provisions. FHR #3871, January 29, 1970, Fairchild Hiller/RAD

Hygiene Systems Analysis Debris Generation and Flow Patterns. FHR #3864 December 30, 1969, Fairchild Hiller/RAD

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-1.4.2.1.1 Sheet No. 1
Operational Description No. A- 1.4.2.1.1
Subsystem Full Body Wash
By: P. Trotta Date: 6-17-70

Title: Shower

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght required per year-lbs			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Water - Hot/Cold	Contaminated with soap and body soil	Water purity	37,440	156,000	312,000	62.4	Water to be recovered
Filters/Traps	Saturated with organic body debris	Voids filled and, bacteria growth	156	650	1300	20	
Towels	Contaminated with debris	Freshness	1,400	5,880	11,760	8	Density depends on packing method
Washcloths	Contaminated with debris	Freshness	150	627	1,254	16	Density depends on packing method
Soap	Disolved	Soap	82	343	686	62.4	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.4.2.1.1 Sheet No. 1
Operational Description No. A-1.4.2.1.1
Subsystem Full Body Wash
By: P. Trotta Date: June 17, 1970

TABLE III. WASTES

Title: Shower

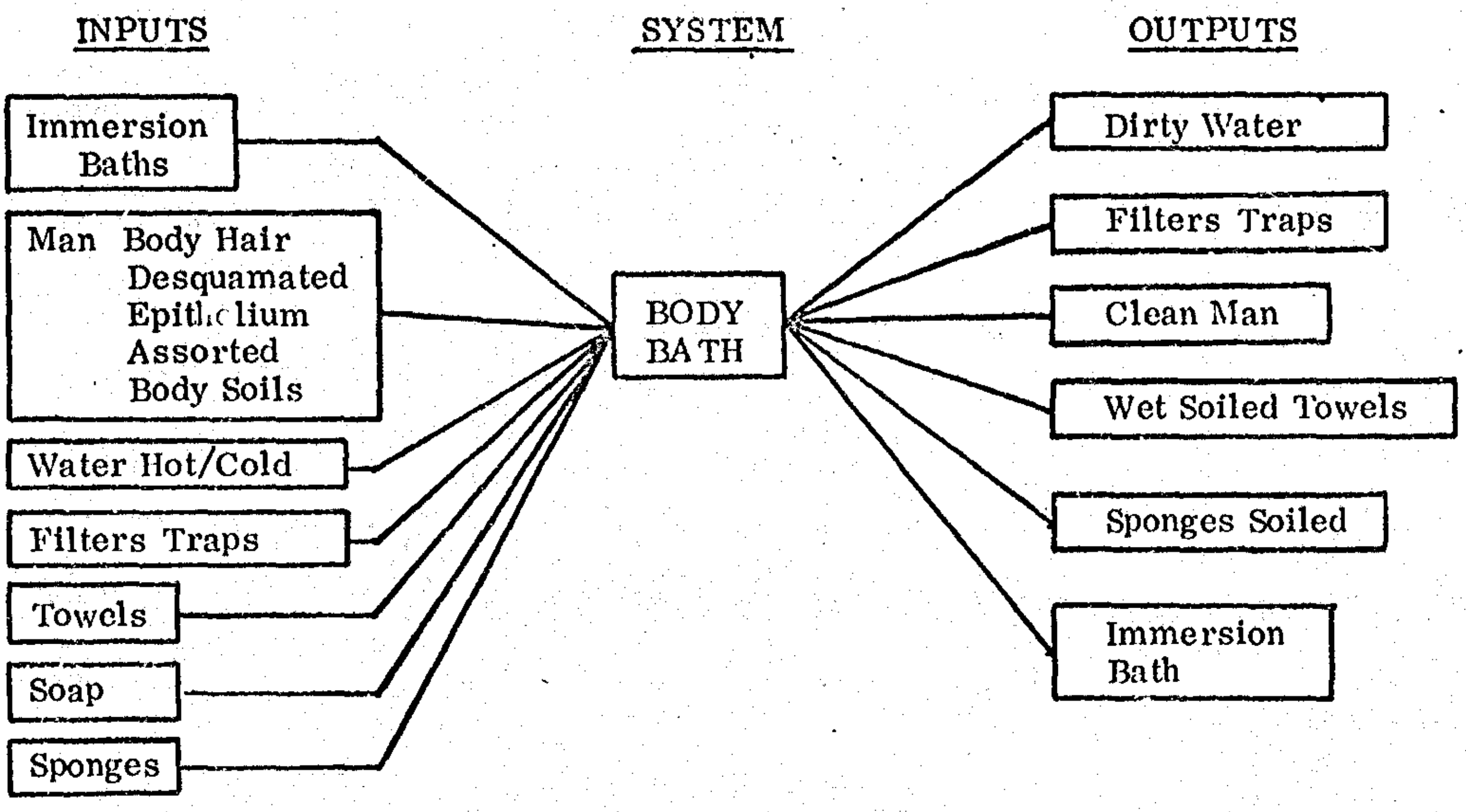
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght required per year-lbs 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Contaminated Wash Water	Liquid, water, organic body soils	H_2O	Purification	37,440	156,000	312,000	62.4	2.6 - 130, replacement water
Filters/Traps	Solid, plastic, granular, microbial activity	Sporke Teflon	Decontaminate and clean	156	650	1300	20	0.04 - 2, clean filter
Towels	Solid Textile Damp	Cellulose C-H-N	Launder	1400	5,880	11,760	8	0.4 - 2.4 launder
Washcloths	Solid Textile Damp	Cellulose C-H-N	Launder	150	627	1,254	16	Included with towels

Doc. No. A-1.4.2.1.2
Sheet No. 1
By: P. Trotta
Date: 22 June 1970

OPERATIONAL DESCRIPTION

TITLE: Immersion Bath

SCHEMATIC BLOCK DIAGRAM:



RATIONALE:

The immersion bath concept consists of a plastic suit which has four pads of sponge material on the inner surface strategically located, which are replaced every bath. The crewman steps into the suit and seals it around himself (the suit does not cover his head). Water is introduced through lines from the water management subsystem. Washing is obtained by either rubbing the sponge areas over the body, use of a washcloth, or direct hand washing. Upon completion of the wash, water is pumped out to the water management subsystem. The man rinses the same way, steps out of the suit, washes the suit out and dries it after removing the four sponge pads.

The immersion bath uses up filters and traps as they remove clogging materials and debris from the water prior to its return to the water management system. The other consumables/expendables are listed in Table I and are related to the bathing process.

Doc. No. A-1.4.2.1.2
Sheet No. 2
By: P. Trotta
Date: 22 June 1970

TABLE I. IMMERSION BATH RATIONALE

A. Baths taken 3 times/wk/man

B. Wash water usage is 7 lbs/bath for body plus 3 lbs/bath to wash bath.

C. Soap usage - .044 lbs/bath.

D. Wash sponges - 0.02 lbs/sponge, 4 sponges/bath.

E. Filters/Traps - good for 6 baths before replacement. Elements are 0.5 lbs each.

F. Towels - 0.75 lbs/usage.

G. Immersion bath should last for 52 baths before requiring replacement. Bath weighs about 11 lbs each.

REFERENCES:

Vol. 1 Preliminary Design Report (Space Station: Hygiene, Waste Management, and Food Subsystems). FHR #3900 June 1, 1970 Fairchild Hiller/RAD.

Design Sheets (Hygiene and Food Management) for MDAC. FHR #3902 June 5, 1970. FH/RAD.

Preliminary Definition - Integrated Hygiene System Material Provisions. FHR #3871. Jan. 29, 1970, FH/RAD.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.4.2.1.2 Sheet No. 1
Operational Description No. A- 1.4.2.1.2
Subsystem Full Body Wash
By: P. Trotta Date: 22 June 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Immersion Bath

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	REMARKS
Water Hot/Cold	Contaminated with Soap and Body Soil	Water Purity	18,720	78.000	156,000	62.4	
Filters/Traps	Saturated with Debris from Wash Water	Filter Element Voids Filled	156	650	1,300	20	
Towels	Wet and Soiled in Drying	Freshness	821	3,422	6,843	8	Depends on Packing Method.
Soap	Dissolved in Wash Water	Soap	82	343	686	62.4	
Sponges	Contaminated with Debris	Freshness	150	627	1,254	1.2	Depends on Packing Method
Immersion Bath Suit	Worn out	Life Expect.	396	1,650	3,300	40.0	Depends on Packing Method

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.4.2.1.2 Sheet No. 1
Operational Description No. A-1.4.2.1.2
Subsystem Full Body Wash
By: P. Trotta Date: 22 June 1970

TABLE III. WASTES

Title: Immersion Bath

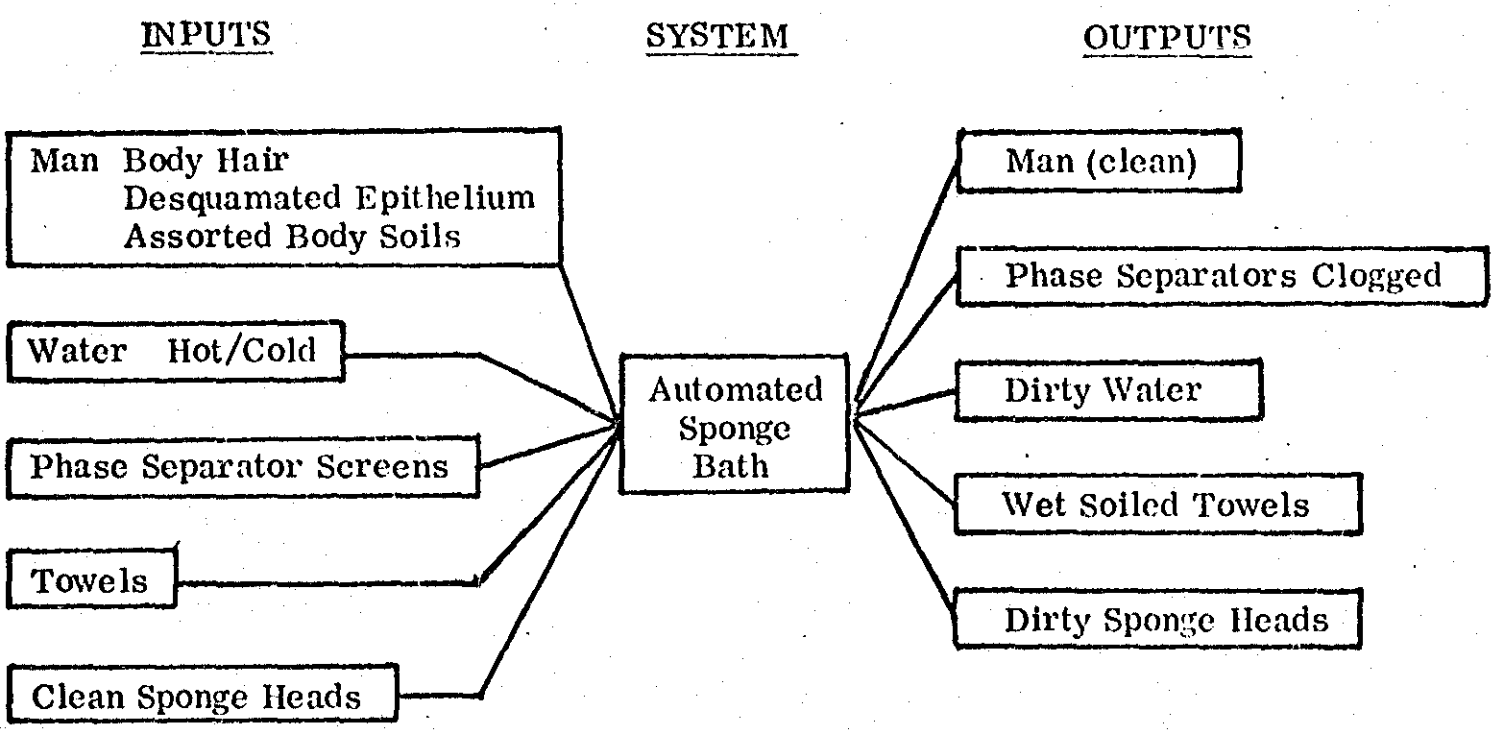
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Dirty Wash Water	Liquid-Water, Organic Body Soil	H2O	Remove Contaminants	18,720	78,000	156,000	62.4	1.3 → 65 Replaces Water
Exhausted Filters and Traps	Solid-Plastic, Screen, Micro Organisms	Glass/Teflon	Remove Contaminants	156	650	1,300	20	0.04 → 2.0 Clean Filters
Used Towels	Solid Fabric, Damp	Cellulose C-H-N	Launder	821	3,422	6,843	8	0.4 → 2.4 Launder
Used Sponges 12" x 12" x 1/4" Changed ever 3 washes .02566/sponge	Solid, Plastic Inert Pathogenic	Polyurethane	Launder	150	627	1,254	1.2	Clean with Towels
Spent Immersion Bath Suit	Solid Sheet Plastic	Polyester/ Glass	-	396	1,650	3,300	40	-

Doc. No. A-1.4.2.1.3
Sheet No. 1
By: P. Trotta
Date: 18 June 1970

OPERATIONAL DESCRIPTION

TITLE: Automated Sponge Bath

SCHEMATIC BLOCK DIAGRAM:



RATIONALE:

The automated sponge bath has water delivery lines leading to a hand-held flexible sponge. A metering/mixing valve dispenses a controlled amount of water and detergent to the sponge at the option of the crewman. The hand-held unit is moved over the body for local cleaning. A return line permits pickup of water from the body with liquid moved through the sponge and line by a blower. At the pickup end, an air/water separator is used to remove the used water for delivery to the water management system. Sponge heads are replaceable and are provided in quantity to allow a clean sponge for each wash. The sponges remove gross particulate matter from the water prior to its entry into the phase separator which is of the passive screen type. Table I supplies the rationale for the material rates.

Doc. No 1.4.2.1.3
Sheet No. 2
By: P. Trotta
Date: 18 June 1970

TABLE I - AUTOMATED SPONGE BATH RATIONALE

A. Bath Usage - 1 man/day

B. Water Usage - 0.5 lbs/man/day

C. Phase Separators - 0.2 lb each, changed twice/month/man

D. Sponge Heads - 0.02 lbs each, changed 1/day/man

E. Towels - 0.27 lbs/each, one/man/day (these are lighter than bath towels)

F. Detergent - 1 Ml/usage (.0022 lbs) Benz Alkonium Chloride

REFERENCES:

Vol 1 Preliminary Design Report (Space Station: Hygience. Waste Management. and Food Subsystems), FHR #3900, June 1 1970, Fairchild Hiller/RAD.

Design Sheets (Hygiene and Food Management) for MDAC, FHR #3902, June 5, 1970, Fairchild Hiller/RAD.

Preliminary Definition - Integrated Hygiene System Material Provisions, FHR #3871, January 29, 1970, Fairchild Hiller/RAD.

Hygiene Systems Analysis Debris Generation and Flow Patterns, FHR 3864, December 30, 1969, Fairchild Hiller/RAD

Study of Housekeeping Concepts For Manned Space

Doc. No. B- 1.4.2.1.3 Sheet No. 1
Operational Description No. A- 1.4.2.1.3
Subsystem Full Body Wash
By: P. Trotta Date: 18 June 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Automated Sponge Bath

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght req'd per year-lbs			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Water (Hot/Cold .5 lb/usage 1/usage/man/day	Contaminated with soap and body soil	H_2O	2190	9125	18250	62.4	
Filters .2 lb each 12 usages/filter	Become saturated with debris	Purity of filter material	57.6	240	480	20	
Towels .75 lb ea used 4 days	Become wet and soiled in drying	Cotton terry cloth	1250	5000	10000	8	
Clean sponge heads 1/2" x 2" x 3" .03	Become saturated with debris	Purity of sponge material	88	365	730	1.2	Density is a function of packaging
Detergent	Diluted in wash water	Germicidal action	10	40	80	75	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.4.2.1.3 Sheet No. 1
Operational Description No. A-1.4.2.1.3
Subsystem Full Body Wash
By: P. Trotta Date: 18 June 1970

TABLE III. WASTES

Title: Automated Sponge Bath

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght req'd per year-lbs 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Used Wash Water	Liquid, water, organic body soil	H_2O	Decontaminate	2190	9125	18250	62.4	.2 → 7 reprocess water
Clogged Phase Separators	Solid plastic screen, micro-organisms	Glass/teflon	Decontaminate	57.6	240	480	20	0.01 → clean screens
Used towels	Solid, textile, damp	Cellulose C-H-N	Launder	1200	5000	10000	8	0.6 → 3.6 launder
Used sponge heads	Solid, plastic, pathogenic	Polyurethane	Decontaminate	88	365	730	1.2	Clean with towels
Detergent	Liquid - detergent germicide	Amine + quaternari	None	10.0	40	80	75	0.0 recovery

Doc.No. A-1.4.3.1.1
Sheet No. 1
By: P. Trotta
Date: 18 June 1970

OPERATIONAL DESCRIPTION

TITLE: Hygiene Center

SCHEMATIC BLOCK DIAGRAM

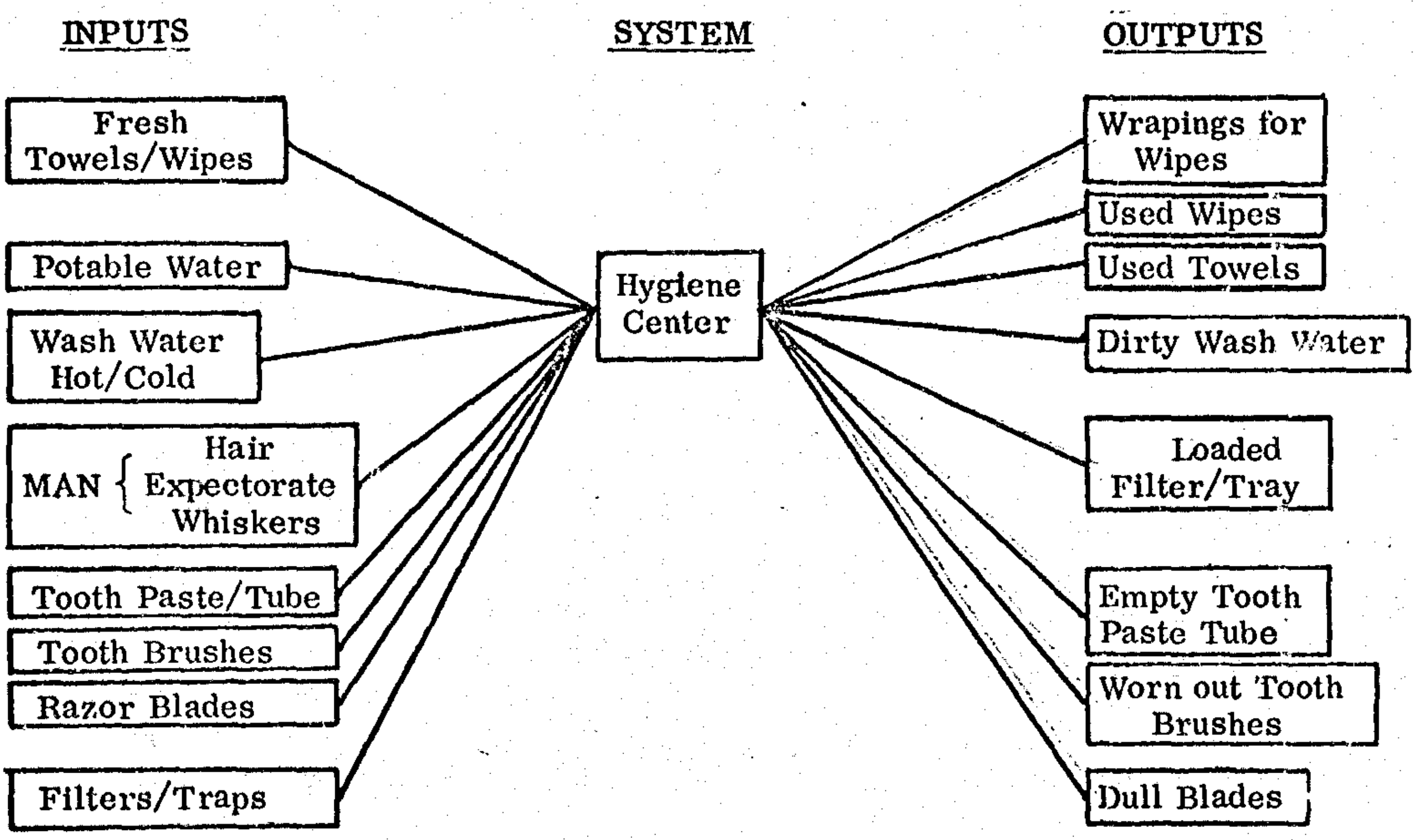


Figure I. Hygiene Center Material Flow

RATIONALE:

For daily grooming and simple hands and face washing a personal hygiene center is assumed consisting of a personnel storage area and a sink which flows hot/cold water and collects the water by airflow when gravity is absent. The functions and material flow through the hygiene center are shown in Figure 1.0. The rationale behind the consumables/expendables and wastes listed in document B and C-1.4.3.1.1 is supplied in Table 1.

Doc. No. A-1.4.3.1.1.
Sheet No. 2
By: P. Trotta
Date: 18 June 1970

Table 1. Hygiene Center Rationale

A. Hands and face wash - once in morning and before each meal - 4 times per man/day.

1.	Water usage	-	120 ml/man/usage
2.	Towels	-	1/man/day - 0.27lb each
3.	Soap	-	0.004 lbs/usage

B. Hands/face wipes - for refreshment after meals and after body evacuations, an average of 12 wipes/day/man. Wiper are premoistened with a cleaner plus a bactericide propylene glycol and alcohol and packaged in an aluminum foil cover. Wipes weigh about 3 gms with about 1 gms for the wrapping (0.1 lbs/man/day).

C. Shaving - assuming one shave each day using safety razor and soap lather generator. Blades are 1.0 gms each and are usable about 5 times each. Soap, water and towelling are included in "A" above.

D. Har cutting, nails, etc. - performed on or as needed basis - estimated at 0.0175 lbs/man/day (8gms).

E. Oral hygiene - twice/day using 50 ml potable water for rinsing each usage.

a. tooth paste - 3 gms/usage
b. spent tooth paste tube - once per man/month 25 gms each.
c. tooth brush - 1 per 90 days - 30 gms each.

F. Spares - the sink would have scheduled and unscheduled maintenance items.

1. Scheduled:
   - Filter material used to collect the drain water and separate it from the air. Replace once/man/month, 0.5 lbs/unit.
   - Activated charcoal odor control elements used at the rate of one cannister (0.92 lbs) every 500 sink usages or .222 lbs/man/month.

2. Unscheduled:
   - One set of sink parts for each 4 men once per year at a weight of 20 lbs/set.

REFERENCES:

Vol. 1 Preliminary Design Report (Space Station: Hygiene, Waste Management, and Food Subsystems). FHR #3900, June 1, 1970, Fairchild Hiller/RAD

Design Sheets (Hygiene and Food Management) for MDAS, FHR #3902, June 5, 1970, Fairchild Hiller/RAD.

Preliminary Definition - Integrated Hygiene System Material Provisions, FHR #3871, February 2, 1970, Fairchild Hiller/RAD.

Hygiene Systems Analysis Debris Generation and Flow Patterns, FHR #3864, December 30, 1969, Fairchild Hiller/RAD.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B- 1.4.3.1.1 Sheet No. 1
Operational Description No. A- 1.4.3.1.1
Subsystem Partial Body Wash
By: P. Trotta Date: 6/18/70

Title: Hygiene Center

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght req'd per year-lbs			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Potable Water	In teeth washing	Purity of Water	965	4020	8040	62.4	
Wash Water	In washing (hands & face)	Purity of Water	4,650	19,350	32,700	62.4	
Tooth Paste in Individual Tubes	Dissolved in Saliva and mixed with water	Paste inside the tube	58	241	482	70	
Tooth Brushes	Worn out by usage	Bristles become bent and soft	3.2	14.3	28.6	100	
Razor Blades	Dulled in shaving	Loses sharpness	1.93	8.7	17.4	400	
Odor control cartridge	Saturated with debris during utilization	Absorbent	32	134	268	50	
Filter Screen	"	Free Area	72	300	600	20	
Spare Sink Parts	Wear	Seals & Fits	60	250	500	100	
Towels	Soiled in use	Freshness	1185	5,340	10,680	8	
Wipes	Opened and Soiled in use	Cleanliness	460	1,820	3,640	70	
Soap	Combined with Body Soil	Emulsifiers	70	292	584	62	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.4.3.1.1 Sheet No. 1
Operational Description No. A-1.4.3.1.1
Subsystem Partial Body Wash
By: P. Trotta Date: 6/18/70

TABLE III. WASTES

Title: Hygiene Center

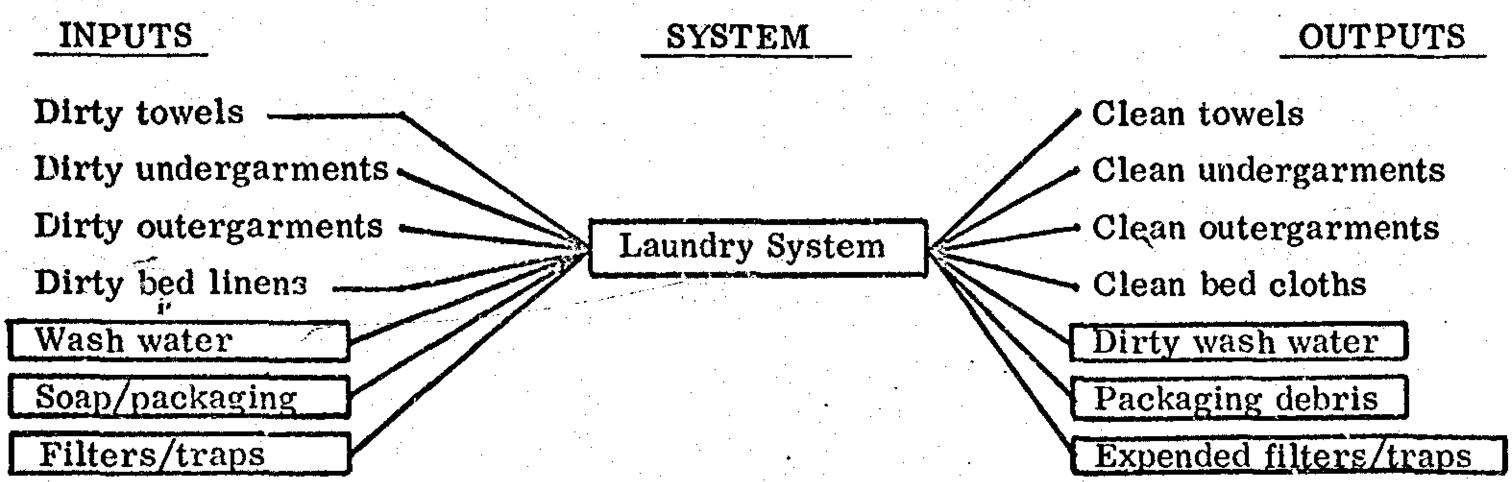
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght req'd per year-lbs 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Dirty Water	Liquid, water, Soap, organics	H_2O	Decontaminate	5,615	23,370	46,740	62.4	
Empty Tooth Paste Tubes	Solid, metal and plastic, tube, soap residues	Aluminum foil Nylon top	Refill	8	36	72	190	
Worn Tooth Brushes	Solid, plastic rod, inert	Nylon	Replace worn bristles	3.2	14.3	28.6	100	
Razor Blades	Solid, metal sheet, inert, sharp	Steel	Resharpen	1.93	8.7	17.4	400	
Odor Control Cartridge	Solid, carbon, granular, organic contaminants	Activated charcoal	Reactivate	32	134	268	50	
Filter Screen	Solid, plastic, organic contaminants	Glass, Teflon	Reverse flush	72	300	600	20	
Failed Sink Parts	Solid, metal, inert	Stainless steel	Replace worn seals	60	280	500	100	
Soiled Towels	Solid, fabric light body soil	Cellulose, c, H_2, N_2	Launder	1185	5,340	10,680	8	
Wipes, Packaging	Solid, metal, foil	Aluminum	None	115	455	910	65	
Wipes, Soiled Tissues	Solid, paper & liquids, body soil	Cellulose, propylene glycol	None	345	1,365	2730	25	

Doc. No. A-1.4.4.1.1
Sheet No. 1
By: P. Trotta
Date: 18 June 1970

OPERATIONAL DESCRIPTION

TITLE: Laundry

SCHEMATIC BLOCK DIAGRAM



RATIONALE:

The laundry will use packaged soap at a rate equivalent to 1% of the clothing usage rate (by weight). Soap packaging is assumed at 5% of the soap weight. Water is used in a ratio of 20 to 1 by weight with material to be washed. The number of changes of clothing and linens per year times the weight of these articles provides the weight of wash/year. The articles to be washed and their rates are covered in other documents as shown in Table I - Laundry Rationale. Also included are the scheduled/unscheduled maintenance items.

TABLE I - LAUNDRY RATIONALE

A. Laundry load:

- Clothing usage = 0.42 lbs/man/day (see A-1.2.2.1.1)
- Bed linens = 0.063 lbs/man/day (see A-1.2.2.2.1)
- Toweling/shower = 0.83 lbs/man/day (see A-1.4.2.1.1)
- Toweling/grooming = 0.27 lbs/man/day (see A-1.4.3.1.1)

  Total Wash = 1.633 lbs/man/day.

- Laundry cycle = 11.431 lbs/man load once/week - two hours wash and dry cycle.

Doc. No. A-1.4.4.1.1
Sheet No. 2
By: P. Trotta
Date: 18 June 1970

TABLE I - LAUNDRY RATIONALE (Cont'd.)

B. Scheduled Maintenance:

- Filter material used to filter lint, etc. from the drain water. Replace after each 1000 lbs of wash. 0.5 lbs each unit.
- Filter material used as air seperator, 0.5 lbs/unit replaced after each 500 hours of use.

C. Unscheduled Maintenance:

- Motor/gearbox - 16 lbs/set - 2000 hour life expectancy
- Valving bearings, seals and controls - 20 lbs/set - expected replacement at the rate of 5 lbs/1000 hours of use.

REFERENCES:

Vol. 1 Preliminary Design Report (Space Station: Hygiene, Waste Management, and Food Subsystems) FHR 3900 June 1, 1970 FH/RAD

Surface Active Agents and Detergents; AM. Schwartz, J.W. Perry, J. Berch. Vol. II, Interscience Publishers, Inc., N.Y. 2nd Printing, May 1966.

Handbook of Garment Selection Criteria for a Space Station. NASA CR 102051, by B. Welson & Co., Inc. Hartford Connecticut (1969)

Preliminary Definition - Integrated Hygiene System Material Provisions, FHR 3871 Feb. 2, 1970 FH/RAD

Hygiene Systems Analysis Debris Generation and Flow Patterns, FHR 3864 Dec. 30, 1969 FH/RAD

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.4.4.1.1 Sheet No. 1
Operational Description No. A-1.4.4.1.1
Subsystem Revitalization of Textiles
By: P. Trotta Date: 18 June 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Laundry

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	REMARKS
Wash Water	Soil and Soap dissolved in it	Soil removal capacity	35540	148080	296160	62.4	
Soap (5% additional for packaging weight)	Diluted with water, combined with soil	Detergency	70	293	586	63	
Filter screen/lint	Saturated with debris	Free area	10	45	90	20	
Filter screen/seperator	Saturated with debris	Free area	2.4	10	20	20	
Motor/gear train	Wear out	Life	10	41.5	93	200	
Valving bearings, seals and controls	Wear out	Fit, seal, life	12.5	52	104	100	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.4.4.1.1 Sheet No. 1
Operational Description No. A-1.4.4.1.1
Subsystem Revitalization of Textiles
By: P. Trotta Date: 18 June 1970

TABLE III. WASTES

Title: Laundry

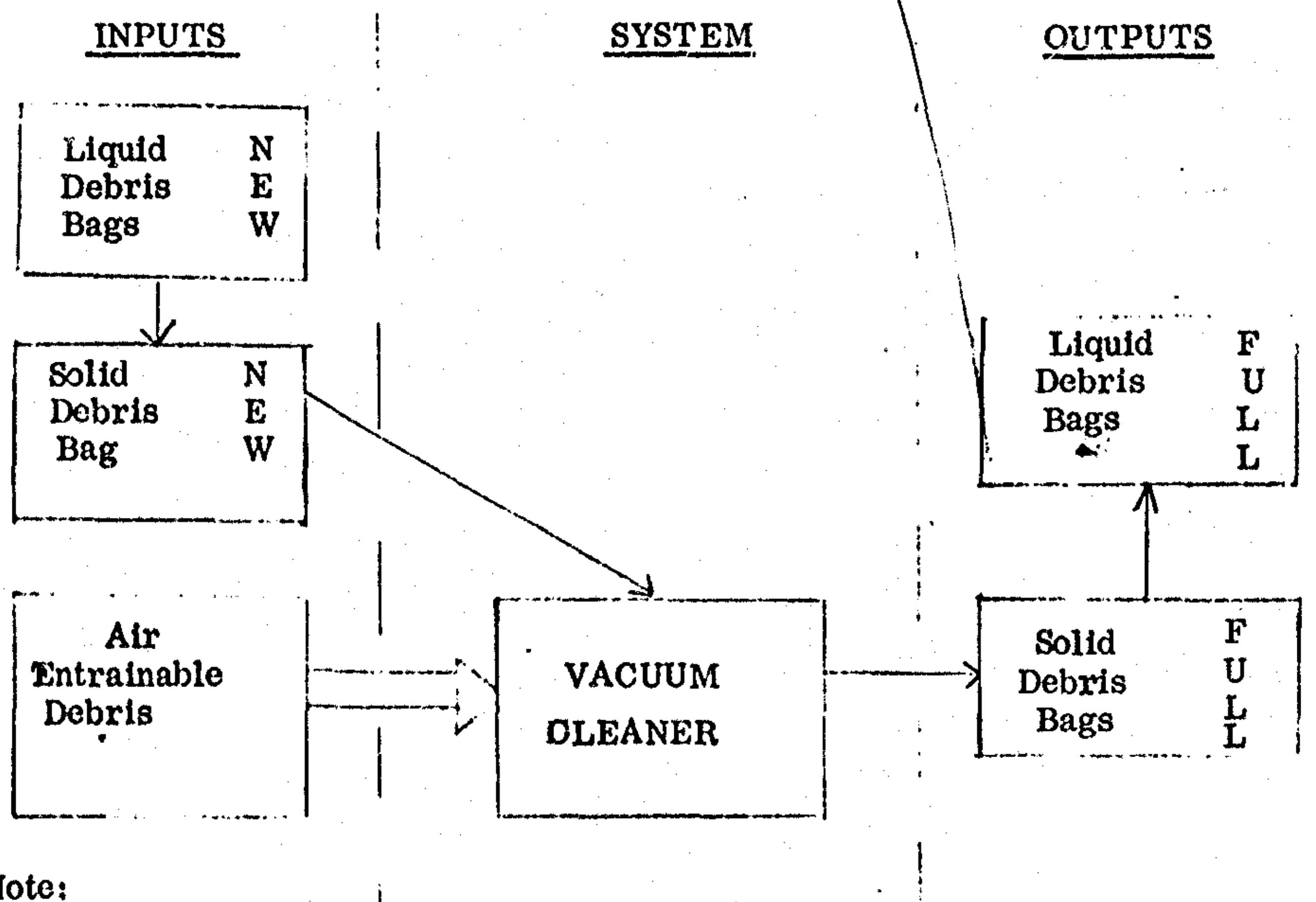
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Wash water	Liquid, water organic soil	H_2O	De-contaminate	143,000	600,000	1,200,000	62.4	
Soap packaging	Solid, organic bulkey, inert	Polyetheline	Reprocess	3.5	15	30	30	
Filter screen/lint	Solid, plastic screen plus textile lint	Glass, teflon cellulose	Reverse flush	10	45	90	20	
Filter screen/seperator	Solid, plastic screen	Glass, teflon	Reverse flush	2.4	10	20	20	
Failed motor/gears	Solid, Metal, cylinder, compact	Steel, copper, plastic	Replace worn parts	10	41.5	93	200	
Failed valving, bearings, seals, controls	Solid, metal compact	Steel, copper plastic	Replace worn parts	12.5	52	104	100	

Doc. No. A-1.4.5.1.1
Sheet No. 1
By: P. Trotta
Date: 19 June 1970

OPERATIONAL DESCRIPTION

TITLE: Vacuum Cleaner

SCHEMATIC BLOCK DIAGRAM:



Note:

(1) Liquid (inc. urine) spillage on surfaces (inc. Fabrics) and in air

(2) Hair on surfaces and in air

(3) Food particles on surfaces and in air

(4) Dust particles, paper (small bits), work debris

RATIONALE:

The vacuum cleaner will be used routinely and will have the capacity of retaining fluids as well as solids. One master unit will service the quarters of each 4 men or fraction thereof, on the assumption of one unit/deck.

The vacuum cleaner consumes empty bags at the same rate it produces full ones. The debris bags will be replaceable and will consist of a liquid debris bag section (5 gms), capable of holding 100 mc of liquid overflow from the main section (50 gms) which will hold the solid debris (1 liter) (50 gm, 1 liter). The bags will be replaced after any emergency spill and routinely once a month/unit. Two emergency spills (50 gms) per unit per year are assumed along with 0.5 lbs of routinely collected debris/unit/month. The average density of the solid debris is assumed to be approx. 10 lb/Ft^3 and the liquid approx. 62.4 lb/Ft^3. The scheduled maintenance includes replacement of the blower motor (7 lbs) and the hoses (1 lb) once per unit per year.

REFERENCES:

Vol. 1 - Preliminary Design Report (Space Station: Hygiene, Waste Management, and Food Subsystems). FHR #3900 June 1, 1970 Fairchild Hiller/RAD.

Housekeeping and Trash Disposal Equipment Space Station. - FHR 3800 Feb. 16, 1970 FH/RAD.

Hygiene Systems Analysis Debris Generation and Flow Patterns. - FHR #3864 Dec. 30, 1969 FH/RAD.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-1.4.5.1.1 Sheet No. 1
Operational Description No. A-1.4.5.1.1
Subsystem Crew Quarters Housekeeping
By: P. Trotta Date: 19 June 1970

Title: Vacuum Cleaner

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght req'd per year-lbs			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Fresh Solid Liquid Debris Bags	Filled with Solid/Wet Debris	Volume	5.1	21.2	42.4	60	
Replacement Blower Motors	Wear Out	Seals, Fits, Lubrication	21	37.5	175.0	200	
Replacement Hose	Wear Out	Pressure Integrity	3	12.5	25	20	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.4.5.1.1 Sheet No. 1
Operational Description No. A-1.4.5.1.1
Subsystem Crew Quarters Housekeeping
By: P. Trotta Date: 19 June 1970

TABLE III. WASTES

Title: Vacuum Cleaner

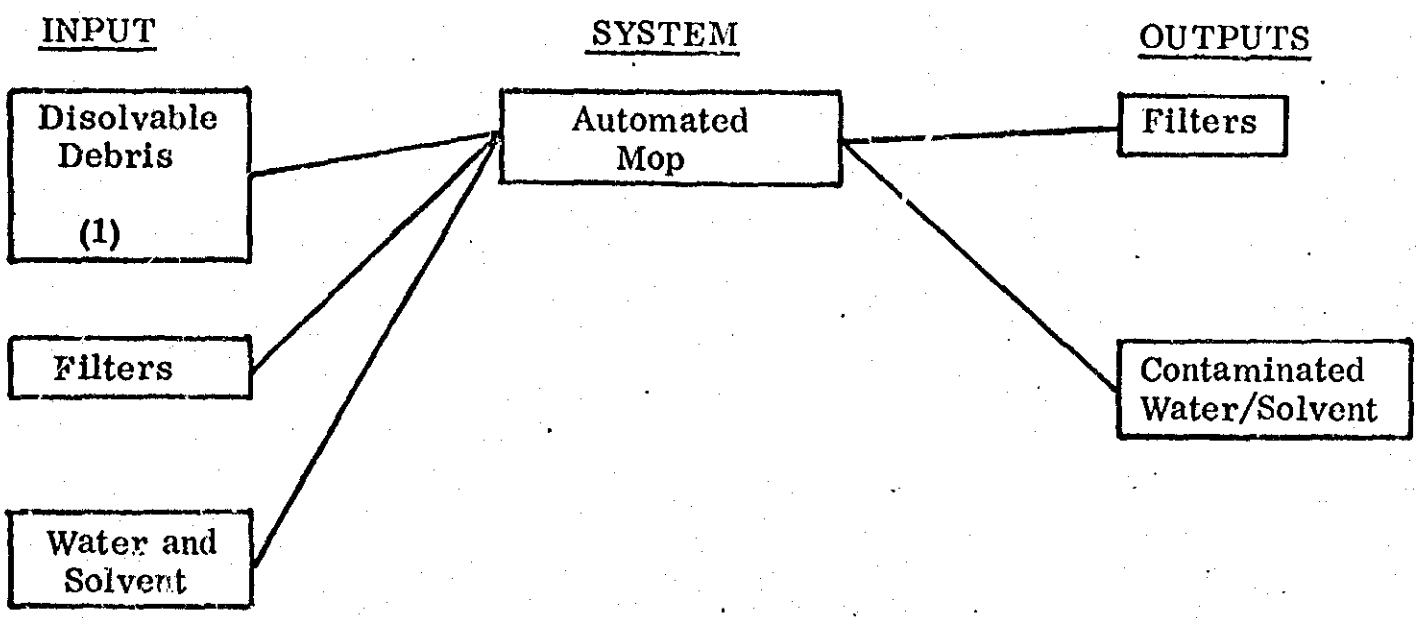
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght req'd per year-lbs 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Liquid/Solid Debris Bags	Solid, Plastic Sheet, Organic Debris	Teflon	Empty, Reverse Flush	5.1	21.1	42.4	60.0	
Solid Debris in Bags	Solid, Organic	Dust, Food, Hair	None	21	87.5	175.0	10	
Failed Blower Motor	Solid, Metal Compact cylind.	Aluminum, Copper	Repair, worn part	21	87.5	175.0	200	
Failed Hose	Solid, Plastic Hollow Tube	Teflon	Patch	3	12.5	25	20	

Doc. No. A-1.4.5.2.1
Sheet No. 1
By: P. Trotta
Date: 22 June 1970

OPERATIONAL DESCRIPTION

TITLE: Surface Washer/Wiper (Automated Mop)

SCHEMATIC BLOCK DIAGRAM



RATIONALE:

The automated mop provides for damp wiping operations in zero or low gravity fields and will be used to clean surfaces on a routine basis, probably weekly. One unit is assumed for each four men. It is expected that the unit will require two lbs of water per unit/week used for damp wiping, tables, lounges, bed sheets, coveralls, wall surfaces, ietc.. One percent by weight of a bactericide will be added to the water. The blower motor (7 lbs.) is expected to have a 2000 hour life and the hoses (1 lb) 500 hours of life. The unit will be used about one hour/man/week.

