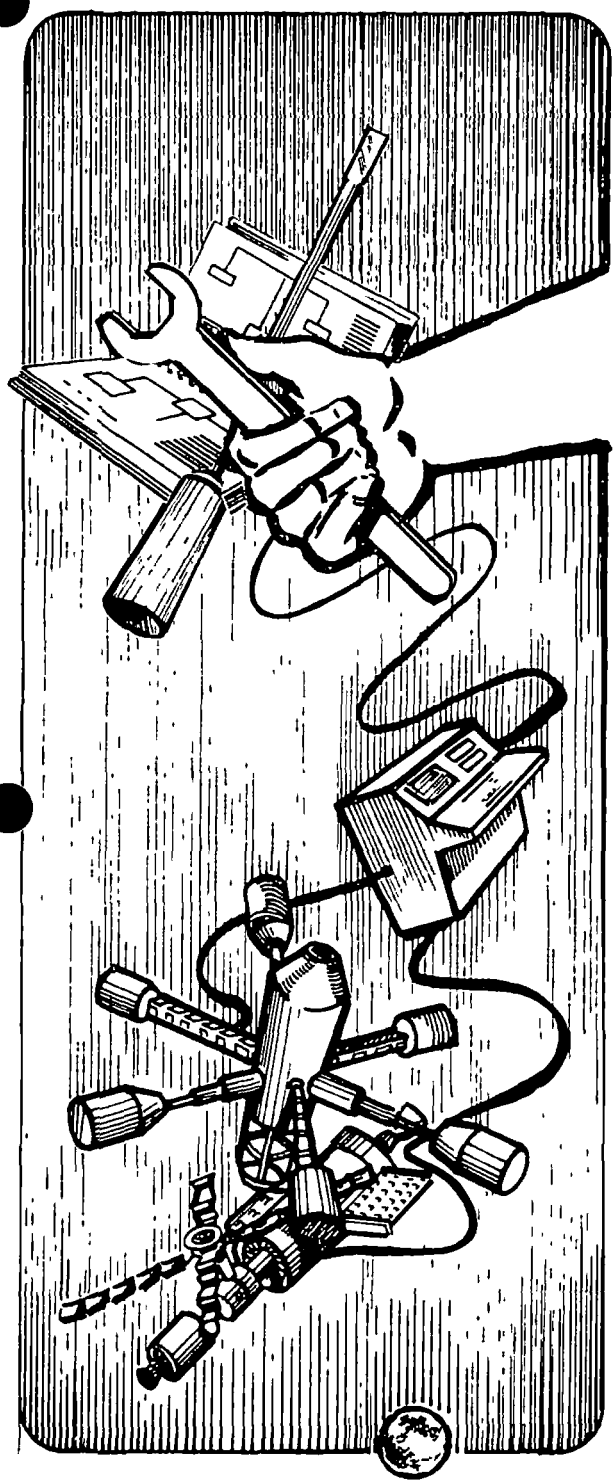

FINAL REPORT FOR THE CREW INTERFACE SPECIFICATIONS PREPARATION FOR IN-FLIGHT MAINTENANCE AND STOWAGE FUNCTIONS

NOVEMBER 9, 1972

PREPARED BY
GENERAL ELECTRIC
APOLLO & GROUND SYSTEMS - HOUSTON PROGRAMS
HOUSTON, TEXAS

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1.0 INTRODUCTION

This report presents the findings and data products developed during the Phase II Crew Interface Specification Study for Inflight Maintenance and Stowage functions in future manned spaceflights. The study was performed by General Electric, Apollo and Ground Systems, Houston Programs, under contract with the NASA, Manned Spacecraft Center for the purpose of developing a set of documentation that can be used as definitive guidelines to improve the present process of defining, controlling and managing the crew interface requirements that are related to maintenance (including assembly and servicing) and stowage functions. This study was performed for the Flight Crew Operations Directorate of the NASA, Manned Spacecraft Center under Contract NAS 9-12249. The Technical Monitor for the study was Mr. G. C. Franklin, Chief, Operations Support Branch of the Flight Crew Integration Division.

As manned spacecraft missions progress toward long duration flight and semi-autonomous operations, flight crews become more dependent on onboard technical and procedural data for systems, process and operational management of their vehicle. The specific problems of crew interface with the inflight maintenance and stowage processes require significant planning for provisioning and become critical if appropriate data is not supplied to the crew. In order that this crew interface data is supplied to NASA in a timely manner, specifications are needed that will allow NASA to define these requirements and be able to impose such contractual requirements on contractors to supply this data when desired, and with the proper format and content.

The guidelines for the Phase I Study (NAS 9-11336) were to maintain a measure of continuity and consonance with presently implemented NASA and contractor engineering practices while evolving new concepts for crew interface requirements definitions and operational support for the expanded inflight maintenance and stowage functions that will exist in future manned spaceflight missions. In addition it was important to consider the implications on crew interface design and support requirements of future spacecraft design and data management system concepts. These guidelines were used in the Phase I study activity in the identification and description of present NASA processes being utilized in the development of crew procedures and in the investigation of new processes and requirements associated with stowage and inflight maintenance.

Phase I study results indicate that a need existed for a standard method of identifying the location on the spacecraft of controls, displays, stowage items, subsystems components, tools, test equipment, maintenance aids, etc. Since no systematic consistent coding method had yet been established by NASA for usage in description of systems configurations and crew procedures for training, a standard location coding system was developed during Phase I suitable for incorporation into a NASA specification.

Another problem area identified during the Phase I study was that of loose equipment and stowage management. Operational experience in recent manned spacecraft programs emphasized the need for a specification that will define the basic process required for stowage management on future manned spacecraft programs and identify related data systems and elements necessary for vehicle preparation and stowage, inflight stowage management, and postflight stowage operations.

A third area where Phase I study results indicated that definitive specifications were needed was that of inflight maintenance. Specifically, specifications are needed to define the data products required by NASA to support both the design, development and operational phases of inflight maintenance planning, and the time phasing for delivery of this data by the contractor during the life of a program. In particular the requirement exists to specify integrated data formats for procedures and graphics to support inflight maintenance functions during crew training and inflight operations.

Thus, it was the purpose of this second phase of study to extend the concepts developed during Phase I into definitive NASA specifications in the areas of location coding and loose equipment and stowage management, and to further develop inflight maintenance data concepts in preparation for a third phase in which the maintenance data will be finalized into NASA specifications.

2.0 SUMMARY OF RESULTS

The results of the General Electric, Apollo and Ground Systems, Houston Programs, Phase II Crew Interface Specification Study on Inflight Maintenance and Stowage functions are summarized in this section. Subsequent sections of the report contain discussions of results and data products (specifications) developed in each area identified below.

The primary purpose of this Phase II of the Crew Interface Specification Program for Inflight Maintenance and Stowage was to develop specification document(s) for: (1) Operations Location Coding Requirements, and (2) Stowage Management Data Requirements. A secondary purpose was to further develop and expand inflight maintenance data concepts in format and content suitable for incorporation into specification data.

The following NASA Specifications were developed and delivered during this contract:

SC-C-0009	General Specification, Operations Location Coding System for Crew Interfaces
SC-S-0011	General Specification, Loose Equipment and Stowage Management Requirements
SC-S-0012	General Specification, Loose Equipment and Stowage Data Base Information Requirements
SC-S-0013	General Specification, Spacecraft Loose Equipment Stowage Drawing Requirements
SC-S-0014	General Specification, Inflight Stowage Management Documentation Requirements

Each of the specifications is presented and discussed in later sections of this report. As of the time of this report, all of the above specifications have received final NASA approval and have been officially published.

In the area of inflight maintenance the Phase II study has produced a preliminary process description of inflight maintenance data product management during a typical spacecraft program as well as definition of the different data products required to support each program phase. Data product requirements for troubleshooting, remove/repair/replace and scheduled maintenance were reviewed and recommended format/content requirements were developed. Recommendations are presented in Section 6.0 for incorporating these data product requirements into NASA Specifications during the next phase of the program.

3.0 OPERATIONS LOCATION CODING SYSTEM

During the Phase I study activity, GE developed a detailed system which provided a standard method of location coding of crew interface items on future manned spacecraft. The Phase II effort under this contract involved additional study to expand the concept to cover all types of spacecraft configurations under consideration by NASA, and integration of the coding requirements into the Operations Location Coding System Specification. The initial four months' effort during this contract was dedicated to preparing and submitting to NASA/MSC the proposed Operations Location Coding System Specification. After initial submittal, the specification was revised in response to technical evaluations and recommendations from Flight Crew Operations Directorate personnel and in accordance with the Technical Monitor's direction. The specification was then distributed for center-wide MSC review, and further revisions were incorporated. The finalized specification was approved and issued by NASA/MSC as Specification SC-C-0009 and is included as Appendix A to this report.

Figure 1 is an overview of the Operations Location Coding System developed by GE under this contract. Figure 2 summarizes the advantages of standardizing the coding system and Figure 3 summarizes the applications of the system to manned spacecraft.

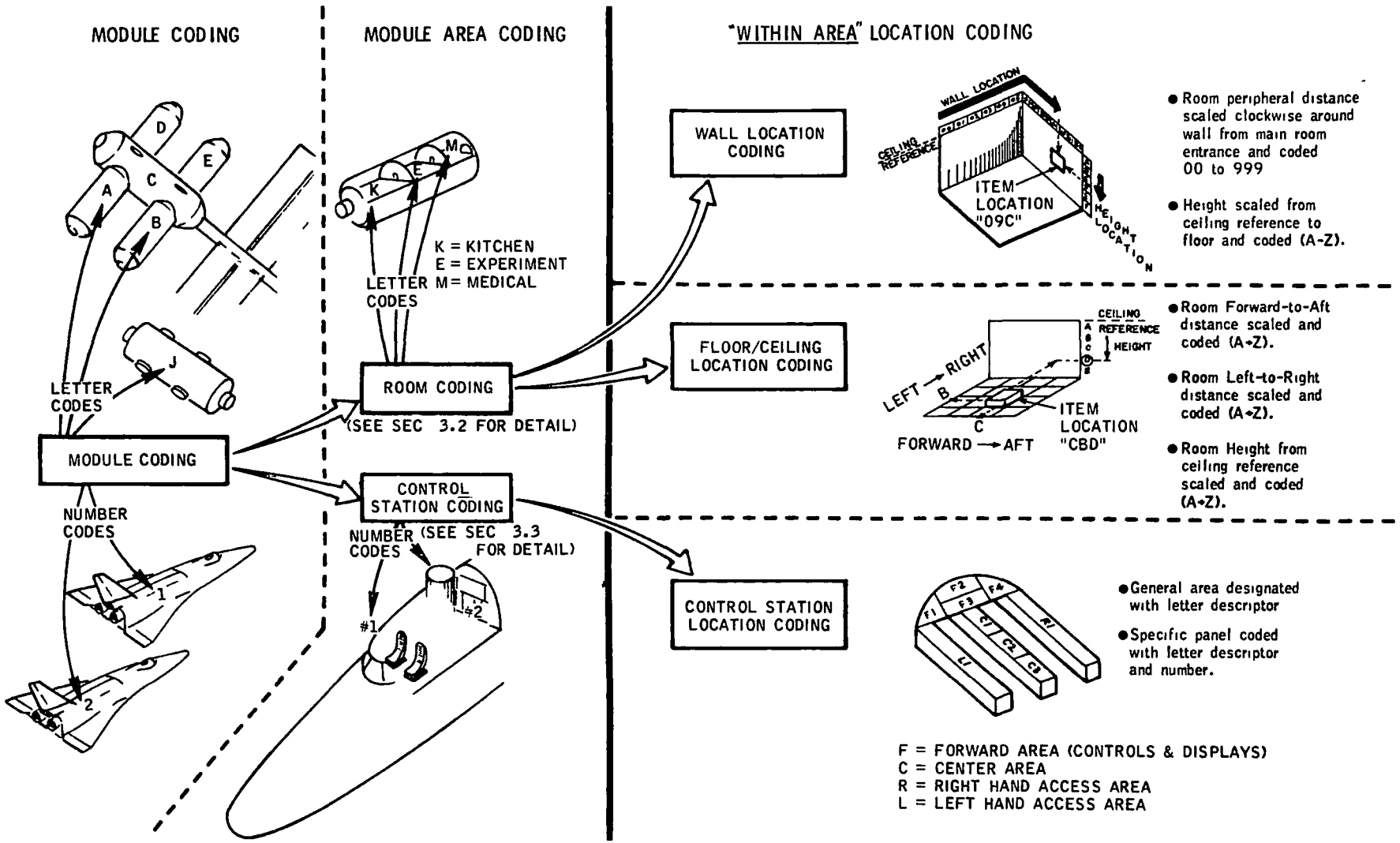


FIGURE 1 - OVERVIEW OF OPERATIONS LOCATION CODING SYSTEM

THE OPERATIONS LOCATION CODING SYSTEM:

- REDUCES TRAINING TIME OF ALL PROGRAM PERSONNEL SINCE THE CODING SYSTEM IS THE SAME FOR ALL VEHICLES/SPACECRAFT.

- PROVIDES LOCATION DESIGNATION INFORMATION FOR NUMEROUS PROGRAM USAGES AT A MUCH EARLIER TIME IN THE PROGRAM AS A RESULT OF HAVING A PREDEFINED LOCATION CODING SYSTEM SPECIFICATION.

- REDUCES COST OF PRIME CONTRACTOR ENGINEERING TIME SINCE
  - NO ENGINEERING STUDIES ARE NECESSARY TO ESTABLISH A VEHICLE CODING SYSTEM.
  - RELATED PROCEDURAL AND TRAINING DATA HAVE A STANDARD BASE FOR IDENTIFYING CREW INTERFACE ITEMS.

- IS APPLICABLE TO ALL FUTURE SPACECRAFT AND CAN HANDLE CHANGES IN CONFIGURATION WITHOUT REDESIGNATIONS OF MAJOR BLOCKS OF LOCATIONS.

FIGURE 2 - ADVANTAGES OF HAVING A STANDARD OPERATIONS LOCATION CODING SYSTEM

THE OPERATIONS LOCATION CODING SYSTEM:

WHICH ITEMS APPLICABLE TO

- PROVIDES A STANDARD METHOD OF LOCATION CODING OF CREW INTERFACE ITEMS INCLUDING:
  - CONTROL/DISPLAY PANELS
  - ACCESS PANELS
  - SYSTEMS COMPONENTS
  - EXPERIMENTS
  - STOWAGE AREAS, LOCKERS, & SUBCOMPARTMENTS

VEHICLE APPLICABILITY

- HAS GENERIC APPLICATIONS FOR ALL FUTURE SPACECRAFT TYPES:
  - LAUNCH VEHICLES
  - LUNAR LANDER VEHICLES
  - EARTH ORBITAL SHUTTLE VEHICLES AND PAYLOADS
  - SPACE STATION VEHICLES (ZERO AND ARTIFICIAL G)
  - SPACE TUG VEHICLES

WHERE APPLICABLE

- IDENTIFIES WHERE ITEMS CAN BE FOUND: (NO ADDITIONAL LOCATION VERBAGE IS REQUIRED)
  - WITHIN SPACE STATION CONFIGURATION
  - WITHIN MODULE
  - WITHIN ROOM
  - WITHIN A LOCKER
  - WITHIN CONTROL OR WORK STATION

PRODUCT APPLICABILITY

- HAS APPLICATIONS FOR:
  - CREW STATION DESIGN AND OPERATIONAL REVIEW ACTIVITIES
  - PANEL IDENTIFYING AND TRAINER/FLIGHT ARTICLE LABELING
  - DESIGNATIONS OF CONTROL/DISPLAY PANEL LOCATIONS ON SYSTEMS SCHEMATIC DATA, OPERATIONS HANDBOOKS, AND OTHER TRAINING DATA
  - STOWAGE LIST LOCATION DATA
  - FLIGHT CREW OPERATIONS AND INFLIGHT MAINTENANCE DATA
  - MANUFACTURING AND GROUND PREPARATIONS DATA
  - TEST AND CHECKOUT PROCEDURES DATA
  - DESIGNATING EVA WORK SITE LOCATIONS

FIGURE 3 - THE OPERATIONS LOCATION CODING SYSTEM APPLICATIONS

4.0 SPACECRAFT LOOSE EQUIPMENT AND STOWAGE MANAGEMENT

The second major task of this Phase II study was to develop stowage management specification(s) that will provide definitive guidelines for future spacecraft contractors as to the format and content of data required by NASA to support spacecraft stowage and stowage management during design, development and real-time missions operations. After study evaluations and discussions with the contract technical monitor, it was agreed that four specifications were needed to completely define the stowage management process requirements. These are:

(1) A top-level stowage management process specification which defines time-phased stowage process requirements with respect to spacecraft program milestones.

(2) A stowage information management specification which defines and standardizes input/output stowage management requirements for a computerized stowage management system.

(3) A stowage drawing specification which standardizes and establishes illustration requirements for documentation of loose equipment stowage configurations, and

(4) An inflight stowage management specification which defines documentation requirements for onboard data supporting inflight stowage management.

It was agreed that the basic purpose of the four proposed stowage management specifications would be to define a standardized process for stowage management on future spacecraft programs and identify related data systems and elements necessary for vehicle preparation and stowage, inflight stowage management, and postflight stowage operations. Figure 4 summarizes the scope of the requirements of these specifications.

As the preparation effort progressed on these four new stowage management specifications, each was assigned a NASA/MSC control number and initial drafts were reviewed by the Technical Monitor and later circulated for center-wide NASA/MSC review. Figure 5 illustrates the titles and control numbers of the stowage management specifications, their relationship to each other (documentation tree) and the relationship of the Operations Location Coding System Specification previously discussed in Section 3.0. Figure 6 summarizes the advantages of the stowage management specifications.

The following sections discuss the development and resulting content of each of the stowage management specifications prepared under this contract. At the time of this report all of the stowage management specifications have received final NASA approval and have been officially published.

STOWAGE MANAGEMENT SPECIFICATIONS

SCOPE:

THE STOWAGE MANAGEMENT SPECIFICATIONS PROVIDE FOR:

- EARLY DEFINITION BY THE CONTRACTOR OF THE PLAN FOR IMPLEMENTING THE PROGRAM STOWAGE MANAGEMENT PROCESS

- ESTABLISHMENT OF STOWAGE INFORMATION MANAGEMENT SYSTEM DATA BASE WHICH INCLUDES INFORMATION FOR VEHICLE PREPARATION AND LAUNCH STOWAGE, STOWED EQUIPMENT LOGISTICS TRACKING, INFLIGHT STOWAGE OPERATIONS, & POST LANDING STOWAGE OPERATIONS.

- REQUIREMENTS FOR LOOSE EQUIPMENT STOWAGE DRAWING(S) TO SUPPORT STOWAGE REVIEWS, TESTS, TRAINING & LAUNCH STOWAGE

- REQUIREMENTS FOR INFLIGHT STOWAGE MANAGEMENT DOCUMENTATION

FIGURE 4 - STOWAGE MANAGEMENT SPECIFICATIONS SCOPE

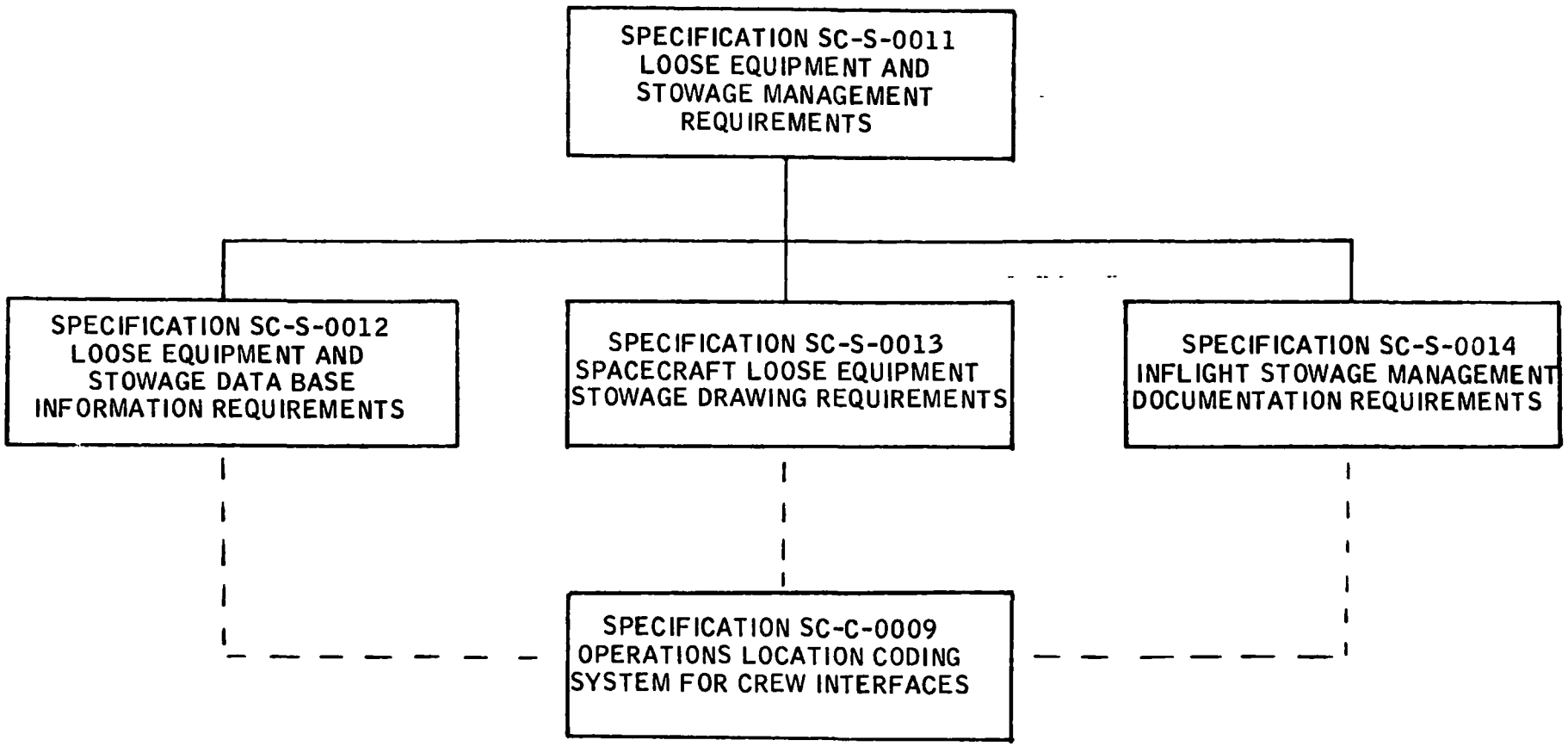


FIGURE 5 - STOWAGE MANAGEMENT SPECIFICATION TREE

ADVANTAGES OF STOWAGE MANAGEMENT SPECIFICATIONS

- APPLIES LESSONS LEARNED ON APOLLO & SKYLAB TO FUTURE PROGRAMS
- REQUIRES CONTRACTORS AND CENTER ORGANIZATIONS TO DEFINE THE STOWAGE PROCESSES AND CONCEPTS EARLY, AND IN A TIMELY MANNER PROVIDE DOCUMENTATION ELEMENTS TO SUPPORT STOWAGE ACTIVITIES.
- PROVIDES A STOWAGE DATA BASE WHICH IS A CENTRALIZED FOCAL POINT FOR ALL STOWAGE RELATED INFORMATION. PROVIDES FOR WIDE IMMEDIATE DISSEMINATION OF DATA AS CHANGES ARE APPROVED, THROUGH USE OF REMOTE TERMINALS AT VARIOUS SITES.
- PROVIDES STANDARDIZED FORMAT/CONTENT DEFINITION FOR STOWAGE INFORMATION (LISTS, REPORTS, ETC.) AND STOWAGE GRAPHICS (FLIGHT DATA, STOWAGE DRAWINGS, ETC.) THEREBY REDUCING TRAINING TIME OF ALL PROGRAM PERSONNEL.
- REDUCES COST OF PRIME CONTRACTOR ENGINEERING SINCE NO DEVELOPMENTAL STUDIES ARE NECESSARY TO ESTABLISH STOWAGE DOCUMENTATION SYSTEM.

FIGURE 6 - ADVANTAGES OF STOWAGE MANAGEMENT SPECIFICATIONS

4.1 LOOSE EQUIPMENT AND STOWAGE MANAGEMENT REQUIREMENTS SPECIFICATION

Through recent experience in implementing loose equipment and stowage management on the Apollo and Skylab programs, it became apparent that the proper time phasing of stowage activities with other program milestones and the timely availability and content of stowage-related data products could be critical to the efficiency and success of the stowage activities and overall spacecraft crew station development. A specification was required which would define the basic process required for stowage management on future manned spacecraft programs and identify related data systems and elements necessary for vehicle preparation and stowage, inflight stowage management, and postflight stowage operations.

After discussions with the Technical Monitor, it was agreed that a top-level stowage process specification would be prepared which would accomplish the purpose stated above. This process specification would cover time-phasing of all stowage related activities for a spacecraft program and specify delivery requirements for related contractor data products to support the stowage process. Requirements for the data products would be given at a top level, and additional specifications would be prepared to describe in detail the requirements of the individual data products. Figure 5 illustrates this documentation-tree approach to the family of stowage management specifications.

The first specification to be prepared and delivered during the ensuing effort was the top-level Loose Equipment and Stowage Management Requirements Specification, SC-S-0011. The specification was reviewed and approved by the Technical Monitor and then circulated for center-wide NASA/MSC review, in which it received approval with only minimal changes requested, which have been incorporated into the final version.

Figure 7 contains a summary of the purpose and scope of the specification. Figure 8 depicts in summary form the time-phased stowage management process together with the related data products identified in the specification. The complete specification is included as Appendix B to this report.

SPECIFICATION SC-S-0011

LOOSE EQUIPMENT AND STOWAGE MANAGEMENT REQUIREMENTS

PURPOSE: TO DEFINE GENERAL LOOSE EQUIPMENT AND STOWAGE MANAGEMENT PROCESS AND IDENTIFY SUPPORTING DATA SYSTEMS AND ELEMENTS NECESSARY FOR ALL PHASES OF A SPACECRAFT PROGRAM

SCOPE:

- DESCRIBES NASA STOWAGE PROCESS
- SPECIFIES STOWAGE PROCESS DEFINITION REQUIREMENTS BY CONTRACTOR
- SPECIFIES TOP LEVEL STOWAGE INFORMATION MANAGEMENT REQUIREMENTS
- SPECIFIES TOP LEVEL STOWAGE GRAPHICS REQUIREMENTS

FIGURE 7 - SPECIFICATION SC-S-0011, LOOSE EQUIPMENT AND STOWAGE MANAGEMENT REQUIREMENTS

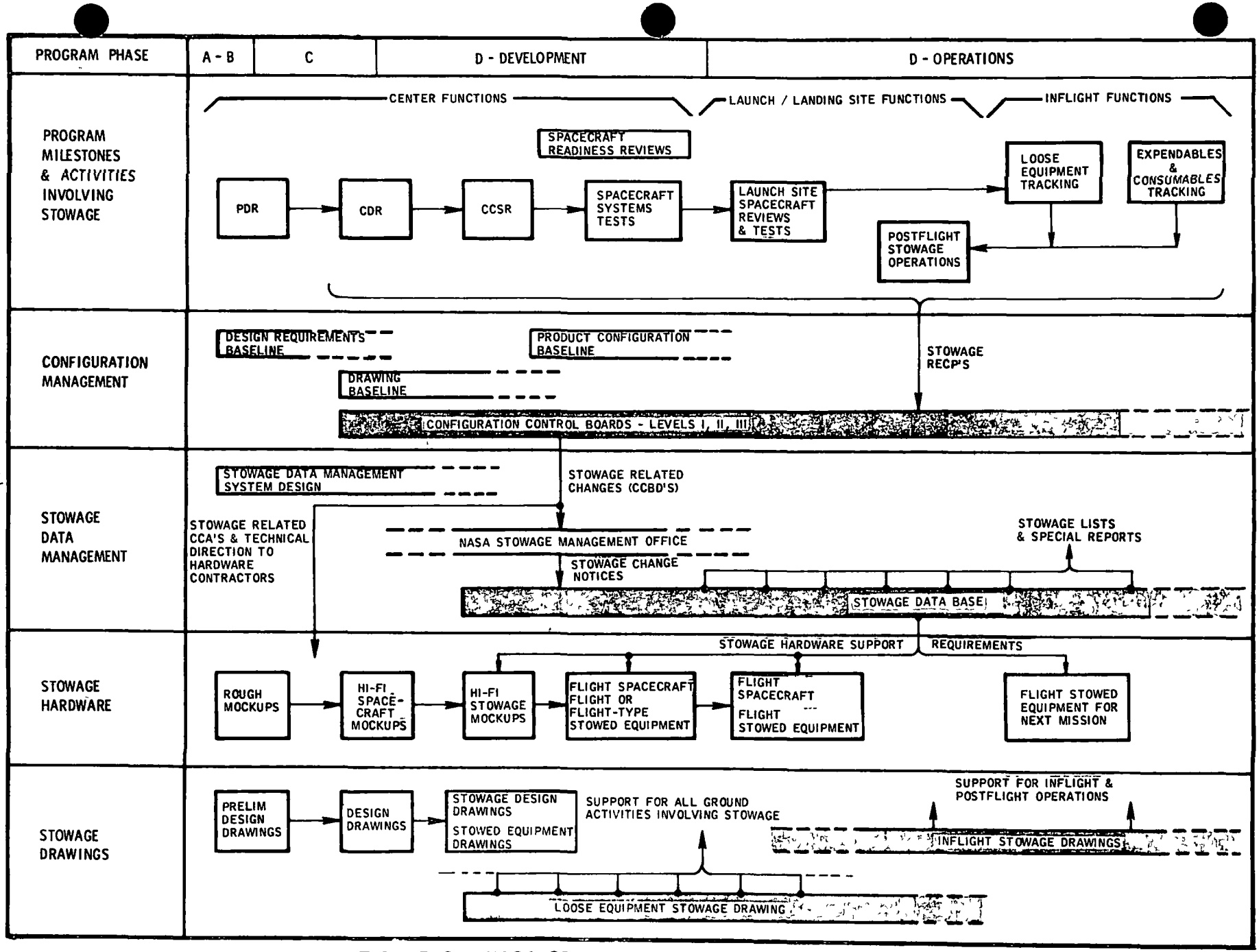


FIGURE 8 - NASA STOWAGE MANAGEMENT PROCESS

4.2 LOOSE EQUIPMENT AND STOWAGE DATA BASE INFORMATION REQUIREMENTS SPECIFICATION

The loose equipment stowage inventory on early space flights was small, and as a result stowage management was accomplished with relatively informal methods of control and tracking. However, on the Apollo Program the number of stowed items greatly increased, and a regularly updated stowage list was implemented as a formally published statement of program stowage requirements. Stowage in the Skylab Program represented a fourfold increase over the Apollo Program, and as a result, application of computer technology was necessary for defining and tracking stowage requirements. An expanded computer program was developed for the Skylab Program and implemented to provide a central data base from which the Skylab Stowage List, as well as other special reports could be generated. Skylab Program experience has shown that a stowage computer system is essential to future manned spaceflight programs, and should be expanded to include all data relevant to stowage management, including premission logistics, launch stowage configuration, inflight usage, and postflight usage. To this end, it was agreed that a specification should be prepared which defines for future manned spacecraft programs the specific data elements of a stowage information management system and establishes requirements for format and content of the various stowage reports and input/output display data utilized in the management of loose equipment stowed onboard the spacecraft.

Discussions with the Technical Monitor and other NASA/MSC personnel associated with stowage activities on previous programs indicated that the specification should cover information requirements for loose equipment management during all phases of a spacecraft program, including design, development, checkout and inflight operations. In addition to information related to stowed equipment description and stowage configurations of the spacecraft, data requirements would be included to support the logistics operations of loose equipment management for all program activities requiring usage or evaluation of stowed equipment (i.e., crew station reviews, spacecraft systems tests, launch site spacecraft reviews and tests, etc.).

Figure 9 summarizes the purpose and scope of the resulting Specification SC-S-0012, Loose Equipment and Stowage Data Base Information Requirements. Figure 10 illustrates the relationship of the information requirements contained in the specification to the computer system utilized to manage stowage data for a particular program. Details of implementation of the data requirements on the computer were not made a part of the specification, since they would vary from one system to another.

Initial drafts of the specification were reviewed by the Technical Monitor and later circulated for center-wide MSC review. Comments and recommendations for change were minimal, and were incorporated prior to the final draft of the document. Appendix C to this report contains the complete text of the specification.

SPECIFICATION SC-S-0012

LOOSE EQUIPMENT AND STOWAGE DATA BASE INFORMATION REQUIREMENTS

PURPOSE: TO IDENTIFY SPECIFIC DATA BASE ELEMENTS FOR STOWAGE INFORMATION MANAGEMENT SYSTEM. TO ESTABLISH USER FORMAT/CONTENT REQUIREMENTS OF INPUT/OUTPUT AND DISPLAY DATA TO SUPPORT THE STOWAGE MANAGEMENT PROCESS

SCOPE: INCLUDES INFORMATION THAT IS MAINTAINED IN THE STOWAGE DATA BASE WHICH SUPPORTS ACTIVITIES IN THE AREAS OF SPACECRAFT DEVELOPMENT, VEHICLE LOGISTICS AND PREPARATIONS, INFLIGHT STOWAGE CONFIGURATION MANAGEMENT, AND VEHICLE POSTFLIGHT SUPPORT.

FIGURE 9 - SPECIFICATION SC-S-0012, LOOSE EQUIPMENT AND STOWAGE DATA BASE INFORMATION REQUIREMENTS

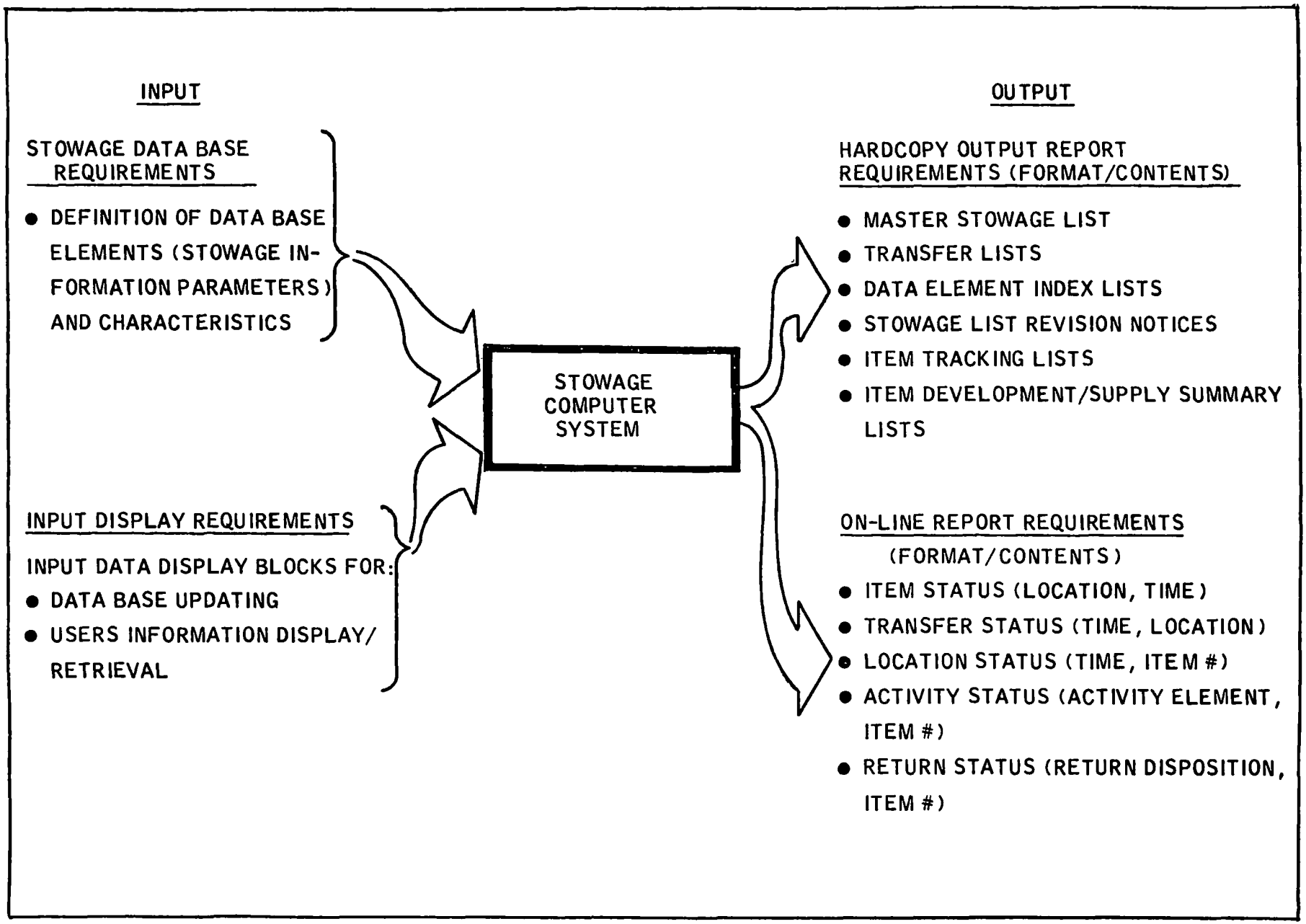


FIGURE 10 - INPUT AND OUTPUT INFORMATION AND DISPLAY REQUIREMENTS, SPECIFICATION SC-S-0012

4.3 SPACECRAFT LOOSE EQUIPMENT STOWAGE DRAWING REQUIREMENTS SPECIFICATION

One of the lessons learned in connection with crew station and stowage activities in recent manned spacecraft programs is the importance of an up-to-date spacecraft stowage drawing, which illustrates the stowage configuration of all loose equipment carried onboard the spacecraft. At the numerous Apollo and Skylab crew station reviews and engineering tests, which were conducted to verify the validity of contractor design implementation of stowage requirements, the need for timely availability of a new type of stowage drawing became apparent. Three dimensional perspective illustrations of the loose equipment items and their stowage provisions on board the spacecraft were needed for management visibility into the stowage process, for training and preparation of flight and ground crews, and for quality verification of the stowage preparation of the vehicle.

With still further increases in stowage requirements anticipated in future spacecraft programs, and with the continued involvement of multiple spacecraft and payload prime contractors, it is necessary that standardized formats and contents for stowage drawings be established, and delivery and revision requirements be specified for timely availability of these drawings in support of stowage-related program activities.

During June 1969, at NASA request, GE developed a concept for improving the Apollo spacecraft stowage drawings. This concept was implemented during the remainder of the program and greatly improved the effectiveness of the drawings. The same GE concept was applied later during the Skylab program to achieve consistency and continuity of stowage information among the several Skylab modules. This concept was reported to NASA as part of the Phase I study, Contract NAS 9-11336, (Reference 1) and subsequently implemented by NASA on the complete Skylab module cluster. During this present Phase II contract effort, the concept was further detailed and expanded into a complete stowage drawing specification covering both format, content, control, delivery, and revision requirements.

Figure 11 summarizes the purpose and scope of the resulting Specification, SC-S-0013, Spacecraft Loose Equipment Stowage Drawing Requirements. Figure 12 illustrates the overall configuration of the stowage drawing. The complete text of the specification is contained in Appendix D to this report.

Initial drafts of the specification were reviewed by the Technical Monitor and subsequently circulated for center-wide MSC review. Comments and recommendations for changes were minimal, and were incorporated prior to the final draft of the document.

SPECIFICATION SC-S-0013

SPACECRAFT LOOSE EQUIPMENT STOWAGE DRAWING REQUIREMENTS

(FORMERLY CALLED FIELD SITE DRAWINGS)

PURPOSE: TO ESTABLISH SPACECRAFT SUMMARY STOWAGE ILLUSTRATION REQUIREMENTS FOR ALL MANNED SPACECRAFT PROGRAMS. TO SPECIFY A SINGLE SUMMARY DRAWING IN WHICH IMPLEMENTATION OF STOWAGE REQUIREMENTS IS DOCUMENTED PICTORIALLY FOR EACH VEHICLE OR MODULE.

SCOPE:

- SPECIFIES REQUIREMENTS FOR DOCUMENT DELIVERY, ORGANIZATION, REVISIONS, EFFECTIVITY, ETC.
- SPECIFIES FORMAT AND CONTENT REQUIREMENTS FOR OVERVIEW ILLUSTRATIONS (STOWAGE MAPS) AND DETAILED STOWAGE LOCATION ILLUSTRATIONS.

FIGURE 11 - SPECIFICATION SC-S-0013 - SPACECRAFT LOOSE EQUIPMENT STOWAGE DRAWING REQUIREMENTS

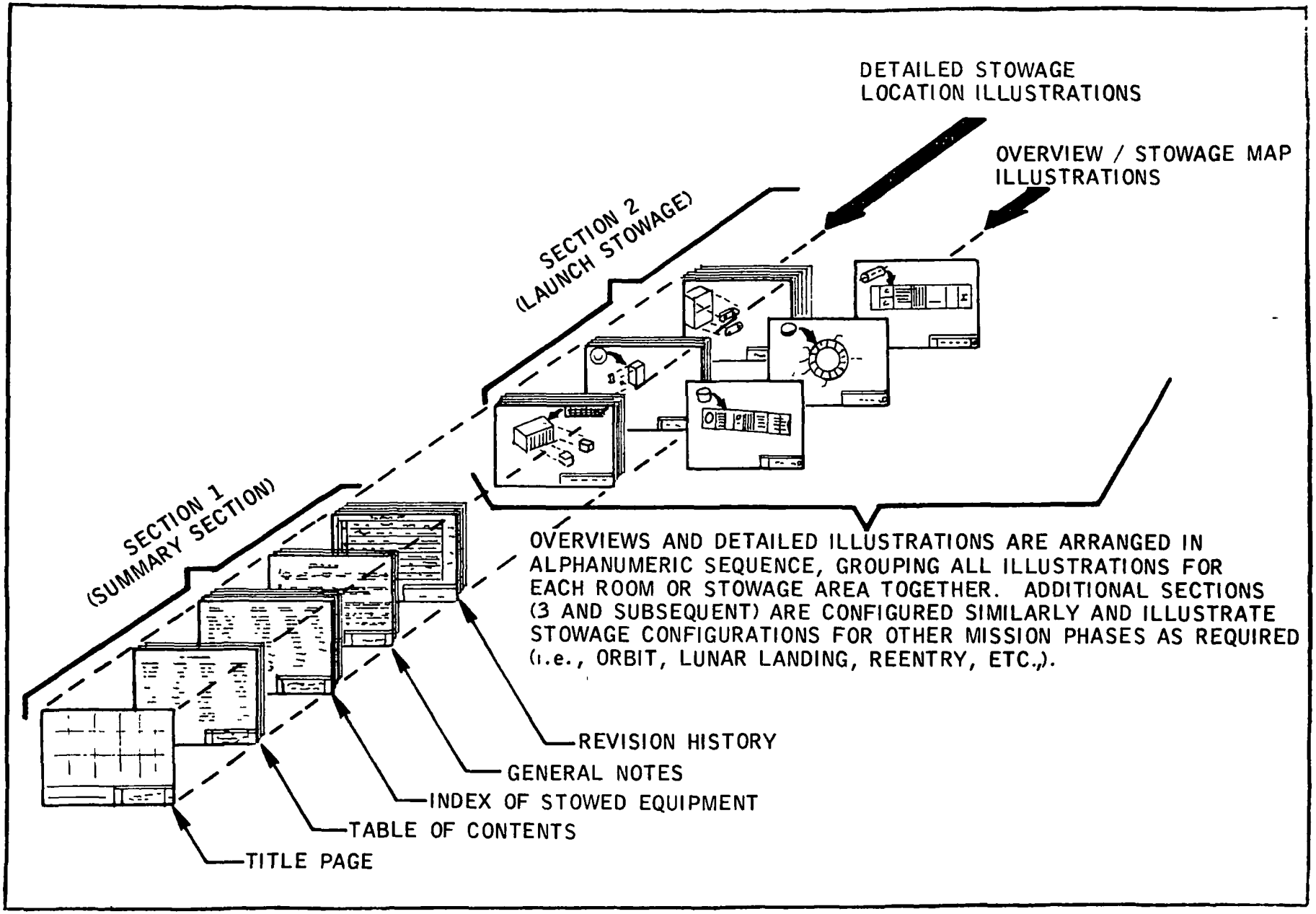


FIGURE 12 - SPACECRAFT LOOSE EQUIPMENT STOWAGE DRAWING CONFIGURATION

4.4 INFLIGHT STOWAGE MANAGEMENT DATA REQUIREMENTS SPECIFICATION

Future long-term space missions will be characterized by increased crew time required for housekeeping and inflight maintenance functions with the related increase in loose equipment stowage management activities. The task of inflight stowage bookkeeping requirements must be minimized and made a manageable function so that valuable crew time is not utilized in excessive clerical activities. Sufficient onboard data must be provided, however, to facilitate crew tasks of locating equipment, planning and implementing logistics transfers, and managing mass-properties of the spacecraft as equipment locations are changed inflight.

One of the principal objectives of this Phase II Crew Interface Specification Study for Inflight Maintenance and Stowage functions was to investigate data products which could serve multiple functions throughout the design, development, and operational phases of a program. A prime candidate for study in this regard was the relationship between: (1) the spacecraft stowage drawings used during development and checkout; and (2) the stowage management data carried aboard the spacecraft inflight. GE experience with the new data formats for the Apollo stowage drawings and the Skylab inflight stowage data (see Section 4.3) indicated that both ground and inflight functions could be served by stowage data of similar format and content. To this end, additional study was conducted during this Phase II effort to define a Loose Equipment Stowage Drawing (Section 4.3) which with minor modifications could be utilized to construct the inflight graphics portion of the onboard stowage management data package.

Results of the study indicated that the onboard stowage data should be organized into two documents:

(1) An Inflight Stowage Management Document which contains an alphabetical index of all stowed equipment and graphics which illustrate stowage configurations for launch and later mission phases.

(2) An Inflight Transfer Document which provides a chronological sequence of transfers of equipment from one location to another, and correlates each transfer to its respective activity element in the mission flight plan.

Figure 13 summarizes the purpose and scope of the resulting Specification, SC-S-0014, Inflight Stowage Management Data Requirements. Figure 14 illustrates the configuration of the Inflight Stowage Management Document. The complete text of the specification is contained in Appendix E to this report.

Although functional requirements imposed on an inflight data management system are inherent in Specification SC-S-0014, details of system implementation were not a part of this study effort. Automatic retrieval capability, bulk storage, hard-copy output, etc., are fundamental capabilities of numerous data management systems concepts. The selection process of an inflight data management system must, however, consider total information requirements, rather than select categories such as inflight stowage data. The planning phase of a systems development approach should be initiated during the Phase III study effort after analysis and definition of total system requirements.

SPECIFICATION SC-S-0014

INFLIGHT STOWAGE MANAGEMENT DOCUMENTATION REQUIREMENTS

PURPOSE: TO ESTABLISH REQUIREMENTS FOR INFLIGHT STOWAGE DATA UTILIZED BY THE CREWMEN (LISTS, MAPS, HISTORIES, DETAILED ILLUSTRATIONS, ETC.)

SCOPE:

- SPECIFIES REQUIREMENTS FOR DATA ORGANIZATION AND MAJOR SECTIONS
- SPECIFIES FORMAT AND CONTENT REQUIREMENTS FOR STOWAGE LISTS (LAUNCH LOCATION, TRANSFER LOCKER LOCATION HISTORY, ETC.)
- SPECIFIES FORMAT AND CONTENT REQUIREMENTS FOR LAUNCH CONFIGURATION ILLUSTRATIONS, STOWAGE MAPS, CONFIGURATION FOR TRANSFERS, ETC.

FIGURE 13 - SPECIFICATION SC-S-0014 - INFLIGHT STOWAGE MANAGEMENT DATA REQUIREMENTS

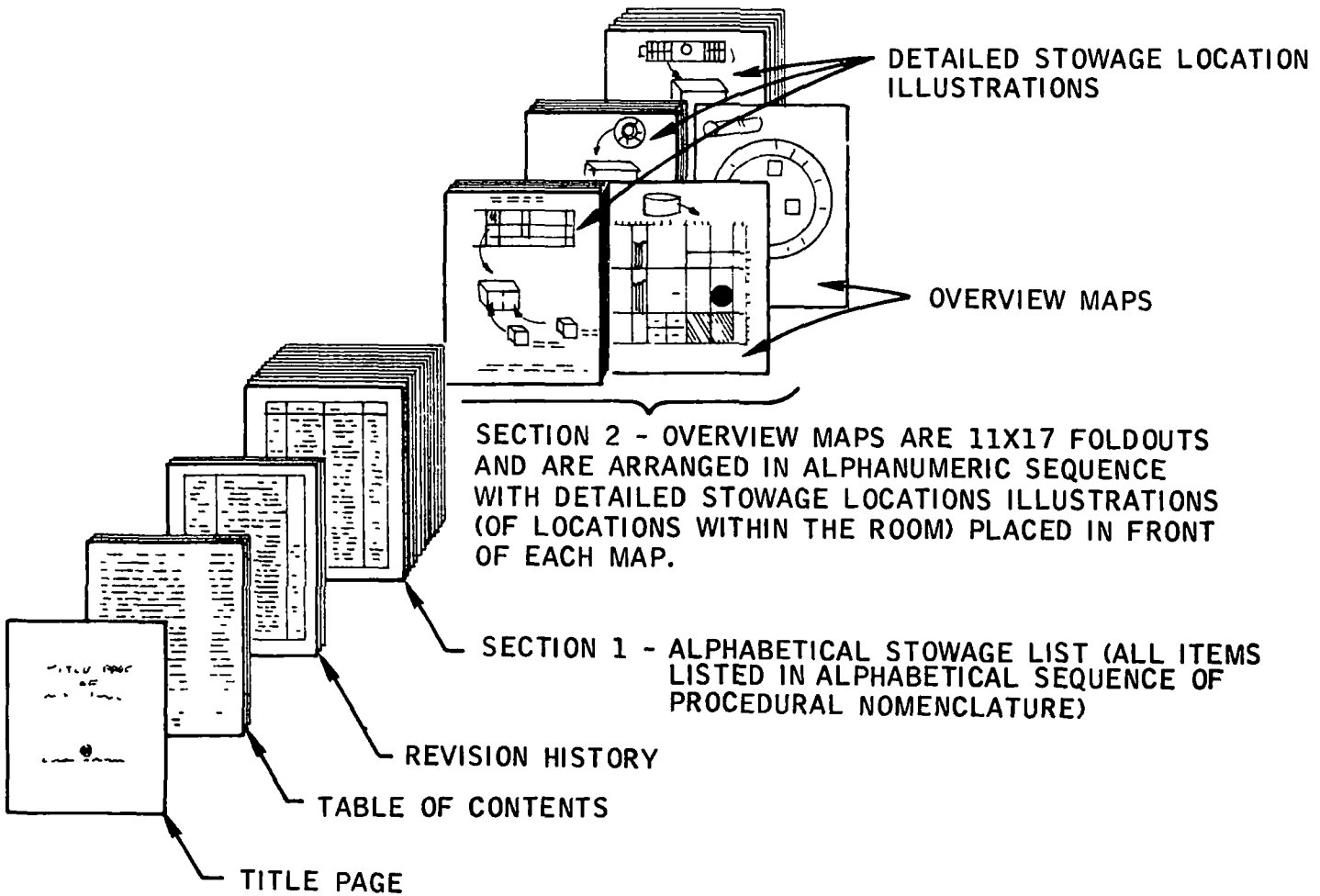


FIGURE 14 - INFLIGHT STOWAGE MANAGEMENT DOCUMENT CONFIGURATION

Initial drafts of the specification were reviewed by the Technical Monitor and subsequently circulated for center-wide MSC review. Comments and recommendations for change were minimal, and were incorporated prior to the final draft of the document.

5.0 INFLIGHT MAINTENANCE PROCESS AND DATA PRODUCTS STUDY

5.1 SUMMARY OF THE PHASE I INFLIGHT MAINTENANCE STUDY

A significant portion of the Phase I Crew Interface Specification Study was devoted to an examination of state-of-the-art maintainability programs, processes and supporting data products being employed in the Department of Defense and Commercial transport aircraft programs. Although these activities are not directly analogous to the requirements for inflight maintenance in future manned spacecraft, it was felt that the practices now being employed should be examined to determine those elements that are appropriate for future manned spacecraft inflight maintenance programs.

5.1.1 Review of Department of Defense Maintainability Programs and Processes

The initial Phase I study activity was to examine the Maintainability Programs of both the Navy and Air Force as representative examples of present state-of-the-art process concepts. Of particular concern were the analytical requirements and the supporting documentation considered necessary to provide sufficient planning and monitoring visibility.

A large-scale descriptive chart of these maintainability processes was developed during the Phase I program and was included within the Phase I Mid-Term Report. The purpose of this chart was to identify the basic elements of the process and the formats and contents of associated documentation requirements. This study exercise provided an excellent data vehicle for surveying the magnitude of this process and the applicability of process elements to subsequent NASA manned spaceflight programs.

In evaluating the appropriateness of these DOD maintainability process elements for NASA program requirements it was observed that a significant segment of these process elements and related documentation defines quantitative analytical techniques and factors used in maintainability engineering. These tools are used during the early design activities to assist in establishing maintainability requirements. These quantitative factors and indices are basic to the systems design process and are the analytical means whereby maintainability requirements are quantitatively specified, measured and demonstrated. These factors and systems measures include Availability Factors (Inherent, Achieved, Operational) and Maintenance Indices (Maintenance Man-Hours, Mean-Time-Between-Maintenance, Maintenance Downtime, Mean-Time-to-Repair, etc.) and are used in conjunction with costs and test data to establish quantitatively specifiable requirements on systems design. In particular, these measures are addressing the problem of accomplishing maintenance tasks for large-scale procurement of weapons systems. The tasks are repeated many times and the need for optimizing their performance has significant implications for total systems costs.

It is not anticipated that the numbers of flight articles, maintenance tasks, or skilled maintenance technicians required by NASA in their future manned spaceflight activities will be comparable to those of the DOD program. However, there will be different parameters and trade-offs of significance for maintenance (e.g., propulsion weight requirements associated with on-board spares, weights, etc.) which will be an integral part of the basic spacecraft

design process and will require use of many of these quantitative factors. It is not the purpose of the Crew Interface Specification Study to develop new design disciplines, new quantitative maintainability predictive measures, since those presently used are applicable, but to force the application of these techniques as a tool in the early identification and location of candidate inflight maintenance items. Consequently, the Phase I and Phase II study activities have not addressed these quantitative factors but have been directed toward program elements wherein inflight maintenance requirements are considered throughout the program.

In reviewing and assessing the applicability of other aspects of these DOD maintainability processes for NASA's spacecraft development programs, it was observed that the DOD processes all require designation within the governmental establishment of a responsible organization for maintenance management and within the prime contractor of a responsible maintainability organization. The purpose of such requirements is obviously to centralize maintainability management responsbility so that integrated systems maintainability decisions are made more efficiently.

Within future NASA manned spaceflight programs, where refurbishable shuttle type vehicles are used in conjunction with payloads that can exist in space for long-duration flights, a duality of operating functions emerges within the maintainability discipline. Namely, there is a requirement for ground maintenance by maintenance technicians and engineers of the basic vehicles and payloads. This activity, of necessity, must be intimately related to and integrated with the methods and procedures used in the checkout, launch, landing and refurbishment functions of the spacecraft. In addition, the inflight maintenance requirements for vehicle preparation and real-time activity by the flight crew must be integrated with the procedures and training methods used in the flight planning and flight crew operating functions.

These relationships between the new maintenance requirements and the already established functions within the manned spaceflight organizations suggests that the NASA should designate for future spacecraft developments the responsibility for the ground and inflight maintenance monitoring activities to organizations and personnel that are intimately familiar with the established operating procedures in the launch/landing and flight crew planning and training areas.

The requirement for establishment of a central overall responsibility for maintainability within the future manned spaceflight programs, in a manner similar to the DOD Maintainability programs, would appear to be desirable but not necessarily mandatory. The important concept is that there is maintained a well established maintainability - design liaison function between the operational groups and the spacecraft design functions. Namely, as spacecraft systems are designed, the detail requirements for both 1-G ground maintenance and Zero-G inflight maintenance must be considered. This design liaison function should be actively pursued throughout the design/development program by the "inflight" and "ground" maintenance organizations. The integration of the activities of these groups should

be accomplished through some management mechanism. Whether it is accomplished by action of Configuration Management Boards only, or whether a specific organization for integrating the "maintainability" concerns on future programs, it will probably be dictated by the size and magnitude of the program maintainability requirements rather than by "technical discipline" considerations.

The previous observations have addressed the implications for the NASA of the "Quantitative" and "Organizational" factors of the DOD Maintainability Processes and Programs that were reviewed during the Phase I and Phase II studies. In addition to these elements, other aspects of the total process were examined for these implications for the NASA Inflight Maintenance program concept. Figure 15 contains an upper-level general summary of the total DOD weapon system development cycle and the basic Maintainability process elements that support this cycle. To this system development cycle flow diagram has been added a gross description of the anlogous elements of an Inflight Maintenance program. These elements include definition of:

A) Basic Inflight Maintenance Concept
B) Inflight Maintainability Analyses and System/Equipment Design and Development
C) IFM Task Analyses
D) IFM Support Requirements Development
E) IFM Procedures Verification

The Basic Inflight Maintenance Concept will lay down the basic philosophy that should guide the systems design effort as it relates to maintenance provisioning for the spacecraft being developed. For example, on the Apollo Program, the program decision was made to provide extremely reliable components and design in sufficient levels of redundancy to accomplish the mission goals of that program without relying on performance by the crew of major inflight maintenance tasks. This has proven to be a proper decision in view of the success of the Apollo missions. In future missions of much longer duration, such design concepts may not be feasible. However, it is important that for each new mission concept and spacecraft development program, a definitive guideline for Inflight Maintenance be defined early in the program so that systems can be designed to meet the operational goals. This concept will, of necessity, be flexible and modifiable thru system design and test programs, but it still should be an "operational" guideline that directs system development in a manner consistent with operational requirements.

