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Space Station

WORK PACKAGE 2 ADVANCED DEVELOPMENT

SSS86-0056

INTERIOR ARCHITECTURE & MOCKUPS

Project 30. MANNED SPACE SYSTEMS HABITABILITY

May 23, 1986

Prepared by: Project Engineering-Advanced Development/
Rockwell/Grumman
For NASA Lyndon B. Johnson Space Center

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GRUMMAN



Grumman Aerospace Corporation
Bethpage, N.Y. 11714



Rockwell International

Space Station Systems Division
Rockwell International Corporation
12214 Lakewood Boulevard
Downey, California 90241



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This document is submitted by the Rockwell Space Station Systems Division Advanced Development Project Office in compliance with the Advanced Development Plan, Rockwell document No. SSS85-0011, Revision 2, dated October 30, 1985.

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This document combines information that is (1) an update of the "Design and Construction of Scale Modules of Habitation Modules Report" (Rockwell document SSS85-0083) and (2) the initial release of the report identified in DR-05 as "High Fidelity Mockup Report", as indicated on Pages 39-40 of DR-05.

Manned Space Systems Habitability
Interior Architecture & Mockups

Interim report

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Manned Space Systems Habitability
Interior Architecture & Mockups

Interim report

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ABSTRACT

The objective of Grumman's Manned Space Systems Habitability IR&D project is to develop guidelines and design criteria for Space Station habitat modules by focusing on three related functional disciplines: human factors, interior architecture, and crew support. Specific objectives for Interior Architecture study are:

- with the aid of scale models and existing mockups, select two or three of the most promising architecture candidates for continued evaluation
- using full scale mockups, evaluate the most promising candidates and select the preferred one
- construct a high fidelity mockup of the selected concept for in-depth evaluation.

This report presents results of the evaluation of three architecture candidates to select the preferred concept for further study. The evaluation approach is described, and the rationale for selection is given. Other concepts that reflect new interest in the space community for modules with a multipurpose or combined habitat role are also discussed, as well as plans for fabricating mockups to support studies and evaluations during the coming year.

1 - INTRODUCTION

This is an interim report for the Interior Architecture study conducted within Grumman's Manned Space Systems Habitability IR&D Project described in Reference (1).

The overall objective for the Manned Space Systems Habitability Project is to develop guidelines, design criteria, and concepts for Space Station habitats and habitability functions that will enhance the crew's living accommodations in space, and provide an environment for achieving a high productivity level. Human factors, interior architecture, and crew support disciplines play important, interrelative roles. This report focuses on the interior architecture contribution to this project, which is scheduled for completion in September 1986.

1.1 STUDY OBJECTIVES

- The long-term objective is to select and refine preferred concepts, and to build high-fidelity mockups of the selected habitat configurations
- Develop multipurpose and combined habitat function modules to reflect the growing interest in such concepts
- Utilizing appropriate mockups, develop, demonstrate, and evaluate the following:
 - Support structure interfaces for equipment and facilities
 - Utilities interfaces
 - Manufacturing techniques
 - Coordination of work activities with work sites
 - Crew use of all crew accommodations
 - Common man/machine work station interfaces
 - Housekeeping techniques
 - On-orbit maintenance and reconfiguration capabilities
 - Stowage concepts
 - Timelines, work duty cycles, and human productivity to the extent practicable at one "g".

2 - SUMMARY

This report documents the results of evaluations conducted to select the preferred interior architecture for further study.

The candidate concepts evaluated during 1985 were: NASA reference, central core, service deck, center beam, and multi-beam loft. After extensive analysis, the service deck, central core, and multi-beam loft were selected for further evaluation. The service deck was replaced for evaluation by its derivative, the interstitial deck.

The evaluation aids used for the selection process were low fidelity full scale mockups and 1/25th scale models of the habitat modules. Full scale partial mockups of the crew quarters and laboratory for the multi-beam loft and central core were also constructed to aid in the selection process.

Selection criteria for the first evaluation were established by a joint Rockwell/Grumman team. These criteria were weighted to emphasize architectural concerns and were judged on a rating scale of zero (unacceptable) to four (excellent). Four evaluation teams, Requirements Assessment, Architecture, Crew Facilities, and Operations, rated the concepts by functional site, e.g., crew quarters, galley, wardroom, waste collection, personal hygiene, operations work station, maintenance work station, health medical facility, exercise area, plus an overall rating.

A second evaluation was held using NASA-developed criteria related to Manned Systems, Programmatics, and Engineering and Manufacturing.

The major conclusions reached at the end of the evaluations were consistent and reflected Rockwell and Grumman agreement:

- Loft and central core concepts can meet NASA requirements
- No standout winner; functional differences tend to cancel out
- Astronauts and architects tend to prefer the loft to live in for 90 days

- More "natural appearing" environment
 - Better ease of movement
 - More usable volume
- Loft is more consistent with the general trend toward the open center compatible with laboratory and logistics modules.

Therefore, the loft concept was chosen for further study.

There is growing interest in the space community in developing multipurpose modules, i.e., modules containing laboratory and habitat functions. Also, a "combined" habitat module concept containing all functions for crew habitation and station management is gaining support. These concepts are a departure from those studied in 1985 which addressed a separation of functions into two modules: an "active" module for crew activities for station management, meal preparation and consumption, exercise, etc, and a "quiet" module, containing functions primarily associated with crew rest and medical diagnosis and treatment.

A mockup design and fabrication plan and schedule to support the studies and evaluations are discussed along with rationale for the use of each mockup.

3 - ARCHITECTURAL MOCKUPS EVALUATION

3.1 CANDIDATE CONCEPTS EVALUATED

During the early part of 1985, preliminary studies were conducted for five habitation module architectures:

- NASA Reference
- Center Core
- Service Deck
- Center Beam
- Multi-Beam Loft.

The NASA reference design has an open, roughly rectangular center with the major subsystems installed above the ceiling and below the floor.

The central core concept houses the common subsystems at one end of a central vertical slab of equipment, with crew accommodations within the central core and on either side.

The service deck houses common subsystems in "donuts" at each end of the module, with most equipment along the side walls. Utilities and stowage are located primarily in an interstitial deck.

The NASA center beam concept has a single, nearly central utility and mounting support beam to which equipment and stowage units are attached.

The multi-beam loft is an upside down derivative of the service deck with equipment grouped on either side and specialized habitable zones in the upper portion or "loft".