REFERENCES:

Vol. 1 Preliminary Design Report (Space Station - Hygiene, Waste Management, and Food Subsystems) FHR 3900, June 1, 1970, Fairchild Hiller/RAD.

Housekeeping and Trash Disposal Equipment Space Station. FHR 3880 February 16, 1970, Fairchild Hiller/RAD.

Preliminary Definition - Integrated Hygiene System Material Provisions, FHR3871, February 2, 1970, Fairchild Hiller/RAD.

Hygiene Systems Analysis Debris Generation and Flow Patterns, FHR3864, December 30, 1969, Fairchild Hiller/RAD.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-1.4.5.2.1 Sheet No. 1
Operational Description No. A-1.4.5.2.1
Subsystem Crew Quarters Housekeeping
By: P. Trotta Date: 22 June 1970

Title: Automated Mop

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total wght req'd per year-lbs			Average Density As Received lbs/cu.ft.	REMARKS
			12 man	50 man	100 man		
Filters	Contaminated with debris	Free Area	10.8	45	90	20.0	
Sponge Heads	Contaminated with debris	Purity of Sponge Material	7.2	30	60	3.0	
Wash Water	Contaminated with debris	Freshness	312	1300	2600	62.4	
Bactericide	Diluted	Germicidal Strength	3.1	13.0	26.0	60.0	
Replacement Blower	Wear out	Seals, bits, lubricant	2.1	9.1	18.2	200.0	
Replacement Hoses	Wear out	Pressure, integrity	1.25	5.2	10.4	20.0	

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 1.4.5.2.1 Sheet No. 1
Operational Description No. A- 1.4.5.2.1
Subsystem Crew Quarters Housekeeping
By: P. Trotta Date: 22 June 1970

TABLE III. WASTES

Title: Automated Mop

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total wght req'd per year-lbs. 12 man	50 man	100 man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Exhausted Filters	Solid Plastic Sheet, Organic Debris	Teflon/Glass	Reverse Flush	10.8	45	90	20.0	
Dirty Sponge Heads	Solid, Plastic Organic Debris	Polyurethane	Decontaminate (Launder)	7.2	30	60	3.0	
Used Wash Water and Bactericide	Liquid, Water	H_20	Filter Distill	315	1313	2626	62.4	
Failed Blower	Solid, Metal,	AL, Cu	Replace worn parts	2.1	9.1	18.2	200.0	
Failed Hose	Solid, Plastic Hollow Tube	Teflon	Patch	1.25	5.2	10.4	20.0	

PROVIDE AND CONTROL ATMOSPHERIC ENVIRONMENT

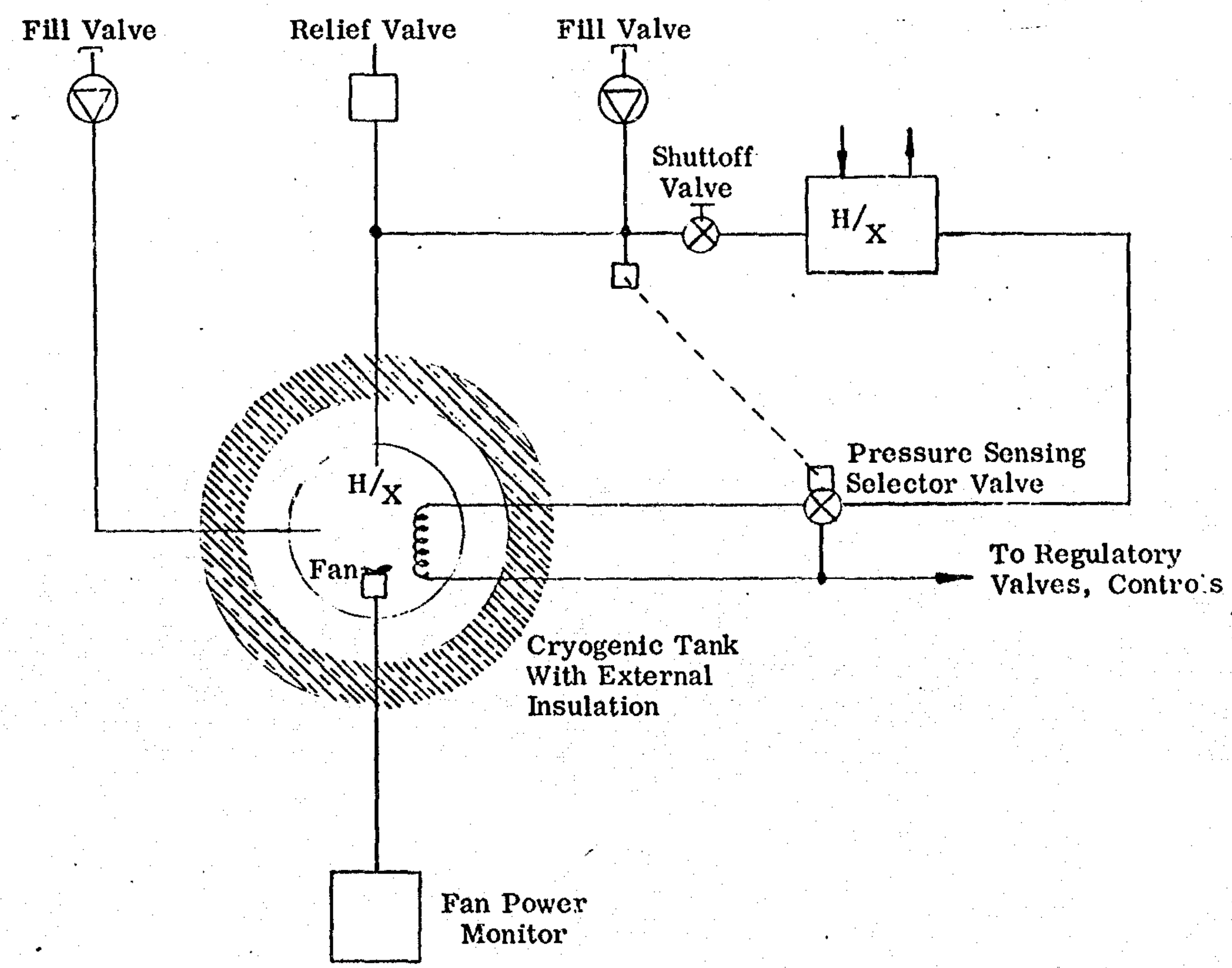
TABLE OF CONTENTS

Doc. No. A-1.5.1.1.1
Sheet No. 1
By: C. Cinicove
Date 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Supercritical Storage and Supply

SCHEMATIC DIAGRAM:



Typical Schematic Per Tank

Doc. No. A-1.5.1.1.1
Sheet No. 2
By: C. Cinicove
Date 31 July 1970

OBJECTIVE:

This system will store the oxygen and nitrogen needed to meet the cabin leakage requirements and pressurization functions.

RATIONALE:

The atmosphere supply will independently maintain two pressurized volumes. The gas will be stored at 3000 psia and 0°F. The storage bottles will consist of 3 nitrogen and 3 oxygen tanks to provide adequate redundancy to minimize hazards associated with degraded mission modes. A heat exchanger located within each tank will provide energy for pressurization so as to maintain isobaric conditions. A small fan will be used to sense the density of the oxygen as well as increase internal energy exchange.

The components and plumbing systems although long life items will require some repairs. The N_2 and O_2 utilized are accounted for wastes in other systems and are not considered as such here. The following additional assumptions are made.

1. Weight rates vary with crew size because either quantity, size or use rate must be adjusted to suit.
2. Component failures/repairs assumed are for 1 year - 12 men.
   - Pressure seals - 0.08 lbs each - 8 replacements
   - Selector valve - 3.0 lbs each - 0.5 replacements

REFERENCES:

Roth, E.M., Selection of Space Cabin Atmospheres. Part I and IV, NASA - TN-D-2008, August 1963.

Life Support For Space Flights Of Extended Time Periods. NASA CR-614, General Dynamics (Contract NAS 1-2934)

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B- 1.5.1.1.1 Sheet No. 1
Operational Description No. A- 1.5.1.1.1
Subsystem Atmospheric Gas Supply
By: C. Cinicove Date: 31 July 1970

Title: Supercritical Storage and Supply

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Nitrogen	Leakage	Availability	670	2,500	5,000	15.4	
Oxygen	Metabolized	Availability	8,400	34,200	74,400	16.4	
Pressure Seals	Wear	Life	.64	2.6	5.2	100	
Pressure Sensing Selector Valve	Wear	Life	1.5	6.0	12.0	250	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C- 1.5.1.1.1 Sheet No. 1
Operational Description No. A- 1.5.1.1.1
Subsystem Atmospheric Gas Supply
By: C. Cinicove Date: 31 July 1970

Title: Supercritical Storage and Supply

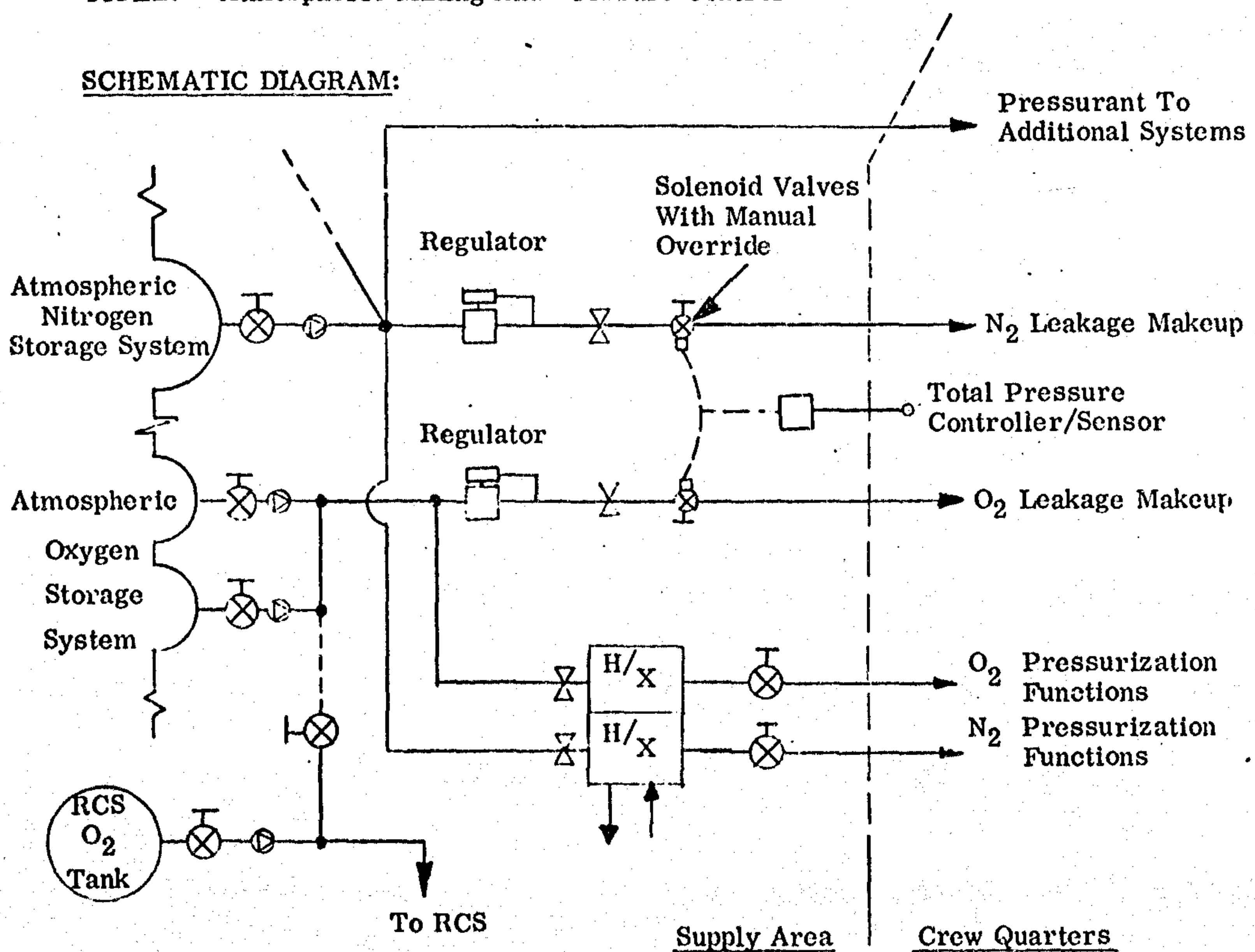
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu. ft.	Index Of Utilization Potential And Remarks
				12 Man	50 Man	100 Man		
Pressure Seals	Solid - Metal Ring	Fe, Ni, Cu	N/R	.64	2.6	5.20	100	
Pressure Sensing Selector Valve	Solid - Metal	Al, Fe, Ni	N/R	1.5	6.0	12.0	250	

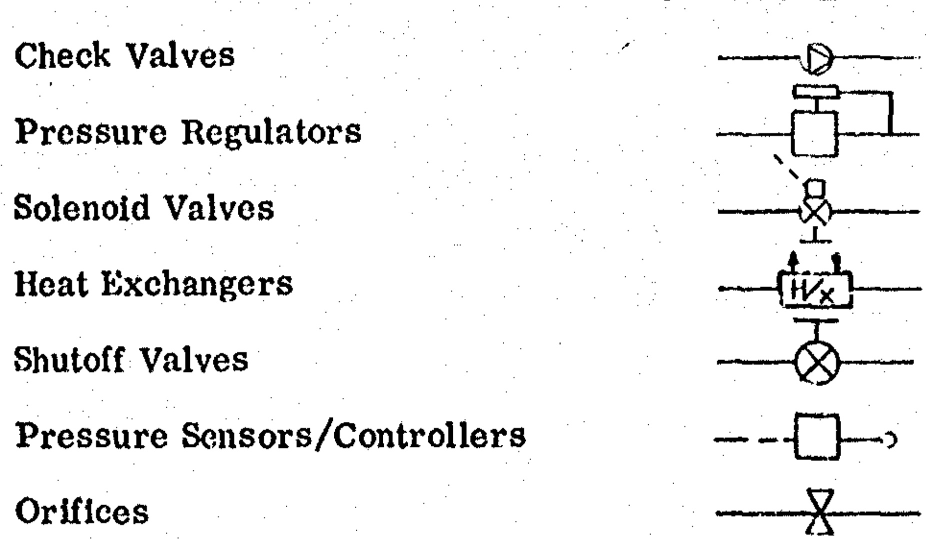
Doc. No. A-1.5.2.1.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Atmospheric Mixing And Pressure Control

SCHEMATIC DIAGRAM:





Doc. No. A-1.5.2.1.1
Sheet No. 2
By: C. Cinicove
Date: 31 July 1970

RATIONALE:

The Atmospheric Mixing And Pressure Control System will maintain the total cabin pressure and regulate the flow of oxygen and nitrogen to the cabin for leakage and pressurization requirements. Heat exchangers are required to warm the cryogens when the flows are large and the gasses expand rapidly. The valving provides manual override of all solenoid valves; in addition, oxygen can be tapped from the RCS supply for specified emergency conditions. Complete mixing of the atmospheric components is accomplished by supplementary circulation fans located in each compartment.

The components, pressure vessels and plumbing are normally long life items, but some repairs are allowed for requiring spares and resulting in wastes. The N_2 or O_2 required to operate valves are not considered as wastes or consumables because they are utilized in the atmosphere. The wastes are predicated on the following assumptions:

1. Component size, component wear as numbers of components are proportional to crew size; therefore weight of wastes will be linear with crew size also.
2. Component failures/repairs assumed are:
   - Regulator diaphragm - .024 lbs each, one failure/year/12 men
   - Pressure seals - .03 lbs each, 10 failures/year/12 men
   - Pressure sensor parts - .01 lbs each, one failure/year/12 men
   - Solenoid valves - 1.0 lbs each, 0.5 failure/year/12 men

REFERENCES:

Roth, E.M., Selection of Space Cabin Atmospheres. Part I and IV, NASA - TN-D-2008, August 1963.

Life Support for Space Flights of Extended Time Periods. NASA CR-614, General Dynamics (Contract NAS 1-2934).

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B- 1.5.2.1.1 Sheet No. 1
Operational Description No. A- 1.5.2.1.1
Subsystem Atmospheric Control
By: C. Cinicove Date: 31 July 1970

Title: Atmospheric Mixing and Pressure Control

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Regulator diaphragm	Wear	Life	.024	.10	.20	550	
Pressure seals	Wear	Life	.30	1.2	2.5	20	
Pressure sensor parts	Wear	Life	.01	.05	.10	300	
Solenoid valves	Wear	Life	.5	2.0	4.0	290	

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Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.5.2.1.1 Sheet No. 1
Operational Description No. A-1.5.2.1.1
Subsystem Atmospheric Control
By: C. Cinicove Date: 31 July 1970

Title: Atmospheric Mixing and Pressure Control

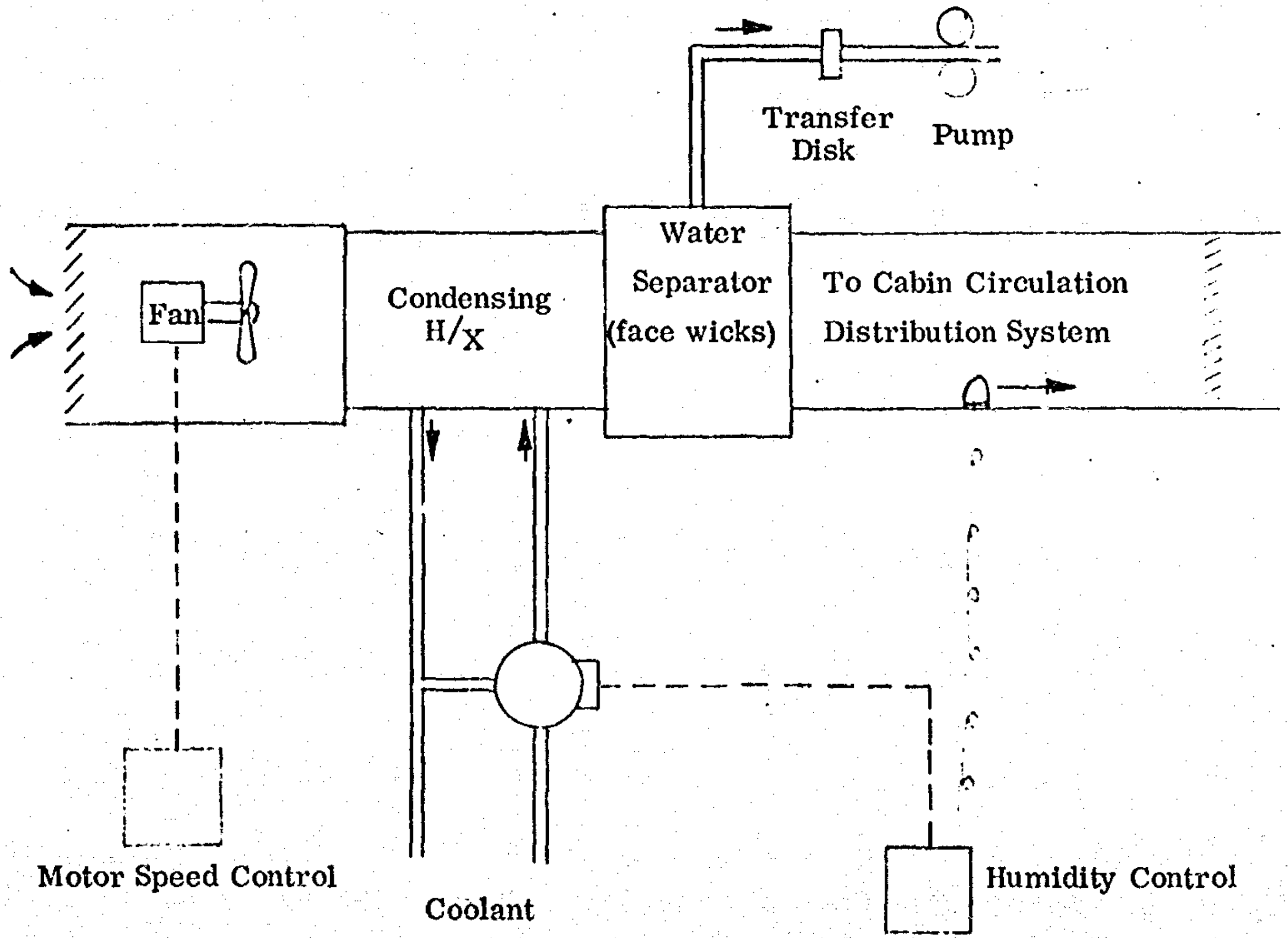
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Regulator Diaphram	Solid - Metal Sheet	Fe, Ni, Co	N/R	.024	.1	.2	550	
Pressure Seals	Solid - Metal Ring	Fe, Ni, Cu	N/R	.30	1.2	2.5	20	
Pressure Sensor, Contact Set	Solid - Metal Strip	Fe, Cu	N/R	.01	.05	.1	300	
Solenoid Valve	Solid - Metal	Fe, Cu	Repair on board	.5	2.0	4.0	290	

Doc. No. A-1.5.3.1.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Variable Speed Fan System (Thermal Control)

SCHEMATIC DIAGRAM:



Doc. No. A-1.5.3.1.1
Sheet No. 2
By: C. Cinicove
Date: 31 July 1970

RATIONALE:

The Atmospheric Thermal And Humidity Control System will maintain the relative humidity and cabin temperature within a preset range for crew comfort. Humidity is primarily controlled by modulating the heat exchanger coolant flow. Cabin temperature control is primarily effected by varying the airflow through the heat exchanger. The transfer disc incorporates a microporous water transfer device to prevent air carry over into the condensate collection system.

The components and ducting are considered to be long life components but some repairs are allowed for requiring spares and resulting in waste products. Water spillage into the atmosphere is not considered waste as it is utilized. The following assumptions have been made:

1. Weight rates vary with crew size because either quantity, size or use rate must be adjusted to suit.
2. Component failures/repairs assumed are for one year/12 men.
   - Microporous filter - .01 lbs each - 16 replacements
   - Pressure seals - .08 lbs each - 12 replacements
   - Fan Motor - 8.5 lbs each - 0.3 replacements
   - Temperature/Humidity control unit - .01 lbs each - 8 replacements
   - Face Wicks - New - .01 lbs each - 12 replacements
   - Face Wicks - Old - .10 lbs each
   - Control Valves - 3.0 lbs each - .5 replacements

REFERENCES:

Roth, E.M., Selection of Space Cabin Atmospheres. Part I and IV, NASA - TN-D-2008, August 1963.

Life Support For Space Flights of Extended Time Periods. NASA CR-614, General Dynamics (Contract NAS 1-2934).

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-1.5.3.1.1 Sheet No. 1
Operational Description No. A- 1.5.3.1.1
Subsystem Atmospheric Temp. & Humid. Control
By: C. Cinicove Date: 31 July 1970

Title: Variable Speed Fan System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year-Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Microporous Filter	Filled	Effectiveness	.16	.70	1.5	30	
Face Wicks	Filled	Effectiveness	.12	.5	1.00	11	
Pressure Seals	Wear	Life	1.0	4.0	8.0	20	
Fan Motor	Wear	Life	3.0	7.0	14.0	290	
Temperature Control Unit Parts	Wear	Life	.32	1.30	2.6	60	
Humidity Control Unit Parts	Wear	Life	.32	1.30	2.6	60	
Control Valve	Wear	Life	1.5	6.0	12.0	260	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.5.3.1.1 Sheet No. 1
Operational Description No. A-1.5.3.1.1
Subsystem Atmospheric Temp. & Humid. Control
By: C. Cinicove Date: 31 July 1970

TABLE III. WASTES

Title: Variable Speed Fan System

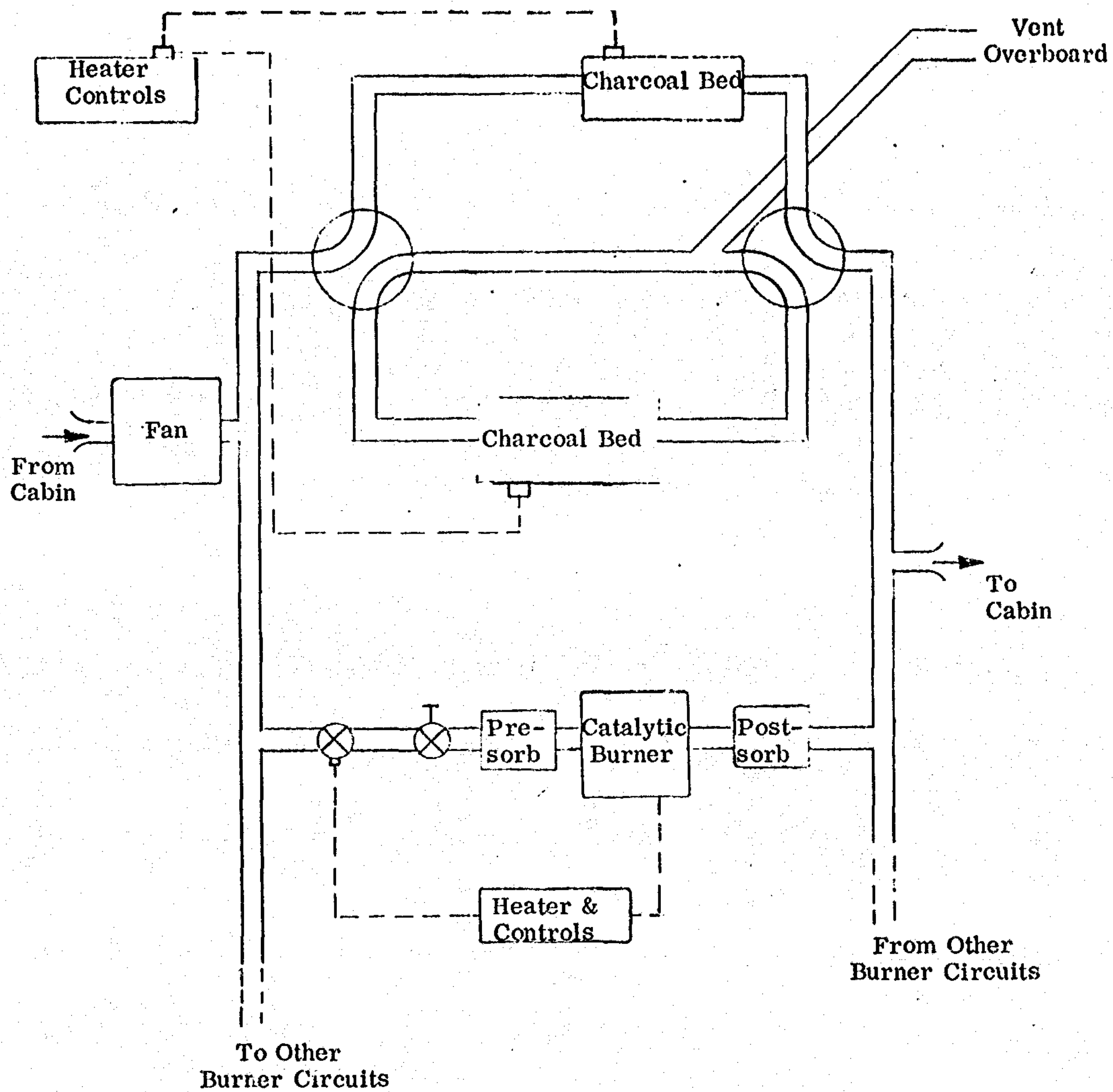
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Microporous Filter	Solid, Membrane, Plastic	Flourinated Plastic Compound	N/R	.16	.70	1.5	30	
Pressure Seal	Solid - Rubber, Sheet	Butyl	N/R	1.0	4.0	8.0	20	
Fan Motor	Solid - Cylindrical, Metal	Copper and Iron	N/R	3.0	7.0	14.0	290	
Temperature Control Unit Parts	Solid - Plastic, Metal	Phenolic, Cu, Fe	Repair component	.32	1.30	2.6	60	
Face Wicks	Solid - Wet, Fibrous mat	Cotton/Nylon	N/R	1.2	5.0	10.0	60	
Humidity Control Unit Parts	Solid - Plastic Metal	Phenolic, Cu, Fe	Repair component	.32	1.30	2.6	60	
Humidity Control Valve	Solid - Metal	Fe, Ni, Cu	Repair on board	1.5	6.0	12.0	260	

Doc. No. A-1.5.4.1.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Regenerable Charcoal/Catalytic Oxidation System (Contaminant Removal)

SCHEMATIC DIAGRAM:



Doc. No. A-1.5.4.1.1
Sheet No. 2
By: C. Cinicove
Date: 31 July 1970

RATIONALE:

The Contaminant Removal System removes harmful and irritating contaminants from the cabin atmosphere. The charcoal beds are used to remove sorbable gases such as benzene, freon, ethanol and others; the catalytic burner module removes non-sorbable contaminants such as hydrogen, carbon monoxide and methane using catalytic oxidizing techniques. The pre- and post-sorbants remove halogenated gasses such as hydrogen cloride, chlorine and flourine. The charcoal beds are alternately desorbed every 10 days by venting the beds to space and driving the contaminants off by direct heating. The capacity of the catalytic modules are deliberately oversized to allow for local poisoning of the catalytic material. Whenever a heater failure or massive poisoning incapacitates a module, another is valved into the circuit to replace it.

Study of Housekeeping Concepts For Manned Space

Doc. No. B- 1.5.4.1.1 Sheet No. 1
Operational Description No. A- 1.5.4.1.1
Subsystem Contaminant Removal System
By: C. Cinicove Date: 31 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Regenerable Charcoal Catalytic Oxidizing System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Charcoal Bed	Deactivated	Coconut Charcoal	8	36	72	40	
Catalytic Burner	Poisoned with H_2S	Catalytic action	8	36	72	280	
Presorber/Postsorber	Deactivated	$CuSO_4$	4	18	36	180	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-1.5.4.1.1 Sheet No. 1
Operational Description No. A-1.5.4.1.1
Subsystem Contaminant Removal System
By: C. Cinicove Date: 31 July 1970

TABLE III. WASTES

Title: Regenerable Charcoal/Oxidizing System

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Fan Motor	Solid - Metal	Fe, Cu	Repair on board	1	3	5	250	
Regulator	Solid - Metal	Al, Fe, Ni	Repair on board	.09	.40	.80	250	
Heater Control	Solid - Metal	Fe, Cu	Repair on board	2	6	10	225	
4 Way Valve	Solid - Metal	Fe, Ni	Repair on board	5	20	35	285	
Pre-sorber/Post-sorber	Solid - Metal	Al, $CuSO_4$, Si	N/R	4	18	36	180	
Catalytic Burner	Solid - Metal	Al, Paladium Alumina Catalyst	N/R	8	36	72	280	
Charcoal Bed	Solid - Wood	Activated Charcoal, Aluminum	Replace Charcoal	8	36	72	40	
Contaminated Gasses	Gaseous-Ambient	HCl, Cl_2, F_2, benezene, NH_3, freon 13, CH_4, ethanol, H_2S, toluene, etc.	Dump overboard	.8	1.0	1.8	–	

Doc. No. A-1.5.5.1.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Direct Storage Method (Bacterial/Particulate Control System)

RATIONALE:

The Bacterial/Particulate Control System will remove contaminating particles from the cabin air. Particles such as lint, dirt, hair, fungi, viruses, etc. are passed through a bacterial filter rated at .3 μ; in addition, the bacterial filters are protected by a 50 μ filter and a hydrophobic-hyrophilic debris trap. The direct bagged storage technique requires that laden filters be placed in plastic bags and stored in lockers for ultimate disposition.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.5.5.1.1 Sheet No. 1
Operational Description No. A- 1.5.5.2.1
Subsystem Bacterial/Particulate Control System
By: C. Cinicove Date: 31 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Direct Storage Method

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Filter Storage Bags	Utilized	Usefulness	38	150	300	4.	
Filter Screens	Clogged	Filterability	300	1440	2880	20.	

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 1.5.5.1.1 Sheet No. 1
Operational Description No. A- 1.5.5.1.1
Subsystem Bacterial/Particulate Control System
By: C. Cinicove Date: 31 July 1970

TABLE III. WASTES

Title: Direct Storage Method

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Filter Bags	Solid - Plastic	Polyethylene	N/R	24	100	200	4.	
Filter Screens	Solid - Film	Paper, Fe, Ni	N/R	360	1440	2880	20.	

Doc. No. A-1.5.5.2.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Sterilization/Storage Method (Bacterial/Particulate Control System)

RATIONALE:

The Bacterial/Particulate Control System will remove contaminating particles from the cabin air. Particles such as lint, dirt, hair, fungi, viruses, etc. are passed through a bacterial filter rated at .3 μ; in addition, the bacterial filters are protected by a 50 μ filter and a hydrophobic-hyrophilic debris trap. The heat sterilized concept utilizes a sterilizer that heats and kills all living matter trapped in the filters; storage then proceeds, using plastic bags and storage lockers, as before.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B- 1.5.5.2.1 Sheet No. 1
Operational Description No. A- 1.5.5.2.1
Subsystem Bacterial/Particulate Control System
By: C. Cinicove Date: 31 July 1970

Title: Sterilization/Storage Method

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Filter Storage Bags	Utilized	Usefulness	38	150	300	4.	
Filter Screens	Clogged	Filterability	300	1440	2880	20.	

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 1.5.5.2.1 Sheet No. 1
Operational Description No. A- 1.5.5.2.1
Subsystem Bacterial/Particulate Control System
By: C. Cinicove Date: 31 July 1970

TABLE III. WASTES

Title: Sterilization/Storage Method

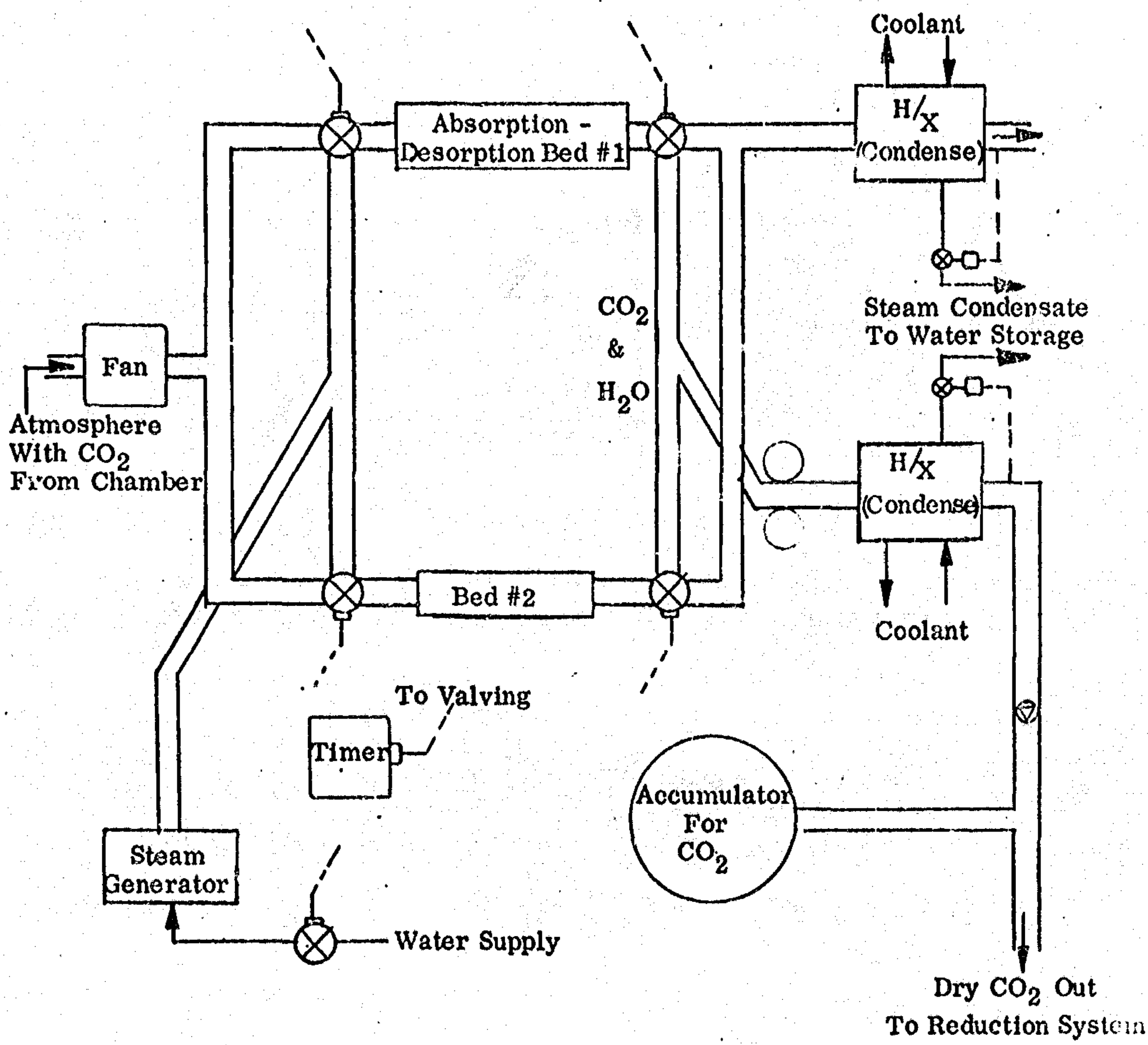
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Heater Coil And Control	Solid - Metal	Fe, Cu, C	Repair on board	10	20	35	225	
Filter Bags	Solid - Plastic	Polyethylene	N/R	38	150	300	4.	
Filter Screens	Solid - Film	Paper, Fe, Ni	N/R	360	1440	2880	20.	

Doc. No. A-1.5.6.1.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: CO_2 Removal/Concentration System

SCHEMATIC DIAGRAM:



RATIONALE:

The steam desorbing CO_2 concentrator will remove gaseous CO_2 from the cabin atmosphere and concentrate it in a pressurized accumulator. The accumulator outlet supplies the CO_2 reduction system onboard. To conserve power, one bed will be on the absorption phase while the other is steam desorbing.