As system design progresses, there will be a requirement for an Inflight Maintenance Analytical and Design Liaison effort that continually reminds the program design effort of the requirements for inflight maintenance provisions that are consistent with crew capabilities and related on-board provisions. To support this design liaison effort will require completion by the contractor of a definitive Inflight Maintenance Analysis. This analysis will define the planned Inflight Maintenance tasks to be performed. This analysis is the basis for definition of the Inflight Maintenance Support Requirements Developmental Program wherein support equipment, spares, tools, technical data and crew training requirements are identified and development

SYSTEM DEVELOPMENT CYCLE

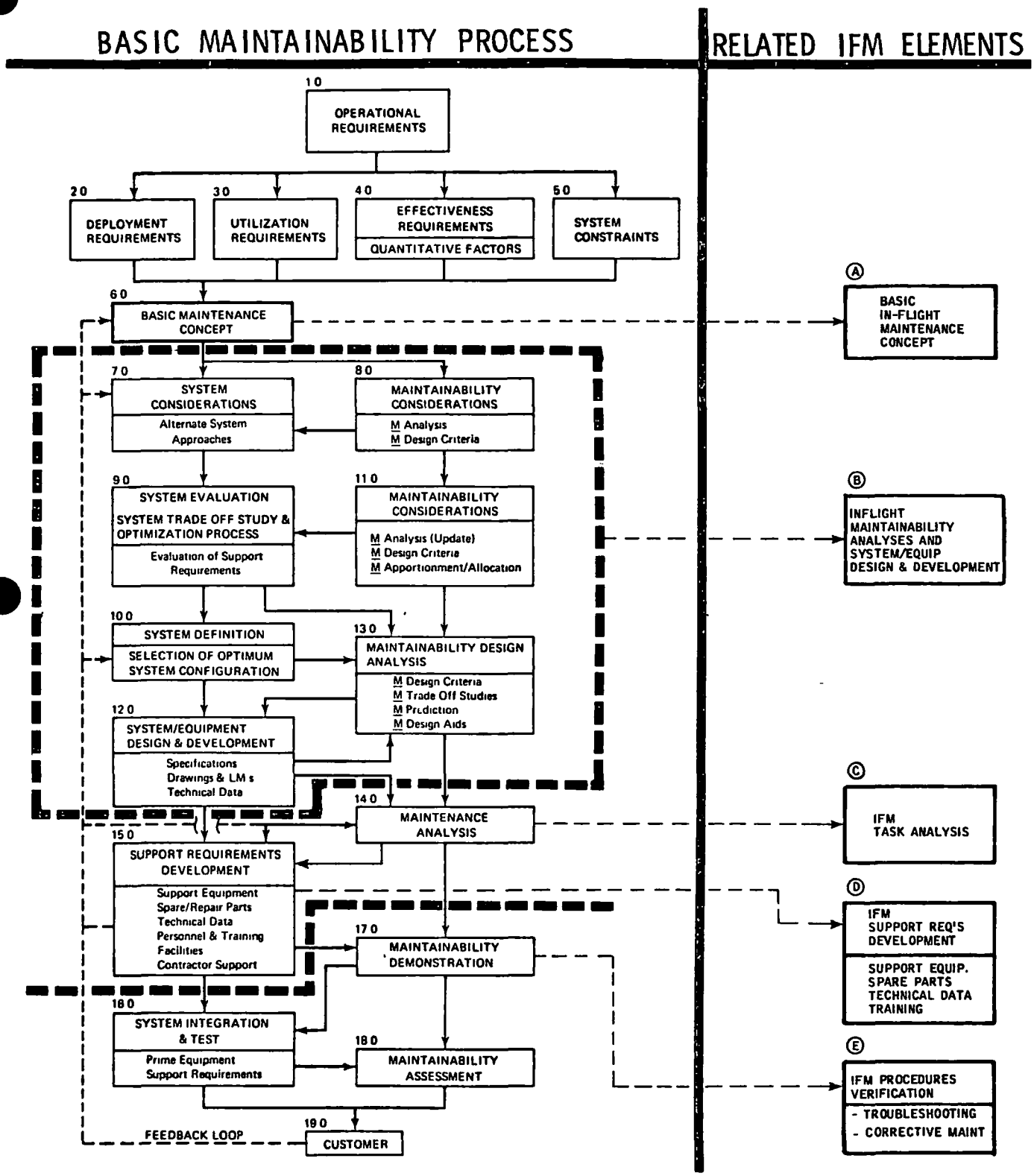


FIGURE 15

monitored up to the provisioning of the flight articles. One other aspect of the Inflight Maintenance program will be the program activity necessary to Verify the Validity and Feasibility of Inflight Maintenance Procedures. Particularly, will this effort address the problems of equipment management and procedures accomplishment in Zero-G environments. These procedures will constitute a major element in the technical on-board flight data necessary to support inflight maintenance.

The above elements of the inflight maintenance processes for future manned spaceflight were examined in detail during the Phase II study effort of this program and will be discussed in further detail in subsequent paragraphs of this report.

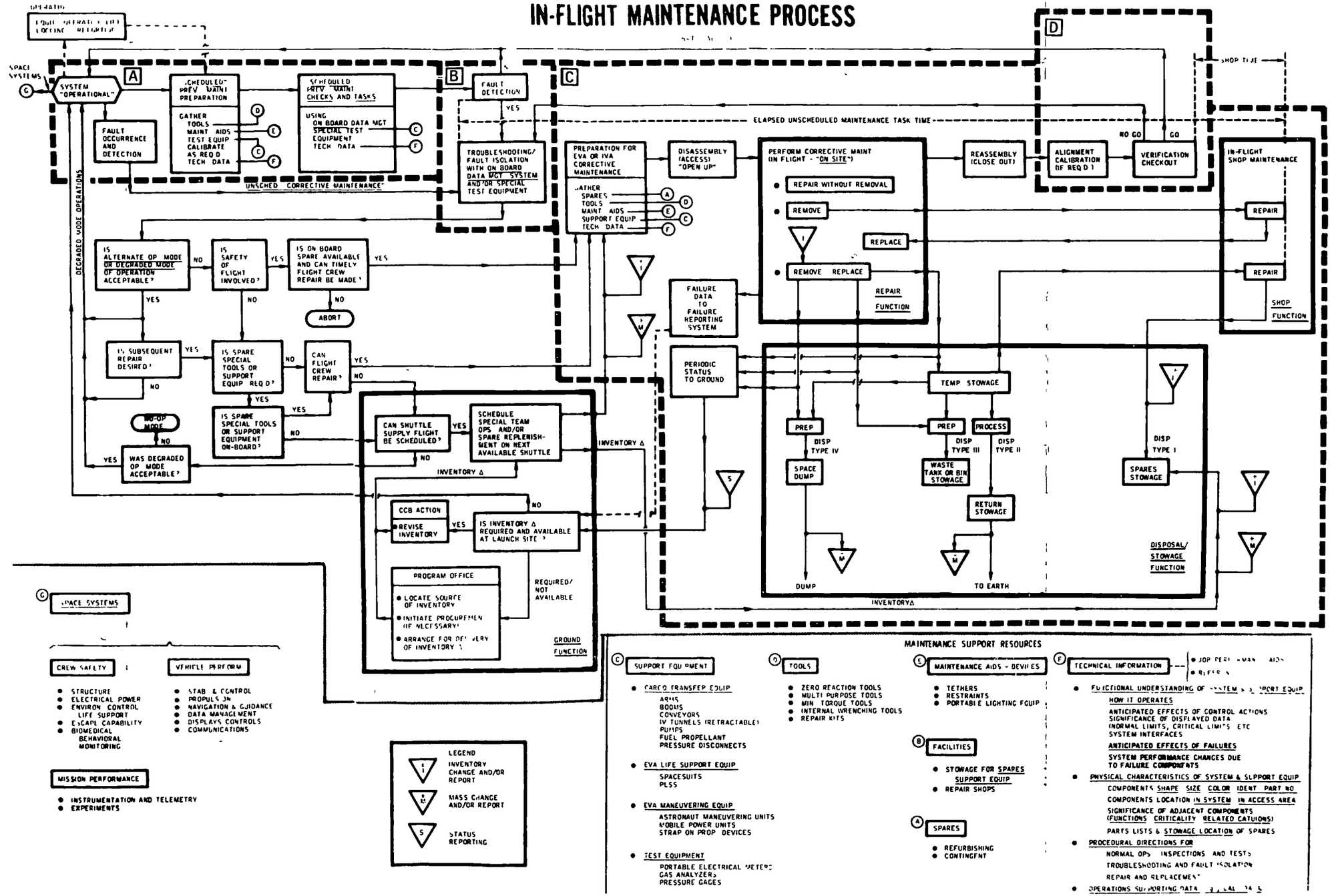
In summary of the DOD Maintainability program and processes reviewed during the Phase I study, it appears that the disciplines being used in defining ground maintenance requirements can be applied to provide adequate consideration of inflight maintenance requirements. However, these DOD processes require a significant amount of analytical and documentation activities, and as such, may be too extensive a program for NASA's inflight maintenance requirements. The Phase II study program on inflight maintenance was thus directed toward defining what elements appear to be appropriate for NASA's future manned spaceflight program needs.

5.1.2 Development of an Inflight Maintenance Process Description

A major portion of the Phase I study effort consisted of developing a method of describing the "inflight operational" processes of the flight crew so that visibility into the supporting resources and crew functions could be obtained. The resulting mass/function flow diagramming technique was then used to describe the near future manned spaceflight mission crew functions, operational elements and resources of the Inflight Maintenance Process. Background data for this process description was obtained from a detailed review of the Skylab, Shuttle and Space Station space vehicle configurations and the related mission plans and concepts, flight plans and other operational documents. Figure 16 contains this Inflight Maintenance Process description that was developed during the Phase I study. This chart identifies the major crew functions required, the logic decisions that must be made, and the related functional paths associated with those decisions. For each of the crew functions, the resources that will be necessary to perform these functions have also been established. This systems engineering analytical approach to defining these inflight maintenance crew activities and associated resources has provided significant insight into the program problems of inflight maintenance associated with the space environment. The designing and planning for "on-board" spares, tools, special test equipment, Zero-G mobility aids, and technical data required for inflight maintenance in space is a more complex process than those associated with aircraft programs where "ground" maintenance is not limited by the inflight operational constraints on weight, facilities, and safety of flight considerations.

FIGURE 16

IN-FLIGHT MAINTENANCE PROCESS



5.1.3 Information Requirements of the Inflight Maintenance Process

The Inflight Maintenance chart also contains a grouping of these crew functions into those basic activities requiring a different type of technical information. These inflight maintenance data types include:

A) Scheduled Maintenance
B) Troubleshooting, Fault Isolation or Systems Diagnostics
C) Corrective Maintenance
D) Calibration and Checkout

Figure 17 contains a description of the further analysis of the characteristics of these information requirements and the supporting systems data that was made during the Phase I study. The purpose of this categorization of supporting technical data was to establish a basis for the subsequent review of the present state-of-the-art in technical data being utilized in the DOD maintenance-support services and within commercial aircraft maintenance operations.

The inflight maintenance informational categories noted above are essentially the "procedural" types of supportive data required for different aspects of the basic inflight maintenance process. In addition to these procedural data requirements, there were other aspects of the crew preparation for inflight maintenance that was considered during the Phase I study. The total training and real-time mission requirements for IFM supportive data were found to include different procedural data types as well as supportive systems data, graphics data and special calibration and test data. In summary, the basic data types that served as a basis for the survey of DOD state-of-the-art technical data included:

1) Systems Configuration and Performance Data

This data is essentially the "Theory of Operations" data that in schematic form presents the system design and the associated data that defines normal operating ranges and the limits associated with caution and warning light operations, automatic regulator operations, etc.

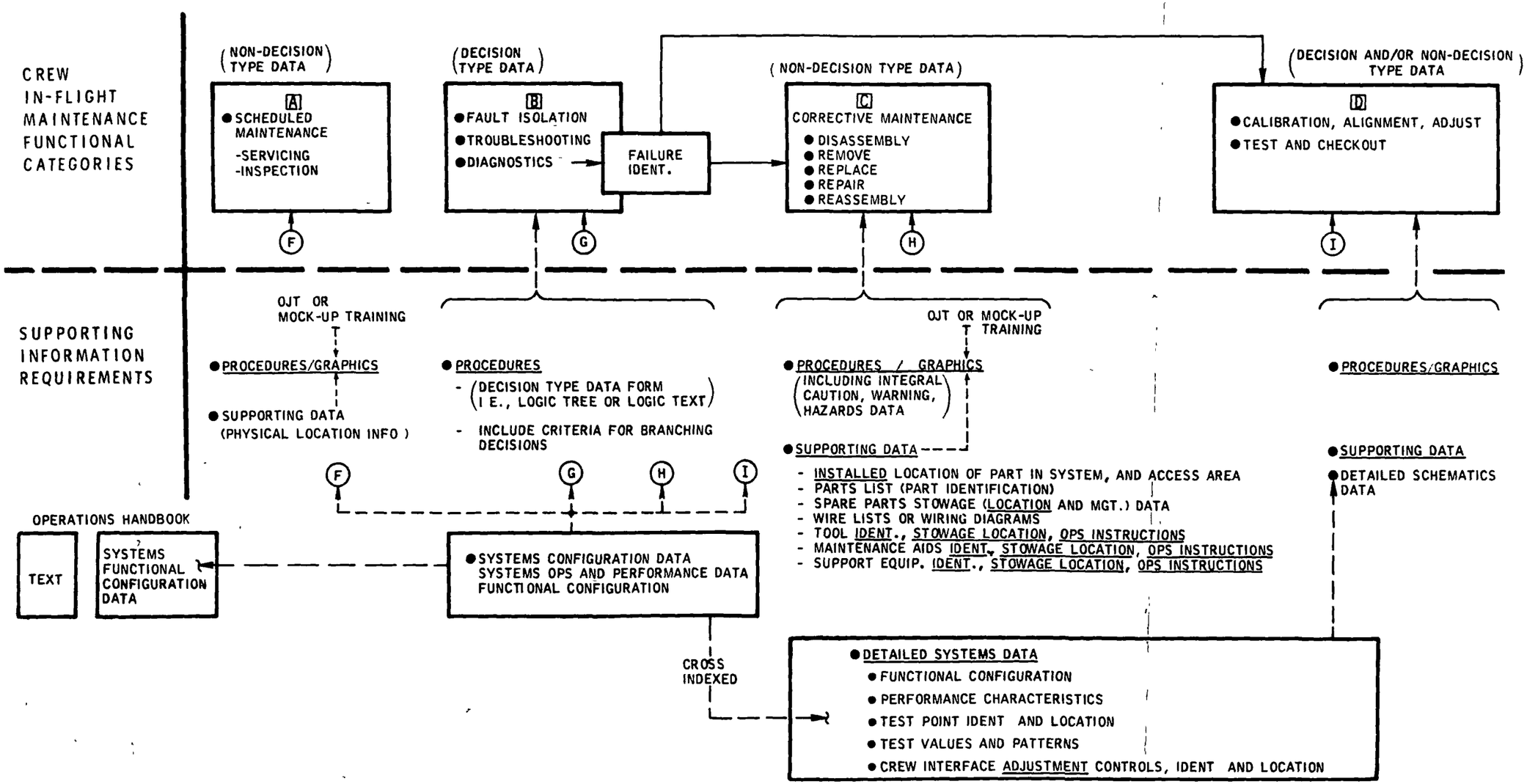
2) Procedural or Checklist Data (Non-Decision Type)

Data of this form defines for crew training and/or operational usage the step-by-step sequences of tasks necessary to perform a scheduled or planned operations or maintenance activity. This type of data is necessary for "Scheduled" and/"Corrective" maintenance.

3) Procedural or Checklist Data (Decision Type)

The inflight "Troubleshooting or Diagnostic" activity of the crew will require supporting data that defines the logical process that must be utilized in collecting symptoms and making logical evaluations of system status to determine system failures and to identify the related Corrective Maintenance required.

FIGURE 17 -INFORMATION REQUIREMENTS OF CREW IN-FLIGHT MAINTENANCE FUNCTIONS



4) Supportive Graphics for Procedural and Checklist Data

The essential information to communicate to crewmen performing inflight maintenance may be pictorial or graphic in nature. Namely, it may be most important to know the specific location of an item of equipment within an access panel or the orientation of movement in three-dimensions of a control or assembly. These types of information in most cases cannot suitably be communicated through textual descriptions nor will graphic data alone be a suitable communication media. It is a major concern of the Crew Interface Specification Development Study to establish what is an appropriate amount of integral graphics to be included as integral supportive data for inflight maintenance procedural and checklist data.

5) Calibration and Checkout Data

A special type of data may be required in the test, checkout and calibration of some types of equipment. The identification and location of test points that are to be used for diagnostics and calibration is an important aspect of the supportive data for inflight maintenance. In addition, the definitions of normal and abnormal waveforms patterns for these test points will constitute a major type of data that must be considered for training and on-board usage.

5.1.4 Review of State-of-the-Art in Maintenance Technical Data

The Phase I review of DOD systems configurations and performance data included examination of ten concepts for electronic maintenance. These included: FORECAST, JOBTRAIN, MDS, MAINTRAIN, BAMAGAT, IMC, SIMS, ATOMS, FIST, and ADMIRE. All of these concepts contained various types of systems data and a common approach of having the systems experts generate troubleshooting strategy and supportive technical information to carry it out. In field tests utilizing a number of these concepts, it was shown that electronics maintenance was markedly improved through use of these techniques. However, use of these techniques would require extensive changes in the conventional manuals and training now being used in the services and, therefore, no extensive implementation of these techniques has been observed. Of these systems only the SIMS systems was investigated in detail. This system, more than any of the others, has been formalized for service usage. Military Specification {MIL-M-24100A(SHIPS)} sets forth the requirements for SIMS type technical manuals, technical orders and other instructions for installation, operation, maintenance and repair of electronic, electrical and mechanical systems. This specification in particular defines a special form of block-schematic data that is used in conjunction with a matching blocked schematic text. This systems data provides schematic and textual material describing the functions of each module and the location of the modules with upper level

sub-assemblies and assemblies. This SIMS system data format appears to be a quite useful data concept that could be selectively applied for some types of manned spaceflight inflight maintenance equipments and functions. Determining the areas where such application is appropriate will constitute a facet of the Phase II and Phase III study efforts.

Additional "systems" data information types reviewed included the present Apollo and Skylab Programs' Systems and Operations Handbook data, functional schematic data and the General Electric Operating Logic data concept. All of the systems data concepts noted above are prepared at the "operational levels" of systems detail. It should be noted that a more detailed level of systems data will be required to support inflight maintenance activities on future manned spaceflight programs than has been provided in the above noted systems documents. The inclusion of more detailed data, such as that noted in the SIMS system, means the volume of the on-board flight data file would increase significantly and as such would present a major flight planning problem. The solution to this problem involves a "selective" provisioning of the systems data necessary to support the "planned for" inflight maintenance items. The provisioning of only "selective" systems data for the crew poses an additional problem of what systems data is essential to support crew maintenance tasks. Of all the data concepts reviewed, only the General Electric developed Operating Logic technique offers a data concept that would provide a method of selectively determining the "essential" systems data required to support the maintenance on an "operating function" of the spacecraft. This type of investigation should constitute a major facet in the Phase III studies of the Crew Interface Specification Development Study.

The investigations of sequential procedural data techniques conducted during the Phase I study included reviews of:

1) Scheduled Servicing and Inspection Data
(Naval Air Training and Operating Procedures Standardization (NATORS) Program Manuals)

2) Air Force PIMO Job Performance Aids

3) Apollo and Skylab Operating Handbook and Flight Data File Checklist Data

4) General Electric Modular Equipment Transporter Operators Familiarization Manual

The format concepts of these operations and maintenance procedures data show some variances,but one concept of significance seems to be the integrated procedural-graphical concept. Studies conducted by the Air Force illustrate the effectiveness of the integration of pictorial graphics with related procedures in standardized job performance aids that greatly reduce maintenance errors and performance times. It would appear that in areas where relative little flight crew training time is available for inflight maintenance training, these job-performance aids, where proceduralized/graphics are used, are essential for corrective maintenance and some of the more complex scheduled maintenance items.

A major segment of any maintenance activity is the "diagnosis" of the systems problems. The improvement of this type of data has been a major concern of DOD and commercial aircraft maintenance personnel. The Phase I study examined a number of "decision" type troubleshooting and fault isolation procedure concepts. These included:

1) F14 aircraft Logic-Text and Logic Tree Troubleshooting data

2) L1011 Transport Fault Isolation Logic Design

3) DC10 Troubleshooting data

4) Apollo Crew malfunction procedures

All of these types of data illustrate the general agreement that the supporting data for troubleshooting activities is a logical process and as such must present a logical path and branching criteria for decision-making within the diagnostic process. The Phase I study evaluation and subsequent Phase II examinations of these data types indicate that with modifications, the Apollo Crew Malfunction procedures can be expanded into an acceptable format for future in-flight maintenance troubleshooting usages. Methods for referencing from these procedures to Corrective Maintenance work packages should be added to this format.

The creative use of graphics to illustrate those in-flight maintenance activities, where flight crewmen are required to remember significant amounts of equipment nomenclature and specific spatially complex configurations of this equipment within stowage locations and access panels, can contribute significantly to reducing training time. More accurate maintenance performance can also be achieved with real-time job performance aids that can "refresh" the memory of the flight crewmen and overcome the lengthy periods between last training review and in-flight task requirement.

In summary, the Phase I study effort consisted of a significant program of data collections and subsequent surveys of state-of-the-art concepts for maintenance planning, preparation and in-flight task performance. The Phase I study was focused on the "in-flight" aspects of the In-flight Maintenance process in order to establish "what" crew functions and related equipments and supporting data elements would be required. Mission, spacecraft, systems and crew requirements were surveyed and a detailed description, in flow diagram form, if a generic in-flight IFM process were developed. Related supporting information requirements were identified and categorized on the basis of implications for maintenance procedures determination and crew training documentation and training activities. These categories of information served as the conceptual framework for the subsequent survey of representative state-of-the-art data concepts of the Department of Defense, Commercial transport aircraft and the NASA Manned Spacecraft Center. From these reviews were developed preliminary data concepts for consideration as a basis for future spaceflight IFM data support specification.

The above detailed review and amplification of the IFM Phase I study effort has been included in this report as a ready reference and because it was addressing the "in-flight" aspects of the IFM and related information requirements and supporting data concepts. The Phase II study interest has been the completion of this process description thru surveys of ground preparation activities in both DOD programs and within the NASA Skylab program.

5.2 PHASE II IN-FLIGHT MAINTENANCE (IFM) STUDY

The Phase I study established generic in-flight crew IFM functions and related supporting equipments and data requirements. The evolution of these equipments and data in a timely manner to support IFM flight activities requires supporting ground-preparations activities that must begin with design and continue throughout the spacecraft development program. These "ground preparations" functions of the IFM process must be integrated with spacecraft design, configuration management, spacecraft stowage and provisioning and other logistics functions if an effective IFM program for future spaceflight is to be obtained.

Within recent years in both DOD and Commercial airline and aircraft programs one observes the emphasis that is being placed on "planning" for operations and maintenance. This emphasis has come mainly thru the need to reduce total systems costs. It is particularly noteworthy to observe that the recent marketing efforts on the series of wide-bodied jet transports (DC-10 and L1011) have made "maintenance" of these vehicles the major marketing thrust. Emphasis, for the first time in commercial aircraft history, is placed on the availability of new types of troubleshooting and fault isolation supporting data. It is recognized that these programs are dealing with maintenance of fleets of vehicles and many iterations of similar faults that must be isolated by large numbers of maintenance personnel requiring large amounts of training for such activities. A major portion of the "planning" for maintenance in these programs relates to facilities and supplies that are on the ground when relatively unlimited space is available for maintenance tasks and spares and test equipment stowage.

This will generally not be the case in future spaceflights. Namely, if in-flight maintenance is going to be accomplished, it must be a completely "planned" act. If a part is to be replaced, the spare must be on-board. There must have been stowage space provided for this spare planned in the early design of the vehicle. Provisions for disposing of the replacement part must also be considered in design of the vehicle. Tools and their stowage must also have been planned as part of the design of the vehicle. Access by crewman to the part, if within the vehicle, must be considered in spacecraft vehicle design and if it is outside the vehicle then provisions for EVA to accomplish the task must be provided. Zero-g will also make planning for every aspect of the maintenance act an essential part of spacecraft design. All of these IFM acts must also be accomplished while the vehicle is "operational in space". This superimposes "safety-of-flight" considerations upon each IFM task.

The previous discussion emphasizes the fact that all IFM activities must be "planned" and designed for". Unscheduled maintenance tasks will require design considerations in spacecraft development to a similar degree as other IFM tasks and other crew operational activities. In past aircraft design projects, the facilities and ground support equipment could be designed to "adjust" or "make-up" for some design configuration "oversights" that resulted from a "lack" or poor consideration of the crew interface requirements for maintenance. Such degrees of freedom will not exist in the designing of long-duration space vehicles. The need to design and provision the spacecraft for each IFM tasks forces a new ordering of the design process. The Phase II Study has been directed toward examining the ground-preparation elements of the system development cycle and establishing and describing a process that will allow the NASA to evoke IFM considerations in a timely manner in future spacecraft development programs.

5.2.1 Survey of DOD Ground Preparation Processes for Maintenance

To establish a basis for the definition and recommendation of appropriate ground preparation elements for a NASA In-Flight Maintenance Process Specification, a further detailed survey of the DOD Maintainability Programs and of the NASA Manned Spacecraft Center Apollo and Skylab programs ground-preparations and configuration management procedures and process was made during the present study. In Figure 15 the gross description of the basic DOD maintainability process in the System Development Cycle was presented and was discussed with reference to the "quantitative" and "organizational" aspect of the process. The Phase II Study examined more in detail the process elements and their related IFM elements.

The Basic Maintenance Concept of the DOD program is established thru operations, deployment, utilization and effective requirements definitions and systems constraints. Requirements are defined in an iterative and evolutionary manner from gross mission parameters down to detailed systems requirements and constraints. In Figure 15 this is represented by the feedback loop that modifies the Basic Maintenance Concepts and Systems design, etc. During the Apollo Program development, the decision was made to attack the systems reliability problem thru an emphasis on high quality and well tested parts and systems redundancies. Thus, a requirement for In-Flight Maintenance did not exist. Design activities were guided by this requirement which has proven to be sound in operations. For future missions of much longer duration the decision must be made by the time of the Preliminary Design Reviews. The IFM trade-offs in future missions will assume greater complexities due to the inability to design systems for infinite duration. Namely, a much greater segment of future long-duration mission vehicles will require in-flight maintenance. As a result, trade-offs on systems designs will require more detailed analyses and predictions of the crew interface requirements that will in turn scope and affect systems design provisions.

In examining and estimating the volume of supporing data that is required by the DOD Maintainability Program it became evident that significant engineering and documentation preparation time will be required to provide all elements of this process. It has been a concern of the Phase II Study effort

to examine other processes and to assess the appropriateness of these documentation requirements. Namely, to establish the validity of IFM concepts will require examination in detail of the rationale for their inclusion as IFM tasks. This means the results of design trade-offs must be documented with sufficient detail so that mature program and configuration control decisions can be made early in the program. For example, as the tools for IFM are defined and developed, it is important to know all the tasks that have established the need for the tool. Otherwise tools may be deleted from the requirements when a task is deleted.

The above example is cited to illustrate the basic nature of the ground preparation documentation that is associated with IFM. Namely, this program documentation is to establish a means for the NASA to examine the rationale of the engineering and design decisions affecting IFM as well as to survey the scope and magnitude of logistics activities in provisioning for IFM test, training and flight.

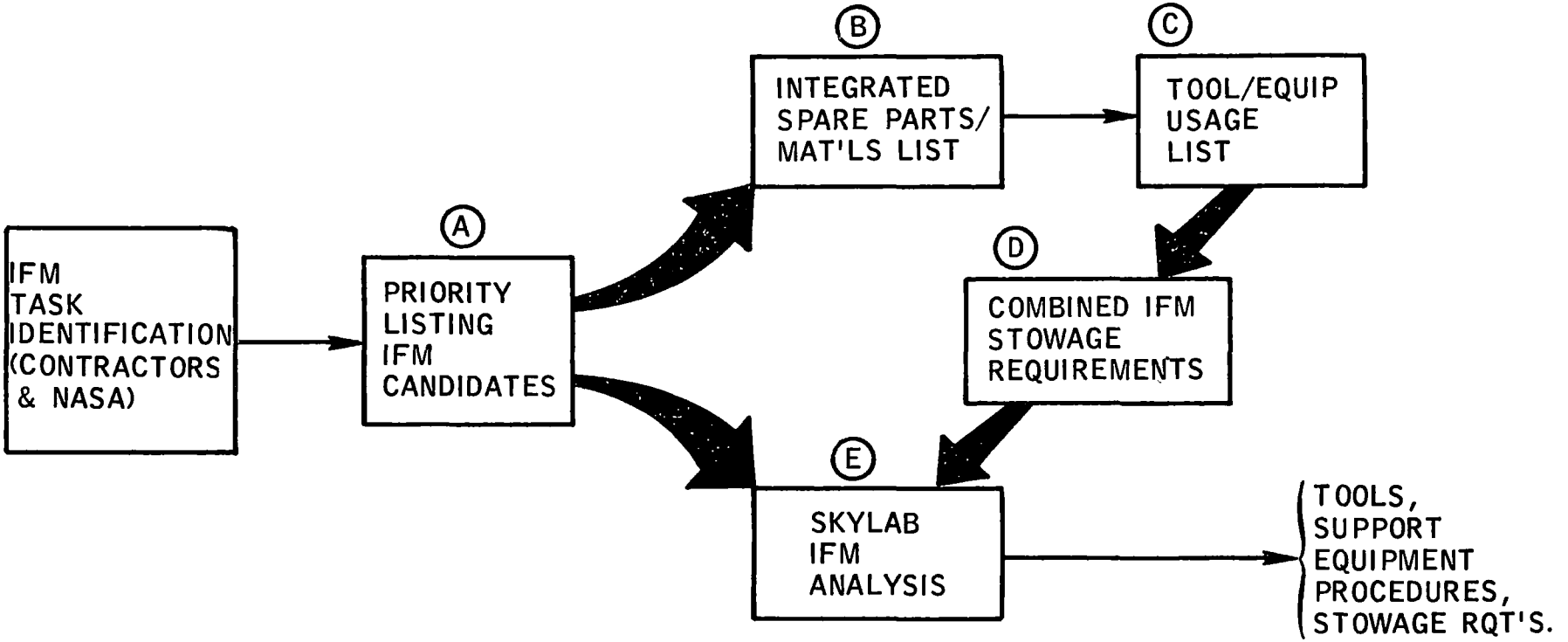
To establish the engineering rationale requires that early in the design process, as systems configurations are being established, the contractors must define the IFM tasks which are being considered in the design of all systems. This means that by the time of the Critical Design Reviews for a program the evidence must be provided the NASA which identifies those candidate IFM tasks for which design provisions are being considered along with the related support equipments (spares, tools and mobility aids, etc.).

With the above identified task and support equipments defined then the development and verification of procedures will proceed which supports the training and technical data development program.

5.2.2 Survey of NASA-MSC Skylab IFM Ground Preparation Processes

Prior to the development of a recommended NASA total IFM process, the present processes being utilized by the NASA for the Skylab program were examined in detail. Figure 18 is a summary chart of the basic documentation elements of IFM analyses and ground preparation activities used in the Skylab program. In addition representative detailed formats on each of the supporting documentation types have been included in Figures 19 thru 24.

A review and critique of this process and related data formats establish some background information about development of this data that should be noted. The prime contractors for the various modules of the Skylab clusters provided the information of the type presented in Figure 23 (Skylab In-Flight Maintenance Analysis), whereas the remainder of the IFM documentation elements was developed by the Integration Support Contractor for the Skylab program. This included Figure 24 (IFM Maintenance Integration Task Review) which in effect was a review and assessment by the support contractor of the data identified in Figure 23. Though similar to documentation utilized in the DOD Maintainability programs it provides more of a logistic summary of the task data rather than data which will provide visibility into the rationale of the engineering selection of these tasks and of the supporting requirements of these tasks. It appears that an optimization study of these



SKYLAB INFLIGHT MAINTENANCE TASK SELECTION PROCESS

FIGURE 18

FIGURE 19

Ⓐ PRIORITY LISTING SKYLAB INFLIGHT MAINTENANCE CANDIDATES

TASK REF. NO. (TRN)	OWS	MDA	AM	OTHER	SCHED/UNSCHED	PRIORITY GP	CANDIDATE TASK	CRITICALITY	PROBABILITY	REDUNDANT	ALT MODE	COMPLEXITY	MISSION EFFECT	CREW EFFECT
12	X				U	50	Switch Assy., Control Panel 1B78542-1 Replacement	H	M	N	Y	H	Y	N
13	X				U	20	Valve Assy., Drinking Water Dispenser 1B78612-1 Replacement	H	L	N	Y	L	Y	Y
14	X				U	50	Switch Assy., Control Panel 1B78542-501 Replacement	H	L	N	Y	H	Y	N
15	X				U	50	Switch Assy., Control Panel 1B78542-503 Replacement	H	L	N	Y	H	Y	N
16	X				U	50	Switch Assy., Control Panel 1B78542-505 Replacement	H	L	N	Y	H	Y	N
17	X				U	50	Switch Assy., Control Panel 1B78542-507 Replacement	H	L	N	Y	H	Y	N
18	X				U	50	Circuit Breaker Assy. 1B78543-505 Replacement	H	L	N	Y	H	Y	N
19	X				U	50	Switch Assy., Control Panel 1B78542-509 Replacement	H	L	N	Y	H	Y	N
20	X				U	50	Switch Assy., Control Panel 1B78542-511 Replacement	H	L	N	Y	H	Y	N
21	X				S	20	Chamber Assy., Air Mixing 1B78136-1 Cleaning	M	H	N	N	L	N	Y
22	X	X	X		U	20	Fan, Ventilating, PLV 20M42270-3 Replacement	M	H	N	Y	L	Y	Y

FIGURE 20

SKYLAB IFM INTEGRATED SPARE PARTS/MATERIALS LIST

NOMENCLATURE / PART NO.			Switch Assembly Control 1B78542-507 TRN 17	Circuit Breaker Assembly 1B78543-505 TRN 18	Switch Assembly Control 1B78542-509 TRN 19	Switch Assembly Control 1B78542-511 TRN 20	Fan, Ventilating, PLV 20M42270-3 TRN 22	Valve Assembly, Water Dispenser 1B78850-1 TRN 23	PPO_2 Sensor Cartridge Spare P/N 61B880055-23 61B880055-5 TRN 24	Fan, Mol Sieve 61A830017-11 TRN 25	Solids Trap Assembly 61A830190-11 TRN 26	Power Module, Collection 1B83241-1 TRN 27,40	Clock Precision 1953532-1 TRN 28	Probe Assembly Heated 1B77645-1 TRN 30	Control Unit, Window Heating FD6900004-010 TRN 31	Filter, Odor Control 155C402100-3 TRN 32	Filter, Cartridge Oxygen/Nitrogen 61C830084-3 TRN 33	Light Bulbs (20 Watt) GE 308 IF TRN 34	Floodlight, Gen. Illumination 1569364-1 TRN 35
INSTALLED QTY / RECOMM. SPARES	CONTRACTOR INPUTS	OWS	5	4	4	4	16 / 5	2 / 1				2 / 1		3 / 1		1 / 5			44 / 12
		MDA					3 / 1								1 / 1				8 / 2
		AM					8 / 3		3 / 6	4 / 1	2 / 28						2	X / 24	
		OTHER											1 / 1						
TOTAL INSTALLED			5	4	4	4	27	2	3	4	2	2	1	3	1	1	2	X	52
INTEGRATORS COMPOSITE ANALYSIS																			
	COMPOSITE FLIGHT SPARES		DELETED	DELETED	DELETED	DELETED	8	1	6	1	28	1	1	1	0	5	DELETED	24	6
	COMPOSITE BACKUP SPARES						1	0	0	0	0	0	0	1	1	0		0	6

FIGURE 21

TOOL/EQUIPMENT USAGE LIST

I. Tool Kit Inventory

DESCRIPTION	TRN USAGE	USAGE LOCATION	STOWAGE	QUANTITY
6. (Continued)				
c. 12 Inch, P/N 3242	T027, S183	SWS	Tool Kit	1
7. Sockets, Standard				
a. 1/4-in., Double Square, P/N 3212	100	AM MDA OWS	Tool Kit	1
b. 1/4-in., Double Hexagon, P/N 3301	T020, T027	OWS	Tool Kit	1
c. 5/16-in., Double Hexagon, P/N 3302	T020, T027, S183	OWS	Tool Kit	1
d. 3/8-in., Double Hexagon, P/N 3213	WMC Vent Fan Cage, 31, 65a, 65c, 138, 142, T013	MDA OWS	Tool Kit	1
e. 7/16-in., Double Hexagon, P/N 3214	51, 142, M509, Thigh Restraints, SAL	MDA OWS	Tool Kit	1
8. Sockets, Deep				
a. 3/8-in., Double Hexagon, P/N 3165	General Application	AM MDA OWS	Tool Kit	1
b. 7/16-in., Double Hexagon, P/N 3177-1	49	OWS	Tool Kit	1
c. 1/2-in., Double Hexagon, P/N 3210	S056	MDA	Tool Kit	1

FIGURE 22

COMBINED IFM STOWAGE REQUIREMENTS

NOMENCLATURE / PART NUMBER		Power Module, Collection 1B83241-1 TRN 27,40	Clock, Precision 195332-1 TRN 28	Probe, Assembly, Heated 1B77645-1 TRN 30	Control Unit, Window Heating FD6900004-010 TRN 31	Filter, Odor Control 155CA02100-3 TRN 32	Filter, Cartridge Oxygen & Nitrogen 61C830084-3 TRN 33	Light Bulbs (20 Watt) GE 308 IF TRN 34	Floodlight, General Illumination 1B69364-1 TRN 35	Activated Charcoal Canister 61B830010-87 TRN 36	Battery, Portable (Timing) 61B880051-5 TRN 37	Cartridge, Filter and Charcoal 1B80661-1 TRN-41	O-Ring 1B75334-505 TRN 42	Seal, Inbd Hatch AA5652-A TRN 43
UNIT	WEIGHT (pounds)	5.25	0 50	2 200	10 1	5 00		TBD	2 00	13.20	10	30 00	031	1 75
	DIMENSION (inches)	6.00 Dia 12.00	2.00 Dia 3.0	2.00 3 0 30 0	10 5 7.5 6 0	8.00 Dia 7.25		TBD	16 00 1 50 1 75	10 00 Dia 18.00	0.50 Dia 0.25	16 37 Dia 11 36	4 25 Dia 0 125	18 692 Dia 0 374
	VOLUME (cu in.)	339.12	12 00	180.00	472 50	464.00		TBD	42 00	1800 00	.06	3044 25	1 76	35 35
RECOMM STOWAGE AREA		OWS	MDA	OWS	OWS	OWS		AM	OWS	OWS	AM	OWS	OWS	OWS
INTEGRATORS COMPOSITE ANALYSIS	SL-1 UNITS CONSIDERED	1	1	1		5		24	6	8	4	5	4	3
	SL-1 COMBINED WEIGHT (pounds)	5 25	0.50	2 20		25		TBD	12 00	105 60	40	150 00	12	5 25
	SL-1 COMBINED VOLUME (cu in)	339.12	12.00	180 00		2320 00	DELETED	TBD	252 00	14400 00	24	15221 25	7 04	106 05
	SL-3/SL-4* WEIGHT (pounds)			(Qty. 1) 2.20	(Qty 1) 10.1				(Qty 6) 12.00	(Qty 2) 26 40				-
	SL-3/SL-4* DIMENSION VOLUME (cu in.)			180 00	472.50				252 00	3600 00				

*Items identified for SL-3/SL-4 are considered "Backup" spares and would be required for inclusion on the CSM stowage list only as a contingency of Cluster requirements

FIGURE 23

SKYLAB INFLIGHT MAINTENANCE ANALYSIS

MDAC-WD TRN 12

A. CANDIDATE DESCRIPTION

ITEM NOMENCLATURE: SWITCH ASSEMBLY, CONTROL PANEL
PART NO.: 1B78542-1
SYSTEM: ELECTRICAL
WORK AREA(S): CONTROL CONSOLE
QTY. INSTALLED: 24

DELETED

C. FMEA
FMEA REFERENCE NO
CRITICALITY CATEGORY
CRITICALITY NUMBER

D. MODULE PREFERENCE NO.

E. STOWAGE LIST NUMBER

B. RECOMMENDED NO. OF SPARES: 1 (1 Backup)

BASIC MAINTENANCE DATA				SUPPORT REQUIREMENTS						
F. REPLACEABLE	G. ACCESSIBLE	H. DETECTION AND ISOLATION CAPABILITY	I. MAINTENANCE ENVIRONMENT AND HAZARDOUS CONDITIONS	J. MAIN. TIME	K. PERSONNEL NO.	K. PERSONNEL SKILLS AND TRAINING	L. STOWAGE REQUIREMENTS (WTS, DIMEN., ENVIR.)	M. VERIFICATION	N. TOOLS AND PROCEDURES	O. REMARKS
Y	Y	Observation of power loss on applicable circuit	IVA - Shirtsleeve Possible exposure for area containing current carrying busses	.3	1	No Special Skills Familiarization Training Req'd.	3.575 x 1.40 x 1.0 inch Weight .150 lbs	Operational check of replaced switch	3/16" Slot Screwdriver 15/32" Deep Well Socket Insertion/Removal and Contact Tool Unserviceable Tag Personnel Restraints Equipment Restraints	Selection Insurance for components which are single failure points Disposition - Trash Lock

FIGURE 24

TRN 12

INFLIGHT MAINTENANCE INTEGRATION REVIEW

TASK: Replacement (Unscheduled)

PART NO.: 1B78542-1

NOMENCLATURE: Switch Assembly Control

MODULE CONTRACTOR(S): OWS

BRIEF:

This item initially submitted for evaluation as an IFM task.

Subsequent analysis by MDAC-WD produced the following recommendation: "These items are considered maintainable from the standpoint that it is possible to fault isolate and replace them in-flight. However, the onboard and backup spares have been deleted as candidate spares because a tradeoff evaluation of the potential hazardous safety conditions created by the performance of in-flight maintenance of electrical panels".

SUMMATION:

It is out recommendation that this item be DELETED as an IFM task until all safety considerations have been resolved.

data formats should be conducted before final agreement is reached in these supporting data concepts. This optimization study has been included in the proposed Phase III Study Plan as a task required prior to formalizing any of these data concepts into specification form.

Another point observed in review of the Skylab IFM data formats is the large amounts of data on each format which only identify the task, related part number affected, etc. This heading type data constitutes a major portion of each of the data formats. This factor also should be studied for optimization prior to any formalizing of such data formats into specification form. It has also been included within the proposed Phase III Study Plan.

Figure 19 of these Skylab formats was developed as a priority listing of the In-Flight Candidate Tasks. The criteria used for assessing priorities are mainly qualitative in nature and may be of questionable value for future programs where more definitive criteria may need to be established. Namely, for long-duration planetary type missions a much more rigid analytical discipline should be developed to assist in determining the IFM tasks for which planning will be done.

During the Phase II, investigation was also initiated to study some alternate data formats that may provide more appropriate visibilities into the crew interface aspects of these tasks. Figure 25 contains a preliminary concept for one type of data that may provide a better appreciation in the program of the crew operational requirements and related support equipment needs. This data format provides a gross check on the feasibility of demands in the flight crew of the tasks and identifies in summary form the access areas, tools and mobility aids required and the "basic" maintenance position of the crew from which he will perform these tasks. Such data formats should be examined further during the Phase III Study before finalizing the related specifications.

Figures 20, 21 and 22 of these Skylab data formats constitute the logistics types of data to identify and monitor provisioning of tools, spares, materials, etc., and relate these equipments to stowage locations and volume. The forms contain contractor data and integration support contractor assessment data in stowage for the three basic Skylab Program missions. Whether such integration of future missions into basic blocks of missions, such as the Skylab, is unknown at this time but specified documentation requirements must be designed flexible enough to handle either one mission or multiple missions if required.

Another facet of the IFM logistics data requirements observed is that many early decisions on tool requirements were made with sufficient data about "all" planned usages of these tools. In future mission planning the tool data should consider all task involvements of these tools so that decisions to include or eliminate tools can be made from "total tool usage" requirements. Such requirements establish needs for additional integration studies of these tool data formats prior to final specification of such data. These will also constitute subject tasks for Phase III.

FIGURE 25: MAINTENANCE TASK ANALYSIS DATA

(1) SYSTEM: XYZ

(2) REQUIREMENT: REMOVE, REPLACE COMPUTER ASSEMBLY (3) CREW PROC. REF: TBD

(4) PART #/ASSY D62381/COMPUTER ASSEMBLY (5) MTBF 1156 (6) OP. LIFE 4000 (7) FMEA REF. 4.2.27

(8) S/C LOCATION: AM-062B

(9) SPARES REQUIRED 3 (10) UNIT WT. 10.62 LBS. (11) UNIT DIMEN. 8" X 10" X 4"

(12) STOWAGE LIST ITEM # 650.04.02 (13) SPARES STOW. LOC: AM-022H

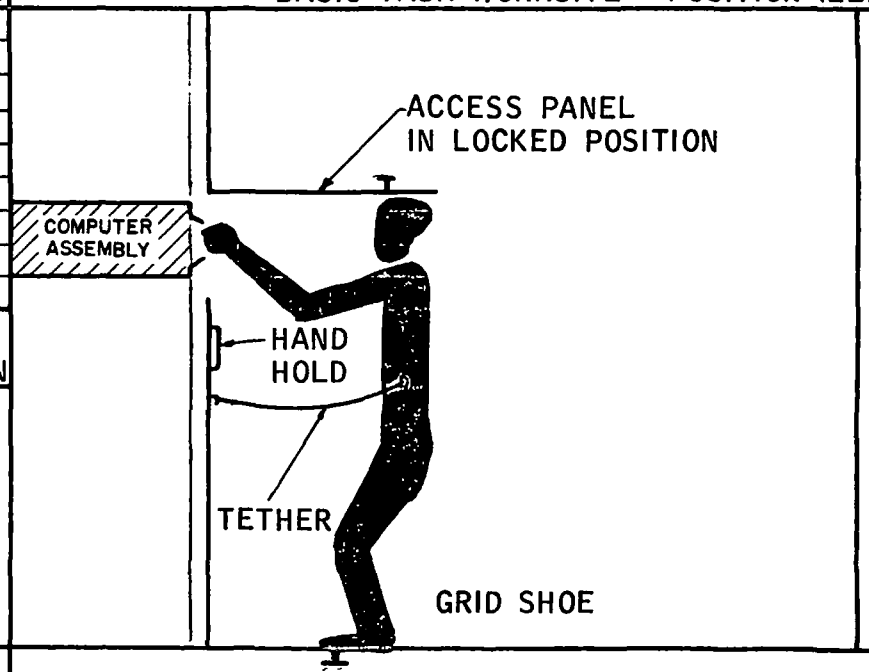
(14) TOOLS REQUIRED

NAME	STOW. LOCATION
• SCREWDRIVER	AM-016B
• WRENCH, RATCH.	AM-016B

(15) MOBILITY/RESTRAINT AIDS

ITEM	STOW. LOCATION
HANDHOLD	INST.-AM 0638
TETHER, WAIST	AH-026B
SHOE, GRID	AH-016C

BASIC TASK WORKSITE - POSITION (ELEV.)



SPECIAL TASK SKILL REQMTS:

NONE

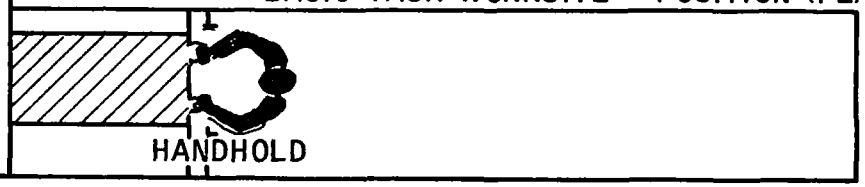
SPECIAL TEST EQUIPMENT:

NONE

(16) REMARKS

TETHER REQUIREMENT IS ASSOCIATED WITH DETAILED CHECKS OF MODULE MADE AT SITE.

BASIC TASK WORKSITE - POSITION (PLAN)



In summary, the Skylab IFM documentation review appears to be addressing the basic needs of an IFM program, but it appears an optimization of the data requirements could reduce the volume of such data without losing program visibility into the related IFM ground preparation activities.

5.2.3 Development of a Preliminary IFM Process Description

After review of DOD and NASA programs on maintainability and In-Flight Maintenance a reference baseline was established of the basic technical and configuration management procedures that should be considered in future NASA IFM Processes. This basic background data, a Preliminary In-Flight Maintenance Development Process, was developed to establish the procedures required and their relationships to basic NASA Configuration Management policies. This process is presented in Figure 26. In Phase III this process will be further reviewed and examined.

5.2.4 IFM Data Concepts Development

The reviews of data concepts during the Phase I program identified many different varieties and types that might be adapted for use for IFM support on future manned spaceflights. However, one factor of prime importance should be stressed. If the NASA wishes to reduce data costs of the IFM support documentation, some measure of standardization is essential. With each new program a major "creative" engineering effort is required by contractors to establish what is considered by the NASA as "acceptable" documentation of such analyses and design efforts. By having well defined specifications of the format and contents that satisfy the NASA requirements, many wasted engineering hours could be saved for more productive work. It is with this prime purpose in mind that the present IFM Study has been conducted. The completion of the Phase III Study will provide such definitive specifications.

5.2.4.1 On-Board IFM Data Concept Requirements

During the Phase I Study, extensive examination was made of present state-of-the-art concepts to support maintenance activities that could be considered analogous to in-flight maintenance requirements. The major types of on-board in-flight maintenance data requirements identified included:

1) Scheduled Maintenance. Sequential flight data file checklist data such as is used in the Apollo and Skylab Programs appears adequate with the addition of graphics to illustrate certain complex access and equipment procedures.

2) Troubleshooting Data. The format and contents of the present Crew Malfunction Data utilized in the Apollo and Skylab Program appears to be one of the more advanced supporting data concepts of this type now in use. However, for future IFM usage, adaptations must be included whereby: (1) an acceptable method for cross-referencing to the appropriate corrective maintenance procedures is available, and (2) provisions for troubleshooting to the In-Flight Replaceable Unit (IRU) exists.

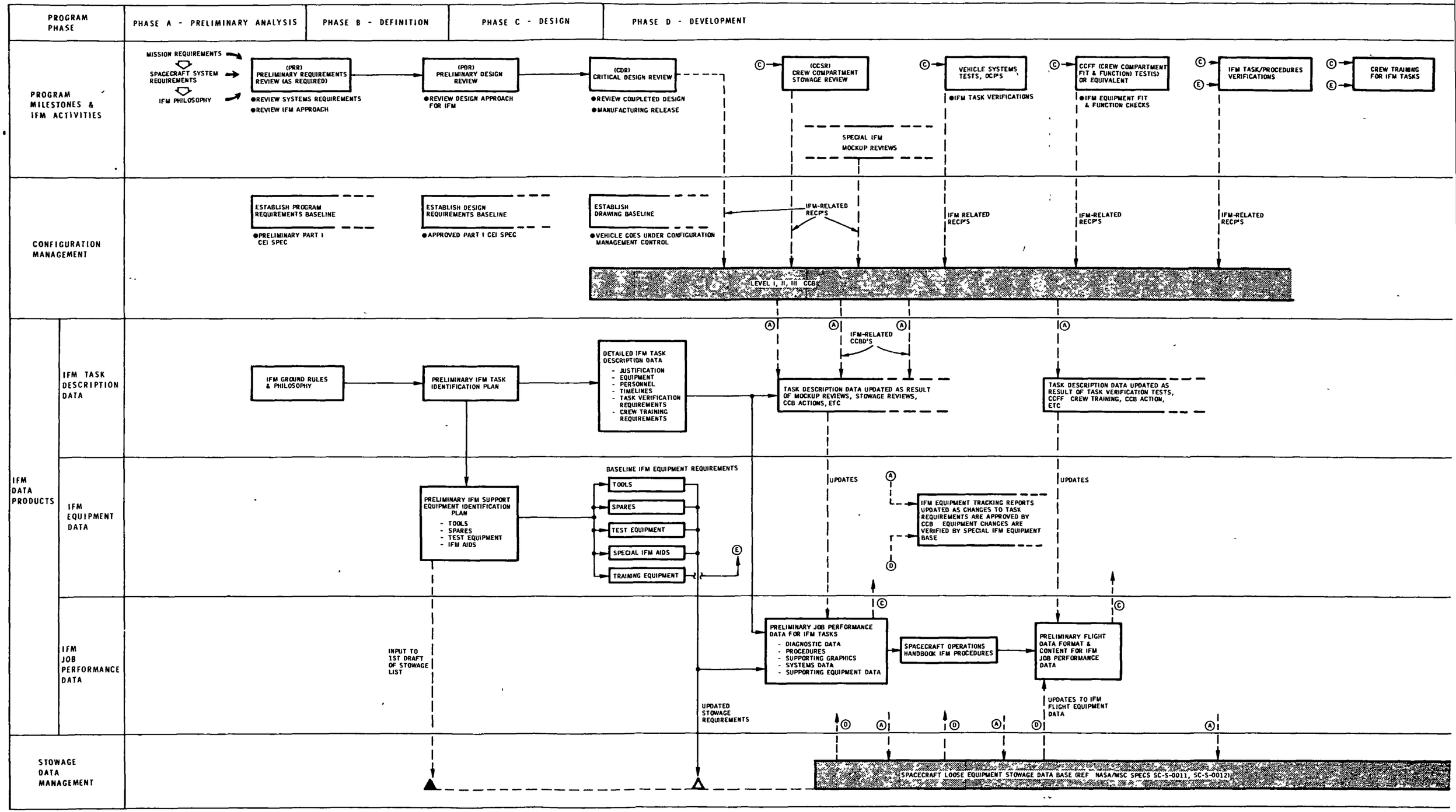


FIGURE 26 PRELIMINARY INFLIGHT MAINTENANCE DEVELOPMENT PROCESS FOR NASA MANNED SPACECRAFT PROGRAMS

3) Corrective Maintenance Data. The basic format for this data contains step-by-step checklist data plus integrated graphics and pictorial data as has been included in the Air Force PIMO proceduralized data format and/or in the General Electric MET Operators' Familiarization Handbook. A major factor determining the amount of graphics necessary to support the IFM corrective maintenance data will be the availability of high fidelity mock-ups and simulators as well as the amount of time that is available for training of the responsible crewman.

4) Calibration and Checkout Data. Data of this type will be governed largely by the nature and capabilities of the controls/displays and test equipment that is provided on-board. However, one type of information that will be required is the anticipated normal and abnormal wave forms and patterns observed at each test point within the affected spacecraft and/or scientific experiments systems. These data may be used to support adjustment of equipments for regular operation or for data collection as a part of the troubleshooting and corrective maintenance procedures.

Development of specifications for acceptable standard formats and content requirements for the above data types will constitute a major portion of the proposed Phase III Study.

5.2.4.2 IFM Ground-Preparation Data Concept Requirements

As previously discussed in Section 5.2.2, there is a need for standardization and optimization of data requirements associated with the planning and provisioning for IFM. The proposed Phase III Study will address the further conceptualization and final specification of these supporting data concepts which will include:

1) Engineering Data identifying the IFM candidate task requirements and the associated tools, spares, mobility aids and supporting test equipment necessary for each task.

2) Logistics Data that allows tracking of the IFM related stowage and provisioning efforts as they support test, training and in-flight activities of future manned spaceflight programs.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The Phase II Crew Interface Specification development study has provided the NASA with the following five major crew interface specifications:

SC-C-0009	General Specification, Operations Location Coding System for Crew Interfaces
SC-S-0011	General Specification, Loose Equipment and Stowage Management Requirements
SC-S-0012	General Specification, Loose Equipment and Stowage Data Base Information Requirements
SC-S-0013	General Specification, Spacecraft Loose Equipment Stowage Drawing Requirements
SC-S-0014	General Specification, In-Flight Stowage Management Documentation Requirements

These specifications have been reviewed and coordinated throughout the NASA MSC and they are now approved for usage by the NASA on any future manned spacecraft programs as is deemed appropriate.

In the area of In-Flight Maintenance, the IFM ground-preparations procedures and processes were examined and a preliminary description of the Total In-Flight Maintenance process was developed.

Related IFM data product concepts required to support the ground preparations and on-board IFM activities were also identified. These Phase II Study activities have established a basis for the proposed Phase III Study activities to develop and prepare a minimum of five specifications for In-Flight Maintenance. These include:

1) IFM Management Specification

2) IFM Task Analysis Specification

3) IFM Support Equipment Development and Logistics Documentation Specification

4) IFM Crew Malfunction (Troubleshooting) Procedures Specification

5) IFM Crew Procedures Document Specification.

SC-C-0009
April 10, 1972

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

Houston, Texas

GENERAL SPECIFICATION

OPERATIONS LOCATION CODING SYSTEM FOR CREW INTERFACES

SC-C-0009

April 11, 1972

THIS SPECIFICATION HAS BEEN
APPROVED BY THE MANNED SPACECRAFT
CENTER (MSC) AND IS AVAILABLE
FOR USE BY MSC AND
ASSOCIATED CONTRACTORS

Prepared by: _____
Operations Support Branch, CD2

Approved by: _____
Flight Crew Integration Division, CD

Approved by: _____
Director of Flight Crew Operations, CA

Approved by: _____ 5/10/72
Reliability and Quality Assurance Office, NA

FOREWORD

Operational experience in previous spacecraft programs (Mercury, Gemini, Apollo and Skylab) has emphasized the need for establishing a specification for assignment of location codes to the crew interfaces of the spacecraft. Particularly, Skylab Program experience has shown that present systems for identifying stowage locations and control-display panels are: (1) not adequate to handle the magnitude of items required to be located, (2) have little location significance, and (3) require program personnel to learn multiple systems for designating and locating crew interface items.

The trend toward larger and more complex spacecraft with much larger free volume for crew operations and with increased numbers of controls and displays and larger inventories of loose equipment further emphasizes the need for a standard and large capacity coding system for locating and designating crew interface items. The Operations Location Coding System for crew interfaces specified herein has been established to meet these needs.

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FIGURES

TABLES

1.0 INTRODUCTION

1.1 PURPOSE. The purpose of this specification is to establish a standard method of location coding of crew interface items in manned spacecraft and has general applications for:

a. Crew station design and operation review activities

b. Panel and trainer/flight article labeling

c. Designations of control/display panel locations on systems schematic data, operations handbooks, and other training data

d. Stowage list location data

e. Flight crew operations and in-flight maintenance procedures data

f. Manufacturing and ground preparations

g. Test and checkout procedures data

h. Designating EVA work site locations

1.2 SCOPE. The Operations Location Coding System for crew interfaces has application to all manned spacecraft including launch type vehicles, lunar lander type vehicles, earth orbital shuttle vehicles and payloads, space station type vehicles (zero and artificial G), and space tug type vehicles, and shall provide specific location coding information on the following crew interface items:

a. Control and display panels

b. Stowage areas, lockers, subcompartments and containers

c. Access panels

d. Systems components and equipment

e. Stowage of experiments and loose equipment

1.3 APPLICABLE DOCUMENTS. The following documents, of the issue in effect on the date of invitations for bids or procurement, form a part of this specification to the extent specified herein.

1.3.1 NASA Specifications.

SC-D-0001	Metal Foil Decals
SC-M-0003	Markings, Labeling, and Color Manned Spacecraft and Related Flight Crew Equipment Functional Design Requirements for

1.3.2 Military Standard.

MIL-STD-1472 Human Engineering Design Criteria for Military Systems, Equipment and Facilities

1.4 DEFINITIONS. For the purpose of this specification, the following definitions shall apply:

a. Room - Designated free volume space (partitioned or arbitrarily separated from other volumes) in or around spacecraft, occupied by a crewman.

b. Bulkhead - One of the enclosures of a spacecraft room. It may be a vertical surface between a deck and overhead, or may be a curved portion of a cylinder, or the entire portion of a cylindrical room.

c. Overhead - That surface of the room that is above (as determined by the nominal crew operating position) and is the room surface that attaches to the upper bulkhead boundary. In some quonset and cylindrical rooms, the bulkhead surfaces are continuous and no overhead exists.

d. Deck - That surface of the room that is footward (as determined by the nominal crew operating position) and is the room surface that attaches to the lower bulkhead boundary. In some quonset and cylindrical rooms, the bulkhead surfaces are continuous and no deck exists.

e. Overhead Reference Plane - An arbitrarily designated reference plane which is tangent to or parallel with upper bulkhead boundary and used as a reference for height coding.

f. Bulkhead Locations - Items, areas, or volumes that are within, attached to, or directly adjacent to the "defined" bulkhead of the room, and which are routinely accessible from within the room, either directly or through bulkhead openings, and have design provisions for repeated access.

g. In Front of Bulkhead Locations - Items, areas, or volumes that are directly in front of and attached to or adjacent to designated bulkhead locations or other in-front of bulkhead locations.

h. Hidden Locations - Items, areas or volumes located behind bulkhead maintenance access covers or openings which are not designed for routine access.

i. Control Station - A partitioned room or a designated area within a room, usually in "cockpit or console" configuration style, in which crew activities involve operations and monitoring of spacecraft or experiments controls/displays.

2.0 RESPONSIBILITIES

2.1 NASA/MSC

a. Shall monitor contractor utilization of this specification and determine compliance with same.

b. Shall apply the specification to contractor and government furnished equipment.

c. Shall approve deviations to the specification.

d. Shall update, revise, or otherwise modify the specification as required.