After analysis of the five configurations, three were selected as the most promising candidates for continuing development, the multi-beam loft, central core and service deck. This effort led to the selection of the central core and loft concepts for further development and evaluation. A detailed description of the

architectural concepts and rationale for selection of the core and loft are contained in the Grumman report SS005/ATD-02, "Manned Space Systems Habitability, Habitat Module Interim Architecture and Mockups Initial Report," 29 August 1985.

A detailed description of the service deck is contained in Reference (2) and is attached as Appendix I.

Some key characteristics of the central core concept are:

- Takes advantage of weightless neutral body posture to separate traffic vertically and horizontally from work stations
- Two-level architecture
 - Passive, quiet activities below
 - Active 3-D motions traffic above
 - Each work station compartment separately accesses aisle - no choke points
 - Inboard facing posture compatible with pressure shell curvature
- Full, direct observation and access to pressure shell interior surfaces
- Movable, passive, non-plumbed stowage containers on curved pressure walls.

Some key characteristics of the multi-beam loft are:

- Two-level architecture
 - Specialized/private upper level
 - General/communal lower level
- Axial transit path straight through module - end port to end port
 - Direct access to path from all zones
 - Path not blocked by maintenance
- End "Donuts" for ECLSS, Power, TCS
 - High packaging efficiency
 - Three-side equipment access
- Open midsection for habitation
 - Access to wall and back of ORU racks by hinging
 - Adaptable to various store/equipment needs.

These characteristics provided the basis for narrowing the field of candidates to these two for selection as the "best" architectural concept.

3.2 EVALUATION AIDS USED

During the architectural development process, several mockups and models were constructed and evaluated. Low fidelity full-size habitat mockups for each concept were constructed as described below to aid in the selection process. In addition, 1/25th scale models were fabricated and used in the evaluations. Figure 3-1 shows the mockup area at Grumman used for the evaluation. Figures 3-2 and 3-3 are typical models used as evaluation aids.