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Study of Housekeeping Concepts For Manned Space

Doc. No. B- 1.5.6.1.1 Sheet No. 1
Operational Description No. A- 1.5.6.1.1
Subsystem CO_2 Control & O_2 Generation
By: C. Cinicove Date: 31 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: CO_2 Removal/Concentration Systems

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Absorption/Desorption Bed	Mechanical or chemical failure	Ability to exchange ion effectively	6	18	24	105	
Condensor/Separator	Contaminated	Capillary action of separator	40	120	200	270	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.5.6.1.1 Sheet No. 1
Operational Description No. A- 1.5.6.1.1
Subsystem CO_2 Control & O_2 Generation
By: C. Cinicove Date: 31 July 1970

Title: CO_2 Removal/Concentration System

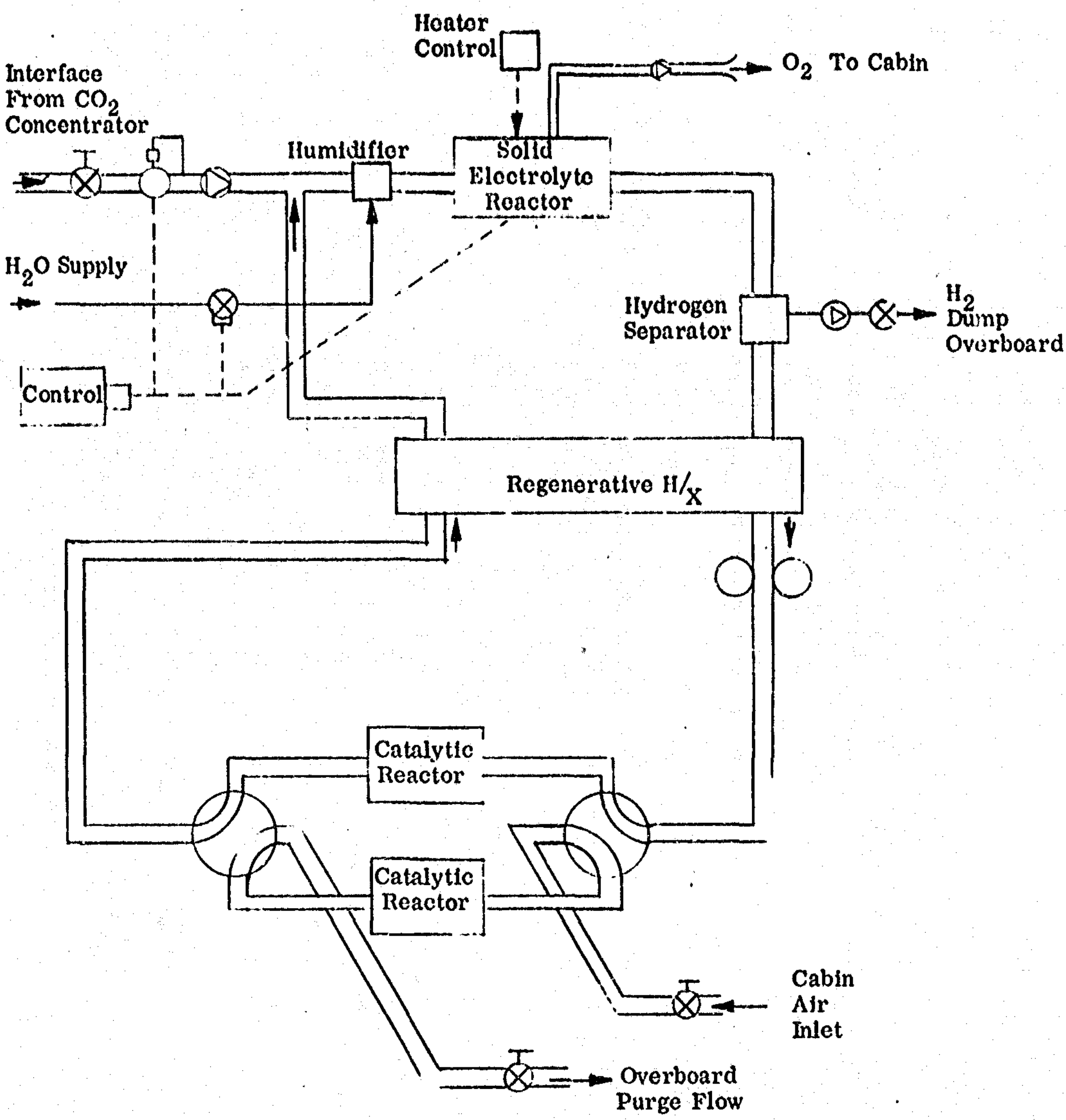
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Fan	Solid - Metal	Fe, Cu	Repair on board	8.5	17	25.5	290	
Absorption Bed	Solid - Metal	Fe, Resin	N/R	6	18	24	105	
Diverter Valve	Solid - Metal	Fe, Cu	Repair on board	1	3	6	230	
Condensor/Separator	Solid - Metal	Fe, Ni, Cu	N/R	40	120	200	270	
Timer	Solid - Metal	Fe, Ni	Repair on board	2	7	12	116	
Solenoid Valve	Solid - Metal	Fe, Cu	Repair on board	2.0	8.0	16	300	
Compressor	Solid - Metal	Fe, Al	Repair on board	2.0	8.0	16	425	
Water Regulator	Solid - Metal	Fe, Ni	Repair on board	.096	.40	.80	520	
Check Valve	Solid - Rubber	Butyl	Replace seal	.030	.12	.24	20	
Carbon Dioxide	Gas - CO_2	CO_2	Reduce	9,000	37,500	75,000	.11	

Doc. No. A-1.5.6.2.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: CO_2 Reduction System (Solid Electrolyte)

SCHEMATIC DIAGRAM:



RATIONALE:

The Solid Electrolyte CO_2 Reduction System resupplies part of the metabolic oxygen requirements for the cabin. The system requires an interface with the steam-desorbed CO_2 concentrator. Inlet CO_2 joins the circulation stream and passes through a wick-type humidifier. The humidifies gas stream enters the electrolytic reactor where CO_2 and H_2O vapor break down to form CO, H_2 and O_2. In this reactor, oxygen is electrochemically separated and vented directly into the cabin for metabolic consumption. Reactor effluent then enters the hydrogen separator where gaseous H_2 is removed and vented overboard. Carbon and CO_2 are released within the catalytic reactors. Carbon is deposited on the catalyst while the remaining CO_2 is diverted back to the incoming stream and recycled through the system. A cabin air purge through the catalytic reactors can be effected for easier replacement of the units.

Study of Housekeeping Concepts For Manned Space

Doc. No. B- 1.5.6.2.1 Sheet No. 1
Operational Description No. A- 1.5.6.2.1
Subsystem CO_2 Control & O_2 Generation
By: C. Cinicove Date: 31 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: CO_2 Reduction System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	REMARKS
Electrolyte Modules	Catalytic depletion	Catalytic Effectiveness	45	150	300	285	
Catalyst Cartridges	Catalytic depletion	Catalytic Effectiveness	50	200	400	150	
Cabin Air	Vented overboard	O_2, N_2	50	200	400	.08	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-1.5.6.2.1 Sheet No. 1
Operational Description No. A-1.5.6.2.1
Subsystem CO_2 Control & O_2 Generation
By: C. Cinicove Date: 31 July 1970

Title: CO_2 Reduction System

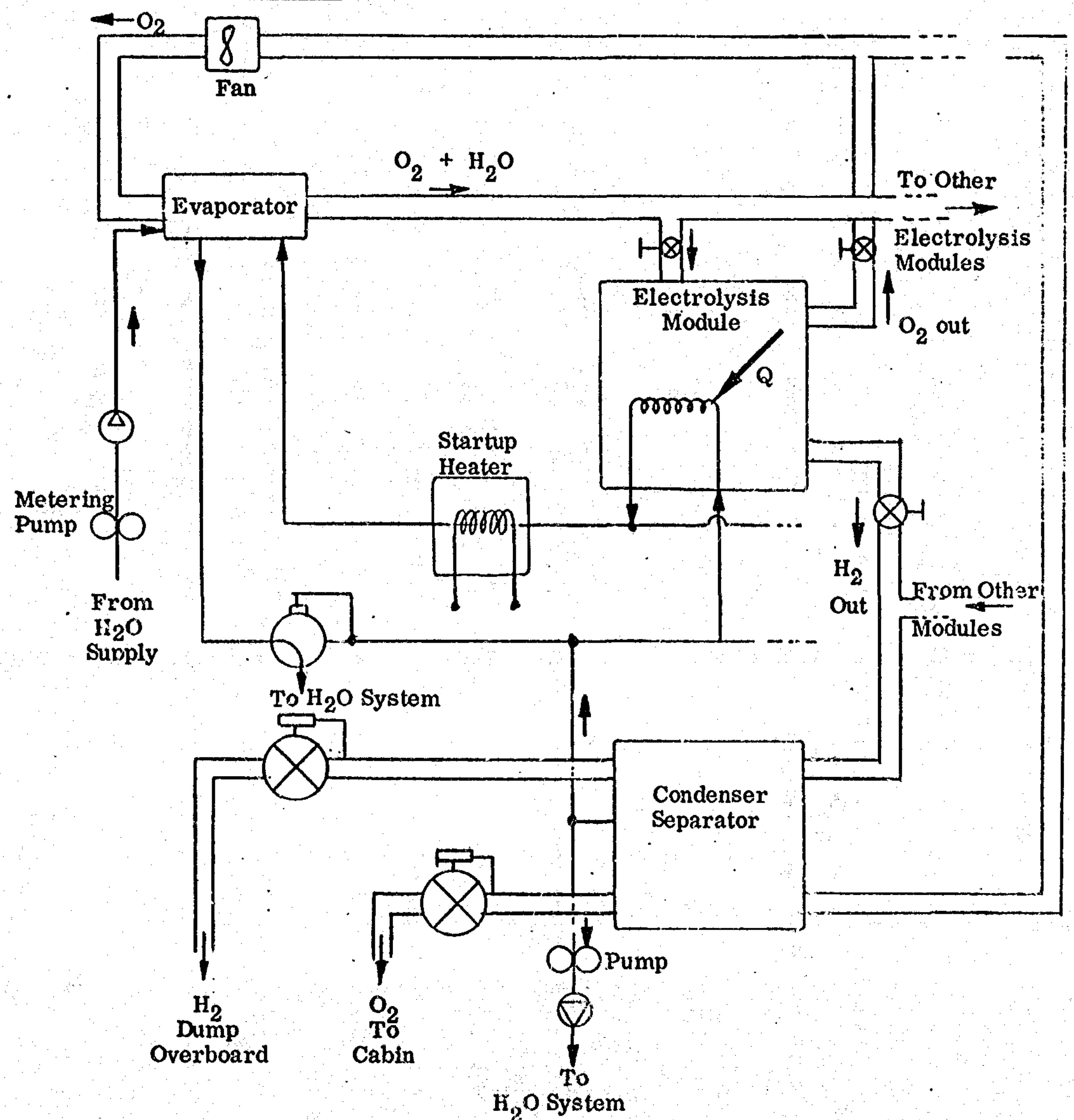
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
				12 Man	50 Man	100 Man		
Humidifier	Solid - Metal	Aluminum	Replace wicking	3.0	12	24	95	
Heater Control	Solid - Metal	Fe, Cu	Repair on board	2.0	6.0	10.0	225	
Main Control	Solid - Metal	Fe, Cu	Repair on board	2.0	6.0	10.0	200	
Electrolyte Modules	Solid - Metal	Fe, Ni, ceramic	N/R	45	150	300	285	
Hydrogen Separator	Solid - Metal	Al, Pd	N/R	10	35	80	165	
Heat Exchanger	Solid - Metal	Al, Fe, Ni	N/R	7	21	42	125	
Compressor	Solid - Metal	Fe, Ni	Repair on board	8	16	32	300	
Catalyst Cartridges	Solid - Metal	Catalytic agent	Replace	50	200	400	150	Expected Qty.
4 Way Valves	Solid - Metal	Fe, Ni	Repair on board	5.0	20	40	280	
Check Valve	Solid - Metal	Butyl	Replace seal	.03	.12	.24	20	
CO_2 Regulator	Solid - Metal	Al, Fe, Ni	Repair on board	.096	.40	.80	250	
Oxygen	Gaseous-Ambient	O_2	Dump to cabin	7,000	29×10^3	57×10^3	.07	
Carbon	Solid - Chunks	C	N/R	2,220	9×10^3	1.8×10^4	50	
Hydrogen	Gaseous-Ambient	H_2	N/R	45	180	360	.005	

Doc. No. A-1.5.6.3.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Water Electrolysis System (Circulating Gas Concepts)

SCHEMATIC DIAGRAM:



Doc. No. A-1.5.6.3.1
Sheet No. 2
By: C. Cinicove
Date: 31 July 1970

RATIONALE:

The Water Electrolysis System is used to generate makeup oxygen; that is, the part of the metabolic oxygen requirement not supplied by the O_2 Generation/CO_2 Control System. The hydrogen byproduct can also be used for recycling a carbon dioxide reduction process. Control of the process is maintained by varying the water metering pump and the power into the electrolysis modules.

Study of Housekeeping Concepts For Manned Space

Doc. No. B- 1.5.6.3.1 Sheet No. 1
Operational Description No. A- 1.5.6.3.1
Subsystem CO_2 Control & O_2 Generation
By: C. Cinicove Date: 31 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Water Electrolysis System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Water	Electrolyzed	O_2 and H_2	850	3500	7000	62.4	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C- 1.5.6.3.1 Sheet No. 1
Operational Description No. A-1.5.6.3.1
Subsystem CO_2 Control & O_2 Generation
By: C. Cinicove Date: 31 July 1970

Title: Water Electrolysis System

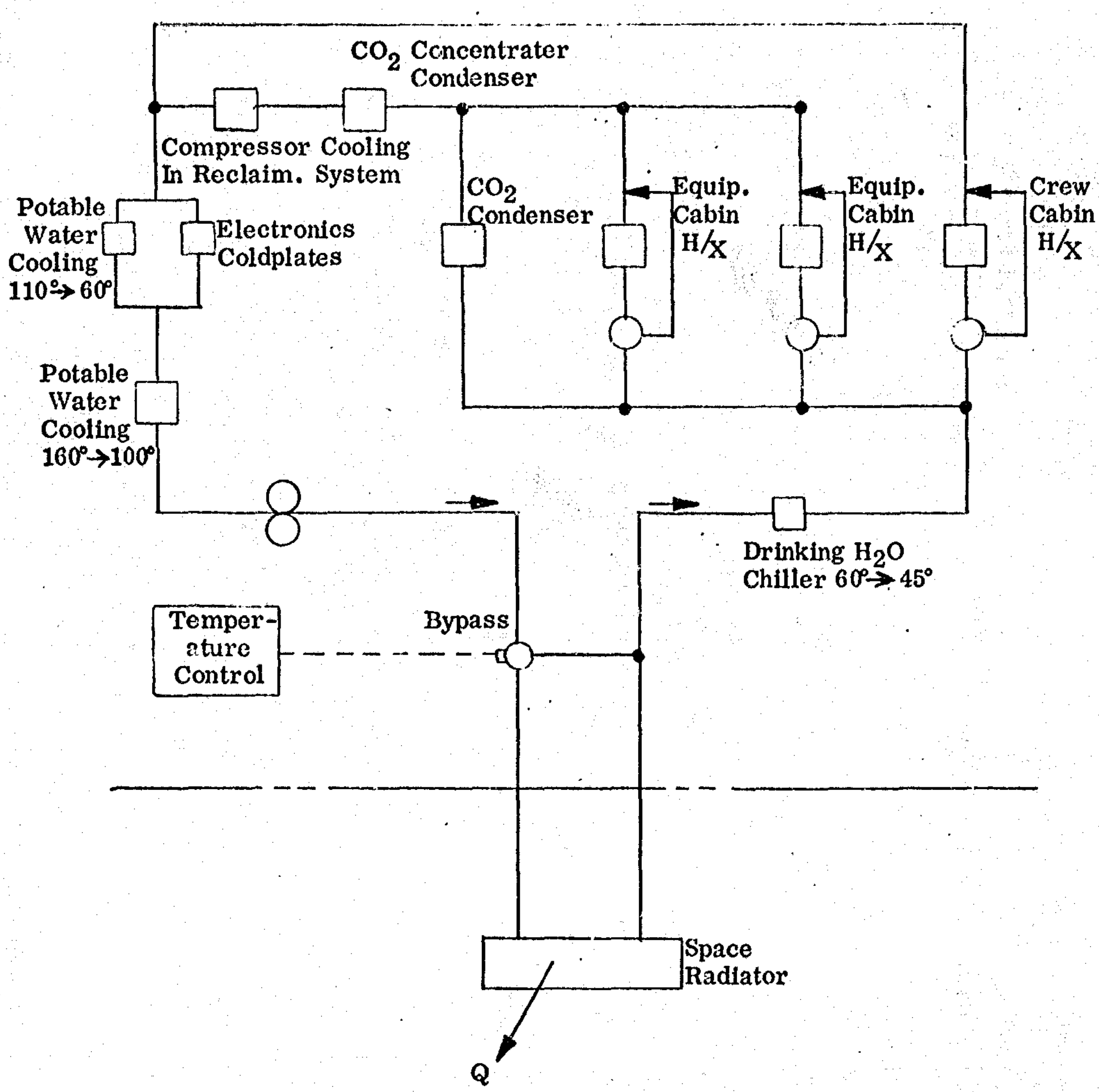
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Evaporator	Solid - Metal	Aluminum	Replace wicking	3.0	12	24	95	
Startup Heater Assembly	Solid - Metal	Fe, Cu	Repair on board	2	6	10	225	
Electrolytic Module	Solid - Metal	Fe, Ni	N/R	5	20	40	130	
Fan	Solid - Metal	Fe, Cu	Repair on board	1	3	5	250	
Regulators	Solid - Metal	Al, Fe, Ni	Repair on board	.096	.40	.80	250	
Check Valve	Solid - Rubber	Butyl	Replace seal	.03	.12	.24	20	
Condensor	Solid - Metal	Aluminum	N/R	12	40	80	250	
Oxygen	Gaseous-Ambient	O_2	Vent to cabin	750	3150	6300	.070	
Hydrogen	Gaseous-Ambient	H_2	Dump overboard	100	390	780	.005	
Metering Pump	Solid - Rubber	Butyl	Replace seal	.03	.12	.24	20	

Doc. No. A-1.5.7.1.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Coolant Loop

SCHEMATIC DIAGRAM:



Do.c No. A-1.5.7.1.1
Sheet No. 2
By: C. Cinicove
Date: 31 July 1970

RATIONALE:

The liquid thermal transport circuit will provide the necessary cooling flow capacity required by all heat exchangers and condensors in the thermal control system. The space radiator and the bypass valve are sized to maintain temperature levels within the intravehicular circuit. The bypass valve is controlled by temperature sensors in the radiator interloop and by the cabin temperature/humidity controller. Water was selected for the transport fluid due to its non-toxic nature.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.5.7.1.1 Sheet No. 1
Operational Description No. A-1.5.7.1.1
Subsystem Thermal Transport Circuit
By: C. Cinicove Date: 31 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Coolant Loop

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Coolant Fluid	Leaked away	H_2O	2	8	16	62.4	

Study of Housekeeping Concepts For Manned Sp e

TABLE III. WASTES

Doc. No. C- 1.5.7.1.1 Sheet No. 1
Operational Description No. A- 1.5.7.1.1
Subsystem Thermal Transport Circuit
By: C. Cinicove Date: 31 July 1970

Title: Coolant Loop

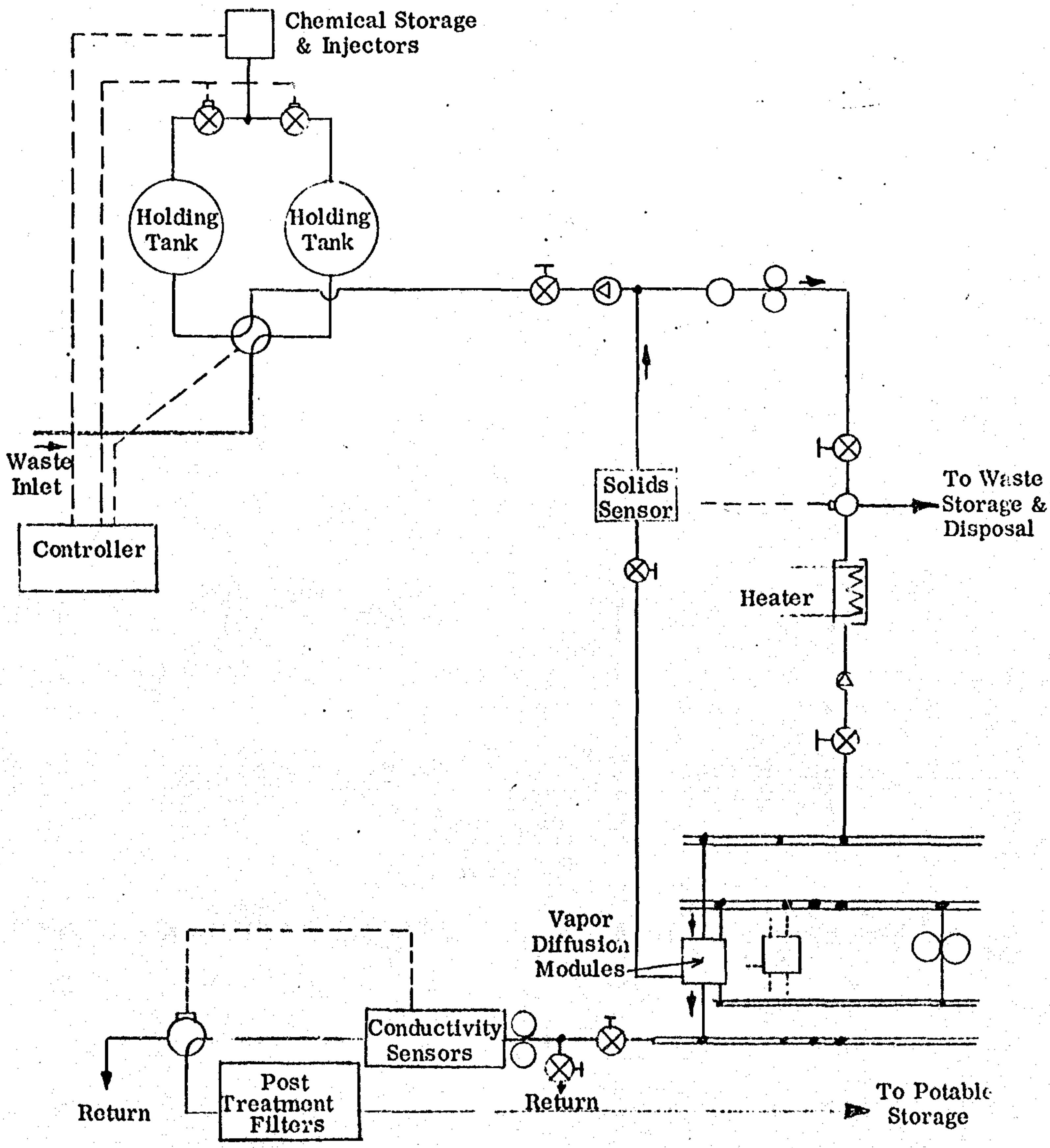
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Bypass Valve Control	Solid - Metal	Fe, Cu, Ni	Repair on board	2.0	8.0	16.0	200	
Bypass Valve	Solid - Metal	Fe, Cu	Repair on board	5.0	20.	40.	280	

Doc. No. A-1.5.8.1.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Water Reclamation System (Diffusion/Thermal Concept)

SCHEMATIC DIAGRAM:



RATIONALE:

The Water Reclamation System will collect and purify waste water and deposit it in the potable storage tanks. Pretreatment equipment is employed to fix volatile free ammonia, destroy organics and kill baoteria. The vapor diffusion modules use distillation techniques to separate the water from the dissolved solids. Internal membrane barriers control the liquid-gas interface and prevent bacterial or organic carryover. The post treatment equipment passes the condensate through bacterial and charcoal filters to remove any residual organics and bacteria; in addition, conductivity sensors monitor the effectiveness of the process and prevent any contamination from spreading. The solids sensor detects residuum concentrations in the circulation loop and feeds them to the waste management system for disposal.

REFERENCES:

Metzger, C.; Hearld, A.B.; McMullen, B. Water Recovery From Human Waste During Prolonged Confinement. Tech. rep. AMRL-TR-65-170, Aerospace Medical Research Laboratories, April 1960.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-1.5.8.1.1 Sheet No. 1
Operational Description No. A-1.5.8.1.1
Subsystem Water Mgmt.
By: C. Cinicove Date: 31 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Water Reclamation System (Vapor Diffusion/Thermal Distillation)

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Pretreatment Chemicals	Utilized	Cr_2O_3 and H_2SO_4	1270	5280	10,560	66	
Post Treatment Chemicals	Neutralized	Chemical Effectiveness	250	1040	2,000	34	
Membrane Barriers	Clogged	Diffusability	84	154	308	32	
Bacterial Filters	Clogged	Filtering Effect	6.0	11	22	30	

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 1.5.8.1.1 Sheet No. 1
Operational Description No. A- 1.5.8.1.1
Subsystem Water Mgmt.
By: C. Cinicove Date: 31 July 1970

TABLE III. WASTES

Title: Water Reclamation System (Vapor Diffusion/Thermal Distillation)

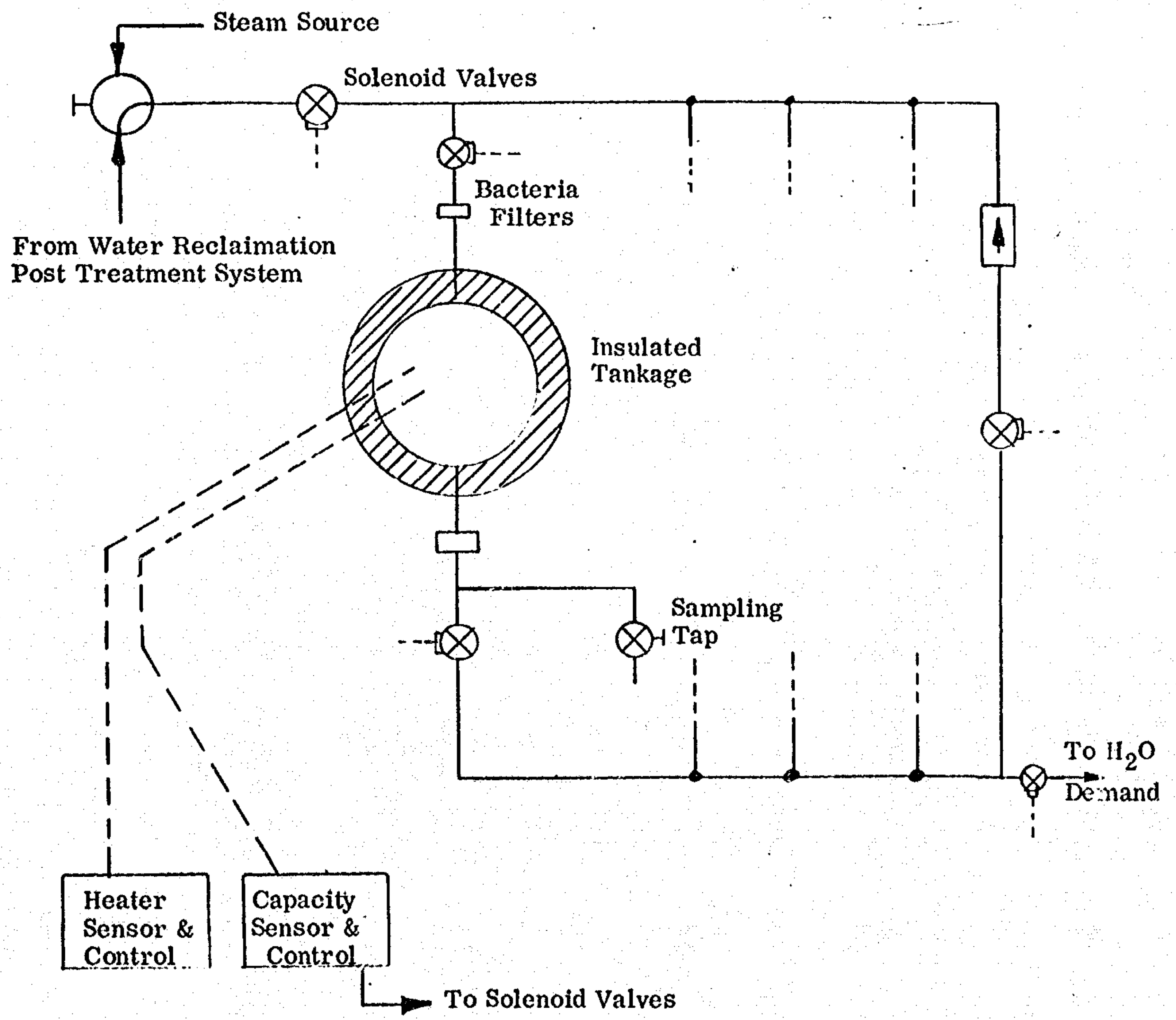
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Heater Control	Solid - Metal	Fe, Cu, Ni	Repair on board	2.0	8.0	16.0	280	
Conductivity Sensor	Solid - Plastic	Phenolic, Fe, Cu	Repair on board	1.0	4.0	8.0	80	
Heating Unit	Solid - Ceramic	Ceramic, Ni	N/R	1.0	4.0	8.0	300	
Pressure Regulator	Solid - Metalic	Aluminum, St Stl	Repair on board	.096	.4	.8	550	
Solids Sensor	Solid - Plastic	Phenolic, Fe, Cu	Repair on board	1.28	5.0	10	80	
Pressure Seals	Solid - Rubber	Butyl	N/R	.03	.13	.30	20	
Solenoid Valve	Solid - Metal	Fe, Cu	Repair on board	5.0	20	40	280	
Bacterial Filter Canister	Solid - Metal Cylinder	Flourinated plastic compound	Recharge	6	11	22	30	
Charcoal Canister	Solid - Metal Cylinder	Activated Charcoal	Refill	150	500	1000	66	
Waste Concentrate	Liquid - Fluid	Urine residuum	N/R	1490	6200	12400	64	

Doc. No. A-1.5.8.2.1
Sheet No. 1
By: C. Cinicove
Date: 31 July 1970

OPERATIONAL DESCRIPTION

TITLE: Potable Water Storage System

SCHEMATIC DIAGRAM:



Doc. No. A-1.5.8.2.1
Sheet No. 2
By: C. Cinicove
Date 31 July 1970

RATIONALE:

A. The Potable Water Storage System will hold reclaimed and treated water at 160°F in insulated tankage. Surface tension devices within each tank will provide an expulsion means. The inlet and outlet of each tank will be provided with a bacterial filter; a sampling tap is provided so that water may be withdrawn for testing purposes. The fill-hold-drain cycle will be automatically controlled by time capacity sensors coupled to solenoid valves. Water for the 45°F outlet will be cooled by a heat exchanger. The delivery of potable water for use on demand implies supplying certain specific quantities for specific uses or functions. The hardware required to implement the potable water storage system will be predicated on these specific delivery requirements. The following requirements represent average and peak delivery rates per man.

The requirements and schematic are based on the information referenced below.

Use	Temperature (°F)	Average (lbs/day)	Peak (lb/hr)
Food and Drink	160°	1.14	13.0
Preparation	45°	5.85	13.0
Body Shower	-	5.60	26.0
Local Washing	-	1.50	26.0
Housekeeping	-	.50	13.0
Misc.	-	10.0	60.0

The following tabulation shows the unit weight and estimated numbers of component failures per year for the various sized crews. It is assumed here that the consumption or utilization rate of specific components such as filters and seals are directly related to the amount of service they must withstand. Because this service is predicated on the daily requirements of the individual crew members, the replacement rate of the above components is proportional to the crew size.

Conversely, the rate of replacement for system components such as heating elements, sensors, controls and valves is particularly sensitive to the number of individual storage tanks, where each tank requires 3 valves, one heater sensor/control and one capacity sensor/control. However, the actual compliment of storage tanks does not increase directly with crew size. For example, if the potable water requirements were to double, the number of storage tanks would increase only 30% with an accompanying increase in the tank diameter of about 15%.

	Unit Weight lbs.	Failures Expected Per Year		
		12 men	50 men	100 men
Seals	.003 avg.	10	42	84
Filter	.18 avg.	9	37	75
Valves	2.5	2	6	9
Capacity/Control	.35 avg.	3	9	14
Heater Sensor/ Control	.35	2	6	9
Heater Element	1.0	1	3	5
Packaging	10%	-	-	-

REFERENCES:

1. Feindler, K.: Filtering System for Aerospace Water Reclamation. Tech Rep. AMRL-TR-67-157. Aerospace Medical Research Lab, December 1967.

2. Metzger, C.; Hearld, A.B.; and McMullen, B.G.: Evaluation of Water Reclamation Systems and Analysis of Recovered Water for Human Consumption, Tech. Rep. AMRL-TR-65-37, Aerospace Medical Research Lab., Feb. 1967.

Study of Housekeeping Concepts For Manned Space

Doc. No. B- 1.5.8.2.1 Sheet No. 1
Operational Description No. A-1.5.8.2.1
Subsystem Water Mgmt.
By: C. Cinicove Date: 31 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Potable Water Storage System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	Total Weight Required Per Year - Lbs.			Average Density As Received lbs/cu.ft.	REMARKS
			12 Man	50 Man	100 Man		
Bacterial Filters	Contaminated	Effectiveness to filtration	1.6	6.7	13.5	30	
Seals	Worn	Life	.030	.13	.25	20	
Valves	Worn Seats	Life	5.0	15.0	22.5	280	
Capacity Control	Failure	Availability	1.0	3.2	4.9	80	
Heater Sensor/Control	Failure	Availability	0.7	2.1	3.2	280	
Heater Element	Failure	Availability	1.0	3.0	5.0	300	
Packaging	Opened	Protectiveness					10% by weight

FAIRCHILD HILLER
REPUBLIC AVIATION DIVISION
FARMINGDALE, LONG ISLAND, NEW YORK

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C- 1.5.8.2.1 Sheet No. 1
Operational Description No. A- 1.5.8.2.1
Subsystem Water Mgmt.
By: C. Cinicove Date: 31 July 1970

Title: Potable Water Storage System

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	Total Weight Required Per Year - Lbs. 12 Man	50 Man	100 Man	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
Pressure Seals	Solid - Rubber	Butyl	N/R	.030	.13	.25	20	
Capacity Control	Solid - Plastic	Phenolic, Cu, Fe	Repair on board	1.0	3.2	4.9	80	
Solenoid Valve	Solid - Metal	Fe, Cu	Repair on board	5.0	15	22.5	280	
Heater Sensor/Control	Solid - Metal	Fe, Cu, Ni	Repair on board	0.7	2.1	3.2	280	
Filter, Bacterial	Membrane - Sheet	Flourinated plastic compound	N/R	1.6	6.7	13.5	30	
Heater Element	Solid-Ceramic	Ceramic material, Ni	N/R	1.0	3.0	5.0	300	
Packaging	Solid- Plastic Spongy	Styrofoam	Reuse as is	1.0	3.0	5.0	5	

MAINTAIN SPACECRAFT FUNCTIONS

CONTROL SPACECRAFT ORBIT POSITION AND ATTITUDE

SECTION 2.1

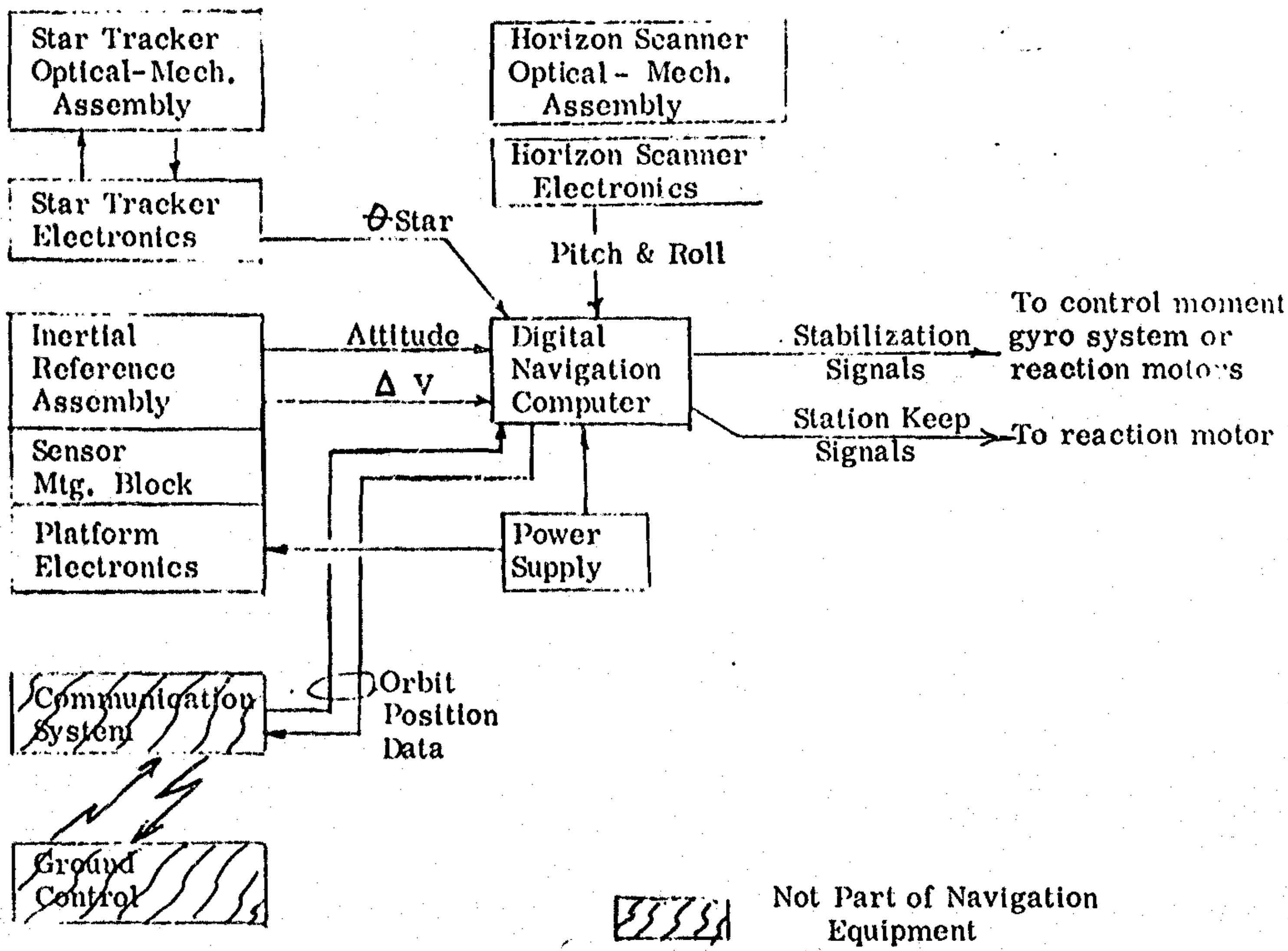
TABLE OF CONTENTS

Doc. No. A-2.1.1.1.1
Sheet No. 1
By: J. Torian
Date: 14 May 1970

OPERATIONAL DESCRIPTION

TITLE: Electronic Systems (Navigation, Guidance, Stabilization and Control)

1. SCHEMATIC DIAGRAM



Navigation and Guidance -- Stabilization and Control
Electronic Systems

2. APPROACH TO AVIONICS SYSTEMS

This section is devoted to an evaluation of the waste products of the major avionics systems which, it is anticipated, will be employed in a space station. At this stage of the effort, much of the equipment is still undefined or at best is only broadly defined. The approach taken, therefore, is to postulate particular equipment based on experience, references in the literature and contact with vendors knowledgable in the state of the art. In the rationale associated with the analysis of each equipment category a description of the equipment including a block diagram and a breakdown into line replacement unit (LRU's) is given. The references are cited at the end.

A key ingredient of the analysis which determines the electronics waste is the avionics subassembly level (LRU) which will be replaced in the space station. This level must be compatible with the fault isolation capabilities of the built-in-test (BIT) system and/or the external test equipment required for fault isolation and be compatible with the technical skills of the personnel as well. In addition, if the level of replacement is too low, a substantial stock and inventory control system must be maintained. In the analyses conducted herein, the LRU selected has been a compromise among these various factors and represents our best judgment at the present time. The failure rates of these LRU's have been estimated or determined and included in the tables. Using the calculated failure rates of the subassembly in question and the weight and volume of that subassembly, the total weight of failed subassemblies per year may be determined. The minimum single replacement weight is the weight of the lowest replaceable subassembly.

It is anticipated that all failed Avionics LRU's will be returned to earth for repair and analysis of cause of failure. The original packaging material used to deliver the replacement item will be used as packaging material for the return of the failed part.

3. OPERATIONAL DESCRIPTION AND RATIONALE

The Navigation and Guidance stabilization and control electronic system comprises a strapdown inertial reference assembly and an associated digital computer. In addition, telescopic star sighting are used to update the system and for alignment as required. Orbit position and attitude data are sent to ground control via the communications system for monitoring and correction as required.

The analyses of consumables and expendables is based on the assumption of four inertial measuring unit LRU's plus two star tracker LRU's and two horizon scanner LRU's.

The communications to ground control (shown cross-hatched) are analyzed under the communications system analysis and are shown in the schematic diagram merely for completeness.

Estimates of the LRU sizes, weights a l failure rates were obtained by extrapolation from data available on the Minneapolis Honeywell H-429 Guidance and Navigation System (Ref. 1) and on an Inertial Navigation Element proposed by Lear Siegler (Ref. 2) for use in the F-15 aircraft. While it is realized that neither of these systems will be the one employed in the space station, it is felt that they are representative of the state-of-the-art for which data is available to this contractor. These data have been extrapolated to the space station requirements by application of engineering judgment. Failure data based on an aircraft environment have been extended to the space environment by application of a factor of 6.5. That is, an item which might have an estimated failure rate of 65 failure per million hours of operation in a military aircraft environment, would have an estimated failure rate of 10 failures per million hours of operation in the benign environment of the space station.

The Platform Electronics LRU is mounted on the Sensor Mounting Block LRU and the combination is called the Inertial Reference Assembly.

The combined failure rate of these two LRU's is 33 plus 17 equal to 50. This compares with an Inertial Reference Assembly failure rate of 59 (Ref. 3).

Table I is a summary sheet of the analysis for the Navigation and Guidance stabilization and control Electronic Systems. Document No. B-2.1.1.1.1 summarizes the consumables and expendables and document No. C-2.1.1.1.1 summarizes the waste items.