2.2 CONTRACTOR

a. Shall be responsible for compliance with this specification.

b. Shall request specification deviations from NASA/MSC.

c. Shall recommend revisions to the specifications, as deemed appropriate.

3.0 DESCRIPTION OF OPERATIONS LOCATION CODING SYSTEM FOR CREW INTERFACES

3.1 GENERAL DESCRIPTION. The Operations Location Coding System for crew interfaces provides a unique alpha-numeric designator for coding; a) modules, b) areas within modules, e.g., rooms, and control stations, c) locations of items within those areas. Specific designators or codes to be assigned to each of the above categories are illustrated in a top level overview of the Operations Location Coding System in Figure 1. As implied by Figure 1, the system consists of two basic coding conventions, one applicable to "control station" type areas and the other applicable to all other spacecraft areas or "rooms". Description of these two coding conventions and guidelines to their applications are presented in the following paragraphs of this specification. The technical description is divided into three major sections. The first two sections describe separately the two coding conventions. The third section establishes guidelines for applying each of the two coding conventions to extra-vehicular worksites. The subsections, within each section, describe the technique of coding the module, areas within the module, and the locations within the areas in this specific order.

Operations location coding of spacecraft shall be accomplished within the framework of guidelines presented in the following paragraphs.

3.2 ROOM CODING CONVENTION. The Room Coding Convention, as illustrated by Figure 2, consists of two distinct systems, one applicable to location coding of room bulkheads and the other applicable to location coding of room overhead and deck. A description of each coding system and their application guidelines is presented in the following paragraphs.

3.2.1 Room Bulkhead Coding. The room bulkhead code shall consist of two functional groups of designators -- a module/room designator and a room bulkhead location designator. As noted in Figure 2, a third functional group of designators, subcompartment discrete codes, shall be used when location designators within lockers, drawers or compartments are required. Instructions contained in 3.2.1.1 through 3.2.1.3 define the content of the Room Bulkhead Coding System and room configuration formats when applying the system.

3.2.1.1 Module/Room Coding. The first group of three (3) characters (XXX-00000) for the Room Coding Convention, Figure 2, shall designate the module and room within the module. The first character, the module code, shall be either a number or letter designator (except "I" which is not used and the letter "V" which is reserved for extra-vehicular work-site designation). The number code (0 thru 9) shall be used to sequentially designate shuttle or mass transfer type spacecraft. Letters, sequentially assigned and starting with "A" shall be used to designate all other spacecraft modules. The second character (0X0-00000) of the module/room code is a basic room designator. The room designators (letters) which shall be used when applying the Room Coding Convention are presented in Table I. A module code and a single character room code will normally be sufficient to describe the function within the room and to identify uniquely each room within multi-modular spacecraft. Some of the basic Room Designators, second character, presented in Table I are generic designators of rooms whose names encompass a class of functions, e.g., Lab, Experiment, System. Modules in which two or more functions (within a class) are performed in separate rooms shall have a two character room code. The second room character shall also be a letter designator. The code descriptors (00X-00000) which shall be used to describe room functions, when required, are presented in the last column in Table I.

3.2.1.2 Room Bulkhead Scale Coding. As illustrated in Figure 2, a second group of characters (000-XXXXX) after the first dash and following the module/room code is used for location coding of a bulkhead and of an overhead/deck.

The first three characters (000-XXX00) of the bulkhead code shall designate peripheral distance around the bulkhead from the left frame of the main entrance to the room or a designated bulkhead coding starting point if no obvious entrance exists. These characters of the bulkhead code shall be numbered sequentially from 00 to 999 with each unit of the bulkhead code scaled to ten centimeters (or four inches) of bulkhead distance. (English units presented in parenthesis following metric units, throughout this specification, are not intended to show unit equivalents but to specify the scale or dimension requirement for both the English and metric systems.) When the

Table I

Module/Room Designators

CODING CONVENTION	FIRST CHARACTER MODULE DESIGNATOR	SECOND CHARACTER BASIC ROOM/CONTROL STATION DESIGNATOR	THIRD CHARACTER ROOM FUNCTIONAL DESCRIPTOR
ROOM CONVENTION	NUMBERS (0 - 9) FOR SHUTTLE TYPE MODULES LETTERS (A -Z, EXCLUDING I)* FOR ALL OTHER MODULES.	A = AIRLOCK	N = NADIR C = CELESTIAL OTHER LETTERS AVAILABLE FOR ASSIGNMENT
		B UNASSIGNED *	UNASSIGNED *
		C = CONTROL CENTER	A-Z *CODE LETTERS UNASSIGNED *
		D = UNASSIGNED *	UNASSIGNED *
		E = EXPERIMENTS AND L = LABS	USED WITH BASIC CODES "E" AND "L" A = ANIMAL/AGRICULTURE B = BIOLOGY/AGRICULTURE E = ELECTRICAL/ELECTRONIC F = FILM PROCESSING/PHOTOGRAPHY H = HEALTH/MEDICAL M = MECHANICAL O = OPTICS P = PHYSICS Z = AIRLOCK OTHER LETTERS UNASSIGNED*
		F = FACILITIES, STOWAGE MAINT , MISCELLANEOUS	A-Z = UNASSIGNED * F = FOOD STOWAGE L = LAUNDRY
		G = GENERAL USAGE	A-Z = UNASSIGNED * B = BRIEFING/CONFERENCE C = CHAPEL L = LIBRARY S = STUDY D = DINING R = RECREATION T = THEATER
		H = HYGIENE, PERSONAL	A-Z = UNASSIGNED *
		J = UNASSIGNED *	UNASSIGNED *
		K = KITCHEN	A-Z = UNASSIGNED *
		M = MEDICAL & CREW CARE	A-Z = UNASSIGNED * H = HOSPITAL D = DISPENSARY
		N = UNASSIGNED *	UNASSIGNED *
		Ø = UNASSIGNED *	UNASSIGNED *
		P = PAYLOAD	A-Z CODING FOR SPECIFIC "PAYLOAD" AREA DESIGN *
		Q = QUARTERS, CREW	A-Z CODING FOR SPECIFIC "QUARTERS" DESIGNATION *
		R = UNASSIGNED *	A-Z CODING FOR SPECIFIC "ROOM" *
		S = SYSTEMS	USED WITH BASIC CODE "S" A = ACTIVE THERMAL CONTROL C = CRYOGENIC SYSTEM D = DATA PROCESSING E = ELECTRICAL POWER G = GUIDANCE & CONTROL L = LIFE SUPPORT/ENVIRONMENTAL CONTROL M = MAINTENANCE P = PROPULSION R = REACTION CONTROL T = TELECOMMUNICATIONS OTHER LETTERS UNASSIGNED*
		T = TUNNELS/PASSAGEWAYS	A-Z = UNASSIGNED *
		U = UNASSIGNED * V = NOT USED *	A-Z = UNASSIGNED * A-Z = UNASSIGNED *
		W = WARDROOM	A-Z = UNASSIGNED *
		X = EXERCISE/GYM Y = UNASSIGNED * Z = UNASSIGNED *	A-Z = UNASSIGNED * A-Z = UNASSIGNED *
CONTROL STATION CONVENTION	SAME AS ABOVE	NUMBER 0-9	NUMBER (USED WITH 2ND CHARACTER TO DESIGNATE NUMBERS OF CONTROL STATIONS)
EXTRA-VEHICULAR WORK-SITES DESIGNATION	SAME AS ABOVE	V	LETTER A—Z EXCLUDING I WHEN USING ROOM CODING CONVENTION OR NUMBER 0-9 WHEN USING CONTROL STATION CODING CONVENTION

* V = EXTRAVEHICULAR LOCATION

bulkhead perimeter is less than ten meters (or 33.3 feet), only two characters need to be used -- 00 to 99. The third character is used to code room bulkhead locations greater than 99 to accommodate a maximum perimeter of 100 meters (or 333.3 feet). Peripheral locations from ten to 100 meters (or 33.3 to 333.3 feet) will be coded 100 to 999 respectively. Figure 3 illustrates the application of room bulkhead coding to a typical space station room and specifies guidelines for general application of this coding convention.

The fourth character (000-000X0) or third if a two digit bulkhead scale code is applicable, as indicated by Figure 3, is a letter designator (A through Z excluding "I") and shall be measured from the overhead to the designated deck. Height measurement in rooms not having an apparent (or structurally defined) overhead shall be from an arbitrarily designated reference plane to provide height location resolution. Figure 4 illustrates typical height location coding and includes room configurations which require designation of arbitrary overhead reference planes. Example 1 of Figure 4 is a room in which there is an apparent overhead and therefore does not require designation of an arbitrary overhead reference plane. The room overhead may be used as a reference for height coding. A quonset type room typical of a partitioned cylindrical module, Example 2 of Figure 4, is an example of a room configuration which requires an arbitrary overhead reference plane. The overhead reference plane of Room A is established at a point tangent to the pressure bulkhead and parallel to the deck.

The height as measured from the overhead reference plane would be applicable to locating and coding of items on the bulkhead planes that are perpendicular to the deck plane and to items located on the deck, if required. (Guidelines to establish height codes for items located on the deck are specified in 3.2.2.2).

The curved bulkhead of quonset rooms requires a special coding method. This method requires that the curved bulkhead be folded out from the line of tangency of the overhead reference plane to the pressure bulkhead and projected onto an equal area plane as illustrated in Example 2 of Figure 4. Bulkhead projections shall be required on both sides of those quonset rooms that extend the full deck diameter of the module. The bulkhead height coding on these surfaces shall be the same unit size (ten cm.) as on the end bulkheads but shall be measured from the projected bulkhead overhead reference line. This is the curvilinear distance of the room bulkhead and will not coincide with the height coding of the end bulkhead.

Example 3 of Figure 4 illustrates other variations of the quonset room height coding. This is further illustrated in three dimensions in Figure 5 for all the basic quonset room types. Specific examples of item height coding in room bulkhead coding and overhead/deck coding systems are included in Figure 6. The overhead/deck coding system is discussed in 3.2.2.

The height axis for all rooms shall be scaled to a unit dimension of ten centimeters (or four inches). Use of a similar scale for both the height and the peripheral distance thus permits a location resolution to a ten centimeter (or four inch) square for bulkheads in conjunction with the bulkhead scale code. The ten centimeter height scale will handle a maximum vertical distance of 2.5 meters. Bulkheads having a height greater than 2.5 meters shall be scaled with the minimum possible integer unit size (in increments of five centimeters or one inch) to provide maximum location resolution.

The fifth character (000-0000X) of the room bulkhead code (or fourth if peripheral distance is less than 10 meters or 33.3 feet) is a discrete code used to locate such items as access panels, lockers, loose equipment, etc. that are adjacent to but remote from the bulkhead (in front of or behind the bulkhead). This character is normally not required. Coding of typical items requiring this discrete code are included among those items illustrated in Figure 7 and 8. Guidelines that determine when this discrete code shall be used are as follows:

a. Items located adjacent to and in front of another item on the bulkhead shall have a fifth (or fourth) character discrete code. This code for the item on the bulkhead shall be the letter "A" (first level, 000-0000A). Item(s) in front of and adjacent to "A" shall be designated "B' (second level from bulkhead, 000-0000B), "C" (third level from bulkhead, 000-0000C), etc. Examples [M], [N], [Ø], [P], [Q] of Figure 7 and Examples [2], [3], [4] and [5] of Figure 8 are illustrative of lockers coded with a third dimension discrete, the fourth character following the dash.

b. Lockers located in front of two or more lockers whose level from the bulkhead is different shall be coded with the next highest sequential letter. This is illustrated in Figure 7 with Examples [M] and [Q] on the first level (A), in front of the bulkhead, [R] on the second level (B) and lockers [N] and [P] on the third (C) and fourth (D) levels, respectively.

c. Hidden items located behind bulkhead access panels shall use a fifth character discrete (000-0000X), fourth if room perimeter is less than ten meters, for location designation. A number discrete shall be used for hidden components to discriminate from letter designated in-front of the bulkhead location codes. Examples [J], [K] and [L] of Figure 7 and [7] and [8] of Figure 8 are illustrative of coded items located behind bulkhead access panels.

3.2.1.3 Room/Bulkhead Subcompartment Coding. The third group of two characters, (000-00000-XX) separated from the bulkhead scale code by a dash, is a subcompartment discrete code. These characters will not normally be required and shall be used only when items within a locker or compartment location are to be designated. Examples of subcompartment coding are illustrated in Example [1] of Figure 8. Both letter discretes (A through Z excluding "I") and number discretes (0 through 9) shall be used, if required, to avoid a two character subcompartment code. Example [1] illustrates usage of one character letter and number codes as well as two character codes.

3.2.2 Room Deck/Overhead Scale Coding. In addition to the bulkhead perimeter coding, room deck/overhead coding will normally be required for location coding of a spacecraft room. Guidelines for application of deck/overhead coding are presented in 3.2.2.1 through 3.2.2.3.

3.2.2.1 Module/Room Coding. As indicated by Figure 2, the module/room code for a room deck/overhead is identical to that for room bulkhead perimeter coding. Guidelines for coding modules and rooms when applying deck/overhead coding shall be in accordance with 3.2.1.1.

3.2.2.2 Deck and Overhead Grid Coding. The second group of five characters (000-XXXXX) of the deck/overhead grid code shall be used to locate items that are remote from the bulkhead and bulkhead locations. The first character (000-X0000) is an area designator which defines the grid area containing items or equipment requiring a location code. This character shall be one of the following four letter descriptors:

a. D - Area designator for items located on the Deck.

b. O - Area designator for items located Overhead.

c. A - Area designator for items located Above the overhead.

d. B - Area designator for items located Below the deck.

Coding examples and illustrations of the usage of this grid area code will be covered in the subsequent paragraphs which specify guidelines for complete deck/overhead location coding.

The second and third characters (000-0XX00) of the deck/overhead scale code designate subdivisions of a plane (overhead or deck plan) described by a two-dimensional coordinate system. The two axes of the coordinate system, as illustrated in Figure 9, shall be designated with letters (A through Z excluding "I" and number 0 through 9) in a left-to-right direction and a forward-to-aft direction. The second character shall be the forward-to-aft letter designator and the third character shall be the left-to-right letter designator. Guidelines for application of deck/overhead coding to space vehicles are specified in Figure 9.

The fourth character (000-000X0) of the deck/overhead code is a room height scale and shall be a letter designator that measures height from the overhead reference plane to the midpoint of an item. As noted in Figure 2, the height code, applicable to deck/overhead coding, is normally not required. Such items as a multi-drawer film vault or cabinet containing several drawers, remotely located from the bulkhead, will however, require a height code to uniquely code and locate each drawer. If the height of each drawer is less than ten centimeters (or four inches), then the height code shall be the midpoint of the total film vault or cabinet. A fifth character, a high resolution designator, 0 through 9, shall then be used to discretely identify

the film drawers. As noted in Figure 2, the high resolution characters shall also be used to discriminate between two or more small items, all of which have the same height code and whose midpoints fall within the same 40 centimeter (or 15 inch) square of the grid area. Such items shall be discretely coded with a letter (A through Z, excluding "I"). The use of the high resolution coding character will rarely be required and shall never be used without a room height letter designator, the fourth character. Coding examples of items located on an overhead and deck are presented in Figure 10.

3.2.2.3 Deck and Overhead Subcompartment Coding. Subcompartment coding of items located on the deck or overhead shall be in accordance with 3.2.1.3.

3.3 CONTROL STATION CODING CONVENTION. The Control Station Coding Convention is consistent with the Room Coding Convention as three distinct groups of coding characters are used in each convention. Instructions in the application of the Control Station Coding Convention and its description are presented in 3.3.1 through 3.3.3.

3.3.1 Module Code/Control Station Designation. The first functional group of characters (XXX-0000) is a module and control station designation. The module shall be coded as specified in 3.2.1.1. The control station designators (0XX-0000) are one or two digit codes which shall be discrete sequential numbers. As noted in Figure 2, the third character (00X-0000) of the module/control station code will not normally be required since a single digit permits the designation of ten control station sites (0 through 9) within each module.

3.3.2 Control Station Panel or Subdivision Coding. The second group of characters (000-XXXX) shall designate the panel or area and subdivisions within the control station. The first character, (000-X000) the area designator, shall be in accordance with the letter codes specified in Figure 11 which illustrates the directional significance of the codes and the relative location of the coded areas in a typical cockpit type control station. Division of a control station into directional areas for location coding may not, in some cases, be apparent. For example, the Forward/Right Hand Access Area (F/R) and the Forward/Left Hand Access Area (F/L) of Figure 11 may, optionally, be coded either F or R and F or L. A determining factor for coding such panels shall be function(s) performed on the panels. If the functions performed on the "F/R Panel" and the "F/L Panel" are operationally more related to the control/display functions of the other Forward Panel arrangements, then the letter designator shall be "F". However, if these panels are functionally more related to the Right Hand Access or Left Hand Access area control/display arrangements or compartment functions then the area designator shall be "R" or "L". For such cases where the panels or side areas do not have an obvious functional relation to either the forward areas or side areas, then an arbitrary designator, one of the two or more options, shall be selected.

The second and third characters (000-0XX0) following the area or functional designator are panel or subdivision numbers. The panels or subdivisions within each area shall be numbered sequentially starting with the number "1" in a top left-to-right and top-to-bottom progression. The panels or subdivision numbers may be divisions of the Forward Control and Display Area and of the Right and Left Hand Access Areas (access doors to compartments or functional control and display panels), number of windows having items located on or adjacent to each window, and panels, access doors, items or equipment located on or attached to other designated areas. The panels or subdivision numbers of the functional designator shown in Figure 11 are discrete codes which merely designate the total number of similar functional equipment and their relative position within the control station. Coding of items located on these functional equipments is discussed in 3.3.3.

A subdivision of designated areas into rational subdivisions will be apparent for equipments located on or attached to most of the directional areas, e.g., Bulkhead Areas, Deck Area, and Window Areas, since the number designator is a discrete identifier of each equipment or item. Areas containing controls and displays, however, shall be subdivided (within each area) according to function(s) performed or according to designed subdivisions of the control and display panel.

The second character of the panel or subdivision code will not normally be required since a single number designator enables the coding of ten (0 through 9) subdivisions.

The fourth character (000-000X) of the control station panel or area code is a panel change code. This code shall be a letter designator (A through Z excluding "I"). Guidelines for applying this code when panel changes occur are specified in Table II, which illustrates the coding of changes to typical panels. These guidelines will preserve the sequential character of panel numbers even after numerous changes are made. Situations which may occur and are not covered in Table II are the relocation of a panel from nominally stowed positions to operationally installed positions. Such panels shall be designed per their installed location. Panels used in multicycle operational locations shall have unique identifiers in addition to their locations designation. The preferred designation is the primary operational location (the position in which the panel remains installed for the longest period of time). However, if deemed necessary for good crew operating practices, panels may be designated with multiple location codes.

3.3.3 Control Station Subcompartment Coding. The subcompartment discrete code shall be used to designate items located on the functional equipment identified and designated (by letter) in Figure 11. Such items shall be either a sequential number, starting with the number "1", or a letter (A through Z excluding "I"). The subcompartment code shall also be used to designate items within a locker or compartment located on or attached to the functional areas identified in Figure 11. Coding of these items shall be in accordance with 3.2.1.3.

PANEL CHANGE DESIGNATION METHOD

PANEL CHANGE	PREVIOUS PANEL DESIGNATION (PRIOR TO CHANGE)	NEW PANEL(S) DESIGNATOR
SINGLE PANEL SUBDIVIDED INTO TWO PANELS	F11	F11A, F11B
SINGLE PANEL REPLACED WITH A NEW PANEL OF EQUAL OR SMALLER AREA	F11	F11A
TWO PANELS REDESIGNATED AS SINGLE PANEL	F11, F12	F11A (F12 DELETED)
SEVERAL PANELS REDESIGNATED AS FEWER PANELS	F11, F12, F13	F11A, F12A (F13 DELETED)
PREVIOUSLY CHANGED PANEL SUBDIVIDED INTO TWO PANELS	F11A	F11B, F11C
TWO PREVIOUSLY CHANGED PANELS REDESIGNATED AS SINGLE PANEL	F11A, F12A	F11C
NEW PANEL INSERTED BETWEEN TWO PREVIOUSLY DESIGNATED PANELS	F11, F12	F11, F11A, F12
PREVIOUSLY DESIGNATED PANEL RELOCATED TO A NEW DIRECTIONAL AREA	F11 (F11 Deleted)	C3, C3A, C4 (Where F11 is relocated between two panels of new area); C3, C4, C5 (Where F11 is relocated adjacent to last designated panel in new area)

Applications of the Control Station Coding Convention including subcompartment coding are illustrated in Figures 12 through 14. Figure 12 is a coded planview of the forward area of a typical control station of a lunar landing type spacecraft in which directional orientation, e.g., forward, left, right, is defined with respect to the crewman's position when operating the primary controls and displays--namely, those located on the Forward Panels. For illustrative convenience, the functional areas of the planview, shown in the upper right-hand corner of Figure 12, have been separated. A coded planview of the other portions of the control station as viewed from the forward area and one aspect of the complete spacecraft are shown in Figure 13. Application of this coding convention to a large console type control station is illustrated in Figure 14.

3.4 EXTRA-VEHICULAR WORKSITE CODING. Location coding of extravehicular (EV) worksites shall be accomplished by application of either of the two coding conventions presented in 3.2 and 3.3 of this specification. Selection of either coding convention as more appropriate for coding a specific worksite shall be based on predominant configuration similarities between the EV worksite and a control station or a module room. When applying either of these conventions to EV worksites, the second character (OVO-0000) of the module/room or module/control station codes shall always be designated by the letter "V". The third character (OVX-0000) using the Module/Room Convention shall be a discrete letter designator (A through Z excluding "I"), and the third character using the Module/Control Station Convention shall be a discrete number designator (0 through 9). Otherwise, the guidelines for application of the coding convention to EV worksites shall be in accordance with those specified in 3.2 and 3.3.

4.0 OPERATIONS LOCATION CODING PLAN

A documented plan illustrating the applications of this Operations Location Coding Systems Specification shall be submitted by the contractor to NASA-Manned Spacecraft Center for review and approval on a date mutually acceptable to both the Government and the contractor, but in any event not later than 90 days subsequent to contract award. This plan shall include a description of the means by which the contractor will meet the requirements imposed by this specification and the procurement document including, but not limited to:

a. Identification of the spacecraft modules that are affected.

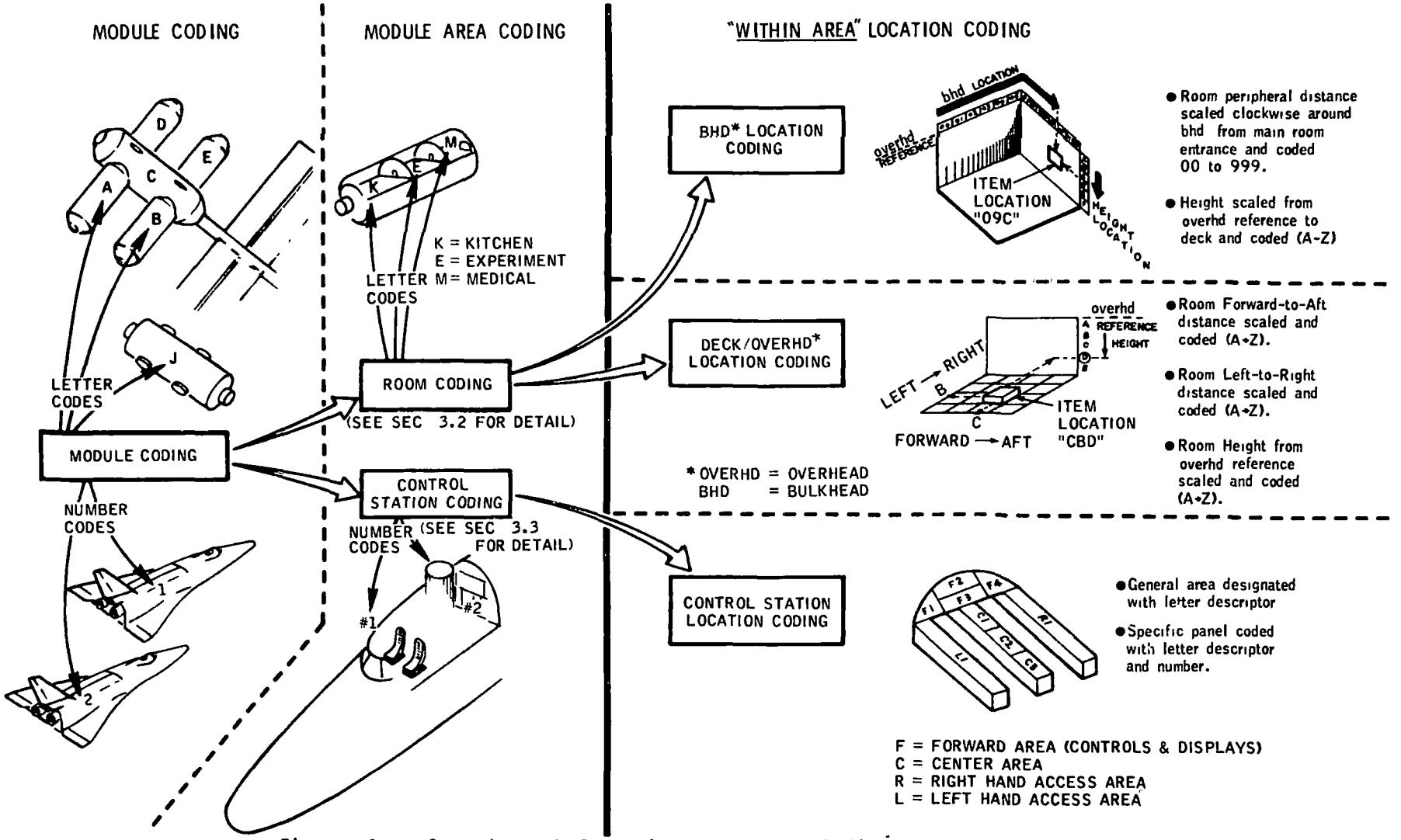
b. Identification of the functional name and locations within the spacecraft of all areas to be designated as "Rooms", "Control Station", and "Extra-vehicular Worksites".

c. Identification of the proposed coded designation of the above areas.

d. Identification of the proposed coding to be applied within each room, control station, or work station.

e. Identification of rooms, or portions thereof, requiring Room or Control Station placards or labels and preliminary placard configurations, illustrating room configurations as laid out for location coding. As a general guideline, placards shall be required for rooms in which there is a significant amount of preparation activity such as stowage of items, fitchecking of items or maintenance. Figure 15 contains typical examples of different placard types that may be required for various types of spacecraft rooms. These placards or labels shall be prepared in accordance with NASA General Specification SC-D-0001. Figure 16 is an example of a typical Room Placard. As noted in this figure, the Room Placard shall contain the module designation and the room designation at the top of the decal. The location code associated with lockers, compartments, etc., identified in Figure 16, shall be consistent with placards attached to these equipments and shall contain only their specific location codes within the room (XXXX). Control station type room placards shall contain the module designator and the control station number. Illustration of the directional areas and panel numbers within each area will not normally be required on these control stations. Placards or labels identifying the control station panels shall contain only the area designator and the panel identification codes (XXX). Module designators and control station number designators are not required on the panel placards.

f. Identification of all lockers, control/display panels, their location code designators and preliminary placard or label configurations. Placard markings and colors shall be in accordance with NASA General Specification SC-M-0003.



- Room peripheral distance scaled clockwise around bhd from main room entrance and coded 00 to 999.
- Height scaled from overhd reference to deck and coded (A-Z)
- Room Forward-to-Aft distance scaled and coded (A-Z).
- Room Left-to-Right distance scaled and coded (A-Z).
- Room Height from overhd reference scaled and coded (A-Z).
- General area designated with letter descriptor
- Specific panel coded with letter descriptor and number.

Figure 1. Overview of Operations Location Coding System

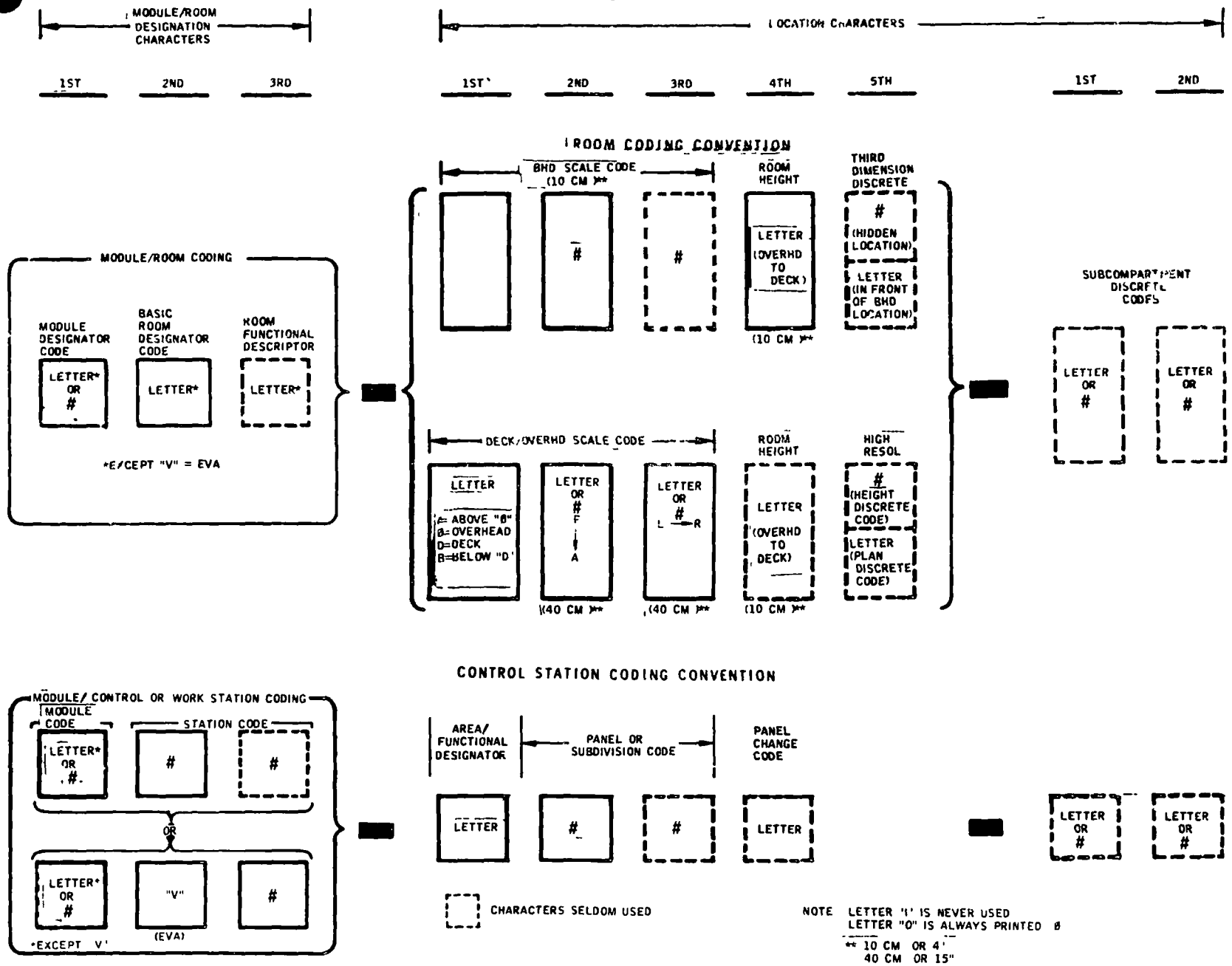
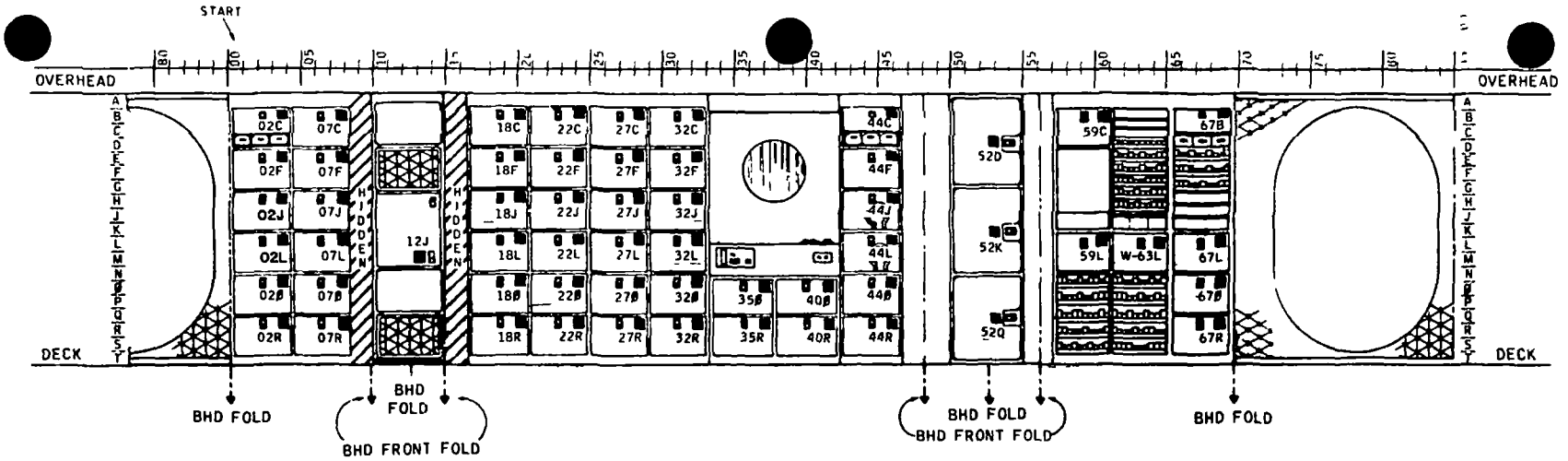
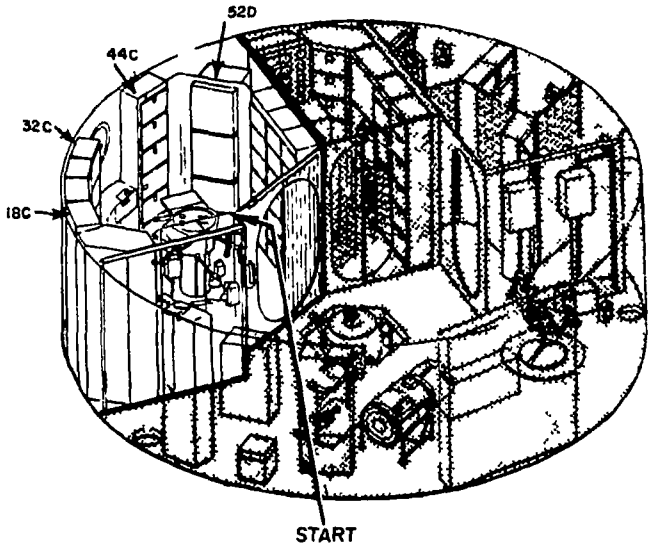


Figure 2 Operations Location Coding System





GUIDELINES FOR APPLICATION OF ROOM BULKHEAD CODING

1 LAYOUT SHALL START AT FIRST VERTICAL STATION AFTER MAIN DOOR-TO-ROOM, IF POSSIBLE

2. ROOM PERIMETER SHALL BE UNFOLDED (EMPTY ROOM ELEVATION) AND LAID OUT AS ABOVE (CLOCKWISE WITH RESPECT TO THE STANDARD PERIPHERAL SCALE).

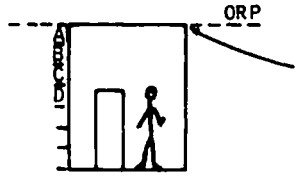
3. ROOM HEIGHT SHALL BE MEASURED FROM AN OVERHD REFERENCE PLANE TO DECK

4. ITEMS LOCATED ON BULKHEAD SHALL BE CODED AT THEIR MIDPOINT WITH RESPECT TO BOTH PERIPHERAL DISTANCE AND HEIGHT ITEMS SUCH AS LOCKERS AND CABINETS HAVING SIDE OPENING DOORS SHALL BE CODED AT THEIR POINT OF ACCESS (A CABINET HAVING TWO OR MORE ACCESS PANELS/DOORS IS THUS PROVIDED WITH A UNIQUE LOCATION CODE FOR EACH ENTRANCE)

Figure 3. Operations Location Coding System (Room Bulkhead Coding)

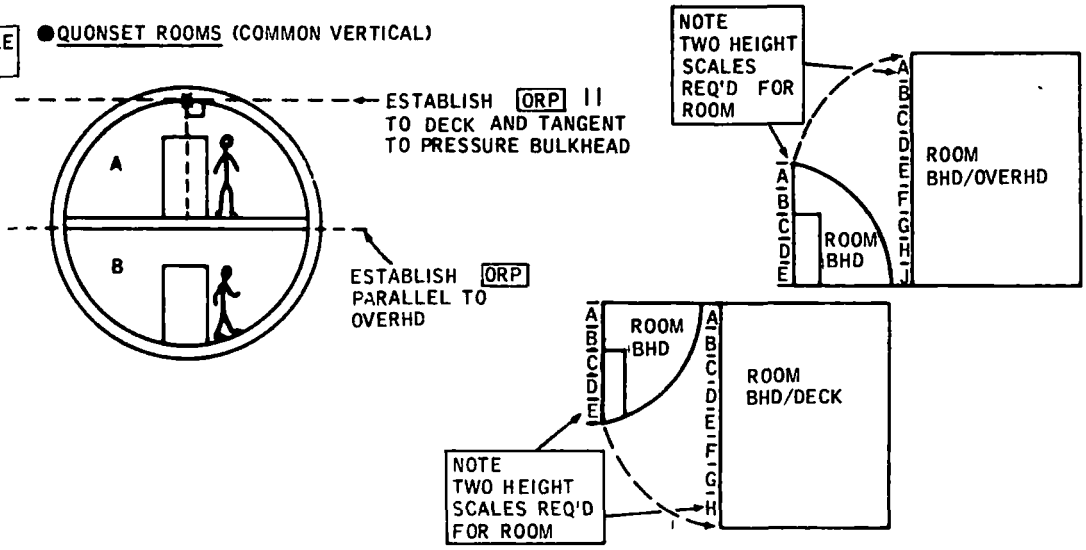
EXAMPLE 1

● PARALLEL DECK/OVERHEAD ROOM



EXAMPLE 2

● QUONSET ROOMS (COMMON VERTICAL)



EXAMPLE 3

● QUONSET ROOM (COMMON FLOOR)

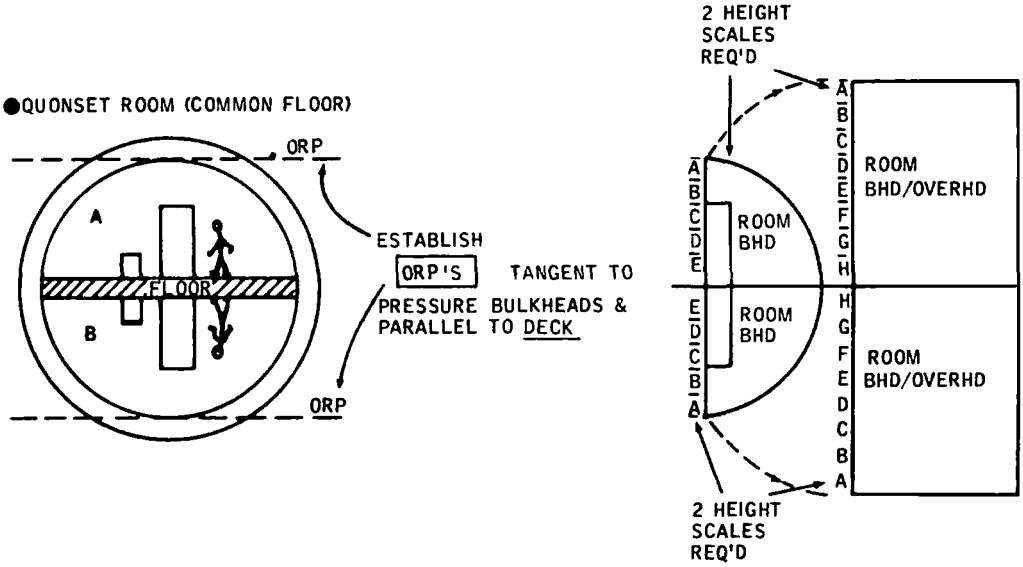
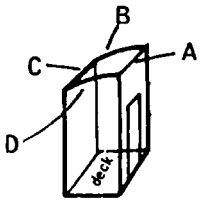


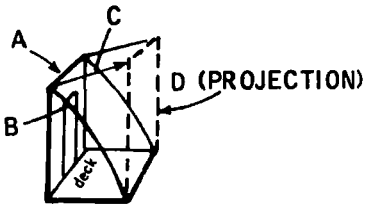
Figure 4. Height Location Coding

TYPE I

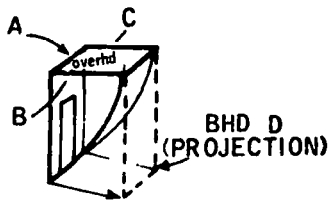


ALL FOUR BHD HEIGHTS
ARE CODED WITH PERPENDICULAR
BHD HEIGHT CODING METHOD

TYPE II A

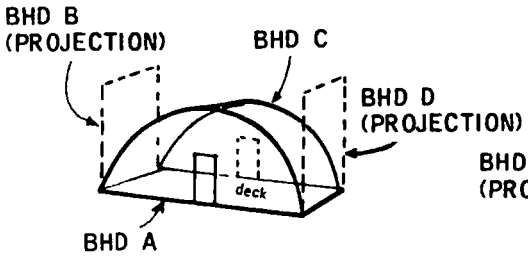


TYPE II B

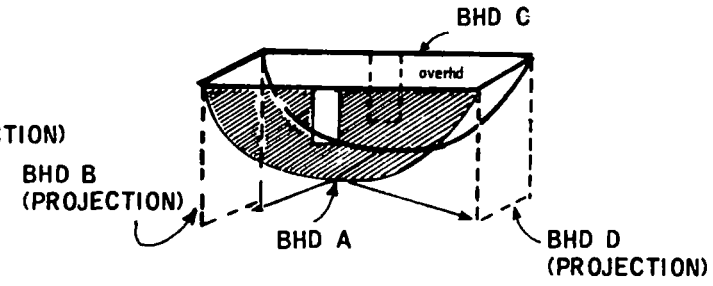


BHDs A, B, & C = PERPENDICULAR BHD
HEIGHT CODING METHOD
BHD D = CURVED BHD HEIGHT
CODING METHOD

TYPE III A



TYPE III B

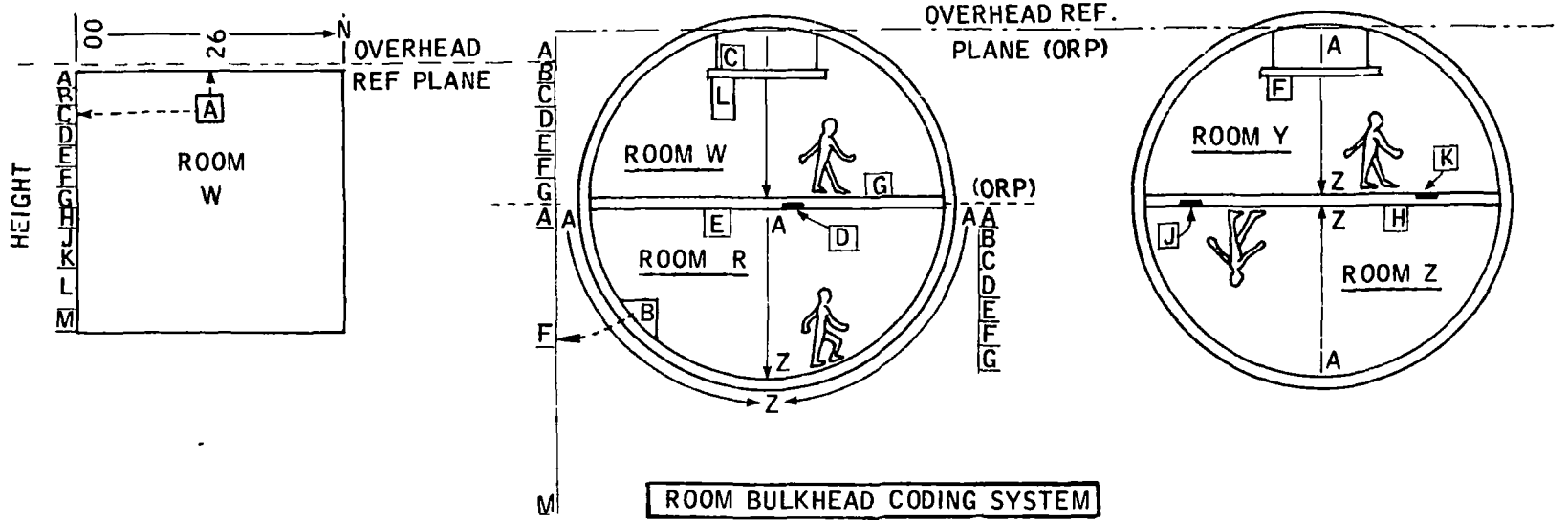


BHDs A & C = PERPENDICULAR BHD HEIGHT CODING METHOD

BHDs B & D = CURVED BHD HEIGHT CODING METHOD

Figure 5.

Quonset Room Types



ROOM BULKHEAD CODING SYSTEM

[A] EQUIPMENT LOCATED ON BHD IS CODED W - 26C*

[B] EQUIPMENT LOCATED ON QUONSET BHD IS CODED R - 26F

HEIGHT CODING IS SCALED FROM OVERHD REFERENCE PLANE, OR IN THE CASE OF A CURVED BHD, FROM THE TOP OF THE CURVED BHD FOLD OUT.

ROOM DECK/OVERHEAD CODING SYSTEM

[C] [D] EQUIPMENT LOCATED ABOVE OVERHD IS CODED W-AMN AND R-AMN

[E] [F] EQUIPMENT LOCATED ON OVERHD IS CODED R-OMN AND Y-OMN

[G] [H] EQUIPMENT LOCATED ON DECK IS CODED W-DMN AND Z-DMN

[J] [K] EQUIPMENT LOCATED BELOW DECK IS CODED Z-BMN AND Y-BMN

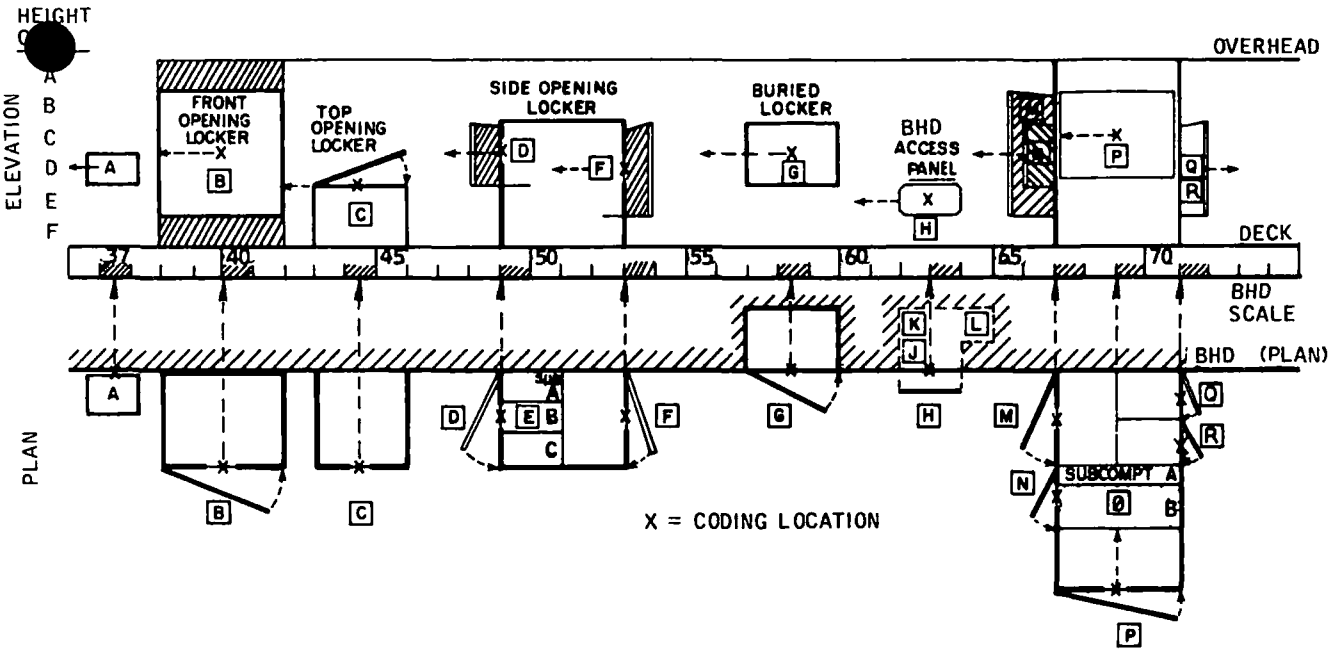
[L] EQUIPMENT LOCATED BELOW OVERHD IS CODED W-OMNC

C = HEIGHT CODE

RELATIVE HEIGHT LOCATION, E.G., ABOVE OVERHD, ON DECK IS NORMALLY SUFFICIENT TO LOCATE ITEMS ON DECK/OVERHD. SPECIAL CASES, [L], MAY REQUIRE USE OF AN ADDITIONAL CHARACTER TO ACCURATELY LOCATE ITEM ABOVE DECK OR BELOW OVERHD

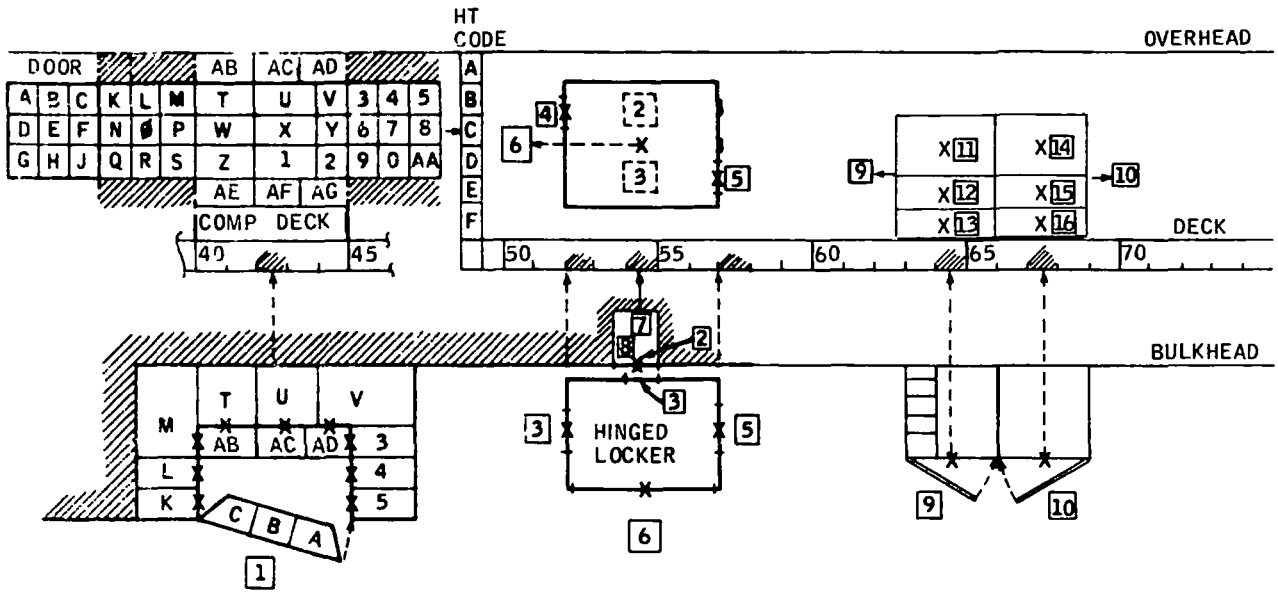
*ASSUMES ALL ROOM BHD LOCATIONS TO BE "-26" AND ALL DECK AND OVERHD LOCATIONS TO BE "MN"

Figure 6. Examples Of Height Location Coding



	BULKHEAD CODING CONVENTIONS	CODING OF EXAMPLES (ROOM CODE IS "E") ROOM-(BHD) HT -SUB
A	EQUIPMENT LOCATED ON BHD	E - 3 7 D
B	FRONT-OPENING LOCKER LOCATED ON BHD	E - 4 0 C
C	TOP-OPENING LOCKER LOCATED ON BHD	E - 4 4 D
D	SIDE-OPENING LOCKER LOCATED ON BHD	E - 4 9 C
E	SUBCOMPARTMENT OF LOCKER D (E-49C)	E - 4 9 C - B
F	SIDE-OPENING LOCKER LOCATED ON BHD	E - 5 3 D
G	BURIED LOCKER LOCATED ON BHD	E - 5 8 C
H	ACCESS PANEL OPENING ON BHD	E - 6 3 E
J	HIDDEN COMPONENT	E - 6 3 E 1
K	HIDDEN COMPONENT	E - 6 3 E 2
L	HIDDEN COMPONENT	E - 6 3 E 3
M	SIDE-OPENING LOCKER IN FRONT OF BHD (1ST LEVEL)	E - 6 7 C A
N	SIDE-OPENING LOCKER IN FRONT OF BHD LOCATION (3RD LEVEL)	E - 6 7 C C
Ø	SUBCOMPARTMENT IN LOCKER N (E-67CC)	E - 6 7 C C - B
P	FRONT-OPENING LOCKER IN FRONT OF BHD LOCATION (4TH LEVEL)	E - 6 9 C D
Q	SIDE-OPENING LOCKER IN FRONT OF BHD (1ST LEVEL)	E - 7 1 D A
R	SIDE-OPENING LOCKER IN FRONT OF BHD (2ND LEVEL)	E - 7 1 D B

Figure 7. Illustrative Examples of Bulkhead Location Coding



EXAMPLE

[1] LOCKER LOCATED ON BHD IS CODED _____ E - 4 2 C

SUBCOMPARTMENT CODING CONVENTION IS TOP LEFT → RIGHT, TOP → BOTTOM LETTERING DESIGNATIONS

- DOOR SUBCOMPS FIRST (E-42C - A,B,C,D,E,F,G,H, AND J)
- LEFT-HAND SUBCOMPS SECOND (E-42C - K,L,M,N,Ø, P,Q,R AND S)
- CENTER SUBCOMPS THIRD (E-42C - T,U,V,W,X,Y,Z,1 AND 2)
- RIGHT-HAND SUBCOMPS FOURTH (E-42C - 3,4,5,6,7,8,9,0, AND AA)
- OVERHD (SUBCOMP) FIFTH (E-42C - AB,AC,AD) DECK (SUBCOMP) SIXTH (E-42C - AE,AF,AG)

[2] ACCESS PANEL - COVERED BHD LOCATION (1ST LEVEL) _____ E - 5 4 B A

[3] ACCESS PANEL ON BACK OF HINGED LOCKER IN FRONT OF BHD LOCATION (2ND LEVEL) _____ E - 5 4 D B

[4] ACCESS PANEL ON LEFT SIDE OF HINGED LOCKER IN FRONT OF BHD LOCATION (3RD LEVEL) _____ E - 5 2 B C

[5] ACCESS PANEL ON RIGHT SIDE OF HINGED LOCKER IN FRONT OF BHD LOCATION (3RD LEVEL) _____ E - 5 7 D C

[6] HINGED LOCKER IN FRONT OF BHD LOCATION (4TH LEVEL) _____ E - 5 4 C D

[7] COMPONENT HIDDEN BEHIND ACCESS PANEL (E-54BA) _____ E - 5 4 B 1

[8] COMPONENT HIDDEN BEHIND ACCESS PANEL (E-54BA) _____ E - 5 4 B 2

[9] FILM VAULT DOOR (LEFT) _____ E - 6 4 D

[10] FILM VAULT DOOR (RIGHT) _____ E - 6 7 D

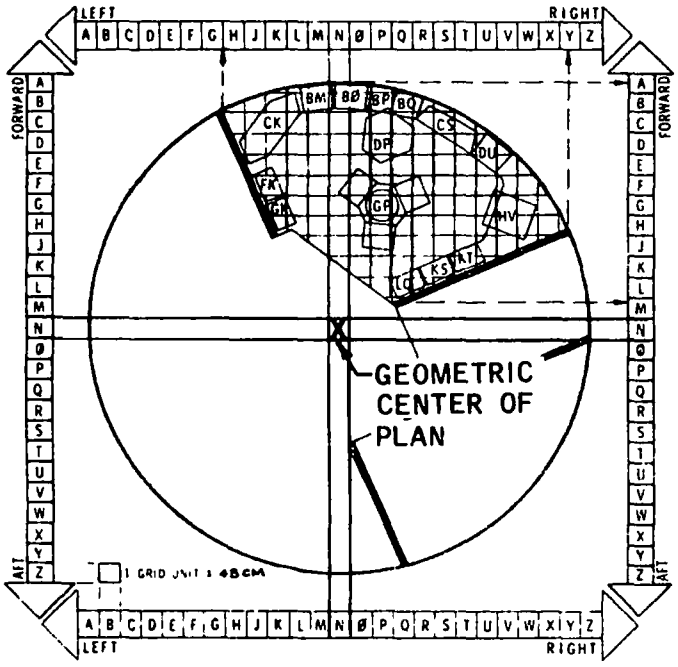
[11] FILM DRAWER (TOP) _____ E - 6 4 C

[12] FILM DRAWER _____ E - 6 4 E

[13] FILM DRAWER (BOTTOM) _____ E - 6 4 F

[14] [15] [16] FILM DRAWERS _____ E - 6 7 C, E, F

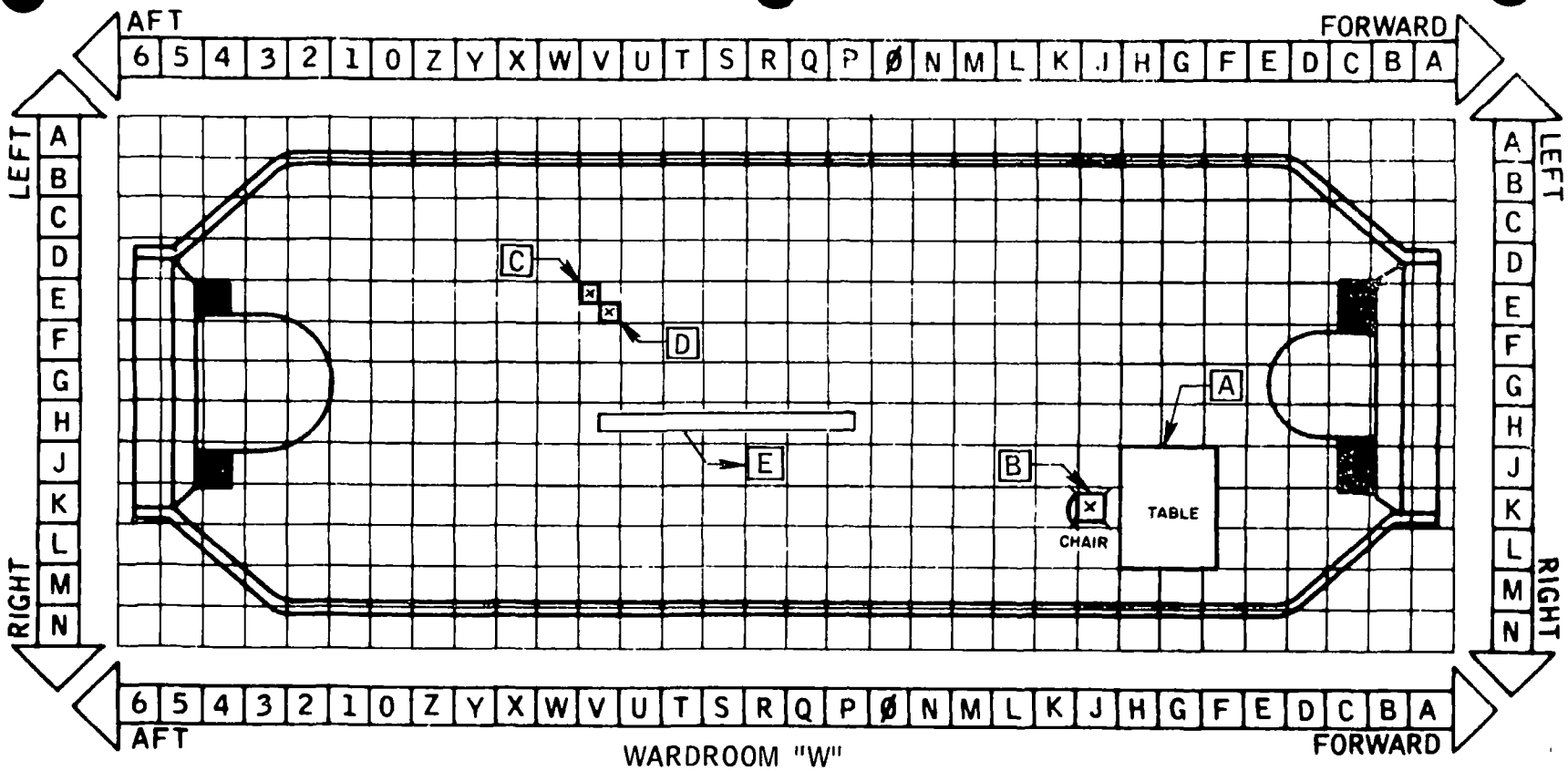
Figure 8
Illustrative Examples of Bulkhead Location Coding (Cont'd.)