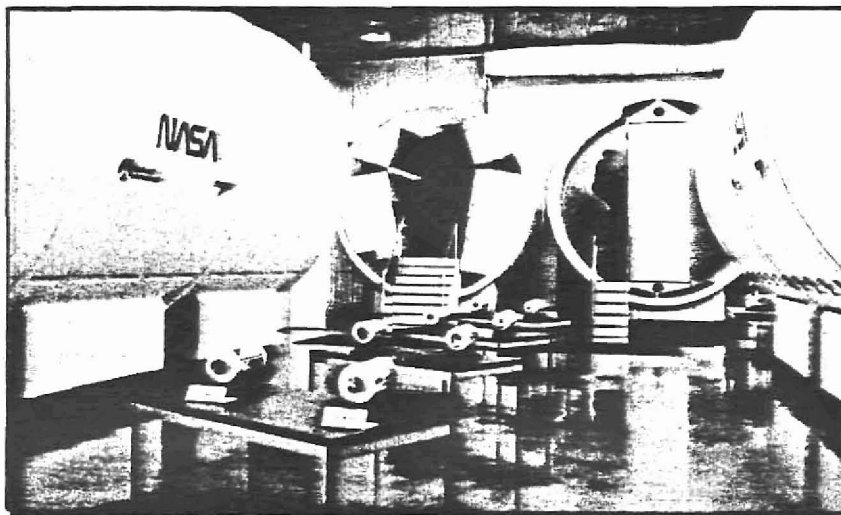


Fig. 3-1 Mockup Area at Grumman's Bethpage Facility

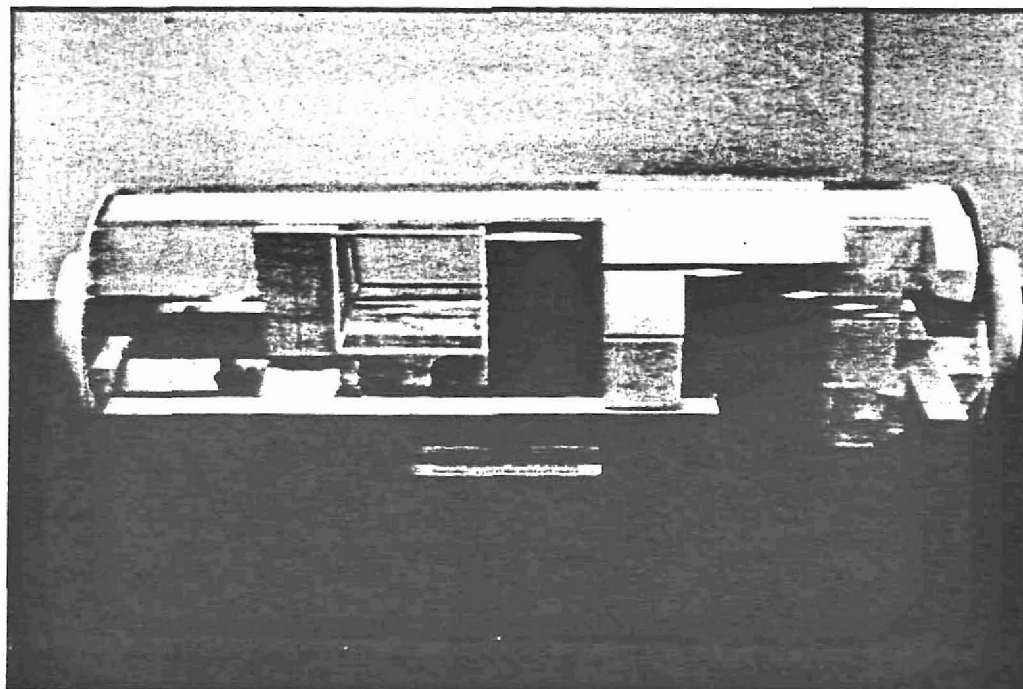


Fig. 3-2 Central Core - Habitat 1 Model 1/25th Scale

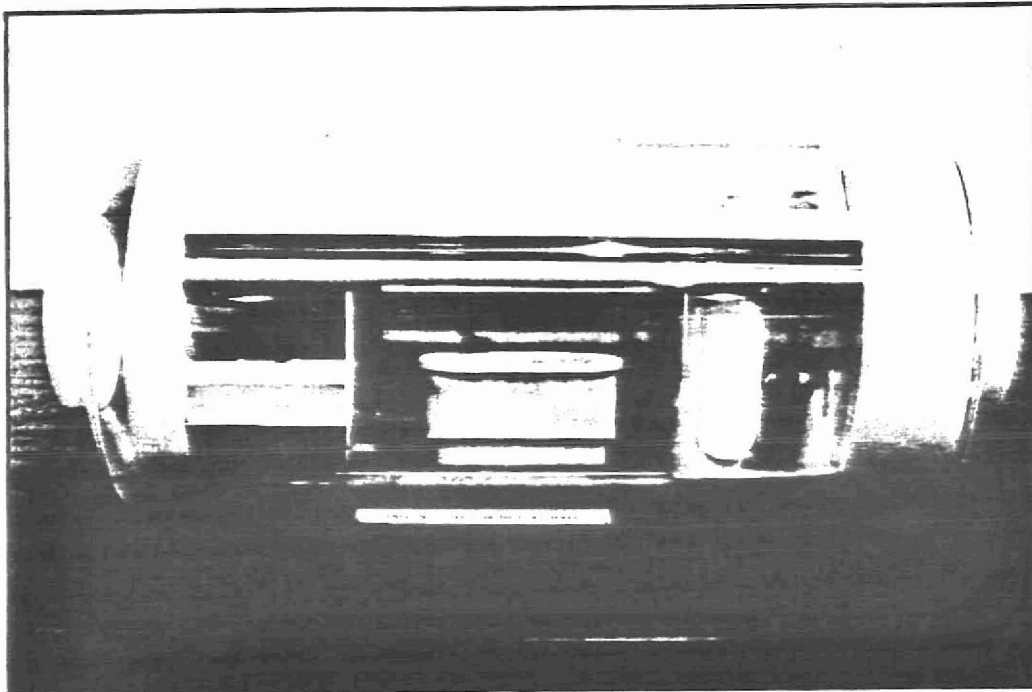


Fig. 3-3 Loft - Habitat 1 Model 1/25th Scale

Loft Concept (Fig.3-4)

A. Habitat No. 1

This mockup is a cylinder of 165 in. internal diameter and a cylinder length of 28 ft representing a complete habitat. It features an open center, horizontal arrangement of two levels, an upper level (loft) and a main level. The internal furnishings provided in this module were those associated with crew activities during their active hours, and include:

- Galley/wardroom
- Waste collection compartment with appropriate facilities volumetrically represented
- Personal hygiene compartment with appropriate facilities volumetrically represented
- Exercise area
- Medical facility
- Miscellaneous stowage volumes
- Operations work station
- Electronic equipment racks
- ECLSS equipment volume
- Power/Thermal equipment volume.

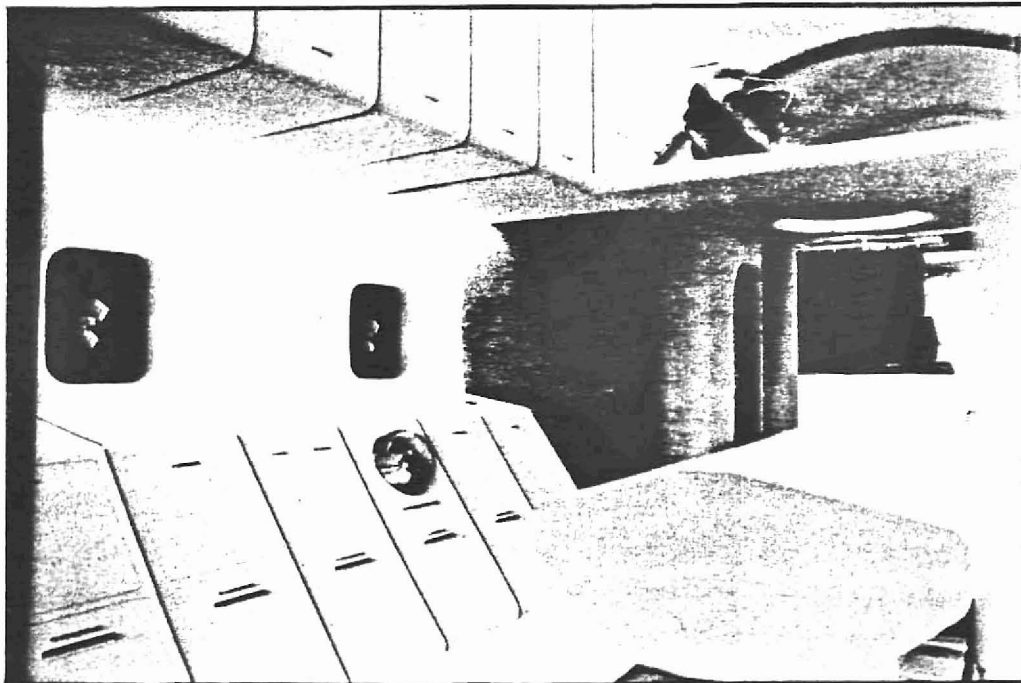


Fig. 3-4 Loft - Habitat 1 Full-Scale Mockup

B. Crew Quarters (Fig. 3-5)

A partial full-size mockup of a typical crew quarters with its full complement of furnishings was constructed.

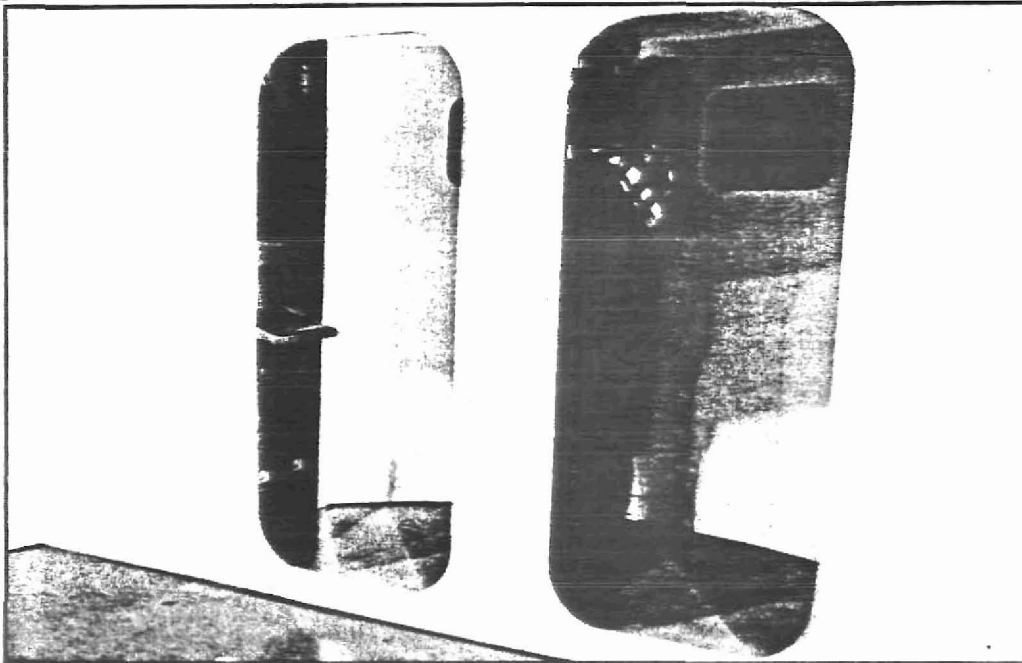


Fig. 3-5 Loft - Crew Quarters Full-Scale Mockup

C. Laboratory (Fig. 3-6)

A partial full-size mockup of a laboratory segment showing how the loft concept is a viable architecture for conducting experiments in a zero-g environment.