Doc. No. A-2.1.1.1.1
Sheet No. 4
By: J. Torian
Date: 14 May 1970

4. REFERENCES:

1. Technical Description H-429 Guidance and Navigation System - Honeywell Aerospace Division, St. Petersburg, Florida.

2. Lear Siegler Publication No. GRP-011-0569-IIB, Inertial Navigation Element - F-15 Avionics System.

3. Fairchild Hiller ATS-F & G Proposal.

4. Bendix Corporation Navigation & Control Division, OAO Star Tracker Program N69-39788, NASA CR10695.

TABLE I. AVIONICS WASTE ANALYSIS

SUBSYSTEM: NAVIGATION AND GUIDANCE STABILIZATION AND CONTROL ELECTRONIC SYSTEMS

LRU Part Type	Number of Items	Weight Per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Power Supply Package	1	25	25	14	0.123	30.6	25	Cu, Fe, Al, Si Semicond	77 lbs/cu.ft. Solid Metals, Insulation	Return-to-Earth for repair and determination of failure. Package to avoid handling and shipping damage.
Computer	1	35	35	74	0.648	226.8	35	Cu, Fe, Al, Si Semicond	52 lbs/cu.ft. Solid Metals, Insulation	Return-to-Earth for repair and determination of failure. Package to avoid handling and shipping damage.
* Sensor Mounting Block	1	40	40	33	0.289	115.6	40	Cu, Fe, Al, Si Semicond	80 lbs/cu.ft. Solid Metals, Insulation	Return-to-Earth for repair and determination of failure. Package to avoid handling and shipping damage.
* Platform Electronics	1	10	10	17	0.149	14.9	10	Cu, Fe, Al, Si Semicond	52 lbs/cu.ft. Solid Metals, Insulation	Return-to-Earth for repair and determination of failure. Package to avoid handling and shipping damage.
** Star Tracker Mechanical Assy	1	25	25	22	0.192	48	25	Cu, Fe, Al, Si Semicond, SiO_2	44 lbs/cu.ft. Solid Metals, Optical Glass, Insulation	Return-to-Earth for repair and determination of failure. Package to avoid handling and shipping damage.
Star Tracker Electronics	1	14	14	11	0.096	13.4	14	Cu, Fe, Al, Si Semicond	42 lbs/cu.ft. Solid Metals, Insulation	Return-to-Earth for repair and determination of failure. Package to avoid handling and shipping damage.
Horizon Scanner Mechanical Assy	1	25	25	22	0.192	48	25	Cu, Fe, Al, Si Semicond	44 lbs/cu.ft. Solid Metals, Optical Glass Insulation	Return-to-Earth for repair and determination of failure. Package to avoid handling and shipping damage.
Horizon Scanner Electronics	1	14	14	11	0.096	13.4	14	Cu, Fe, Al, Si Semicond	42 lbs/cu.ft. Solid Metals, Insulation	Return-to-Earth for repair and determination of failure. Package to avoid handling and shipping damage.

* The Platform Electronics LRU is mounted on the Sensor Mounting Block LRU.

** Reference 4

Study of Housekeeping Concepts For Manned Space

Doc. No. B-2.1.1.1.1 Sheet No. 1
Operational Description No. A-2.1.1.1.1
Subsystem Navigation Guideance, Stabilization & Control
By: J. Torian Date: 5/15/70

TABLE II. CONSUMABLES/EXPENDABLES

Title: Electronic Systems

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr Total lbs.	Daily Rate-lbs/day	Unit Wght lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed power supply package	Part Failure	Component Part	30.6		25	77	RTE
2. Failed computor	Part Failure	Component Part	226.8		35	52	RTE
3. Failed sensor mounting block	Part Failure	Component Part	115.6		40	80	RTE
4. Failed platform electronics	Part Failure	Component Part	14.9		10	52	RTE
5. Failed star tracker mechanical assembly	Part Failure	Component Part	48		25	44	RTE
6. Failed star tracker electronics	Part Failure	Component Part	13.4		14	42	RTE
7. Failed horizon scanner mechanical assembly	Part Failure	Component Part	48		25	44	RTE
8. Failed horizon scanner electronics	Part Failure	Component Part	13.4		14	42	RTE
9. Packaging for replacement parts	Environmental integrity destroyed	Internal environment changed				5	Reuse for returning failed items

RTE = Return to Earth for Repair/Analysis

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FARMINGDALE, LONG ISLAND, NEW YORK

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 2.1.1.1.1 Sheet No. 1
Operational Description No. A-2.1.1.1.1
Subsystem Navigation, Guidance, Stabilization & Control
By: J. Torian Date: 5/15/70

TABLE III. WASTES

Title: ELECTRONIC SYSTEM

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs./Day	Unit Wght lbs.	Average Density As Received lbs/cu.ft.	Remarks
1. Failed power supply package	Solid Metal RTE	Cu, Fe, Al, Si	Repair	30.6	-	25	77	
2. Failed computor	Solid Metal RTE	Cu, Fe, Al, Si	Repair	226.8	-	35	52	
3. Failed sensor mounting block	Solid Metal RTE	Cu, Fe, Al, Si	Repair	115.6	-	40	80	
4. Failed platform electronics	Solid Metal RTE	Cu, Fe, Al, Si	Repair	14.9	-	10	52	
5. Failed star tracker mechanical assembly	Solid Metal RTE	Cu, Fe, Al, Si, SiO_2	Repair	48.0	-	25	44	
6. Failed star tracker electronics	Solid Metal RTE	Cu, Fe, Al, Si	Repair	13.4	-	14	42	
7. Failed horizon scanner mechanical assembly	Solid Metal RTE	Cu, Fe, Al, Si, SiO_2	Repair	48.0	-	25	44	
8. Failed horizon scanner electronics	Solid Metal RTE	Cu, Fe, Al, Si	Repair	13.4	-	14	42	
9. Packaging for replacement parts	Solid Plastic RTE	Plastic Sponge and Sheeting	Reuse as is	-	-	-	5	

RTE = Return-to-Earth for repair/analysis

Doc. No.: A-2.1.1.2.1
Sheet No. 1
By: J. Torian
Date: 18 May 1970

OPERATIONAL DESCRIPTION

TITLE: Control Moment Gyros (Navigation, Guidance, Stabilization and Control)

1. SCHEMATIC DIAGRAM

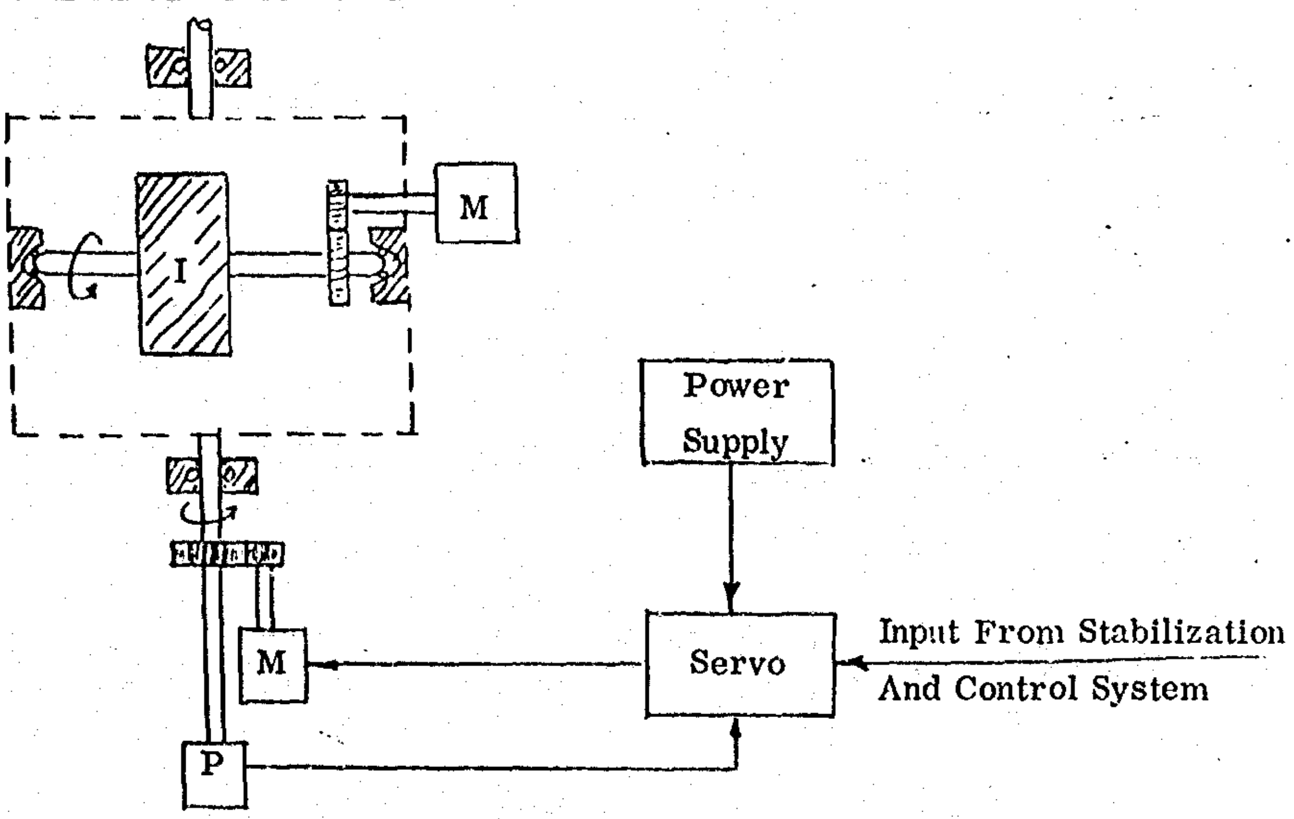

Figure A. Control Moment Gyro System

2. OPERATIONAL DESCRIPTION AND RATIONALE

Control Moment Gyros (CMG's) will be used for attitude stabilization of both the space station and space base (Ref. 1). The system comprises three CMG's, oriented in the x, y and z directions, with associated spin drive motors, gimbals, gimbal angle drive motor and gimbal angle pick-offs. In operation, the gimbal angle is driven off by a servo under control of signals from the stabilization and control system until the disturbance moments are compensated.

The analyses given herewith is based on an assumed gyro wheel weight of 240 pounds. The estimated bearing and motor weights have been sized accordingly and are given in the analysis Table II. If a different size gyro wheel is employed, the weights of bearings and motors may be scaled linearly as a first approximation.

The failure rates employed were obtained from Ref. 2, modified by engineering judgment and combined other sources.

3. REFERENCES

1. NASA, Space Station RFP

2. MIL-HDBK-217A (1 Dec. 1965) Reliability Stress and Failure Rate Data for Electronic Equipment

Doc. No. A-2.1.1.2.1
Sheet No. 3
By: J. Torian
Date: 18 May 1970

TABLE I, AVIONICS WASTE ANALYSIS

SUBSYSTEM: NAVIGATION AND GUIDANCE STABILIZATION AND CONTROL — ELECTRO-MECHANICAL SYSTEMS

LRU Part Type	Number of Items	Weight Per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
CMG Gyro Bearing	6	6	36	5.2	0.274	16.4	6	Fe	Solid, Metal 250 lbs/cu. ft.	Return-to-Earth for determination of failure, package with replacement package
CMG Gimbal Bearing	6	6	36	2.6	0.137	8.2	6	Fe	Solid, Metal 250 lbs/cu.ft.	Return-to-Earth for determination of failure, package with replacement package
CMG Drive Motor	3	50	150	7.5	0.187	93.5	50	Cu, Fe, Insul.	Solid, Metal 200 lbs/cu.ft.	Return-to-Earth for determination of failure, package with replacement package
CMG Gimbal Angle Pick-Off	3	1	3	7.0	0.184	1.8	1	Cu, Fe, Insul.	Solid, Metal 200 lbs/cu. ft.	Return-to-Earth for determination of failure, package with replacement package
CMG Servo Electronics	3	15	45	11.00	0.289	43.4	15	Al, Cu, Fe, Insul. Si Semicond.	Solid, Metal 52 lbs/cu.ft.	Return-to-Earth for determination of failure, package with replacement package
CMG Gimbal Angle Servo Motor	3	25	75	7.5	0.187	46.8	25	Cu, Fe, Insul.	Solid, Metal 200 lbs/cu.ft.	Return-to-Earth for determination of failure, package with replacement package
CMG Power Supply	1	15	15	14.00	0.123	18.5	15	Al, Cu, Fe, Insul., Si Semi-cond.	Solid, Metal Insulation 77 lbs/cu.ft.	Return-to-Earth for determination of failure, package with replacement package

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TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-2.1.1.2.1 Sheet No. 1
Operational Description No. A-2.1.1.2.1
Subsystem Navigation, Guidance, Stabil. & Cont.
By: J. Torian Date: 5/18/70

Title: Control Moment Gyros

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total lbs.	Daily Rate lbs/day	Unit Wt. lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. CMG Gyro Bearing	Part Failure	Component Part	16.4	-	6	250	RTE
2. CMG Gimbal Bearing	Part Failure	Component Part	8.2	-	6	250	RTE
3. CMG Drive Motor	Part Failure	Component Part	93.5	-	50	200	RTE
4. CMG Gimbal Angle	Part Failure	Component Part	1.8	-	1	200	RTE
5. CMG Servo Electronics	Part Failure	Component Part	43.4	-	15	52	RTE
6. CMG Gimbal Angle Servo Motor	Part Failure	Component Part	46.8	-	25	200	RTE
7. CMG Power Supply	Part Failure	Component Part	18.5	-	15	77	RTE
8. Packaging for Replacement Parts	Environmental Integrity Destroyed	Internal Environment Changed	-	-	-	5	Reuse for Returning Failed Items

RTE = Return-to-Earth for Repair/Analysis

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-2.1.1.2.1 Sheet No. 1
Operational Description No. A-2.1.1.2.1
Subsystem Navigation, Guidance, Stabil. & Cont.
By: J. Torian Date: 5/18/70

Title: Control Moment Gyros

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate lbs/day	Unit Wt. lbs.	Average Density As Received lbs/cu.ft.	Remarks
1. Failed CMG Gyro	Solid Metal RTE	Fe	Repair	16.4	-	6	250	
2. Failed CMG Gimbal Bearing	Solid Metal RTE	Fe	Repair	8.2	-	6	250	
3. Failed CMG Gimbal Motor	Solid Metal RTE	Cu, Fe	Repair	93.5	-	50	200	
4. Failed CMG Gimbal Angle Pick-Off	Solid Metal RTE	Cu, Fe	Repair	1.8	-	1	200	
5. Failed CMG Servo Electronics	Solid Metal RTE	Al, Cu, Fe, Si	Repair	43.4	-	15	52	
6. Failed CMG Gimbal Angle Servo Motor	Solid Metal RTE	Cu, Fe	Repair	46.8	-	25	200	
7. Failed CMG Power Supply	Solid Metal RTE	Al, Cu, Fe, Si	Repair	18.5	-	15	77	
8. Packaging from Replacement Parts	Solid Plastic Reuse	Plastic Sponge and Sheeting	Reuse As Is	-	-	-	5	

Doc. No. A-2.1.1.2.2
Sheet No. 1
By: J. Torian
8 June 1970

OPERATIONAL DESCRIPTION

TITLE: Reaction Jet Control - Monopropellant System

1. SCHEMATIC DIAGRAM

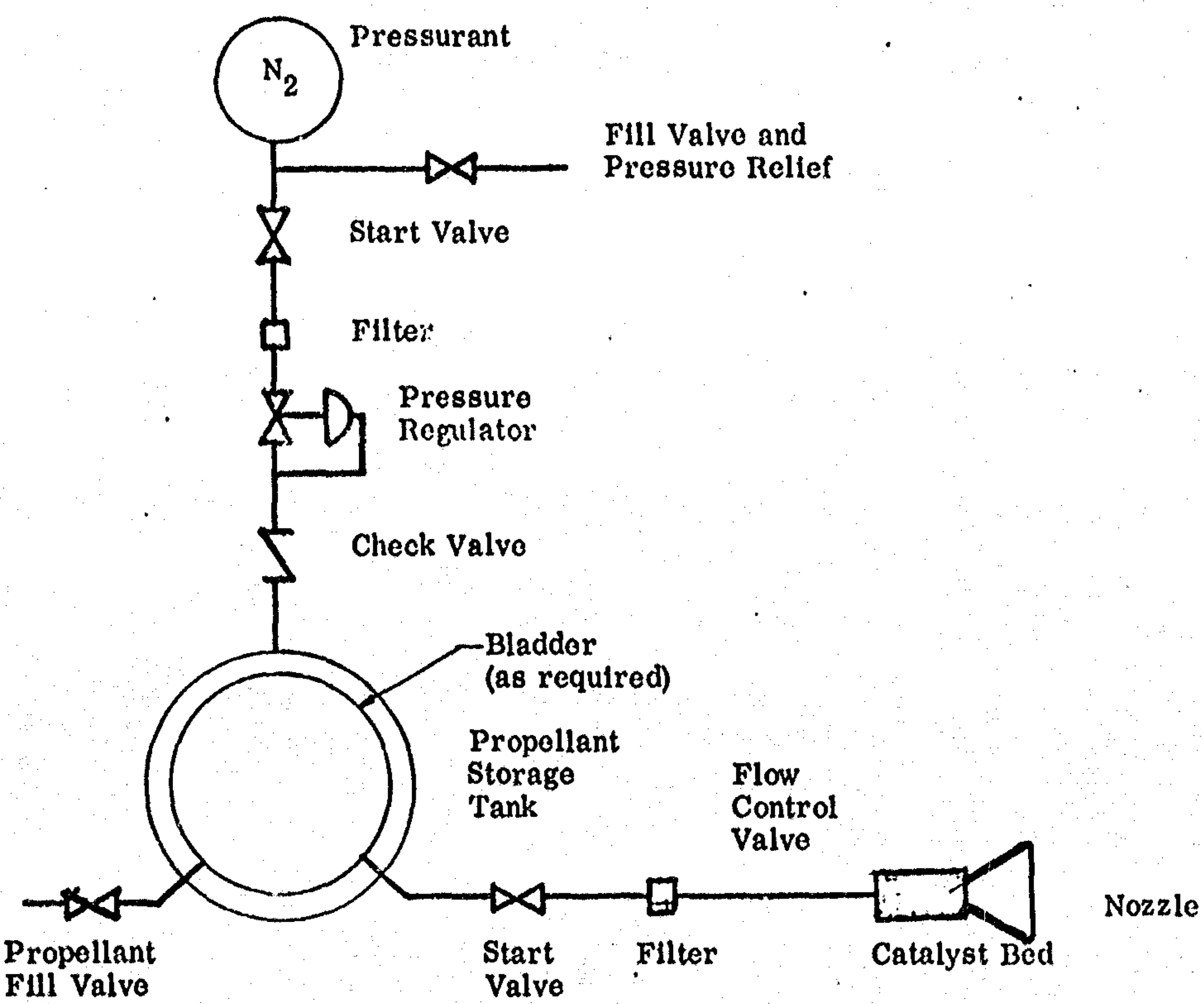

Figure 1. Typical Monopropellant Propulsion System

Doc. No. A-2.1.1.2.2
Sheet No. 2
By: J. Torian
8 June 1970

2. OPERATIONAL DESCRIPTION AND RATIONALE

These systems employ fuels which break down in the presence of a catalyst, into hot gaseous products which provide the desired thrust. In general, such systems are more reliable than bipropellant systems because they have fewer component parts.

The system, as shown in Figure 1, comprises a pressurant tank, various valves and filters, a pressure regulator, a propellant storage tank, a flow control valve, catalyst bed and nozzle. The system depicted in the figure shows only one nozzle. If more than one nozzle is employed, each duplicated nozzle would require an associated catalyst bed and flow control valve. Thus, if twelve nozzles are employed, the consumables/expendable data for one nozzle, catalyst bed and flow control valve must all be multiplied by twelve.

3. REFERENCES

1. Auxiliary Propulsion Survey
AFSC - USAF
AF APL-TR-68-67 3 Parts

2. Failure Rate Data Handbook, Tri-Service and NASA - SP 63-470

3. Study of Space Station Propulsion System Resupply and Repair.
Victor A. DesCamp; Martin Marietta Corporation; Denver, Colorado.
Jan. 1970. N70-22830; NASA CR102542

TABLE I. AVIONICS WASTE ANALYSIS

SUBSYSTEM: REACTION JET CONTROLS; MONOPROPELLANT SYSTEMS

Part Type	Number of Items	Weight Per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Pressurant Tank	1	250	250	23	0.202	505	250	Titanium	Solid Metal 10 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Fill Valve and Pressure Relief	1	3	3	30	0.263	7.9	3	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
N_2 Start Valve	1	2	2	40	0.350	7.0	2	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Filter	2	1	2	50	0.438	8.76	1	Stainless Steel	Perforated Metal 170 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Pressure Regulator	1	5	5	60	0.526	26.3	5	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Check Valve	1	1	1	3	0.026	0.26	1	Fe, Cu	Solid Metal 2[illegible] [illegible]u.ft. [illegible]tor	Return-to-Earth for determination of failure. Package with replacement package.

TABLE I. AVIONICS WASTE ANALYSIS

SUBSYSTEM: REACTION JET CONTROLS; MONOPROPELLANT SYSTEMS

Part Type	Number of Items	Weight Per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Bladder	1	50	50	8	0.070	35	50	Plastic	Solid, Plastic 50 lbs/cu.ft. (collapsed)	Return-to-Earth for determination of failure. Package with replacement package.
Propellant Storage Tank	1	1000	1000	23	0.202	2020	1000	Titanium	Solid Metal 10 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Propellant Fill Valve	1	2	2	3	0.026	0.52	2	Fe, Cu	Solid Metal 260 lbs/cu.ft (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Fuel Start Valve	1	2	2	40	0.350	7.0	2	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Flow Control Valve	12*	3	36	120	1.05	378	3	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Catalyst Bed	12*	35	420	50	0.438	1840	35	Iridium	Solid Metal 350 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Nozzle	12*	5	60	38	0.333	200	5	Fe, Titanium	Solid Metal 94 lbs/cu.ft. Formed	Return-to-Earth for determination of failure. Package with replacement package.

* Based on assumption that twelve nozzles are used in the system

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TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-2.1.1.2.2 Sheet No. 1
Operational Description No. A-2.1.1.2.2
Subsystem Nav., Guid., Stab., and Control
By: J. Torian Date: 29 May 1970

Title: Reaction Jet Control - Monopropellent System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Year Total lbs.	Daily Rate lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed Pressurant Tank	Part Failure	Component Part	505		250	10	RTE
2. Failed Fill Valve and Pressure Relief	Part Failure	Component Part	7.9		3	260	RTE
3. Failed N_2 Start Valve	Part Failure	Component Part	7.0		2	260	RTE
4. Failed Filter	Part Failure	Component Part	8.76		1	170	RTE
5. Failed Pressure Regulator	Part Failure	Component Part	26.3		5	260	RTE
6. Failed Check Valve	Part Failure	Component Part	0.26		1	260	RTE
7. Failed Bladder	Part Failure	Component Part	35.0		50	50 collapsed	RTE
8. Failed Propellant Storage Tank	Part Failure	Component Part	2020.0		1000	10	RTE
9. Failed Propellant Fill Valve	Part Failure	Component Part	0.52		2	260	RTE
10. Failed Fuel Start Valve	Part Failure	Component Part	7.0		2	260	RTE
11. *Failed Flow Control Valve	Part Failure	Component Part	378.0		3	260	RTE
12. *Failed Catalyst Bed	Part Failure	Component Part	1840.0		35	350	RTE
13. *Failed Nozzles	Part Failure	Component Part	200.0		5	94	RTE
14. Packaging for Replacement Parts	Environmental integrity destroyed	Internal Environment changed				5	Reuse for returning failed items

* Based on the assumption that 12 thruster nozzles are used in the system.

RTE = Return to earth for repair/analysis

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Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.1.1.2.2 Sheet No. 1
Operational Description No. A-2.1.1.2.2
Subsystem Nav., Guid., Stab., and Control
By: J. Torian Date: 29 May 1971

TABLE III. WASTES

Title: Reaction Jet Control - Monopropellent System

WASTE ITEM	Characteristics State And Attributes		Chemical Composition	Action Required To Reclaim	10 Year Total lbs.	Daily Rate lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	Remarks
1. Failed Pressurant Tank	Solid	Metal RTE	Titanium	Repair	505		250	10	
2. Failed Fill Valve & Pressure Relief	Solid	Metal RTE	Fe, Cu	Repair	7.9		3	260	
3. Failed N_2 Start Valve	Solid	Metal RTE	Fe, Cu	Repair	7.0		2	260	
4. Failed Filter	Solid	Metal RTE	Stainless Steel	Clean or Replace	8.76		1	170	
5. Failed Pressure Regulator	Solid	Metal RTE	Fe, Cu	Repair	26.3		5	260	
6. Failed Check Valve	Solid	Metal RTE	Fe, Cu	Repair	0.26		1	260	
7. Failed Bladder	Solid	Plastic RTE	Plastic	Repair or Replace	35		50	50 collapsed	
8. Failed Propellant Storage Tank	Solid	Metal RTE	Titanium	Repair	2020		1000	10	
9. Failed Propellant Fill Valve	Solid	Metal RTE	Fe, Cu	Repair	0.52		2	260	

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Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.1.1.2.2 Sheet No. 2
Operational Description No. A-2.1.1.2.2
Subsystem Nav., Guid., Stab., and Control
By: J. Torian Date: 29 May 1970

TABLE III. WASTES

Title: Reaction Jet Control - Monopropellent System

WASTE ITEM	Characteristics State And Attributes		Chemical Composition	Action Required To Reclaim	10 Year Total lbs.	Daily Rate lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	Remarks
10: Failed Fuel Start Valve	Solid	Metal RTE	Fe, Cu	Repair	7.0		2	260	
11. *Failed Flow Control Valve	Solid	Metal RTE	Fe, Cu	Repair	378		3	260	
12. *Failed Catalyst Bed	Solid	Metal RTE	Iridium	Chemically Treat or Replace	1840		35	350	
13. *Failed Nozzles	Solid	Metal RTE	Fe, Titanium	Repair	200		5	94	
14. Packaging for Replacement Parts	Solid	Plastic RTE	Plastic Sponge and Sheeting	Reuse as is				5	

* Based on the assumption that 12 thruster nozzles are used in the system.

RTE = Return to earth for repair/analysis

Doc. No. A-2.1.1.2.3
Sheet No. 1
By: J. Torian
8 June 1970

TITLE: Reaction Jet Control - Bipropellant System

1. SCHEMATIC DIAGRAM

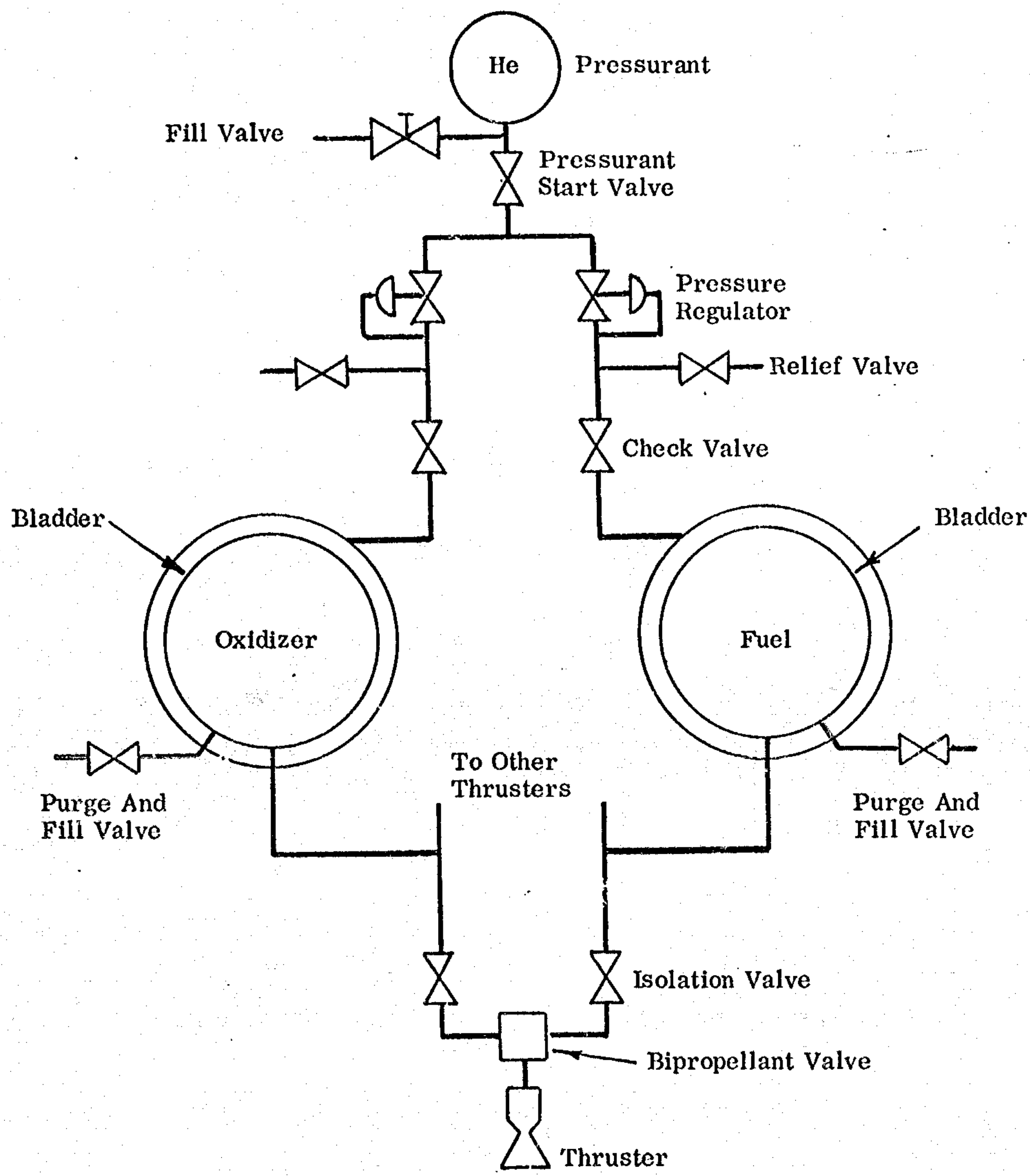

Figure 1. Typical Bipropellant Propulsion System

2. RATIONALE

These systems generally utilize a fuel plus an oxidant such as LOX and LH_2 which are mixed and ignited to provide combustion explosions which provide the thrust desired. These systems are currently in common usage.

The system as shown schematically in Figure 1, comprises a pressurant tank, various valves, pressure regulators, oxidizer and fuel tanks with bladders, a bi-propellant valve and thruster nozzle(s). The system depicted in the figure shows only one thruster nozzle. If more than one nozzle is employed, each duplicated thruster nozzle would also require an associated bipropellant valve and isolation valve. Thus, if twelve thruster nozzles are employed in a system, the consummables/expendables data for one thruster nozzle, bipropellant valve and two isolation valves must all be multiplies by twelve.

Estimates of fuel, oxidizer and pressurant consumption have not been included, but can be determined from data contained in reference 3.

3. REFERENCES

1. Auxiliary Propulsion Survey
ASFC - USAF
AF APL-TR-68-67 3 Parts
2. Failure Rate Data Handbook
Tri-Service and NASA SP 63-470
3. Study of Space Station Propulsion System Resupply and Repair.
Victor A. DesCamp; Martin Marietta Corporation; Denver, Colorado
Jan. 1970 - N70-22830; NASA CR102542

Doc. No. A-2.1.1.2.3
Sheet No. 3
By: J. Torian
Date: 8 June 1970

TABLE I. AVIONICS WASTE ANALYSIS

SUBSYSTEM: STABILIZATION AND CONTROL - MECHANICAL SYSTEMS - REACTION JET CONTROL - BIPROPELLANT SYSTEM

LRU Part Type	Number of Items	Weight Per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Pressurant Tank	1	250	250	23	0.202	505	250	Titanium	Solid Metal 10 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Fill Valve	1	3	3	30	0.263	7.9	3	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Pressurant Start Valve	1	2	2	40	0.350	7.0	2	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Pressure Regulator	2	5	10	60	0.526	52.6	5	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Relief Valve	2	3	3	30	0.263	15.8	3	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Check Valve	2	1	2	3	0.026	0.52	1	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Oxidizer Tank	1	500	500	23	0.202	1010	500	Titanium	Solid Metal 10 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.

TABLE I. AVIONICS WASTE ANALYSIS (continued)

SUBSYSTEM: STABILIZATION AND CONTROL - MECHANICAL SYSTEMS - REACTION JET CONTROL - BIPROPELLANT SYSTEM

LRU Part Type	Number of Items	Weight Per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Oxidizer Tank Bladder	1	25	25	8	0.070	17.5	25	Plastic	Solid Plastic 50 lbs/cu.ft. (collapsed)	Return-to-Earth for determination of failure. Package with replacement package.
Fuel Tank	1	500	500	23	0.202	1010	500	Titanium	Solid Metal 10 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Fuel Tank Bladder	1	25	25	8	0.070	17.5	25	Plastic	Solid Plastic 50 lbs/cu.ft. (collapsed)	Return-to-Earth for determination of failure. Package with replacement package.
Purge and Fill Valve	2	2	4	3	0.026	1.04	2	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Isolation Valve	24*	2	48	3	0.026	12.48	2	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Bipropellant Valve	12*	4	48	120	1.05	504.0	4	Fe, Cu	Solid Metal 260 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.
Thruster Nozzle	12*	7	84	38	0.333	279.7	7	Fe, Titanium	Solid Metal 94 lbs/cu.ft. (Form Factor)	Return-to-Earth for determination of failure. Package with replacement package.

* Based on the assumption that 12 thruster nozzles are used in the system

RTE = Return-to-Earth

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-2.1.1.2.3 Sheet No. 1
Operational Description No. A-2.1.1.2.3
Subsystem Nav., Guid., Stab., and Control
By: J. Torian Date: 2 June 1970

Title: Bipropellant System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total lbs.	Daily Rate lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed Pressurant Tank	Part Failure	Component Part	505		250	10	RTE
2. Failed Fill Valve	Part Failure	Component Part	7.9		3	260	RTE
3. Failed Pressurant Start Valve	Part Failure	Component Part	7.0		2	260	RTE
4. Failed Pressure Regulator	Part Failure	Component Part	52.6		5	260	RTE
5. Failed Relief Valve	Part Failure	Component Part	15.8		3	260	RTE
6. Failed Check Valve	Part Failure	Component Part	0.52		1	260	RTE
7. Failed Oxidizer Tank	Part Failure	Component Part	1010		500	10	RTE
8. Failed Oxidizer Tank Bladder	Part Failure	Component Part	17.5		25	50 Collapsed	RTE
9. Failed Fuel Tank	Part Failure	Component Part	1010		500	10	RTE
10. Failed Fuel Tank Bladder	Part Failure	Component Part	17.5		25	50 Collapsed	RTE
11. Failed Purge and Fill Valve	Part Failure	Component Part	1.04		2	260	RTE
12. *Failed Isolation Valve	Part Failure	Component Part	12.48		2	260	RTE
13. *Failed Bipropellant Valve	Part Failure	Component Part	504.0		4	260	RTE

*Based on the assumption that 12 thruster nozzles are used in the system.

RTE = Return-to-earth

Study of Housekeeping Concepts For Manned Space

Doc. No. B-2.1.1.2.3 Sheet No. 2
Operational Description No. A- 2.1.1.2.3
Subsystem Nav., Guid., Stabi., and Control
By: J. Torian Date: 2 June 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Bipropellant System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total lbs.	Daily Rate lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
14. *Failed Thruster Nozzle	Part Failure	Component Part	279.7		7	94	RTE
15. Packaging For Replacement Parts	Environmental Integrity Destroyed	Internal Environment Changed				5	Reuse for Returning Failed Items

*Based on the assumption that 12 thruster nozzles are used in the system

RTE = Return-to-earth

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Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-2 1 1 2 3 Sheet No. 1
Operational Description No. A-2 1 1 2 3
Subsystem Nav., Guid., Stab., and Control
By: J. Torian 3 June 1970

Title: Bipropellant System

WASTE ITEM	Characteristics State And Attributes		Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	Remarks
1. Failed Pressurant Tank	Solid	Metal RTE	Titanium	Repair	507		250	10	
2. Failed Fill Valve	Solid	Metal RTE	Fe, Cu	Repair	7.9		3	260	
3. Valve Pressurant Start	Solid	Metal RTE	Fe, Cu	Repair	7.0		2	260	
4. Failed Pressure Regulator	Solid	Metal RTE	Fe, Cu	Repair	52.6		5	260	
5. Failed Relief Valve	Solid	Metal RTE	Fe, Cu	Repair	15.8		3	260	
6. Failed Check Valve	Solid	Metal RTE	Fe, Cu	Repair	0.52		1	260	
7. Failed Oxidizer Tank	Solid	Metal RTE	Titanium	Repair	1010		500	10	
8. Failed Oxidizer Tank Bladder	Solid	Plastic RTE	Plastic	Repair or Replace	17.5		25	50 Collapsed	
9. Failed Fuel Tank	Solid	Metal RTE	Titanium	Repair	1010		500	10	
10. Failed Fuel Tank Bladder	Solid	Plastic RTE	Plastic	Repair or Replace	17.5		25	50 Collapsed	
11.* Failed Purge and Fill Valve	Solid	Metal RTE	Fe, Cu	Repair	1.04		2	260	

*Based on the assumption that 12 thruster nozzles are used in the system.

RTE = Return-to-earth

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-2.1.1.2.3 Sheet No. 2
Operational Description No. A-2.1.1.2.3
Subsystem Nav., Guid., Stab., and Control
By: J. Torian Date: 3 June 1970

Title: Birpopellant System

WASTE ITEM	Characteristics State And Attributes		Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	Remarks
12.* Failed Isolation Valve	Solid	Metal RTE	Fe, Cu	Repair	12.48		2	260	
13.* Failed Bipropellant Valve	Solid	Metal RTE	Fe, Cu	Repair	504.0		4	260	
14.* Failed Thruster Nozzles	Solid	Metal RTE	Fe, Titanium	Repair	279.7		7	94	
15. Packaging of Replacement Parts	Solid	Plastic RTE	Plastic Sponge and Sheeting	Reuse as is				5	

*Based on the assumption that 12 thruster nozzles are used in the system.

RTE = Return-to-earth

PROVIDE FOR ELECTRIC AND THERMAL POWER

SECTION 2.2

TABLE OF CONTENTS

Doc. No. A-2.2.1.1.1
Sheet No. 1
By: J. Torian
Date: 8 June 1970

OPERATIONAL DESCRIPTION

TITLE: Solar Arrays (Electric Power Source)

1. SCHEMATIC DIAGRAM

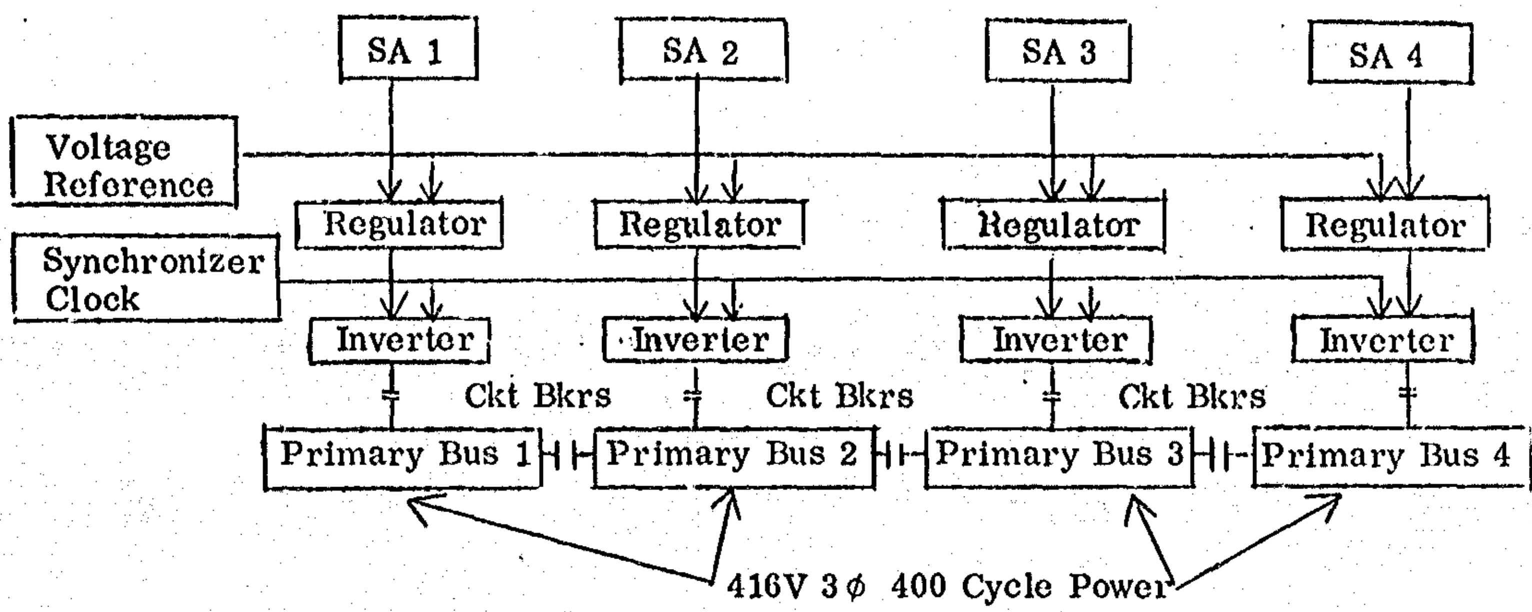

Figure 1. Solar Array Schematic

2. RATIONALE

The 1975 Space Station power requirements will run between 25 kilowatts and 42 kilowatts including from 4 to 15 kilowatts for experiment support. Solar arrays with 7500 sq. ft. of surface and with batteries, chargers and regulators will furnish an average electric power of 25 kilowatts.

When nuclear power plants are used as a prime power source, roll out solar arrays and batteries will be maintained as a source of 25 kilowatts standby power.