GUIDELINES FOR APPLICATION OF DECK/OVERHEAD CODING

1. THE DECK/OVERHEAD PLAN SHALL BE LAID OUT AS FOLLOWS·
   A. THE PLAN AXES SHALL BE PARALLEL WITH THE MODULE AXES.
   B. THE GEOMETRIC CENTER OF THE PLAN SHALL BE LOCATED AT MIDPOINT OF FORWARD-TO-AFT AXES.
   C. THE LEFT-TO-RIGHT SCALE SHALL START AT LEFT-FORWARD CORNER OF PLAN GRID.
2. THE OVERHEAD PLAN SHALL BE LAID OUT AS VIEWED FROM ABOVE AND PROJECTED ON THE PLANE OF THE DECK . (THIS ARRANGEMENT, AS OPPOSED TO ROTATING OVERHEAD PLANE ON DECK PLANE, MAINTAINS DIRECTIONAL CONSISTENCEY IN CODING WITH RESPECT TO DECK .)
3. ITEMS SHALL BE CODED AT THEIR PLAN "MIDPOINTS" AS RELATED TO THE PLAN GRID.
4. PLANS SHALL BE SCALED TO A UNIT DIMENSION OF 40 CM. (OR 15 INCHES) UP TO MAXIMUM SPACECRAFT DIAMETERS OF TEN METERS (OR 43.7 FEET). SPACECRAFT HAVING DIAMETERS GREATER THAN 10 METERS SHALL BE SCALED WITH THE MINIMUM MULTIPLE OF FIVE CM. (E.G. 45 CM.) TO PROVIDE MAXIMUM LOCATION RESOLUTION.

Figure 9. Deck/Overhead Coding



[A] TABLE LOCATED ON DECK IS CODED
[B] CHAIR LOCATED ON DECK IS CODED
[C] EQUIPMENT LOCATED ON DECK IS CODED
[D] EQUIPMENT LOCATED ON DECK IS CODED
[E] LIGHT FIXTURE LOCATED ON OVERHD IS CODED

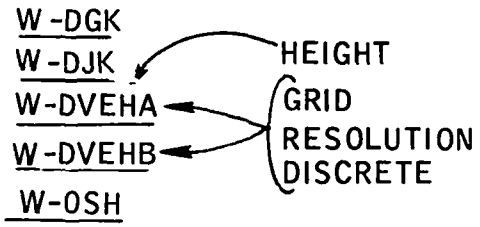
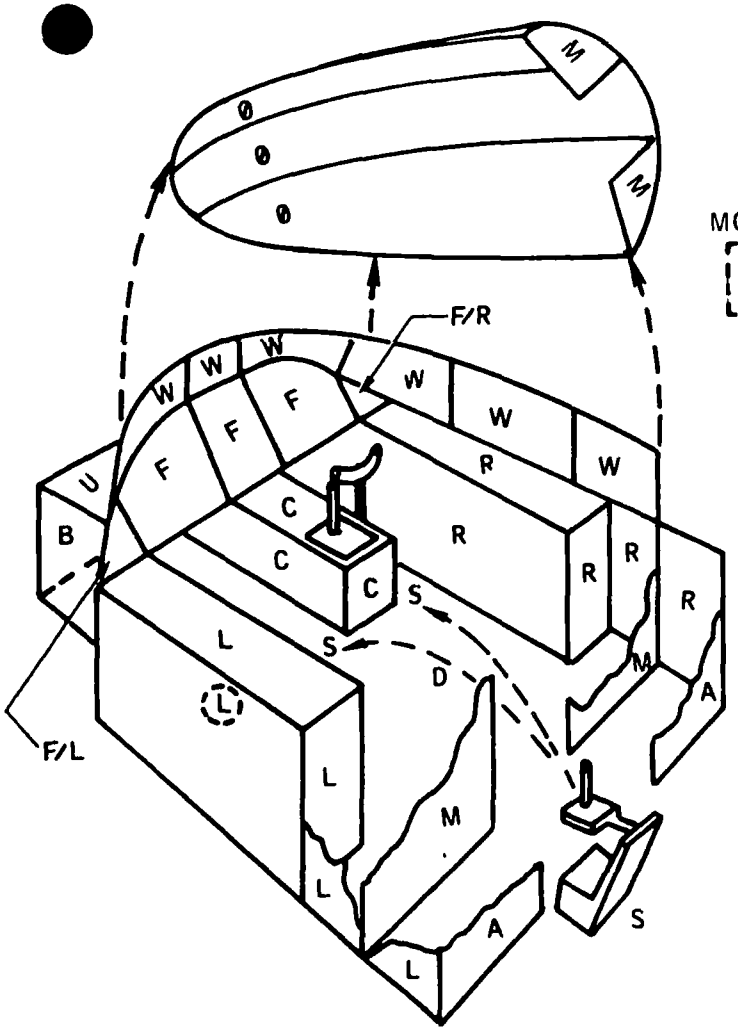
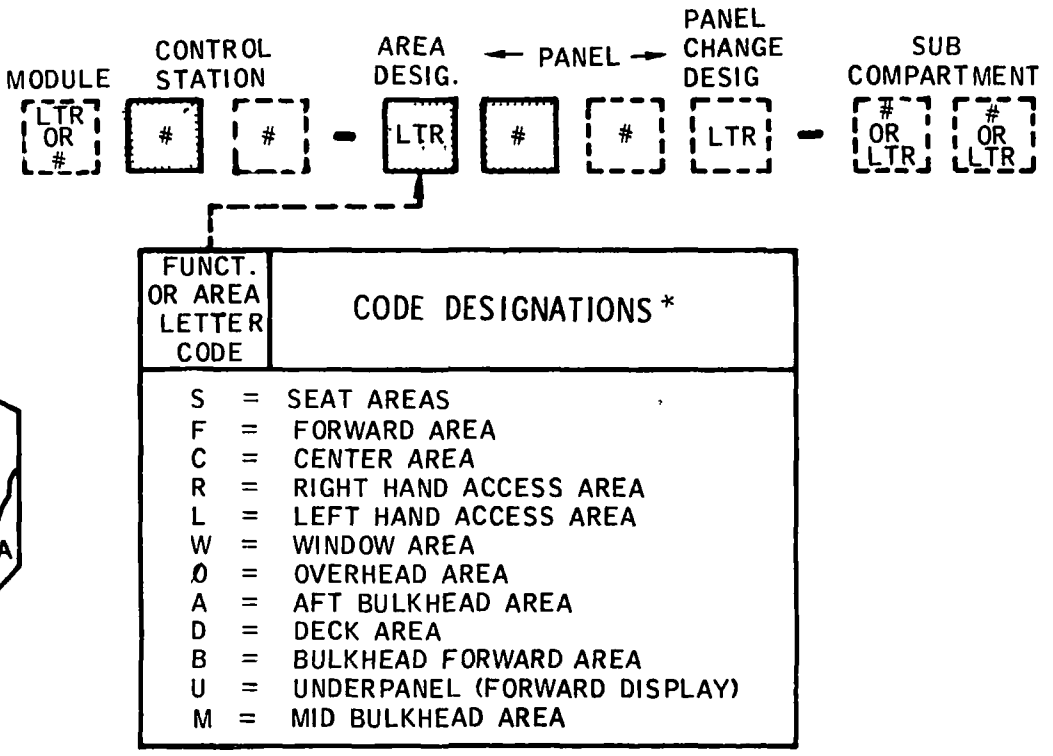


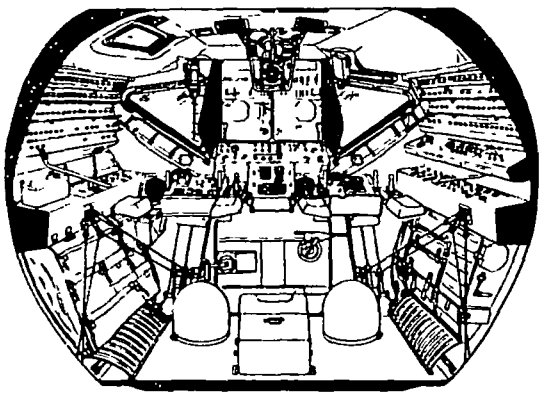
Figure 10. Examples of Deck/Overhead Location Coding

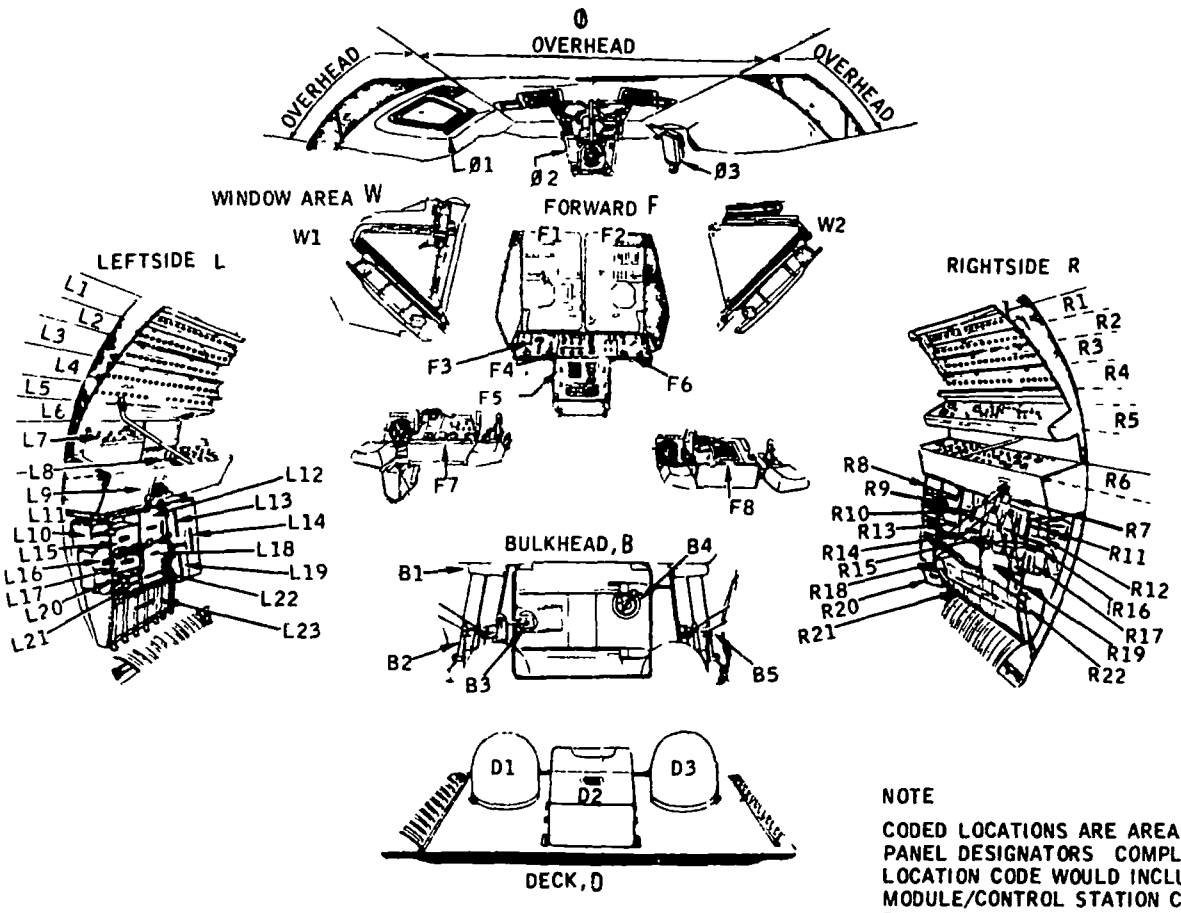




* THESE CODES HAVE DIRECTIONAL SIGNIFICANCE WITH RESPECT TO THE NORMAL "OPERATING" ORIENTATION OF THE CREW TO THE CONTROL STATION.

Figure 11. Control Station Coding Convention





NOTE

CODED LOCATIONS ARE AREA AND PANEL DESIGNATORS COMPLETE LOCATION CODE WOULD INCLUDE MODULE/CONTROL STATION CODE, E G , 11-F1, 11-R12, ETC

Figure 12.

Lunar Landing Type Vehicle Control Station

(Forward Section)

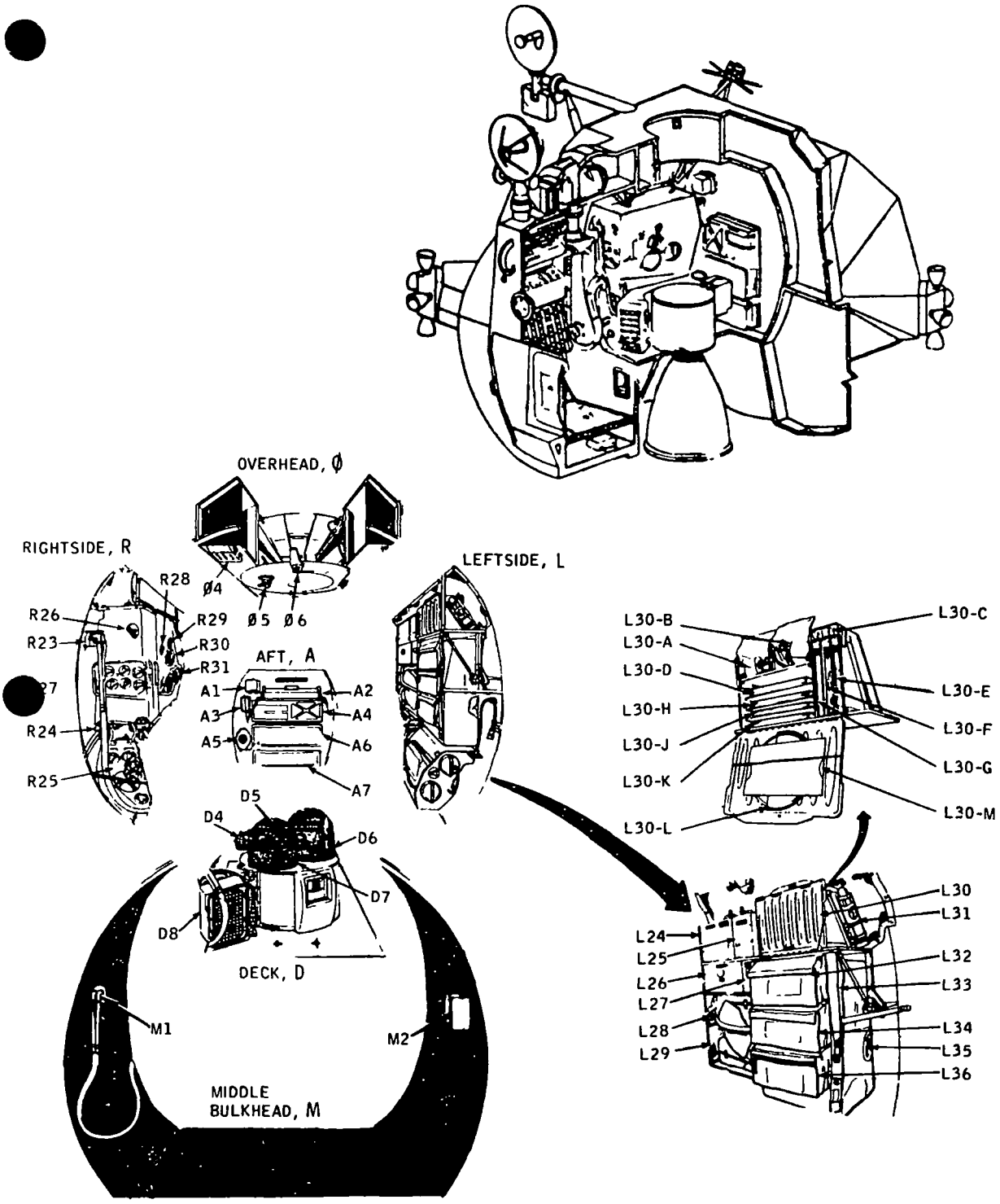
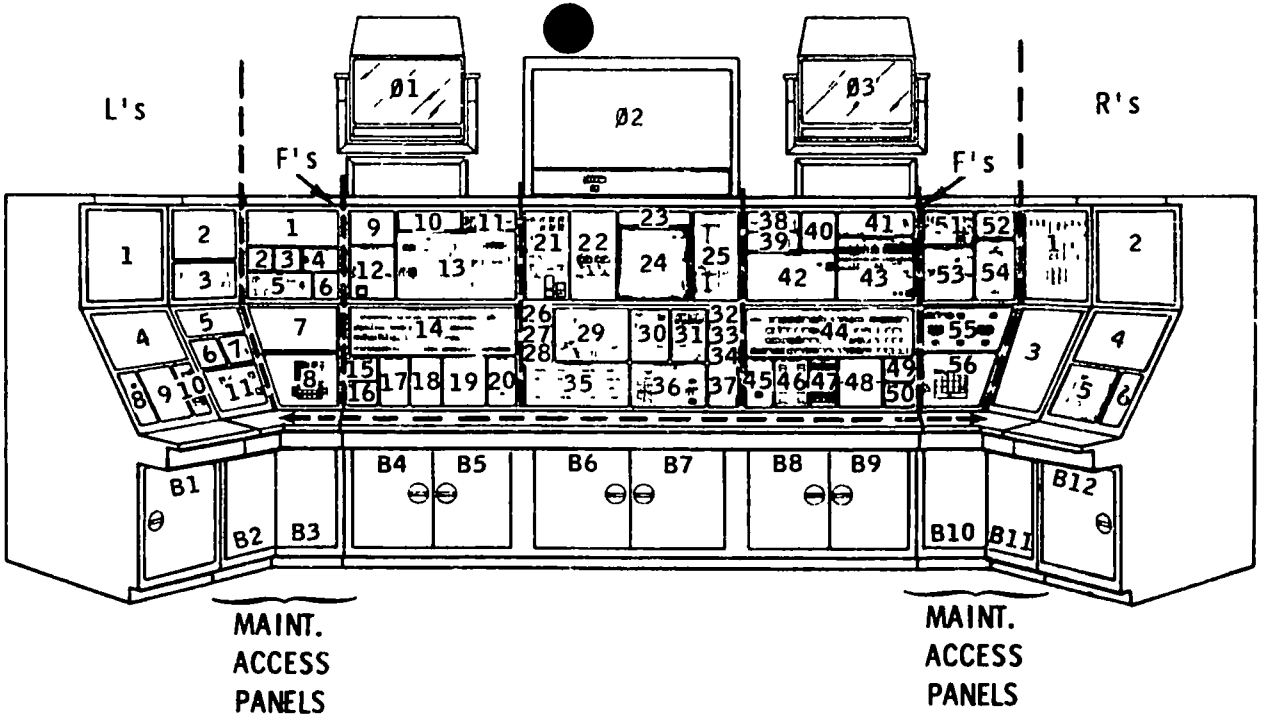


Figure 13.

Lunar Landing Type Vehicle Control Station
(Aft Section)



F = FORWARD CONSOLE PANELS

L = LEFT CONSOLE PANELS

R = RIGHT CONSOLE PANELS

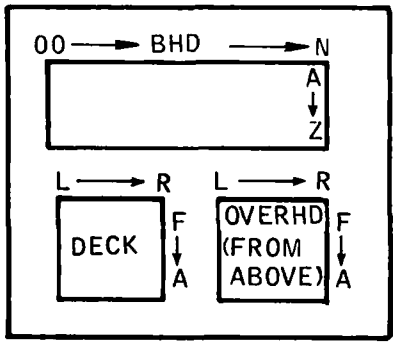
B = BULKHEAD (STOWAGE AREAS)

Ø = OVERHEAD DISPLAYS

- SEQUENTIAL CODING WITH AREAS (L, F, R, B & Ø TOP L→R, TOP →BOTTOM
- T→B, L→R MAY BE MORE APPROPRIATE IN SOME CASES; e.g., F15,16 : F26,27,28 : F32,33,34

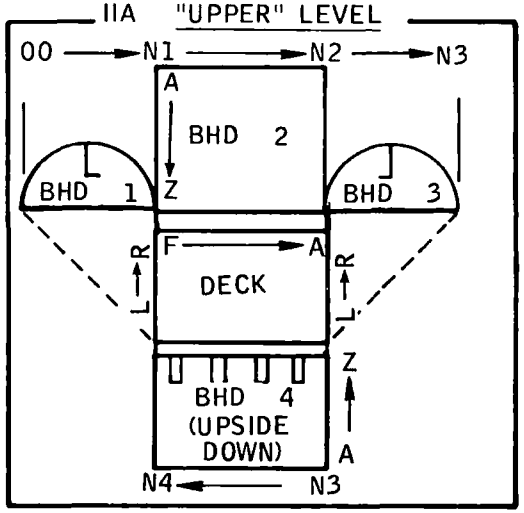
Figure 14. Major Console (Control Station) Coding Example (Room # -)

I PARALLEL DECK/OVERHEAD ROOM

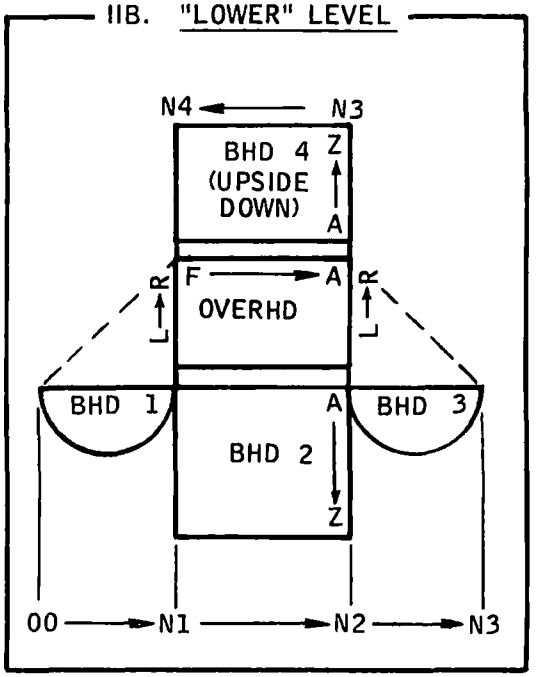


II QUONSET ROOMS

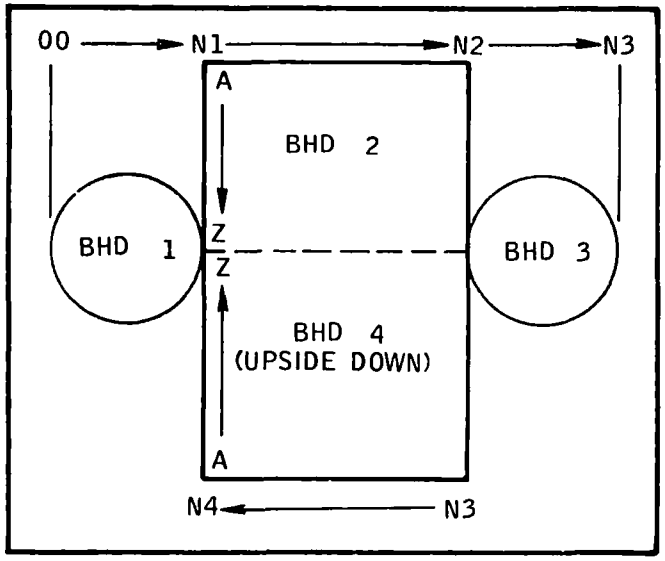
IIA "UPPER" LEVEL



IIB. "LOWER" LEVEL



III. CYLINDER



IV DOME

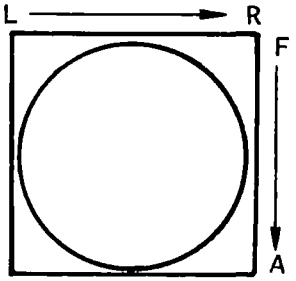


Figure 15. Room Decal Types

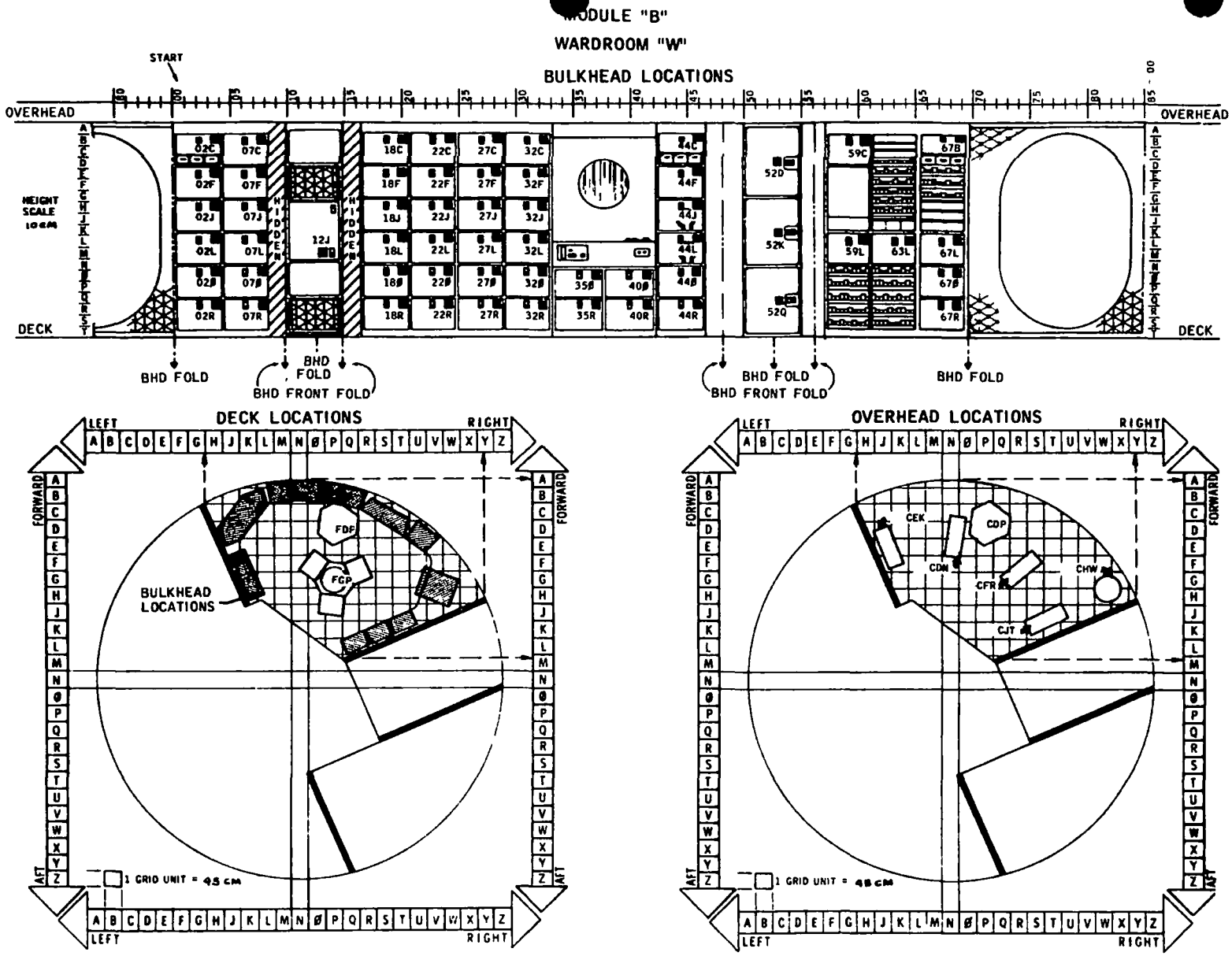


Figure 16. Typical Room Decal

NASA — MSC

SC-S-0011

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER

Houston, Texas

GENERAL SPECIFICATION
PROPOSED LOOSE EQUIPMENT AND STOWAGE MANAGEMENT REQUIREMENTS

This proposed specification has not been approved by the Manned Spacecraft Center and is subject to modification.

FOREWORD

Operational experience in recent manned spacecraft programs has emphasized the need for a specification that will define the basic process required for stowage management on future manned spacecraft programs and identify related data systems and elements necessary for vehicle preparation and stowage, inflight stowage mangement, and post flight stowage operations.

The loose equipment stowage inventory on early space flights was small, and as a result stowage management was accomplished with relatively informal methods of control and tracking. However, on the Apollo Program the number of stowed items greatly increased, and a regularly updated stowage list was implemented as a formally published statement of program stowage requirements.

Stowage in the Skylab Program represented a fourfold increase over the Apollo Program, and as a result continued application of computer technology was necessary for defining stowage requirements. An expanded computer program was developed for the Skylab Program and implemented to provide a central data base from which the Skylab Stowage List, as well as other special reports could be generated. Skylab Program experience has shown that a stowage computer system is essential to future manned space flight programs, and should be expanded to include all data relevant to stowage management, including pre-mission logistics, launch stowage configuration, inflight usage, and post-flight usage.

At the numerous Apollo and Skylab reviews and crew station engineering tests, which were necessary to verify the validity of contractor design implementation

of stowage requirements, the need for timely availability of a new type of stowage drawing that would provide an overview of the loose equipment/spacecraft interfaces became apparent. Such drawings were needed for management visibility into the stowage process, for training and preparation of flight and ground crews, and for quality verification of the stowage preparation of the vehicle. With still further increases in stowage requirements anticipated in future spacecraft programs, and with the continued involvement by multiple spacecraft and payload prime contractors, it is necessary that standardized formats and contents of these summary stowage drawings be established for better program communications and efficiency.

The trend toward larger and more complex spacecraft with larger inventories of loose equipment, and reusable spacecraft requiring rapid refurbishment emphasizes the need for development of efficient stowage management practices and the identification and specification of the requirements for supporting computerized data systems and data products. The stowage management process specified herein, in conjunction with supporting systems and data specifications, has been established to meet these needs.

TABLE OF CONTENTS

FIGURES

1.0 INTRODUCTION

1.1 PURPOSE. The purpose of this specification is to define the general stowage management process to be utilized in manned spacecraft programs and to identify supporting data systems and elements necessary for all phases of a program. Through application of this specification, all program functions, reviews, milestones, tests, and operations requiring stowage activities shall be supported with appropriate stowage equipment and stowage data which previous program experience has shown to be necessary for the adequate preparation of the vehicle and management of spacecraft loose equipment inventories.

1.2 SCOPE. This document establishes the policy, terms, and conditions governing the implementation and execution of the stowage management process and is applicable to all manned spacecraft programs including launch type spacecraft, lunar landers, earth orbital shuttles, space stations, space tug type vehicles and interplanetary spacecraft. Specifically this document provides for:

a. The early definition of a program stowage management process by the contractor during vehicle preliminary design, and incorporation of this process into the overall program plan.

b. The establishment of a stowage information management system which brings together in one data base the information and requirements for stowed equipment management during all phases of the program, including stowed equipment logistics tracking, stowage for launch, in-flight stowage operations, and post-landing stowage operations.

c. Definition of requirements for stowage drawings necessary to support stowage reviews, tests, training, and operations, both on the ground and inflight.

Design requirements for stowed equipment (i.e., mechanical/thermal environment, flammability resistance, etc.,) are out of the scope of this specification. Stowed equipment design requirements are contained in the applicable CEI specification for each item of spacecraft loose equipment.

1.3 APPLICABLE DOCUMENTS. The following documents, of the issue in effect on the date of invitations for bids or procurement, form a part of this specification to the extent specified herein.

1.3.1 NASA Specifications.

SC-C-0009	General Specification, Proposed Operations Location Coding System For Crew Interfaces
SC-S-0012	General Specification, Proposed Loose Equipment and Stowage Data Base Information Requirements
SC-S-0013	General Specification, Proposed Spacecraft Loose Equipment Stowage Drawing Requirements
SC-S-0014	General Specification, Proposed Inflight Stowage Management Documentation Requirements

1.3.2 Other Documents.

MIL-STD-100A	Engineering Drawing Practices
MIL-D-1000	Drawings, Engineering & Associated Lists
NHB 8040.2	Apollo Configuration Management Manual
MSC 01160A	Skylab Program Configuration Management Plan

1.4 DEFINITIONS. For the purpose of this specification, the following definitions shall apply:

a. Stowage - The placement and restraint of loose equipment carried on board the spacecraft.

b. Stowage Provisions - Spacecraft equipment (CFE) designed to contain, restrain, or protect loose equipment (i.e., containers, lockers, tiedowns, attachments, etc.)

c. Stowed Equipment - Loose equipment which is stowed on board the spacecraft (for details on the level to which loose equipment is itemized, see definition of item number in NASA/MSC Specification SC-C-0012).

d. Stowage Hardware - Stowed equipment and stowage provisions (includes flight equipment, prototypes, engineering mockups, training equipment, etc.)

e. Mockup - A model which simulates the size, shape, volume, etc: of space craft equipment. Mockups are used during conceptual studies and design phases to aid in engineering evaluation of equipment design, and later in the program for evaluation of proposed changes to stowage provisions and stowed equipment, flight crew training in stowage procedures, etc.

f. Graphics - Pictorial data, such as drawings, stowage maps, illustrations, etc. (As distinguished from tabular stowage data such as lists, procedures, logs, etc.

g. Negative Reporting - Verbal reports (such as changes to planned stowage procedures) which are entered manually into a computer system. (As distinguished from positive reporting in which information is received by direct data link between terminals of the system).

h. Consumables - Items carried on board which are consumed during the normal course of the mission (i.e., food, water, oxygen, propellant, etc.)

i. Expendables - Items carried on board which are expended through normal use (i.e., film cassettes, magnetic tape, sample bags, soap, towels, etc.)

j. Prepack - The preparation of stowed equipment for subsequent stowage in the spacecraft. Prepack activities may include packaging, folding, grouping of several items into larger stowable assemblies, packages, kits, etc., as well as stowage of items into lockers or containers which have been removed from the spacecraft for stowing during prepack.

k. CEI - Contract End Item (Ref. NHB 8040.2, Apollo Configuration Management Manual)

l. CCSR - Crew Compartment Stowage Review (See 3.3.2)

m. CCFF - Crew Compartment Fit and Function Test (See 3.3.4)

n. CFF - Crew Fit and Function Test (See 3.4.1)

o. PDR - Preliminary Design Review (Ref. NHB 8040.2, Apollo Configuration Management Manual)

p. CDR - Critical Design Review (Ref. NHB 8040.2, Apollo Configuration Management Manual)

q. CFE - Contractor Furnished Equipment (As applied to stowage: That loose equipment and stowage provisions which are furnished by the Spacecraft Prime Contractor.)

r. GFE - Government Furnished Equipment (As applied to stowage: That loose equipment which is furnished by NASA and for which stowage provisions are the responsibility of the prime contractor.)

s. CCB - Configuration Control Board (Ref. NHB 8040.2, Apollo Configuration Management Manual).

t. CCP - Configuration Control Panel (Ref. MSC 01160A, Skylab Program Configuration Management Plan).

u. CCBD - Configuration Control Board Directive (Ref. MSC 01160A, Skylab Program Configuration Management Plan).

v. RECP - Request for Engineering Change Proposal (Ref. MSC 01160A, Skylab Program Configuration Management Plan).

w. ICD - Interface Control Document (Ref. NHB 8040.2, Apollo Configuration Management Manual).

x. OCP - Operational Checkout Procedure. The procedure by which a spacecraft systems test is performed.

y. TCP - Test Checkout Procedure (Similar to OCP).

z. TOD - Test Outline Drawing (Similar to OCP).

aa. SEDR - Systems Engineering Design Requirement (Similar to OCP).

2.0 RESPONSIBILITIES. The National Aeronautics and Space Administration, Manned Spacecraft Center (NASA/MSC) shall insure compliance to this specification by contractors or designated government organizations responsible for implementation of the stowage management process defined herein for manned spacecraft programs. As a minimum this shall include:

a. Organizations responsible for management of program stowage information (stowage data base, stowage lists, special reports, etc.).

b. Organizations responsible for management of stowed equipment support for program reviews and milestones.

c. Organizations responsible for design and allocation of spacecraft stowage provisions and contractor-furnished stowed equipment (CFE).

d. Organizations responsible for government furnished stowed equipment (GFE).

e. Organizations responsible for preparation of onboard stowage documentation used inflight during manned spacecraft operations.

Requests for deviations, additions, or deletions to this specification shall be forwarded to the applicable NASA/MSC spacecraft program office.

3.0 DESCRIPTION OF THE NASA STOWAGE PROCESS.

3.1 GENERAL DESCRIPTION. (See Figure 1) Stowed equipment management for a manned spacecraft program is a process which spans all major

phases of the system development cycle. In order to describe the stowage management process it is necessary to relate the functional interaction of the following elements:

a. Program activities and milestones which involve review of stowed equipment and stowage provisions.

b. Program configuration management as it relates to control of stowed equipment and stowage provisions.

c. Program provisions for stowage data management, including a central stowage data base, regularly updated stowage lists and special stowage information reports.

d. Stowage drawings and inflight stowage management data which illustrates the design implementation and planned operational management of stowage requirements.

e. Stowage equipment hardware logistics requirements to support stowage activities and milestones.

Figure 1 is an overview of the stowage management process which illustrates in summary form for a typical spacecraft program the interaction of the above elements as the program progresses through analysis, definition, design, development and finally flight operations. In the following sections (3.2 - 3.4) the stowage management process is described in detail, with accompanying fold-out illustrations (Figures

2, 4, 5) which depict portions of the stowage process in greater detail than shown in Figure 1. Specific requirements for contractor implementation of this loose equipment and stowage management process are specified in 4.0.

3.2 STOWAGE PROCESS DURING SPACECRAFT SYSTEM DEFINITION AND PRELIMINARY DESIGN (SEE FIGURE 2).

3.2.1 Phase A Stowage Activities. During the preliminary analysis phase (Phase A) primary program emphasis is placed on the definition of spacecraft systems requirements. The stowage activities during this period consist of conceptual and functional studies of stowage requirements for the spacecraft to support requirements defined for other systems such as habitability, life support, experiments, medical, operations support, leisure/recreation, etc. The program requirements baseline is established during this phase with part 1 of the contract end item specification, and with one or more preliminary requirements reviews to examine requirements specifications, system analyses, and functional and conceptual drawings. The stowage data system functional specification and associated data base elements, which define the baseline stowage documentation concept to be used for the remainder of the program, are also reviewed during Phase A. (See Section 5.0).

3.2.2 Phase B Stowage Activities. As preliminary design activities commence during the systems definition phase (Phase B), stowage concepts are further refined in conjunction with spacecraft systems definition. Late in Phase B (or early in Phase C) the preliminary design review (PDR) is held, at which time Part 1 of the contract end item specification is approved, establishing the spacecraft design requirements baseline.

Basic stowage requirements are identified in system engineering flow diagrams such as illustrated in Figure 3. The stowage data management system design is approved at this time and is put under formal control of the program stowage management organization. Stowage design concepts such as standard and modularized stowage containers, rough spacecraft stowage provisions mockups and stowed equipment volumetric mockups are reviewed at the PDR, supported by preliminary spacecraft design drawings.

3.3 STOWAGE PROCESS DURING CRITICAL DESIGN AND DEVELOPMENT (SEE FIGURE 4).

3.3.1 Critical Design Review (CDR). As detailed spacecraft design progresses during Phase C, and design details of stowed equipment (GFE & CFE) become available, the design of spacecraft stowage provisions commences. Since stowage provisions design is necessarily dependent on spacecraft design (i.e., structure, wall placement, systems placement, etc.), finalization of stowage provisions will usually follow the design of spacecraft structure. Late in Phase C (or early in Phase D) the critical design review is held, at which time the compatibility of the spacecraft design with the CEI specification is reviewed by reference to detailed drawings (90 - 95% complete). Among the incomplete drawings are those stowage provisions which await approval of spacecraft structural designs, stowed equipment definition, etc. At the time of CDR, high fidelity spacecraft mockups are reviewed, together with mockups of GFE & CFE stowed equipment (to the extent that they can be defined at the time). Spacecraft functional schematics are reviewed, and interface control drawings (ICD's) are defined for stowed equipment interfaces between

GFE and CFE hardware. At the completion of CDR, the spacecraft drawing baseline is established, and formal configuration management is implemented.

Additional design reviews (Δ CDR) may be required to cover open work or changes resulting from the CDR. Stowage design may or may not be involved in these Delta reviews.

3.3.2 Crew Compartment Stowage Review (CCSR). The Crew Compartment Stowage Review (CCSR) is held to verify the design adequacy of stowage provisions and stowed equipment to meet vehicle mission requirements and plans. Crew equipment/vehicle interfaces are assessed, and stowage procedures are reviewed and verified in preparation for later stowage fit and function tests on the flight vehicle. The review is scheduled so as to precede flight vehicle stowage tests in sufficient time to identify and correct discrepancies prior to these tests. The CCSR is held at the contractor's facility utilizing a high fidelity mockup spacecraft or test article. GFE and CFE stowed equipment is provided in either production or mockup configuration as available.

Requirements for hardware support are defined prior to CCSR by the release of the first complete spacecraft stowage list. Prior to prepack for the CCSR, all crew equipment to be used is laid out and inspected by the flight crew and engineering personnel for conformance to the stowage list, adherence to ICD's and adequacy for use during the review. In conjunction with the operational flight crew review of GFE and CFE stowage interfaces, an engineering review is made of spacecraft stowage provisions design and CFE stowed equipment design to verify design adequacy, conformance to ICD's, etc. Summary stowage illustrations (see Spacecraft Loose Equipment Stowage Drawings, Section 6.2) are

delivered in preliminary form at the CCSR and are utilized as a working document for crew and engineering personnel in evaluating stowage provisions and procedures. The loose equipment stowage drawing is subsequently updated continuously for use in stowage activities during crew training, vehicle test and checkout, and launch stowage.

At completion of CCSR the baseline stowage list is established and forms the initial stowage data base which is placed under configuration management control. Officially approved documentation is then required before changes can be made to the data base.

Additional stowage reviews (Δ CCSR) may be required at the contractor facilities or NASA centers to review open items from the CCSR, other approved stowage changes, etc. Requirements for Δ CCSR's are usually identified by the CCSR review board or later when changes to mission requirements result in stowage redesign.

3.3.3 Stowage Configuration Management. Throughout the system development cycle, requests for changes to spacecraft stowage, which result from stowage reviews, tests, new mission requirements, etc., are made through the various levels (I, II, III) of configuration control panels (CCP's) or control boards (CCB). Approved changes are documented by configuration control board directives (CCBD). The spacecraft program project/contracts offices send the necessary technical direction or contract change (CCA) to GFE and CFE contractors as required by the CCBD. The program stowage management office issues the necessary stowage list change notices which update the stowage data base to reflect the change.

Changes to stowage locations resulting from the change are furnished directly by the contractor to the program stowage management office and documented as revisions to the spacecraft loose equipment stowage document (see Section 6.2). Regularly updated spacecraft stowage lists are issued by the stowage management office, and special stowage information reports (on-line and hard copy) are available from the data base to support program stowage activities and milestones as required (see Section 5.4).

3.3.4 Stowage Activities During Vehicle Assembly, Test, and Checkout.

Stowage activities in the period between CCSR and spacecraft delivery are associated with test and checkout of the spacecraft systems and crew operational training exercises which involve stowage provisions, procedures, or equipment. The relationship of the stowage process to each of these activities is discussed in the following paragraphs:

a. Vehicle Systems Tests. A large number of vehicle/module systems tests, particularly those involving habitability systems and experiments, require stowed equipment support. Flight and/or flight-type stowage items are required for spacecraft contractor subsystem and system tests to the extent necessary for vehicle checkout. These tests include fit checks and operational procedures which verify the compatibility of the stowed equipment (GFE & CFE) with the spacecraft design. These systems tests are supported by formally documented procedures such as OCP's, TOD's, TCP's, SEDR's, etc. Requests for changes to stowage provisions or

stowed equipment resulting from these tests are processed as in 3.3.3. The most significant vehicle systems test affecting stowage is the crew compartment fit and function test (CCFF) which is discussed in 3.3.4(c).

b. Stowed Equipment Bench Review. Prior to the crew compartment fit and function test (CCFF), all stowed equipment to be used in the test is laid out and inspected by the flight crew and its support team. Flight and/or flight-type items are checked for conformance to the vehicle stowage list, adherence to ICD's, and flight configuration worthiness. The bench review is usually scheduled just prior to the CCFF. Equipment support requirements for the CCFF can be identified utilizing the stowage data base, and special reports of these requirements can be generated and used in preparation for the review. The goal of the bench review is to ensure stowed equipment readiness for CCFF.

c. Crew Compartment Fit and Function Test (CCFF). The CCFF test is an operational checkout conducted at the vehicle contractor's facility at an appropriate time in the factory checkout sequence. All stowed GFE and CFE crew equipment is reviewed for compatibility with planned mission operations and for interfaces with other equipment and with the vehicle itself. All crew equipment configuration is either approved for flight or changes recommended and implemented as necessary through the appropriate change authority (see 3.3.3). The checkout takes place in the actual flight vehicle, under clean room conditions, with flight configuration hardware. The exercise consists of simulated

mission usage, including vehicle stowage, unstowing and restowing operations to verify planned inflight equipment usage. The review is scheduled in sufficient time to identify and correct discrepancies prior to delivery of the vehicle.

All GFE crew equipment is scheduled for delivery to the contractor's facility not less than 30 days before the date of the review in order to allow sufficient time for handling, inspection, and bench review (Ref. 3.3.4b). Contractor developed CCFF procedures, updated stowage lists, special stowage information reports and the spacecraft loose equipment stowage drawing(s) are required for the test participants as working tools during CCFF. At the conclusion of the test a review board considers the results and assigns to resolve open items.

d. Crew Operational Training Exercises. In parallel with the vehicle test and checkout sequence, crew operational training exercises are conducted at contractor facilities or NASA centers utilizing training and mockup spacecraft and stowed equipment. The stowed equipment hardware support requirements for crew training is a necessary part of the stowage management system data base. Special data reports are available from the data base to aid in logistics planning of these functions.

e. Preparation of Inflight Stowage Documentation. Included in the on-board flight data file for the spacecraft is the inflight stowage management documentation. This data is prepared in parallel with vehicle test and checkout

and is evaluated by the crew during manned stowage tests and crew training exercises. The stowage data base and spacecraft loose equipment stowage drawing(s) serve as primary sources for tabular and graphic flight stowage data respectively. Alphabetical stowage equipment lists, transfer lists, stowage maps, detail location illustrations, and stowage location histories assist the crew during inflight stowage activities. (See Section 6.3).

3.4 STOWAGE PROCESS DURING LAUNCH PREPARATION AND FLIGHT OPERATIONS (SEE FIGURE 5).

3.4.1 Launch Site Stowage Activities. In the period between vehicle delivery and mission launch, the following activities involving stowage are conducted at the launch site:

a. Bench Reviews. Conducted prior to final CCFF tests to verify flight worthiness of all stowed equipment, particularly late deliveries.

b. Delta Crew Compartment Fit and Function Test (Δ CCFF) Conducted at the launch site to assure final verification of crew equipment, crew interfaces, and stowage procedures. Additional Δ CCFF tests may be required, especially if there is a long time period between the initial test and launch stowage.

c. Altitude Chamber Test All stowed equipment must be of flight configuration and designated as the flight item for the vehicle. Stowage of the vehicle is usually conducted using the identical procedures used for flight stowage.

(Altitude chamber tests may also be conducted at contractor facilities prior to vehicle delivery.

d. Special Equipment Crew Fit and Function Tests (CFF) Conducted for stowed experiments, payloads, extravehicular crew equipment, etc., in order to verify worthiness of the flight equipment and procedures. These tests are usually conducted at the launch site but at a location away from the flight vehicle.

e. Late Fit Checks For stowed equipment not fit checked at the contractor's facility. These fit checks may be incorporated into the Δ CCFF test or conducted independently.

f. Count Down Demonstration Test (CDDT) The crew station is usually partially stowed, as required to accomplish test objectives, with the flight hardware in order to assure a true CDDT for the complete space vehicle. Normally the stowed equipment is not exercised during this activity, with the exception of space suits and other crew carry-on type items.

g. Flight Stowage The final stowage before launch. After flight stowage has been accomplished, there are no changes to stowed equipment. In the event that launch is recycled and restowage is required, any changes require approval of program management. Recycle requirements applicable to stowed equipment are provided by equipment suppliers and are part of applicable stowage procedures.

h. Postflight Vehicle Stowage. The unstowing of the spacecraft after return to earth. Stowage operations will be required on return vehicles to remove expendables, used personal equipment (spacesuits, etc.), and limited life items which must be replaced or refurbished, as well as unstowing of payloads returned to earth aboard the shuttle.

The stowage information management system (see Section 5.0) furnishes updated stowage lists and special reports to support hardware tracking for each of the activities listed above. The spacecraft loose equipment stowage documents are utilized as references for both the flight crew, engineering support teams, and quality control personnel who monitor vehicle stowage. Late requests for stowage changes resulting from launch site tests are referred to the appropriate configuration control board and coordinated with center CCB activities. The stowage data base is updated continuously as previously outlined in Section 3.3.3.

3.4.2 Stowage Activities During Flight Operations. The stowage management process during flight operations addresses inflight tracking and ground tracking of loose equipment, consumables, and expendables in order to: (1) assist the crew inflight with stowage procedures for equipment transfers, housekeeping, operational experiments, and preparation for changes in mission phase (such as re-entry); (2) aid in making preparations at the launch/landing site for post-flight stowage operations; and (3) aid in preparing stowage and resupply requirements for the next mission. Figure 5 illustrates the functional relationship of the stowage management elements during flight operations. Off-nominal stowage activities and inventory reports

(negative reporting) are furnished by the spacecraft crew to the ground-based stowage management team, who update the data base and initiate any actions requiring program management approval for stowage changes, procurements, and procedures changes in support of the mission and for future launches. The stowage information management system furnishes special reports which support the stowage management team and mission control in the management of stowage configuration, mass properties, procedures update, onboard inventory, and resupply planning. The stowage list for the next mission is continually updated. Inflight stowage documents (see Section 5.3) are utilized by the spacecraft crew in performance of mission activities inflight, and returned to earth for use during postflight ground stowage operations.

4.0 LOOSE EQUIPMENT AND STOWAGE MANAGEMENT PROCESS DEFINITION BY CONTRACTOR.

Contractor definition of the method by which the loose equipment and stowage management process described in this specification is to be implemented shall be a requirement for all manned spacecraft programs. The contractor's stowage management plan shall be submitted at the preliminary design review (PDR), formalized at the critical design review (CDR), and updated when functions involving major stowage management changes are implemented. The stowage management plan shall include the contractor's approach to implementing:

a. Stowage process functional flow diagram (see Figure 3) which defines in functional terms such stowage related requirements as inflight resupply, operational aspects of consumption of food, water, spares, personal

hygiene equipment and medical supplies, inventory requirements, bulk-stowage changes, etc.

b. Reviews, tests, and milestones involving stowage (see Section 3.2 - 3.4).

c. Contractor interface with the NASA stowage information management system (see Section 5.0).

d. Spacecraft loose equipment stowage drawing (see Section 6.2).

e. Control and handling of CFE loose equipment at the contractor facility and launch site.

f. Control and handling of GFE loose equipment in accordance with approval GFE handling procedures.

g. Inflight stowage management (see Sections 3.4.2, 6.3).

5.0 STOWAGE INFORMATION MANAGEMENT.

5.1 GENERAL DESCRIPTION. Management of stowage data for manned spacecraft programs shall be implemented by NASA/MSC through the use of a computerized stowage information management system, employing a central stowage data base from which all stowage information reports shall be generated. This stowage information system shall be employed through each phase of the spacecraft development cycle and shall provide the necessary flexibility to handle changing requirements for stowage information as the program progresses from design to manufacturing, checkout, and

flight operations (see Figure 1). Detailed requirements for the stowage computer information system are contained in NASA/MSC Spec SC-S-0012. The following sections describe general requirements for the stowage data base, stowage information reports, and scheduling requirements which relate the stowage computer information system definition to program milestones.

5.2 STOWAGE DATA BASE. The stowage data base shall contain provisions (data elements) for all information necessary to identify and describe each stowed item of equipment on the spacecraft, its usage inflight (stowage locations, inflight, transfers, etc.), and its usage in support of program stowage activities during design, development, checkout, and launch preparation. The number of data elements necessary to accomplish these requirements may vary from one program to the next, however from experience on manned spacecraft programs to date there has been established a set of data elements common to all programs which provides a baseline upon which stowage information systems for future programs can be tailored. This baseline set of stowage data elements is defined in NASA/MSC specification SC-S-0012. The stowage data elements constitute a data base into which all program stowage information is filed, and from which all stowage management reports are generated.

5.3 STOWAGE INFORMATION USAGE BLOCKS. The stowage data elements discussed in 5.2 may be grouped into five functional blocks to facilitate updating of information by the user. These blocks of information are described below. Examples of input on-line displays for each of these data blocks are contained in NASA/MSC Specification SC-S-0012.

a. Common Data. Data element entries which are required for (or of interest to) all users of the stowage information system, e.g.,item number, nomenclature, functional descriptor, part no., weight, etc.

b. Item Development/Supply Summary. Data element entries characteristic of summary procurement information for a given item, e.g., Total quantity ordered, replacement time, spares requirements, qualification status, mission effectivity for item usage, etc.

c. Stowage Activity Support. Data element entries associated with the tracking of item hardware types (flight hardware, flight-type, training hardware, mockups, etc.) and their scheduled usage in program activities and milestones, e.g., Milestones, milestone date, location, type of hardware required, preinstallation acceptance data requirements, etc.

d. Spacecraft Stowage Configuration. Data element entries which describe the item status relative to its stowage allocation for a specific mission phase, e.g., Stowage location, quantity, mission phase (launch, return, orbit, etc.).

e. Inflight Stowage Management. Data element entries associated with the inflight transfer and management of a stowed item, e.g., Activity elements wherein the stowed item is affected, "from" location, "to" location, and quantities involved.

5.4 STOWAGE INFORMATION REPORTS. The stowage information management system shall be capable of providing both on-line reports and hardcopy (batch) reports. On-line reports are utilized for the following functions:

a. Display of information in connection with making updates and changes to the stowage data base.

b. Real time display of information for stowage planning and flight control activities on the ground.

c. Display of information to the crew onboard the spacecraft (at such time that spacecraft are provided with an onboard information system terminal. The design of such a data management system will determine the format/content of these displays).

Hard-copy reports are utilized for the following functions:

a. To establish and control spacecraft stowage configuration (i.e. spacecraft stowage lists, transfer lists, etc.).

b. To provide reference material for special studies (i.e. mass properties reports, transfer summaries, logistics requirements, etc.).

c. To manage stowed equipment inflight (onboard stowage configuration reference data).

Details of format and contents of stowage information reports are contained in NASA/MSC Specification SC-S-0012. Inflight stowage data requirements are contained in NASA/MSC Specification SC-S-0014.

5.5 SCHEDULING AND CONTROL REQUIREMENTS (SEE FIGURE 2 AND 4).

During Phases A-B the functional specification shall be defined for the stowage computer information management system, and data base elements shall be defined in accordance with NASA/MSC Specification SC-S-0012. At the preliminary design review (PDR) the functional specification and data elements shall be approved and any further changes shall be controlled by the spacecraft program office stowage management organization.

The first rough draft of the contents of the stowage data base shall be provided at the PDR in the form of preliminary basic data (item identifications, functional descriptor, etc.). This data shall be updated at the critical design review (CDR). At an appropriate time prior to the spacecraft stowage review (CCSR), the first complete stowage list shall be released in batch report format. This list shall serve as the requirements document to be used in evaluating stowage provisions during CCSR. At the conclusion of CCSR the baseline stowage list will be approved, and any further changes will be controlled by the spacecraft program configuration management system. Approved configuration control board directives (CCBD's) affecting stowage are referred to the program stowage management organization, who in turn shall make the necessary inputs/updates to the data base. A stowage list change notice documents each change to information in the data base.

The program stowage management organization shall act as the clearing house for all requests for stowage information reports, and shall publish the more widely used reports on a regular schedule. As a minimum this shall include the spacecraft stowage list(s). (Ref. NASA Specification SC-S-0012).

6.0 STOWAGE DRAWING REQUIREMENTS.

6.1 GENERAL DESCRIPTION. Drawings associated with stowage management may be described in three categories:

a. Design Drawings. The engineering drawings to which stowed equipment and vehicle stowage provisions are manufactured.

b. Loose Equipment Stowage Drawings (In Previous Programs called Field-Site Installation Drawings). Which illustrate pictorially in three dimensions the spacecraft stowage provisions and equipment to be stowed at each spacecraft stowage location for each applicable mission phase.

c. Inflight Stowage Maps and Location Illustrations. Which are simplified pictorial illustrations of the spacecraft stowage configuration for use by the crew during the mission.

The requirements for engineering design drawings for stowed equipment and stowage provisions do not form a part of this specification. Engineering drawing requirements for NASA manned spacecraft programs are contained in MIL-STD-100A, and MIL-D-1000. The following sections describe general requirements for loose equipment stowage drawings and inflight stowage drawings.

6.2 SPACECRAFT LOOSE EQUIPMENT STOWAGE DRAWING. A spacecraft loose equipment stowage drawing shall be prepared by the vehicle prime contractor for each spacecraft vehicle (or module) illustrating implementation of stowage requirements defined by the spacecraft stowage list. The format and content of the loose equipment stowage drawing is defined by NASA/MSC Specification SC-C-0013. Figure 6 shows the basic configuration of the drawing. The purposes and functions served by the loose equipment stowage drawing are:

a. To serve as the single summary document in which the implementation of stowage requirements (CFE & GFE) identified in the spacecraft stowage list is documented for each spacecraft vehicle (or module).

b. To illustrate in three dimensional detail the stowage configuration of each stowage location identified by a unique operations location code (Ref. NASA/MSC Specification SC-C-0009).

c. To illustrate for each stowage location the item(s) to be stowed, the spatial orientation of the item(s), and where necessary the stowage sequence of the items.

d. To serve as a data reference for field use by personnel who perform vehicle stowage and personnel who monitor and check the stowage.

e. To serve as a working reference document for flight crew and engineering personnel in evaluating stowage and planning stowage changes during vehicle design, development, and checkout.

f. To serve as the basic reference for preparation of inflight stowage drawings utilized by the flight crew during the mission.

Figures 2, 4, and 5 illustrate the usage of the loose equipment stowage drawing during the spacecraft development cycle. The loose equipment stowage drawing shall be delivered in preliminary form at the earliest vehicle milestone at which stowage design is reviewed (usually CCSR) and further updated continuously as changes are made to stowage design. It is especially important that the drawing reflect the present state of spacecraft design for crew interface reviews on flight vehicles such as CCFF, altitude chamber, etc. NASA/MSC Specification SC-S-0013 delineates the method to be utilized in revising the drawing as changes to stowage design are made.