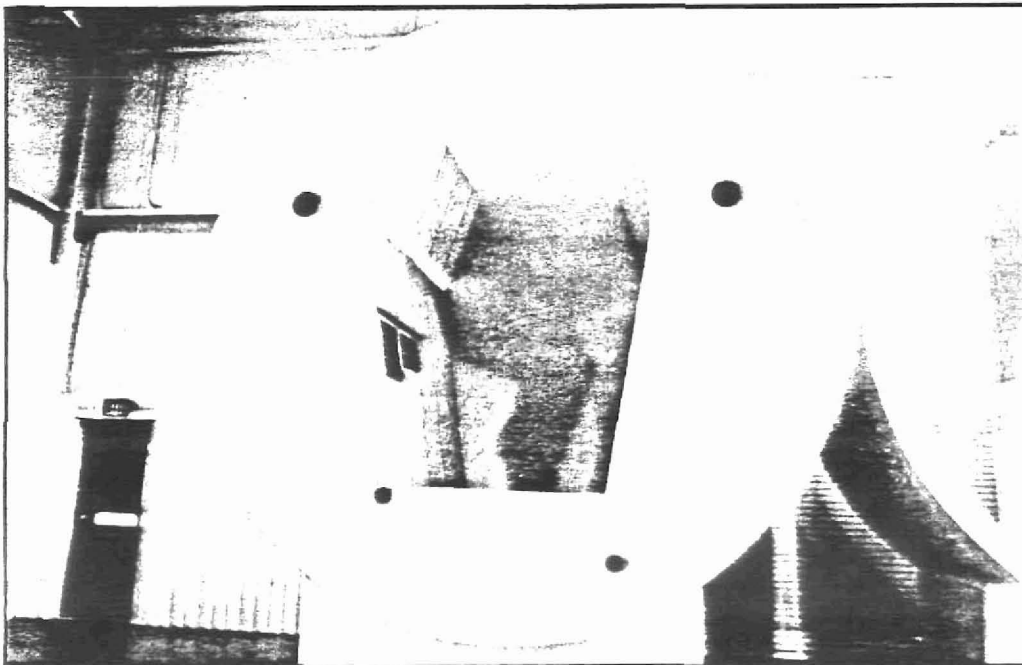


Fig. 3-6 Loft - Laboratory Segment Full-Scale Mockup

Central Core Concept (Fig. 3-7)

A. Habitat No. 1

This mockup is a cylinder of the same dimensions as the loft mockup. It features a horizontal, two-level architecture with the cylinder divided lengthwise at the vertical diameter by equipment racks called the "core." The interior furnishings provided are similar to those in the loft but with some differences as noted below:

- Galley/wardroom in lower portion
- Waste collection compartment in lower portion of the cylinder
- Personal hygiene compartment in lower portion of the cylinder with individual dressing rooms on each side of the core
- Health exercise and medical facilities in upper portion, with medical facility sectioned off with erectable partitions
- Miscellaneous stowage containers
- Operations work station in lower portion of the cylinder on one side of the core
- ECLSS in end portion of the core
- Subsystem equipment in lower portion of the core.

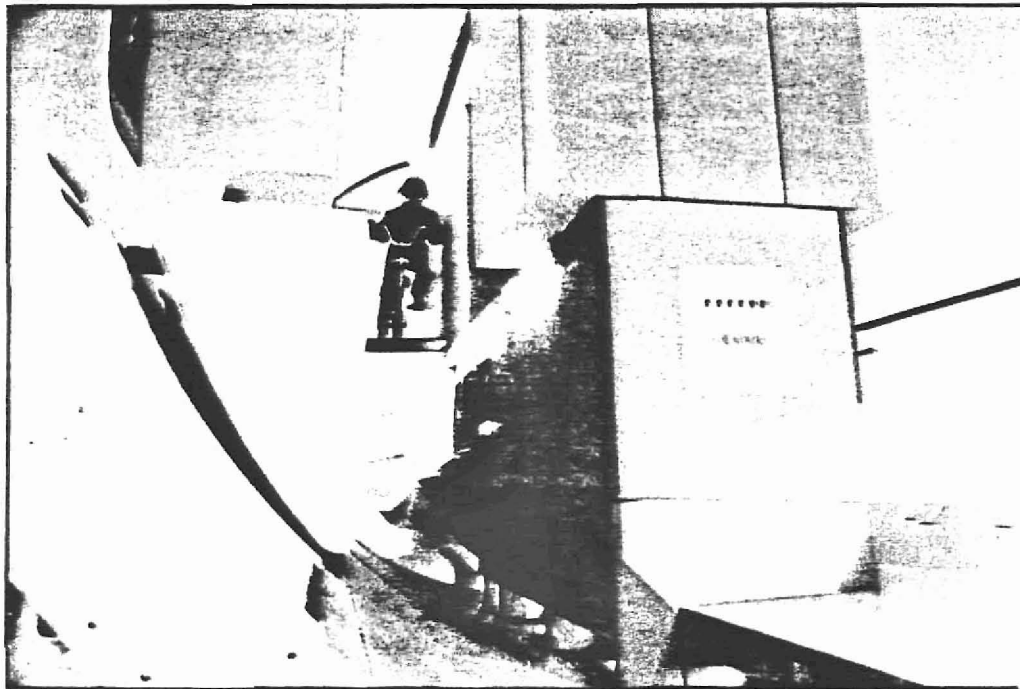


Fig. 3-7 Central Core - Habitat 1 Full-Scale Mockup

B. Crew Quarters (Fig. 3-8)

A partial full-size mockup of a typical crew quarters with its full complement of equipment and furnishings.