The electrical power system has been divided for purposes of this analyses into three basic functional categories:

a. the primary electric power system, i.e., solar array system covered in this document including all items up to the primary power buses. As shown in Figure 1, the solar array system is divided into four separate arrays, each with an associated regulator and inverter. The regulators are referenced to a common voltage reference and the inverters are keyed to a synchronizer clock to insure frequency phase lock. This enables interconnection of the four buses without synchronization problems. Primary buses 1 and 2 may be fed by solar arrays 1 or 2 and 3 or 4. Each "bus" comprises three wires to accommodate the three phase system.

Although only one regulator and inverter per solar array are shown in the schematic, a spare regulator and inverter are included in the tabulation of avionic waste analysis. In addition, although only five circuit breakers are shown, a number of power contactors, monitor meters and remote control switches which are estimated to be a part of the system have also been included in the tabulation.

b. the power conditioning system covered in document number A-2.2.2.1.1 includes everything between the primary buses and the distribution buses such as transformation, inversion, rectification, regulation, battery chargers, batteries and fuel cells.

c. the distribution system, covered in document number A-2.2.3.1.1, comprises the buses, loading and transfer devices, fault isolation and subsystem "on-off" control.

In order to insure compatibility, it is assumed the design requirements for Space Base will be used to drive the design of the Space Station. For example, the use of 400 cps 3 Ø 416 volt distribution proposed by North American Rockwell in the reference is designed to provide flexibility, to accommodate the long cable runs involved in the Space Base and to minimize the weight of the power conditioning system.

3. REFERENCES

NASA Request For Proposal For Phase B Definition Of A Space Station Program.

North American Rockwell Space Station Program Phase B Definition, Technology Requirements Review, PDS70-217, 25 March 1970.

Doc. No. A-2.2.1.1.1
Sheet No. 3
By: J. Torian
Date: 8 June 1970

TABLE I. AVIONICS WASTE ANALYSIS

SUBSYSTEM: SOLAR ARRAYS PRIMARY POWER SYSTEM

LRU Part Type	Number of Items	Weight Per Items	Total Weight Pounds	Failure Rate Fails/10^6 Hrs.	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Solar Arrays *	4	1844	7376	- *	-	24587	1844	Si Semicond Al. Cu, Steel, Plastics	0.12#/cu.ft. Semi-rigid, Aluminum structure of glass.	** RTE For repair and determination of cause of failure.
Regulator +	5	15	75	8.4	7.36×10^{-2}	55	15	Si Semicond. Cu, Fe, Al Plastics	77#/cu ft., Solid metals, Insulation	Pkg. to avoid handling and shipping damage.
Inverter +	5	25	125	12	1.05×10^{-1}	131	25	Si Semicond. Cu, Fe, Al Plastics	77#/cu ft., Solid metals, Insulation	Pkg. to avoid handling and shipping damage.
Voltage Reference	1	2.5	2.5	4.3	3.76×10^{-2}	0.9	2.5	Si Semicond. Cu, Fe, Al Plastics	52#/cu ft. Solid metals, Insulation	Pkg. to avoid handling and shipping damage.
Synchronizer Clock	1	2.5	2.5	4.3	3.76×10^{-2}	0.9	2.5	Si Semicond. Cu, Fe, Al Plastics	52#/cu ft. Solid metals, Insulation	Pkg. to avoid handling and shipping damage.
Circuit Breakers	7	1	7	1	0.876×10^{-2}	0.6	1	Cu, Fe, Al Plastics	77#/ cu ft. Solid Metals, Insulation	Pkg. to avoid handling and shipping damage
Power Contactors	8	1	8	1	0.876×10^{-2}	0.7	1	Cu, Fe, Al Plastics	77#/ cu ft. Solid Metals, Insulation	Pkg. to avoid handling and shipping damage.
Monitor Meters (DC)	4	0.5	2	0.5	0.44×10^{-2}	0.09	0.5	Cu, Fe, Al, Si, Qz, Plastic	77#/cu ft. Solid Metals, Insulation	Pkg. to avoid handling and shipping damage.
Monitor Meter Sws.	8	0.25	2	1	0.876×10^{-2}	0.18	0.25	Cu, Fe, Al Plastics	77#/cu ft. Solid Metals, Insulation	Pkg. to avoid handling and shipping damage.
Remote Control Switches	15	0.25	4	1	0.876×10^{-2}	0.35	0.25	Cu, Fe plastics	77#/cu ft. Solid Metals, Insulation	Pkg. to avoid handling and shipping damage.
Primary Syst. Wiring	-	-	400	-	-	-	-	Aluminum	AWG0000-19.5#/100' AWG000-15.4#/100' AWG00 -12.3#/100' AWG-0-9.7#/100'	Pkg. to avoid handling and shipping damage.

* Designed for 3 yrs. end of life
** RTE means return to earth
\+ Includes switchable redundant unit.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-2.2.1.1.1 Sheet No. 1
Operational Description No. A-2.2.1.1.1
Subsystem Electric Power Source
By: J. Torian Date: 8 June 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Solar Arrays

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr Total lbs.	Daily Rate-lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed Solar Arrays	Part Failure	Component Part Sub-Assembly	24587		1844	0.12	RTE
2. Failed Regulator	Part Failure	Component Part	55		15	77	RTE
3. Failed Inverter	Part Failure	Component Part	131		25	77	RTE
4. Failed Voltage Reference	Part Failure	Component Part	0.9		2.5	52	RTE
5. Failed Synchronizer Clock	Part Failure	Component Part	0.9		2.5	52	RTE
6. Failed Circuit Breakers	Part Failure	Component Part	0.6		1	77	RTE
7. Failed Power Contactors	Part Failure	Component Part	0.7		1	77	RTE
8. Failed Monitor Meters (DC)	Part Failure	Component Part	0.09		0.5	77	RTE
9. Failed Monitor Meters (AC)	Part Failure	Component Part	0.09		0.5	77	RTE
10. Failed Monitor Meter Sws.	Part Failure	Component Part	0.18		0.25	77	RTE
11. Failed Remote Control Sws.	Part Failure	Component Part	0.35		0.25	77	RTE
12. Failed Primary Sys. Wiring	Part Failure	Component Part	-		-	14	RTE
13. Packaging For Replacement Parts	Environmental Integrity Destroyed	Internal Environment Changed	-		-	5	Reuse For Returning Failed Items

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Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.2.1.1.1 Sheet No. 1
Operational Description No. A-2.2.1.1.1
Subsystem Electric Power Source
By: J. Torian Date: 8 June 1970

TABLE III. WASTES

Title: Solar Arrays

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	Remarks
1. Failed Solar Arrays	Solid Metal RTE	Al, Cu, Fe Plastics, Si-Semiconductor	Replace	24587	-	1844	0.12	Replace After 3 yrs. Life
2. Failed Regulator	Solid Metal RTE	Al, Cu, Fe Plastics, Si-Semiconductor	Repair	55	-	15	77	
3. Failed Inverter	Solid Metal RTE	Al, Cu, Fe, Plastics, Si-Semiconductor	Repair	131	-	25	77	
4. Failed Voltage Reference	Solid Metal RTE	Al, Cu, Fe, Plastics, Si-Semiconductor	Repair	0.9	-	2.5	52	
5. Failed Synchronizer Clock	Solid Metal RTE	Al, Cu, Fe, Plastics, Si-Semiconductor	Repair	0.9	-	2.5	52	
6. Failed Circuit Breaker	Solid Metal RTE	Cu, Fe, Al Plastic	Replace	0.6	-	1	77	
7. Failed Power Contactor	Solid Metal RTE	Cu, Fe, Al Plastic	Replace	0.7	-	1	77	
8. Failed Monitor Meter(DC)	Solid Metal RTE	Cu, Fe, Al, SiO_2, Plastic	Repair	0.09	-	0.5	77	
9. Failed Monitor Meter(AC)	Solid Metal RTE	Cu, Fe, Al, SiO_2, Plastic	Repair	0.09	-	0.5	77	
10. Failed Monitor Meter Switches	Solid Metal RTE	Cu, Fe, Al, Plastics	Repair	0.18	-	0.25	77	

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Doc. No. C-2.2.1.1.1 Sheet No. 2
Operational Description No. A-2.2.1.1.1
Subsystem Electric Power Source
By: J. Torian Date: 8 June 1970

TABLE III. WASTES

Title: Solar Arrays

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs./day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	Remarks
11. Failed Remote Control Switches	Solid Metal RTE	Cu, Fe, Plastics	Replace	0.35	-	0.25	77	
12. Failed Primary System Wiring	Solid Metal RTE	Al	Replace	-	-	-	14	
13. Packaging For Replacement Parts	Solid Metal RTE	Plastic Sponge and Sheeting	Reuse as is	-	-	-	5	

OPERATIONAL DESCRIPTION

TITLE: Radioisotope Brayton Cycle (Electric Power Source)

SCHEMATIC DIAGRAM

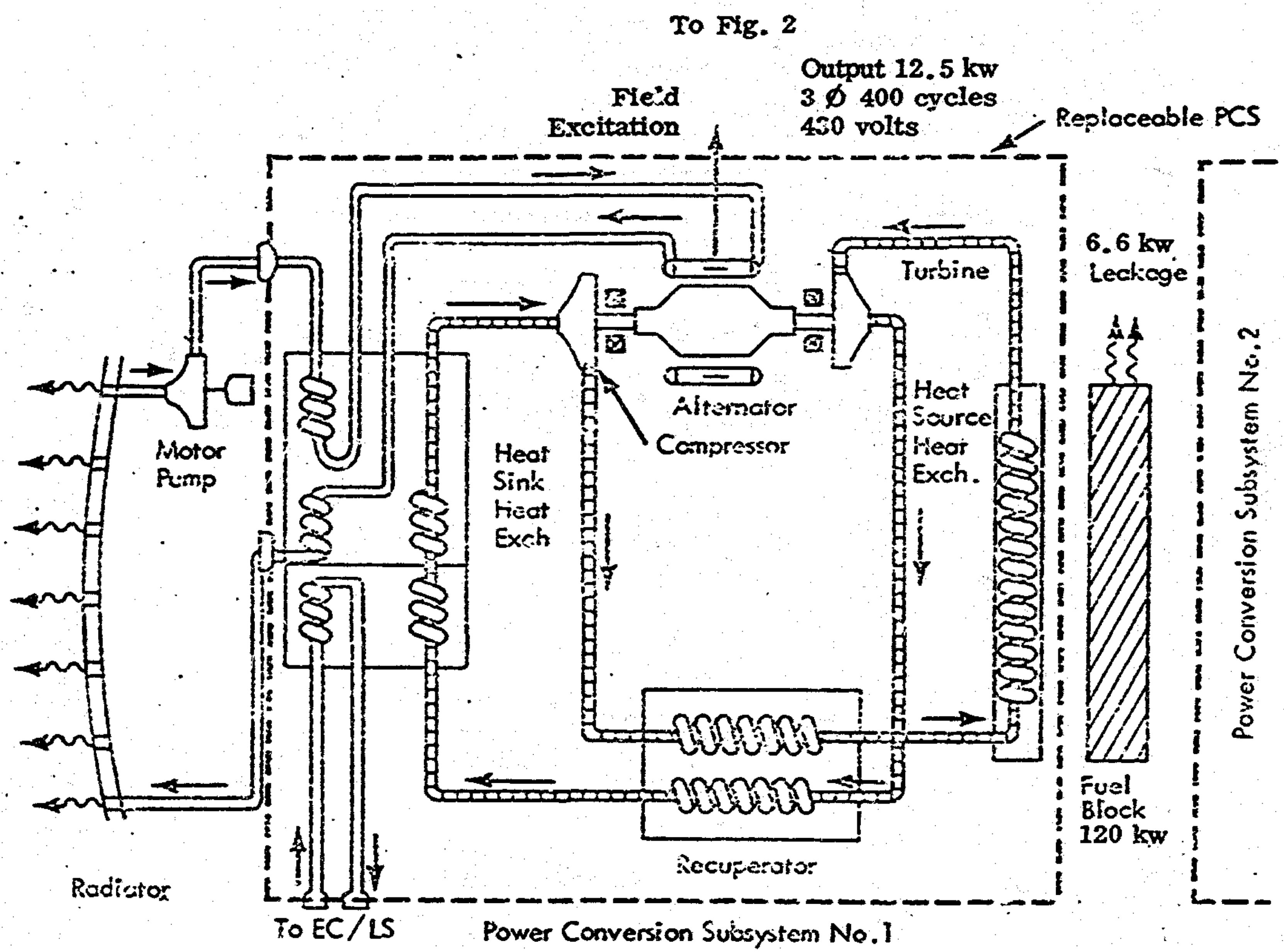

Figure 1. Brayton Cycle Power Conversion System Schematic

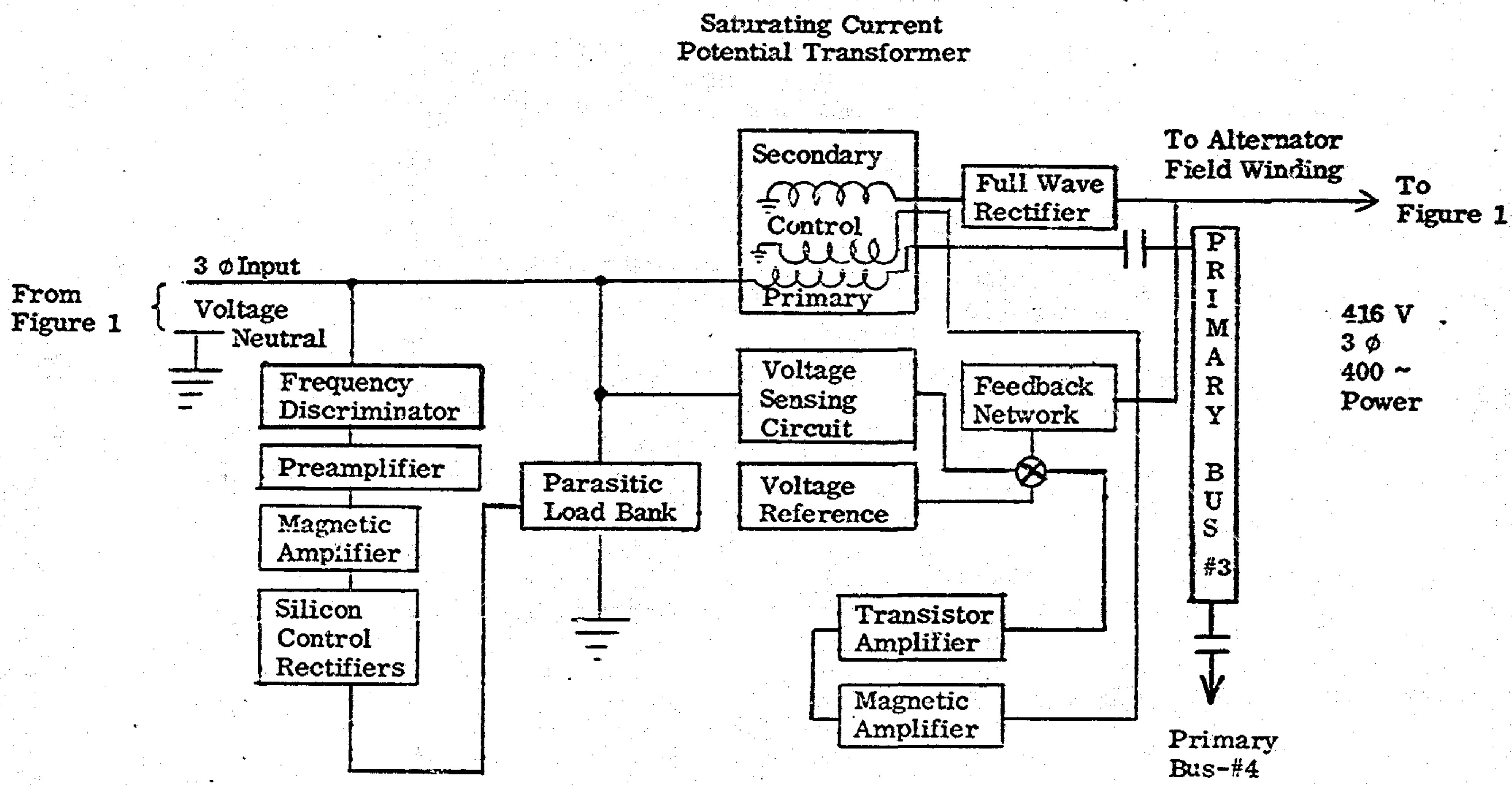

Figure 2. Brayton Cycle Power System Auxiliary Schematic

Doc. No. A-2.2.1.2.1
Sheet No. 2
By: J. Torian
Date: 18 June 1970

2. RATIONALE

The 1975 Space Station power requirements will run between 25 and 42 kilowatts including from 4 to 15 kilowatts for experiment support. For the Space Base, it is estimated 100 kilowatts will be provided from four 25 kilowatts nuclear power plants. This analysis is based on a 25 kilowatt radioisotope/Brayton system which is considered the basic building block for nuclear power sources.

The electrical power system has been divided for purposes of this analyses into three basic functional categories:

a the primary electric power system, i.e. the radioisotope/Brayton system, including all items up to the primary power buses. These are discussed in this document.

b. the power conditioning system, covered in document A-2.2.2.1.1, includes everything between the primary buses and the distribution buses such as transformation, inversion, rectification, regulation battery chargers, batteries and fuel cells and

c. the distribution system, covered in document number A-2.2.3.1.1, comprises the buses, loading and transfer devices, fault isolation and subsystem "on-off" control.

The system considered comprises two 12.5 kilowatt subsystems of the type shown in the schematic of Figure 1 to produce a total of 25 kilowatts of power. A fuel block of 120 kilowatts thermal capacity is considered necessary to supply the two subsystems based on the efficiency of the Brayton cycle system and the estimated thermal lossess. Such a system would have the following weight breakdown:

Figure 1	Isotope Fuel Block	2500 pounds
	Shielding	2500 pounds
	Power Conversion System Weight	4200 pounds
Figure 2	Power Distribution System	3300 pounds
	Power Conditioning System	1400 pounds

It is anticipated that neither the fuel block or the shielding will need replacement during the life of the Space Station. It is further anticipated that each Power Conversion System (PCS) will be replaceable as a complete unit. Accordingly, the failure rate of the PCS will be equal to the sum of the failure rates of all the elements of the system.

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The net failure rate of the PCS is derived as follows: (See Table 1 for Waste Analysis)

PCS Element	Failures Per Million Hours Of Operation
Turbine	15
Heat Exchangers (3)	3
Compressor	7
Alternator	8
PCS Total	33

External to the PCS are the motor/pump for circulating coolant through the radiator.

Pump/Motor	17.5
Radiator	1

In addition to the PCS, the additional equipment shown in Figure 2 is essential to the Radioisotope Brayton cycle power system for speed regulation and voltage control. As such, it is considered to be an integral part of the primary Radioisotope Brayton cycle power source. Table 1A summarizes the Waste Analysis.

Frequency control is effected by varying the load on the generator by applying additional load when the frequency is too high as indicated by a frequency discriminator system and associated load bank and reducing the load when the frequency is too low. In addition, voltage regulation before the primary bus is achieved by varying the voltage on the alternator field winding under control of a voltage sensing system. Primary Buses 3 and 4 may be connected to RI/Brayton Power Generation Units 1 or 2 and 3 or 4 respectively.

3. REFERENCES

NASA Request For Proposal For Phase B Definition Of A Space Station Program.

North American Rockwell Space Station Program Phase B Definition Technology Requirements Review, PDS70-217, 25 March 1970.

Integrated Manned Interplanetary Spacecraft Concept Definition Final Report System Definition D2-113544-4, Prepared For NASA Langley by Boeing Aerospace Group, January 1968.

Summary Of Electrical Component Development For A 400 Hertz Brayton Energy Conversion System - Corcoran and Yeager, Lewis Research Center. NASA Technical Note NASA TN D-4874.

3. REFERENCES (Continued)

Space Station Supporting Research And Technology Initial Briefing, McDonnell Douglas Astronautics Company, 24 March 1970.

Doc. No. A-2.2.1.2.1
Sheet No. 6
By: J. Torian
Date: 18 June 1970

TABLE 1

WASTE ANALYSIS FOR BRAYTON CYCLE POWER CONVERSION SYSTEM SCHEMATIC (see Fig. 1)

Part Type	Number of Items	Weight per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs	Number of Failures per Year	Total Weight per 10 Yrs	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Fuel Block	1	2500	2500	-	-	-	2500	P_u -238	Metal-Solid 1224 #/cu ft	89 yr half-life merits recovery
Shielding	1	2500	2500	-	-	-	2500	Uranium-lithium hydride	Solid 51.2 #/cu ft	-
Replaceable PCS	2 †	4200	8400	33	0.29	24,360	4200	Fe, Cu, Al insulation	Metal assembly replaceable as a unit 16.1#/cu ft	RTE for repair and determination of cause of failure
Radiator	1	2300	2300	1	0.009	207	2300	Aluminum, and insulation quartz	Metal tubing and sheets and back surfaced mirrors 11#/cu ft	Pkg to avoid handling and shipping damage
Pump/Motor	2	25	50	17.5	0.15	75	25	Fe, Cu, Al, insulation	Metal, solid 200#/cu ft	"

† Two (2) spare pcs units are carried

TABLE 1A

WASTE ANALYSIS FOR BRAYTON CYCLE POWER SYSTEM AUXILIARY SCHEMATIC (see Fig. 2)

Part Type	Number of Items	Weight per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs	Number of Failures per Year	Total Weight per 10 Yrs	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Frequency Discriminator	9 †	2	18	12	1.05×10^{-1}	18.9	2	Si Semi-Cond Al, Cu, Fe, Plastics	52#/cu ft solid metals, insulation	**RTE for repair and determination of causes of failure
Magnetic Preamplifier	6	2	12	0.35	0.31×10^{-2}	0.37	2	Al, Cu, Fe, Ni, Plastics Si-Semi cond.	80#/cu ft solid metals, insulation	Pkg to avoid handling and shipping damage
Magnetic Amplifier	6	3	18	2.8	2.45×10^{-2}	4.41	3	"	"	"
Silicon Controlled Rectifiers	18	.25	4.5	3.0	2.63×10^{-2}	1.18	0.25	Si-SCR Ceramics Al, Cu	77#/cu ft solid metals, insulation	"
Parasitic Load Bank	6	60	360	0.05	0.44×10^{-3}	1.58	60	Nichrome Ceramics Fe, Cu	"	"
Voltage Sensing CCT	2	2	4	4.3	3.76×10^{-2}	1.5	2	Si-Semi Cond Al, Cu, Fe, Plastics	52#/cu ft solid metals, insulation	"
Voltage Reference	2	2	4	4.3	3.76×10^{-2}	1.5	2	"	"	"
Transistor Amplifier	2	1.5	3	4.3	3.76×17^{-2}	1.1	1.5	"	"	"
Magnetic Amplifier	2	3	6	2.8	2.45×10^{-2}	1.5	3	Al, Cu, Fe, Ni, Plastics Si-Semi Cond	80#/cu ft solid metals, insulation	"
Feedback Network	2	.25	0.5	2.9	2.54×10^{-2}	0.13	0.25	Nichrome, ceramics, Al, Plastics, Cu	52#/cu ft solid metals	"
Full Wave Rectifier	2	1.5	3	6.0	5.26×10^{-2}	1.6	1.5	Fe, Cu, Al, Si-semi-cond ceramics	77#/cu ft solid metals, insulation	"
Saturating Current Potential Transformer	2	40	80	0.45	0.395×10^{-2}	3.16	40	Fe, Cu, Al plastics	80#/cu ft solid metals, insulation	"
Circuit Breakers	4	1	4	1	0.876×10^{-2}	0.35	1	"	77#/cu ft solid metals, insulation	"

** RTE means Return to Earth
† Includes switchable redundant units

TABLE 1A

WASTE ANALYSIS FOR BRAYTON CYCLE POWER SYSTEM AUXILIARY SCHEMATIC (see Fig. 2)

Doc. No. A-2.2.1.2.1
Sheet No. 8
By: J. Torian
Date: 18 June 1970

Part Type	Number of Items	Weight per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs	Number of Failures per Year	Total Weight per 10 Yrs	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Power Contactors	4	1	4	1	0.876×10^{-2}	0.35	1	Fe, Cu, Al plastics	77#/cu ft solid metals, insulation	Pkg to avoid handling and shipping damage
Monitor Meters (DC)	2	0.5	1	0.5	0.44×10^{-2}	0.04	0.5	Cu, Al, Fe SiO_2 plastics	"	"
Monitor Meters (AC)	2	0.5	1	0.5	0.44×10^{-2}	0.04	0.5	"	"	"
Remote Control Switches	8	0.25	2	1	0.876×10^{-2}	0.17	0.25	Cu, Fe, Al plastics	"	"

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Doc. No. B-2.2.1.2.1 Sheet No. 1
Operational Description No. A-2.2.1.2.1
Subsystem Electric Power Source
By: J. Torian Date: 18 June 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Radioisotope Brayton System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr Total lbs	Daily Rate lbs/day	Unit Weight lbs	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed Fuel Block	89 yr half life	Pu-238 Radioactivity	-	-	2500	1224	RTE
2. Failed Shielding	Not consumed	-	-	-	2500	51.2	-
3. Failed Replaceable P.C.S.	Part failure	Component part	24,360	-	4200	16.1	RTE
4. Failed Radiator	Part Failure	Component part	207	-	2300	11	RTE
5. Failed Pump/Motor	Part Failure	Compoment part	75	-	25	200	RTE
6. Packaging for Replacement Parts	Environmental integrity destroyed	Internal environment changed	-	-	-	5	Reuse for returning failed items.

NOTE:
This Table pertains to the portion of the system covered in Figure 1, The Power Converstion System.

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Doc. No. B- 2.2.1.2.1 Sheet No. 2
Operational Description No. A- 2.2.1.2.1
Subsystem Electric Power Source
By: J. Torian Date: 18 June 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Radioisotope Brayton System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr Total lbs	Daily Rate lbs/day	Unit Weight lbs	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed Frequency Discriminator	Part failure	Component part	18.9	-	1	52	R.T.E.
2. Failed Magnetic Preamplifier	Part failure	Component part	0.37	-	2	80	"
3. Failed Magnetic Amplifier	Part failure	Component part	4.41	-	3	80	"
4. Failed Silicon Controlled Rectifiers	Part failure	Component part	1.18	-	0.25	77	"
5. Failed Parasitic Load Bank	Part failure	Component part	1.58	-	60	77	"
6. Failed Voltage Sensing	Part failure	Component part	1.5	-	2	52	"
7. Failed Voltage Reference	Part failure	Component part	1.5	-	2	52	"
8. Failed Transistor Amplifier	Part failure	Component part	1.1	-	1.5	52	"
9. Failed Magnetic Amplifier	Part failure	Component part	1.5	-	3	80	"
10. Failed Feedback Network	Part failure	Component part	0.13	-	0.25	52	"
11. Failed Full Wave Rectifier	Part failure	Component part	1.6	-	1.5	77	"
12. Failed Saturating Current Transformer	Part failure	Component part	3.16	-	40	80	"
13. Failed Circuit Breaker	Part failure	Component part	0.35	-	1	77	"
14. Failed Power Contactor	Part failure	Component part	0.35	-	1	77	"

NOTE: This Table pertains to the portion of the system covered in Figure 2, The Power System Auxiliary.

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TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-2.2.1.2.1 Sheet No. 3
Operational Description No. A-2.2.1.2.1
Subsystem Electric Power Source
By: J. Torian Date: 18 June 1970

Title: Radioisotope Brayton System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr Total lbs	Daily Rate lbs/day	Unit Weight lbs	Average Density As Received lbs/cu.ft.	REMARKS
15. Failed Monitor Meter (DC)	Part failure	Component part	0.04	-	0.5	77	RTE
16. Failed Monitor Meter (AC)	Part failure	Component part	0.04	-	0.5	77	"
17. Failed Remote Control Switches	Part failure	Component part	0.17	-	0.25	77	"
18. Packaging for Replacement Parts	Environmental Integrity Destroyed	Internal Environment Changed	-	-	-	5	Reuse for returning failed items

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Doc. No. C-2.2.1.2.1 Sheet No. 1
Operational Description No. A-2.2.1.2.1
Subsystem Electric Power Source
By: J. Torian Date: 18 June 1970

TABLE III. WASTES

Title: Radioisotope Brayton System

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs.	Unit Size lbs.	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
1. Failed Fuel Block	Solid, Metal, RTE	Pu-238	–	–	–	2500	1224	89 yr half-life merits recovery
2. Failed Shielding	Solid, Metal, RTE	Uranium - Lithium Hydride	Repair	2500	–	2500	51.2	
3. Failed Pcs.	Solid, Metal RTE	Fe, Cu, Al Insulation	Repair	24360	–	4200	16.1	
4. Failed Radiator	Solid, Metal, RTE	Al, SiO_2 Insulation	Repair	207	–	2300	11	
5. Failed Pump/Motor	Solid, Metal RTE	Fe, Cu, Al. Insulation	Repair	75	–	25	200	
6. Packaging for Replacement Parts	Solid, Plastic RTE	Plastic Sponge and Sheeting	Reuse as is	–	–	–	5	

NOTE: This Table pertains to the portion of the system covered in Figure 1, The Power Conversion System.

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Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.2.1.2.1 Sheet No. 2
Operational Description No. A-2.2.1.2.1
Subsystem Electric Power Source
By: J. Torian Date: 18 June 1970

TABLE III. WASTES

Title: Radioisotope Brayton System

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs.	Unit Weight Lbs.	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
1. Failed Frequency Discriminator	Solid, Metal, RTE	Al, Cu, Fe, Si Semi Cond Plastics	Repair	18.9	-	2	52	
2. Failed Magnetic Preamplifier	Solid, Metal, RTE	Al, Cu, Fe, Ni, Plastics Si-Semi Cond.	Repair	0.37	-	2	80	
3. Failed Magnetic Amplifier	Solid, Metal, RTE	"	Repair	2.8	-	3	80	
4. Failed Silicon Controlled Rectifiers	Solid, Metal, RTE	Al, Cu, Si-Semi Cond	Repair	1.18	-	0.25	77	
5. Failed Parasitic Load Bank	Solid, Metal RTE	Fe, Cu, Nichrome Ceramic	Repair	1.58	-	60	77	
6. Failed Voltage Sensing Circuit	Solid, Metal, RTE	Al, Cu, Fe, Si-Semi Cond Plastics	Repair	1.5	-	2	52	
7. Failed Voltage Reference	Solid, Metal, RTE	"	Repair	1.5	-	2	52	
8. Failed Transistor Amplifier	Solid, Metal, RTE	"	Repair	1.1	-	1.5	52	
9. Failed Magnetic Amplifier	Solid, Metal, RTE	Al, Cu, Fe, Ni, Si-semi cond Plastics	Repair	1.5	-	3	80	
10. Failed Feed Back Network	Solid, Metal, RTE	Al, Cu, Ni-chrome, Ceramics, Plastics	Repair	0.13	-	0.25	52	

NOTE: This Table pertains to the portion of the system covered in Figure 2, The Power System Auxiliary.

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Doc. No. C-2.2.1.2.1 Sheet No. 3
Operational Description No. A-2.2.1.2.1
Subsystem Electric Power Source
By: J. Torian Date: 18 June 1970

TABLE III. WASTES

Title: Radioisotope Brayton System

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	Index Of Utilization Potential And Remarks
11. Failed Full Wave Rectifier	Solid, Metal, RTE	Al, Cu, Fe, Si-semi cond ceramics	Repair	1.6	-	1.5	77	
12. Failed Saturating Current Potential Transformer	Solid, Metal, RTE	Al, Cu, Fe Plastics	Replace	3.16	-	40	80	
13. Failed Circuit Breakers	Solid, Metal, RTE	"	Replace	0.35	-	1	77	
14. Failed Power Contactor	Solid, Metal, RTE	"	Replace	0.35	-	1	77	
15. Failed Monitor Meter (DC)	Solid, Metal, RTE	Al, Cu, Fe, $Si\,O_2$, Plastic	Repair	0.04	-	0.5	77	
16. Failed Monitor Meter (AC)	Solid, Metal, RTE	"	Repair	0.04	-	0.5	77	
17. Failed Remote Control Switches	Solid, Metal, RTE	"	Replace	0.17	-	0.25	77	
18. Packaging for Replacement Parts	Solid, Plastic, RTE	Plastic Sponge and Sheeting	Reuse as is	-	-	-	5	

NOTE: This Table pertains to the portion of the system covered in Figure 2, The Power System Auxiliary.

DOC No. A-2.2.2.1.1
Sheet No. 1
By: J. Torian
Date: 17 August 1970

OPERATIONAL DESCRIPTION

TITLE: Power Conditioning System

1. Schematic Diagram

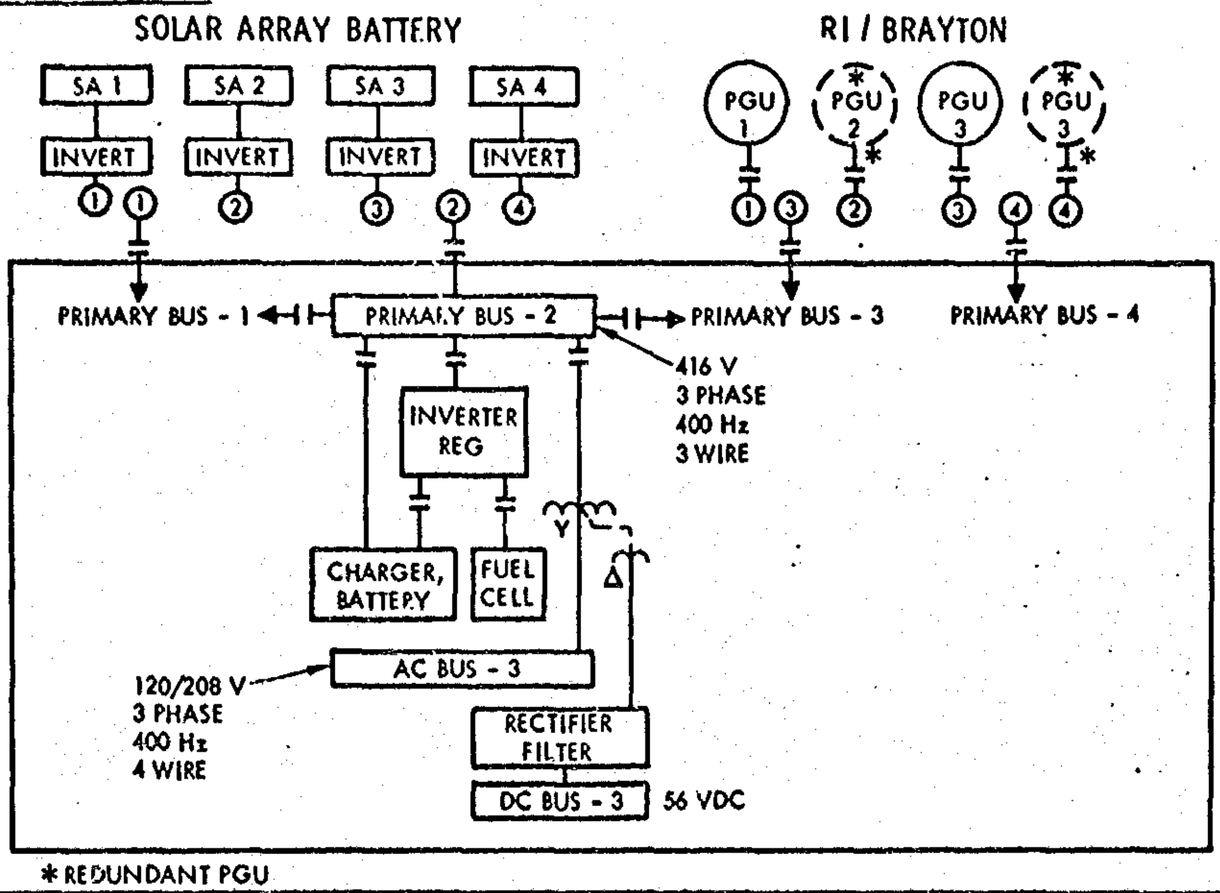

Figure 1. Power Conditioning Schematic

2. Operational Description and Rationale

As shown in Figure 1, the power conditioning system comprises those equipments which take the 416V, 3ϕ, 400 Hz primary power and modify it to provide battery power, power for a 56 volt dc bus and 120/208 V 3 ϕ 400 Hz for distribution in the space vehicle. Accordingly, the power conditioning system comprises inverter regulators, batteries and battery chargers, fuel cells, transformers, rectifier filters, miscellaneous circuit breakers and a switch, control and meter panel. The power conditioning equipment associated with all four primary buses is essentially the same. However the amount of battery capacity associated with buses 1 and 2, which are the solar cell fed buses, is greater in order to handle the earth orbit solar cell illumination cycle. Battery power for the Brayton/Isotope power system is required to start-up the system and for handling communications and other vital house keeping functions during start-up. The fuel cells are used as back up and can be used to provide emergency power to the primary buses by using the inverter regulator to convert the DC output of the fuel cell to AC for the bus supply. Using a Charger, Battery, Regulator (CBR) combination rating of 135 watts each and 80 pounds each, 185 CBR's will provide 25,000 watts average power. For the RI/Brayton system 74 CBR's are employed to provide 10,000 watts average power. Hydrogen-oxygen fuel cells to provide 10,000 watts are also provided at a weight of approximately 1.5 #/kw-hr or 15,000 pounds. Of this weight 1 pound is for the reactants which yield about 1 pound of water per kw-hr.