6.3 INFLIGHT STOWAGE MANAGEMENT DOCUMENTATION. The in-flight stowage drawings, together with supporting tabular stowage data, make up the onboard stowage management documentation which is utilized by the crew during the mission. Figure 7 illustrates the basic sections of data and graphics which make up the onboard stowage configuration document. The stowage maps and detailed stowage location illustrations carried inflight are similar in content to the spacecraft loose equipment stowage drawing (Section 6.2) but are simplified to the extent that information not necessary for inflight usage is deleted (such as equipment part numbers, assembly numbers, special ground stowage instructions, etc.). Detailed requirements for inflight stowage management documentation is contained in NASA/MSC Specification SC-S-0014.

The inflight stowage management data shall be prepared for each spacecraft and/or module for use during the vehicle test and checkout period, sufficiently early to support the necessary crew training exercises and flight data reviews, and must be updated to reflect the final as-flown configuration of the vehicle and payloads.

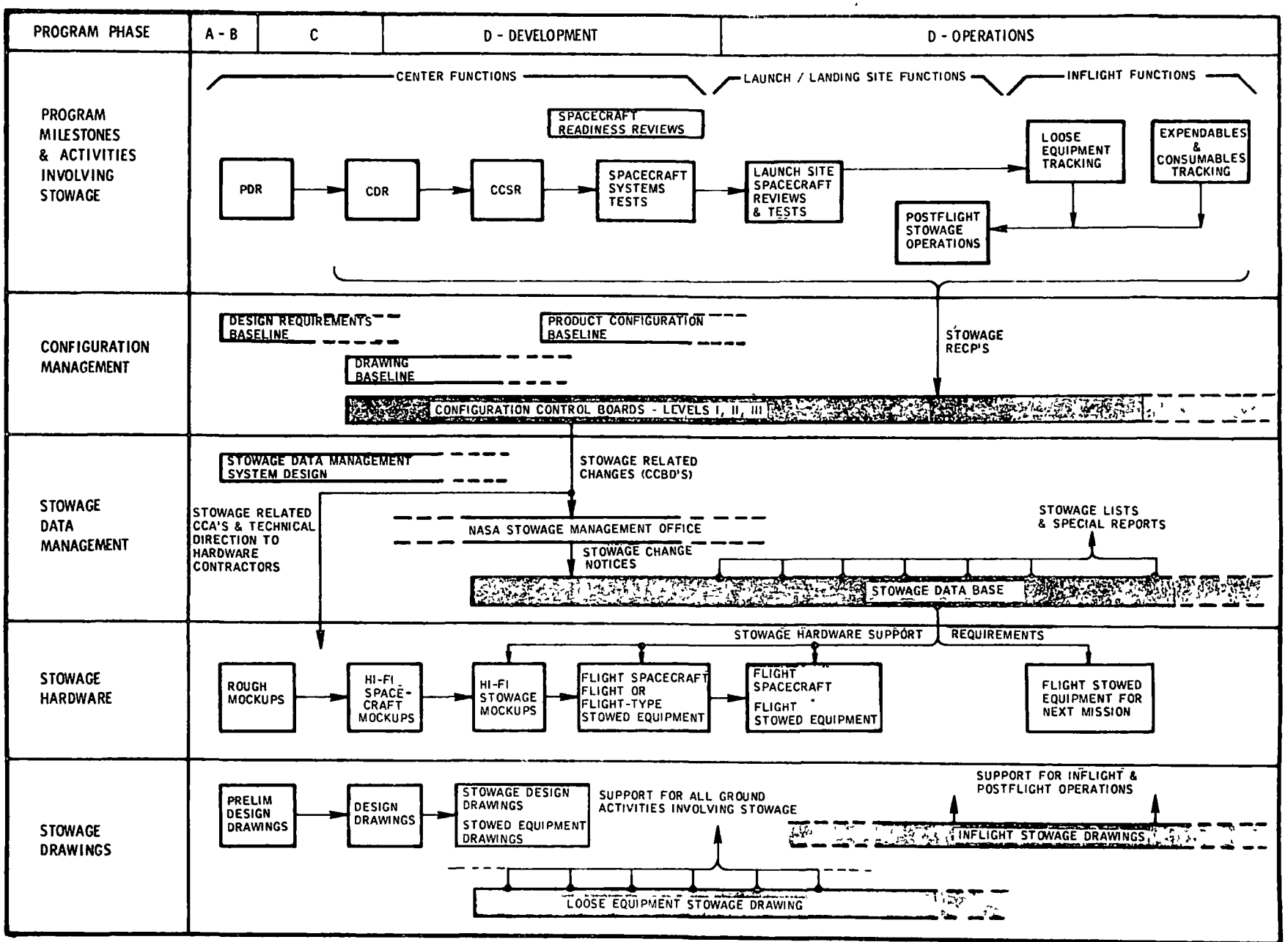


FIGURE 1 - NASA STOWAGE MANAGEMENT PROCESS

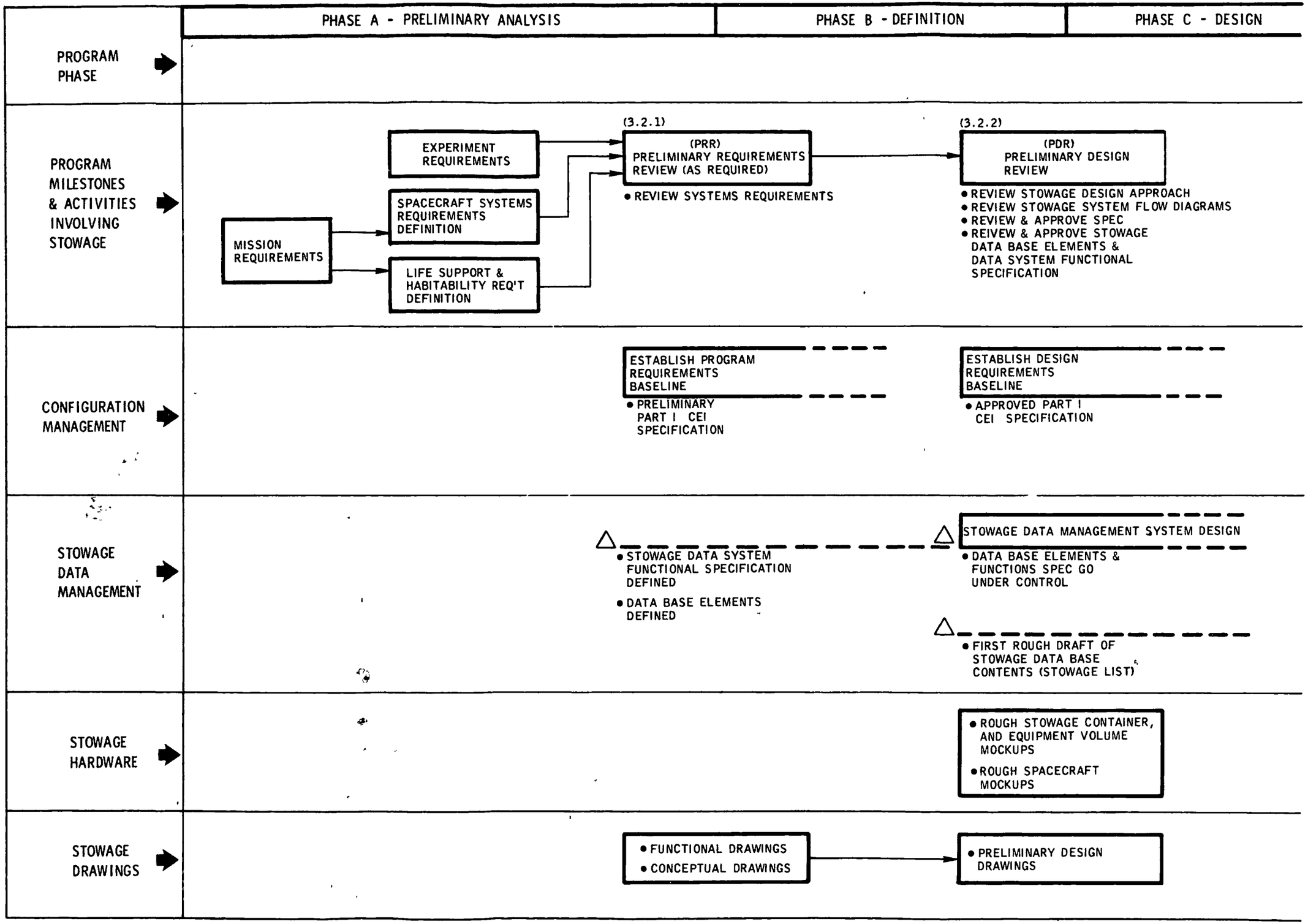


FIGURE 2 - STOWAGE MANAGEMENT PROCESS - SPACECRAFT SYSTEM DEFINITION AND PRELIMINARY DESIGN

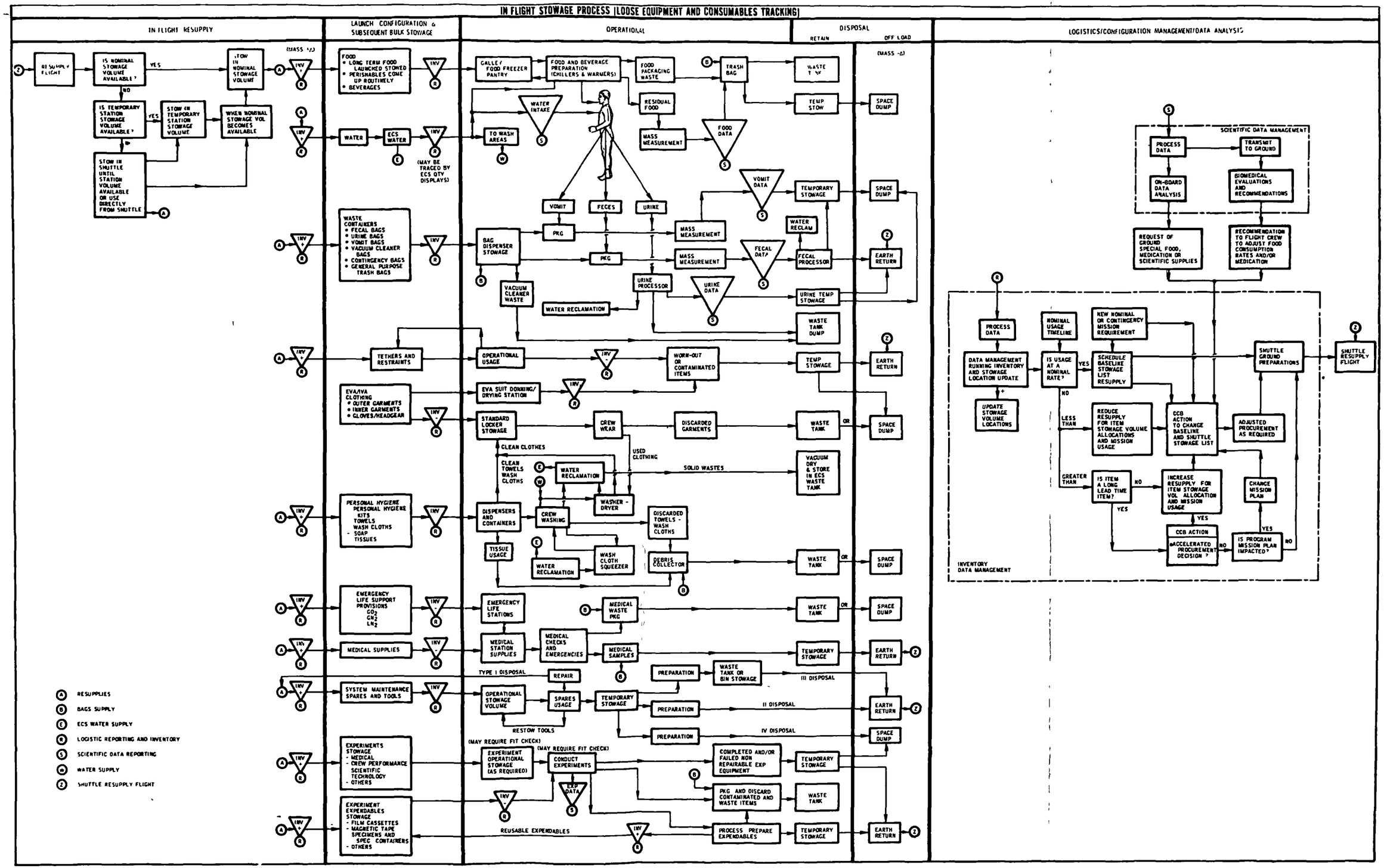
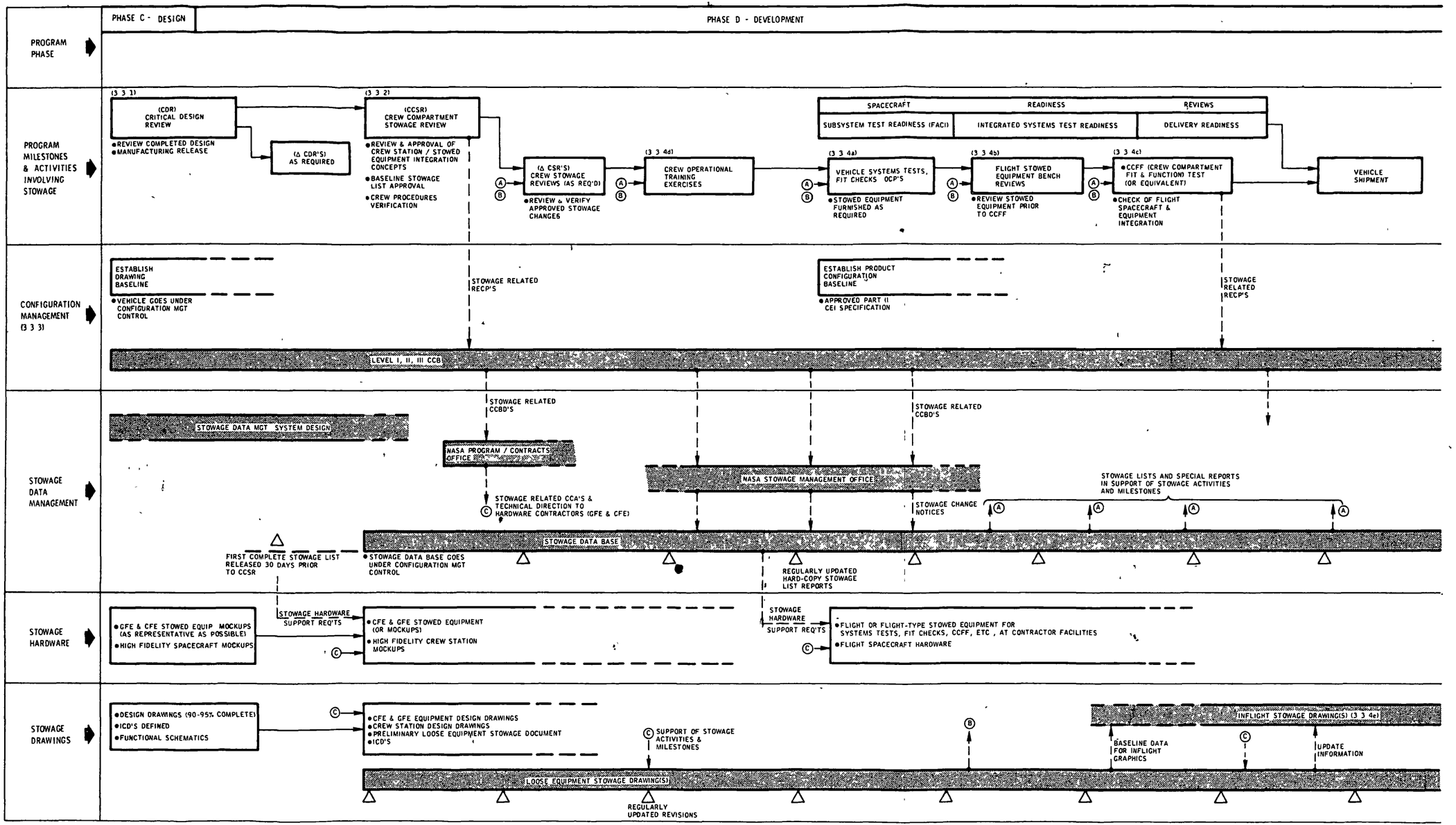


FIGURE 3 - STOWAGE PROCESS FUNCTIONAL FLOW (EXAMPLE)


PROGRAM PHASE
PHASE C - DESIGN
PHASE D - DEVELOPMENT
PROGRAM MILESTONES & ACTIVITIES INVOLVING STOWAGE
(3 3 1)
(CDR) CRITICAL DESIGN REVIEW
•REVIEW COMPLETED DESIGN
•MANUFACTURING RELEASE
(Δ CDR'S) AS REQUIRED
(3 3 2)
(CCSR) CREW COMPARTMENT STOWAGE REVIEW
•REVIEW & APPROVAL OF CREW STATION / STOWED EQUIPMENT INTEGRATION CONCEPTS
•BASELINE STOWAGE LIST APPROVAL
•CREW PROCEDURES VERIFICATION
(Δ CSR'S) CREW STOWAGE REVIEWS (AS REQ'D)
•REVIEW & VERIFY APPROVED STOWAGE CHANGES
(3 3 4d)
CREW OPERATIONAL TRAINING EXERCISES
SPACECRAFT READINESS REVIEWS
SUBSYSTEM TEST READINESS (FACI)
INTEGRATED SYSTEMS TEST READINESS
DELIVERY READINESS
(3 3 4a)
VEHICLE SYSTEMS TESTS, FIT CHECKS OCP'S
•STOWED EQUIPMENT FURNISHED AS REQUIRED
(3 3 4b)
FLIGHT STOWED EQUIPMENT BENCH REVIEWS
•REVIEW STOWED EQUIPMENT PRIOR TO CCFF
(3 3 4c)
•CCFF (CREW COMPARTMENT FIT & FUNCTION) TEST (OR EQUIVALENT)
•CHECK OF FLIGHT SPACECRAFT & EQUIPMENT INTEGRATION
VEHICLE SHIPMENT
CONFIGURATION MANAGEMENT (3 3 3)
ESTABLISH DRAWING BASELINE
•VEHICLE GOES UNDER CONFIGURATION MGT CONTROL
STOWAGE RELATED RECP'S
ESTABLISH PRODUCT CONFIGURATION BASELINE
•APPROVED PART II CEI SPECIFICATION
STOWAGE RELATED RECP'S
LEVEL I, II, III CCB
STOWAGE DATA MANAGEMENT
STOWAGE RELATED CCBD'S
STOWAGE DATA MGT SYSTEM DESIGN
NASA PROGRAM / CONTRACTS OFFICE
STOWAGE RELATED CCA'S & TECHNICAL DIRECTION TO HARDWARE CONTRACTORS (GFE & CFE)
STOWAGE RELATED CCBD'S
NASA STOWAGE MANAGEMENT OFFICE
STOWAGE CHANGE NOTICES
STOWAGE LISTS AND SPECIAL REPORTS IN SUPPORT OF STOWAGE ACTIVITIES AND MILESTONES
STOWAGE DATA BASE
FIRST COMPLETE STOWAGE LIST RELEASED 30 DAYS PRIOR TO CCSR
•STOWAGE DATA BASE GOES UNDER CONFIGURATION MGT CONTROL
REGULARLY UPDATED HARD-COPY STOWAGE LIST REPORTS
STOWAGE HARDWARE
•GFE & CFE STOWED EQUIP MOCKUPS (AS REPRESENTATIVE AS POSSIBLE)
•HIGH FIDELITY SPACECRAFT MOCKUPS
STOWAGE HARDWARE SUPPORT REQ'TS
•CFE & GFE STOWED EQUIPMENT (OR MOCKUPS)
•HIGH FIDELITY CREW STATION MOCKUPS
STOWAGE HARDWARE SUPPORT REQ'TS
•FLIGHT OR FLIGHT-TYPE STOWED EQUIPMENT FOR SYSTEMS TESTS, FIT CHECKS, CCFF, ETC , AT CONTRACTOR FACILITIES
•FLIGHT SPACECRAFT HARDWARE
STOWAGE DRAWINGS
•DESIGN DRAWINGS (90-95% COMPLETE)
•ICD'S DEFINED
•FUNCTIONAL SCHEMATICS
•CFE & GFE EQUIPMENT DESIGN DRAWINGS
•CREW STATION DESIGN DRAWINGS
•PRELIMINARY LOOSE EQUIPMENT STOWAGE DOCUMENT
•ICD'S
SUPPORT OF STOWAGE ACTIVITIES & MILESTONES
INFLIGHT STOWAGE DRAWING(S) (3 3 4e)
BASELINE DATA FOR INFLIGHT GRAPHICS
UPDATE INFORMATION
LOOSE EQUIPMENT STOWAGE DRAWING(S)
REGULARLY UPDATED REVISIONS

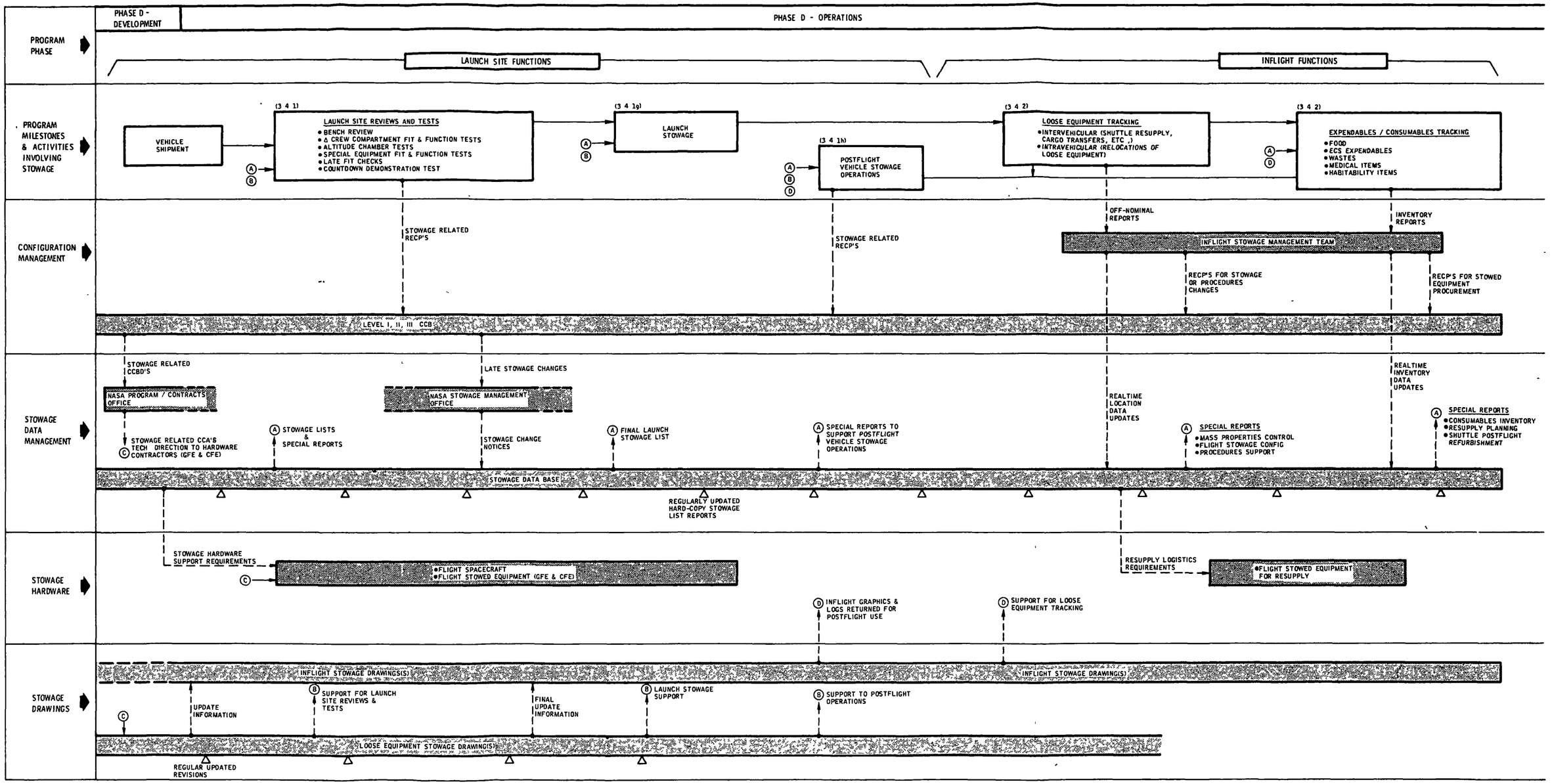


FIGURE 5 - STOWAGE MANAGEMENT PROCESS - LAUNCH PREPARATION AND FLIGHT OPERATIONS

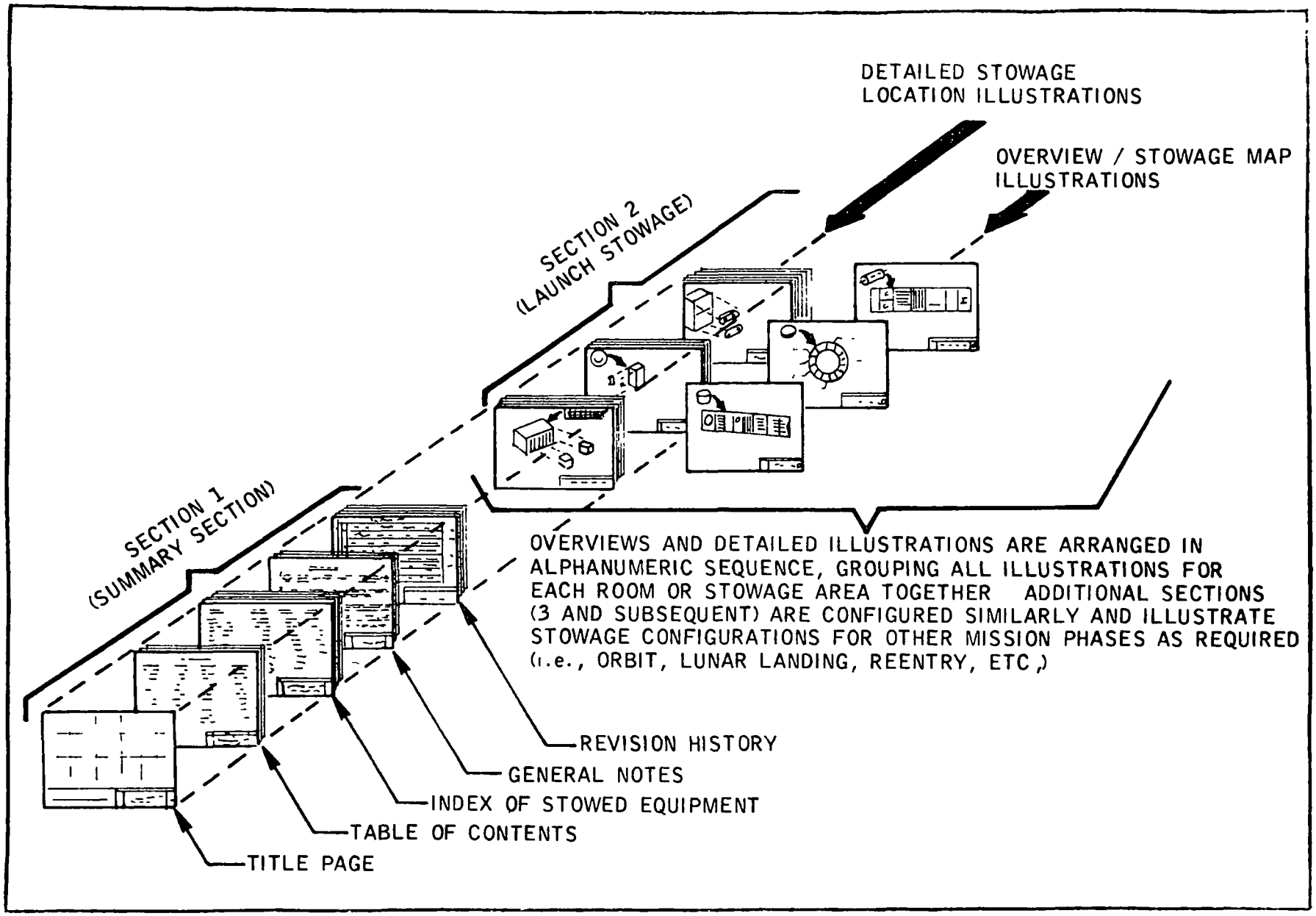


FIGURE 6 - SPACECRAFT LOOSE EQUIPMENT STOWAGE DRAWING CONFIGURATION

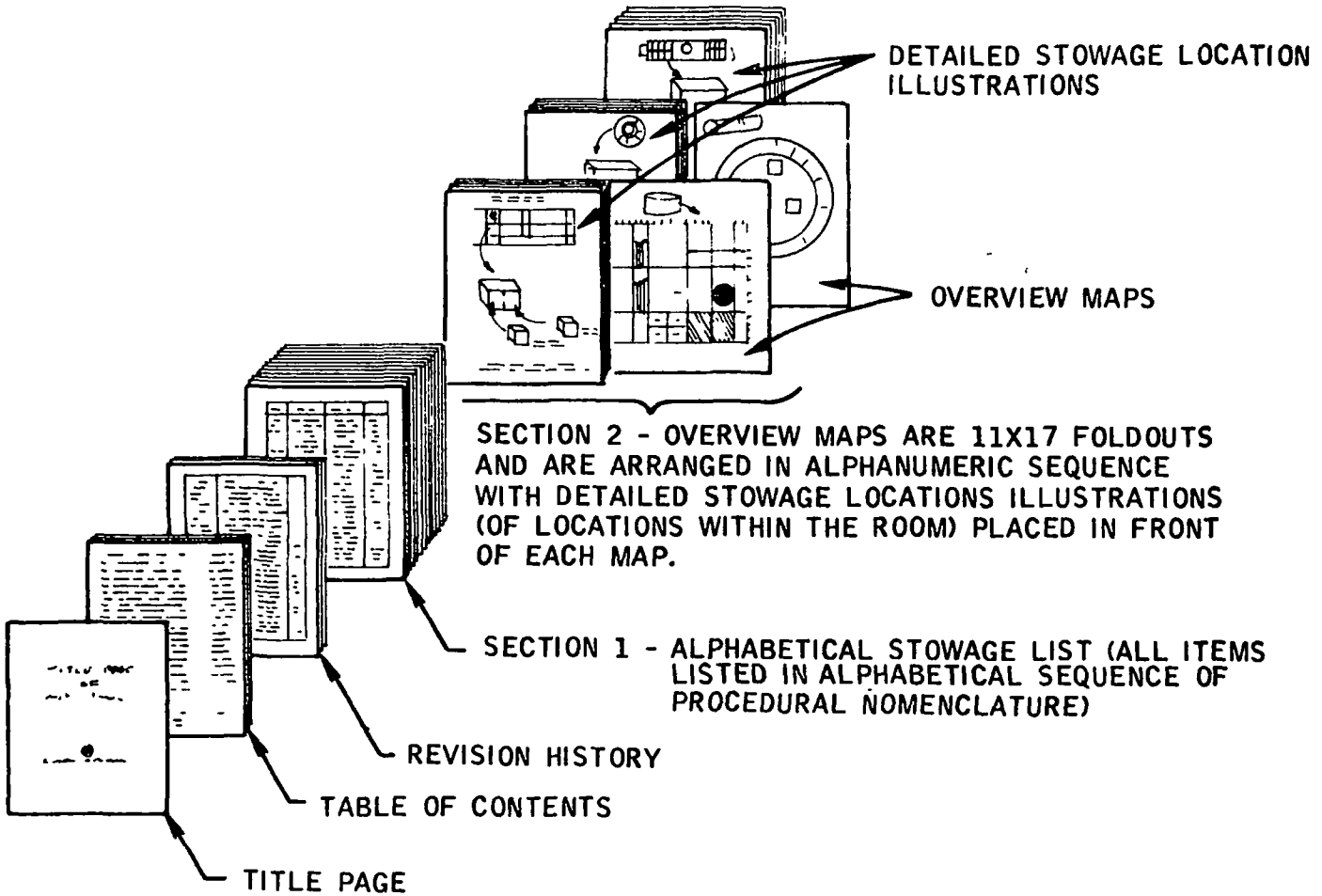


FIGURE 7 - INFLIGHT STOWAGE MANAGEMENT DOCUMENT CONFIGURATION

SC-S-0012

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER

Houston, Texas

GENERAL SPECIFICATION

PROPOSED LOOSE EQUIPMENT AND STOWAGE DATA BASE INFORMATION REQUIREMENTS

This proposed specification has not been approved by the Manned Spacecraft Center and is subject to modification.

FOREWORD

This specification is one of a series of specifications which establish requirements for the execution and implementation of a stowage management process for future manned spacecraft programs. The need for these specifications stemmed from an increasing amount of stowage equipment and related stowage management problems as vehicles of successive space programs (Gemini, Apollo, and Skylab) became increasingly complex and were designed to accommodate longer mission durations. A significant contribution to stowage management during the Apollo and Skylab Programs was the development and maintenance of a computerized stowage information management system which is the prime source for generating the essential documentation associated with the management of loose equipment. Apollo and Skylab Program experience and the trend toward larger and more complex spacecraft with larger inventories of loose equipment emphasize a need for early definition of stowage management system requirements; particularly computer system input and output data necessary to meet stowage management documentation requirements. The computer input and output requirements specified herein are established to allow a timely implementation of stowage management data processing procedures to support the needs of future manned spacecraft programs.

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1.0 INTRODUCTION

1.1 PURPOSE. The primary intent of this specification is to identify the information necessary to support the total Stowage Management Process as defined in NASA Specification SC-S-0011. The specific objectives of this Stowage Data Base Management specification are: (1) to define specific data base elements for inclusion in a stowage computer system and (2) to establish user format/content requirements of input/output and display data to support the Stowage Management Process.

1.2 SCOPE. This specification has application throughout the Stowage Management Process and includes information that is maintained in the basic stowage data base which supports activities in the areas of spacecraft development, vehicle logistics and preparations, inflight stowage configuration management, and vehicle post-flight support.

1.3 APPLICABLE DOCUMENTS. The following documents (latest revisions) form a part of this specification to the extent specified herein.

SC-C-0009	General Specification, Operations Location System, Crew Interfaces
SC-S-0011	General Specification Proposed Stowage Management Process Requirements

1.4 DEFINITIONS. For the purpose of this specification the following definitions shall apply:

a. Data Element. A stowage information item or stowage management parameter which constitutes a Data Base input.

b. Data Base. An aggregate of stowage information, data elements, records or data files to be stored in a computer system and from which can be selected output data to form stowage management documents or displays.

2.0 RESPONSIBILITIES

The Manned Spacecraft Center (MSC), National Aeronautics and Space Administration shall insure compliance to this specification by contractor(s) or designated government organizations responsible for development, maintenance, and operation of the Stowage Computer System. In addition, contractors responsible for flight equipment and government agencies responsible for government furnished equipment (GFE) shall comply with this specification to the extent specified herein.

Requests for deviations, additions, or deletions to this specification should be forwarded to the NASA/Manned Spacecraft Center.

3.0 DATA BASE INFORMATION REQUIREMENTS

3.1 GENERAL. Stowage data base information requirements for which the stowage management organization shall make data processing provisions, are identified in this specification. These include input data (data base elements and input displays) and output data (on-line CRT displays and hard copy batch reports). The formats presented in the following paragraphs are initial requirements which shall provide baseline hard copy and CRT display formats and shall, as a minimum, contain those data elements identified in each format. It is recognized that the data display formats requirements identified in this specification are subject to modification as the information management system is expanded to meet additional future requirements (i.e., inclusion of more data elements or files to accommodate additional users).

The data base elements specified in Pargraph 3.1 are fields which form logical stowage management records or a file which forms records of stowage management user data. Other files which must be incorporated in the data base, such as systems files for software operation and language statements for performing users requests, are dependent on the structure of the information mangement system utilized and, to some extent, on the computer system hardware utilized. Requirements for such files do not form a part of this specification. In addition, systems or users' functions, other than report generation, are not specifically addressed. However, user display requirements, i.e., on-line displays which requires inquiry function capability or an applications program, implies that these requirements must be in phase with the overall computer system requirements.

3.2 DATA BASE REQUIREMENTS. Data Base Elements which shall form the Stowage Computer System Data Base for manned spaceflight programs are presented in Appendix A. Descriptions, contents of each element, and field size characteristics are also provided. As noted in the appendix, the total number of fields required for each data element has been estimated. For many of the data elements, this estimate is an accurate description of the number of fields which shall be required. For example, item number, nomenclature, physical dimensions, volume, and shape have single value descriptors which are unique to each stowed item and which shall require a single entry for each data element. Others, however, such as number of stowage locations per item, number of interface control documents, installation control drawings, and reference experiment numbers, are spacecraft configuration dependent. The number of entries for these data elements will, thus, differ with variations in spacecraft configuration/design. A fundamental stowage computer system requirement, therefore, is line count updating capability to accommodate a number of data element entries. The number of fields for all data elements presented in the appendix is the total number per line.

The format, number and type of character (alphanumeric) for each data element are also presented in the appendix.

*The Stowage Management Data Base which will be developed for manned space-*craft programs shall, as a minimum, include the elements presented in the appendix of this specification. While the intent of this specification is not to specify hardware requirements, Skylab Program experience has shown that a system capable of storing a voluminous amount of data will be required. For example, pertinent information relative to approximately 3000 items of loose equipment are needed to support the Skylab stowage management process. The computer system, therefore, must have a large storage capacity with direct access capability, which can be easily expanded and modified to accommodate expanding data base requirements and additional stowage system users' requirements for future manned spacecraft programs.

3.3 STOWAGE COMPUTER SYSTEM/DISPLAY OUTPUT REQUIREMENTS. Basically, requirements for the following three types of displays are specified in the following paragraphs of this specification: (1) standard input CRT display formats for updating and modifying the Data Base, (2) standard report formats for the generation of hardcopy stowage management documents, and (3) on-line reporting displays. The following paragraphs delineate specific requirements for format and information content of each type of display.

3.3.1 Format Contents of Input Displays. The primary purpose of the on-line displays is to provide a basic means of updating the master files and verifying new entries. Since these displays must contain all the information relative to a specific item/item number, a primary consideration for blocking the input data for CRT display should be ease of understanding by the data base users. This is particularly desirable if all input data for a given item cannot be displayed simultaneously. Expansion of the data base to include additional data elements or a larger number of entries per data elements, which will be required for future manned spacecraft programs,

will preclude the use of a single CRT input display. The alternative then is to establish input data block(s) which are unique to each user's activity. To avoid display repetition of some data elements among two or more users, a Common Data Block should be established and displayed with all other data blocks or logical groups of blocks. If the Common Data Block is not displayed with the other Input Data Blocks, then universal identifiers, such as part number and nomenclature, will have to be defined and displayed with each data block during input updates and modification to the data elements. In addition to the Common Data Block, the data elements, presented in Appendix A, have been grouped into the following functional blocks which meet input display requirements.

a. Common Data Block (See Figure 1). Data element entries which are required for (or of interest to) all stowage computer system users, e.g., Item Number, Nomenclature, Functional Descriptor, Weight, Part Number.

b. Stowage Activity Support Block (See Figure 2). Data element entries associated with tracking of an item hardware type (flight training mockups) and their scheduled usage in program activities and stowage milestones, e.g., Milestones (reviews), Milestone Dates, Site (milestone location), type of hardware required, etc.

c. Spacecraft Stowage Configuration Block Data Elements (See Figure 3). Entries which describe the item status relative to its launch and return stowage location for a specific mission phase, e.g., Item Location, Quantity, Mission Phase, Return Weight, Volume.

d. Inflight Stowage Management Block Data Element (See Figure 4). Entries associated with the inflight transfer and management of a stowed item, e.g., "From" Location, "To" Location, Activity Element, Quantity.

e. Item Development Supply Summary Block (See Figure 5). Data element entries characteristic of summary procurement information for a given item, e.g., total quantity ordered, replacement time, spares requirements, mission affected by item usage, qualification status, etc.

Display formats requirements for each of the five data blocks are presented in Figures 1 through 5. The presentation formats of these data blocks are intended to provide basic guidelines for the organization of input displays for users convenience. Consideration should also be given to the grouping of the input data blocks if all data blocks cannot be displayed on a single CRT page. From the users' viewpoint, for example, the data blocks could logically be combined into two groups. These are: (1) Common Data Block, Stowage Activity Support Block and the Item Development and (2) Common Data Block, Spacecraft Stowage Configuration Block, and the Inflight Management Stowage Block. However, other factors related to programming and hardware utilization may indicate some other input data display technique to be more desirable.

Prior to implementation of the operational input display formats, the stowage management organization shall review and approve the formats.

3.3.2 Hardcopy Report Requirements. Hardcopy output reports requirements of the Stowage Computer System are summarized in Table I. These reports are generated by high speed line printers in the computer center. Standard formats and content requirements for each hardcopy report are provided in Figures 6 through 22. Batch output reports from a large data base containing an aggregate of information applicable to multi-spacecraft or a modular space station must be output limited by logical selectors (per input request). Some of the output reports, as noted in the hardcopy formats, are limited as a result of relating a data set or a number of data elements to a fixed value or range of

values of some other data element. Figure 17, Item Location Status, for example, is illustrative of this in that the output data is related to a return disposition code. Other reports, not output limited by such relationships, shall be limited through selection (input request) of either a module, spacecraft or mission and/or mission phase.

Changes to the hardcopy output formats and their contents shall be approved by the Stowage Management Organization. Since such changes are anticipated, the system must provide sufficient flexibility to readily modify the display formats as well as delete and modify any field. The deletion and modification of a field may affect the structure of the file. In order to maintain the integrity of the file and allow for such changes, a file reformat/maintenance capability must also be provided. This feature enables the definition of a new file by incorporating desired changes or deletions to the fields.

3.3.3 On-Line Display Requirements. On-line CRT display requirements are summarized in Table II. Display formats and cross-referenced data elements for each display function are illustrated in Figures 23 through 27. Specification of on-line CRT display requirement necessitates an inquiry capability to insure rapid information retrieval and response to a variety of users' questions and the maintenance of cross-reference data elements. While definition of specific inquiry functions is not within the scope of this specification, they are implicit in the display/content formats.

4.0 SCHEDULE AND CONTROL REQUIREMENTS

Users access to the stowage data base shall be limited to those individuals approved and/or assigned by the Stowage Management Organization. Modifications and updates to the stowage files and reorganization of the data base and formats shall be approved by the Stowage Management Organization and shall be accomplished at a master control terminal in an interactive operating mode. Access to the data base from other terminals shall be limited to display of requested data (read only). Records of updates or modifications shall be made on a journal file and displayed on the CRT prior to entering the elements into the data base. In addition, the stowage management file(s) shall be periodically recorded and maintained on a backup magnetic tape to allow rebuilding of the direct access file.

At the Preliminary Design Review (PDR), the data elements shall be approved and any further changes shall be controlled by the Stowage Management Organization. The first rough draft of the contents of the Stowage Data Base shall be provided at this time in the form of preliminary basic data (Item identifications, functional descriptor, etc.). This data shall be updated at the Critical Design Review (CDR). Thirty days prior to the Spacecraft Stowage Review (CCSR), the first complete stowage list shall be released in batch report format (Master Stowage List). This list shall serve as the requirements document to be used in evaluating stowage provisions during CCSR. At the conclusion of CCSR, the baseline stowage list will be approved, and any further changes shall be controlled by the Stowage Management Organization.

The Stowage Management Organization shall act as the clearing house for all requests for stowage information reports, and shall publish the more widely used reports on a regular schedule. As a minimum, this shall include the Master Stowage List (Figure 6) and the Inflight Transfer List (Figure 7).

TABLE I

HARDCOPY BATCH REPORT REQUIREMENTS SUMMARY

REPORT	REQUIREMENTS
1. MASTER STOWAGE LIST (Ref: Fig. 6) (Frequency of distribution of this report shall be established by Stowage Management Organization)	a) Printed in alphanumeric sequence of the Item Number. b) Use Preprinted Forms c) Each page heading should include: - Module/Room or Module/Control Station name or Code - Report Title and Number - Date - Page number d) Include data elements in the format as shown in Figure 6
2. INFLIGHT TRANSFER LISTS (Ref: Fig. 7) (Frequency of distribution of this report shall be established by Stowage Management Organization)	a) Printed in order of increasing Greenwich Mean Time (GMT) b) Use preprinted forms c) Each page heading should include: - Module/Room or Module/Control Station name or Code - Report Title and Number - Date - Page number d) Include data elements in the format as shown in Figure 7.
3. STOWAGE LIST REVISION NOTICES (Ref:Fig.8) (As requested)	a) By specific change dates, list all changes incorporated into the data base in alphanumeric sequence of item numbers. b) Each page heading should include: - Module/Room or Module/Control Station name or code - Report Title and Number - Date - Page number c) Include data elements in the format as shown in Figure 8.

TABLE I (Cont'd)

REPORT	REQUIREMENTS
4. STOWAGE LOCATION LIST (Ref. Fig. 9) (As requested) Mainly used for major points in mission.	a) At any specified GMT and by Module/Room or Control Station, list item number in alphanumeric sequence by stowage locations. b) Each page heading should include: - Module/Room or Module/Control Station Code - Report Title and Number - Date - Page number c) Include data elements in the format as is shown in Figure 9.
5. STOWAGE LIST ALPHABETICAL INDEX (Ref Figure 10) (As requested)	a) Print in alphabetical sequence of part nomenclature the Master Stowage List Data b) Use Preprinted Master Stowage List form c) Each page heading should include - Module/Room or Module/Control Station Code - Report Title and Number - Date - Page Number d) Include data elements in the format as shown in Figure 10.
6. STOWAGE LIST REF. NOTES (Ref: Figure 11) (As requested)	a) List Reference Notes in numerical sequence and for each note, list all affected item numbers. b) Each page heading should include: - Module/Room or Module/Control Station Name or Code - Report Title and Number - Date - Page number c) Include data elements in the format as shown in Figure 11.

TABLE I (Cont'd)

REPORT	REQUIREMENTS
7. GENERALIZED REPORT GENERATOR (Ref. Figure 12) (As requested)	a) Provide for the selection of any combination of data elements per user's request. b) Each page heading should include: - Module/Room or Module/Control Station Name or Code - Report Title and Number - Date - Page number c) Typical output format is shown in Figure 12.
8. ITEMS STOWAGE HISTORY STATUS REPORT (Ref. Figure 13)	a) Print transfer history of item(s) with respect to GMT and related quantity, location and activity element. b) Each page heading should include: - Module/Room or Module/Control Station Name or Code - Report Title and Number - Date - Page number c) Include data elements in the format shown in Figure 13.
9. ALPHABETICAL PROCEDURAL NOMENCLATURE REPORT (Ref. Figure 14)	a) Print item transfer status with procedural nomenclature in alphabetical sequence. b) Preprinted for Master Inflight Management Stowage List applications. c) Each page heading should include: - Module/Room or Module/Control Station Name or Code - Report Title and Number - Date - Page number d) Include data elements shown in Figure 14.

TABLE I (Cont'd)

REPORT	REQUIREMENTS
10. ACTIVITY ELEMENT AND STOWAGE ITEMS (Ref. Figure 15) (As requested)	a) Print all or selected activity elements in order of increasing number with related items alphanumerically sequenced) b) Each page heading should include: - Module/Room or Module/Control Station Name or Code - Report Title and Number - Date - Page number c) Include data elements in the format as shown in Figure 15.
11. STOWAGE ITEMS AND ACTIVITY ELEMENTS (Ref. Figure 16) (As requested)	a) Print all or selected item numbers in alphanumeric sequence with related activity elements. b) Each page heading should include: - Module/Room or Module/Control Station Name or Code - Report Title and Number - Date - Page number c) Include data elements in the format as shown in Figure 16.
12. RETURNED ITEMS DISPOSITION REPORT (Ref: Figure 17) (As requested)	a) Print the returned item numbers in alphanumeric sequence for each disposition code by module/room. b) Each page heading should include: - Module/Room or Module/Control Station Name or Code - Report Title and Number - Date - Page number c) Include data element in the format as shown in Figure 17.

TABLE I (Cont'd.)

REPORT	REQUIREMENTS
13. FLIGHT CREW STANDARD NOMENCLATURE REPORT (Ref: Figure 18) (As requested)	a) Print item nomenclature versus related procedural nomenclature in item number alphanumeric sequence. b) Each page heading should include: - Module/Room or Module/Control Station name or code - Report Title and Number - Date - Page number c) Include data elements in the format as shown in Figure 18.
14. ITEM FUNCTIONAL DESCRIPTOR REPORT (Ref: Figure 19) (As requested)	a) Print out functional descriptors of loose equipment in alphabetical sequence with the related item number, item nomenclature, and return disposition code. b) Each page heading should include: - Module/Room or Module/Control Station Name or Code - Report Title and Number - Date - Page number c) Include data elements in format as shown in Figure 19.
15. PRE-LAUNCH ITEM TRACKING REPORT (Ref: Figure 20) (As requested)	a) Provide complete status of item usage by hardware type prior to launch. b) Each page heading should include: - Module/Room or Module/Control Station - Report Title and Number - Date - Page number c) Include data elements as shown in Figure 20.

TABLE I (Cont'd)

REPORT	REQUIREMENTS
16. ITEM DEVELOPMENT/SUPPLY SUMMARY REPORT (Ref: Figure 21) (As requested)	a) Provide development/procurement information status for specified item numbers. b) Each page heading should include: - Module/Room or Module/Control Station Name or Code - Report Title and Number - Date - Page number c) Include data elements in the format as shown in Figure 21.
17. TRANSACTION EXCEPTION RECORD (Ref: Figure 22) (As requested)	a) Print out line (card) input and display input error messages (if applicable) b) Typical format shown in Figure 22.

TABLE II

ON-LINE CRT DISPLAY REQUIREMENTS

DISPLAY REPORT	REQUIREMENT
1. ITEM STATUS (Ref. Figure 23)	Provide multiple displays with automatic paging to document item location, procedural nomenclature, quantity and functional descriptor for selected item number, module, and GMT or GMT range. See display format, Figure 23.
2. TRANSFER STATUS (Ref. Figure 24)	Provide multiple displays with automatic paging to document transfer history (GMT, item nos., procedural nomenclature, quantity, "From" Location and "To" Location) of all items for selected GMT or GMT range. See display format, Figure 24.
3. LOCATION STATUS (Ref. Figure 25)	Provide multiple displays with automatic paging to document location status (item no., GMT, and procedural nomenclature) for selected location(s), module(s), and GMT or GMT range. See display format, Figure 25.
4. ACTIVITY STATUS (Ref. Figure 26)	Provide multiple displays with automatic paging to document activity element status (item number, procedural nomenclature) for selected activity elements numbers and modules. See display format, Figure 26.
5. RETURN STATUS (Ref. Figure 27)	Provide multiple displays with automatic paging to document return status (item nos., nomenclature and locations) for selected return disposition codes and modules. See display format, Figure 27.