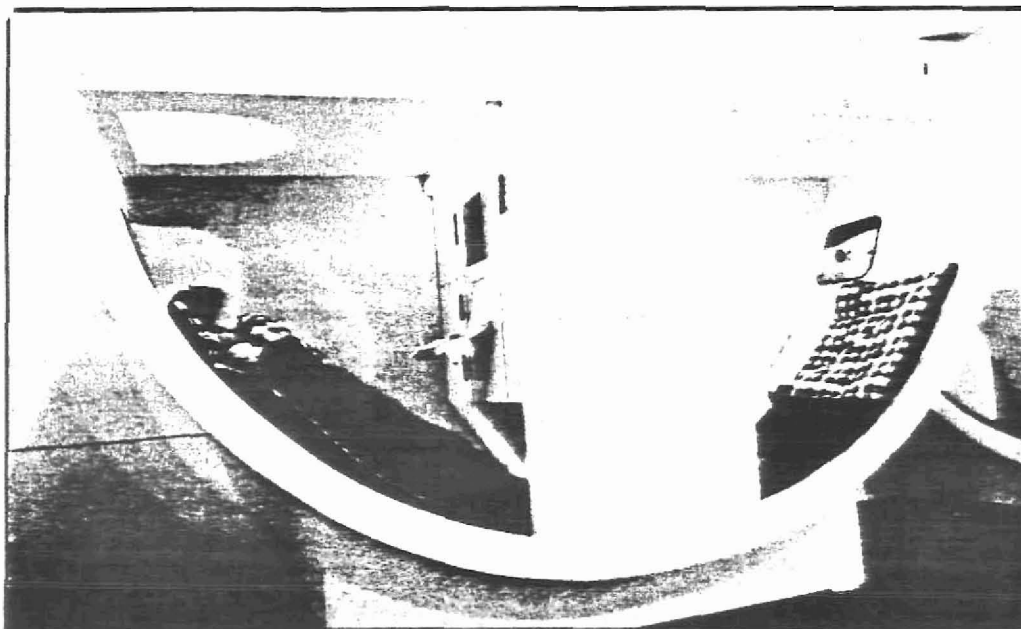


Fig. 3-8 Central Core - Crew Quarters Full-Scale Mockup

C. Laboratory (Fig. 3-9)

A partial full-size mockup of a laboratory segment showing how experiments and equipment could be accommodated.

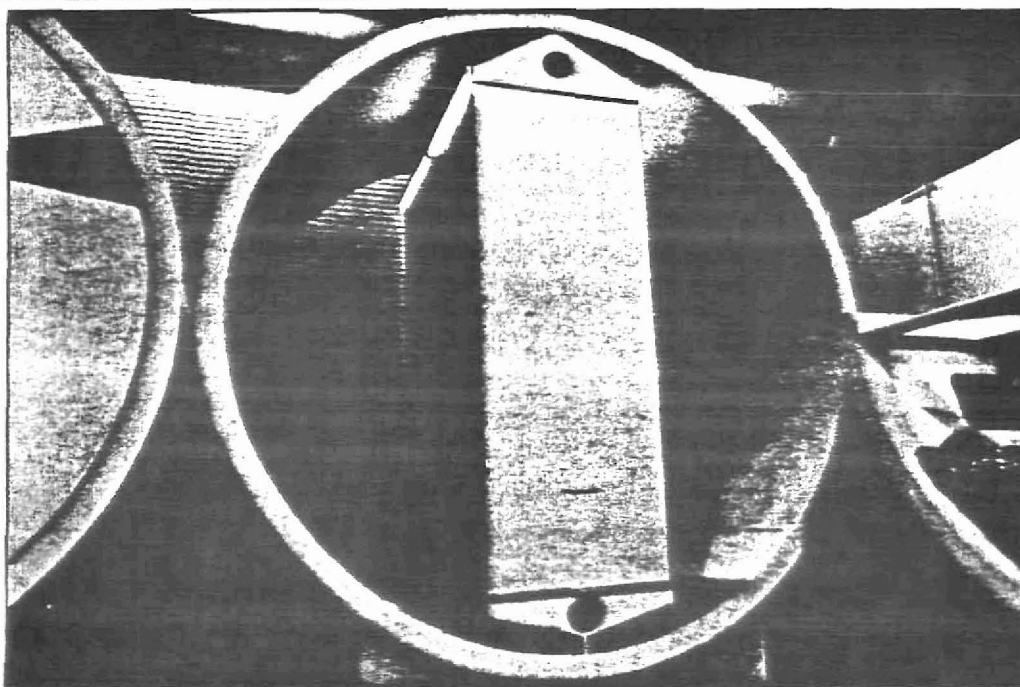


Fig. 3-9 Central Core - Laboratory Segment Full-Scale Mockup

A third architectural concept, the interstitial deck, was evaluated along with the loft and central core. No full-scale mockup was built, but a 1/25th scale model of a habitat was used for evaluation.

3.3 EVALUATION APPROACH

A series of architecture reviews was held during the last quarter of 1985 to assess the candidate concepts.

For the first review, an evaluation criteria was established to be applied to the various aspects of architecture review, from functional units to the overall architectural configuration. These criteria, listed below, were weighted to emphasize architectural concerns. The order and value of the parameters varied according to the emphasis placed by the various review teams. .

- Free volume (useful)
- Ease of movement (circulation, traffic)
- Volumetric efficiency (shape factors)
- Modularity (in-orbit reconfiguration)
- Cleaning/sanitation
- Safety
- Useability (functional performance)
- Orientation
- Esthetics, amenities, ambiance
- Availability
- Access to pressure shell
- Mobility and restraint
- Neutral body position
- Maintainability
- Stowage
- Functional site interrelationships
- Window locations
- Commonality.

The rating scale used by all evaluators is shown below:

0 = Unacceptable: Poor; must be rethought and redesigned

- 1 = Minimally Acceptable: Bearable; minimally fulfills requirements but needs rethinking and redesign
- 2 = Good: Well-designed; some improvement may be needed
- 3 = Very Good: Very well done; no improvement necessary
- 4 = Excellent: Strikingly well-designed; no better configuration comes to mind.

The review teams created for the evaluation provided a broad, comprehensive survey of the concepts.

The Requirements Assessment team was concerned with compliance to various requirements; the Architecture team emphasized traffic flow, volume usage, functional site arrangements, accessibility; Crew Facilities team focused on crew support elements, e.g., galley/wardroom volume and arrangement, waste collection and personal hygiene facilities arrangement and adequacy from the standpoint of crew use; and the Operations group centered on maintenance, maintainability, and other operational conditions.