TABLE 1. POWER CONDITIONING SYSTEM WASTE ANALYSIS

LRU Part Type	Number of Items	Weight per Items	Total Weight Pounds	Failure Rate Fails/10^6 Hrs.	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Circuit Breaker	24	1	24	1	0.876×10^{-2}	2.1	1	Fe, Cu, Al Plastics	77#/cu ft, Solid Metals, Insulation	* RTE for repair and determination of cause of failure
Inverter Regulator	5	40	200	20.4	1.79×10^{-1}	358	40	Si Semicond. Fe, Cu, Al Plastics	77#/cu ft, Solid Metals, Insulation	Pkg. to avoid handling & shipping damage
Solar Array Battery Charger Regulators	185	80	14800	13.4	1.14×10^{-1}	16872	80	Si Semicond. Fe, Cu, Al Plastics	77#/cu ft, Solid Metals, Insulation	Pkg. to avoid handling & shipping damage
RI/Brayton Battery Charger Regulator	74	80	5920	13.4	1.14×10^{-1}	6749	80	Si Semicond. Fe, Cu, Al Plastics	77#/cu ft, Solid Metals, Insulation	Pkg. to avoid handling & shipping damage
Fuel Cell	4	3750	15000					Hydrogen, Oxygen Al, Cu, Plastics		H_2O produced may be utilized on board
Rectifier Filter	5	20	100	6	5.26×10^{-2}	52.6	20	Si Semicond. Fe, Cu, Al Ceramics	77#/cu ft Solid Metals, Insulation	* RTE same as items above
Transformer	5	25	125	0.25	0.22×10^{-2}	2.75	25	Fe, Cu, Al Plastics	80#/cu ft Solid Metals, Insulation	* RTE same as items above
Power Contactors	28	1	28	1	0.876×10^{-2}	2.45	1	Fe, Cu, Al Plastics	77#/cu ft Solid Metals, Insulation	* RTE same as items above
Monitor Meters (DC)	2	0.5	1.0	0.5	0.44×10^{-2}	0.04	0.5	Cu, Al, Fe, SiO_2, Plastics	77#/cu ft Solid Metals, Insulation	* RTE same as items above
Monitor Meters (AC)	2	0.5	1.0	0.5	0.44×10^{-2}	0.04	0.5	Cu, Al, Fe, SiO_2, Plastics	77#/cu ft Solid Metals, Insulation	* RTE same as items above
Monitor Meter Switches	2	0.25	0.5	1	0.876×10^{-2}	0.04	0.25	Cu, Fe, Al Plastics	77#/cu ft Solid Metals, Insulation	* RTE same as items above
Remote Control Switches	5	0.25	1.25	1	0.876×10^{-2}	0.11	0.25	Cu, Fe Plastics	77#/cu ft Solid Metals, Insulation	* RTE same as items above

* RTE means return to earth

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Doc. No. B-2.2.2.1.1 Sheet No. 1
Operational Description No. A-2.2.2.1.1
Subsystem Regulate Power
By: J. Torian Date: 8/17/70

TABLE II. CONSUMABLES/EXPENDABLES

Title: Power Conditioning System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr Total Lbs	Daily	Unit Weight Lbs	Average Density As Received lbs/cu.ft.	REMARKS
1 - Failed Circuit Breaker	Part Failure	Component Part	2.1	-	1	77	RTE
2 - Failed Inverter Regulator	Part Failure	Component Part	358	-	40	77	RTE
3 - Failed Solar Array Battery Charger Regulator	Part Failure	Component Part	16872	-	80	77	RTE
4 - Failed RI/Brayton Battery Charger Regulator	Part Failure	Component Part	6749	-	80	77	RTE
5 - Failed Fuel Cell	Part Failure	Component Part		-	3750		RTE
6 - Failed Rectifier Filter	Part Failure	Component Part	52.6	-	20	77	RTE
7 - Failed Transformer	Part Failure	Component Part	2.75	-	25	80	RTE
8 - Failed Power Contactor	Part Failure	Component Part	2.45	-	1	77	RTE
9 - Failed Monitor Meter (DC)	Part Failure	Component Part	0.04	-	0.5	77	RTE
10 - Failed Monitor Meter (AC)	Part Failure	Component Part	0.04	-	0.5	77	RTE
11 - Failed Monitor Meter Switches	Part Failure	Component Part	0.04	-	0.25	77	RTE
12- Failed Remote Control Switches	Part Failure	Component Part	0.11	-	0.25	77	RTE

Study of Housekeeping Concepts For Manned Space

Doc. No. B- 2.2.2.1.1 Sheet No. 2
Operational Description No. A- 2.2.2.1.1
Subsystem . Regulate Power
By: J. Torian Date: 8/17/70

TABLE II. CONSUMABLES/EXPENDABLES

Title: Power Conditioning System

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr Total Lbs	Daily	Unit Weight Lbs	Average Density As Received lbs/cu.ft.	REMARKS
13 - Packaging for Replacement Parts	Environmental Integrity Destroyed	Internal Environment Changed	-	-	-	5	Reuse for Returning Failed Items

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Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.2.2.1.1 Sheet No. 1
Operational Description No. A-2.2.2.1.1
Subsystem Regulate Power
By: J. T. T. Date: 8/17/70

TABLE III. WASTES

Title: Power Conditioning System

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr Total lbs.	Daily Rate-lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	Remarks
1 - Failed Circuit Breaker	Solid Metal RTE	Fe, Cu, Al Plastics	Replace	2.1	-	1	77	
2 - Failed Inverter Regulator	Solid Metal RTE	Fe, Cu, Al Plastics Si-Semicond.	Repair	358	-	40	77	
3 - Failed Solar Array Battery Charger Regulator	Solid Metal RTE	Fe, Cu, Al Plastics Si-Semicond.	Repair	16872	-	80	77	
4 - Failed RI/Brayton Battery Charger Regulator	Solid Metal RTE	Fe, Cu, Al Plastics Si-Semicond.	Repair	6749	-	80	77	
5 - Failed Fuel Cell	Solid Metal RTE	Fe, Cu, Al Plastics Si-Semicond.	Replace		-			
6 - Failed Rectifier Filter	Solid Metal RTE	Fe, Cu, Al Ceramics Si-Semicond.	Repair	52.6	-	20	77	
7 - Failed Transformer	Solid Metal RTE	Fe, Cu, Al Plastics	Replace	2.75	-	25	80	
8 - Failed Power Contactor	Solid Metal RTE	Fe, Cu, Al Plastics	Replace	2.45	-	1	77	
9 - Failed Monitor Meter (DC)	Solid Metal RTE	Cu, Al, Fe SiO_2, Plastics	Repair	0.04	-	0.5	77	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.2.2.1.1 Sheet No. 2
Operational Description No. A-2.2.2.1.1
Subsystem Regulate Power
By: J.T.T. Date: 8/17/70

TABLE III. WASTES

Title: Power Conditioning System

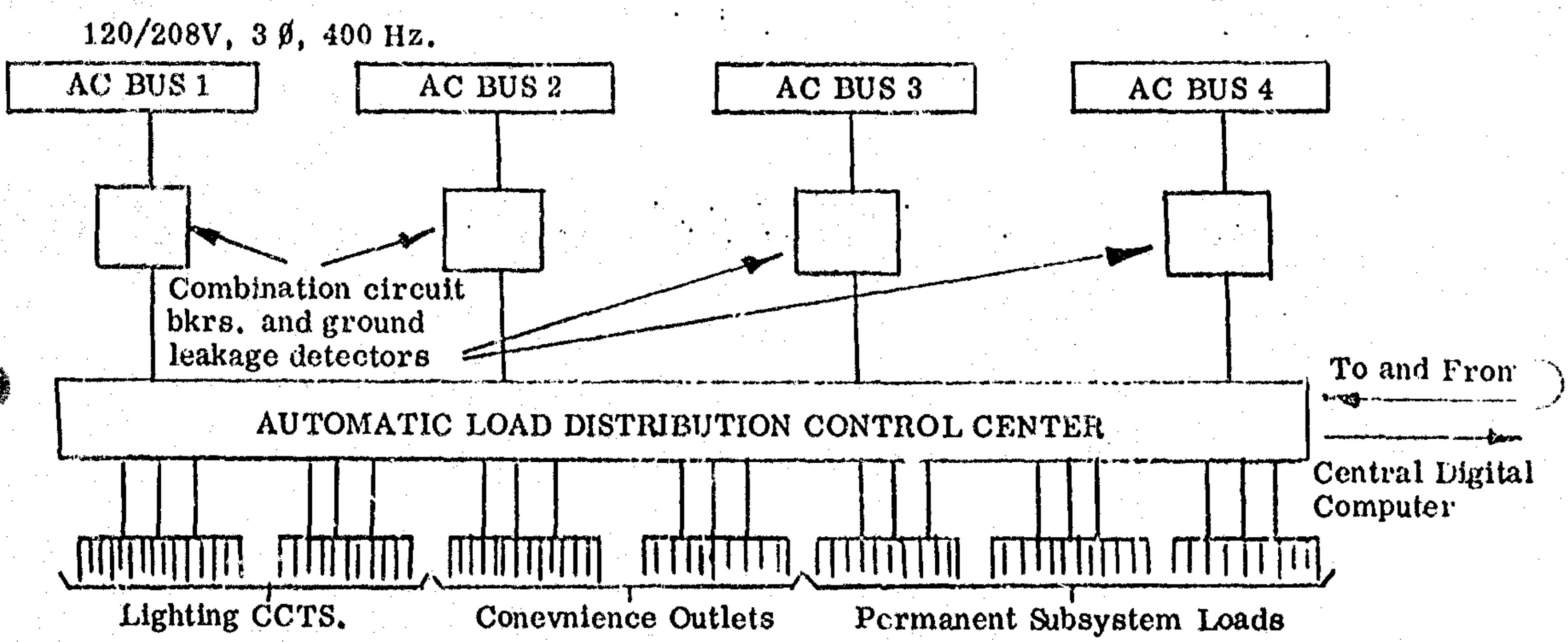
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr Total lbs.	Daily Rate-lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	Remarks
10 - Failed Monitor Meter (AC)	Solid Metal RTE	Cu, Al, Fe SiO_2, Plastics	Repair	0.04	-	0.5	77	
11 - Failed Monitor Meter Switches	Solid Metal RTE	Cu, Fe, Al Plastics	Repair	0.04	-	0.25	77	
12 - Failed Remote Control Switches	Solid Metal RTE	Cu, Fe Plastics	Replace	0.11	-	0.25	77	
13 - Packaging for Replacement Parts	Solid Plastic RTE	Plastic Sponge and sheeting	Reuse as is	-	-	-	5	

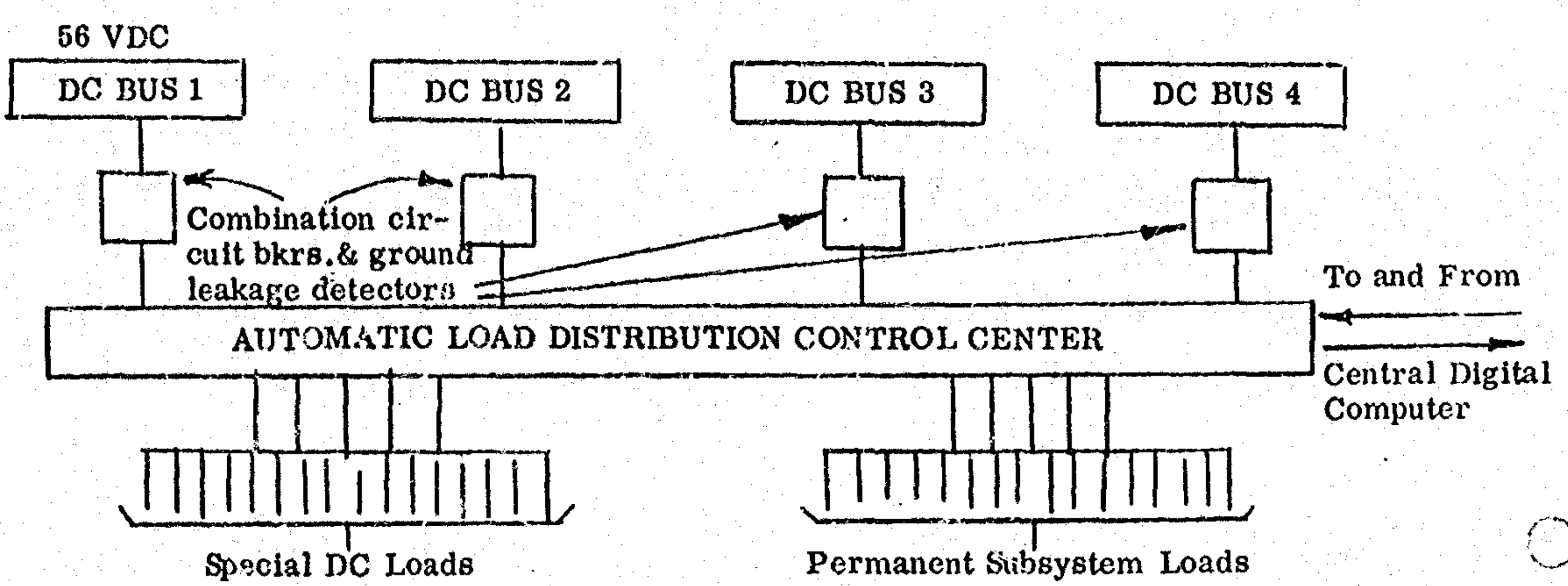
Doc. No. A-2.2.3.1.1
Sheet No. 1
By: J. Torian
Date: 12 August 1970

OPERATIONAL DESCRIPTION

TITLE: Power Distribution System

1. Schematic Diagram





2. Operational Description and Rationale

As shown in Figure 1 , the 120/208V, 3ϕ, 400 Hz, power distribution system comprises the wiring, circuit breakers, shock protection trip-out devices and the automatic load distribution control center which functions to monitor and control the bus loading and transfer, fault isolation and subsystem "ON-OFF" control. About 10% of the power is made available at 50 VDC and the distribution and control of this power is handled in a similar manner as the 120/208V, 3ϕ, 400 Hz power. The combination circuit breaker and ground leakage detectors are designed not only to protect the equipment from damage during overloads or short circuits but also to protect personnel from shock hazard in the event a leakage path is established from any one of the "hot" lines to ground through the man's body, clothing or suit.

The automatic load distribution control center senses bus loading, faults, low voltage, etc. and under control of the central computer system switches loads, transfers equipment to different buses as required and turns various subsystems ON or OFF as required. The centers, one for the AC system and the other for the DC system comprise a number of computer compatible elements such as solid state circuit breaker/load control rivets and current sensitive elements. While the number of these will vary with the complexity and amount of subsystems which are installed, a representative estimate has been used in the waste analysis which may be readily extrapolated when more specific data is known.

TABLE I. POWER DISTRIBUTION SYSTEM WASTE ANALYSIS

Doc. No. A-2.2.3.1.1
Sheet No. 3
By: J. Torian
Date: 12 August 1970

Part Type	Number of Items	Weight per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs.	No. of Failures per Year	Total Weight per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition of Special Handling Requirements
120/208 VOLT - 3φ - 400 HERTZ EQUIPMENT										*RTE for repair and determination of cause of failure
Cct. Bkr. & Ground Leakage Detector	4	20	80	11	0.96×10^{-1}	76.8	20	Fe, Cu, Al, Si Semiconductor Plastics	77#/cu ft Solid Metals, Insulation	Pkg. to avoid handling and shipping damage
Cct. Bkr/Load Control Unit	21	20	420	6	5.26×10^{-2}	220	20	Fe, Cu, Al, Si Semiconductor Plastics	77#/cu ft Solid Metals, Insulation	Pkg. to avoid handling and shipping damage
Current Sensitive Element	21	1.5	31.5	11	0.96×10^{-1}	30.3	1.5	Fe, Cu, Al, Si Semiconductor Plastics	77#/cu ft Solid Metals, Insulation	Pkg. to avoid handling and shipping damage
Individual Line Cct. Bkr.	84	0.5	42	1	0.88×10^{-2}	3.7	0.5	Fe, Cu, Al Plastics	77#/cu ft Solid Metals, Insulation	Pkg. to avoid handling and shipping damage
Monitor Meters (AC)	2	0.5	1.0	0.5	0.44×10^{-2}	0.04	0.5	Cu, Al, Fe, SiO_2, Plastics	77#/cu ft Solid Metals, Insulation	Pkg. to avoid handling and shipping damage
Monitor Meter Switches	2	0.25	0.5	1	0.88×10^{-2}	0.04	0.25	Fe, Cu, Al Plastics	77#/cu ft Solid Metals, Insulation	Pkg. to avoid handling and shipping damage
Remote Control Switches	21	0.25	5.3	1	0.88×10^{-2}	0.47	0.25	Fe, Cu Plastics	77#/cu ft Solid Metals, Insulation	Pkg. to avoid handling and shipping damage

TABLE I. POWER DISTRIBUTION SYSTEM WASTE ANALYSIS (cont'd)

Doc. No. A-2.2.3.1.1
Sheet No. 4
By: J. Torian
Date: 12 August 1970

Part Type	Number of Items	Weight per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hrs.	No. of Failures per Year	Total Weight per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition of Special Handling Requirements
56 VOLT - D.C. EQUIPMENT										*RTE for repair and determination of cause of failure
Cct. Bkr. & Ground Leakage Detector	4	20	80	11	$0.96x10^{-1}$	76.8	20	Fe, Cu, Al, Si-Semiconductor Plastics	77#/cu ft Solid Metals, Insulators	Pkg. to avoid handling and shipping damage
Cct. Bkr. & Load Control Unit	8	20	160	6	$5.26x10^{-2}$	84.8	20	Fe, Cu, Al, Si-Semiconductor Plastics	77#/cu ft Solid Metals, Insulators	Pkg. to avoid handling and shipping damage
Current Sensitive Element	8	1.5	12	11	$0.96x10^{-1}$	11.5	12	Fe, Cu, Al, Si-Semiconductor Plastics	77#/cu ft Solid Metals, Insulators	Pkg. to avoid handling and shipping damage
Individual Line Cct. Bkr.	32	0.5	16	1	$0.88x10^{-2}$	1.4	0.5	Fe, Cu, Al Plastics	77#/cu ft Solid Metals, Insulators	Pkg. to avoid handling and shipping damage
Monitor Meters (DC)	2	0.5	1.0	0.5	$0.44x10^{-2}$	0.04	0.5	Cu, Al, Fe, SiO_2, Plastics	77#/cu ft Solid Metals, Insulators	Pkg. to avoid handling and shipping damage
Monitor Meter Switches	2	0.25	0.5	1	$0.88x10^{-2}$	0.04	0.25	Fe, Cu, Al Plastics	77#/cu ft Solid Metals, Insulators	Pkg. to avoid handling and shipping damage
Remote Control Switches	8	0.25	2.0	1	$0.88x10^{-2}$	0.18	0.25	Fe, Cu Plastics	77#/cu ft Solid Metals, Insulators	Pkg. to avoid handling and shipping damage

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Doc. No. B-2.2.3.1.1 Sheet No. 1
Operational Description No. A-2.2.3.1.1
Subsystem Power Distribution System
By: J. T. Torian Date: 8/12/70

TABLE II. CONSUMABLES/EXPENDABLES
Power Distribution System
Title: 120/208 Volt 3ϕ 400 Hertz Equipment

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total lbs	Daily	Unit Weight lbs	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed Cct. Bkr. & Ground Leakage Detector	Part Failure	Component Part	76.8	-	20	77	RTE
2. Failed Cct. Bkr/Load Control Unit	Part Failure	Component Part	220	-	20	77	RTE
3. Failed Current Sensitive Element	Part Failure	Component Part	30.3	-	1.5	77	RTE
4. Failed Individual Live Cct. Breaker	Part Failure	Component Part	3.7	-	0.5	77	RTE
5. Failed Monitor Meter (AC)	Part Failure	Component Part	0.04	-	0.5	77	RTE
6. Failed Monitor Meter Switches	Part Failure	Component Part	0.04	-	0.5	77	RTE
7. Failed Remote Control Switches	Part Failure	Component Part	0.47	-	0.25	77	RTE
8. Packaging for Replacement Parts	Environmental Integrity Destroyed	Internal Environment Changed	-	-	-	5	Reuse for Returning Failed Items

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Power Distribution System

Title: 56 Volt - D.C. Equipment

Doc. No. B-2.2.3.1.1 Sheet No. 2
Operational Description No. A-2.2.3.1.1
Subsystem Power Distribution System
By: J.T. Torian Date: 8/12/70

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total lbs	Daily	Unit Weight lbs	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed Cct. Bkr. & Ground Leakage Detector	Part Failure	Component Part	76.8	-	20	77	RTE
2. Failed Cct. Bkr. & Load Control Unit	Part Failure	Component Part	84.8		20	77	RTE
3. Failed Current Sensitive Element	Part Failure	Component Part	11.5	-	12	77	RTE
4. Failed Individual Line Cct. Breaker	Part Failure	Component Part	1.4	-	0.5	77	RTE
5. Failed Monitor Meters (DC)	Part Failure	Component Part	0.04	-	0.5	77	RTE
6. Failed Monitor Meter Switches	Part Failure	Component Part	0.04	-	0.25	77	RTE
7. Failed Remote Control Switches	Part Failure	Component Part	0.18	-	0.25	77	RTE
8. Packaging for Replacement Parts	Environmental Integrity Destroyed	Internal Environment	-	-	-	5	Reuse for Returning Failed Items

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.2.3.1.1 Sheet No. 1
Operational Description No. A-2.2.3.1.1
Subsystem Power Distribution System
By: J. T. Torian Date: 8/12/70

TABLE III. WASTES

Title: Power Distribution System
120/208 Volt 3ϕ 400 Hertz Equipment

WASTE ITEM	Characteristics State And Attributes		Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs	Daily	Unit Weight lbs	Average Density As Received lbs/cu.ft.	Remarks
1. Failed Cct. Bkr. & Ground Leakage Detector	Solid	Metal RTE	Fe, Cu, Al Si, Semicond. Plastics	Repair	76.8	-	20	77	
2. Failed Cct. Bkr/Load Control Unit	Solid	Metal RTE	Fe, Cu, Al Si, Semicond. Plastics	Repair	220	-	20	77	
3. Failed Current Sensitive Element	Solid	Metal RTE	Fe, Cu, Al Si, Semicond. Plastics	Repair	30.3	-	1.5	77	
4. Failed Individual Line Cct. Breaker	Solid	Metal RTE	Fe, Cu, Al Plastics	Replace	3.7	-	0.5	77	
5. Failed Monitor Meter (AC)	Solid	Metal RTE	Cu, Al, Fe, SiO_2, Plastics	Repair	0.04	-	0.5	77	
6. Failed Monitor Meter Switches	Solid	Metal RTE	Cu, Al, Fe, Plastics	Repair	0.04	-	0.25	77	
7. Failed Remote Control Switches	Solid	Metal RTE	Cu, Fe Plastics	Replace	0.47	-	0.25	77	
8. Packaging for Replacement Parts	Solid	Plastic RTE	Plastic Sponge & Sheeting	Reuse as is	-	-	-	5	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.2.3.1.1 Sheet No. 2
Operational Description No. A-2.2.3.1.1
Subsystem Power Distribution System
By: J. T. Torion Date: 8/12/70

TABLE III. WASTES

Title: Power Distribution System
56 Volt - D. C. Equipment

WASTE ITEM	Characteristics State And Attributes		Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs	Daily	Unit Weight lbs	Average Density As Received lbs/cu.ft.	Remarks
1. Failed Cct. Bkr. & Ground Leakage Detector	Solid	Metal RTE	Fe, Cu, Al, Si Semicond. Plastics	Repair	76.8	-	20	77	
2. Failed Cct. Bkr. & Load Control Unit	Solid	Metal RTE	Fe, Cu, Al, Si Semicond. Plastics	Repair	84.8	-	20	77	
3. Failed Current Sensitive Element	Solid	Metal RTE	Fe, Cu, Al, Si Semicond. Plastics	Repair	11.5	-	12	77	
4. Failed Individual Line Cct. Breaker	Solid	Metal RTE	Fe, Cu, Al, Plastics	Replace	1.4	-	0.5	77	
5. Failed Monitor Meters (D. C.)	Solid	Metal RTE	Cu, Al, Fe, SiO_2, Plastics	Repair	0.04	-	0.5	77	
6. Failed Monitor Meter Switches	Solid	Metal RTE	Fe, Cu, Al, Plastics	Repair	0.04	-	0.25	77	
7. Failed Remote Control Switches	Solid	Metal RTE	Fe, Cu, Plastics	Replace	0.18	-	0.25	77	
8. Packaging for Replacement Parts	Solid	Plastic RTE	Plastic Sponge & Sheeting	Reuse as is	-	-	-	5	

PROVIDE FOR SYSTEM MAINTENANCE AND REPAIR

SECTION 2.3

TABLE OF CONTENTS

Doc. No. A-2.3.1.1.1
Sheet No. 1
By: J.S. Whyte
Date: 8 September 1970

OPERATIONAL DESCRIPTION

TITLE: Structural Maintenance

OBJECTIVE:

To define the structural type waste associated with room partitioning and structural maintenance and repair on spacecraft in orbit.

RATIONALE:

A. Partitions

Multi-manned space orbiting vehicles will have as their purpose the performance of many different types of tasks. Accommodations for compartmental changes to quickly comply with new requirements will be designed. The various layouts will be provided for in the basic design with fixed female attachments preinstalled. Moving of the facilities in this manner does not indicate that any consumables, expendables or waste products will result. The necessary hand tools will be ship stored in maintenance lockers and will probably be reusable indefinately. The weightlessness of space plus designing for space will minimize the wear and breaking of fasteners or even damaging the threads, therefore, only a one piece spare contingency for fasteners seems necessary. This is assumed as 10 fasteners/wall, 5 walls/deck, 2decks alterable.

Interiors are being designed utilizing metal surfaces treated to produce corrosion and wear protection. Present plans indicate that surfaces are not to be painted. Therefore, there will be no need to establish resurface treatments with their attendant supplies. Stainless steels and aluminum do, however, discolor with age and will need some cleaning to enhance their appearance. A quarterly clean wipe down with an approved paper towel or automated sponge mop (see A-1.4.5.2.1) wetted in a detergent water solution will accomplish this and not create outgassing atmospheric contamination nor increase the potential for fire. It is estimated that two heavy duty towels (0.25 lbs.each) or sponges and one percent by weight of a detergent per gallon of water will be required per deck, once per quarter - five cleanable decks are assumed for an average spacecraft.

Doc. No. A-2.3.1.1.1
Sheet No. 2
By: J.S. Whyte
Date: 8 September 1970

B. Structural (including external items)

The vacuum of space, lack of propellant gas blast and materials selections will minimize the need for exterior structural care. Deteriorated or damaged antenna and solar cell panels, beyond acceptable tolerance, will be returned to earth as scrap, as it is inadvisable to undertake their repair or resurfacing in space. Optical cleanliness will require wiping with a detergent cleaner and lint free towelling if the optics can be brought indoors for cleaning. Cleaning by some EVA techniques are possible but not considered wise.

In the event of punctures in the pressure wall, it would be advisable to perform a fix immediately. Repairs can be affected by patching on the pressure side, using fiberglass cloth and a self actuating structural bonding agent. The average size fiberglass patch is assumed at 0.25 lbs. and it is assumed that the rate of usage would be around five a year average.

Structural damage such as distortion or fracture has been analysed and discounted. The reasoning is that structural design is predicted upon launching loads which far exceed the anticipated survivable in-orbit loadings.

The inflatable seals, as installed, will have a one or two unit redundancy which allows for adequate safety margin between supply missions, negating unscheduled maintenance or repair requirements. Scheduled bi-annual maintenance on seals appears warranted at this point for each of two 5 foot diameter seals. The components for docking (latching mechanisms), such as shock absorbers and alignment gear, is envisioned to be spring loaded and dry lubricated, as opposed to fluid operated, to minimize maintenance and reduce in-orbit maintenance requirements. Scheduled maintenance routines on a yearly basis will probably apply to each of the latching mechanisms or major mechanical assemblies therefrom. Twenty-four manhours per month are estimated to perform the aforementioned tasks.

Documents B-2.3.1.1.1 and C-2.3.1.1.1 summarize the anticipated expendables, consumables and waste products.

Doc. No. A-2.3.1.1.1
Sheet No. 3
By: J.S. Whyte
Date: 8 September 1970

REFERENCES:

AIAA Paper No. 69-1062, Space Station Operations; Requirements and Interactions. Fritz C. Runge, McDonnell Douglas Astronautics Co.

ASD-TDR-62-1015, Repair of Leaks in an Aerospace Environment, AFSC Wright-Patterson AFB, Ohio. (Project No. 8170, Task No. 817005).

N63-18867, Self-Sealing Spacecraft Structures in the Meteoroid Environment. Northrup Space Laboratories No. NSL63-64, April 1963, James J. Piechocki

ARS Paper 2543-62, Metrotoid Protection for Space Radiators. I. J. Loeffler, S. Lieblien, and N. Clough, NASA Lewis Research Center, Cleveland, Ohio, 1962.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-2.3.1.1.1 Sheet No. 1
Operational Description No. A-2.3.1.1.1
Subsystem Maintenance Facilities
By: J.S. Whyte Date: 8/25/70

Title: Structural Maintenance

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total lbs.	Daily Rate lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
Towel/Sponge	Soiled	Freshness	10		.25	8.0	
Wash Water	Soiled	Freshness	300		7.5	62.4	
Powdered Detergent	In Solution	Phosphate	30		0.08	60.0	
Male Slide Fasteners	Wear	Life	25		0.25	500	
Glass Cloth Patch	As A Scab Patch	Availability	12.5		0.25	100	
Airlock Seals	Worn	Life	400		10.0	40.0	
Airlock Latching Mechanisms	Worn	Life	1000		50.0	200.0	
Antennas & Solar Cells	Surface Deterioration	Surface Integrity	INDETEMINANT				

FAIRCHILD HILLER
REPUBLIC AVIATION DIVISION
FARMINGDALE, LONG ISLAND, NEW YORK

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-2.3.1.1.1 Sheet No. 1
Operational Description No. A-2.3.1.1.1
Subsystem Maintenance Facilities
By: J.S. Whyte Date: 8/25/70

Title: Structural Maintenance

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
Towel/Sponge	Solid, Soiled, Textile Sheet	Cellulose	Wash	10		0.25	8.0	
Containers For Detergent	Solid, Plastic Box	Polyethylene	Reuseable By Refilling	.5		.5	5.0	
H_2O	Liquid, Soiled	H_2O + Detergent	Filter	300		7.5	62.5	
Partition Fasteners	Solid, Metal	Ni, Cr, Fe	N/A	25		.25	500	
Antennas And Solar Cells	Solid, Metal, Large, Bulky	Al, Fe, Selenium, Cu, Borosilicates						
Glass Cloth Patch Separators	Solid, Plastic Inert, Sheet	Teflon	N/R	12.5		0.25	65	
Worn Airlock Seals	Solid, Plastic, Tubular	Rubber	N/R	400		10.0	40	
Worn Airlock Latch Mechanism Assemblies	Solid, Metal Heavy	Fe	Overhaul	1000		50.0	200	

Doc. No. A-2.3.1.2.1
Sheet No. 1
By: J.S. Whyte
Date: 4 September 1970

OPERATIONAL DESCRIPTION

TITLE: Avionics Systems Maintenance

OBJECTIVE:

To define the potential waste resulting from the maintenance and repair of the on-board avionics subsystem including: Communications; Navigation and Guidance, Stabilization and Control; associated propulsion interface valving.

RATIONALE:

A. Avionics

All components of the avionics subsystems are expected to have reliability, back up redundancy and shuttle resupply so as to preclude in-orbit maintenance, except in emergency situations. Repair is not intended, just removal and replacement, or bridging, and returning defective units to earth for analysis and disposition.

Interchanging units will be accomplished using hand tools supplied at time of initial launching. The failed components, probably red tagged, will replace the new unit in its stock bin.

Push then screw-in electrical connectors, with a positive lock feature, can be disconnected or connected by hand, eliminating the need of accessory implements.

Some intercomponent rewiring or contact repair is to be expected, requiring a wire cutter, solderless crimping kit and spare wire/s for jumping the harness. Two kits and one spool of each guage of wire will be required for a 12 man mission; five kits and two spools for 50 men, and ten kits and 5 spools for the 100 man base providing also for modules. Heat shrinkable insulators are part of the kit and will require a heat source. A standard hair dryer type is advised since it can be used for multi-duty purposes such as, accelerated epoxy airing or hair drying. One will be sufficient for 12 men, two for 50 and five for 100 man mission.

Doc. No. A-2.3.1.2.1
Sheet No. 2
By: J.S. Whyte
Date 4 September 1970

B. Propulsion Interface Valving

With break-open fluid lines proposed in the first reference for in-flight maintenance on fluid lines carrying toxic fluids and the resulting potential hazard to the entire crew, a preventative proposal seems in order. It is recommended that each interface valve of the toxic lines have the repairable fittings encased in a sealing flexible boot chamber on both ends for easy removal by hand tools. In addition, the boot should be equipped with a sensor/warning device and adapter host to vacuum. An additional benefit would be that only one portable breathing apparatus is needed for the maintenance man, in each compartment; the sealed boot around each removable fitting obviates the need for standby oxygen masks for the whole area crew complement.

Tubing maintenance, as a plumbing requirement, and filter control under general maintenance is provided for in Document A-2.3.1.3.1.

C. Summary

A list of anticipated expendables, consumables and waste products are specified in Table I without quantitative data. Recognizing that the performance of these tasks will occur sporatically, it is difficult at this time to estimate waste rates or man-hour expenditures for these maintenance tasks. It must suffice to say that on a 12 man crew the task will be accomplished, when required, by the individual/s trained in the respective area. On 50 and 100 man complements, a maintenance division with subsystem maintenance assignments are forseen with probably one-quarter of their working schedule devoted to preventative maintenance tasks.

TABLE I. Avionics Systems Waste Analysis

Consumable/Expendable	Associated Wastes
• Electric wire crump and splice tool	Wire and insulation remnants
• Various gauges electric cables	Old wire, cables, spent spools and wire packaging
• Solderless splice, terminal kits	Terminal remnants
• Shrinkable sleeve insulators	Insulation and tape remnants
• Fluid line seals • Tubing material • Tube cutting, forming, tightening tools	Fluid line remnants, plastic and and metal tubing ends, seal covers
• Original cartons and packaging	Waste packaging
• O_2 for safety masks	CO_2

Doc. No. A-2.3.1.2.1
Sheet No. 3
By: J.S. Whyte
Date: 4 September 1970

REFERENCES:

Study of Space Station Propulsion System Resupply and Repair. By Victor A. Des Camp, Martin Marietta Corp., Denver, Colorado, January 1970. N70-22830

Selecting Between Redundancy And Repair In Manned Spacecraft. Memorandum RM-4325-NASA, The Rand Corporation, Santa Monica, California, Sept. 1964.

The Requirement For Maintainable Electronics On Long Duration Manned Space Missions. By M.L. Johnson, AIAA Paper A70-24895

Doc. No. A-2.3.1.3.1
Sheet No. 1
By: J.S. Whyte
Date: 10 September 1970

OPERATIONAL DESCRIPTION

TITLE: Utilities Maintenance

OBJECTIVE:

To define the potential waste that results during the course of maintaining or repairing the utilities of spacecrafts in orbit. These utilities include the plumbing, electrical, heating, airconditioning, machine shop, space suits and other general spacecraft support systems.

RATIONALE:

Every effort is being applied to design and establish each mission; 12, 50 or 100 man to perform maintenance free. Systems, sub-systems, components and details will be scrutinized minutely to assure space bound reliability with long life. The maintenance and repair demands then become minimal and probably non-existant for the relatively short duration 12 man excursion. Therefore, this analysis will provide little in the way of maintenance provisioning on the workshop missions.

However, the extended flight duration of space stations and bases require acknowledging the probability that difficulties will occur. Also, man performed, spontaneous or scheduled, inspections will be needed to keep things flowing. An example would be the proposed endless belt style waste handling system. It may prove beneficial to replace some items, such as human waste facilities, periodically perhaps to coincide with a supply mission. These and many other "ifs" or "maybes" generate the need to resolve the needs of a capability to cope with routine and potentially serious troubles.

An earth parallel for this capability would be an office building. The maintenance control center usually occupies a designated area with all equipment therein stocked. Schedules are posted and emergency calls flow through with trained personnel dispatched to the fault area. The confines of a spacecraft will not permit the luxury of an equivalent set-up. Therefore, a scaled down version is visualized with the overall maintenance capability established on the space ships control deck, thereby tying in this function with command for rapid coordination, diagnosis, prognosis and rectification.

A. Plumbing

In general, the plumbing system will survive any anticipated mission duration without serious deficiencies. However, this should not discount having a maintenance and repair facility in readiness. For leaks; a two piece, bolted elastomer lined clamp, to fit over the point of leakage will provide a permanent, easily installed, light weight, small volume fix.

Valving of all types, ball, gate, check, pressure regulator, directional control, etc., will no doubt, be durable, but may require some servicing, especially if tight closure is required. It is expected that they will be of high quality with metal/metal, honed seating, and seals. A routine inspection frequency will have to be followed to check for leakage or to operate valves that are not normally actuated routinely. Gland tightening should be accomplishable using an adjustable hand wrench. It is possible that some valve replacement may be necessary. To achieve this, the appropriate experience gained from modulated exothermic tube brazing experiments performed on the Orbital Workshop, (Manufacturing and Process experiments - Document A-3.6.1.1.1), could be applied. An alternate to the brazed fittings are "cryofittings" where nickel/titanium fittings are stored in liquid N_2 in an expanded state. After placement on tubing and allowed to return to room temperature, the fitting shrink-fits in place to form a pressure tight assembly. Valves and other components can be fastened in this manner. For disassembly, saturating the area with liquid N_2 in a rag allows the fitting to loosen and be removed. A conventional hand wheel type cutter is recommended for cutting of tubing to size.

B. Electrical

Electrical maintenance in the main requires that uninterrupted power be available at all locations implying the care of generators, control apparatus, power transmittion lines, circuitry, circuit control and electric drives. Once again, a routine inspection schedule is indicated with special attention given to the least used devices.

Even with the stated concept of limitating maintenance to "remove and replace" supported by back-up redundant components, there will always be the need for some "on the spot" repairs. Cannabalizing defective parts is the most likely means by which fixing will be attempted so that tooling kits should be supplied, if not already provided for other purposes. Portable VTVM, ohmmeters, wattmeters, etc. compact and light in weight should be available as a portable instrumentation package.

As pointed out previously, some in-orbit wiring is inevitable. A stock of wire, wiremold, wire raceway strips, 45° and 90° elbows and outlets with the wiremold held down using self-tapping screws or other convenient fasteners. Conduit tubing would require bending tools and other tools that would tend to disqualify its use except in very special cases. Many reasons direct the selection of wire mold; wire is not integral and can be used for many purposes, storing is easier, visual wire inspection at any point, etc.

Bulbs will probably be a specification controlled item with long life requirements, but some replacement needs must be expected. Waste disposal of the bulb material and gas fill as well as accidental breakage are some of the problems. Incandescent or fluorescent style sockets do have a tendency to require some replacement or adjustment after a prolonged period. Minimum on-board socket spares need be carried since the logistic shuttle schedule can supply these needs without inconvenience.

It is anticipated that electrical connectors of the most advanced types with installations requiring hand action only and positive locking acknowledgement by feel or sound will be used; therefore, there should be little difficulty from these parts. Spares of the connectors and cable rewiring will be minimized with switch-over redundancy incorporated where critical networks exist. Some rewiring will, however, come about so that solderless terminal and connector kits as well as cabling and wire will be required to be stocked. Wire specified in Document A-2.3.1.2.1 should serve this general purpose also. As major modification programs become necessary, the shuttle should supply all additional provisions. Motors, generators, relays, thermostats, rheostats, circuit breakers, time delay switches, etc., when defective, are to be returned to earth for failure analysis and disposition even if first cannabalized.

Electric power generators, in whatever form eventually used, will, in all likelyhood, support the entire 12 man flight duration. For the 50 and 100 man flight, unless great progress is made in simplifying and thereby improving the expected life of the generator, a contingency for in-orbit replacement seems in order. This applies even if a redundant unit is on stand-by and is alternately sharing the load and life cycle. It is expected that the base will be outfitted to accept an external plug-in from a shuttle craft during the replacement period. In talking about power generation, it occurs that demand factors increase as time passes. Consideration of this demand growth should be provided for.

Ladders, scaffolding and platform requirements in the areas subjected to artificial gravity will be built in, thereby minimizing the need to store and transport these maintenance aids from area to area.

C. Heating

Solar radiation will undoubtedly be the source for heating the various in-orbit spacecrafts. The radiation will be collected by radiators and stored in a fluid medium which will be circulated to the required areas. The heated medium will be compounded to prevent any foreseeable deterioration and provide efficient operation for the first year of for small stations. Conversely, draining and resupply of the fluid and inhibitors will be required bi-annually for the larger, longer duration orbitting stations. Provisions for material or fluid breakdown and sediment formation must be provided in the form of filter traps strategically located. Sensing units to determine viscosity, particle, suspension quantity, heat or temperature, and flow will establish the method of control. Depending upon the degree of sophistication, additives can be automatically or manually metered requiring, in either case, expendables. The other components of an operating heat source will be maintained by the same personnel maintaining the plumbing or electrical systems.

D. Air Conditioning

Air conditioning systems which make use of mechanical or absorption type refrigeration may require periodic refrigerant recharging. Refrigerant losses will undoubtedly be slow leaks, rather than catastrophic. These leaks will impose a load on the atmospheric trace contaminant control system.

Recognizing the versitility requirements of spacecraft design and the feasibility of having individual, modulated air conditioning units, it only seems fitting that each compartment be self-equipped. From the maintenance viewpoint, periodic checks of all units should be made to assure efficiency and continued operation. Some control components, such as rheostats, should be carried as spares due to the abuse usually imposed on them. Continued operation is very desirable. Also, a few spare units, kept in the maintenance facilities, will be instrumental in minimizing local discomfort. Otherwise, there will be no need for other expendables, consumables, nor waste definitions. Defective units are to be stored in the maintenance area to await analysis, repair, cannabalization or return to earth.

E. Machine Shop

It may be decided upon to have some machine shop facilities on board a space base. From the raw material stock, a myriod of detail parts can be made upon demand, allowing a spares trade-off. Should this be the case, chips, cutting oils, solvents, wiping cloths, clothing, worn tools and the like, form waste items that have to be disposed of. Chips could be resmelted for reuse, oil from cutting and squeeze outs from rags would be reusable after fine filtering. The wipes may be cleanable or disposable. Tool sharpening and part grinding will create atmospheric contamination unless the whole area is "control airflow flooded" when in operation.

Pump impellers should not be a cause of repair; however, shaft bushings, when intermittantly operated, will need some maintenance. Spare undersized I.D. bushings are suggested for replacement purposes along with a flexible holder and single point cutter to undercut the shaft in place; if machine shop facilities are not available or convenient.

F. Space Suits

Space suits are really considered to be part of the general maintenance concern, but is broken out for emphasis.

The life support packages attached to the suit are to be maintained by the respective utility maintenance group. The polycarbinate head globe may receive some scratches that will have to be polished out and yet maintain optical quality. Tooth paste is a perfectly good abrasive for this job and a simple grid screen can be applied to determine if the optical quality is acceptable.

Damaged outer reflective film can be patched with an equivalent high/low temperature, pressure sensitive, adhesive backed tape.

Repairs to the suit's main fabric is not advisable considering the intricacies of design requirements incorporated therein.

G. General Maintenance

General maintenance relates to those operational functions not normally performed by any one of the utility groups. Bulb changing, lubrication, if required, duct cleaning, surface restoration, instrument calibration are a few examples of tasks performed be a general maintenance group. Inventory control and ordering of supplies would, in orbit, be a requirement of this area.

Table I lists the anticipated consumables/expendables and waste products respectively, that were determined from this review. Quantification data is omitted due to a lack of operating definition and experience in these areas.