Figure 1: Block I - Common Data Block Display Format

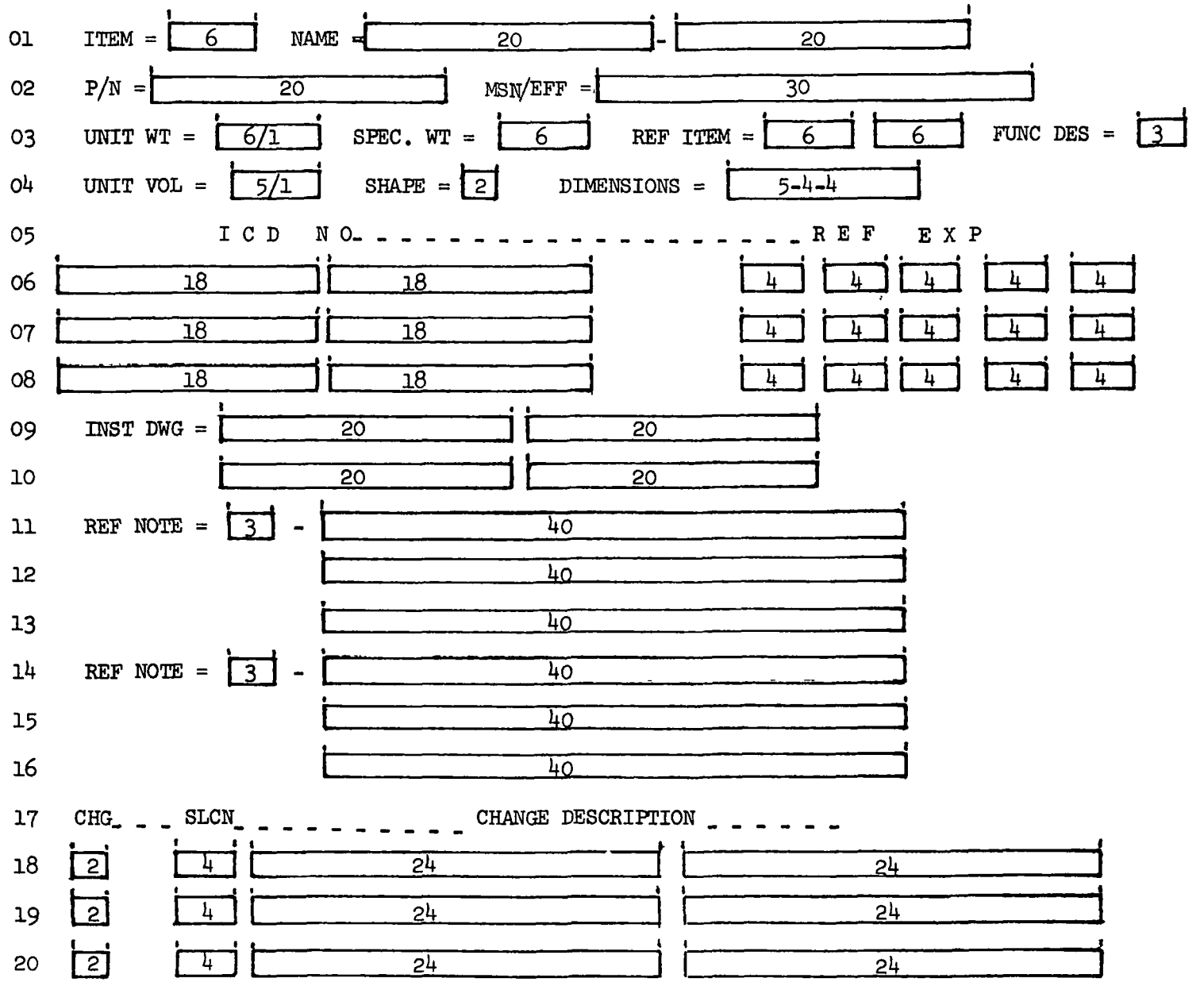


Figure 2: Block II - Stowage Activity Support Input Display Format

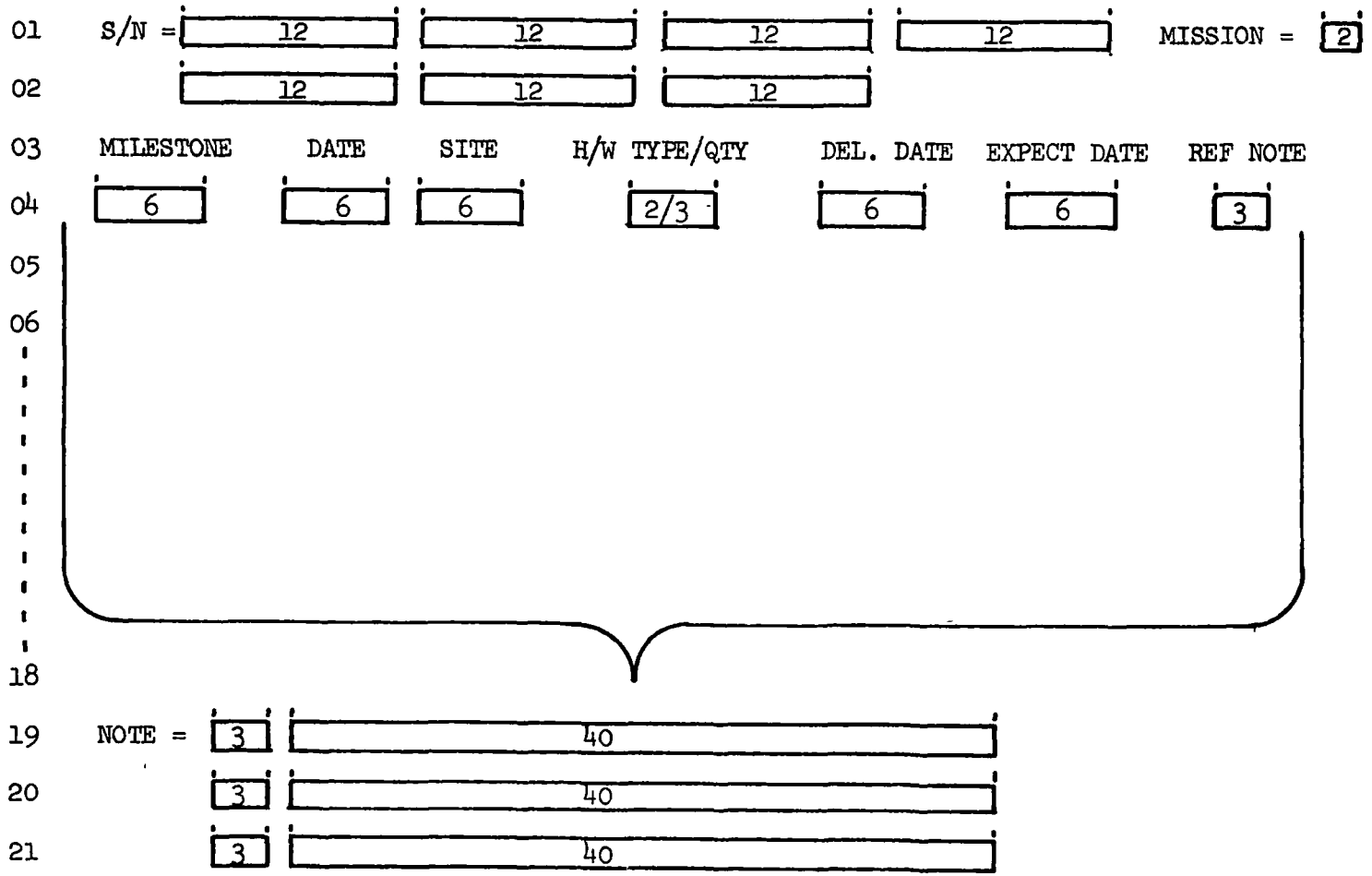


Figure 3: Block III - Spacecraft Stowage Configuration Display Format

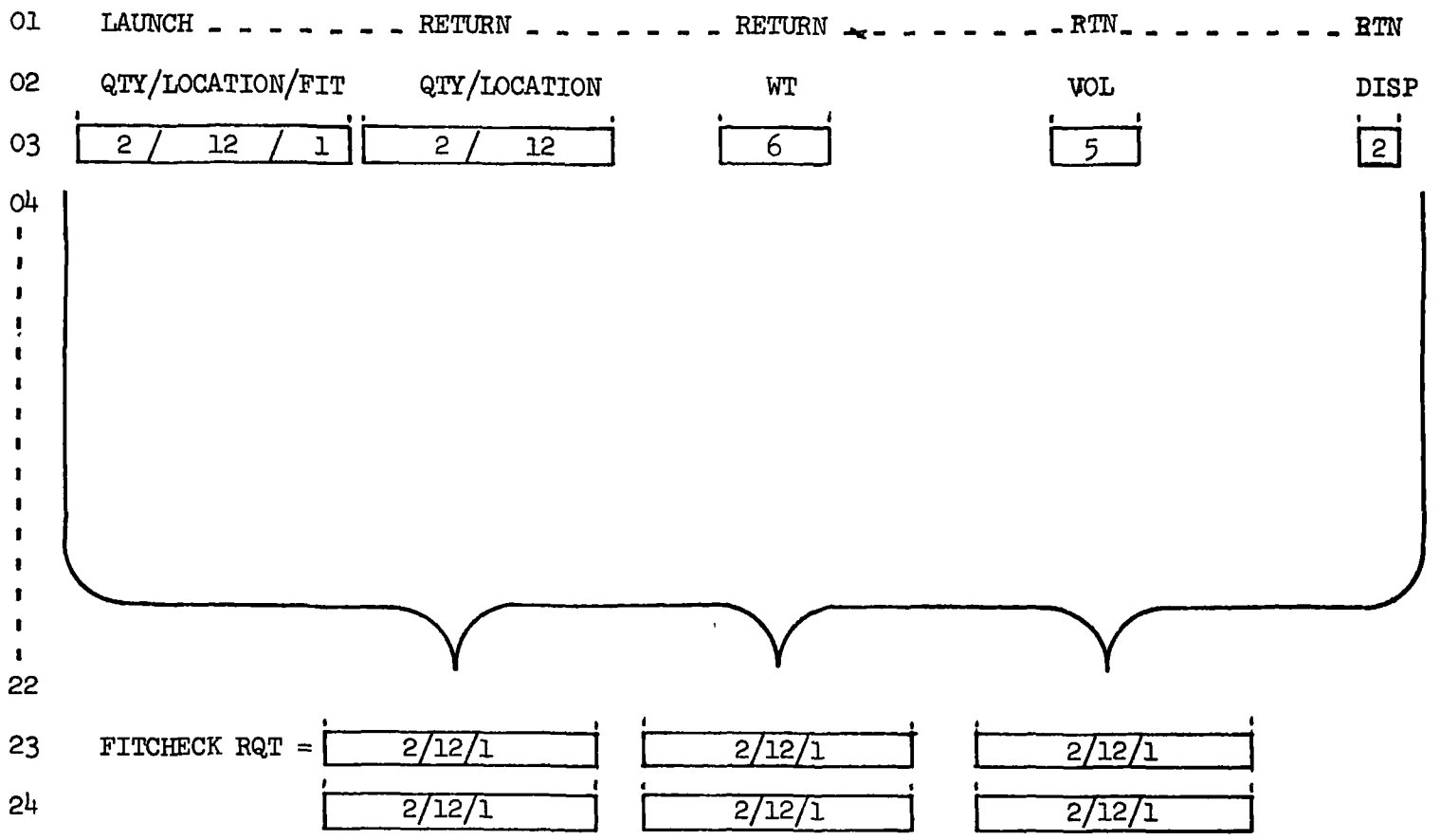


Figure 4: Block IV - Inflight Stowage Management Typical Display Format

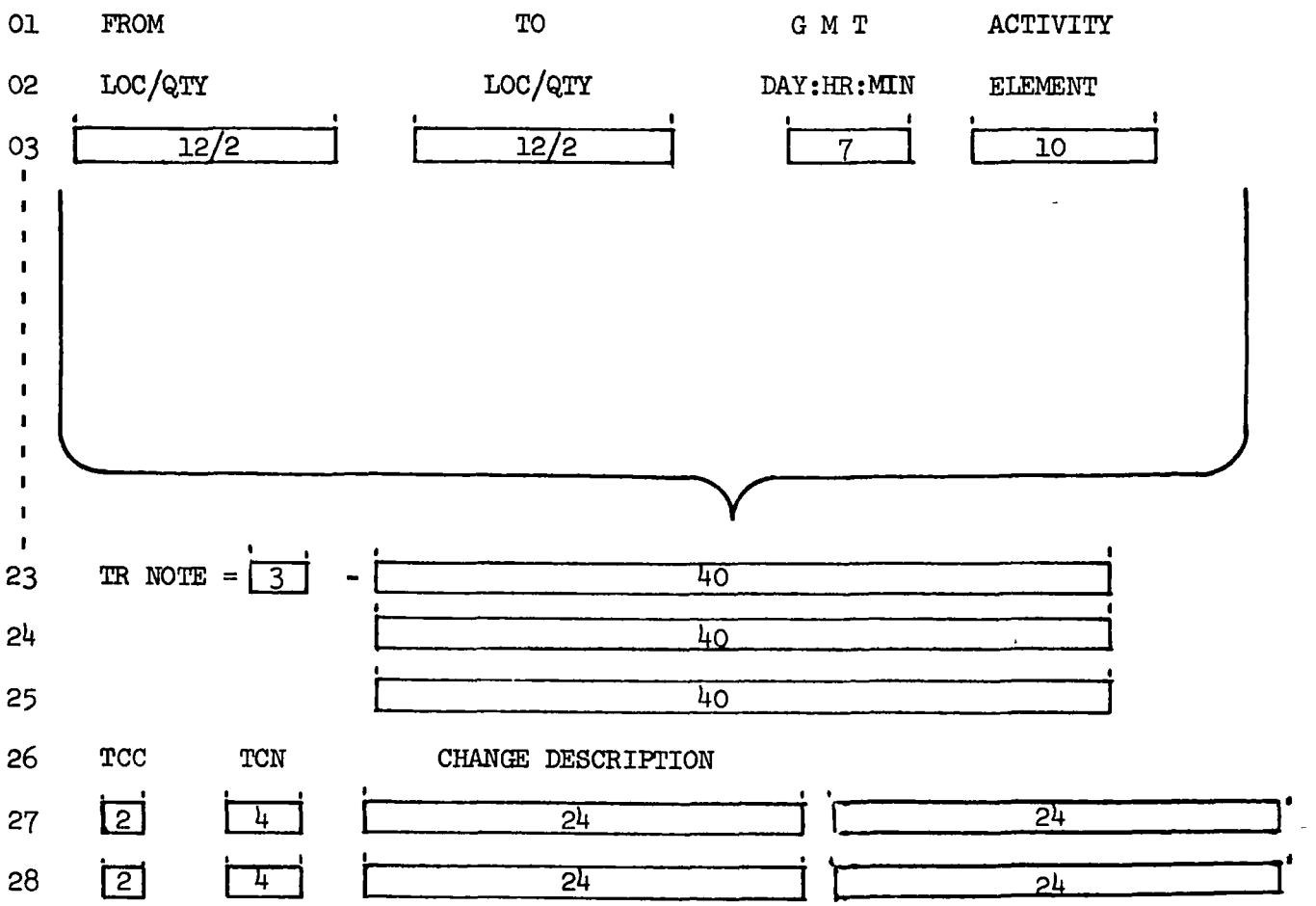


Figure 5: Block V - Item Supply/Development Input Display Format

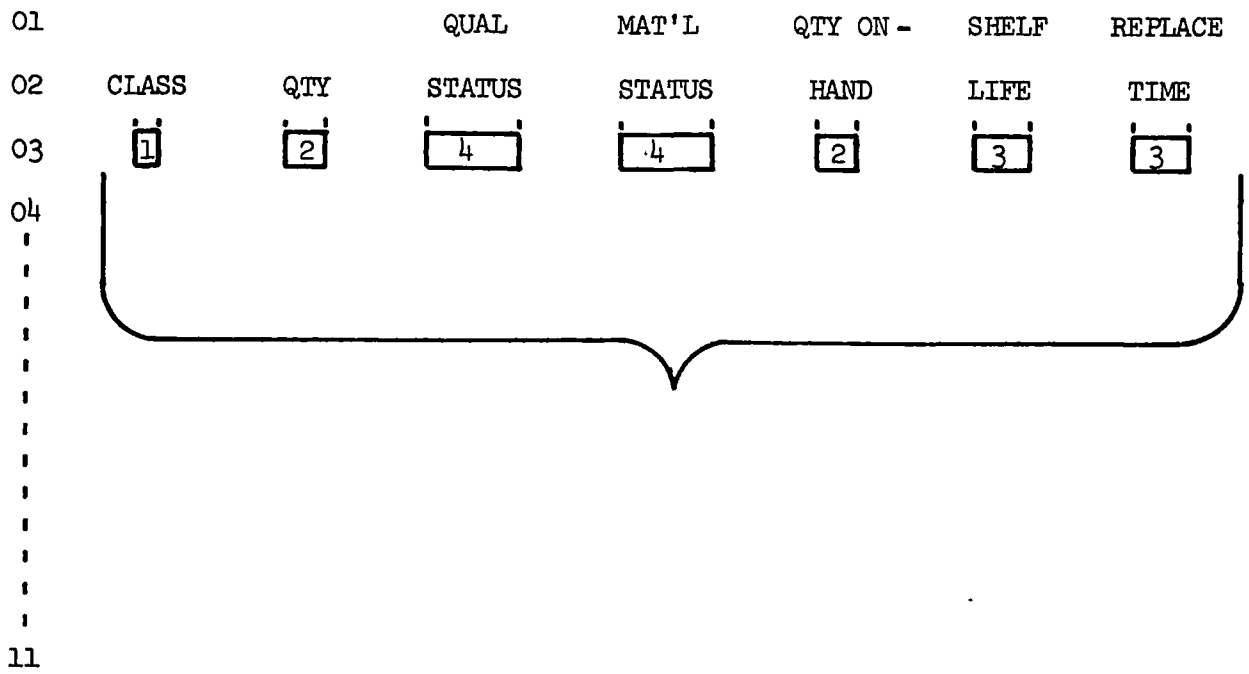


FIGURE 6
MASTER STOWAGE LIST
MODULE ___

PAGE #
DATE

ITEM NO* / REF.ITEM	NOMENCLATURE / PART NO / PROCED. NOM.	FUNC. DES.	UNIT SPEC WT-LBS / UNIT EST/ACT WT-LBS / DIMENSIONS	QTY/LOC TOTAL	LAUNCH LOC	QTY/LOC TOTAL	RTN LOC	RTN WT	RTN VOL	RTN DISP	REF NOTE

*ITEM NO. PRINTED IN ALPHANUMERIC SEQUENCE.

FIGURE 7
INFLIGHT TRANSFER LIST
MODULE ___

PAGE #
DATE

ITEM NO. / REF. ITEM	PROCED. NOM. / PART NO	FUNC. DES.	ACTIVITY ELEMENT	GMT*	QTY/FROM LOCATION	QTY/TO LOCATION	CHANGE NOTICE

*PRINTED WRT INCREASING GMT.

FIGURE 8
STOWAGE LIST REVISION NOTICE
MODULE ____
FROM (DATE) THRU (DATE)

PAGE #
DATE

ITEM NO. / REF. ITEM	NOMENCLATURE / PART NO.	UNIT WT. / UNIT VOL.	CHG. CODE	CHANGE NOTICE	CHANGE DESCRIPTION	CHG.* DATE

*PER CHANGE DATE REQUEST, PRINT IN ALPHANUMERIC SEQUENCE OF ITEM NO.

FIGURE 9
STOWAGE LOCATION LIST
MODULE/ROOM ___ GMT* ___

PAGE #
DATE

ITEM NO.	NOMENCLATURE	PART NO.	QTY.	LOCATION*	UNIT WT/C	DIMENSIONS

*PER GMT & LOCATION, PRINT IN ALPHANUMERIC SEQUENCE OF ITEM NUMBER.

FIGURE 10
STOWAGE LIST ALPHABETICAL INDEX
MODULE _____

PAGE #
DATE

ITEM. NO. / REF. ITEM	NOMEN.* / PART NO	FUNC. DES.	UNIT SPEC WT-LBS / UNIT EST/ACT WT.-LBS / DIMENSIONS	QTY/LOC TOTAL	LAUNCH LOC	QTY/LOC TOTAL	RTN LOC	RTN WT	RTN VOL	RTN DISP	REF NOTE

*PRINT TRANSFER STATUS OF ALL ITEMS WITH NOMENCLATURE IN ALPHABETICAL SEQUENCE.

FIGURE 11
STOWAGE LIST REFERENCE NOTES
MODULE ____

PAGE #
DATE

NOTE *(#) DESCRIPTION

ITEM NUMBER _____ NOMENCLATURE

*PER REFERENCE NOTE, NO REQUEST LIST ITEM NOS. AFFECTED IN ALPHANUMERIC SEQUENCE

FIGURE 12
GENERALIZED REPORT*
MODULE ____

PAGE #
DATE

ITEM NO.	PROC. NOMEN.	FUNC. DES.	ACTIVITY ELEMENT	GMT	LOCATION	QTY.	UNIT WT.

*PER USERS' REQUEST, PRINT ANY COMBINATION OFDATA ELEMENTS.

FIGURE 13
ITEM TRANSFER STATUS
MODULE _____ PHASE _____

PAGE #
DATE

ITEM NO.*	PROC. NOMEN.	QTY.	FROM LOCATION	TO LOCATION	GMT	ACTIVITY ELEMENT

*PER ITEM REQUEST, PRINT TRANSFER HISTORY WRT INCREASING GMT.

FIGURE 14
ALPHABETICAL PROCEDURAL NOMENCLATURE
MODULE ____

PAGE #
DATE

ITEM NO. REF. ITEM	*PROC. NOM. PART NO	FUNC. DES.	ACTIVITY ELEMENT	GMT	FROM LOCATION	TO LOCATION	CHANGE NOTICE

*PRINT ITEMS TRANSFER STATUS WITH PROCEDURAL NOMENCLATURE IN ALPHABETICAL SEQUENCE.

FIGURE 15
ACTIVITY ELEMENTS AND STOWAGE ITEMS
MODULE ____

PAGE #
DATE

ACTIVITY ELEMENT*	ITEM NO.	PROCEDURAL NOMENCLATURE

*PER ACTIVITY ELEMENT(S) REQUEST, PRINT ITEMS AFFECTED WITH PROCEDURAL NOMENCLATURE IN ALPHABETICAL SEQUENCE.

FIGURE 16
STOWAGE ITEMS AND ACTIVITY ELEMENTS
MODULE ____

PAGE #
DATE

ITEM NO.*	PROCEDURAL NOMENCLATURE	ACTIVITY ELEMENT

*PER ITEM NUMBER(S) REQUEST, PRINT RELATED ACTIVITY ELEMENTS WITH PROCEDURAL NOMENCLATURE IN ALPHABETICAL SEQUENCE.

FIGURE 17
RETURNED ITEMS DISPOSITION CODE
MODULE ____

PAGE #
DATE

RETURN DISP* _____

ITEM NO.	PROC. NOMEN.	FUNC. DES.	LOCATION
---	---	---	---

*PER RETURN DISPOSITION CODE PRINT ITEM NOS. IN ALPHA NUMERIC SEQUENCE.

FIGURE 18
FLIGHT CREW STANDARD NOMENCLATURE
MODULE ____

PAGE #
DATE

ITEM NO.*	PROC. NOMEN.	STOWAGE LIST NOMEN.
---	---	---

*PER ITEM NUMBER REQUEST, PRINT PROCEDURAL AND STOWAGE LIST NOMENCLATURE WITH ITEM NOS. IN ALPHANUMERIC SEQUENCE.

FIGURE 19
ITEM FUNCTIONAL DESCRIPTOR
MODULE ____

PAGE #
DATE

FUNC. DES.*	ITEM. NO.	NOMENCLATURE	UNIT WT/C	UNIT VOL/C	DIMENSIONS
---	---	---	---	---	---

*PRINT FUNCTION DESCRIPTORS IN ALPHABETICAL SEQUENCE WITH ITEM NOS. LISTED IN ALPHANUMERIC SEQUENCE FOR EACH FUNCTIONAL DESCRIPTOR.

FIGURE 20
PRELAUNCH ITEM TRACKING STATUS

PAGE #
DATE

MILESTONE LOCATION* _____

ITEM NO.	NOMEN.	MILESTONE DATE	HARDWARE TYPE*/QTY	DEL. DATE
---	---	---	---	---

*PER MILESTONE LOCATION, PRINT STATUS OF ITEM USAGE BY HARDWARE TYPE.

FIGURE 21
ITEM DEVELOPMENT/SUPPLY SUMMARY STATUS

PAGE #
DATE

ITEM NO.* _____ NOMEN. _____ PART NO. _____

HARDWARE TYPE	QUAL STATUS	MAT'L STATUS	QTY ON HAND	SHELF LIFE	REPLACE TIME
---	---	---	---	---	---

*PER ITEM NO(S). REQUEST, PRINT DEVELOPMENT/PROCUREMENT STATUS.

FIGURE 22
TRANSACTION EXCEPTION RECORD*

PAGE #
DATE

1 ——————————————————→ 80 CARD COLUMN

1 ——————→ 20

←—————— CARD IMAGE ——————→ ←— ERROR MESSAGE —→

*PRINT OUT LINE (CARD) INPUT & DISPLAY INPUT ERROR MESSAGE (IF APPLICABLE).

FIGURE 23 PAGE #
ON-LINE DISPLAY REPORT #1 DATE

ITEM STATUS MODULE _____
ITEMS* _____ GMT START _____ GMT END _____

LOCATION	PROCEDURAL NOMENCLATURE
---	---

*PER ITEM NO. & GMT REQUEST, DISPLAY LOCATION AND GMT.
(GMT WITHIN RANGE IS TIME OF TRANSFER TO NEW LOCATION)

FIGURE 24 PAGE #
ON-LINE DISPLAY REPORT #2 DATE

TRANSFER STATUS MODULE _____ GMT START _____ GMT END ____

GMT	ITEM NO.	PROCEDURAL NOMENCLATURE	QTY	FROM LOCATION	TO LOCATION
---	---	---	---	---	---

PER GMT RANGE REQUEST, DISPLAY ITEM NO. & LOCATION AFFECTED
BY TRANSFER. (GMT IS TIME OF TRANSFER.)

FIGURE 25 PAGE #
ON-LINE DISPLAY REPORT #3 DATE

LOCATION STATUS
LOCATION _____ MODULE _____ GMT START _____ GMT END ____

ITEM NO.	GMT	PROCEDURAL NOMENCLATURE
---	---	---

PER LOCATION & GMT RANGE REQUEST, DISPLAY ITEM WAS IN LOCATION AND
TIME (GMT) OF TRANSFER TO LOCATION.

FIGURE 26
ON-LINE DISPLAY REPORT #4

PAGE #
DATE

ACTIVITY STATUS

ACTIVITY ELEMENT _____ MODULE _____

ITEM NO.	PROCEDURAL NOMENCLATURE

PER ACTIVITY ELEMENT REQUEST, DISPLAY ITEM NO. AFFECTED.

FIGURE 27
ON-LINE DISPLAY REPORT #5

PAGE #
DATE

RETURN STATUS

RETURN DISPOSITION _____MODULE _____

ITEM NO.	NOMENCLATURE	LOCATION

PER RETURN DISPOSITION REQUEST, DISPLAY ITEM NOS. & THEIR LOCATIONS AT SPACECRAFT RETURN.

APPENDIX A

DATA BASE ELEMENTS

The following data elements shall comprise the System Data Base. Included with each data element are respective characteristics and definitions.

DATA ELEMENT		ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)
1.	ITEM NUMBER	ITEM	1 - 6 (A/N)

DEFINITION The basic control number by which each stowed item is identified in the data base. An item number will be assigned to items which meet one of the following classifications.

1. Items stowed for launch which are individually handled inflight by the crew. (With the exception of multiple like-items such as individual tissues, tablets, etc., for which an item number shall be assigned to the container and contents, i.e., a bottle of tablets, box of tissues, etc.

2. Items which are installed at the factory, but removed for stowage prior to launch, such as stowage lockers.

3. Items installed at the factory which are indiviudally handled inflight by the crew, such as dust covers on optics, etc.

Multiple or redundant item numbers shall not be assigned to the same stowed item. For example, in the case of a medical kit consisting of a bag and contents, the bag shall be assigned an item number and each of its contents shall be assigned an item number, but the complete kit shall not be assigned an item number.

FORMAT The item number format is as follows:

X X 0 0 0 0

TWO LETTER CODE FOUR DIGIT CODE

DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)

1. The two letters indicate the division or organization (NASA or contractor) responsible to the program manager for procurement, qualification, and delivery of the stowage item. This code also indicates (directly or indirectly) whether the item is government furnished (GFE) or contractor furnished (CFE).

2. The four digit numerical code shall be assigned sequentially to items within the responsibility of a given organization (0001 to 9999). This code provides for up to 9,999 stowed items for each responsible organization.

ASSIGNMENT OF ITEM NUMBERS The NASA stowage management organization (or contractor) shall be responsible for assigning item numbers sequentially to stowed equipment as it is approved by the program manager for stowage on the spacecraft.

2. ITEM NOMENCLATURE NOM 2 - 20 (A/N)

DEFINITION A set of names or symbols given to items as a means of identification clarification. The nomenclature appearing on the item control drawing.

FORMAT The item nomenclature shall be arranged as follows in the stowage data base.

(BASIC NOUN OR NOUN PHRASE), (MODIFIERS)

The basic noun or noun phrase is defined as the minimum phrase necessary to establish the concept of the item. For example, the noun "chair" is sufficient to establish the concept. The noun "rule" is not sufficient and would require the noun phrase "slide rule" to establish the concept. (See Federal Item Identification Guide for supply cataloging for a more complete description of a noun-phrase.)

DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)

RESPONSIBILITY

1. The manufacturer of the item assigns the control drawing nomenclature.

2. The NASA stowage management organization shall be responsible for arranging the nomenclature in the format for inclusion in the data base.

3. PART NUMBER — P/N — 1 — 20 (A/N)

DEFINITION A combination of letters and/or numbers as listed on the control drawing for the item (includes dash number).

FORMAT As shown on the item control drawing.

RESPONSIBILITY The manufacturer of the item assigns the part number.

4. MODULE — MOD — 1 — 1 (A/N)

DEFINITION The identifying number or letter assigned to each spacecraft module.

FORMAT As defined by the Mission Program Office.

5. MISSION EFFECTIVITY — MSN-E — 1 — 30 (A/N)

DEFINITION Reference number (or letter) assigned to each mission or spacecraft.

DATA ELEMENT		ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)
6.	ITEM FUNCTIONAL DESIGNATION	F/D	1 - 3 (A)

DEFINITION A three letter code which indicates the functional usage of the item.

FORMAT

1. 1st Letter - Spacecraft System Designator - A generic breakdown of major spacecraft systems. (See Table A1.)

2. 2nd Letter - Top Level Function or Subsystem Designator - For each system designator, a top level subsystem or function breakdown shall be defined. Table A2 contains typical examples for selected systems.

3. 3rd Letter - 2nd Level Function or Category Designator - This character categorizes the item within the system and subsystem. Table A3 contains an example of second level function designators.

RESPONSIBILITY

1. Definition of letter designators - The NASA Stowage Management Office shall define the basic list of 1st, 2nd, and 3rd letter designators, and obtain the concurrence of NASA subystem managers as applicable.

2. Assignment of designators to individual items - The NASA Stowage Management Office shall assign three letter functional designations to items, subject to the review of the applicable subsystem manager.

TABLE A1

SPACECRAFT SYSTEM DESIGNATORS

A - ATTITUDE CONTROL
B -
C - CARGO/CARGO HANDLING
D - DATA MANAGEMENT
E - ECS/LIFE SUPPORT
F - FUEL/CRYOGENICS
G - GUIDANCE & NAVIGATION
H - HABITABILITY
I -
J -
K -
L - LEISURE/RECREATION
M - MEDICAL
N - NUCLEAR POWER
O - OPERATIONS SUPPORT
P - ELECTRICAL POWER
Q - SEQUENTIAL SYSTEMS
R - REACTION CONTROL
S - STOWAGE PROVISIONS/EQUIPMENT RESTRAINT
T - TELECOMMUNICATIONS
U - PNEUMATIC POWER
V - PROPULSION
W -
X - EXPERIMENTS
Y - HYDRAULIC POWER
Z - MISCELLANEOUS

TABLE A2

1ST LEVEL FUNCTION/SUBSYSTEM DESIGNATOR EXAMPLES

1ST LETTER (SPACECRAFT SYSTEM)	2ND LETTER (1ST LEVEL FUNCTION/SUBSYSTEM)
H HABITABILITY	F - FOOD MANAGEMENT G - GARMENTS/BEDDING H - HOUSEKEEPING/TRASH MANAGEMENT P - PERSONAL HYGIENE R - RESTRAINT/MOBILITY
S STOWAGE PROVISIONS/ EQUIPMENT RESTRAINT	B - EQUIPMENT CONTAINMENT - SOFT C - EQUIPMENT CONTAINMENT - RIGID R - EQUIPMENT RESTRAINT - PERMANENT T - EQUIPMENT RESTRAINT - TEMPORARY/ INTERIM
G GUIDANCE & NAVIGATION	A - SUBSYSTEM A B - SUBSYSTEM B C - SUBSYSTEM C D - SUBSYSTEM D ETC.

TABLE A3

2ND LEVEL FUNCTION OR CATEGORY DESIGNATORS

1ST LETTER (SYSTEM)	2ND LETTER (SUBSYSTEM)	3RD LETTER (2ND LEVEL FUNCTION OR CATEGORY)
H HABITABILITY	F FOOD MANAGEMENT	O - OPERATIONAL M - MAINT. & REPAIR (TOOLS) T - TEST EQUIPMENT S - SPARES

DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS	SIZE (MODE)
7. UNIT WEIGHT	U-WT	1	- 6 (N)

DEFINITION The weight in pounds to the nearest thousandth of one unit (round summaries to the nearest hundredth).

RESPONSIBILITY NASA Program Office weights management organization.

8. UNIT WEIGHT CODE	WT-C	1	- 1 (A)

DEFINITION A code indicating the accuracy of the unit weight in accordance with the following:

A = Actual Weight
E = Estimated Weight
T = TBD

9. SPECIFICATION WEIGHT	S-WT	1	- 6 (N)

DEFINITION End-item specification weight.

10. NEXT STOWAGE INTERFACE REFERENCE	REF ITEM	2	- 6 (A/N)

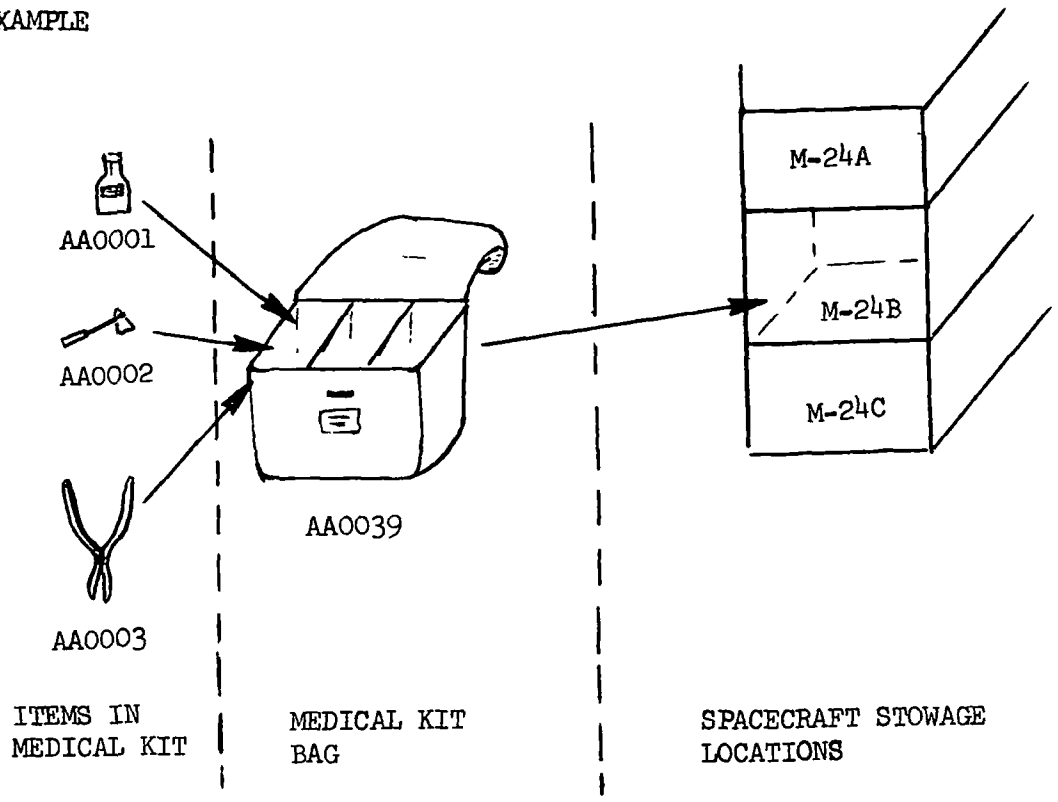
DEFINITION The item number of the next higher stowage interface, if applicable. (Not to be confused with stowage location code) The next higher stowage interface must be a stowed item. (See Figure A1 for example)

FORMAT All stowed items which constitute next higher stowage interfaces are listed.

RESPONSIBILITY NASA Stowage Management Office

DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)

EXAMPLE



Item AA0001 will reference item AA0039 as the next higher stowage interface, its stowage location is M205.

Item AA0039 will not reference a next higher stowage interface, its stowage location is M205.

11. UNIT VOLUME U-VOL 1 - 5 (N)

DEFINITION The volume in cubic feet of the envelope space required to stow a unit item (to the nearest thousandth of a cubic foot), calculated from the dimensions and the shape code where possible.

DATA ELEMENT		ABBREV.	ESTIMATED NO. OF FILEDS-SIZE (MODE)
12.	VOLUME CODE	VOL-C	1 - 2 (A/N)

DEFINITION The first character shall be used to indicate the accuracy of the unit volume in accordance with the following code:

A = Actual Volume
E = Estimated Volume
T = TBD
S = Specification Volume

The second character shall be used to indicate various assumptions with respect to summary totals in accordance with the following code:

0 - Unit volume will be used for calculations to arrive at summary totals.

1 - Stowed item is packed within another stowed item, and therefore only the volume of the next higher stowage interface is to be used for calculation of totals. Assume unit volume = 0.00.

2 - Volume to be determined. Assume unit volume of 0.05 cu. ft. for calculation of totals.

13.	SHAPE CODE	SH	1	- 2 (A/N)

DEFINITION A code indicating the shape of a stowage item or container.

FORMAT The codes are:

RE - RECTANGLE
CU - CUBE
CY - CYLINDER
CN - CONE
SP - SPHERE

DATA ELEMENT		ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)
14.	LENGTH	LG	1 - 5 (N)

DEFINITION The length in inches of the envelope space necessary to contain the item (expressed to the nearest hundredth).

15.	WIDTH	W	1 - 4 (N)

DEFINITION The width in inches of the envelope space necessary to contain the item (expressed to the nearest hundredth) if shape code is CY, CN, or SP width field shall indicate diameter.

16.	HEIGHT	H	1 - 4 (N)

DEFINITION The height in inches of the envelope space necessary to contain the item (expressed to the nearest hundredth).

17.	INTERFACE CONTROL DOCUMENT(S)	ICD	2 - 18 (A/N)

DEFINITION The control number assigned to applicable interface control documents/drawings.

18.	INSTALLATION DRAWING(S)	INSTL	2 - 20 (A/N)

DEFINITION The control number assigned to applicable installation drawings.

DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS	SIZE (MODE)
19. REFERENCE EXPERIMENT NUMBER	EXP	5	- 4 (A/N)

DEFINITION Multiple fields of four characters are provided to contain the experiment number which each requires the use of the stowage item.

20. REFERENCE NOTE NUMBER	NOTE	1	- 3 (A/N)

DEFINITION A number note permitting reference to supporting information and remarks pertinent to a given item.

21. REFERENCE NOTE DESCRIPTION	RND	3	- 40 (A/N)

DEFINITION The reference note which is referred to by the reference note number.

22. CHANGE CODE	CHG	1	- 2 (A/N)

DEFINITION The change control code by which changes to the data for a given item will be controlled. On initial establishment of the item, the field will be blank. The first revision will be designated "A" and the second, "B," etc.

DATA ELEMENT		ABBREV.	ESTIMATED NO. OF FIELDS	SIZE (MODE)
23.	STOWAGE LIST CHANGE NUMBER	SLCN	1	- 4 (A/N)

DEFINITION The number assigned to the stowage list change notice.

24.	STOWAGE LIST CHANGE DESCRIPTION	CR	2	- 24 (A/N)

DEFINITION A brief description of the nature of the change to the stowage list.

25.	CHANGE DATE	CHG. DATE	1	- 6 (A/N)

DEFINITION Date of approval of stowage list change notice.

26.	LINE NUMBER	LN	1	- 2 (N)

DEFINITION A numerical line control permitting sequential entry of item usage information.

27.	ACTION	ACT	1	- 1 (A)

DEFINITION A computer code indicating the action. Desired codes are as follows:

A = ADD
C = CHANGE
D = DELETE
X = INQUIRE
R = REST TO BASELINE

DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)
28. MISSION NUMBER	MSN	1 - 3 (A/N)

DEFINITION The identifying number assigned to a given mission.

FORMAT As defined by Mission Program Office.

29. ITEM CLASSIFICATION	CLAS	1	- 2 (A/N)

DEFINITION A code which indicates the classification of the different types of hardware which are required for a given item to support various reviews, milestones, and training during the program.

FORMAT The item classification code shall consist of a letter, followed by a number (if necessary) in accordance with the following schedule:

1st Character	2nd Character
F = Flight Item	1 = Class 1
T = Training Item	2 = Class 2
M = Mockup	3 = Class 3
Q = Qual Item	
P = Prototype	
D = Development Item	

RESPONSIBILITY The Program Stowage Management Office will define the class (2nd character) breakdown for flight items, qual items, prototypes, development items, etc. The Flight Crew Integration Division will define the class breakdown for training items and mockups.

DATA ELEMENT		ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)
30.	SERIAL NUMBER	SER.	1 - 12 (A/N)

DEFINITION The serial number assigned to each end-item by the manufacturer of the stowed item.

31.	MILESTONE	MS	1 - 6 (A/N)

DEFINITION The name of the milestone, review, test, etc., requiring stowed equipment support. A partial listing of typical milestones is given below:

- CDR
- CCSR - Crew Compartment Stowage Review
- Bench Reviews
- C^2F^2 - Crew Compartment Fit & Function
- Spacecraft Systems Tests
- Experiment/Payload Tests
- Equipment Fit Checks
- Crew Training Exercises
- Δ C^2F^2
- Equipment/Experiment Fit & Function
- Altitude Chamber Tests
- Pre-Pack
- Countdown Demonstration
- Launch Stowage

32.	MILESTONE DATE	DATE	1 - 6 (A/N)

DEFINITION The date at which the milestone is scheduled.

	DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS	SIZE (MODE)
33.	MILESTONE LOCATION/SITE	SITE	1	- 6 (A/N)

DEFINITION The geographical site at which stowed equipment is required to support a given milestone, such as NASA centers, contractor facilities, etc.

34.	QUANTITY REQUIRED	REQ	1	- 2 (N)

DEFINITION The quantity of items, by item classification, required to support a given milestone.

35.	DELIVERY DATE REQUIRED	DEL/REQ	1	- 6 (A/N)

DEFINITION The date of delivery required for each item, by classification, to support a given milestone.

36.	DELIVERY DATE EXPECTED	DEL/EXP	1	- 6 (A/N)

DEFINITION The expected date of delivery for each item, by classification, to support a given milestone.

37.	MISSION PHASE	MSN-P	TBD	- 2 (A/N)

DEFINITION The identifying character(s) assigned to the major phases of a given mission. Examples of mission phases are: launch, earth orbital operations, translunar operations, lunar orbit operations, interplanetary operations, return, etc.

DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)

FORMAT TBD.

RESPONSIBILITY The Mission Program Office will define the breakdown of mission phases.

38. QUANTITY STOWED — QTY — 1 - 3 (N)

DEFINITION The quantity of items per mission number by stowage location during each mission phase.

38. QUANTITY STOWED/LAUNCH
39. QUANTITY STOWED/RETURN
(Others may be required)

40. TOTAL QUANTITY — TOT — 1 - 3 (N)

DEFINITION The total number of items per mission number, per item number, and mission phase.

40. TOTAL QUANTITY/LAUNCH
41. TOTAL QUANTITY/RETURN
(Other may be required)

42. STOWAGE LOCATION — LOC — 1 - 12 (A/N)

DEFINITION The stowage location code of a stowed item.

DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)

42. LAUNCH

43. RETURN
(Others may be required)

FORMAT An alphanumeric code assigned to all stowage locations in each module or spacecraft in accordance with guidelines specified in SC-C-0009.

RESPONSIBILITY Space Program Office/Prime Contractor

44.	RETURN WEIGHT	R-WT	1	- 6 (N)

DEFINITION The unit return weight if it is different from the original unit weight. If the field is blank, the original unit weight will be used in all calculations. This weight will apply only to the line on which it is shown.

45.	RETURN VOLUME	R-VOL	1	- 5 (N)

DEFINITION The unit return volume if it is different from the original unit volume. If the field is blank, the original unit volume will be used in all calculations. This volume will apply only to the line on which it is shown.

46.	FIT CHECK CODE	FCC	3	- 1 (A)

DEFINITION A one character code which indicates whether the fit check is one of close tolerance ("hard") or a volumetric ("soft") fit check. Hard fit check shall normally require a flight or flight-type (Class 1 or 2) item. The code shall be:

H = Hard
S = Soft

	DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS	SIZE (MODE)
47.	FIT CHECK LOCATION	FIT-LOC	3	- 12 (A/N)

DEFINITION All stowage locations, other than the launch stowage location, which require fit check of the item.

48.	PROCEDURAL NOMENCLATURE	PNOM	2	- 20 (A/N)

DEFINITION The set of names used by the flight crew team and crew procedures writers in describing each stowage item.

RESPONSIBILITY Procedural nomenclature will be defined by the Flight Crew Procedures Division.

49.	ACTIVITY ELEMENT NUMBER	A-EL	1	- 15 (N)

DESCRIPTION A descriptor referencing the segment of the crew procedure to be accomplished.

RESPONSIBILITY Activity elements will be defined by the Flight Crew Procedures Division.

50.	GREENWICH MEAN TIME	GMT	1	- 7 (N)

DEFINITION The Greenwich Mean Time at which the activity element is scheduled to be completed.

	DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS	SIZE (MODE)
51.	"FROM" LOCATION	FM	1	- 12 (A/N)

DEFINITION The stowage location code from which stowed items are transferred during inflight phases of the mission.

52.	"TO" LOCATION	TO	1	- 12 (A/N)

DEFINITION The stowage location code to which stowed items are transferred during inflight phases of the mission.

53.	QUANTITY TRANSFERRED	QTY/XFR	1	- 3 (N)

DEFINITION The quantity of items scheduled for transfer from one location to another during inflight phases of the mission.

54.	TRANSFER CHANGE NOTICE	TCN	1	- 4 (A/N)

DEFINITION The number assigned to a transfer change notices for bookkeeping purposes.

55.	TRANSFER CHANGE CODE	TCC	1	- 2 (A/N)

DEFINITION The change control code by which changes to data for a given transfer item will be controlled.

DATA ELEMENT		ABBREV.	ESTIMATED NO. OF FIELDS	SIZE (MODE)
56.	TRANSFER CHANGE DESCRIPTION	TCD	2	- 24 (A/N)

DEFINITION A brief description of the transfer change.

57.	TRANSFER NOTE NUMBER	TN	1	- 3 (A/N)

DEFINITION A note number permitting reference to supporting information and remarks pertinent to the transfer of items.

58.	TRANSFER NOTE DESCRIPTION	TND	3	- 40 (A/N)

DEFINITION The transfer note which is referred to by the transfer note number.

59.	TOTAL QUANTITY	TOT	1	- 3 (N)

DEFINITION The total number of items of each hardware type required for the program.

60.	REPLACEMENT TIME	REP	1	- 3 (A/N)

DEFINITION The time required from go-ahead to replace an item, of each hardware type, expressed in weeks.

61.	QUANTITY ON HAND	QTY LEFT	1	- 2 (N)

DEFINITION Total quantity of items (per hardware type) available or on hand.

	DATA ELEMENT	ABBREV.	ESTIMATED NO. OF FIELDS	SIZE (MODE)
62.	SHELF LIFE	LIFE	1	- 3 (N)

DEFINITION The storage time, months, that can be accumulated on an item before degradation occurs to the point where the item does not meet the applicable specification.

63.	MATERIAL STATUS	MATL	1	- 1 (A)

DEFINITION One of the following alphabetical codes which define the characteristics of materials (COMAT) status:

A = Approved
P = Pending Approval
O = Open (no COMAT submitted)
M = Metal (COMAT may not be required)
W = Waived

64.	POST FLIGHT DISPOSITION	DISP	1	- 1 (A)

DEFINITION One of the following alphabetical codes which defines the disposition status of a stowed item.

R = remains on board in same location
T = remains on board but transferred to another location
B = removed from vehicle and placed in bonded storage
S = removed from vehicle placed in storage for disposition.

65.	QUALIFICATION STATUS	QUAL	1	- 1 (A)

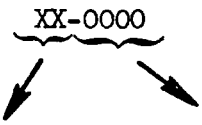
DEFINITION One of the following alphabetical codes which define the qualification status of items.

(TBD)

DATA ELEMENT		ABBREV.	ESTIMATED NO. OF FIELDS-SIZE (MODE)
66.	TRANSFER CODE	TC	1 - 6 (A/N)

DEFINITION An alphanumeric code which identifies the modules affected by the transfer of an item and uniquely describes (by sequential numbers) the items transferred between two modules or within a module.

FORMAT The transfer code shall be as follows:



A two letter or number code (module designators) which identify the modules affected by the transfer of an item.

A four digit code, (sequential numbers) assigned to each item for a given module (XX) designator code. (See NASA/MSC Specification SC-S-0014).

FINAL REPORT
FOR THE
CREW INTERFACE SPECIFICATIONS
PREPARATION
FOR
IN-FLIGHT MAINTENANCE AND STOWAGE
FUNCTIONS

Submitted in Accordance with Data Requirements List
(DRL Line Item #4) of Contract NAS 9-12249

NOVEMBER 9, 1972

PREPARED BY

GENERAL ELECTRIC

APOLLO & GROUND SYSTEMS
HOUSTON PROGRAMS
HOUSTON, TEXAS

Prepared by: F. W. Parker

Prepared by: B. E. Carlton

Approved by: Dr. J. T. Waggoner - Mgr.
Operations Analysis

Approved by: A. B. Thompson - Mgr.
Systems & Ops. Engrg.

ABSTRACT

This report presents the findings and data products developed during the Phase II Crew Interface Specification Study for Inflight Maintenance and Stowage functions, performed by General Electric for the NASA, Manned Spacecraft Center under Contract NAS 9-12249. The objective of the Crew Interface Specification Program for Inflight Maintenance and Stowage is to provide NASA with a set of documentation that can be used as definitive guidelines to improve the present process of defining, controlling, and managing crew interface requirements that are related to maintenance (including assembly and servicing) and stowage functions.

During this contract period, five new NASA Specifications were prepared. These specifications are:

SC-C-0009	General Specification, Operations Location Coding System for Crew Interfaces
SC-S-0011	General Specification, Loose Equipment and Stowage Management Requirements
SC-S-0012	General Specification, Loose Equipment and Stowage Data Base Information Requirements
SC-S-0013	General Specification, Spacecraft Loose Equipment Stowage Drawing Requirements
SC-S-0014	General Specification, Inflight Stowage Management Data Requirements

Additional data was developed defining inflight maintenance processes and related data concepts for inflight troubleshooting, remove/repair/replace and scheduled maintenance activities. The process of maintenance task and equipment definition during spacecraft design and development was also defined and related data concepts were identified for further development into formal NASA specifications during future follow-on study phases of the contract.

A recommended plan for the follow-on study is presented wherein specifications would be developed to provide requirements for the preparation and delivery of inflight maintenance data products by contractors to support each phase of the spacecraft program.

SC-S-0013

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

Houston, Texas

GENERAL SPECIFICATION

SPACECRAFT LOOSE EQUIPMENT

STOWAGE DRAWING REQUIREMENTS

This proposed specification has not been approved by the Manned Spacecraft Center and is subject to modification.

FOREWORD

Operational experience in recent manned spacecraft programs has emphasized the need for a specification that will standardize the format and contents of spacecraft loose equipment stowage drawings for future programs in order to expedite the communication to the NASA of contractor design implementation of stowage list requirements. In addition it is important to identify delivery and revision requirements to insure timely and up-to-date illustrative drawings for usage in program stowage activities.

At the numerous Apollo and Skylab crew station reviews and engineering tests, which were conducted to verify the validity of contractor design implementation of stowage requirements, the need for timely availability of a new type of stowage drawing became apparent. Three dimensional perspective illustrations of the loose equipment items and their stowage provisions on board the spacecraft were needed for management visibility into the stowage process, for training and preparation of flight and ground crews, and for quality verification of the stowage preparation of the vehicle.

With still further increases in stowage requirements anticipated in future spacecraft programs, and with the continued involvement of multiple spacecraft and payload prime contractors, it is necessary that standardized formats and contents for stowage drawings be established. This trend toward larger and more complex spacecraft with larger inventories of loose equipment is further complicated by the reusable spacecraft concept requiring rapid refurbishment. These future space systems emphasize the need for development of efficient stowage management practices. A

major factor in such stowage efficiency is the timely availability of operations support data that will provide pictorial identification of the items to be stowed and their spatial orientation for stowage. The spacecraft loose equipment stowage drawing specified herein has been established to meet these needs.

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FIGURES

1.0 INTRODUCTION

1.1 PURPOSE. The purpose of this specification is to define the format and content requirements for loose equipment stowage drawings for manned spacecraft programs. The purposes and functions served by the Spacecraft Loose Equipment Stowage Drawing specified herein are:

a. To serve as the single reference document in which the implementation of stowage requirements (GFE & CFE) identified in the spacecraft stowage list is documented by the contractor for each vehicle or module.

b. To illustrate in pictorial three dimensional detail the stowage configuration of each stowage location identified by a unique operations location code (Ref. NASA/MSC Specification SC-C-0009).

c. To define for each stowage location the inner volume dimensions, item names, part numbers, quantity of items stowed, the stowage orientation of the items, and where necessary the stowage sequence of the items.

d. To serve as a working reference document for flight crew and engineering personnel in evaluating stowage and planning stowage changes during vehicle design, development and checkout.

e. To serve as a data reference for field use by personnel who perform vehicle stowage and personnel who monitor and verify the integrity of the stowage configuration.

f. To serve as a basic reference for preparation of the illustrations section of inflight stowage management data.

The stowage drawing format and content defined herein are designed to reduce the "search time" required by the user to obtain all relevant information necessary for accurate stowage of a particular area of the spacecraft.

1.2 SCOPE. The Spacecraft Loose Equipment Stowage Drawing Requirements specified herein are applicable to all manned spacecraft programs including launch type spacecraft, lunar landers, earth orbital shuttles, payload modules, space stations, space tug type vehicles, and interplanetary spacecraft. Specifically this specification provides for:

a. General requirements for the Spacecraft Loose Equipment Stowage Drawing, including delivery schedule requirements, revision requirements, and requirements for mission/vehicle effectivity.

b. Requirements for organization of the Loose Equipment Stowage Drawing into major sections.

c. Requirements for format and content of each section of the drawing.

The requirements for engineering design drawings for stowed equipment and stowage provisions do not form a part of this specification. Engineering drawing requirements for NASA-manned spacecraft programs are contained in MIL-STD-100A and MIL-D-1000.

1.3 APPLICABLE DOCUMENTS. The following documents of the issue in effect on the date of invitations for bids or procurement, form a part of this specification to the extent specified herein.

1.3.1 NASA Specifications.

SC-C-0009	General Specification, Proposed Operations Location Coding System for Crew Interfaces
SC-S-0011	General Specification, Proposed Loose Equipment and Stowage Management Requirements

SC-S-0012	General Specification, Proposed Loose Equipment and Stowage Data Base Information Requirements
SC-S-0014	General Specification, Proposed Inflight Stowage Management Documentation Requirements

1.3.2 Other Documents.

MIL-STD-100A	Engineering Drawing Practices

1.4 DEFINITIONS. For the purpose of this specification, the following definitions shall apply:

a. Stowage - The placement and restraint of loose equipment carried on board the spacecraft.

b. Stowage Provisions - Spacecraft equipment (CFE) designed to contain, restrain, or protect loose equipment (i.e., containers, lockers, tiedowns, attachments, etc.).

c. Stowed Equipment - Loose equipment which is stowed on board the spacecraft (for details on the level to which loose equipment is itemized, see definition of item number in NASA/MSC Specification SC-C-0012).

d. Graphics - Pictorial data, such as drawings, stowage maps, illustrations, etc. (As distinguished from tabular stowage data such as lists, procedures, logs, etc.)

e. CCSR - Crew Compartment Stowage Review (Ref. NASA/MSC Specification SC-S-0011).

f. CCFF - Crew Compartment Fit and Function Test (Ref. NASA/MSC Specification SC-S-0011).

g. CFE - Contractor Furnished Equipment (As applied to stowage: that loose equipment and stowage provisions which are furnished by the Spacecraft Prime Contractor).

h. GFE - Government Furnished Equipment (As applied to stowage: that loose equipment which is furnished by NASA and for which stowage provisions are the responsibility of the prime contractor).

i. ICD - Interface Control Document (Ref. NHB 8040.2, Apollo Configuration Management Manual).

2.0 RESPONSIBILITIES.

The National Aeronautics and Space Administration, Manned Spacecraft Center (NASA/MSC) shall insure compliance to this specification by prime spacecraft and module contractors responsible for design and allocation of spacecraft or module stowage provisions.

Requests for deviations, additions, or deletions to this specification shall be forwarded to the applicable NASA/MSC Spacecraft Program Office.

3.0 GENERAL REQUIREMENTS FOR THE SPACECRAFT LOOSE EQUIPMENT STOWAGE DRAWING.

3.1 DEFINITION OF CONTENT. The Loose Equipment Stowage Drawing shall serve as the single reference document which defines for the spacecraft or module the planned stowage configuration of all on-board loose equipment, both contractor furnished (CFE) and government furnished (GFE). Requirements for approval of the drawing prior to issue, revision, etc., shall be determined by mutual agreement of NASA and the spacecraft contractors. This drawing illustrates the contractor plans for implementation of the loose equipment requirements as defined in the official NASA Master Stowage List for the spacecraft/mission. The Loose Equipment Stowage Drawing shall illustrate the physical location of each unique stowage location designated by a stowage location code (Ref. NASA/MSC Specification SC-C-0009). For each coded location the drawing shall illustrate:

a. The inner volume dimensions available for stowage.

b. The name, part number, and quantity of items to be stowed.

c. The stowage orientation of the item(s).

. d. Where necessary the required stowage sequence of item and/or folding sequence of soft goods.

Detailed description of the contents of the Loose Equipment Stowage Drawing is presented in Section 4.0 of this specification.

3.2 DELIVERY SCHEDULE. The Loose Equipment Stowage Drawing shall be delivered in preliminary form at the earliest vehicle milestone at which stowage design is reviewed (usually the crew compartment stowage review -- CCSR) and further updated on a regular schedule as changes are made to stowage design. It is especially important that the drawing reflect the present state of spacecraft stowage design for crew interface reviews on flight vehicles such as the crew compartment fit and function test (CCFF), altitude chamber, etc. Revision requirements are discussed in 3.4.

3.3 MISSION/VEHICLE EFFECTIVITY. A Loose Equipment Stowage Drawing shall be prepared by mission for each spacecraft and associated cargo compartments and/or payload modules. In the event that the drawing is issued with multiple mission or vehicle effectivity, then the pages of the drawing must be organized such that stowage illustrations not applicable to the specific mission or spacecraft under consideration are separate and may be discarded; i.e., the illustrations for a given spacecraft or mission shall not create confusion by including inapplicable data.

3.4 REVISION REQUIREMENTS. The Loose Equipment Stowage Drawing shall be maintained current with spacecraft stowage design. Revisions shall be issued on a regular schedule to be determined by mutual agreement of NASA and the spacecraft contractor. The organization of the drawing as defined in this specification facilitates rapid update since each stowage

location is represented on an "A" size drawing. Individual stowage changes are incorporated by revising only those pages which illustrate the stowage locations affected by the change. By this method the drawing is kept up to date by simple page changes, with accompanying additions to the Table of Contents and Revision History. Section 7.0 of this specification contains detail requirements for the process to be followed in revising the drawing.

4.0 ORGANIZATION OF THE LOOSE EQUIPMENT STOWAGE DRAWING

The Loose Equipment Stowage Drawing shall be organized in the following sections:

a. Section 1, - Summary Section

b. Section 2, - Launch Stowage Section

c. Sections 3-N, Stowage Sections for Additional Mission Phases

Figure 1 illustrates the organization of the sections of the drawing. The content of each of these sections is described in greater detail in 4.1 - 4.3 below.

4.1 SECTION 1 - SUMMARY SECTION. The Summary Section of the Loose Equipment Stowage Drawing contains that data which is required to satisfy basic contractor drawing system requirements. No specific format for this section of the drawing is required provided the data supports the basic drawing concept by including a Title Page, Table of Contents, Index of Stowed Equipment, Revision History, and General Notes. Requirements for each of these are as follows:

4.1.1 Title Page. The Title Page contains the drawing title, latest revision number, mission/vehicle effectivity, and other applicable identifying data such as contractor organization, approvals, date, etc. Figure 2 illustrates a typical title page.

4.1.2 Table of Contents. The Table of Contents contains the official page count for the drawing. Since the pages are not numbered sequentially in the stowage sections of the document, the Table of Contents is utilized as the check for completeness, rather than recording the total page count on each individual sheet of the drawing. The format for the Table of Contents is shown in Figure 3. Note that the pages of the stowage sections, rather than being numbered, are identified by the spacecraft stowage location code which is illustrated on that page. Should the drawing be released with multiple effectivity for a number of similar vehicles, the applicable vehicles for which each page is effective are indicated by vehicle serial number as shown in Figure 3.

4.1.3 Index of Stowed Items. The Stowed Item Index shall consist of a list of the stowed equipment illustrated in the drawing. The equipment nomenclature is utilized as it appears on the official NASA stowage list. Figure 4 shows a typical format for the Stowed Item Index. It is desirable that the list be alphabetical; however, if the list is alphabetized, it must be revised each time a change in equipment is made. For each program the tradeoff will be left to program management as to whether to alphabetize the list, thereby increasing user convenience, or to use a sequential list and eliminate the cost of printing a revised list with each equipment change. A third possible option is to issue addendums to the list with each drawing revision, and periodically incorporate those addendums in an update to the alphabetical list.

4.1.4 General Notes. Notes which are generally applicable to all stowed equipment, several items of equipment, or notes which due to their length

are not suitable for inclusion on the field of the detailed stowage illustration, are grouped together in the summary section and referenced where applicable on the field of the illustrations. Detailed notes applicable only to one stowage item or location shall be called out on the field of the illustrations where possible. Figure 5 illustrates the General Notes.

4.1.5 Revision History. The Revision History is a chronological record of all drawing revisons, and contains the revision number, date, and description of each revision. The total number of pages in the Revision History is indicated on each of its pages. Figure 6 illustrates a typical revision history page.

4.2 SECTION 2 - LAUNCH STOWAGE SECTION. Section 2 of the Loose Equipment Stowage Drawing shall graphically define the planned spacecraft launch stowage configuration. It is this graphics data that illustrates the manner in which the NASA master stowage list requirements are to be implemented. Two types of levels of illustrations shall be utilized:

a. Overview Illustrations (Stowage Maps). For each spacecraft room or area containing stowage locations and identified by a unique letter code (Ref. NASA/MSC Specification SC-C-0009) one or more overview illustrations shall be prepared. The overview shall be on size "B" format and shall provide a configurational map of the area identifying the individual stowage locations. Detailed requirements for the overview illustration are specified in 5.0.

b. Detailed Stowage Location Illustrations. For each uniquely coded stowage location a detailed illustration shall be prepared. The detailed illustration shall be on size "A" format and shall show the stowage container (or location) together with the item(s) of loose equipment to be stowed. Requirements for the detailed stowage location illustrations are specified in 6.0.

Organization of the illustrations within the launch stowage section (see Figure 1) shall be alphanumerically by module/room and stowage location codes. The "A" size detailed stowage illustrations shall be placed in front of the "B" size overview. This arrangement is designed to allow simultaneous reference to the overview, which locates and identifies the stowage location within the area, and the detailed illustration which defines how the location is stowed. Figure 7 shows the arrangement of overviews and detailed illustrations within Section 2 as well as the basic alphanumeric page numbering convention.

4.3 ADDITIONAL MISSION PHASE STOWAGE SECTIONS. Section 3 and subsequent sections illustrate inflight stowage configurations which differ from launch stowage. These additional sections may be required to illustrate stowage for intervehicular or intravehicular cargo and equipment transfers, loose equipment placement inflight, and stowage configurations for later mission phases such as re-entry, lunar landing, interplanetary injection, etc. The format, content, and organization of illustrations within each section are similar to the launch stowage section with the exception that only those stowage configurations which differ from launch stowage shall be illustrated. The basic purpose of these additional mission phase stowage sections is to provide the basic reference data for verification of the fit and function of loose equipment in the planned usage location.

Determination of the degree to which inflight stowage changes are illustrated in Section 3 and subsequent will require judgement. Obviously not all loose equipment stowage changes made inflight will require illustration. The following guidelines shall be followed in determining illustration requirements for inflight stowage changes:

a. Stowage configurations which require fit check prior to launch shall be illustrated.

b. Inflight stowage changes for which the orientation of item(s) or sequence of stowage is critical shall be illustrated. These may include stowage configurations resulting from planned transfers of equipment/payloads between vehicles, stowage configurations for major mission events such as re-entry, etc.

c. Inflight changes for which the stowage orientation or sequence is unimportant need not be illustrated. These may include items which are stowed loose inside utility lockers, interim stowage containers, trash lockers, etc.

5.0 OVERVIEW ILLUSTRATION REQUIREMENTS.

5.1 GENERAL DESCRIPTION. The overview illustration consists of a pictorial view of a room or area of the spacecraft which contains stowage locations. Designation of the room and area and the associated coding of stowage locations shall be in accordance with the operations location coding system for crew interfaces, NASA/MSC Specification SC-C-0009. In general most spacecraft rooms can be presented on one overview illustration. However, in some cases this may not be possible. Selection of the specific areas that will be included in each overview illustration shall be at the discretion of the spacecraft contractor. The areas may consist of rooms, portions of rooms, walls, floor areas, control stations, portions of control stations, and extravehicular stowage areas.

The overview illustration shall show the position of individual stowage locations within the area, together with the corresponding stowage location codes. Sufficient overview illustrations shall be included such that all unique stowage locations in the spacecraft are identified clearly with respect to the stowage location code and physical location within the area. Figures 8, 9 and 10 illustrate typical overview illustrations.

5.2 OVERVIEW ILLUSTRATION CONTENT. The overview shall depict an area in sufficient detail that the general physical arrangement of all stowage locations within the area is clear. The position of each individually coded stowage location shall be identified on the overview, together with the stowage location codes, and if practical the stowage location code scales such as illustrated in Figure 9. The procedural nomenclature of items stowed at each location shall be shown on the overview by illustrating the stowage location decal configurations. Stowed items shall not be illustrated on the overview unless it is essential for clarity in depicting the stowage location (see Figure 8 - Locations D1, D2, and D3). Stowage locations which are identified by a location code, but empty for launch, shall be so indicated on the overview.

5.3 OVERVIEW ILLUSTRATION FORMAT. The overview illustration shall depict on one sheet a specific area of the spacecraft containing several individual stowage locations. The method of illustration which best accomplishes the purpose of the overview may vary between different areas of the spacecraft. For some areas, such as shown in Figure 9, it will be possible to clearly identify stowage location positions and codes in map format. In other cases it will be necessary to utilize three dimensional perspective, with leaders to indicate location code positions, and auxiliary illustrations on the overview to clearly identify all the stowage locations. Figures 8 and 10 illustrate this case. In all cases the overview sheet shall be designed as a fold-out which can be kept in view for ready reference when using the detailed illustrations (see Figure 1). The overview shall be prepared on type "B" format (11" x 17") as defined in MIL-STD-100A. The illustration shall be positioned to the right side of the sheet such that all or a major portion of the illustration will be visible to the right of the detailed illustration pages (size "A" sheets) for simultaneous viewing.