All teams evaluated nine functional sites: crew quarters, galley, wardroom, waste collection, personal hygiene, operations work station, maintenance work station, health medical facility, exercise area; all teams also provided an overall evaluation for a total of 10 ratings for each concept.

Later evaluations used different criteria:

Manned Systems Criteria:

- Takes advantages of zero-g body posture and motion
- Accommodates anthropometric range of crew members
- Traffic patterns provide for easy, safe and non-interfering movement of crew and equipment
- Easy access to the walls by shirt-sleeved crew members for inspection, repair, maintenance and/or cleaning
- Easy access to all equipment surfaces for inspection, repair, maintenance and/or cleaning
- Minimize fixed/permanent secondary structure

- Easy on-orbit reconfiguration, including outfitting, removal and/or replacement of equipment and utilities is provided
- Provides an open environment
- Environment is stimulating, creative, or soothing as appropriate
- Accommodates a variety of on-orbit window placements
- Permits rapid egress from any location in the module
- Provides for both inter- and intra-module growth (including crew size, power level, utilities, fluid storage and transfer systems, etc)
- Replacement of a piece of equipment, or access to a volume, does not require removal of other equipment
- Environment/architecture is user friendly (functionally efficient)
- Architecture optimizes for zero-g environment
- Volume efficiency (crew usable, equipment, unusable)
- Maximizes equipment surface area (control/display and stowage)
- Airflow pattern avoids dead air spaces and enhances particulates collection.

Programmatic Criteria:

- Cost
- Schedule
- Weight
- Flexibility
- Technological risk
- Operational risk
- One-g training.

Engineering & Manufacturing Criteria:

- Interface complexity
- Extent of commonality
- Assembly, checkout and integration
- Quantity and complexity of tooling and test/verification equipment
- Degree of modularity
- Producibility
- Schedule impacts.

Ratings from all teams were compiled, and brief explanations of overall evaluations of the architectures were supplied by each team.

3.4 EVALUATION RESULTS & RATIONALE

At the conclusion of these evaluations, the loft architecture was selected as the most viable of the candidates for Space Station operations and will be studied in greater detail in 1986.

The general conclusions reached after each evaluation were consistent and reflected Rockwell and Grumman agreement. The evaluations were extensive and spanned several days each. The mix of interest of the review teams as well as the caliber of personnel that participated, and the consistency of conclusions lends confidence that the "best" architecture was selected. Continued work on the loft will address a longer module length now envisioned for the Space Station, as shown in Fig. 3-10 through 3-13.

The major conclusions reached at the end of the evaluations are:

- Loft and central core concepts can meet NASA requirements
- No standout winner; functional differences tend to cancel out
- Astronauts and architects tend to prefer the loft to live in for 90 days
 - More "natural appearing" environment
 - Better ease of movement
 - More usable volume
- Loft is more consistent with general trend toward open center compatible with laboratory and logistics modules
- Loft concept was chosen for further study.