TABLE I. Waste Analysis

Consumable/Expendable	Resulting Wastes
• Plumbing repair clamp kits	Clamp holder, seal covers
• Cryofittings, liquid N_2	Gaseous N_2, cartons, rags
• Assorted valves and valve parts	Worn seats and seals
• Modulated exothermic brazing fittings	Outgassing residues
• Plumbing tools (wrench, cutters, formers)	Tube ends, filings
• Machine tools • Bar stock • Cutting lubricant	Chips and oil, cutting tools, wipes
• Motor and pump bearings and bushings	Worn packings, bearings
• Light bulbs	Expended bulbs
• Assorted wiring aids	Wiring reminants
• Refrigerants	Atmospheric contaminants
• Solvents	Atmospheric contaminants
• Space suit maintenance kit	Seals, visor polish and reflector coating residues

PROVIDE COMMUNICATION AND NAVIGATION

SECTION 2.4

TABLE OF CONTENTS

Doc. No. A-2.4.1.1.1
Sheet No. 1
By: J. Torian
Date: 28 August 1970

OPERATIONAL DESCRIPTION

TITLE: To and From Ground - Data Relay Space Satellites (Communications)

SCHEMATIC DIAGRAM:

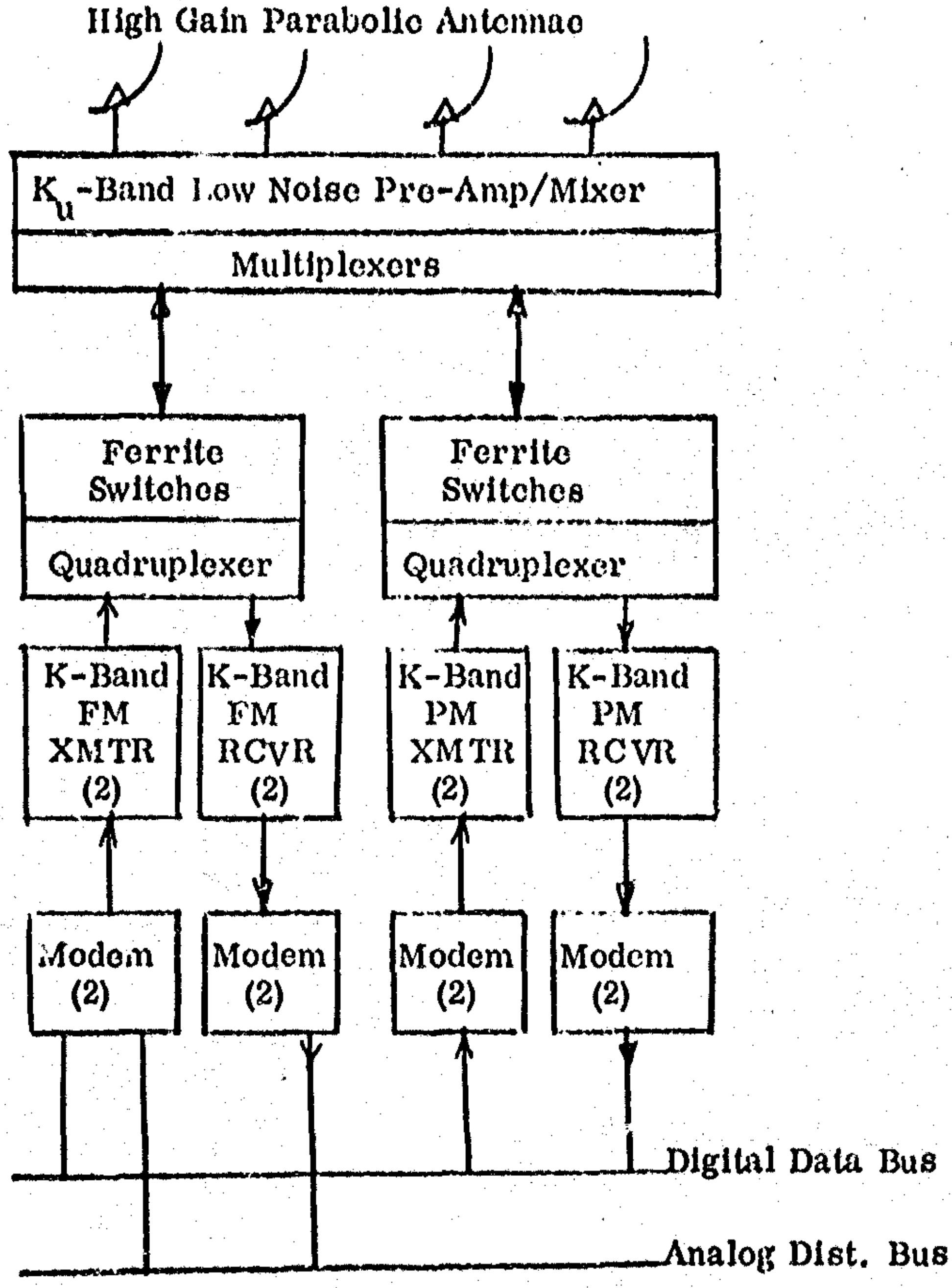

Figure 1. Communications to and from Ground Via DRSS

Doc. No. A-2.4.1.1.1
Sheet No. 2
By: J. Torian
Date: 28 August 1970

OPERATIONAL DESCRIPTION

TITLE: Communications; To and From Ground Via Data Relay Space Satellites

RATIONALE:

The system is predicated on the baseline capability of:

a) Simultaneously receiving two K_u-Band signals demodulating up to 120 Kbps of PSK digital data on a PM subcarrier, and providing one of the data streams as an output to the high speed digital data bus.

b) Simultaneously transmitting two K_u-Band signals and PM modulating the carrier with subcarrier which is PSK modulated by up to 120 Kbps of digital data being received by the subsystem from the high speed digital data bus.

c) Simultaneously receiving two K_u-Band signals, demodulating the frequency multiplexed video, wideband audio, and telephone channels frequency modulating the carrier, and providing the outputs to the appropriate storage, monitor, and telephone terminals on the Space Station.

d) Simultaneously transmitting two K_u-Band signals and FM modulating the carrier with a composite frequency multiplexed signal consisting of multiple audio channels and a video channel of subcarriers which are PSK modulated by digital data. The signals may originate from terminals on board the Space Station or from external radio-linked sources.

e) Detecting amplitude modulation on the K_u-Band signal described above, produced by quadrature lobe switching of the high gain antenna patterns, and providing antenna tracking.

REFERENCES:

Communication Subsystem-Preliminary Design Sheet for Space Station Program McDonnell Douglas Corp.

Weight, Volume and Reliability Tables for the Equipments comprising the Space Station Communications Subsystem - Collins Radio Company letter dated May 18, 1970.

MSFC-DRL-160 Line Item 13 Preliminary Systems Design Data Volume 1, Space Station Preliminary Design Book 2, Electronics MDC G0634

Doc. No. A-2.4.1.1.1
Sheet No. 3
By: J. Torian
Date: 28 August 1970

TABLE 1. AVIONICS WASTE ANALYSIS

SUBSYSTEM: COMMUNICATIONS; TO AND FROM GROUND VIA DATA RELAY SPACE SATELLITES

Part Type	Number of Items	Weight per Item	Total Weight Pounds	Failure Rate Fails/10^6 hr.	No. of Failures Per Year	Total Wt. Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
K_u Band Reflector Feed and Positioner	4	110	440	37	32×10^{-2}	1408	440	Al, Cu, Fe Plastic	50#/cu. ft. solid, Metals, Insulation	RTE for Repair and Determination of Failure Cause
K_u Band Preamp Mixer/Multiplexer	4	20	80	1.3	11×10^{-3}	3.8	20	Al, Cu, Fe, Si-Semiconductor, Plastic	60#/cu. ft. solid, Metals, Insulation	Pkg to Avoid Handling and Shipping Damage
K_u Band Ferrite Switches and Quadruplexers	4	6	24	0.7	6×10^{-3}	1.4	6	Al, Cu, Fe Plastic	60#/cu. ft. solid. Metals, Insulation	Pkg to Avoid Handling and Shipping Damage
K_u Band FM Transmitter	2	25	50	13.6	11.9×10^{-2}	60	25	Al, Cu, Fe, Plastic, Si-Semiconductor, Ceramics	108#/cu. ft. solid, Metals, Insulation	Pkg to Avoid Handling and Shipping Damage
FM Transmitter Modem	2	10	20	3.8	3.3×10^{-2}	6.6	10	Al, Cu, Plastic Si-Semiconduc.	58#/cu. ft. solid, Metals, Insulation	Pkg to Avoid Handling and Shipping Damage
K_u Band FM Receiver	2	10	20	1.4	1.2×10^{-2}	2.4	10	Al, Cu, Plastic Si-Semiconduc.	86#/cu. ft. solid, Metals, Insulation	Pkg to Avoid Handling and Shipping Damage
FM Receiver Modem	2	5	10	2.2	1.9×10^{-2}	1.9	5	Al, Cu, Plastic Si-Semiconduc.	58#/cu. ft. solid, Metals, Insultaion	Pkg to Avoid Handling and Shipping Damage
K_u Band PM Transmitter	2	10	20	1.2	1.1×10^{-2}	2.2	10	Al, Cu, Fe, Plastic Si-Semiconductor Ceramics	86#/cu. ft. solid, Metals, Insulation	Pkg to Avoid Handling and Shipping Damage
PM Transmitter Modem	2	2.5	5	2.3	2×10^{-2}	1.0	2.5	Al, Cu, Plastic, Si-Semiconduc.	72#/cu. ft. solid, Metals, Insulation	Pkg to Avoid Handling and Shipping Damage
K_u Band PM Receiver	2	10	20	1.6	1.4 x 10-2	2.8	10	Al, Cu, Plastic, Si-Semiconduc.	72#/cu. ft. solid, Metals, Insulation	Pkg to Avoid Handling and Shipping Damage
PM Receiver Modem	2	5	10	3.8	3.3 x 10-2	3.3	5	Al, Cu, Plastic, Si-Semiconduc.	58#/cu. ft. solid, Metals, Insulation	Pkg. to Avoid Handling and Shipping Damage

Study of Housekeeping Concepts For Manned Space

Doc. No. B-2.4.1.1.1 Sheet No. 1
Operational Description No. A-2.4.1.1.1
Subsystem Ship to Base Communications
By: J. Torian Date: 28 Aug 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: To and From Ground - Data Relay Space Station (Communications)

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total Lbs.	Daily Lbs.	Unit Weight Lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1 - Failed K_u Band Reflector Feed and Positioner	Part Failure	Component Part	1408	-	440	50	RTE
2 - Failed K_u Band Mixer/ Multiplexer	Part Failure	Component Part	8.8	-	20	60	RTE
3 - Failed K_u Band Ferrite Switches & Quadruplexers	Part Failure	Component Part	1.4	-	6	60	RTE
4 - Failed K_u Band FM Transmitter	Part Failure	Component Part	60	-	25	108	RTE
5 - Failed FM Transmitter Modem	Part Failure	Component Part	6.6	-	10	58	RTE
6 - Failed K_u Band FM Receiver	Part Failure	Component Part	2.4	-	10	86	RTE
7 - Failed FM Receiver Modem	Part Failure	Component Part	1.9	-	5	58	RTE
8 - Failed K_u Band PM Transmitter	Part Failure	Component Part	2.2	-	10	86	RTE
9 - Failed PM Transmitter Modem	Part Failure	Component Part	1.0	-	2.5	72	RTE
10 - Failed K_u Band PM Receiver	Part Failure	Component Part	2.8	-	10	86	RTE
11 - Failed PM Receiver Modem	Part Failure	Component Part	3.3	-	5	58	RTE
12 - Packaging for Replacement Parts	Environmental Integrity Destroyed	Internal Environment Changed	-	-	-	5	Reuse for Returning Failed Items

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.4.1.1.1 Sheet No. 1
Operational Description No. A-2.4.1.1.1
Subsystem Ship to Base Communications
By: J. Torian Date: 28 Aug 1970

TABLE III. WASTES

Title: To and From Ground - Data Relay Space Station (Communications)

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1 - Failed K_u Band Reflector, Feed and Positioner	Solid Metal RTE	Al, Cu, Fe Plastic	Repair	1408	-	440	50	
2 - Failed K_u Band Mixer/Multiplexer	Solid Metal RTE	Al, Cu, Fe Si-Semicon. Plastic	Repair	8.8	-	20	60	
3 - Failed K_u Band Ferrite Switches and Quadruplexers	Solid Metal RTE	Al, Cu, Fe Plastic	Repair	1.4	-	6	60	
4 - Failed K_u Band FM Transmitter	Solid Metal RTE	Al, Cu, Fe Plastic,	Repair	60	-	25	108	
5 - Failed FM Transmitter Modem	Solid Metal RTE	Al, Cu, Plastic, Si-Semiconductor	Repair	6.6	-	10	58	
6 - Failed K_u Band FM Receiver	Solid Metal RTE	Al, Cu, Plastic, Si-Semicon.	Repair	2.4	-	10	86	
7 - Failed FM Receiver Modem	Solid Metal RTE	Al, Cu, Plastic, Si-Semicon.	Repair	1.9	-	5	58	
8 - Failed K_u Band PM Transmitter	Solid Metal RTE	Al, Cu, Fe, Plastic, Si-Semiconductor, Ceram.	Repair	2.2	-	10	86	

Study of Housekeeping Concepts For Manned Space

Doc. No. C- 2.4.1.1.1 Sheet No. 2
Operational Description No. A- 2.4.1.1.1
Subsystem Ship to Base Communications
By: J. Torian Date: 28 August 1970

TABLE III. WASTES

Title: To and From Ground - Data Relay Space Station (Communications)

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
9 - Failed PM Transmitter Modem	Solid Metal RTE	Al, Cu, Plastic, Si-Semiconduc.	Repair	1.0	-	2.5	72	
10 - Failed K_uBand PM Receiver	Solid Metal RTE	Al, Cu, Plastic, Si-Semiconduc.	Repair	2.8	-	10	86	
11 - Failed PM Receiver Modem	Solid Metal RTE	Al, Cu, Plastic, Si-Semiconduc.	Repair	3.3	-	5	58	
12 - Packaging for Replacement Parts	Solid Plastic RTE	Plastic Sponge and Sheeting	Reuse as is	-	-	-	5	Reuse as is

Doc. No. A-2.4.1.2.1
Sheet No. 1
By: J. Torian
Date: 28 August 1970

OPERATIONAL DESCRIPTION

TITLE: To and From Ground Direct (Communications)

SCHEMATIC DIAGRAM

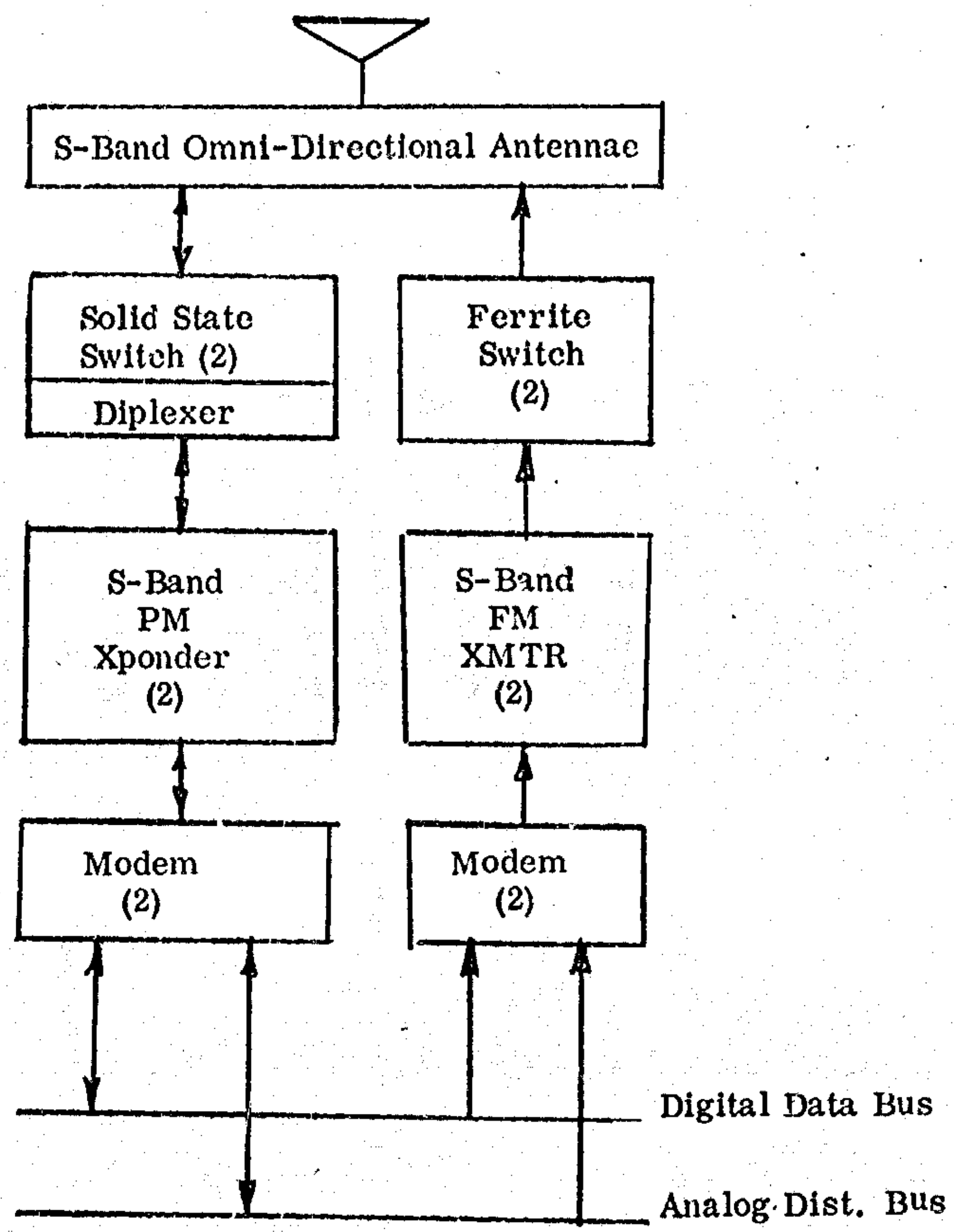

Figure 1. To and From Ground Direct (Communications)

Doc. No. A-2.4.1.2.1
Sheet No. 2
By: J. Torian
Date: 28 August 1970

RATIONALE:

The system is predicated on the baseline capability of:

a) Receiving an S-Band signal on either of two receivers and demodulating the PM baseband signals consisting of PRN ranging signals, a voice subcarrier (FM) and a data subcarrier (FM). The voice and data signals on the subcarrier shall be detected and provided as outputs to the appropriate telephone terminals or the high speed digital data bus. The receiver shall phase-lock to the received carrier signals and it shall be possible to drive a coherent transmitter from the receiver to enable the two units to be used as a transponder.

b) Transmitting on either of two transmitters an S-Band signal capable of being referenced to either the received S-Band signal described in (1) or to a noncoherent auxiliary oscillator. The transmitter shall be PM modulated by the detected PRN ranging signals, a voice signal modulating a subcarrier (FM), a digital date signal modulating a subcarrier (PSK), or combinations of the three signals. The voice signal source will be any of the telephone terminals, and the digital data source will be the high speed digital data bus.

REFERENCES:

Communication Subsystem-Preliminary Design Sheet for Space Station Program-McDonnell Douglas Corp.

Weight, Volume and Reliability Tables for the Equipments comprising the Space Station Communications Subsystem - Collins Radio Company letter dated May 18, 1970.

MSFC-DRL-160 Line Item 13 Preliminary Systems Design Data Volume 1 Space Station Preliminary Design, Book 2, Electronics MDC GO634

Doc. No. A-2.4.1.2.1
Sheet No. 3
By: J. Torian
Date: 28 August 1970

TABLE 1. AVIONICS WASTE ANALYSIS

SUBSYSTEM: To and From Ground Direct (Communications)

Part Type	Number of Items	Weight per Item	Total Weight Pounds	Failure Rate Fails/10^6 hr.	No. of Failures Per Year	Total Wt. Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
S-Band Omni-Directional Antennae	4	2	8	0.2	1.75×10^{-3}	.14	2	Al, Plastic	25#/cu.ft. solid Metals, Insulation	RTE for Repair and determination of cause of failure
S-Band Diplexer/Switches	2	6	12	0.8	7×10^{-3}	.84	6	Al, Fe, Cu	62#/cu. ft. solid Metals, Insulation	Pkg to avoid handling and shipping damage
S-Band Ferrite Switches	2	5.5	11	0.7	6×10^{-3}	.07	5.5	Al, Fe, Cu	60#/Cu.in. solid Metals, Insulation	Pkg to avoid handling and shipping damage
S-Band FM Transmitter	2	14	28	19.2	16.8×10^{-2}	47	14	Al, Cu, Fe, Plastic; Si-Semicon.	80#/cu.ft. solid Metals, Insulation	Pkg to avoid handling and shipping damage
S-Band FM Transmitter	2	12	24	20.0	17.5×10^{-2}	42	12	Al, Cu, Fe, Plastic, Si-Semicon.	58#/cu.ft. solid Metals, Insulation	Pkg to avoid handling and shipping damage
Transponder Modem	2	10	20	6.9	6×10^{-2}	12	10	Al, Cu, Fe, Plastic, Si-Semicon.	60#/cu.ft. solid Metals, Insulation	Pkg to avoid handling and shipping damage
Transmitter Modem	2	2.5	5	3.5	3×10^{-2}	1.5	2.5	Al, Cu, Fe, Plastic, Si-Semicon.	73#/cu. ft. solid Metals, Insulation	Pkg to avoid handling and shipping damage

Study of Housekeeping Concepts For Manned Space

Doc. No. B-2.4.1.2.1 Sheet No. -1
Operational Description No. A-2.4.1.2.1
Subsystem Ship to Base Communications
By: J. Torian Date: 8/28/70

TABLE II. CONSUMABLES/EXPENDABLES

Title: To and From Ground Direct (Communications)

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr Total Lbs.	Daily	Unit Weight Lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1- Failed S-Band Omni-directional Antennae	Part Failure	Component Part	0.14	-	2	25	R.T.E.
2- Failed S-Band Diplexer/ Switches	Part Failure	Component Part	0.84	-	6	62	R.T.E.
3- Failed S-Band Ferrite Switches	Part Failure	Component Part	0.07	-	5.5	60	R.T.E.
4- Failed S-Band PM Transponder	Part Failure	Component Part	47	-	14	80	R.T.E.
5- Failed S-Band FM Transmitter	Part Failure	Component Part	42	-	12	58	R.T.E.
6- Failed Transponder Modem	Part Failure	Component Part	12	-	10	60	R.T.E.
7- Failed Transmitter Modem	Part Failure	Component Part	1.5	-	2.5	73	R.T.E.
8- Packaging for Replacement Parts	Environmental Integrity Destroyed	Internal Environment Changed	-	-	-	5	Reuse for Returning Failed Items

FAIRCHILD HILLER
REPUBLIC AVIATION DIVISION
FARMINGDALE, LONG ISLAND, NEW YORK

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-2.4.1.2.1 Sheet No. 1
Operational Description No. A- 2.4.1.2.1
Subsystem Ship to Base Communications
By: J. Torian Date: 8/28/70

Title: To and From Ground Direct (Communications)

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs.	Unit Weight lbs. lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1 - Failed S-Band Omni-Directional Antennae	Solid Metal RTE	Al, Plastic	Replace	0.14	-	2	25	
2 - Failed S-Band Diplexer/Switches	Solid Metal RTE	Al, Fe, Cu	Repair	0.84	-	6	62	
3 - Failed S-Band Ferrite Switches	Solid Metal RTE	Al, Fe, Cu	Repair	0.07	-	5.5	60	
4 - Failed S-Band PM Transponder	Solid Metal RTE	Al, Cu, Fe, Si-Semicond.	Repair	47	-	14	80	
5 - Failed S-Band FM Transmitter	Solid Metal RTE	Al, Cu, Fe, Si-Semicond.	Repair	42	-	12	58	
6 - Failed Transponder Modem	Solid Metal RTE	Al, Cu, Fe, Si-Semicond.	Repair	12	-	10	60	
7 - Failed Transmitter Modem	Solid Metal RTE	Al, Cu, Fe, Si-Semicond.	Repair	1.5	-	2.5	73	
8 - Packaging for Replacement Parts	Solid Plastic RTE	Plastic Sponge and Sheeting	Reuse as is	-	-	-	5	Reuse as is

Doc. No. A-2.4.2.1.1
Sheet No. 1
By: J. Torian
Date: 28 August 1970

OPERATIONAL DESCRIPTION

TITLE: To and From Experiment Modules (Communications)

1. SCHEMATIC DIAGRAM

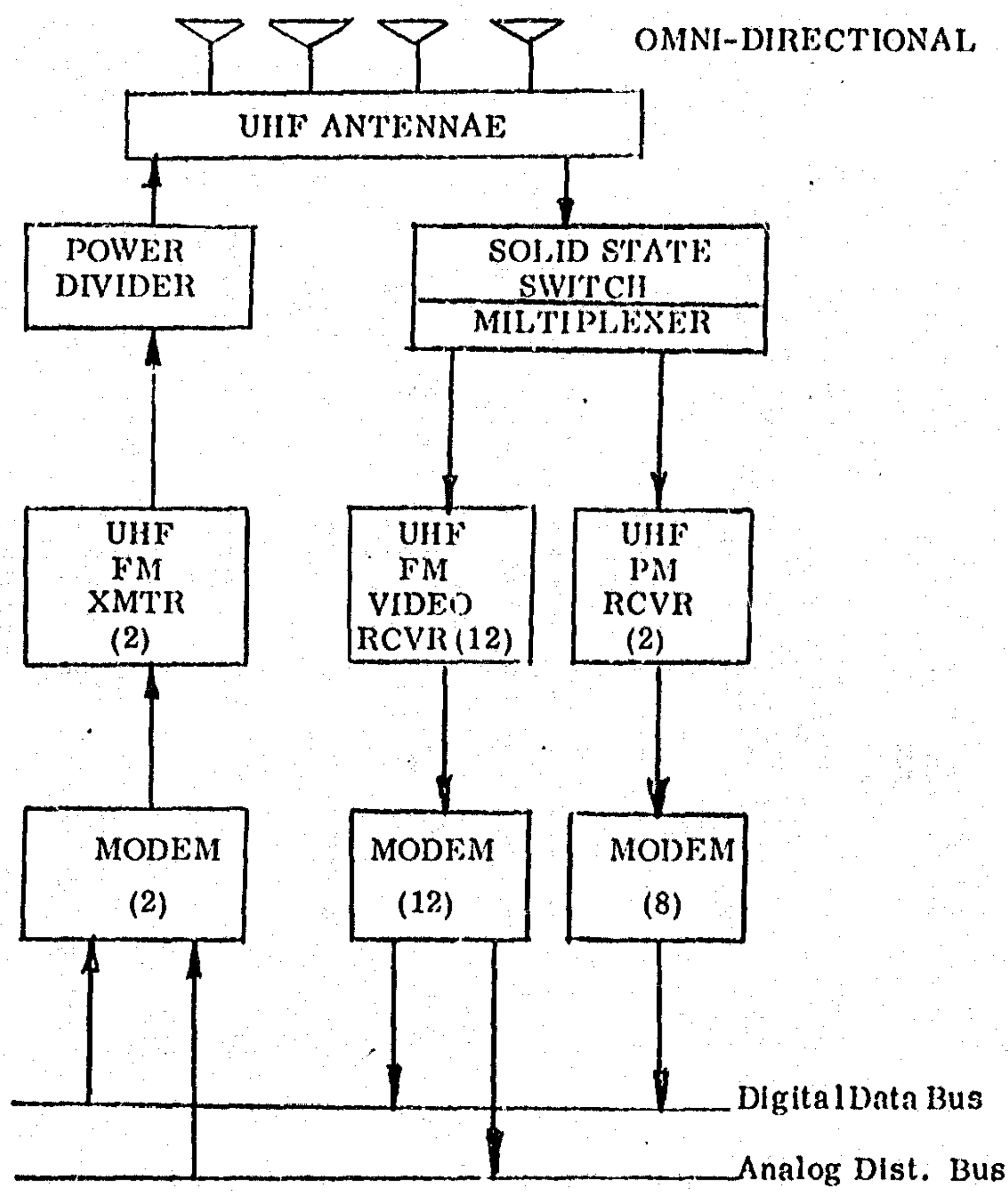

Figure 1. To and From Experiment Modules (Communications)

Doc. No. A-2.4.2.1.1
Sheet No. 2
By: J. Torian
Date: 28 August 1970

2. OPERATIONAL DESCRIPTION AND RATIONALE

The system is predicated on the baseline capability of:

a) Transmitting a UHF signal on either of two transmitters, FM modulating the carrier with PCM command signals being received by the subsystem from the high speed digital data bus at a rate up to 10 kbps.

b) Shall be capable of simultaneously receiving 6 UHF signals on either of two sets of receivers (or a combination of receivers from either set), demodulating the FM video baseband signals. The detected signals shall be provided as outputs to the appropriate monitor or storage terminals on board or provided as modulation signals to the transmitter described in A-2.4.1.1.1.

c) Shall be capable of simultaneously receiving 4 UHF signals on either of two sets of receivers (or on combinations of receivers from either set) and demodulating the PCM signals PSK modulating the carrier at rates up to 300 kbps. The detected data signals shall be provided as modulation signals to the transmitter described in A-2.4.1.1.1.

3. REFERENCES

1. Communication Subsystem - Preliminary Design Sheet for Space Station Program - McDonnell Douglas Corp.
2. Weight, Volume, and Reliability Tables for the Equipments Comprising the Space Station Communications Subsystem - Collins Radio Company Letter dated May 18, 1970.
3. MSFC-DRL-160 Line Item 13 - Preliminary Systems Design Data, Volume 1. Space Station Preliminary Design - Book 2, Electronics, MDC G0634.

Doc. No. A-2.4.2.1.1
Sheet No. 3
By: J. Torian
Date: 28 August 1970

TABLE 1. AVIONICS WASTE ANALYSIS

SUBSYSTEM: COMMUNICATIONS: TO AND FROM EXPERIMENT MODULES

LRU Part Type	Number of Items	Weight Per Items	Total Weight Pounds	Failure Rate Fails/10^6 Hrs.	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
UHF Omni-directional Antennae	4	10	40	0.2	1.75×10^{-3}	0.70	10	Al, Plastic	25#/cu.ft. Solid Metals, Insulation	RTE for repair and determination of cause of
UHF Power Divider	2	2	4	0.2	1.7×10^{-3}	0.07	2	Aluminum	25#/cu.ft. Solid Metals	Failure, pkg. to avoid handling and shipping damage
UHF Solid State Switch/Multiplexer	2	12	24	0.4	3.5×10^{-3}	0.84	12	Al, Fe, Si - Semicond, Plastic	50#/cu.ft. Solid Metals, Insulation	Failure, pkg. to avoid handling and shipping damage
UHF FM Transmitter	2	1.5	3	0.69	6.0×10^{-3}	0.20	1.5	Al, Cu, Fe, Si - Semicond, Plastic	130#/cu.ft. Solid Metals, Insulation	Failure, pkg. to avoid handling and shipping damage
UHF Transmitter MODEM	2	2	4	1.60	1.4×10^{-2}	0.56	2	Al, Cu, Fe, Si- Semicond, Plastic	86#/cu.ft. Solid Metals, Insulation	Failure, pkg. to avoid handing and shipping damage
UHF FM Video Receiver	12	3	36	1.10	$.96 \times 10^{-2}$	3.5	3	Al, Cu, Fe, Si- Semicond, Plastic	130#/cu.ft. Solid Metals, Insulation	Failure, pkg. to avoid handling and shipping damage
UHF PM Data Receiver	8	3	24	1.63	1.43×10^{-2}	3.4	3	Al, Cu, Fe, Si- Semicond, Plastic	130#/cu.ft. Solid Metals, Insulation	Failure, pkg. to avoid handling and shipping damage
Video Receiver MODEM	12	2.5	30	3.25	2.85×10^{-2}	8.6	2.5	Al, Cu, Fe, Si - Semicond, Plastic	72#/cu.ft. Solid Metals, Insulation	Failure, pkg. to avoid handling and shipping damage
Data Receiver MODEM	8	2.5	20	3.25	2.85×10^{-2}	5.7	2.5	Al, Cu, Fe, Si - Semicond, Plastic	72#/cu.ft. Solid Metals, Insulation	Failure, pkg. to avoid handling and shipping damage

Study of Housekeeping Concepts For Manned Space

Doc. No. B-2.4.2.1.1 Sheet No. 1
Operational Description No. A-2.4.2.1.1
Subsystem Inter-Vehicular Communications
By: J. Torian Date: 8/28/70

TABLE II. CONSUMABLES/EXPENDABLES

Title: To and From Experiment Modules (Communications)

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total lbs.	Daily Rate lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed UHF Omni-directional Antenna	Part Failure	Component Part	0.70	-	10	25	RTE
2. Failed UHF Power Divider	Part Failure	Component Part	0.07	-	2	25	RTE
3. Failed UHF Solid State Switch/Multiplexer	Part Failure	Component Part	0.84	-	2	50	RTE
4. Failed UHF FM Transmitter	Part Failure	Component Part	0.20	-	1.5	130	RTE
5. Failed UHF Transmitter MODEM	Part Failure	Component Part	0.55	-	2	86	RTE
6. Failed UHF FM Video Receiver	Part Failure	Component Part	3.5	-	3	130	RTE
7. Failed UHF PM Data Receiver	Part Failure	Component Part	3.4	-	3	130	RTE
8. Failed Video Receiver MODEM	Part Failure	Component Part	8.6	-	2.5	72	RTE
9. Failed Data Receiver MODEM	Part Failure	Component Part	5.7	-	2.5	72	RTE
10. Packaging for Replacement Parts	Environmental Integrity Destroyed	Interval Environment Changed	-	-	-	5	Reuse for returning failed items

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.4.2.1.1 Sheet No. 1
Operational Description No. A-2.4.2.1.1
Subsystem Inter-Vehicular Communications
By: J. Torian Date: 8/28/70

TABLE III. WASTES

Title: To and From Experiment Modules (Communications)

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed UHF Omni-directional Antennae	Solid Metal RTE	Ai, Plastic	Replace	0.70	-	10	25	
2. Failed UHF Power Divider	Solid Metal RTE	Aluminum	Replace	0.07	-	2	25	
3. Failed UHF Solid State Switch Multiplexer	Solid Metal RTE	Al, Fe, Si-Semicond. Plastic	Repair	0.84	-	12	50	
4. Failed UHF FM Transmitter	Solid Metal RTE	Al, Cu, Fe, Si-Semicond. Plastic	Repair	0.20	-	1.5	130	
5. Failed UHF Transmitter MODEM	Solid Metal RTE	Al, Cu, Fe, Si-Semicond. Plastic	Repair	0.56	-	2	86	
6. Failed UHF FM Video Receiver	Solid Metal RTE	Al, Cu, Fe, Si-Semicond. Plastic	Repair	3.5	-	3	130	
7. Failed UHF PM Data Receiver	Solid Metal RTE	Al, Cu, Fe, Si-Semicond. Plastic	Repair	3.4	-	3	130	
8. Failed Video Receiver MODEM	Solid Metal RTE	Al, Cu, Fe, Si-Semicond. Plastic	Repair	8.6	-	2.5	72	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.4.2.1.1 Sheet No. 2
Operational Description No. A-2.4.2.1.1
Subsystem Inter-Vehicular Communications
By: J. Torian Date: 8/28/70

TABLE III. WASTES (cont'd)

Title: To and From Experimental Modules (Communications)

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs/days	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
9. Failed Data Receiver MODEM	Solid Metal RTE	Al, Cu, Fe, Si-Semicond Plastic	Repair	5.7	-	2.5	72	
10. Packaging for replacement parts	Solid Plastic RTE	Plastic Sponge and Sheeting	Reuse as is	-	-	-	5	

Doc. No. A-2.4.2.2.1
Sheet No. 1
By: J. Torian
Date: 28 August 1970

OPERATIONAL DESCRIPTION

TITLE: To and From Space Station Shuttle (Communications)

1. SCHEMATIC DIAGRAM

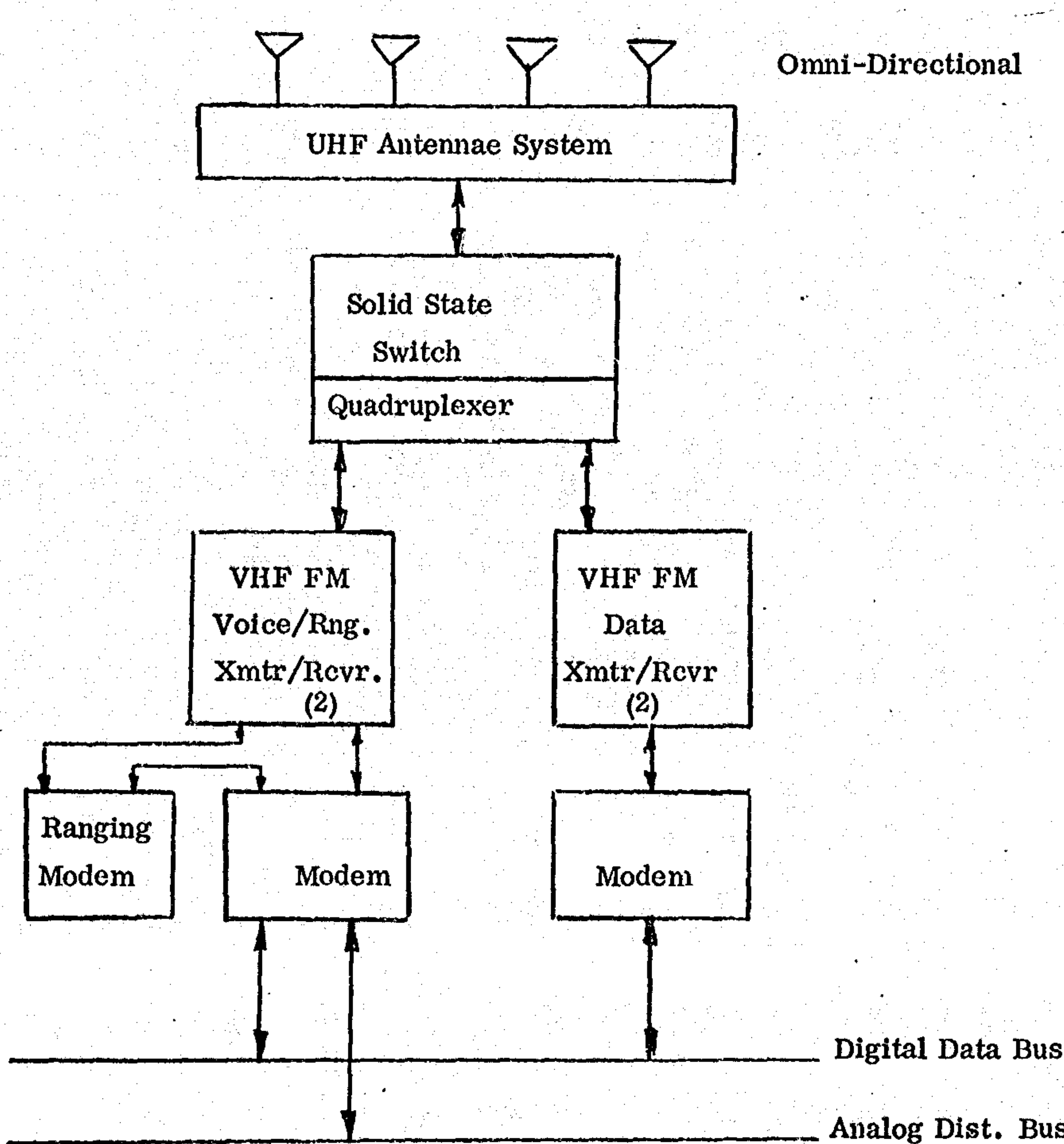

Figure 1. To and From SS Shuttle (Communications)

Doc. No. A-2.4.2.2.1
Sheet No. 2
By: J. Torian
Date: 28 August 1970

2. OPERATIONAL DESCRIPTION AND RATIONALE:

The system is predicated and the baseline capability of:

a) receiving a VHF signal on either of two receivers and demodulating the voice and ranging signals FM modulating the carrier. The detected voice output shall be provided as an output to the onboard telephone system. The detected ranging signals shall be provided as an output to the ranging function described below.

b) shall be capable of receiving a VHF signal on either of two receivers and demodulating the PCM signals PSK modulating the carrier at up to 10 Kbps. The detected data signals shall be provided as an output to the high speed digital data bus.

c) shall be capable of transmitting a VHF signal on either of two transmitters and PSK modulating the carrier at rates up to 10 Kbps with PCM signals received by the subsystem from the high speed digital data bus.

d) shall be capable of transmitting a VHF signal on either of two transmitters and FM modulating the carrier with voice signals originating at the telephone terminals and with ranging signals.

e) shall, in conjunction with a cooperative ranging system in another vehicle, be capable of providing as an output to the high speed digital data bus information on the range and range rate between the two vehicles.

3. REFERENCES:

1. Communication Subsystem - Preliminary Design Sheet for Space Station Program - McDonnell Douglas Corp.

2. Weight, Volume and Reliability Tables for the Equipments Comprising the Space Station Communications Subsystem - Collins Radio Company Letter dated May 18, 1970.