6.0 DETAILED STOWAGE LOCATION ILLUSTRATION REQUIREMENTS

6.1 GENERAL DESCRIPTION. For each overview illustration (see 5.0) a set of detailed illustrations shall be prepared. Detailed stowage location illustration shall define the stowage installation in sufficient detail that any qualified engineer and inspector can stow the vehicle and verify that the stowage is correct. As a general rule, each individual stowage location identified by a unique stowage location code (Ref. NASA/MSC Specification SC-C-0009) shall be illustrated on a separate size "A" drawing sheet. Stowage locations include containers, lockers, or any other locations having provisions designed to contain or restrain an item of loose equipment. In special cases, more than one stowage location may be illustrated on the same sheet (see Figure 11). Typical examples of detailed stowage location illustrations are shown in Figures 11, 12, and 13. The following sections describe the content and format requirements of the detailed stowage location illustration.

6.2 DETAILED STOWAGE LOCATION ILLUSTRATION CONTENT. The details of the configuration of each stowage location shall be shown by illustrating the stowage provisions and stowed item(s) in pictorial three dimensional detail. Each detailed stowage location illustration shall include:

a. A general pictorial reference to the physical position of the stowage location within the area, room, control station, etc.

b. The inner volume dimensions available for stowage, where appropriate. (See Figure 13)

c. The name, part number, and quantity of each item to be stowed.

d. The spatial stowage orientation of the item(s).

e. The required stowage sequence of items, where necessary.

f. Instructions for preparation of items for stowage (where appropriate) such as folding sequence, handling instructions, etc. (See Figure 12)

g. Reference to interface control document (ICD) criteria, where appropriate to stowage.

h. Space permitting, all notes and instructions relevant to the specific stowage location illustrated, with the exception of general notes applicable to more than one stowage location. (See 4.1)

Additional requirements for detailed stowage location illustration content are as follows:

i. Leaders. Leaders shall be utilized to clearly identify the name and part number of each stowed item illustrated (see Figure 11).

j. Page Numbering. Sequential numerical page numbers shall not be utilized. Detailed stowage location illustration sheets shall be identified by the stowage location code illustrated on the sheet (Ref. NASA/MSC Specification SC-C-0009). In some cases pages may be identified with more than one stowage location code. (See Figure 11) The purpose of this type of page numbering is to reduce the labor requirements for page number changes required when stowage changes are incorporated into the drawing, and reduce search time required to locate specific stowage locations.

6.3 DETAILED STOWAGE LOCATION ILLUSTRATION FORMAT. Size "A" drawing sheets ($8\frac{1}{2}$" x 11") as defined in MIL-STD-100A shall be utilized for detailed stowage location illustrations. The size "A" drawing format is utilized to simplify the mechanics of revising the stowage drawing and facilitate search time for quick reference to individual stowage locations and items. In special cases, where space does not permit adequate illustration of a stowage location on type "A" format, size "B" (11" x 17") may be utilized.

The format of the illustration shall be to utilize exploded isometric or perspective views to clarify stowage orientations and stowage sequences. As a general rule the item(s) to be stowed should not be shown in their stowed position, but should be shown in exploded view, separated a short distance from the stowage provisions, with dashed lines indicating the direction of stowage.

Pictorial reference to the position of the stowage location within the room, area, etc., is accomplished by showing a small, simplified portion of the overview illustration with leaders to depict the location within the area. Figures 11 - 13 show various approaches to this technique.

7.0 DRAWING REVISION PROCESS

Operational experience has shown that stowage design changes in manned spacecraft continue to occur throughout manufacture, checkout, and launch site operations. These changes arise from new mission requirements, late definition of payload equipment, and stowage improvements resulting from crew reviews, tests, and training exercises (see Figure 14). It is imperative that the loose equipment stowage drawing revision process permit rapid incorporation of these frequent changes in order that an up-to-date

reference be available which illustrates the current state of stowage design. The organization of the drawing (see 4.0 - 4.3) permits rapid revision without necessitating a complete reissue of the drawing each time a revision is made. The following paragraphs describe the effect of a stowage change on the various components of the drawing:

a. Title Page. Changed to reflect the latest revision and date.

b. Table of Contents. Changed only when pages are added, deleted, or redesignated (changes to stowage location codes).

c. Index of Stowed Equipment. Changed to reflect additions/deletions of stowed equipment, changes to part number, nomenclature, and stowage location.

d. General Notes. Changed only when notes are added or deleted.

e. Revision History. Changed with each revision to include date and description of the revision.

f. Overview Illustration. Changed only when changes are made to the stowage location codes illustrated within the area of the overview, i.e., physical changes, coding redesignations, reassignment of locations originally designated "empty," decal changes, etc.

g. Detailed Stowage Location Illustration. Changed to reflect revised configuration of stowage provisions/stowed equipment. Usually will involve only one page per change, since each stowage location is illustrated on a separate page.

Figure 15 illustrates several typical stowage changes and shows the effect of the change on each of the components of the drawing previously discussed above.

The Loose Equipment Stowage Drawing shall be maintained by the contractor design organization responsible for stowage provisions. As stowage design changes are made, the corresponding pages which are affected in the Loose Equipment Stowage Drawing are brought up to date on the drawing masters. Revisions to the drawing shall be made at regular intervals, as is mutually agreeable to both the contractor and NASA, by issuing the page changes which have been compiled since the last revision, together with an update to the Title Page, Table of Contents, Stowed Equipment Index, and Revision History.

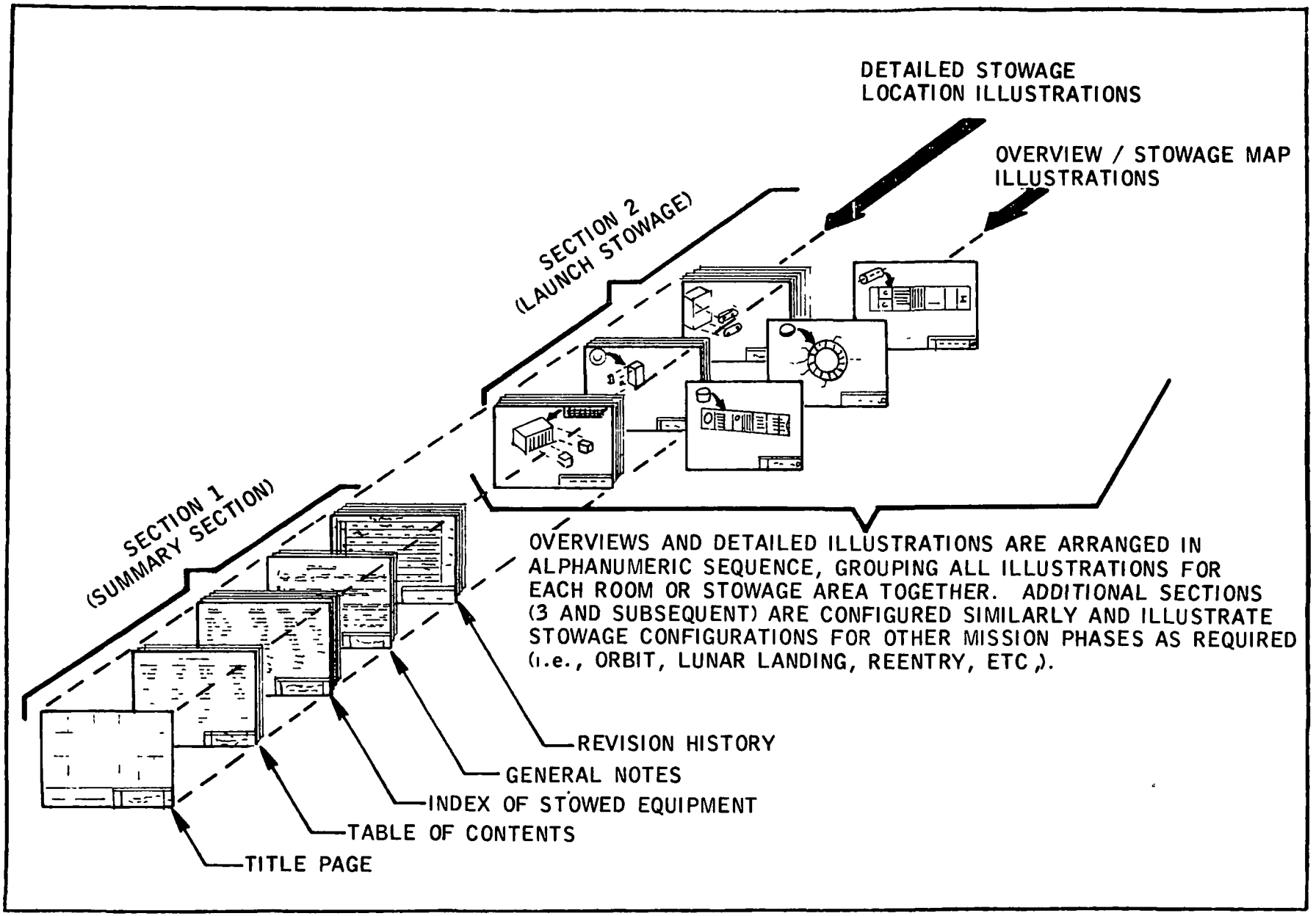


FIGURE 1 - SPACECRAFT LOOSE EQUIPMENT STOWAGE DRAWING CONFIGURATION

III	IN-ORBIT STOWAGE CONFIGURATION	SEE TABLE OF CONTENTS
II	LAUNCH STORAGE CONFIGURATION	SEE TABLE OF CONTENTS
I	SUMMARY DATA (TITLE, TABLE OF CONTENTS, INDEX OF STOWED EQUIPMENT, GENERAL NOTES, REVISION HISTORY	
DRAWING SECTION	CONTENT	PAGES

EXP. MODULE	—	003	TBD
EXP. MODULE	—	002	SS-2
EXP. MODULE	—	001	SS-1
MODEL OR END ITEM	NEXT ASSY	MODULE OR SERIAL NO.	MISSION EFFECTIVITY

CONTRACT NO. NAS 9-XXXX		DOCUMENTATION TYPE: II	
AEROSPACE SYSTEMS CORPORATION	SIZE A	CODEIDENT NO. 36845	LOOSE EQUIPMENT STOWAGE - EXPERIMENT MODULE
DRAWN J. Doe 4/5/74			ABC 123-45678 REV B
CHECKED A.B. Smith 4/7/74	SCALE NONE	SECTION: I	PAGE: 1 OF 12

FIGURE 2 - TITLE PAGE (EXAMPLE)

TABLE OF CONTENTS

SECTION	PAGE(S)	REVISION	CONTENT	EFFECTIVITY
I	1	C	Title Page	001 Thru 003
I	2-3	C	Table of Contents	001 Thru 003
I	4-6	C	Index of Stowed Equipment	001 Thru 003
I	7-9	C	General Notes	001 Thru 003
I	10-12	C	Revision History	001 Thru 003
II	EA-02C	A	Tool Stowage Compartment	001 Thru 003
II	EA-02F	A	Electrical Power Cable Stowage	001 Thru 003
II	EA-15A	B	Portable Utility Light Stowage	001 Thru 003
II	EA-16A	C	Stowage Assy, CO_2 Filter	001 Thru 003
II	EA-16R	B	Emergency Communications Stowage	001 Thru 003
II	EA-000	C	Stowage Map - Airlock	001 Thru 003
II	EC-22A	C	Flight Data Stowage	001
II	EC-43B	A	Utility Locker	001 Thru 003
II	EC-43C	A	Utility Locker	001 Thru 003
II	EC-51F	A	Food Stowage	001, 002
II	EC-62D	A	ECS Spares Stowage	001 Thru 003
II	EC-62E	A	Optics Stowage	001 Thru 003
II	EC-000	B	Stowage Map - Control Station	001 Thru 003
II	EE-04A	A	Experiment T42 Stowage	001
II	EE-04B	A	Camera Equipment Locker	001 Thru 003
II	EE-15P	B	Experiment F22 Spares Locker	001
II	EE-16V	B	Experiment D15 Stowage	002
II	EE-000	B	Stowage Map - Experiments Station	001 Thru 003
II	EW-MAC	C	Recreation Equipment Locker	001 Thru 003
II	EW-PKF	C	Medical Kit Stowage	001, 002
II	EW-22R	A	Inflight Garment Stowage	001 Thru 003
II	EW-22V	A	Food Preparation Equipment Locker	001 Thru 003
II	EW-31B	A	Personal Hygiene Equipment Locker	001 Thru 003
II	EW-000	B	Stowage Map - Wardroom	001 Thru 003
III	EA-02H	B	Inflight Spacesuit Stowage	001, 002
III	EA-16D	B	Inflight Helmet Stowage	001, 002

AEROSPACE SYSTEMS CORPORATION			
SIZE A	CODE IDENT NO 36845	ABC 123-45678	REV. C
SCALE NONE	SECTION 1	PAGE 2 of 12	

FIGURE 3 - TABLE OF CONTENTS (EXAMPLE)

INDEX OF STOWED EQUIPMENT

NOMENCLATURE	PART NUMBER	STOWAGE LIST ITEM NO. REF.	PAGE
Absorber Element	ME901-0218-0061	CG 1410	EA-15B
Accessory Kit	SEB678-0022-101	GC 1010	EC-02C
Aerosol Analyzer	640013	CG 1810	EE-63F
Battery, PLSS	SV722862-2	EG 0002	EA-02A
Belt, Utility	1B83593-1	GC 0008	EC-14A
Boots, Pair	SEB13100143-301/302	EG 1410	EA-02H
Cable, Electrical Power	LDW390-52689-3	EC 1104	EA-02F
Canister, LiOH	LSC-330-122-3-10	EC 1403	EA-16A
Cassette, Film, 35mm	SEB33100775-301	FG 0005	EE-04B
Clip, Data Card	SEB32100094-301	FG 1201	EC-22A
Communications Carrier	1653G-04	EG 1000	EA-16R
Container, Film Cassette	SEB33100775-001	FG 0006	EE-04B
Control Head, CCU	V56-715100	IG 0011	EC-14J
Cushion, Type A	V36-787077-11	GC 3150	EW-MAC
Detector Package	681302	GC 2201	EE-04A
Dispenser, Salt Pkg.	TBD	MG 0050	EW-22V
Dosimeter, Passive	SEB12100045-201	GC 0580	EQ-PKF
Drogue	V28-575202	GC 0510	EA-05A
Drug Kit	SJC42100402-301	MG 0021	EW-PKF
Ejector Assembly	84000002030-030	GC 2100	EE-16V
Electrode Kit	SEC42100163-301	MG 0015	EC-62D
Ergometer Waist Belt	10M04913	MG 0018	EE-15P
Experiment Assy., M151	682031-02	MG 0002	EE-AMB
File, Data	SKB32100074-201	FG 1202	EC-22A
Filter, Type 00	182248G15	GC 0999	EC-62D
Filter, Type PP	182248G16	GC 0998	EC-62D
Food, Frozen	24-0225	MG 0121	EC-51F
Fuse, Spare	SEB33100266-301	GC 1400	EE-15P
Gas Chromatograph	SEB1230022-101	BG 1105	EE-62W

AEROSPACE SYSTEMS CORPORATION			
SIZE A	36845	ABC 123-4567	REV C
SCALE NONE		SECTION 1	PAGE 4 of 12

FIGURE 4 - STOWED EQUIPMENT INDEX (EXAMPLE)

GENERAL NOTES

1. ALL EQUIPMENT SHALL BE GIVEN ADEQUATE CARE AND PROTECTION WHEN BEING PACKAGED FOR VEHICLE INSTALLATION.

2. FIT CHECKS ARE TO BE ACCOMPLISHED PER THE FOLLOWING DRAWINGS: ABC 123-81465, ABC 123-64397, ABC 123-62243.

3. INSTALL THREADED FASTENERS PER MA 0101-005.

4. REMOVE ALL PROTECTIVE SHIPPING CAPS AND TAPE FROM ALL GFE AND CFE HARDWARE BEFORE STOWING.

5. ALL ITEMS ILLUSTRATED IN SECTION III (INFLIGHT TRANSFER STOWAGE) MUST BE FIT CHECKED PRIOR TO LAUNCH.

6. PRIOR TO EARTH LAUNCH, THE FOLLOWING ITEMS IF DAMAGED MAY BE REPLACED WITH NEW PARTS. THESE ITEMS TO BE OBTAINED FROM SPARE PARTS STOCK.

ABC 123-11512-1	FAIRING
ABC 123-00605-2	SHADE ASSY.
ABC 123-01234-1	NETTING ASSY.

AEROSPACE SYSTEMS CORPORATION			
SIZE A	36845	ABC 123-45678	REV C
SCALE NONE		SECTION 1	PAGE 7 of 12

FIGURE 5 - GENERAL NOTES (EXAMPLE)

REVISION HISTORY				
REV.	DATE	PAGE AFFECTED	DESCRIPTION OF CHANGE	EFFECTIVITY
A	1/15/72	1-6	UPDATE TO TITLE PAGE, T.OF C., EQUIP. INDEX	001, 002, 003
		7	ADD NOTE 5	001, 002, 003
		EA-15B	P/N CHANGED TO SEB 33100295-309	001, 002, 003
		EE-04A	TOWEL ASSY QTY CHANGED FROM 4 TO 6	001, 002, 003
		EW-PKF	PAGE ADDITION FOR MEDICAL KIT STOWAGE, P/N SEB 234-5612	001, 002
		EW-RRC	PAGE ADDITION FOR RECREATION LOCKER & CONTENTS	001, 002, 003
		EE-04B	ADDED NOTE FOR FILM STOWAGE SEQUENCE. CHANGED FILM P/N TO SEB 123-45678-102. QTY OF FILM CHANGED TO 10 (WAS 8)	001, 002, 003
		EW-22R	ADDED FOLDING SEQUENCE FOR INFLIGHT COVERALLS. ADDED CWG, P/N SEB 897-65432-105 TO LOCKER. QTY CHANGED FOR INFLIGHT COVERALLS, P/N SEB. 897-56712-103, FROM 4 TO 6	001, 002, 003
B	3/6/72	1-6	UPDATE TO TITLE PAGE, T. OF C., EQUIP. INDEX	001, 002, 003
		8	ADDED NOTES 6, 7, 8,	001, 002, 003
		EW-22M	PAGE DELETED - REPLACED BY EW-22V	001, 002, 003
		EW-22V	PAGE ADDITION - RELOCATION OF FOOD PREPARATION EQUIPMENT LOCKER FROM EW-22M. STOWAGE CONTENTS UNCHANGED	001, 002, 003
		EA-02H	ADDITION OF PAGE, STOWAGE PROVISIONS ADDED FOR INFLIGHT RESTRAINT OF SPACESUIT	001, 002
		EA-16D	ADDED STOWAGE TRANSFER NOTE FOR HELMETS	001, 002
		EE-15P	ADDED FOLLOWING SPARES TO LOCKER: LIGHT BULB, P/N XYZ 123-4444-101 BATTERY, P/N ABC 332-12345-505 FUSE, P/N ABC 332-87654-101	001

AEROSPACE SYSTEMS CORPORATION			
SIZE A	CODE IDENT NO 36845	ABC 123-45678	REV C
SCALE NONE	SECTION I	PAGE 10 of 12	

FIGURE 6 - REVISION HISTORY (EXAMPLE)

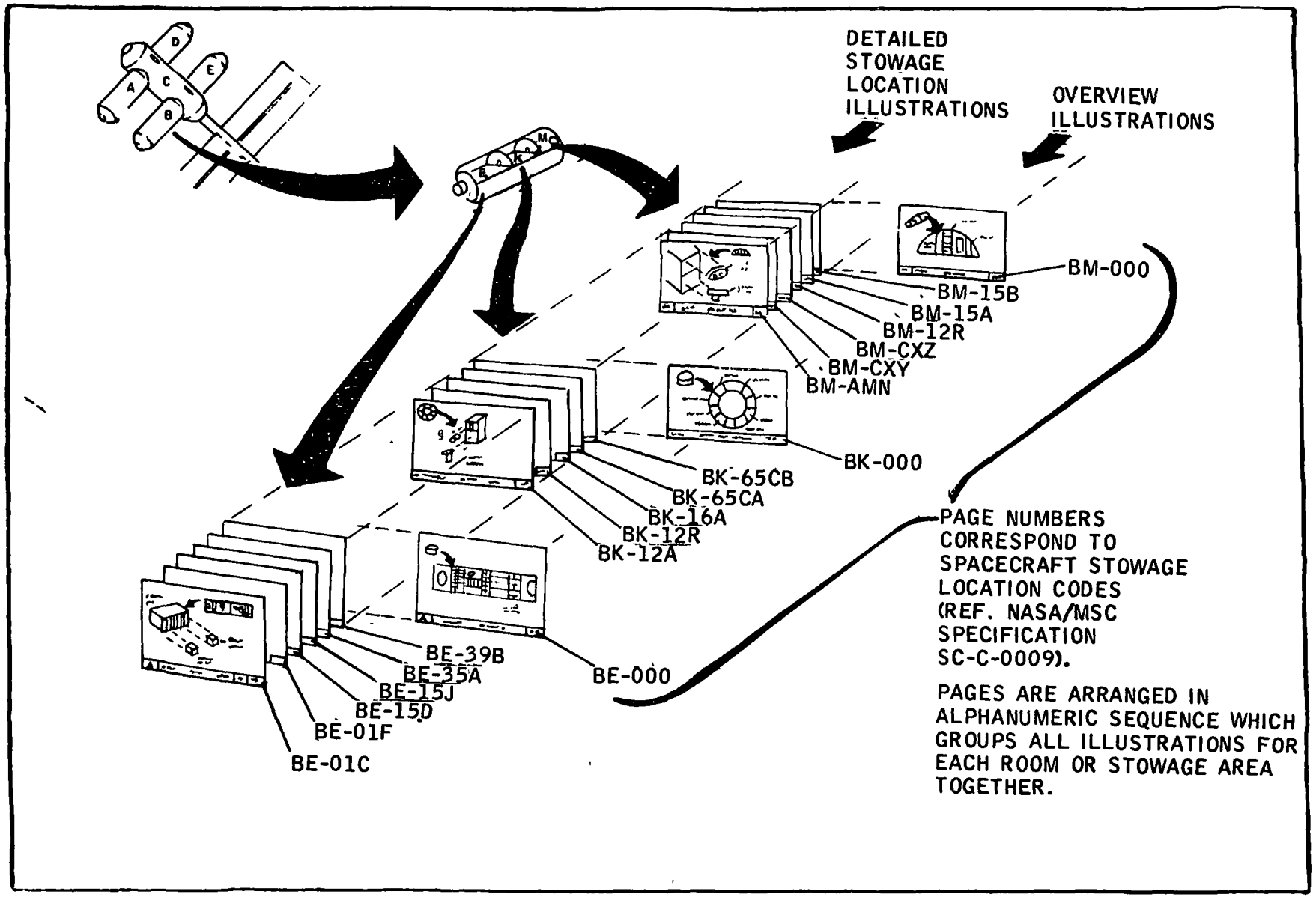


FIGURE 7 - ALPHANUMERIC PAGE NUMBERING CONVENTION

STOWAGE COMPARTMENT DECALS - LEFT SIDE

L9 RESTRAINT SYSTEM STOWAGE

L10 FACIAL WET WIPES

L12 TOWELS

TAPE ROLL

L13 TISSUE DISPENSER

L14 CWG ADAPTER

L16 URINE RCPT

L17 JETTISON BAGS

L18 URINE BAG

EMESIS BAG

DEF COLL DEV

FECAL COLLECTION CONTAINER

L19 TISSUE DISPENSER

L20 UCTA CLAMP

L21 COAS SPARE BULB & FILTER

CSM STRAPS

L23 HAMMOCK STOWAGE

STOWAGE COMPARTMENT DECALS - RIGHT SIDE

R7 RESTRAINT SYSTEM STOWAGE

R8 70MM MAGAZINE

R9 MONOCULAR

R10 ELECTRIC HASSELBLAD WITH 60MM LENS

R11 LCG CONSTANT WEAR ADAPTER

R12 CAMERA BRACKET

R15 16MM CABLE

R16 70MM FILM MAGAZINE

R17 EMERGENCY WRENCH

R13 LEC TETHER PACKAGE

R14 16MM CAMERA WEDGE

CUFF CHKLST

16MM SPARE FUSES

R22 AOT EYEGUARD & FILTER

EYE PATCH

R19 CONT WEB

DUST CAPS

R18 16MM FILM MAGAZINE

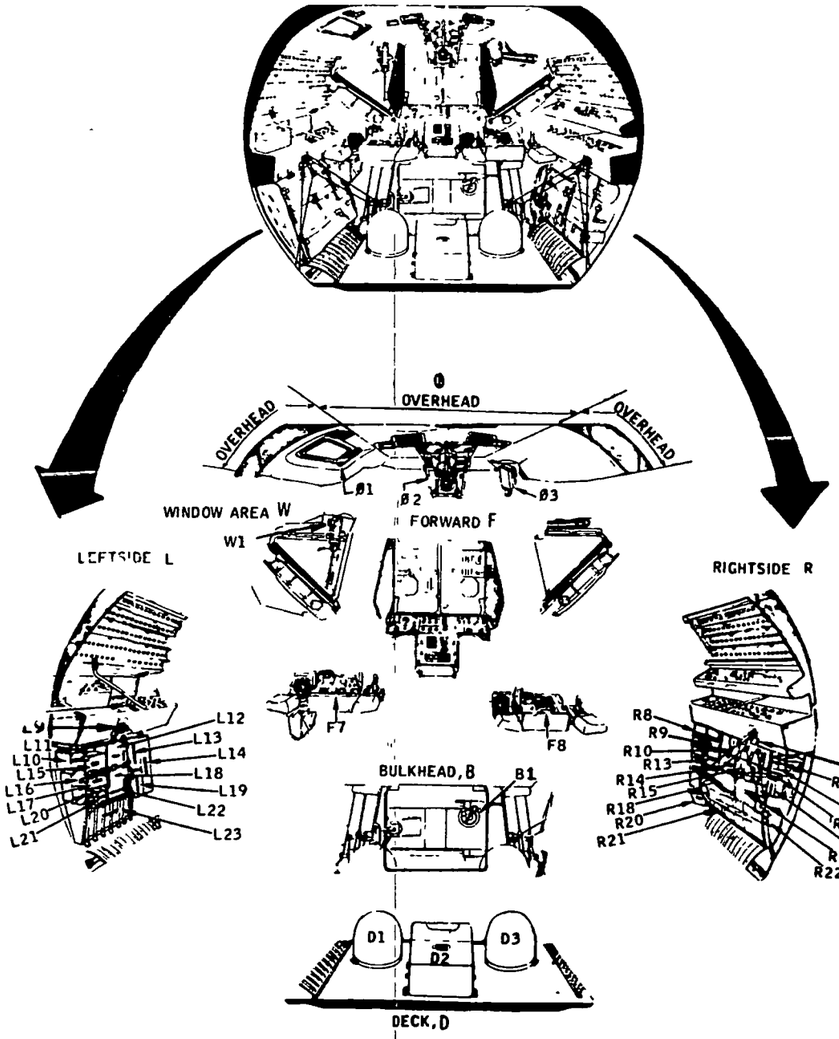
ACA SHORTING PLUG

R21 LCG INTERIM STOWAGE

BUNGEE CORD

PLIERS

SAMPLE ...LL



NOTE: THE FOLLOWING STOWAGE LOCATIONS ARE EMPTY AT LAUNCH: L11, L16, L22, R20

AEROSPACE SYSTEMS CORPORATION			
CONTROL STATION - FORWARD SECTION	SIZE B	CODE IDENT. NO 31307	BCD123-98765 B
	SCALE NONE	SECTION II	PAGE 11-000

FIGURE 8 - OVERVIEW ILLUSTRATION (EXAMPLE)

LOCKER DECALS

W-02C
WIPES 3
TISSUES

W-02F
SMOKE DETECTOR DISPENSED
SMOKE DETECTOR DISPENSED ADAPTER
SMOKE DETECTOR DISPENSED 7 /HANDLE

W-02J
SMOKE HOD FILTER 20
SMOKE HOOF 6
DISPENSED

W-02L
SMOKE HOD COLLECTION BAG 60
SMOKE HOD COLLECTION BAG PATCH CLAMP 60
SMOKE HOD SUCTION HOSE SPRING CLIP 3

W-02Ø
SALT DISPENSER 4
MINERAL SUPPLEMENT DISPENSER 4
GLYCOL CAPSULES DISPENSED 6

W-02R
DISPOSAL BAGS 3

W-07C
MEDICAL KIT DRUG SUPPLY
DRUG LIMITED SUPPLY 6
DRUG SUPPLY 6
MEDICAL ASSEMBLY
DRUG SUPPLY KIT
DRUG SUPPLY CANISTER
DRUG SUPPLY CANISTER 01 2
DRUG SUPPLY CANISTER 02 2

W-07F
MEDICAL KIT TREATMENT EQUIPMENT
TREATMENT EQUIPMENT LINER
TREATMENT EQUIP MENT CONTAINER 6
TREATMENT EQUIPMENT TOPICAL DRUG ORGANIZ 2
TREATMENT EQUIP MENT AMMO BARRIER KIT 2
TREATMENT EQUIP MENT PAD ASSEMBLY 2
TREATMENT EQUIPMENT SMALL BOTTLE KIT
TREATMENT EQUIP MENT MEDICINE 2
TREATMENT EQUIPMENT TOPICAL DRUG KIT
TREATMENT EQUIPMENT CAN OPENER
TREATMENT EQUIP MENT DRUG ORGANIZ 2

W-07J
MEDICAL KIT LABORATORY EQUIPMENT
INCUBATION WORK STATION ASSEMBLY
INCUBATOR RACK PAD ASSEMBLY
MICROSCOPE LAB
MICROSCOPE PAD
MICROBIOLOGY KIT
HEMATOLOGY CHEMICAL TEST KIT
MICROSCOPE KIT

W-07L
MEDICAL KIT DIAGNOSTIC TREATMENT EQUIPMENT
THERAPEUTIC KIT
BANDAGE KIT
DENTAL KIT
WORK TABLE

W-07Ø
DISPOSAL BAGS 2

W-07R
DISPOSALS BAGS 2

W-12J
ENTERTAINMENT TAPE RECORDER
ENTERTAINMENT TAPE RECORDER CASSETTES
ENTERTAINMENT CAMERA
ENTERTAINMENT TAPE RECORDER CASSETTES
ENTERTAINMENT BOOKS COVERS
ENTERTAINMENT PARTS
ENTERTAINMENT BOARD
ENTERTAINMENT DICE 2 CUP
ENTERTAINMENT HEADSET 2
ENTERTAINMENT HEADSET CORD 1
ENTERTAINMENT SPORTING ART
ENTERTAINMENT MICROPHONE
ENTERTAINMENT CARD DEVICES
ENTERTAINMENT GOLF BALLS 240
ENTERTAINMENT BATTERIES
ENTERTAINMENT BATTERY CONTAINER 40

W-18C
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-18F
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-18J
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-18L
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-18Ø
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-18R
BACKUP CLOTHING

W-22C
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-22F
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-22J
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-22L
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-22Ø
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-22R
BACKUP CLOTHING

W-27C
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-27F
CLOTHING MODULE
CLOTHING BAG
JACKET 4
TROUSERS 4
BOOTS
GLOVES
SHIRTS 4
UNDERWEAR SET 14
CONSTANT WEAR GARMENT 2

W-27J
WIPES 3
WASHCLOTH RED
WASHCLOTHS WHITE
WASHCLOTHS BLUE

W-27L
WIPES 3
WASHCLOTH RED
WASHCLOTHS WHITE
WASHCLOTHS BLUE

W-27Ø
WIPES
WASHCLOTH RED
WASHCLOTHS WHITE
WASHCLOTHS BLUE
SHOWER WIPES 3

W-27R
WET WIPES DISPENSER
WASHCLOTH - RED
WASHCLOTHS - WHITE
WASHCLOTHS - BLUE
SHOWER WIPES 3

W-32C
WASHCLOTH RED
WASHCLOTHS WHITE
WASHCLOTHS BLUE
TOWEL ASSEMBLY

W-32F
WASHCLOTH RED
WASHCLOTHS WHITE
WASHCLOTHS BLUE
TOWEL ASSEMBLY

W-32J
WASHCLOTH RED
WASHCLOTHS WHITE
WASHCLOTHS BLUE
TOWEL ASSEMBLY

W-32L
WASHCLOTH RED
WASHCLOTHS WHITE
WASHCLOTHS - BLUE
TOWEL ASSEMBLY

W-32Ø
TRIO RESTRAINT
TRIO STABILIZER
TRIO STOWAGE MODULE

W-32R
WET WIPES DISPENSER 3
WASHCLOTH RED
WASHCLOTHS - WHITE
WASHCLOTHS - BLUE

W-35Ø
OMS FRP

W-35R
OMS FRP

W-40Ø
OMS FRP

W-40R
OMS FRP

W-44C
WIPES 3
TISSUES

W-44F
DAILY EQUIPMENT CONTAINER

W-44J
VACUUM CLEANER CADDY
VACUUM CLEANER SURFACE TOOL
VACUUM CLEANER CREVICE TOOL
VACUUM CLEANER HOSE
VACUUM CLEANER BRUSH ATTACHMENT
VACUUM CLEANER BAGS IN PKG ACCESS CABLE
HIGH POWER ACCESSORY ADAPTER CABLE 3
SHORT STRAP

W-44L
UTILITY CABLE 4
SHORT STRAP 4

W-44Ø
TRASH BAGS 3

W-44R
TRASH BAGS 3

W-52D
FOOD CHILLER

W-52R
FROZEN FOOD

W-52K
FROZEN FOOD

W-59L
RESERVED FOR IN FLIGHT FOOD HANDLING

W-63L
UTENSILS 12
SALT DISPENSER
MINERAL SUPPLEMENT DISPENSER
FECAL TRACER DISPENSER
FECAL TRACER DISPENSER
GLYCOL CAPSULES DISPENSER
SMALL CAN OPENER
LARGE CAN OPENER

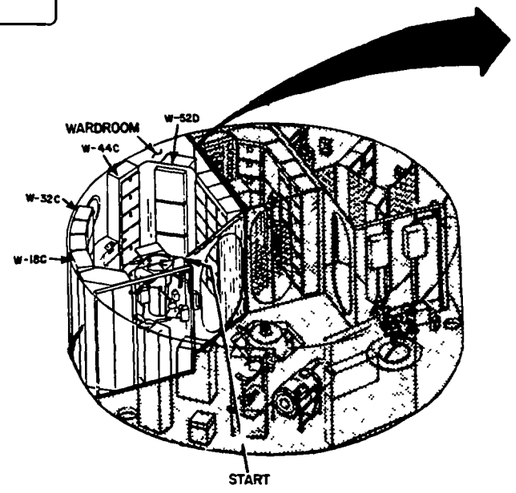
W-67B
WIPES 3
TISSUES

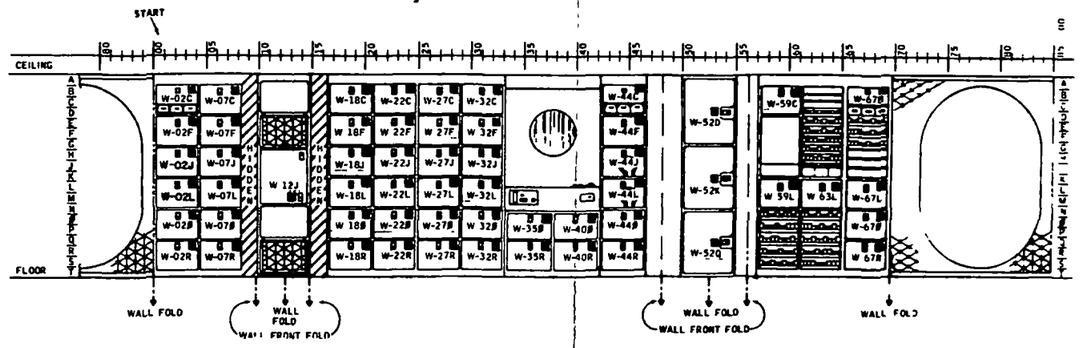
W-67L
RESERVED FOR IN FLIGHT FOOD HANDLING

W-67Ø
RESERVED FOR IN FLIGHT FOOD HANDLING

W-67R
RESERVED FOR IN FLIGHT FOOD HANDLING

NOTE: THE LOCATIONS LISTED BELOW ARE EMPTY FOR EARTH LAUNCH:
W-59C
W-59L
W-67L
W-67Ø
W-67R





MODULE "W" WARDROOM STOWAGE	ACE SPACECRAFT CORPORATION		
	SIZE B	CODEIDENT.NO. 25986	XYZ987-654321 REV. C
	SCALE: NONE	SECTION II	PAGE WW-000

FIGURE 9 - OVERVIEW ILLUSTRATION (EXAMPLE)

STOWAGE LOCATION DECALS

LEFT SIDE

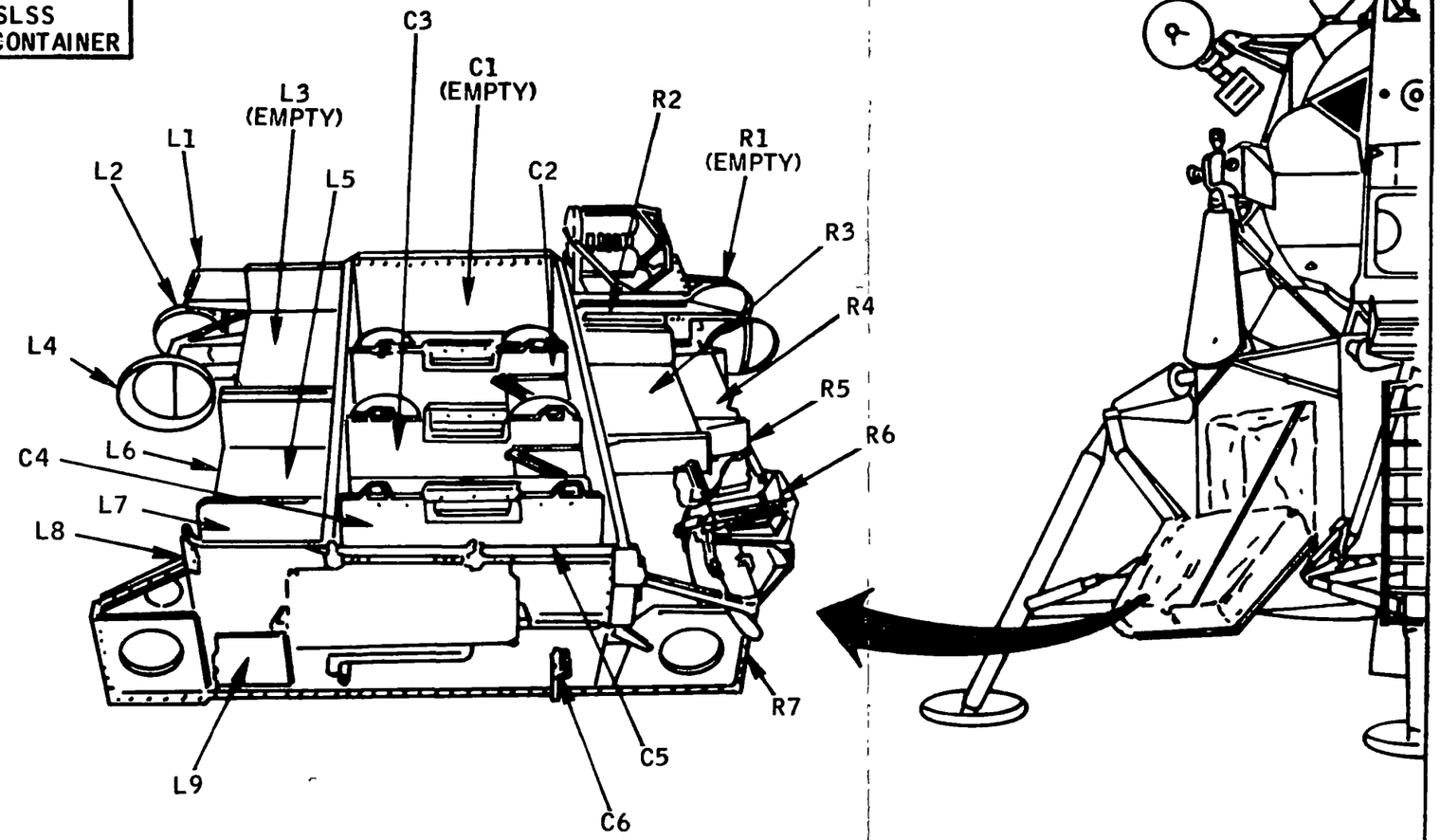
L2	LUNAR RAKE	
L3	SAMPLE RETURN CONTAINER	3
L5	SAMPLE RETURN CONTAINER	2
L6	SOLAR WIND COMPOSITION	
L8	FLAG	

RIGHT SIDE

R2	70MM HASSELBLAD CAMERA	
R3	SAMPLE RETURN CONTAINER	1
R4	16MM CAMERA	
R5	BUDDY / SLSS SAMPLE CONTAINER	

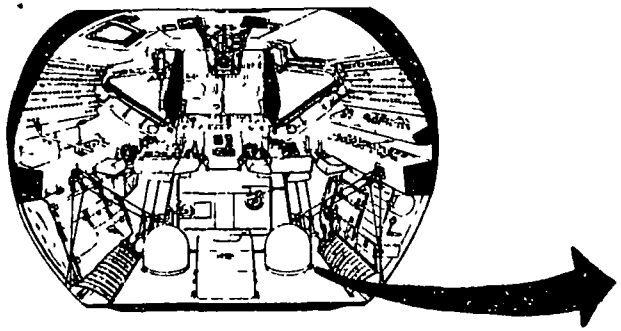
CENTER

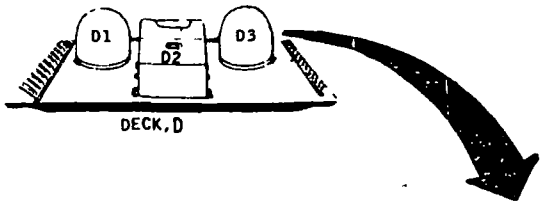
C2	PLSS BATTERY	FOOD PACKAGE	EVA-1
C3	PLSS BATTERY	FOOD PACKAGE	EVA-2
	MISC. STOWAGE		
C4	TCU	LCRU	
C5	SPARE BATTERY LCRU		



MODULAR EQUIPMENT STOWAGE ASSEMBLY - QUAD 4	AEROSPACE SYSTEMS CORPORATION			
	SIZE B	CODE IDENT. NO. 31307	BCD123-98765	REV A
	SCALE NONE	SECTION II	PAGE 1V4-000	

FIGURE 10 - OVERVIEW ILLUSTRATION (EXAMPLE)





STEP 1

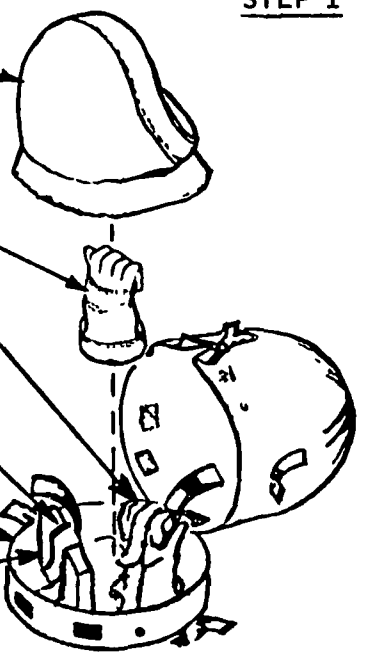
LUNAR EXTRAVEHICULAR
VISOR ASSY (LEVA)
A7I-205000-09

EV GLOVES (PR)
A7LB203034-05/-06
EVA CUFF CHECKLIST (2)
SEB33100302-302
ONE ON EACH LEFT GLOVE

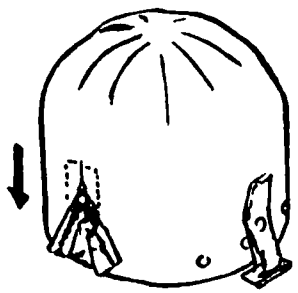
EMU MAINTENANCE KIT
A6L-503000-11

HELMET STOWAGE BAG
A6L-502000-13

EMU MAINT KIT
IN D3 ONLY



STEP 2



REV. B	STOWAGE LOCATIONS D1 & D3	PAGE 11-D1, D3

FIGURE 11 - DETAILED STOWAGE LOCATION ILLUSTRATION (EXAMPLE)

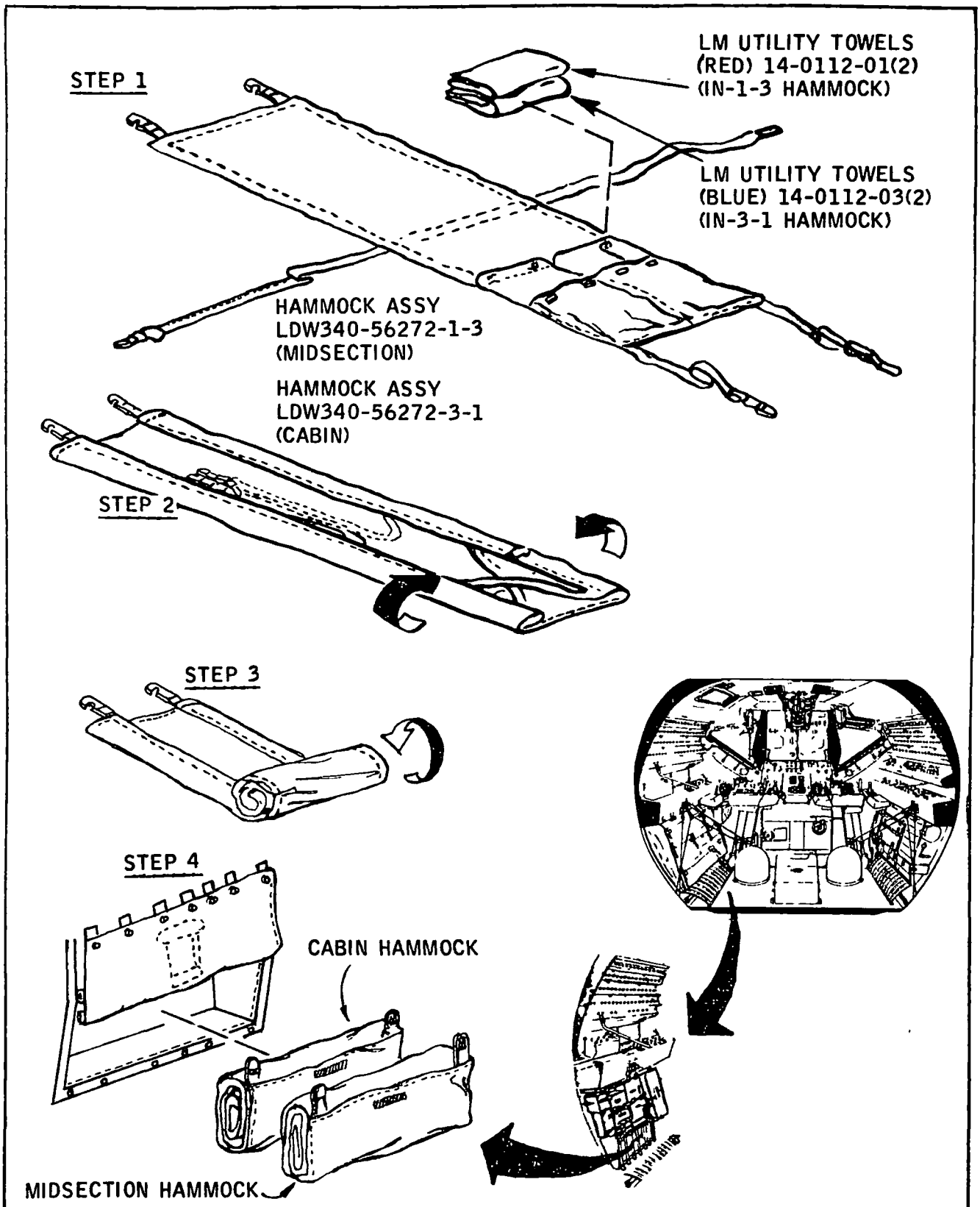


FIGURE 12 - DETAILED STOWAGE LOCATION ILLUSTRATION (EXAMPLE)

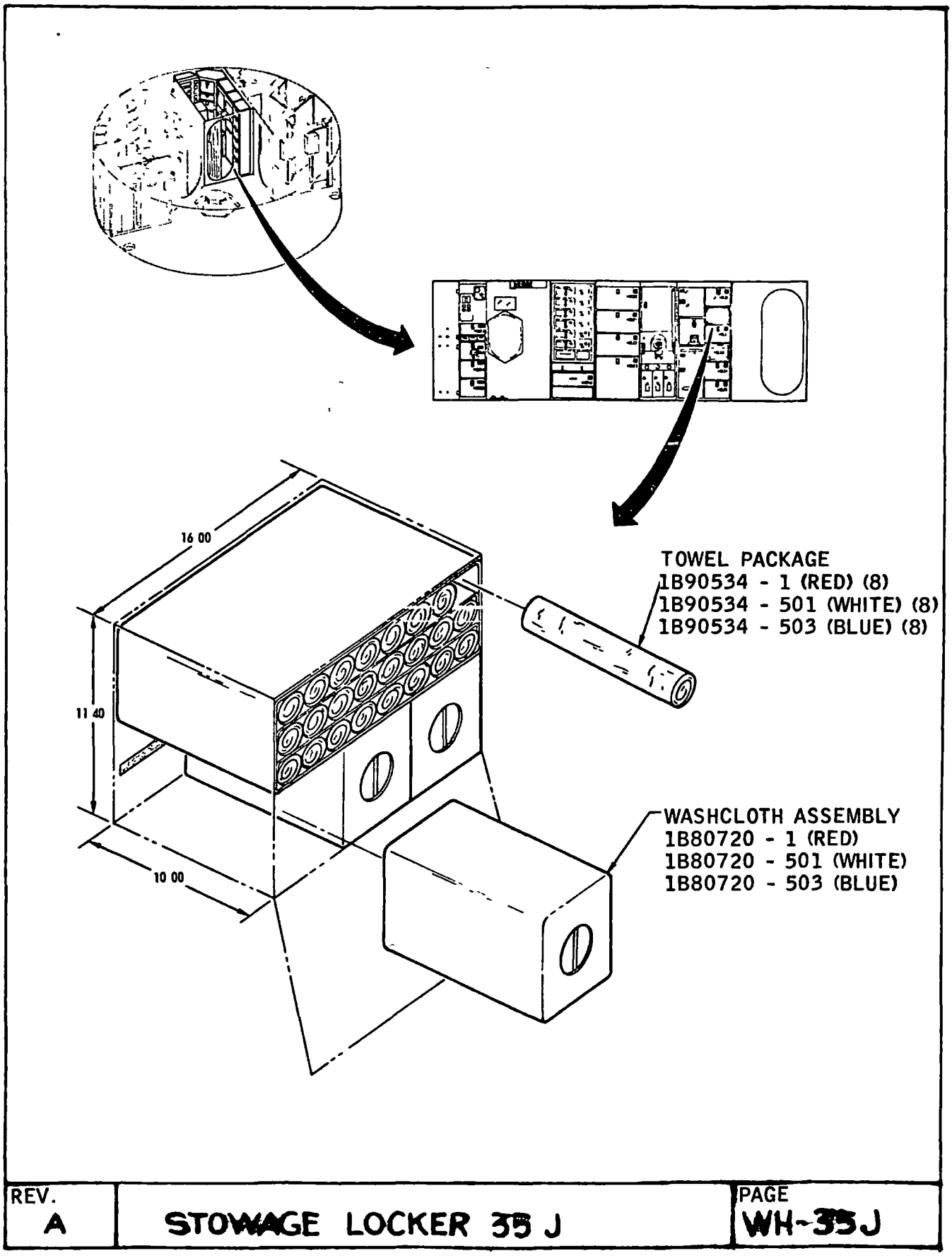


FIGURE 13 - DETAILED STOWAGE LOCATION ILLUSTRATION (EXAMPLE)

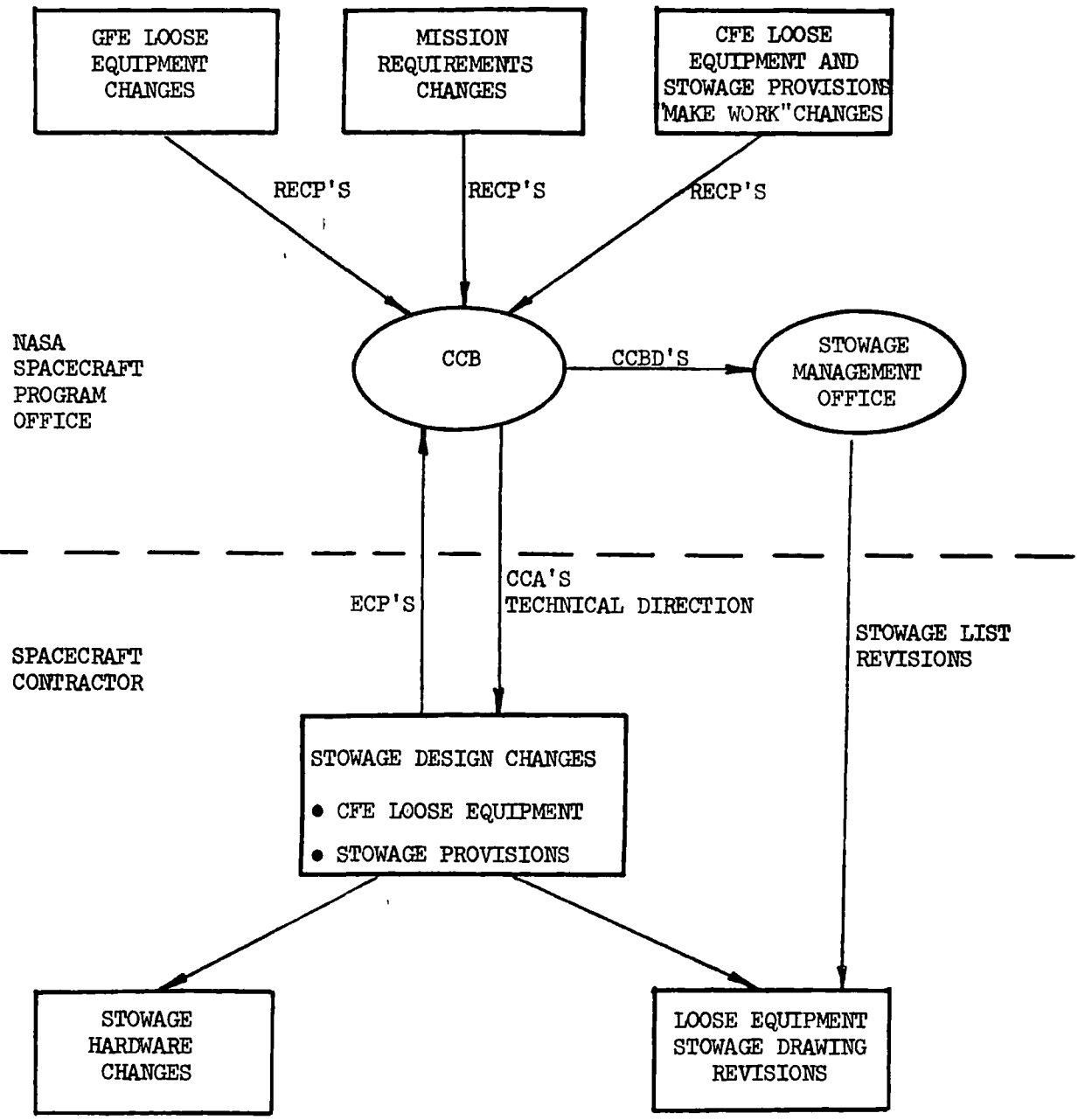


FIGURE 14 - STOWAGE CHANGE PROCESS

TYPE OF CHANGE	SECTION 1					SECTIONS 2 & SUBSEQUENT	
	TITLE PAGE	TABLE OF CONTENTS	STOWED EQUIPMENT INDEX	GENERAL NOTES	REVISION HISTORY	OVERVIEW ILLUSTRATION	STOWAGE LOCATION DETAILED ILLUSTRATION
Loose Equipment Configuration Change	Update with new Rev #	No Change	Update with new P/N	No Change	Update with Revision Description	No Change	Change P/N & Configuration on Field of Illustration
Stowed Item Addition, or Deletion (No Change to Stowage Provisions)	"	No Change	Update	No Change	"	No Change	Addition or Deletion of Item from Field of Illustration
Addition, Deletion, or Recoding of Stowage Provisions	"	Update with New Location Codes	Update with New Location Codes	No Change	"	Update with New Location Codes	Add or Delete Applicable Pages
Redesign of Stowage Provisions (Same Location Code)	"	No Change	No Change	No Change	"	Update if Required	Change to Illustrate New Configuration
Addition of General Note	"	No Change	No Change	Add Note	"	No Change	No Change
Addition of Specific Note	"	No Change	No Change	No Change	"	No Change	Add Note to Field of Illustration

FIGURE 15 - LOOSE EQUIPMENT STOWAGE DRAWING REVISION SUMMARY

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MANNED SPACECRAFT CENTER

Houston, Texas

GENERAL SPECIFICATION

INFLIGHT STOWAGE MANAGEMENT DATA REQUIREMENTS

This proposed specification has not been approved by the Manned Spacecraft Center and is subject to modification.

FOREWORD

This specification is one of a series of specifications which establishes requirements for the execution and implementation of the loose equipment stowage management process for future manned spacecraft programs. The need for these specifications stemmed from an increasing amount of stowage equipment and related stowage management problems as vehicles of successive space programs (Gemini, Apollo, and Skylab) became increasingly complex and were designed to accommodate missions of longer durations. One major problem, in particular, is that of assuring that flight crews and flight crew support teams of future spacecraft programs are provided with the essential data which allows efficient and timely assessment and control of a large inventory of inflight loose equipment. NASA/MSC Specification SC-S-0012, Stowage Data Base Information Requirements, establishes information/data requirements to support future ground operations associated with the development, training and preparation of loose equipment stowage. As an adjunct to that specification, requirements specified herein define the on-board stowage data for near-future missions wherein inflight documents will be used and in more advanced missions where on-board data management systems will be available. In the latter case the functional input and output requirements for the on-board data management system are defined.

TABLE OF CONTENTS

LIST OF FIGURES

TABLES

1.1 PURPOSE. The purpose of this specification is to define format and content requirements for loose equipment and stowage management data that will be included either as hard copy documents within the spacecraft's flight data file or as stored data in more advanced on-board data management systems. This inflight stowage data is used by the flight crews: (1) in locating loose equipment and stowed items on-board the spacecraft, (2) as reference material for the major transfers of items between and within the spacecraft, and (3) as log sheets for taking end-of-mission inventories.

The functions served by this specification are:

a) To provide a standard and single reference which defines the data requirements for inflight loose equipment and stowage management.

b) To provide guidelines for defining functional stowage input/output data requirements for an on-board information management system.

1.2 SCOPE. This specification has application for manned spacecraft programs. The initial requirements addressed are for inflight loose equipment and stowage management data that apply specifically to those programs whose inflight data concepts are similar to that of the Apollo and Skylab Program, e.g., hard copy documents placed on-board prior to launch. The major sections of the inflight loose equipment and stowage management data are defined along with the organization of the sections, and format/contents of each section. Additional requirements, which define loose equipment and stowage information needs within an on-board data management system, are identified for more advanced or autonomous spacecraft which will contain special on-board data management systems capabilities.

1.3 APPLICABLE DOCUMENTS. The following documents, of the issue in effect on the date of invitations for bids or procurement, form a part of this specification to the extent specified herein.