Fig. 3-10 Loft Configuration - Habitat 1 View A

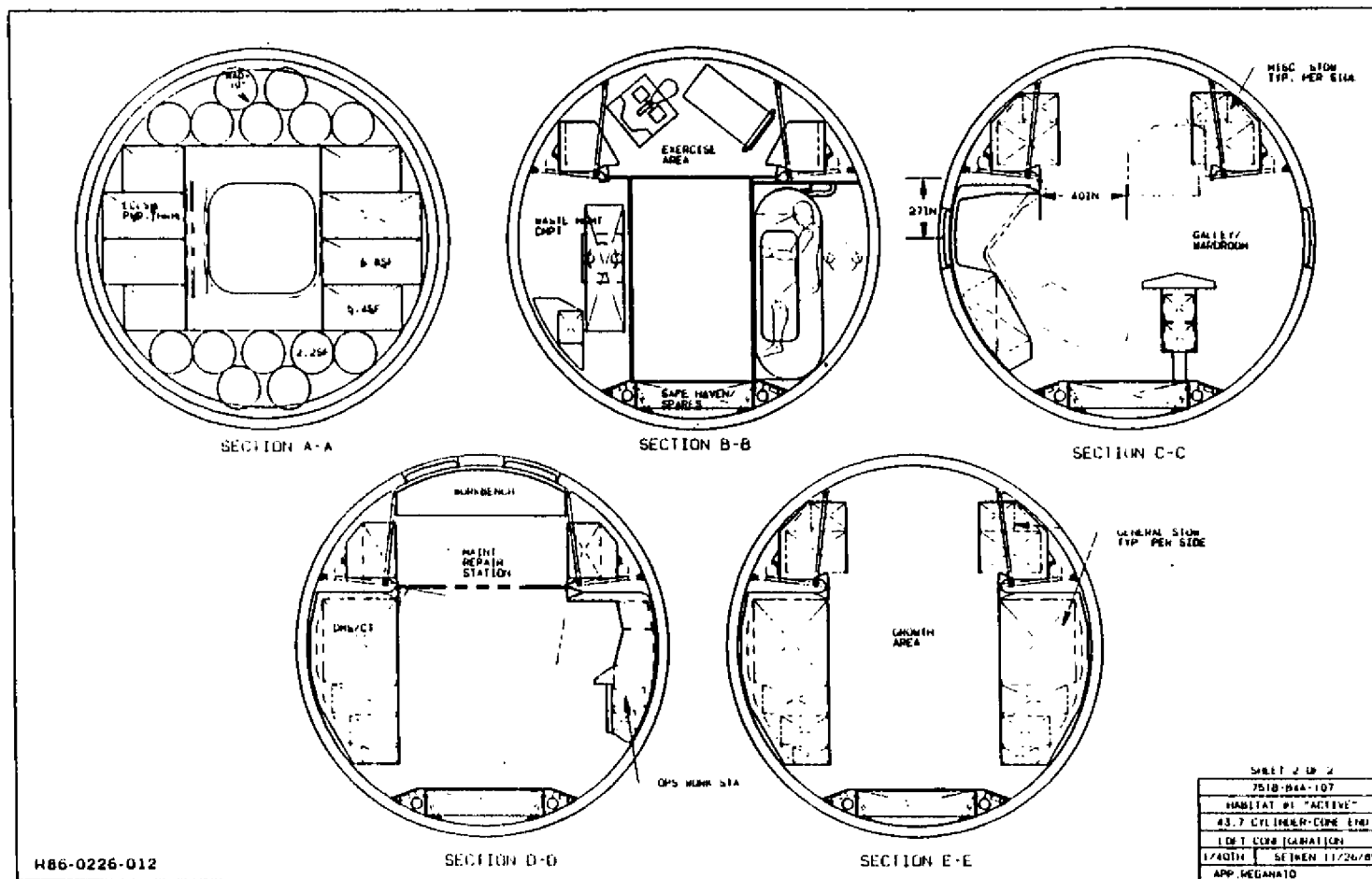


Fig. 3-11 Loft Configuration - Habitat 1 View B

Fig. 3-12 Loft Configuration - Habitat 2 View A

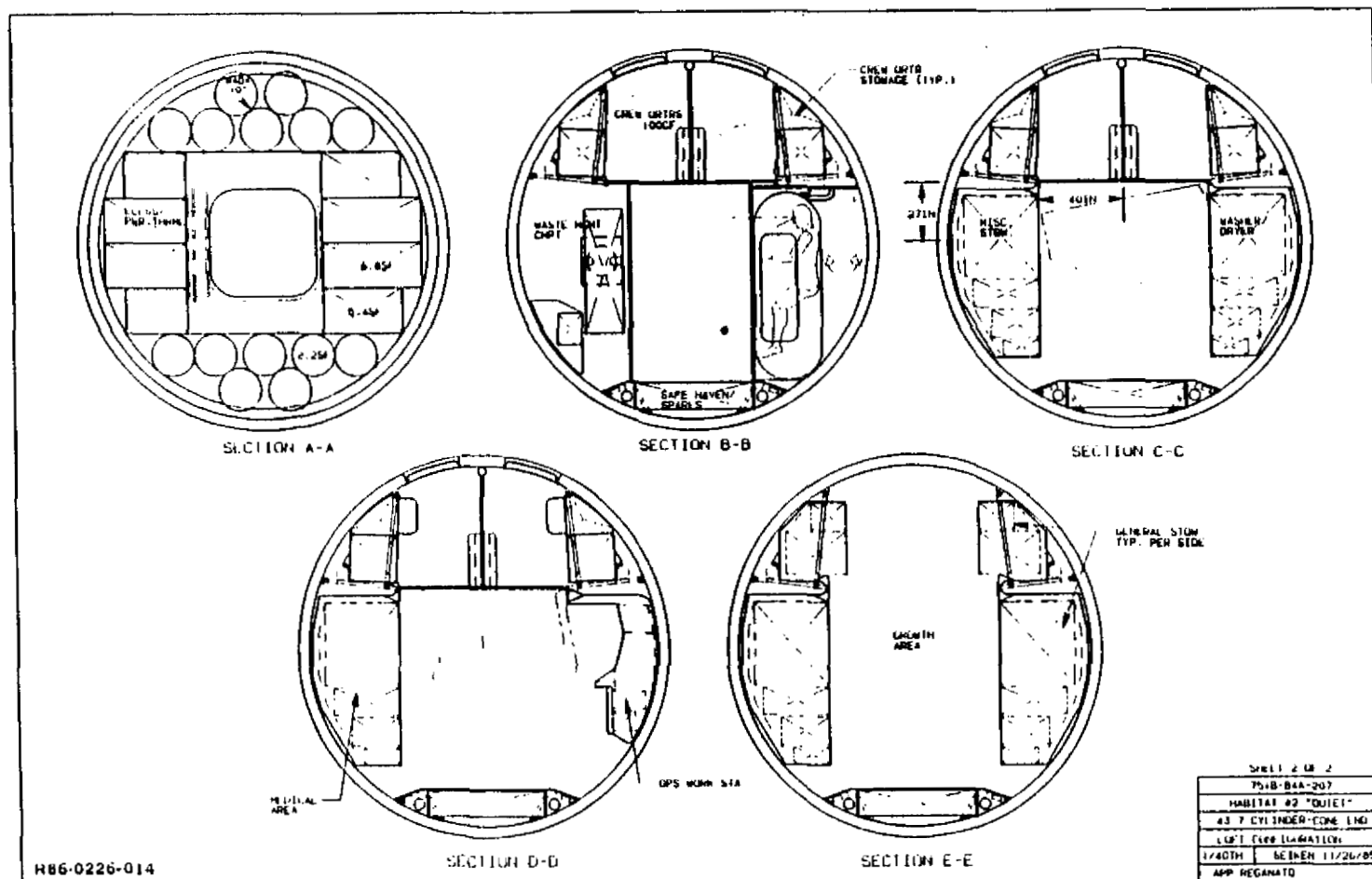


Fig. 3-13 Loft Configuration - Habitat 2 View B

4 - RECENT ENTRIES FOR STUDY

Since the selection of the multi-beam loft concept as the preferred architecture, it has become apparent that interest is growing in developing a Space Station module that serves more than one purpose, specifically laboratory functions with some crew support functions. At the same time, there is renewed interest in the concept of a single module containing all functions needed to provide a habitat for the crew. These concepts are discussed in subsequent paragraphs.

4.1 MULTIPURPOSE FUNCTION CONCEPT

In this concept, a module is configured to provide a work area, or laboratory, for experimental use, and some functions required by the crew to support both laboratory activities, station operations, and certain provisions for crew comfort. The habitat functions associated with this concept will more than likely be a maintenance work station, a command and control station, waste collection and personal hygiene facilities, stowage, and emergency gear. Figures 4-1 and 4-2 depict a preliminary multipurpose module.