3. MSFC-DRL-160 Line Item 13 - Preliminary Systems Design Data - Volume 1

Space Station Preliminary Design - Book 2 - Electronics MDC G0634

TABLE 1. AVIONICS WASTE ANALYSIS

SUBSYSTEM: TO AND FROM SPACE STATION SHUTTLE (COMMUNICATIONS)

LRU PART TYPE	Number of Items	Weight Per Items	Total Weight Pounds	Failure Rate Fails/10^6 Hrs.	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
VHF Omni-directional Antennae	4	15	60	0.2	1.75×10^{-3}	1.05	15	Al, Plastic	25#/cu ft. Solid Metals, Insulation	RTE For Repair and Determination of cause of failure. Pkg. to avoid handling & shipping damage.
Solid State Switch/ Quadruplexer	2	12	24	0.4	3.5×10^{-3}	0.84	12	Al, Fe, Si-Semicond., Plastic	50#/cu ft. Solid Metals, Insulation	
VHF Voice Ranging T/R	2	15	30	32	2.8×10^{-1}	84	15	Al, Cu, Fe, SIO-Semicond., Plastic	58#/cu ft. Solid Metals, Insulation	RTE for Repair and Determination of cause of failure. Pkg. to avoid handling and shipping damage.
Ranging Modem	2	9	18	25	2.2×10^{-1}	40	9	Al, Cu, Fe, SIO-Semicond., Plastic	52#/cu ft. Solid Metals, Insulation	RTE for Repair and Determination of cause of failure. Pkg. to avoid handling and shipping damage.
Voice Modem	2	5	10	4.3	3.8×10^{-2}	3.8	5	Al, Cu, Fe, SIO-Semicond. Plastic	54#/ cu ft. Solid Metals, Insulation	RTE for Repair and Determination of cause of failure. Pkg. to avoid handling and shipping damage.
VHF Data T/R	2	15	30	32	2.8×10^{-1}	84	15	Al, Cu, Fe, SIO-Semicond. Plastic	58#/cu ft. Solid Metals, Insulation	RTE for Repair and Determination of cause of failure. Pkg. to avoid handling and shipping damage.
Data Modem	2	4	8	2.4	2.1×10^{-2}	1.7	4	Al, Cu, Fe, SIO-Semicond. Plastic	55#/cu ft. Solid Metals, Insulation	RTE for Repair and Determination of cause of failure. Pkg. to avoid handling and shipping damage.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-2.4.2.2.1 Sheet No. 1
Operational Description No. A- 2.4.2.2.1
Subsystem Inter Vehicular Communications
By: J. Torian Date: 28 August 1970

Title: To and From Space Station (Shuttle)

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr Total Lbs.	Daily Rate-lbs/day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed VHF Omni-Directional Antennae	Part Failure	Component Part	1.05	-	15	25	RTE
2. Failed Solid State Switch/ Quadruplexer	Part Failure	Component Part	0.84	-	12	50	RTE
3. Failed VHF/Voice Ranging T/R	Part Failure	Component Part	84	-	15	58	RTE
4. Failed Ranging Modem	Part Failure	Component Part	40	-	9	52	RTE
5. Failed Voice Modem	Part Failure	Component Part	3.8	-	.5	54	RTE
6. Failed VHF Data T/R	Part Failure	Component Part	84	-	15	58	RTE
7. Failed Data Modem	Part Failure	Component Part	1.7	-	4	55	RTE
8. Packaging For Replacement Parts	Environmental Integrity Destroyed	Internal Environment Changed	-	-	-	5	Reuse For Returning Failed Items

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.4.2.2-1 Sheet No. 1
Operational Description No. A-2.4.2.2.1
Subsystem Inter Vehicular Communications
By: J. Torian Date: 28 August 1970

TABLE III. WASTES

Title: To and From Space Shuttle (Communications)

WASTE ITEM	Characteristics State And Attributes		Chemical Composition	Action Required To Reclaim	10 Yr Total lbs.	Daily Rate lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed VHF Omni-Directional Antennae	Solid	Metal RTE	Al, Plastic	Replace	1.05	-	15	25	
2. Failed Solid State Switch/ Quadruplexer	Solid	Metal RTE	Al, Fe, Si-Semi-cond. Plastic	Repair	0.84	-	12	50	
3. Failed VHF Voice Ranging T/R	Solid	Metal RTE	Al, Cu, Fe, Si-semicond, Plastic	Repair	84	-	15	58	
4. Failed Ranging Modem	Solid	Metal RTE	Al, Cu, Fe, Si-Semiconductor Plastic	Repair	40	-	9	52	
5. Failed Voice Modem	Solid	Metal RTE	Al, Cu, Fe, Si-semiconductor Plastics	Repair	3.8	-	5	54	
6. Failed VHF Data T/R	Solid	Metal RTE	Al,Cu, Fe, Si-semiconductor Plastic	Repair	84	-	15	58	
7. Failed Data Modem	Solid	Metal RTE	Al, Cu, Fe, Si-semiconductor Plastic	Repair	1.7	-	4	55	
8. Packaging For Replacement Parts	Solid	Plastic RTE	Plastic Sponge and Sheeting	Reuse as is	-	-	-	5	

Doc. No. A-2.4.2.3.1
Sheet No. 1
By: J. Torian
Date: 28 August 1970

OPERATIONAL DESCRIPTION

TITLE: Extra Vehicular Communications

SCHEMATIC DIAGRAM

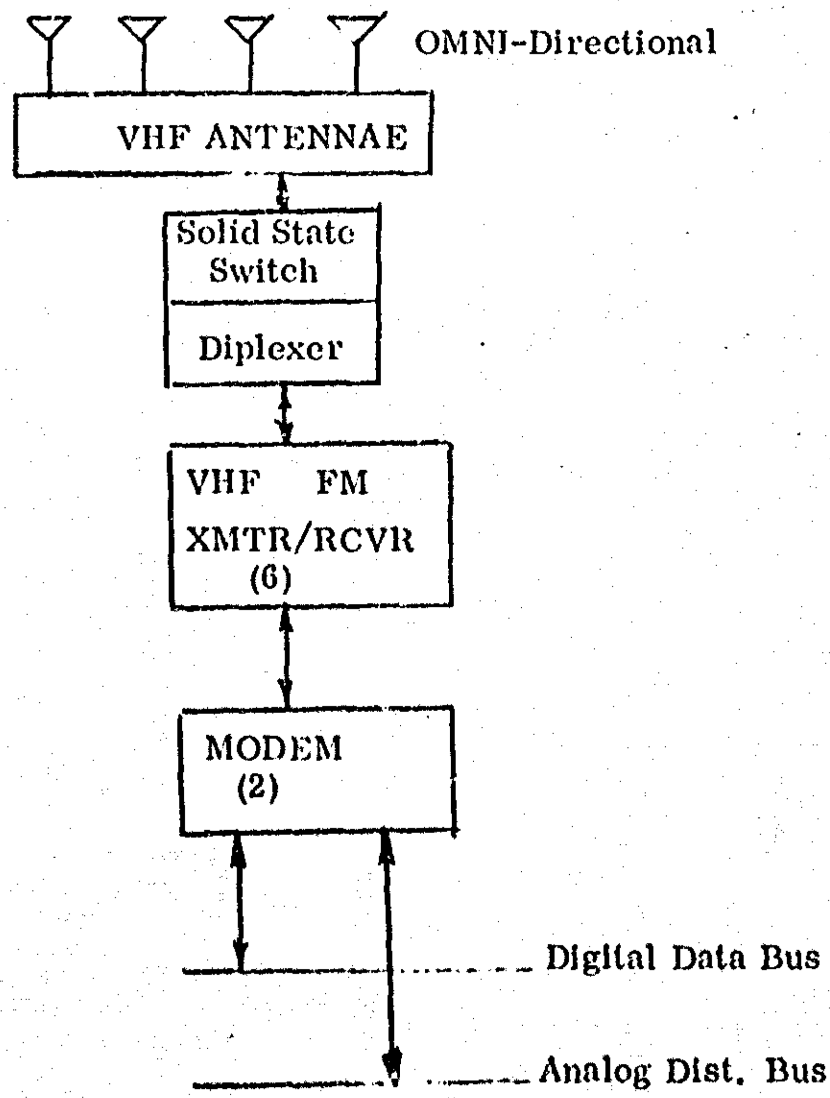

Figure 1 - Communications to and from EVA

Doc. No. A-2.4.2.3.1
Sheet No. 2
By: J. Torian
Date: 28 August 1970

OPERATIONAL DESCRIPTION

RATIONALE:

The system is predicated on the baseline capability of:

a) Simultaneously transmitting two VHF signals on either of two sets of transmitters (or on a combination of transmitters from each set). The carrier of each shall be FM modulated in parallel by a voice signal from an onboard EVA console and by the detected voice signals from the receiver which is not associated with that transmitter's duplex channel receiver.

b) Simultaneously receiving two VHF signals on either of two sets of receivers (or on combinations of receivers from either set). Reception on these frequencies shall be provided at the same time that signals are being transmitted. One receiver of each set will operate in conjunction with one transmitter of each set, thus providing two sets of transmitter-receivers which will have two full-duplex channel capability. The subsystem shall demodulate the FM signals being received, providing the biomedical data subcarriers on each of the two channels as parallel outputs to an onboard EVA console, and providing the linearly summed voice outputs from the two receivers as an output to the same EVA console.

REFERENCES:

Communication Subsystem - Preliminary Design Sheet for Space Station Program - McDonnell Douglas Corp.

Weight Volume and Reliability Tables for the Equipment Compressing the Space Station Communications Subsystem - Collins Radio Company Letter, dated May 18, 1970.

MSFC-DRL-160 Line Item 13 - Preliminary Systems Design Data Volume 1. Space Station Preliminary Design Book 2 - Electronics MDC G0634.

TABLE I. AVIONICS WASTE ANALYSIS

SUBSYSTEM: EXTRA VEHICULAR COMMUNICATIONS

LRU Part Type	Number of Items	Weight Per Items	Total Weight Pounds	Failure Rate Fails/10^6 Hours	Number of Failures Per Year	Total Weight Per 10 Yrs.	Single Load Rate Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
VHF-OMNI-Directional Antennae	4	15	60	0.2	1.75×10^{-3}	1.05	15	Al, Plastic	25#/cu. ft. Solid Metals, Insulation	RTE for repair and determination of cause of failure.
Solid State Switch/ Diplexer	2	18	36	0.4	3.5×10^{-3}	1.26	18	Al, Fe, Si-Semiconductor, Plastic	50#/cu. ft. Solid Metals, Insulation	Pkg. to avoid handling and shipping damage.
VHF FM XMTR/ RCVR	6	2	12	1.56	1.37×10^{-2}	1.64	2	Al, Cu, Fe, Si-Semicond. Plastic	70#/cu. ft. Solid Metals, Insulation	Pkg. to avoid handling and shipping damage.
MODEM	2	8	16	4.73	4.1×10^{-2}	6.56	8	Al, Cu, Fe, Si-Semicond. Plastic	70#/cu. ft. Solid Metals, Insulation	Pkg. to avoid handling and shipping damage.

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-2.4.2.3.1 Sheet No. 1
Operational Description No. A-2.4.2.3.1
Subsystem Inter Vehicular Communications
By: J. Torian Date: 28 August 1970

Title: Extra Vehicular Communications

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total lbs.	Daily Rate lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed VHF OMNI - Directional	Part failure	Component part	1.05	-	15	25	RTE
2. Failed Solid State Switch/ Diplexer	Part failure	Component part	1.26	-	18	50	RTE
3. Failed VHF FM XMTR/RCVR	Part failure	Component part	1.64	-	2	70	RTE
4. Failed MODEM	Part failure	Component part	6.56	-	8	70	RTE
5. Packaging for Replacement Parts	Environmental Integrity destroyed	Internal environment changed	-	-	-	5	Reuse for returning failed items

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.4.2.3.1 Sheet No. 1
Operational Description No. A-2.4.2.3.1
Subsystem Inter Vehicular Communications
By: J. Torian Date: 28 August 1970

TABLE III. WASTES

Title: Extra Vehicular Communications

WASTE ITEM	Characteristics State And Attributes		Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed VHF OMNI Directional Antennae	Solid	Metal RTE	Al, Plastic	Replace	1.05	-	15	25	
2. Failed Solid State Switch/Diplexer	Solid	Metal RTE	Al, Fe, Si-Semicond. plastic	Repair	1.26	-	18	50	
3. Failed VHF FM XMTR/RCVR	Solid	Metal RTE	Al, Cu, Fe, Si-Semicond. plastic	Repair	1.64	-	2	70	
4. Failed MODEM	Solid	Metal RTE	Al, Cu, Fe, Si-Semicond. plastic	Repair	6.56	-	8	70	
5. Packaging for Replacement Parts	Solid	Plastic RTE	Plastic sponge and sheeting	Reuse as is	-	-	-	5	

Doc. No. A-2.4.3.1.1
Sheet No. 1
By: J. Torian
Date: 28 August 1970

OPERATIONAL DESCRIPTION

TITLE: Onboard Communications

SCHEMATIC DIAGRAM

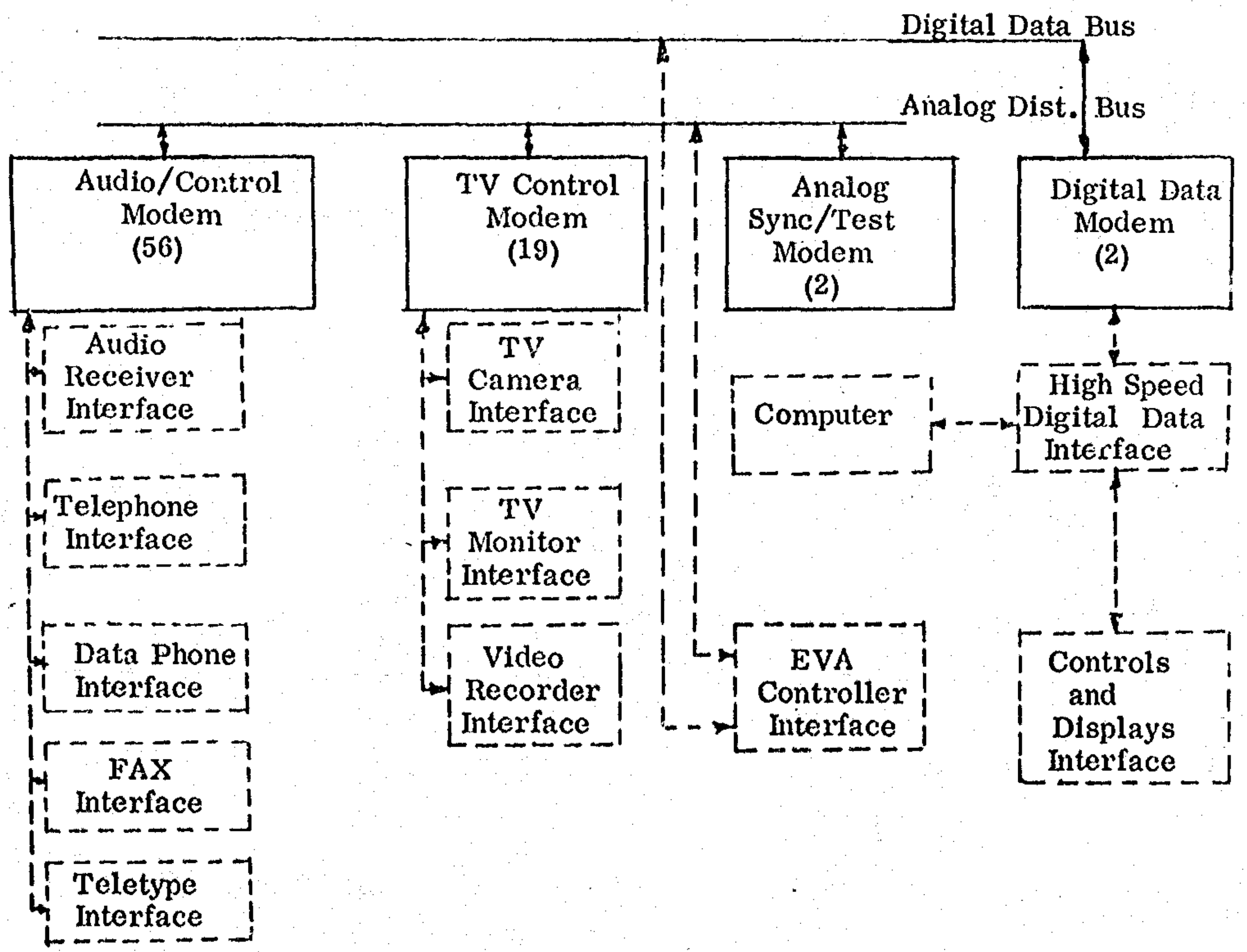

Figure 1. Communications Onboard

OPERATIONAL DESCRIPTION AND RATIONALE

The system is predicated on the baseline capability of:

a) 36 voice bandwidth channels for the onboard distribution of voice, data phone, facsimile, teletype, or similar information on a common bus. These channels shall be provided in a frequency division SSSC format compatible with the earth-based Bell system.

b) 36 audio control terminals for use on the common bus. Terminal-to-terminal access between these terminals shall be selectable at each terminal. Off-hook busy signals shall be provided which shall block other communications to the busy channel unless the conferencing mode is selected. Conferencing capability shall be provided under the control of called terminals.

c) three wideband audio channels for the onboard distribution of entertainment type signals (on the common bus).

d) 14 video (4.5 MHz baseband) channels for the onboard distribution of television signals on a common bus.

e) 19 video control terminals capable of selecting any one of the 14 channels and either providing that channel's video signal as an output or placing a video input signal on that channel.

f) 2 analog synchronization and test terminals.

g) 2 digital data terminals for high speed digital data. Interface between the digital distribution bus and the central digital computer and the controls and displays.

REFERENCES

1. Communication Subsystem - Preliminary Design Sheet for Space Station Program - McDonnell Douglas Corp.

2. Weight, Volume and Reliability Tables for the Equipments Comprising the Space Station Communications Subsystem - Collins Radio Company - Letter dated May 18, 1970.

3. MSFC-DRL-160 Line Item 13
Preliminary Systems Design Data - Volume 1
Space Station Preliminary Design - Book 2 - Electronics
MDC G0634

TABLE 1

AVIONICS WASTE ANALYSIS

SUBSYSTEM: ON BOARD COMMUNICATIONS

Part Type	Number of Items	Weight per Item	Total Weight Pounds	Failure Rate Fails/10^6 Hr	Number of Failures per year	Total Weight per 10 yrs	Single Load Weight Lbs/Unit	Chemical Composition	Physical Characteristics	Disposition and Special Handling Requirements
Audio/Control Modem	36	4	144	4.60	4.0×10^{-2}	57.6	4	Al, Cu, Fe, Si-semi-conductor, Plastic	72#/cu ft solid metals, insulation	RTE for repair and determination of cause of failure
TV Control Modem	19	3	57	3.45	3.0×10^{-2}	17.1	3	"	"	Pkg to avoid handling and shipping damage
Analog Sync/Test Modem	2	5	10	5.75	5.0×10^{-2}	5	5	"	"	"
Digital Data Modem	2	5	10	5.75	5.0×10^{-2}	5	5	"	"	"

Study of Housekeeping Concepts For Manned Space

Doc. No. B-2.4.3.1.1 Sheet No. 1
Operational Description No. A-2.4.3.1.1
Subsystem Intra Vehicular Communications
By: J. Torian Date: 8-28-70

TABLE II. CONSUMABLES/EXPENDABLES

Title: On Board Communications

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10-Yr Total Lbs	Daily	Unit Weight Lbs	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed Audio/Control Modem	Part failure	Component part	57.6	-	4	72	RTE
2. Failed TV Control Modem	Part failure	Component part	17.1	-	3	72	RTE
3. Failed Analog Sync/Test Modem	Part failure	Component part	5	-	5	72	RTE
4. Failed Digital Data Modem	Part failure	Component part	5	-	5	72	RTE
5. Packaging for Replacement Parts	Environmental integrity destroyed	Internal environment changed	-	-	-	5	Reuse for returning failed items

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REPUBLIC AVIATION DIVISION
FARMINGDALE, LONG ISLAND, NEW YORK

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.4.3.1.1 Sheet No. 1
Operational Description No. A-2.4.3.1.1
Subsystem Intra Vehicular Communications
By: J. Torian Date: 8-28-70

TABLE III. WASTES

Title: On Board Communications

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate-lbs.	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
1. Failed Audio/Control Modem	Solid, Metal, RTE	Al, Cu, Fe, Si Semi-cond. plastics	Repair	57.6	-	4	72	
2. Failed TV Control Modem	"	"	"	17.1	-	3	72	
3. Failed Analog Sync/Test Modem	"	"	"	5	-	5	72	
4. Failed Digital Data Modem	"	"	"	5	-	5	72	
5. Packaging for Replacement Parts	Solid, Plastic RTE	Plastic sponge and sheeting	Reuse as is	-	-	-	5	

2.4-32

PROVIDE STATION DATA COLLECTION AND STORAGE

TABLE OF CONTENTS

Doc. No. A-2.5.1.1.1
Sheet No. 1
By: A. Field
Date: 3 September 1970

OPERATIONAL DESCRIPTION

TITLE: Data Management - Electronic

DESCRIPTION AND SCHEMATIC

This section is devoted to an evaluation of the waste products of the Data Management subsystem by electronic means. This subsystem provides the acquisition processing and distribution of data on board the space station. The entertainment and photographic processing will be handled elsewhere and is therefore not covered in this section. Since this subsystem is in its embryonic stages and very little of the hardware is defined except in general terms the following basic assumptions are being made:

- The system will be operational in 1975. Therefore, the hardware being developed and actually available for the 1971-1972 era will be used in the space station.
- The subsystem components will be completely modularized. Most components will consist of standardized book modules containing printed circuit boards with discrete, integrated circuits, MSI or LSI components.
- A redundant digital data bus will be implemented on board the space station. Included in this data bus system will be an interface terminal which will provide the access for the individual components to the data bus. This terminal will be designed such that a catastrophic failure of a component such as a shorted output will not drag down the entire digital data bus. In the event of a data bus failure, the terminal sensing will cause it to be switched to the back-up data bus. With this isolation capability in the interface terminal, then every subsystem component can be considered independent of all the other components. Therefore, the deletion or addition of any component has no affect on the overall system and can be treated arithmetically to update the overall analysis.
- The finalized system will closely resemble the system outlined in Reference 1.

Figure 1 is a block diagram of the possible configuration of such a data management system. It can be seen that this subsystem can be subdivided into three basic categories:

A) Acquisition of Data
B) Processing
C) Distribution

Two types of data busses will be present on the space station. A digital data bus where all digital or low frequency analog data will be circulated and an analog bus which will have the high frequency analog signals such as the Video signals impressed on it.

RATIONALE:

A. Acquisition of Data

The acquisition of digital data from the various sources will be via the digital data bus and will be in the form of either low frequency analog or digital data signals. These signals may come from sensors aboard or external to the space station. In any event these signals must be conditioned before frequency division multiplexing can be used to impress them onto the digital data bus. An identity tag indicating the source of data and a destination tag would be included in all data words. Analog signals must be scaled, in some cases multiplexed, converted to a digital data stream and formated before they can be impressed onto a data bus terminal or modem for access to the data bus line.

As a result, it is assumed that the following components will be involved in conditioning the data sources:

- Discrete components such as resistors, capacitors, variable gain amplifiers and OP amps
- Multiplexers
- Analog-to-digital converters and Digital-to-analog converters

Once conditioned, the data is now converted to FDM and interfaced to the digital data bus through the data bus terminals. These digital data terminals must be not only capable of accepting the data from a source and access the information onto the data

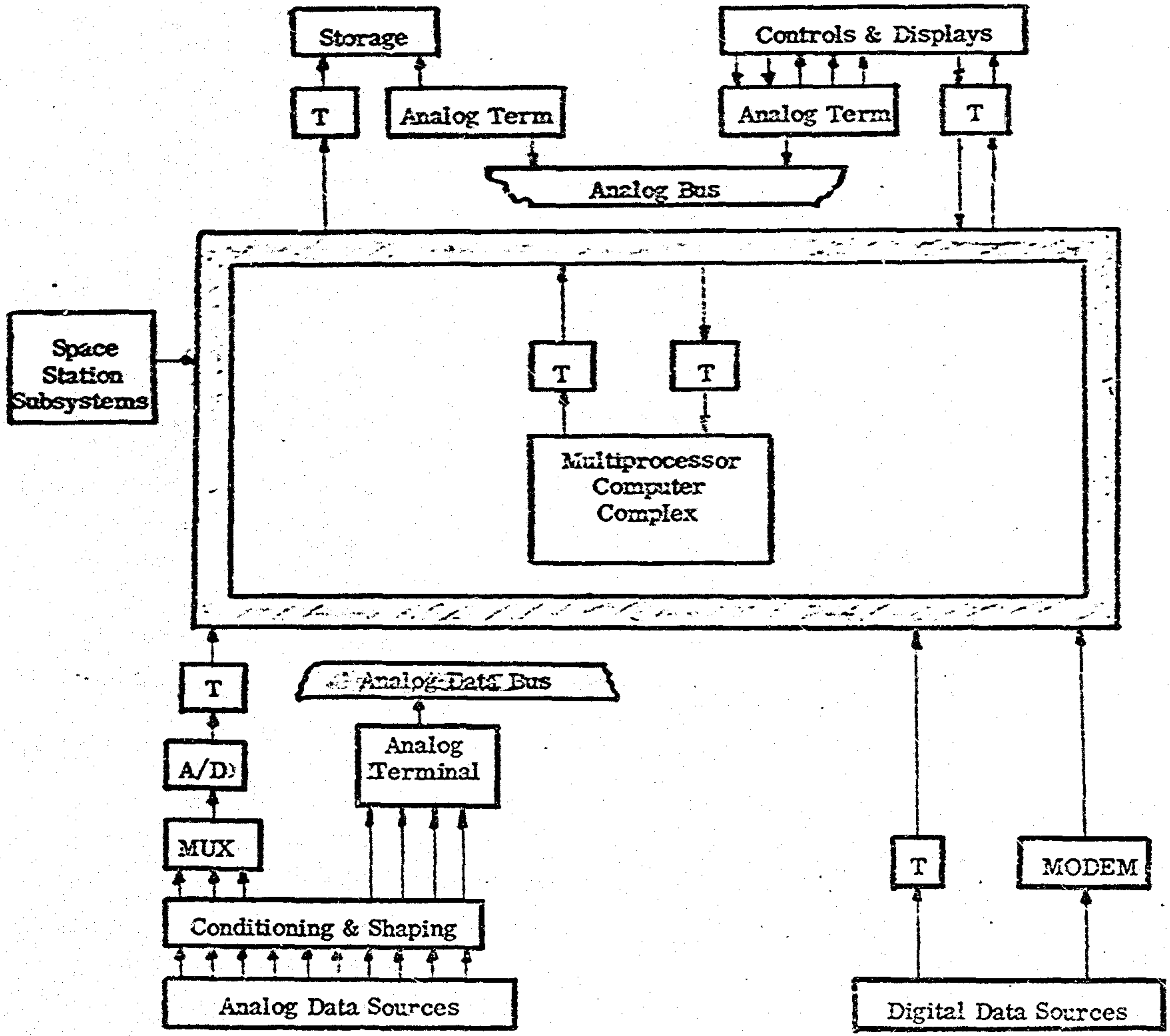

Figure 1. Data Management

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Doc. No. A-2.5.1.1.1
Sheet No. 3
By: A. Field
Date: 3 September 1970

bus at the proper interval, but it must also be capable of accepting data (i.e., computer) which is being transmitted to it from another source. The digital data terminal must therefore contain the following components:

- Data bus line drivers
- Data bus protective circuits
- Clocks, counters, and shift registers for data formating
- Address recognition logic
- Synchronization circuitry

B. Processing

The processing of all data on board the space station will be accomplished by a multiprocessor complex of computers. All computers will be basically identical. What will determine which computer will act as the DMS, Experiment or GNC processor will be the executive routing which will be set in before launch. In the event the DMS processor fails while in orbit, one of the other computers will take over its task and the space station will go into a backup mode until the computer failure can be corrected. The main and auxiliary memories will also be separate from the arithmetic and control section of the computers making them also interchangeable or computer "switchable". The hardware assumed to be used will consist of the following components:

- Data Management (DMS) processor and its main and auxiliary memories
- Experiment processor and its main and auxiliary memories
- Guidance, Navigation and Control (GNC) Processor and its main memory
- Bulk memory system containing enough capacity for retaining all software programs and long term storage of data

Data compression will be performed using software programs and no hardware implementation will be attempted to apply this technique.

C. Distribution

After the information is processed via the computation system complex the results are then fed onto the data bus for transmission to the various display units. The display system will be assumed to consist of the following components:

- Annunciators
- Video display terminal and equipment
- Recorders
- Printers
- Plotters

WASTE ANALYSIS

An analysis of the waste for the data management at the present time can only be done by a gross approximation of the systems and their expected reliability in the 1975-1980 era. An attempt has been made by researching the industry, previous projects, and the libraries to come up with a guess of reliability number which can be expected.

A basis for the approximations is the failure rate data handbook, Reference 2. At best, this only scratches the surface but it was used as a starting point for the work that was performed. At the present time, very little reliability information has been gathered on digital components such as solid state memories, LSI or MSI in outer space. Therefore, the reliability numbers to follow are based on little fact and mostly manufacturers' (optimistic) expectations and should be adjusted to their proper values whenever actual data becomes available.

The data which follows was developed by regrouping the basic components of the Data Management System into similar categories. For example, after study, it was guesstimated that the entire DMS would consist of 750 electronic circuit boards It has also been assumed that on-board maintenance will decrease some failures which might have otherwise been included (i.e., mechanical adjustment on the tape transports).

No data could be found on the failure rates of magnetic tapes or discs. According to the manufacturers they have an indefinite life and fail only due to abuse whether it be by human or machine. Some computer installations claim to have tape files that are still good after 5-10 years. Intuitively one failure was added to the listing which for the overall waste analysis is still negligible. Similarly throughout this analysis it was found that although reference 2 and the other documents contain a vast amount of failure rate data, personal judgement was used to determine which ones to apply and which ones to disregard. This judgement was seen to be capable of varying the failure rates by at least a factor of ten. All this is possible because little experience has been gathered on the hardware to be used (and also not specifically designed) for this system.

REFERENCES:

1. McDonald Douglas Space Station Report #MDC G0634 - "Preliminary Systems Design Data", Volume 1, Book 2, MSFC-DRL-160 Line Item 13, July, 1970.

2. "FARADA", Failure Rate Data Handbook, Volume 1A, Bureau of Naval Weapons, TRI-Service, NASA, (SP-63-470).

3. ATS Program - Fairchild Hiller Corporation.

4. Reliability Report, Nov. 1968, National Semiconductor Corporation, page 14.

5. Reliability of Epoxy Transistors, presented at 1969 Annual Symposium of Reliability by General Electric, page 17.

6. The Requirement for Maintainable Electronics on Long-Duration Manned Space Mission by Mr. M.L. Johnson of the Aerospace Systems Division, April, 1969.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-2.5.1.1.1 Sheet No. 1
Operational Description No. A-2.5.1.1 1
Subsystem Data Collection, Storage & Display
By: A. Field Date: 14 Sept. 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Data Management - Electronics

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total Weight (lbs.)	Daily Rate lbs/day	Unit Weight (lbs.)	Average Density As Received lbs/cu.ft.	REMARKS
Processors							
Controls/Arithmetic Modules	Part Failure	Component Part	48.75		2.5	50	RTE
Main Memory	Part Failure	Component Part	2.5		2.5	50	RTE
Data Storage Media							
Mag. Tape	Abuse	Tape	5		5	40	Indefinite life, failure due to abuse
Mag. Disc	Abuse	Disc	5		5	40	Indefinite life, failure due to abuse
Data Storage Hardware							
Tape Transports	Part Failure	Component Part	101.6		40	42	
Data Management							
System Electronic Circuit Boards	Part Failure	Component Part	9		0.25	50	Assume 750 cards per system

Study of Housekeeping Concepts For Manned Space

TABLE II. CONSUMABLES/EXPENDABLES

Doc. No. B-2.5.1.1.1 Sheet No. 2
Operational Description No. A-2.5.1.1 1
Subsystem Data Collection, Storage & Display
By: A. Field Date: 3 Sept. 1970

Title: Data Management - Electronics

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total Weight (lbs.)	Daily Rate lbs/day	Unit Weight (lbs.)	Average Density As Received lbs/cu.ft.	REMARKS
Sensors	Part Failure	Component Part	52.5		0.25	50	
Displays & Controls							
Cathode Ray Tubes	Part Failure	CRT	17.5		2	2.0	
Keyboard Terminals	Part Failure	Component Part	6.75		6.75	40	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-2.5.1.1.1 Sheet No. 1
Operational Description No. A-2.5.1.1.1
Subsystem Data Collection, Storage & Display
By: A. Field Date: 14 September 1970

Title: Data Management - Electronic

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total Weight (lbs.)	Daily Rate lbs./day	Unit Weight (lbs.)	Average Density As Received lbs/cu.ft.	REMARKS
Processor'								
Controls/Arithmetic Modules (Book Module)	Solid, Rigid Sheet Metal, Plastic	Al, Cu, Phenolic, Fibreglass, Silicon	Repair	48.75		2.5	50	RTE, Repairable
Main Memory (Book Module)	Solid, Rigid Sheet Metal, Plastic	Al, Cu, Phenolic, Fibreglass, Silicon	Repair	2.5		2.5	50	RTE, Repairable
Data Storage Media								
Magnetic Tape	Solid, Plastic, Wound Ribbon	Mylar, Iron Oxide	Replace	5		5	40	Discard Tape
Magnetic Disc	Solid, Rigid Disc, Plastic, Metal	Teflon, Iron Oxide, Fe, Cu	Replace	5		5	40	
Tape Transports	Solid, Metal, Dense	Fe, Cu	Replace	101.6		40	42	
Circuit Board	Solid, Rigid Sheet Plastic & Metal	Al, Cu, Phenolic, Fibreglass, Silicon	Repair	9		0.25	50	

Study of Housekeeping Concepts For Manned Space

Doc. No. C-2.5.1.1.1 Sheet No. 2
Operational Description No. A- 2.5.1.1.1
Subsystem Data Collection, Storage & Display
By: A. Field Date: 14 Sept. 1970

TABLE III. WASTES

Title: Data Management - Electronic

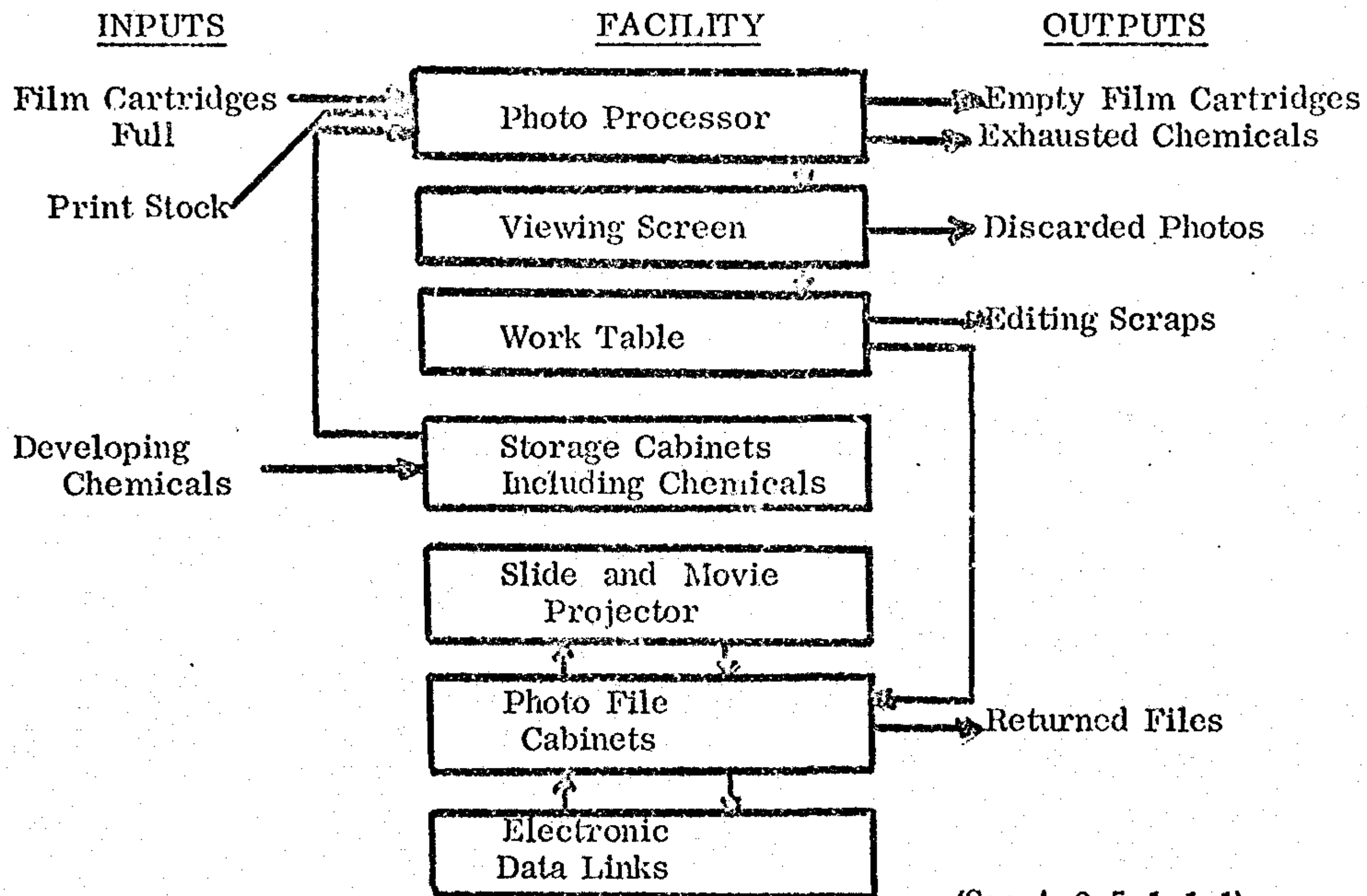
WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total Weight (lbs.)	Daily Rate lbs./day	Unit Weight (lbs.)	Average Density As Received lbs/cu.ft.	REMARKS
Sensor	Solid, Metal (Unknown)	Unknown	Replace	52.5		0.25	50	
Displays & Controls								
Cathode Ray Tube	Solid, Glass, Fragile, Dangerous	SiO_2, Fe	Replace	17.5		2	2	
Keyboard Terminal	Solid, Plastic Semi-cond. Rigid	Phenolic, Al, Cu Silicon	Repair	6.75		6.75	40	

Doc. No. A-2.5.1.2.1
Sheet No. 1
By: P. Trotta
Date: 30 July 1970

OPERATIONAL DESCRIPTION

TITLE: Data Management - Photographic

SCHEMATIC BLOCK DIAGRAM:



(See A-2.5.1.1.1)

RATIONALE:

A photographic lab will manage, develop, edit, supply materials for transmittal (physical and electronic image) and store the photographic data as produced by the various experiments. It is assumed that for every lb. of film there will be: 1 lb. of print stock, 0.1 lb. of scrap materials produced from editing and spoiled film, 1 lb. of empty film cartridges, 1 lb. of developing liquids, and 0.1 lb. of discarded pictures. Cartridges are approximately 4" x 4" x 4" and weigh approximately 1.4 lbs. full each and 0.7 lbs. empty. The photographic laboratory will probably be started with a given capacity that will be able to encompass all of the future work envisioned plus some spare capability. With this assumption, the laboratory here is based on the load of a 100 man station. The laboratory would be the same size for smaller stations, but would have a proportionally smaller throughput. It is estimated that one man would be required, full time, to operate their laboratory. 10 cartridges, on the average, will be used on any day. Developing fluid will be changed in batches every 1 to 2 days and all the film of a particular day will be processed, edited, viewed and printed together.

REFERENCES:

MEES C.E.K.: The Theory of the Photographic Process - The Mac Millan Company. 1959, Rochester, N.Y.

Gundersen, Robt. T.: Earth-Orbiting Space-Base Crew Skills Assessment. NASA, M.S.C., Houston, Texas. NASA TM X-1982, April 1970.

Study of Housekeeping Concepts For Manned Space

Doc. No. B-2.5.1.2.1 Sheet No. 1
Operational Description No. A-2.5.1.2.1
Subsystem Data Collection, Storage & Display
By: P. Trotta Date: 30 July 1970

TABLE II. CONSUMABLES/EXPENDABLES

Title: Data Management - Photographic

Consumable/Expendable ITEM	HOW CONSUMED	BASIC CONSTITUENTS CONSUMED	10 Yr. Total lbs.	Daily Rate lbs./day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
Developing Chemicals	Through reaction with silver halide emulsion on film	Sodium Thiosulfate	25,550	7	14	63	
Film and Cartridges	Exposed to light	Unexposed film	51,100	14	1.4	36	
Print Paper Stock (if used)	Exposed to light	Unexposed paper stock	25,550	7	7	72	

Study of Housekeeping Concepts For Manned Space

TABLE III. WASTES

Doc. No. C-2.5.1.2.1 Sheet No. 1
Operational Description No. A-2.5.1.2.1
Subsystem Data Collection, Storage & Display
By: P. Trotta Date: 30 July 1970

Title: Data Management - Photographic

WASTE ITEM	Characteristics State And Attributes	Chemical Composition	Action Required To Reclaim	10 Yr. Total lbs.	Daily Rate lbs./day	Unit Weight lbs.	Average Density As Received lbs/cu.ft.	REMARKS
Exhausted Developing Chemicals	Liquid Caustic	Sodium Thiosulfate	Reversal of developing, reactions and removal of contaminants	25,550	7	14	63	
Empty Film Cartridges	Solid Metal	Steel	Refill with film	25,550	7	.7	10	
Discarded Pictures	Solid, Plastic, Caustic	Silver Halide Grains in Gelitin on Mylar	Clean and Resurface with fresh emulsion	2,550	.7		25	
Editing Film Scraps	Solid, Plastic, Caustic	Silver Halide Grains in Gelitin on Mylar	Clean and Resurface with fresh emulsion	2,550	.7		10	

PROVIDE FOR SPACECRAFT LOGISTICS

SECTION 2.6

Doc. No. 2.6
Sheet No. 1
By:
Date: 25 September 1970

OPERATIONAL DESCRIPTION

TITLE: Provide for Spacecraft Logistics

These areas were not reviewed during the performance of this study because of the lack of definite plans for future programs.

PROVIDE FOR EXPERIMENT SUPPORT

SECTION 2.7

Doc. No. 2.7
Sheet No. 1
By:
Date: 25 September 1970

OPERATIONAL DESCRIPTION

TITLE: Provide for Experiment Support

These areas were not reviewed during the performance of this study because of the lack of definite plans for future programs.