1.3.1 NASA Specifications

SC-C-0009	General Specification, Operations Location Coding System for Crew Interfaces
SC-S-0011	General Specification, Loose Equipment and Stowage Management Requirements
SC-S-0012	General Specification, Stowage Data Base Information Requirements
SC-S-0013	General Specification, Spacecraft Loose Equipment Stowage Drawing Requirements

2.0 RESPONSIBILITIES

The National Aeronautics and Space Administration Manned Spacecraft Center (NASA/MSC) shall determine compliance to this specification by contractors and government agencies responsible for provisioning of Loose Equipment and Stowage Management data or portions thereof. Requests for deviations, additions, or deletions to this specification shall be forwarded to the applicable NASA/MSC Spacecraft Program Office.

3.0 INFLIGHT STOWAGE MANAGEMENT DATA REQUIREMENTS

3.1 GENERAL DESCRIPTION. The first type of Loose Equipment and Inflight Stowage Management data specified herein is addressed to the format and contents of hard copy stowage management data (Paragraph 3.2) which is developed and stowed on-board (as part of the Flight Data File) prior to launch. It is recognized that future spacecraft designed to accommodate

large crews for longer mission durations than those of current programs will require an efficient means of data search and retrieval. Computerized systems with bulk storage capacity and/or a microfilm system with automatic storage and retrieval capability are considered to be more practical for handling large amounts of information and systems data necessary to minimize man-hours required to operate and maintain the spacecraft. The second type of Loose Equipment and Inflight Stowage Management data (Paragraph 3.4) addresses the input/output requirement of the on-board data management system(s).

The specific configurations and capabilities of the on-board data management system that will evolve with spacecraft development are not predictable at present. However, inflight stowage support data will be included as "stored" information within the on-board data management system. The second type of data defined in this specification provides general guidelines as to input and output requirements for inflight stowage data to be included within the on-board data management system.

The requirements delineated in this specification and in NASA/MSC Specification SC-S-0012, Stowage Data Base Information Requirements can, therefore, provide guidelines for establishing functional output requirements for advanced on-board data management systems. These guidelines and the requirements of the Inflight Stowage Management document are discussed in the following sections.

3.2 INFLIGHT STOWAGE MANAGEMENT DOCUMENT REQUIREMENTS. Hard copy Inflight Stowage Management data shall be organized into two documents. One document shall contain, in addition to the front matter or summary of the contents

of the document, two sections: 1) an alphabetical stowage list in procedural nomenclature of all loose equipment stowed onboard (Section I), and 2) stowage location graphics and stowage maps of spacecraft rooms or designated areas within rooms (Section II). The configuration of this document is illustrated in Figure 1. The second document shall contain the inflight transfer list which provides a chronological sequence of the transfer from one location to another location of each individual item and correlates each item to its respective activity element number in the Flight Plan.

The specific contents and the data format requirements of the Inflight Stowage Management Document are discussed in the following paragraphs 3.2.1 through 3.3.

3.2.1 Front Matter. The front matter of the Inflight Stowage document shall contain the information required by contractor or NASA drawing systems. As a minimum, that data shall include the title page and table of contents. The title page shall define the applicability of the document, e.g., mission number, mission effectivity and/or module(s). The table of contents for Section I needs only the title (mission/module applicability) and page number of the first page of each alphabetical stowage list if more than one list is included in the document. The table of contents of Section II shall list by name the items having stowage location illustrations and rooms or designated areas within rooms for which stowage maps have been prepared and included in Section II. The page numbers for each room stowage map shall be a range of location code designators of individual stowage locations shown on the map. The arrangement of contents within Section II and the page numbering convention are specified in Section 3.2.3.

3.2.2 Section I - Alphabetical Stowage List. The Alphabetical Stowage List, Section I, shall list the procedural nomenclature of all stowed items (which are assigned an item number) in alphabetical sequence. In addition to the procedural nomenclature the list shall include item number, stowage location, and quantity stowed per location. The format and contents of the Alphabetical Stowage List are illustrated in Figure 2. The item number designation and the spacecraft location code shall be in accordance with NASA/MSC Specifications SC-S-0012, Stowage Data Base Information Requirements, and SC-C-0009, Operations Location Coding System for Crew Interfaces, respectively.

The source of the Inflight Alphabetical Stowage List will be the ground-based Stowage Computer System. All data elements, e.g., item number, nomenclature, location and quantity, identified in the Alphabetical Stowage List are data base requirements specified in SC-S-0012. Data element definitions, field size, and other relevant characteristics are contained in that specification. Hard copy printouts of the Alphabetical Stowage List will have sequential page numbers and shall be reduced to a maximum image size of 7 x 10 inches on 8 x $10\frac{1}{2}$ inch page size. This shall be in accordance with Flight Data File printing conventions.

Close coordination between the Stowage Computer System personnel and personnel responsible for the Inflight Stowage Document must be maintained to assure that the Inflight Stowage List conforms to the actual mission baseline.

3.2.3 Section II - Graphical Stowage Location Illustrations/Stowage Maps. Section II of the Inflight Stowage Document contains drawings which illustrate in three dimensional detail the configuration of a particular stowage

location and contains stowage maps of the rooms or areas within the room in which the stowed items (graphically illustrated) are located. Stowage location illustrations shall be required to the extent that the difficulty in locating or transferring an item necessitates additional data to support the crew procedures. The following guidelines determine when a graphical illustration of a stowed item is required for on-board usage.

a) Graphical illustration of loose equipment placement (transfer) of an item for which the orientation or stowed/removal sequence of the stowed item is critical. These may include transfers of loose equipment between spacecraft modules or vehicles, and stowage configurations for major mission events such as re-entry. Transfer of items for which the orientation or stowage/removal sequence is unimportant need not be illustrated. Figure 3 is a typical simplified illustration of a stowed item for which the sequence of procedures for stowing/unstowing is important.

b) Configurations of stowage containers, e.g., lockers, in which numerous items are located and the relative location and/or orientation of the items must be maintained. Items stowed loose inside lockers, interim stowage containers, etc., need not be illustrated.

Each detailed stowage location illustration shall be shown in three dimensional detail and shall include:

a) Part or item name in Procedural nomenclature form of stowed item(s). This nomenclature shall be located adjacent to the exploded view illustration of the item.

b) Pictorial illustration of the sequence of stowing/unstowing procedures or of the configuration of a container within which are stowed multiple items.

c) A general pictorial reference of the physical position of the stowage location within the room or area.

d) Inner volume dimensions available for stowage, if appropriate.

e) Spatial stowage orientation of the item(s).

f) Page number (in location code form) in center of page. Sequential numerical page numbers shall not be used. The page numbers shall be the stowage location code which is illustrated on that page. All pages within Section II shall also be arranged in alphanumeric sequence of the location codes.

Typical stowage location illustrations are shown in Figures 4, 5, 7, and 8. (Figures 6 and 9 are typical stowage maps of spacecraft rooms which contain the locations illustrated in Figures 4, 5, 7, and 8.) Dimensions shown in the attached figures are in inches. If the metric system is used, then the dimensional units shall be in meters.

Stowage maps which pictorially illustrate the physical position, relative size and shape of all stowage locations, shall be prepared and included in Section II for those rooms or areas containing stowed equipment. Illustrations of typical stowage maps are shown in Figures 4 and 7. As indicated in these figures, each stowage location shall be designated by its location code (Ref. MSC Specification SC-C-0009, Operations Location Coding System for Crew Interfaces) and the equipment stowed in each location shall be identified. The stowage location and list of items in each location shall

agree with decals attached to the equipment; e.g., lockers, compartments, drawers, etc. For some areas, multiple stowage maps may be required. For example, if the stowage equipment configuration of a room or area during launch is significantly different than that during entry (as a result of numerous transfers of equipment), then two maps will be required. Areas requiring stowage maps and the number of maps per area required to support inflight crew operations shall be at the discretion of the NASA organization responsible for the Inflight Stowage Management document.

The stowage maps and detailed stowage location illustrations of the inflight document are similar in content to the Spacecraft Loose Equipment Stowage Drawings developed to Support Prelaunch Stowage Management Operations. For inflight use, the illustrations in the Loose Equipment Stowage Drawing shall be simplified to the extent that nonessential information such as part number, assembly numbers, and ground stowage instructions are deleted. In addition, the engineering nomenclature shall be replaced by the procedural nomenclature of the stowed item. Content and format requirements for the Loose Equipment Stowage Drawings are specified in MSC Specification SC-S-0013. Any additional illustrations required for inflight use shall also be prepared in the same format specified in SC-S-0013.

All detailed location illustrations which apply to a specific stowage map shall be grouped together and shall be placed in front of the applicable stowage map as illustrated by the arrangement of Figures 4, 5, and 6 and by 7, 8, and 9. The page identifiers of the detailed stowage illustrations shall be the location code designations, rather than sequential numbers; the page identifiers of the stowage map shall be their respective room or

or area designators. All pages of Section II shall be placed in alphanumeric sequence with respect to the page identifier. The stowage map shall be designed to fold out (B size drawing format) such that it can be kept in view while reading the detailed illustrations. If more than one map is required to illustrate various configurations of a particular room or area, then these maps and related stowage illustrations shall be located adjacent to each other within Section II. The mission phase, time, or event to which each map is applicable shall be designed in the title block.

3.3 INFLIGHT TRANSFER DOCUMENT. The Inflight Transfer document provides a list of all loose equipment transferred from one location to another location. The format for this list is illustrated in Figure 10. The item number, procedural nomenclature, quantity and location are included in the Alphabetical Stowage List and are discussed in Paragraph 3.2.1. The Transfer Code is an alphanumeric designator consisting of two module designators (letters or number) preceding the dash and sequential numbers following the dash. The module designators identify the two modules affected by the item transfer, e.g., from Module A to Module B = AB-; or the module within which the transfer is made, e.g., from Module A to Module A = AA-. For each unique module designator all items transferred during a transfer activity shall carry a common number designator. These numbers shall preferably be in numerical sequence with respect to time of transfer activity. For example, five items transferred during the fourth transfer activity from Module A to Module B would carry a Transfer Code of AB-0004. If one of these five items were transferred to Module C, and this is the sixth transfer activity affecting Module C, then the Transfer Code for this item would be AC-0006. Coding of the module shall be in accordance with NASA/MSC Specification SC-C-0009.

The assignment of sequential numbers to items or groups of items initially included in the Transfer List will logically be based on chronological occurrence of the item transfer. However, as additional items are assigned to the list, these items shall have the next higher sequential number, even though the transfer may be scheduled at an earlier time than some items already on the Transfer List. The Transfer Code shall be the reference designator in the time-correlated flight crew operations (of the Flight Plan) which include item transfer tasks. Updating of, or changes to, the Flight Plan will not affect the Transfer List other than the addition of transfer items to the list.

3.4 ON-BOARD STOWAGE INFORMATION MANAGEMENT SYSTEMS DATA REQUIREMENTS. A logical evolution in future space programs is the development of an autonomous spacecraft which utilizes on-board data management system(s) to provide reference information for the spacecraft operations. Inflight stowage management will be one of the numerous information categories handled by the data management system. While functional systems requirements of an on-board data management system cannot be specified at this time, some output functions and types of input data required are fundamental to stowage management and are not necessarily related to a specific type of data management system.

Detailed stowage computer systems input/output requirements are delineated in NASA/MSC Specification SC-S-0012, Loose Equipment and Stowage Data Base Information Requirements. Although these requirements address a ground-based system, many of the data elements identified in SC-S-0012 and the output data display functions, particularly some of the on-line display functions, are applicable to an on-board data management system to the extent

that data elements unique to ground operations need not be included in the on-board system. In addition, input data display formats and specific characteristics of the data elements are dependent on the type of on-board information management system utilized and are not specified herein.

Fundamental on-line display functions which shall be provided by an on-board data management system are as follows:

1. Item Status - Display the location(s) for a selected item number at or during a GMT or GMT range. Additional data elements that need be displayed shall include procedural nomenclature and quantity per location.
2. Transfer Status - Display "From Location" and "To Location" for selected or all item number(s) and GMT. Display shall also include procedural nomenclature and quantity.
3. Location Status - Display items (item numbers and procedural nomenclature) for a selected spacecraft location and GMT. Quantity of items per location shall also be displayed.
4. Activity Status - Display items (item numbers and procedural nomenclature) affected by selected activity elements.
5. Reference Experiment Status - Display the items (item numbers and nomenclature) used or associated with a specified experiment.
6. Functional Designation Status - Display all items (item numbers and nomenclatures) having common first letter codes or common first and second letter codes of the Item Functional Designators. (See data element number 6 of Table I.)

Data Base elements, some of which are included in the functional displays, are tabulated in Table I. These data elements are those considered

essential to an on-board stowage management data base and were extracted from Appendix A of SC-S-0012.

These on-line functional display requirements are considered the minimum requirements to support inflight stowage operations and additional displays may be required. While batch mode of operation (if an inflight computerized data management system is utilized) is not considered essential to meet stowage operational requirements, other Information Management Systems requirements or total systems requirements may necessitate batch mode operation. (For example, batch mode operation may be required for inventory control, logistics and other information categories that the on-board system must handle.) If batch mode capability is available, then batch output reports could possibly serve some of the above functions allocated to on-line reporting. Updating capability will also be a fundamental requirement of the system, particularly if such functions as consumables tracking or inventory control is performed by the system. The specific means of updating, e.g., ground or on-board, depends on the specific system utilized as well as functions allocated to the system and cannot be specified at this time.

TABLE 1

DATA BASE ELEMENTS

1. ITEM NUMBER. The basic control number by which each stowed item is identified in the data base. An item number will be assigned to items which meet one of the following classifications:

   1) Items stowed for launch which are individually handled inflight by the crew. (With the exception of multiple like-items such as individual tissues, tablets, etc., for which an item number shall be assigned to the container and contents, i.e., a bottle of tablets, box of tissues, etc.

   2) Items which are installed at the factory, but removed for stowage prior to launch, such as stowage lockers.

   3) Items installed at the factory which are individually handled in-flight by the crew, such as dust covers on optics, etc.

   Multiple or redundant item numbers shall not be assigned to the same stowed item. For example, in the case of a medical kit consisting of a bag and contents, the bag shall be assigned an item number and each of its contents shall be assigned an item number, but the complete kit shall not be assigned an item number.

   FORMAT. The item number format is as follows:

   X X — TWO LETTER CODE
   0 0 0 0 — FOUR DIGIT CODE

   1) The two letters indicate the division or organization (NASA or contractor) responsible to the Program Manager for procurement, qualification, and delivery of the stowage item. This code also indicates (directly or indirectly) whether the item is government furnished (GFE) or contractor furnished (CFE).

   2) The four digit numerical code shall be assigned sequentially to items within the responsibility of a given organization (0001 to 9999). This code provides for up to 9,999 stowed items for each responsible organization.

2. PROCEDURAL NOMENCLATURE. The set of names used by the flight crew team and crew procedures writers in describing each stowage item.

3. ACTIVITY ELEMENT NUMBER. A descriptor referencing the segment of the crew procedure to be accomplished.

4. GREENWICH MEAN TIME. The Greenwich Mean Time at which the activity element is scheduled to be completed.

5. MODULE. The identifying number or letter assigned to each spacecraft module.

6. ITEM FUNCTIONAL DESIGNATION. A three letter code which indicates the functional usage of the item.

FORMAT

1) 1st Letter - Spacecraft System Designator - A generic breakdown of major spacecraft systems. (See Table 1.1)

2) 2nd Letter - Top Level Function or Subsystem Designator - For each system designator, a top level subsystem or function breakdown shall be defined. Table 1.2 contains typical examples for selected systems.

3) 3rd letter - 2nd Level Function or Category Designator - This character categorizes the item within the system and subsystem. Table 1.3 contains an example of second level function designators.

7. UNIT WEIGHT. The weight in pounds to the nearest thousandth of one unit (round summaries to the nearest hundredth).

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TABLE 1.2

1ST LEVEL FUNCTION/SUBSYSTEM DESIGNATOR EXAMPLES

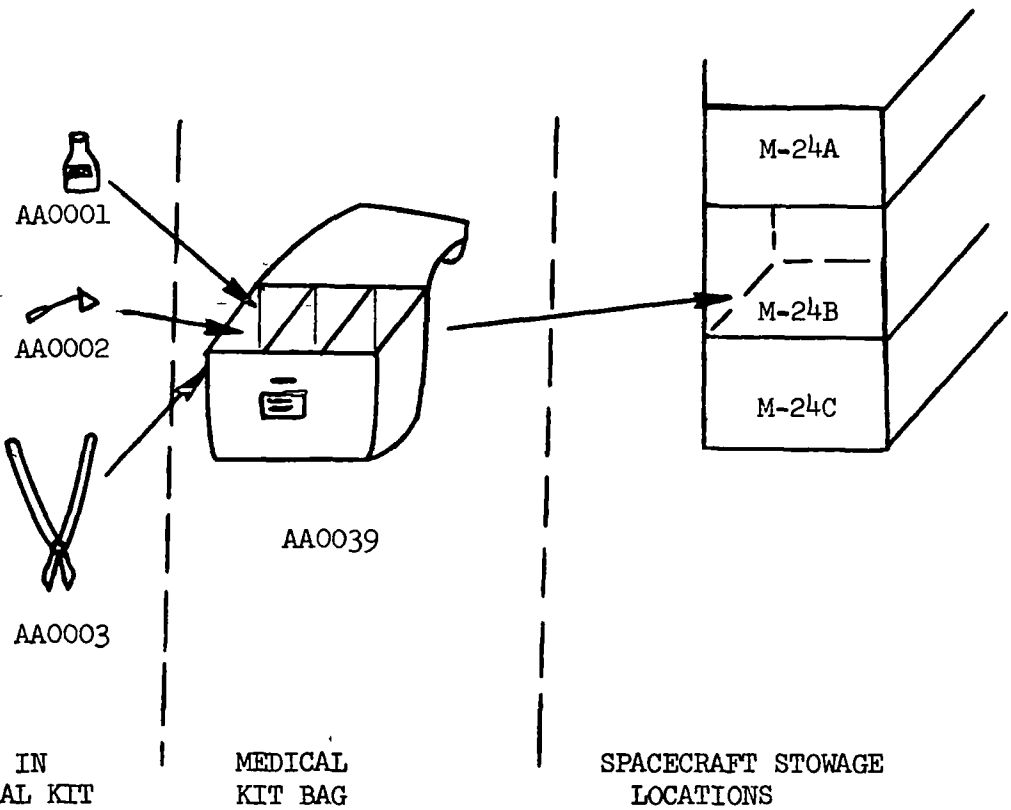
1ST LETTER (SPACECRAFT SYSTEM)	2ND LETTER (1ST LEVEL FUNCTION/SUBSYSTEM)
H HABITABILITY	F - FOOD MANAGEMENT G - GARMENTS/BEDDING H - HOUSEKEEPING/TRASH MANAGEMENT P - PERSONAL HYGIENE R - RESTRAINT/MOBILITY
S STOWAGE PROVISIONS/ EQUIPMENT RESTRAINT	B - EQUIPMENT CONTAINMENT - SOFT C - EQUIPMENT CONTAINMENT - RIGID R - EQUIPMENT RESTRAINT - PERMANENT T - EQUIPMENT RESTRAINT - TEMPORARY/ INTERIM
G GUIDANCE & NAVIGATION	A - SUBSYSTEM A B - SUBSYSTEM B C - SUBSYSTEM C D - SUBSYSTEM D ETC.

TABLE 1.3

2ND LEVEL FUNCTION OR CATEGORY DESIGNATORS

1ST LETTER (SYSTEM)	2ND LETTER (SUBSYSTEM)	3RD LETTER (2ND LEVEL FUNCTION OR CATEGORY)

8. NEXT STOWAGE INTERFACE REFERENCE. The item number of the next higher stowage interface, if applicable. (Not to be confused with stowage location code.) The next higher stowage interface must be a stowed item. (See example.)



Item AA001 will reference item AA0039 as the next higher stowage interface, its stowage location is M205.

Item AA0039 will not reference a next higher stowage interface, its stowage location is M205.

9. UNIT VOLUME. The volume in cubic feet* of the envelope space required to stow a unit item (to the nearest thousandth of a cubic foot), calculated from the dimensions and the shape code where possible.

10. LENGTH. The length in inches* of the envelope space necessary to contain the item (expressed to the nearest hundredth).

11. WIDTH. The width in inches* to the envelope space necessary to contain the item (expressed to the nearest hundredth) if shape code is CY, CN, or SP width field shall indicate diameter.

*Or centimeter if metric system is used.

12. HEIGHT. The height in inches* of the envelope space necessary to contain the item (expressed to the nearest hundredth).

13. REFERENCE EXPERIMENT NUMBER. Multiple fields of four characters are provided to contain the experiment number which each requires the use of the stowage item.

14. REFERENCE NOTE NUMBER. A number note permitting reference to supporting information and remarks pertinent to a given item.

15. REFERENCE NOTE DESCRIPTION. The reference note which is referred to by the reference note number.

16. MISSION PHASE. The identifying character(s) assigned to the major phases of a given mission. Examples of mission phases are: launch, earth orbital operations, translunar operations, lunar orbit operations, interplanetary operations, return, etc.

17. QUANTITY STOWED. The quantity of items per mission number by stowage location during each mission phase

    17. QUANTITY STOWED/LAUNCH

    18. QUANTITY STOWED/RETURN
    (Others may be required)

19. TOTAL QUANTITY. The total number of items per mission number, per item number, and mission phase.

    19. TOTAL QUANTITY/LAUNCH

    20. TOTAL QUANTITY/RETURN
    (Others may be required)

21. STOWAGE LOCATION. The stowage location code of a stowed item.

    21. LAUNCH

    22. RETURN
    (Others may be required)

*Or centimeter if metric system is used.

23. "FROM" LOCATION. The stowage location code from which stowed items are transferred during inflight phases of the mission.

24. "TO" LOCATION. The stowage location code to which stowed items are transferred during inflight phases of the mission.

25. QUANTITY TRANSFERRED. The quantity of items scheduled for transfer from one location to another during inflight phases of the mission.

26. TRANSFER NOTE NUMBER. A note number permitting reference to supporting information and remarks pertinent to the transfer of items.

27. TRANSFER NOTE DESCRIPTION. The transfer note which is referred to by the transfer note number.

28. TRANSFER CODE. An alphanumeric code which identifies the modules affected by the transfer of an item and uniquely describes (by sequential numbers) the items transferred between two modules or within a module.

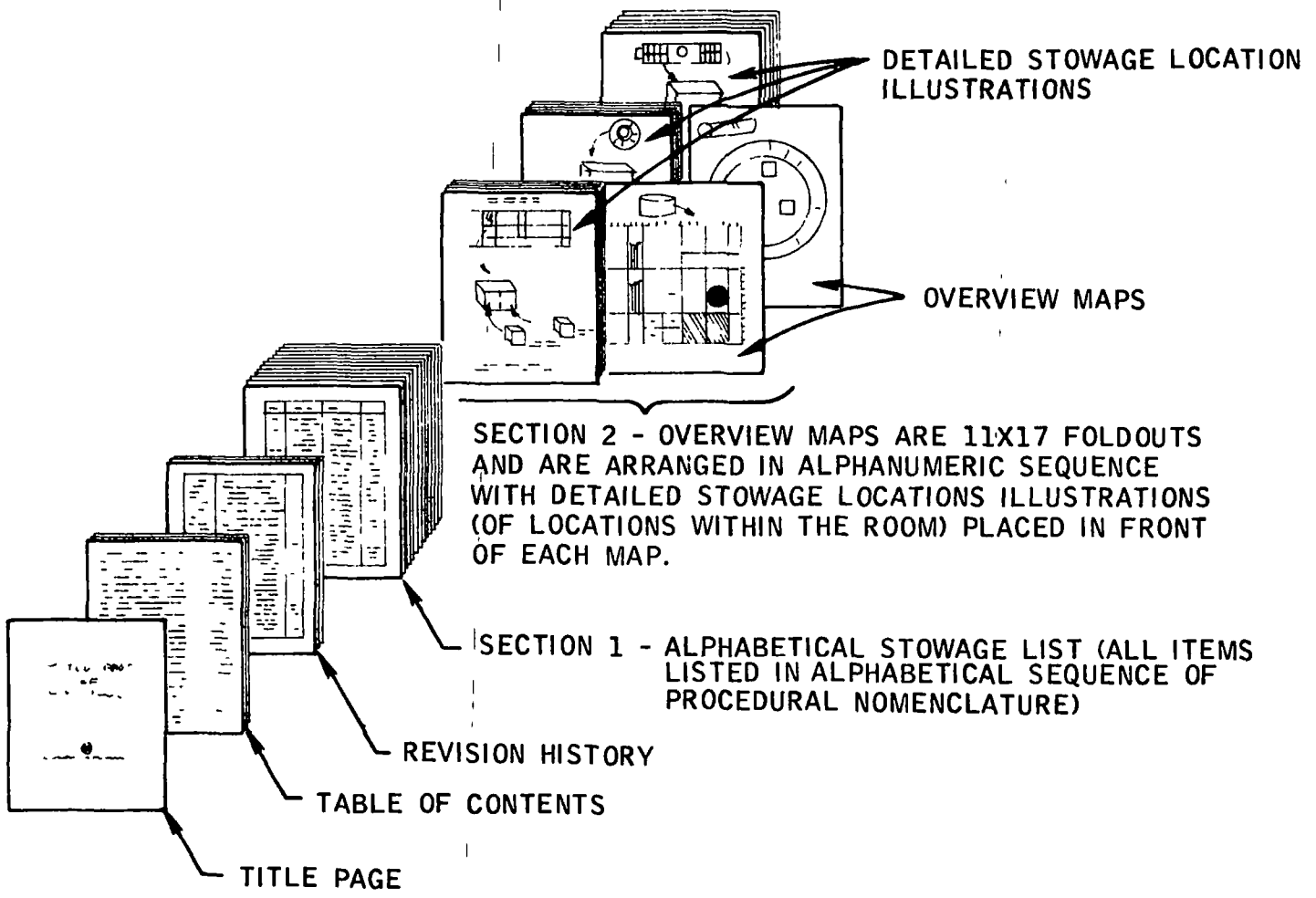
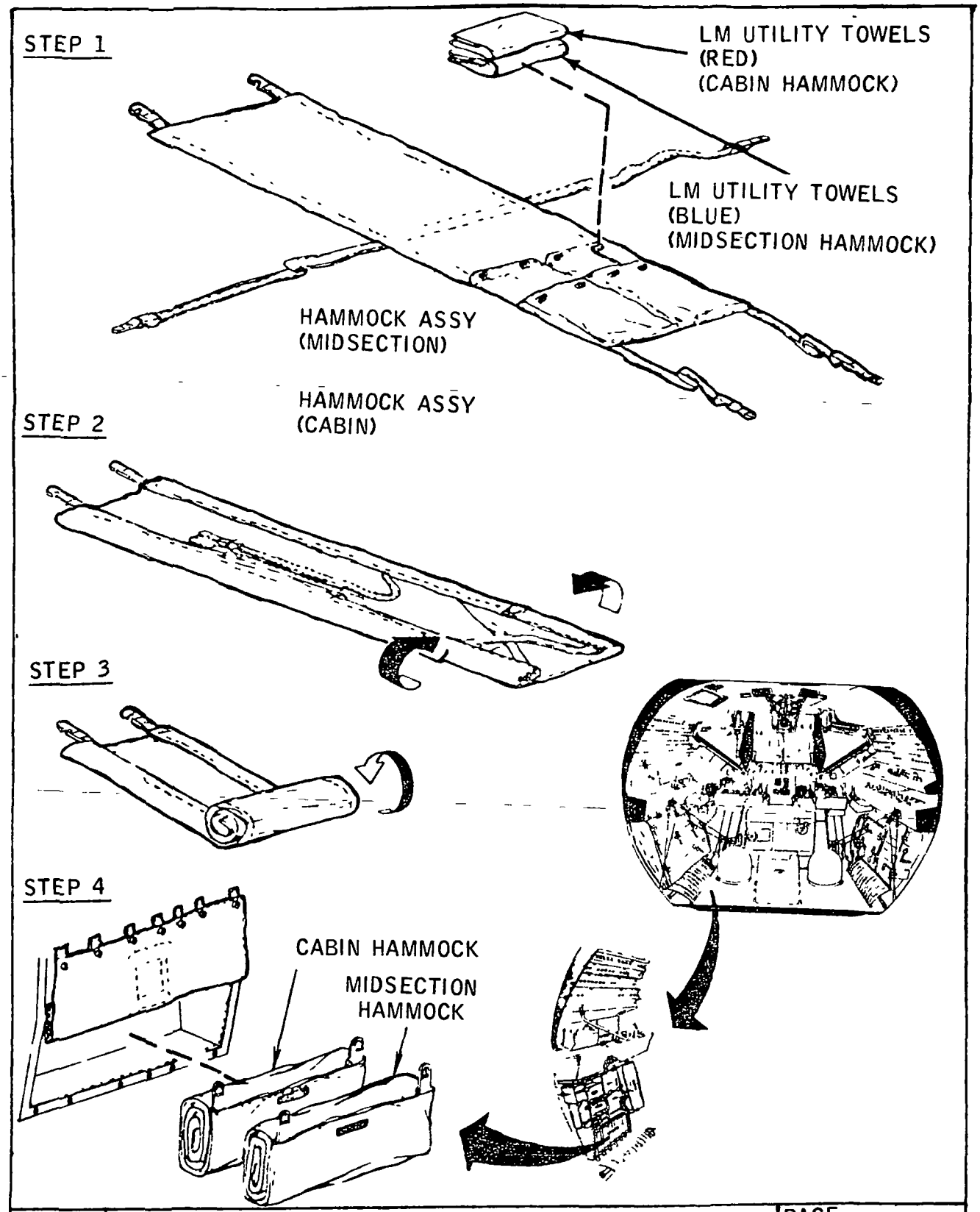


FIGURE 1 - INFLIGHT STOWAGE MANAGEMENT DOCUMENT CONFIGURATION

FIGURE 2

ALPHABETICAL STOWAGE LIST

ITEM NO.	PROCEDURAL NOMENCLATURE	LOCATION	QTY.
MS-0012	Fan/Shroud Assembly	W-716G	1
MS-0041	Filter Assembly	E-231H	2
SA-0033	Filter Coas	E-132J	1
SA-0061	Filter Type JJ	E-140J	3
CP-0004	Flight Data File	W-743N	1
CS-0082	Food Management Items	K-DMR	1



STOWAGE COMPARTMENT L-23	PAGE 11-L23

FIGURE 3 - DETAILED STOWAGE LOCATION ILLUSTRATION (EXAMPLE 1)

LAUNCH CONFIGURATION

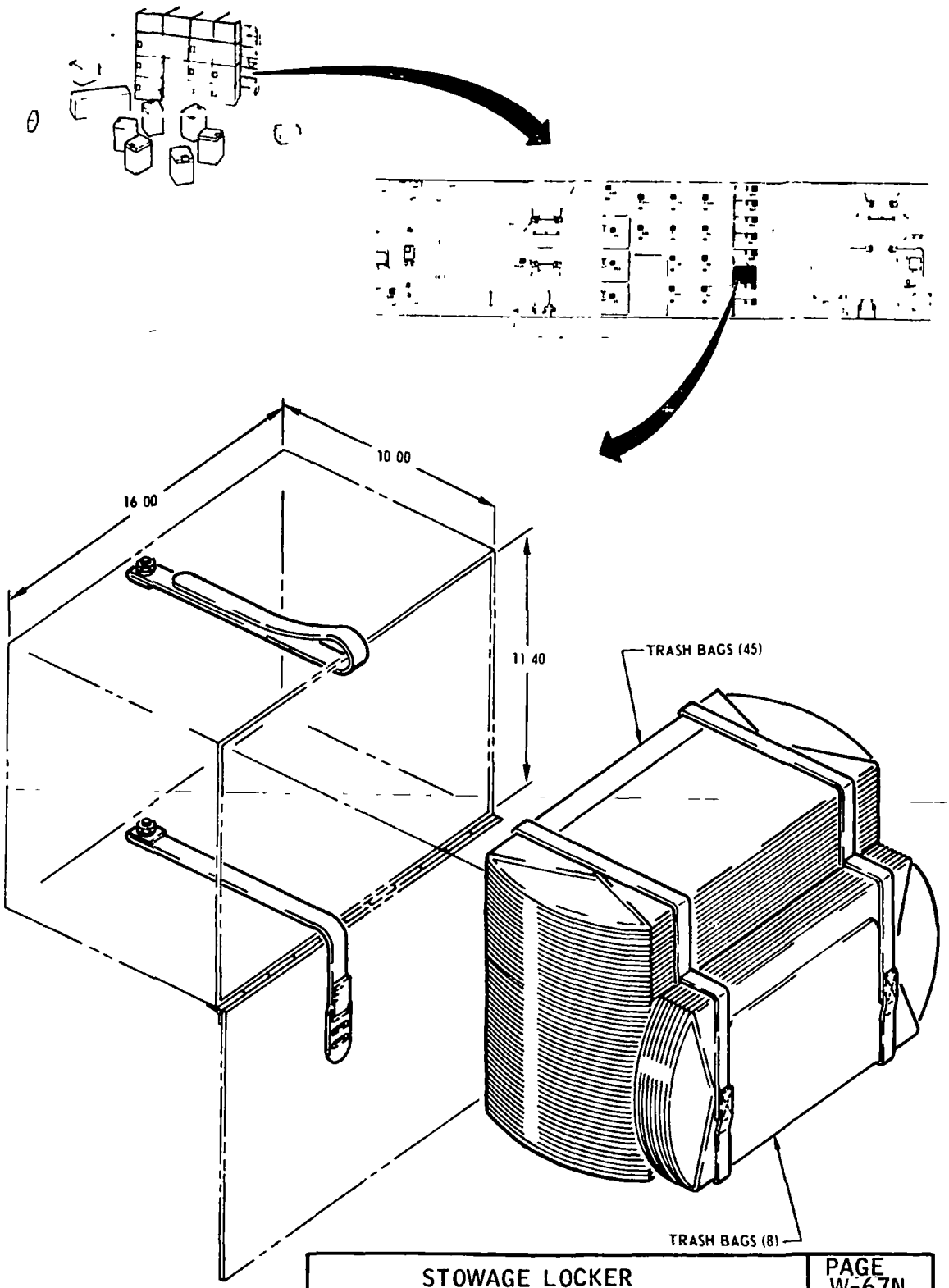
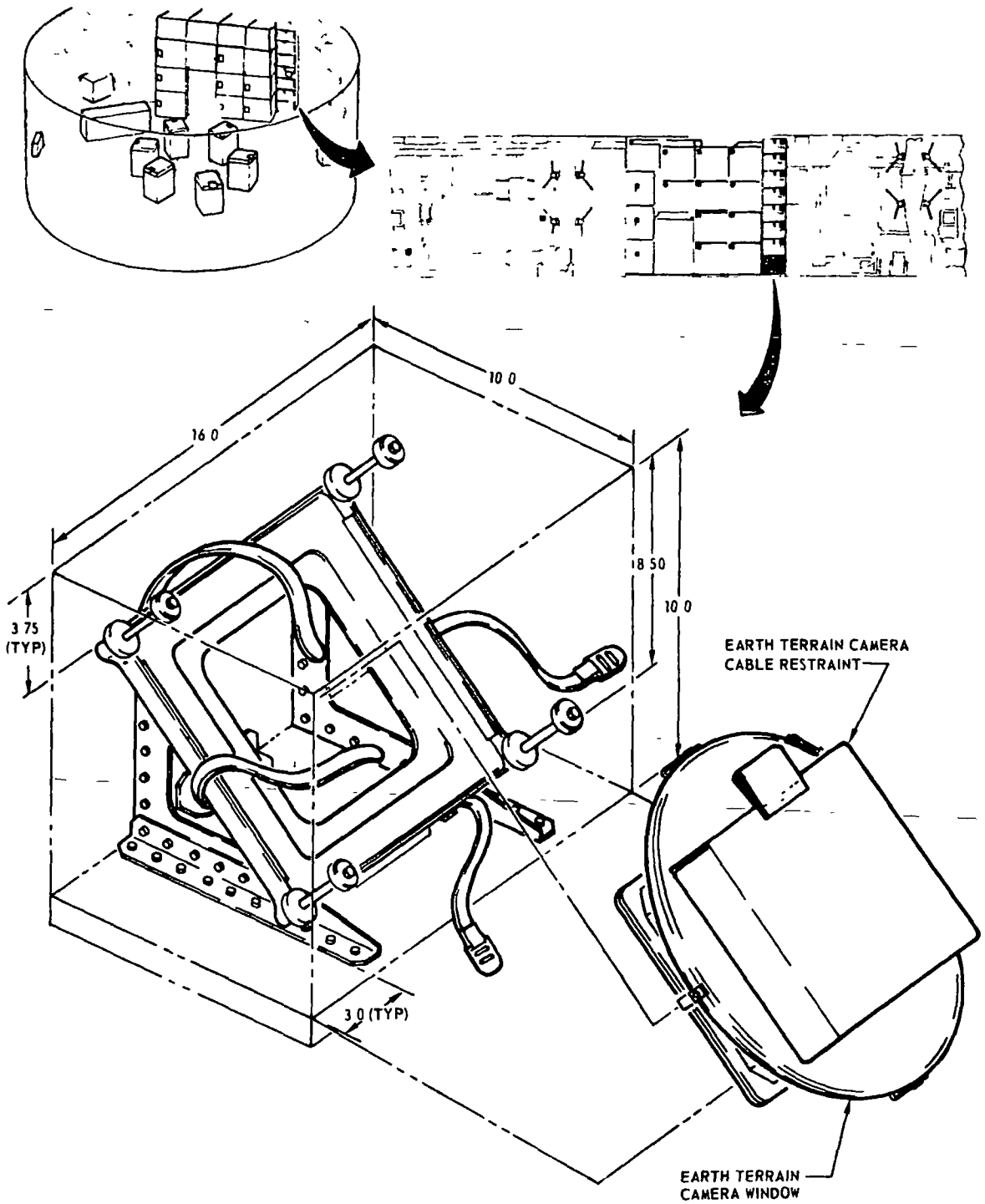


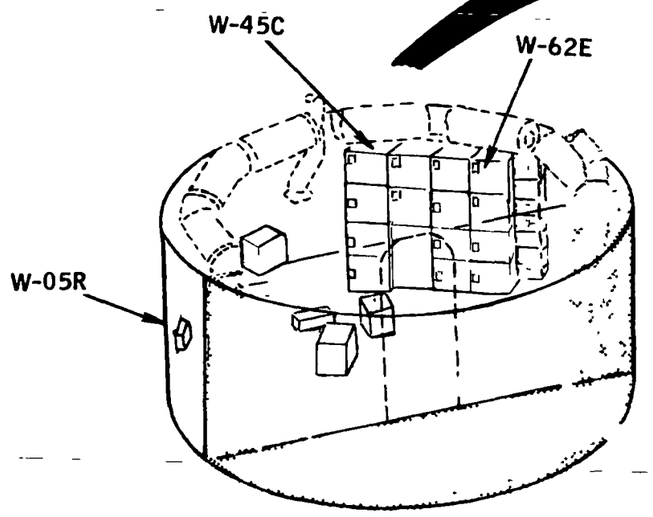
FIGURE 4 - DETAILED STOWAGE LOCATION ILLUSTRATION (EXAMPLE 2)

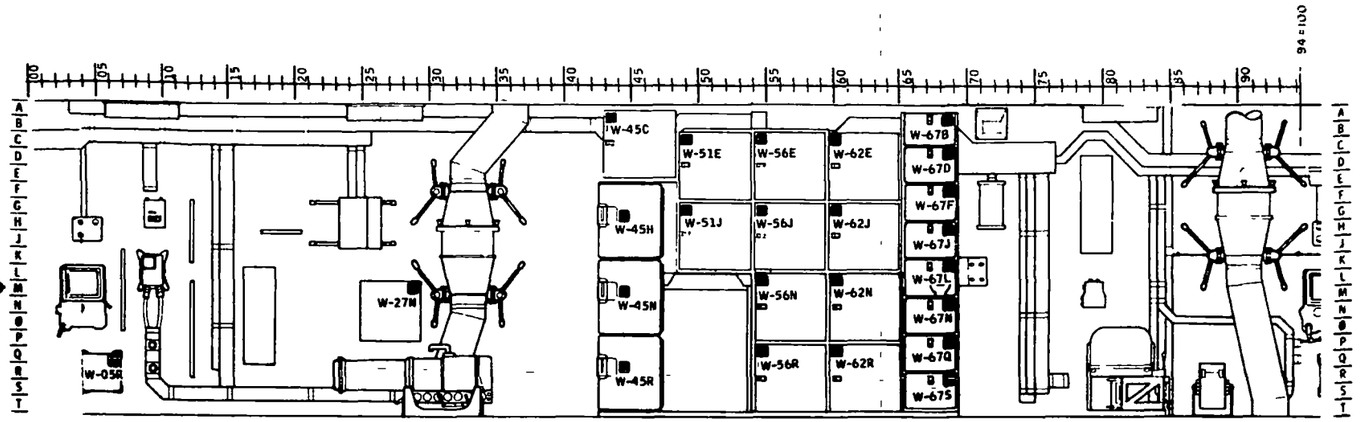
LAUNCH CONFIGURATION



STANDARD LOCKER	PAGE W-67S

FIGURE 5 - DETAILED STOWAGE LOCATION ILLUSTRATION (EXAMPLE 3)





45C
- PRESSURE CONTROL UNIT -WET (2)
- FOOD BOX
- RADIATION SURVEY METER
- CO2 BRACKET (2)
- CO2 ABSORBERS (8)
- CO2 ABSORBERS SHIMS (8)
- PCU CONTAINER (2)

45H
- FROZEN FOOD

45N
- FROZEN FOOD

45R
- FROZEN FOOD

27N
- T013 LIMS
- T013 LIMS DATA CABLE

05R
- DEPRESSURIZATION FITTING

51E
- FOOD (2)
- FOOD BOX
- CONTINGENCY RESUPPLY (2)

51J
- FOOD (2)
- FOOD BOX

56E
- FOOD
- FOOD BOX

56J
- FOOD
- FOOD BOX

56N
- FOOD
- FOOD BOX

56R
- FOOD
- FOOD BOX

62E
- FOOD
- FOOD BOX

62J
- FOOD
- FOOD BOX

62N
- FOOD
- FOOD BOX

62R
- FOOD
- FOOD BOX

67B
- FECAL BAGS (2)
- VACUUM CLEANER BAGS
- CONTINGENCY FECAL BAGS

67D
- FECAL BAGS (2)
- VACUUM CLEANER BAGS
- CONTINGENCY FECAL BAGS

67F
- FECAL BAGS (2)
- VACUUM CLEANER BAGS
- CONTINGENCY FECAL BAGS

67J
- FECAL BAGS (2)
- VACUUM CLEANER BAGS
- CONTINGENCY FECAL BAGS

67L
- O2 MASK (3)
- STOW CONTAINER BOLT (2)

67N
- TRASH BAGS (2)

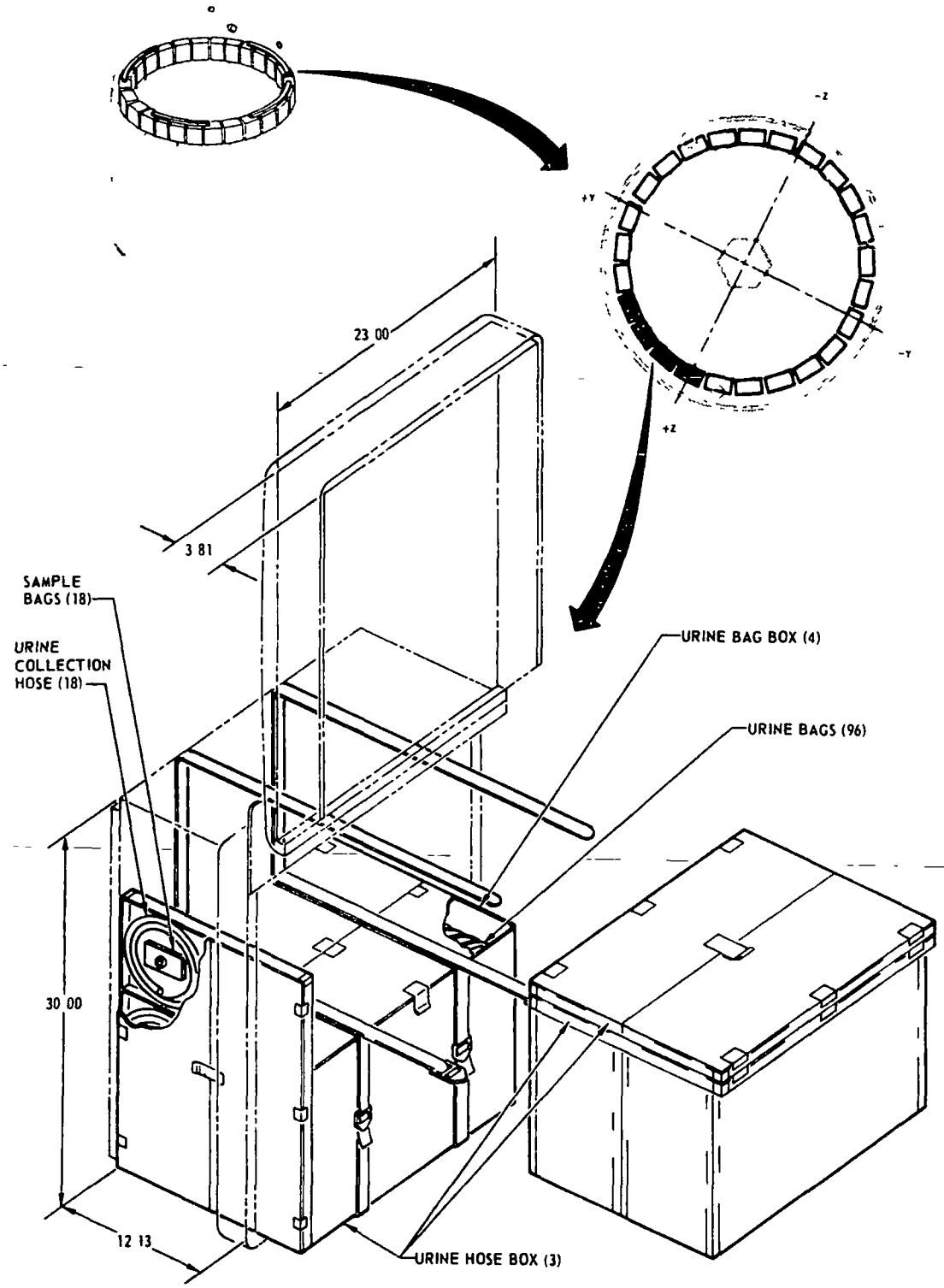
67Q
- FECAL BAGS 2
- CONTINGENCY FECAL BAGS

67S
- ETC SAL WINDOW
- ETC TOP PROTECTIVE COVER
- ETC BOTTOM PROTECTIVE COVER
- ETC POWER CABLE

WARDROOM	PAGE W-000

FIGURE 6 - TYPICAL STOWAGE MAP (EXAMPLE 1)

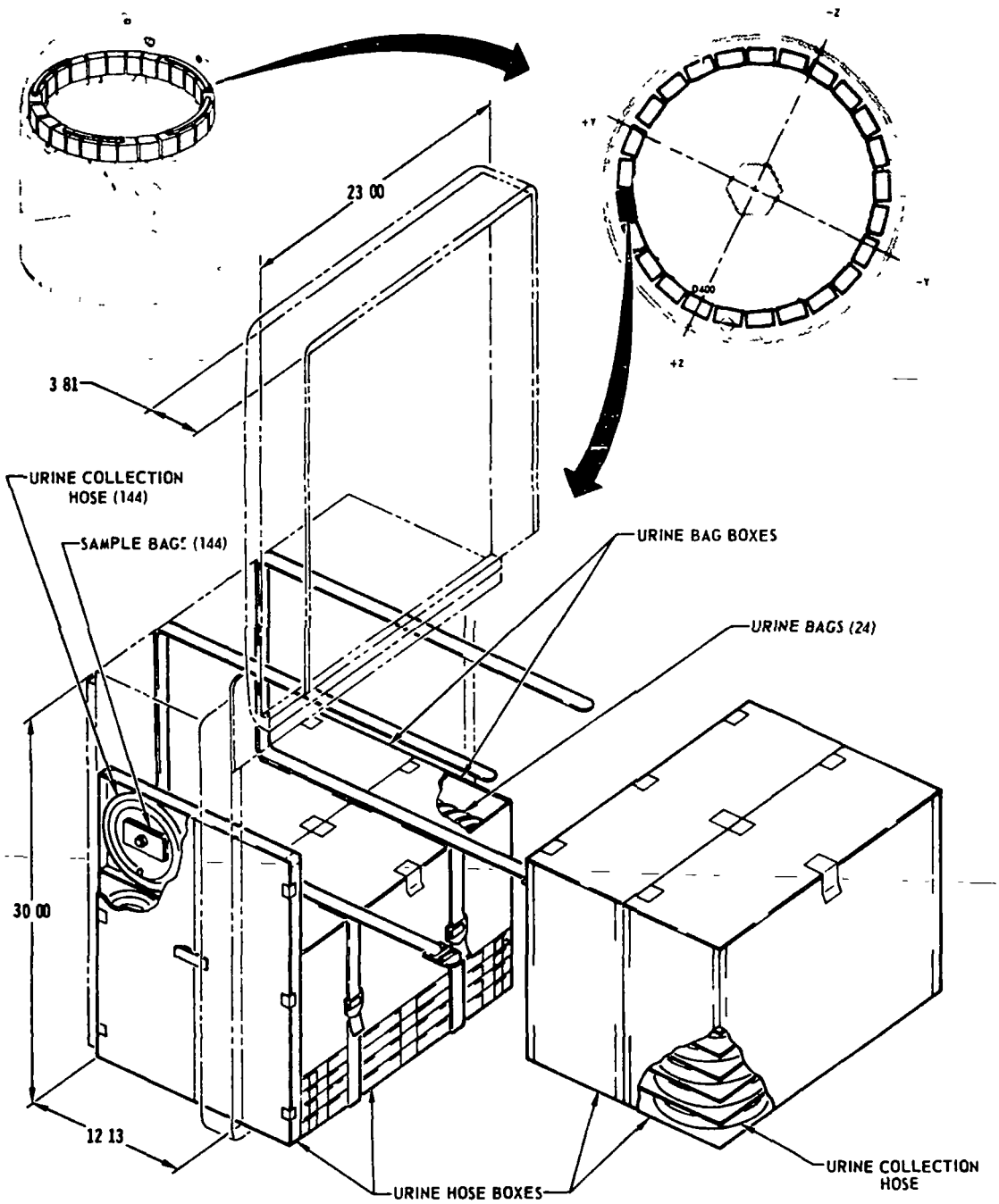
LAUNCH CONFIGURATION



STOWAGE LOCKER	PAGE D-11J

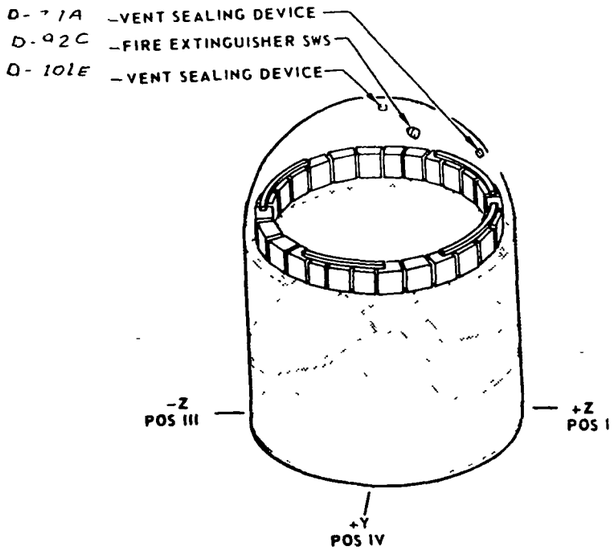
FIGURE 7 - DETAILED STOWAGE LOCATION ILLUSTRATION (EXAMPLE 4)

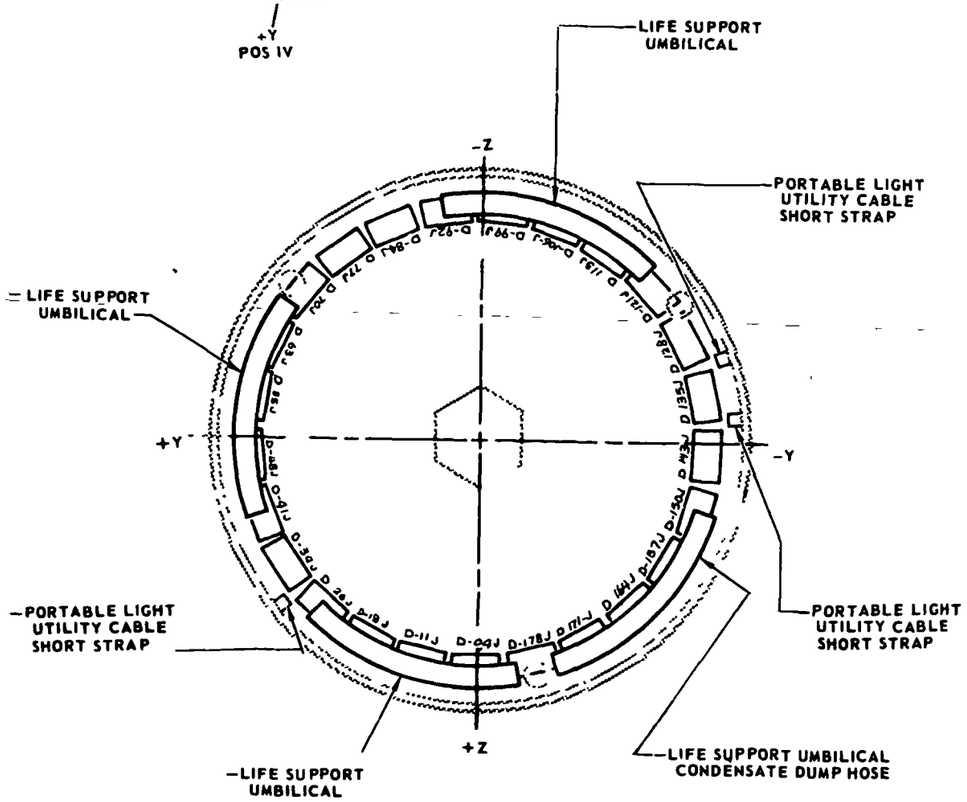
LAUNCH CONFIGURATION



STOWAGE LOCKER	PAGE D-34J

FIGURE 8 - DETAILED STOWAGE LOCATION ILLUSTRATION (EXAMPLE 5)





04J	11J	18J	26J	34J	41J	48J
URINE BAGS (96) URINE COLLECTION HOSES (18) SAMPLE BAGS (18)	URINE BAGS (96) URINE COLLECTION HOSES (18) SAMPLE BAGS (18)	URINE BAGS (96) URINE COLLECTION HOSES (18) SAMPLE BAGS (18)	URINE BAGS (96) URINE COLLECTION HOSES (18) SAMPLE BAGS (18)	URINE BAGS (24) URINE COLLECTION HOSES (144) SAMPLE BAGS (144)	URINE COLLECTION HOSES (198) SAMPLE BAGS (198)	

55J	63J	70J	77J	84J	92J	99J
	(RESERVED FOR NASA HEADQUARTERS)	TOWEL-RED (68) TOWEL-BLUE (68) TOWEL-WHITE (68)		PRESSURE CONTROL UNIT (DRY) (2) SECONDARY O2 PACE	OBS ELECTRODE KIT HIGH POWER ACCESSORY CABLE HIGH POWER ACCESSORY ADAPTER CABLE HELMET STOWAGE STRAP (6) LCG HANGER STRAP (3) PGA HANGER STRAP (3) ADJUSTABLE TETHER (2) SHORT STRAP SAL DATA CABLE SAL POWER CABLE	UCTA (12) FECAL CONTAINMENT SUBSYSTEM 9 BACKUP URINE CUFFS-SMALL (36) BACKUP URINE CUFFS-MEDIUM (108) BACKUP URINE CUFFS-LARGE (36) UTS CUFFS-SMALL (36) UTS CUFFS-MEDIUM (33)

106J	113J	121J	128J	135J	143J	150J
URINE SEPARATORS (7) URINE SEPARATORS FLUSH GUN URINE SEPARATORS MOTOR (2) URINE SEPARATOR POWER CABLE	FLOODLIGHT BULBS (6) SPEAKER INTERCOM ASSY (2) WMC VENT FILTER (2)	WMC VENT FILTER FIRE SENSOR (6) FIRE SENSOR CONTROL PANEL (2) WMC DEBRIS FINE FILTER (20) FIRE SENSOR INDICATOR LAMP ASSEMBLY (6)	WMC VENT FILTER (2) WMC DEBRIS COARSE FILTER (3)	MOL SIEVE CHARCOAL CANISTER (2) FECAL COLLECTOR FILTER (5) PROCESSOR CONTROL PANEL VAN ALLEN BELT DOSIMETER PRD BATTERY PACK (12) 81m BATTERY PACK (4)	H2O GUN FOOD BAG ADAPTER (3) PORTABLE TANK H2O GUN ADAPTER STERILIZATION FITTING WMC PURGE FITTING WARDROOM PURGE FITTING H2O GUN DISPENSER SQUEEZER BAG ADAPTER URINE FLUSH PURGE FITTING H2O SYSTEM EQUIP MOL SIEVE CHARCOAL CANISTER (3) H2O GUN RESUPPLY (6) H2O GUN-DA WARDROOM H2O DISPENSER VALVE WMC H2O DISPENSER VALVE WMC H2O QD O-RING (3) FEMALE H2O HOSE QD MALE H2O HOSE QD FEMALE H2O FITTING QD	MOL SIEVE CHARCOAL CANISTER (3) DUMP HEATER PROBE VENT SEALING DEVICE O-RING 4 TRASH LOCK LID SEAL (3) TRASH LOCK VALVE PLUG PROCESSOR DOOR SEAL (3) TRASH AIRLOCK GAUGE TRASH AIRLOCK EJECTOR HANDLE O-RING SHAFT (4) TRASH AIRLOCK EJECTOR HANDLE O-RING SLEEVE (2) TRASH AIRLOCK GAUGE O-RING OUTER (2) TRASH AIRLOCK GAUGE O-RING INNER (2) SQUEEZER BAL-SEAL SQUEEZER FLAPPER VALVE URINE DUMP HOSE URINE SYSTEM SEPARATOR FILTER O-RING (3) VENT SEALING DEVICE UTILITY CABLE DUMP HEATER PROBE SEALING PLUG (2) SHORT STRAP

157J	164J	171J	178J
PLV FAN DUCT HEATER (8)	FOOD TRAYS (2) URINE TRANSFER HOSE (27) WATER RELIEF VALVE WATER UMBILICAL WATER DESERVICING ADAPTER K_2HPO_4 INJECTOR K_2HPO_4 CONTAINER WARDROOM HOSE 2		BUMP HAT URINE BAGS (9) URINE COLLECTION HOSES (3) SAMPLE BAGS (3) URINE SEPARATOR FILTER (6) RH TRIANGLE SHOES (6) LH TRIANGLE SHOES (6)

DOME	PAGE D-000

FIGURE 9 - TYPICAL STOWAGE MAP (EXAMPLE 2)

ITEM NUMBER	PROCEDURAL NOMENCLATURE	FROM QTY/LOCATION	TO QTY/LOCATION	TRANSFER CODE
CS-0112	CONSTANT WEAR GARMENT	2/AW-18F	2/AE-22C	AA-1
GN-0009	SEXTANT	1/AW-32Ø	1/AE-12B	AA-1
MD-0120	THERAPEUTIC KIT	1/AW-07L	1/AM-110B	AA-1
MD-0115	MEDICAL KIT/LAB EQUIPMENT	1/AW-07J	1/AM-110F	AA-1
MD-0028	DRUG SUPPLY KIT	1/AW-07F	1/CM-113M	AC-3
MD-0101	DRUG SUPPLY CANISTER	1/AW-07C	1/CM-87M	AC-3
MD-0099	MINOR SURGERY KIT	1/AW-07F	1/CM-22C	AC-3

FIGURE 10 - TYPICAL INFLIGHT TRANSFER LIST/FORMAT

APPENDIX F

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