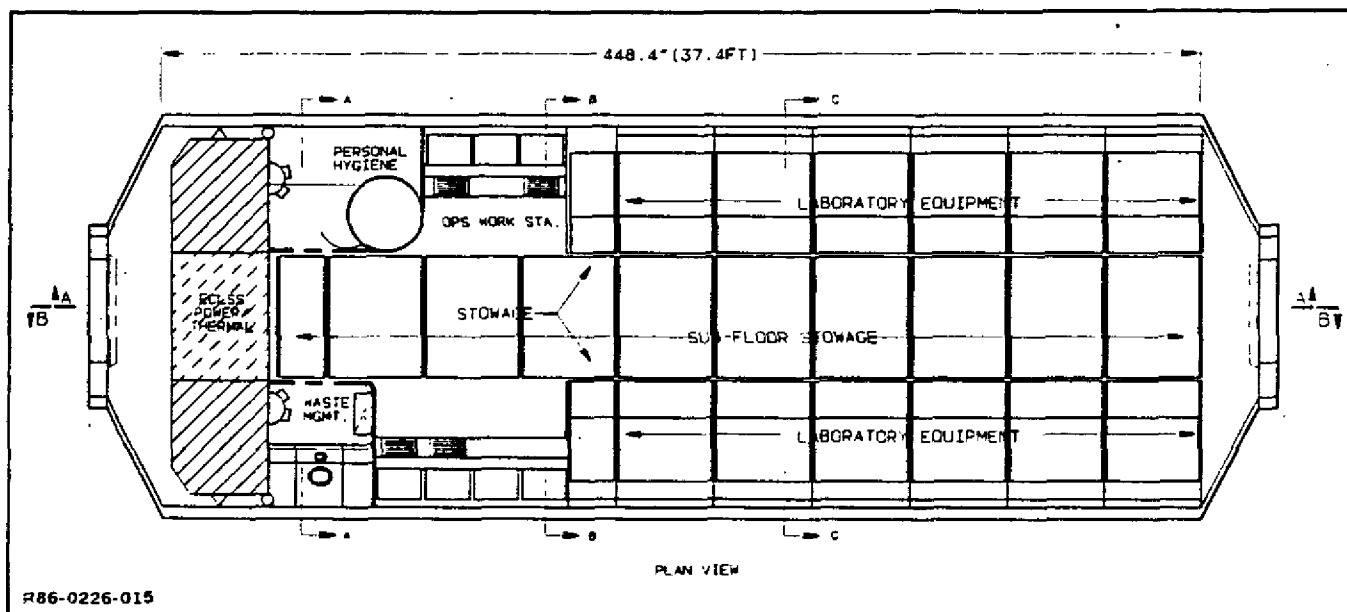


Fig. 4-1 Multipurpose Module View A

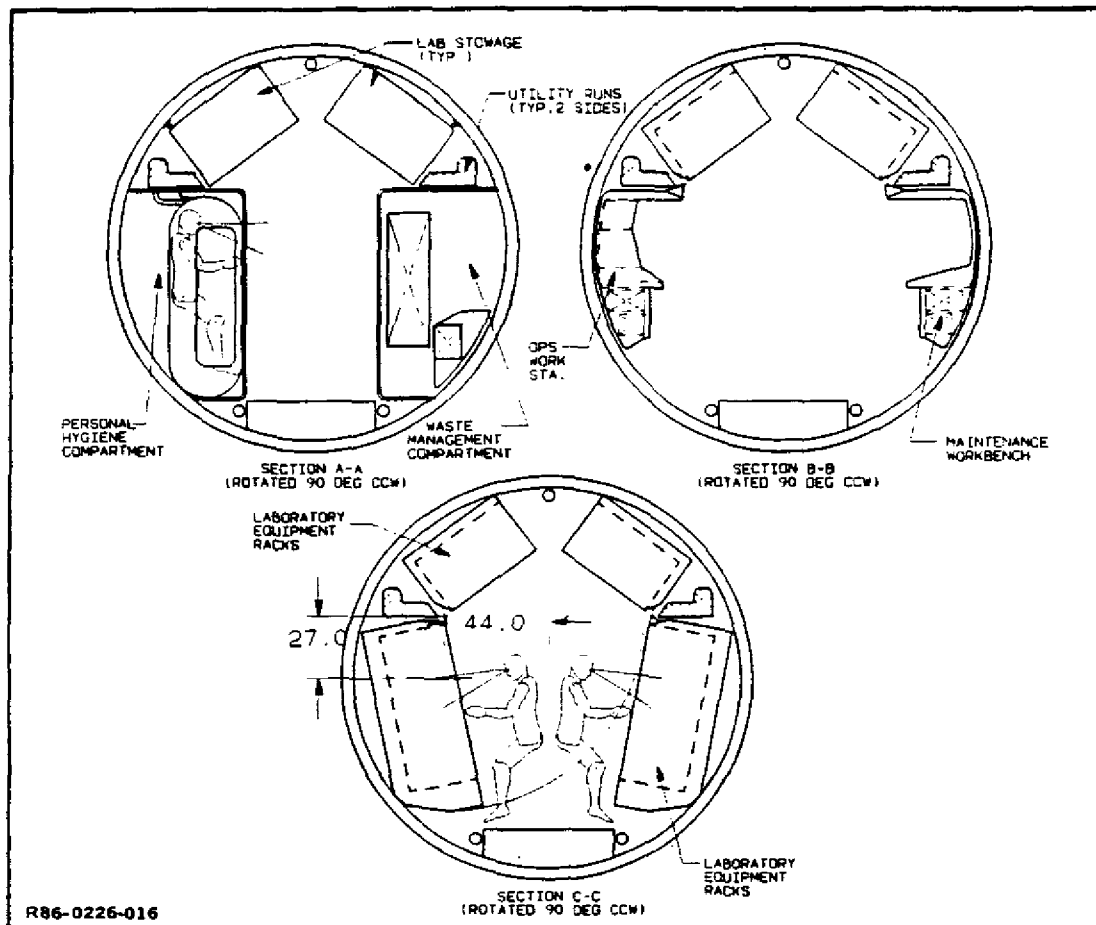


Fig. 4-2 Multipurpose Module View B

Preliminary studies are underway to determine functional site relationships, volumes required for equipment and access, and utilities requirements.

Interest in this concept is so strong that a full-scale mockup of a multipurpose module is included in the study plan for 1986. This mockup will be used to study and evaluate reconfigurability of the laboratory to address the problem of frequent replacement of experiments, and to determine the engineering and cost implications of utilities interfaces peculiar to a laboratory. Safety and maintainability issues will be identified and solutions developed.

4.2 COMBINED HABITAT CONCEPT

This concept was studied briefly in 1985 as reported in Reference (3), but was put aside to concentrate on the separate habitat module scenario. However, the

space community has expressed renewed interest in this concept, so a combined habitat architecture has also been included in the study plan for 1986. Here also, interest is so strong that a full-scale mockup of a combined habitat is planned for 1986 to study the ramifications of combined habitat regarding crew traffic flow, functional site relationships, site volumes required versus available space, utilities interfaces, reconfigurability, maintainability, and the whole range of man/machine interface issues that will surface due to the combination of all habitat functions in a single module. Studies have commenced to develop ruling cross-sections and functional topographies that will lead to a full-scale mockup design. Figures 4-3 and 4-4 depict a preliminary arrangement for a combined habitat.

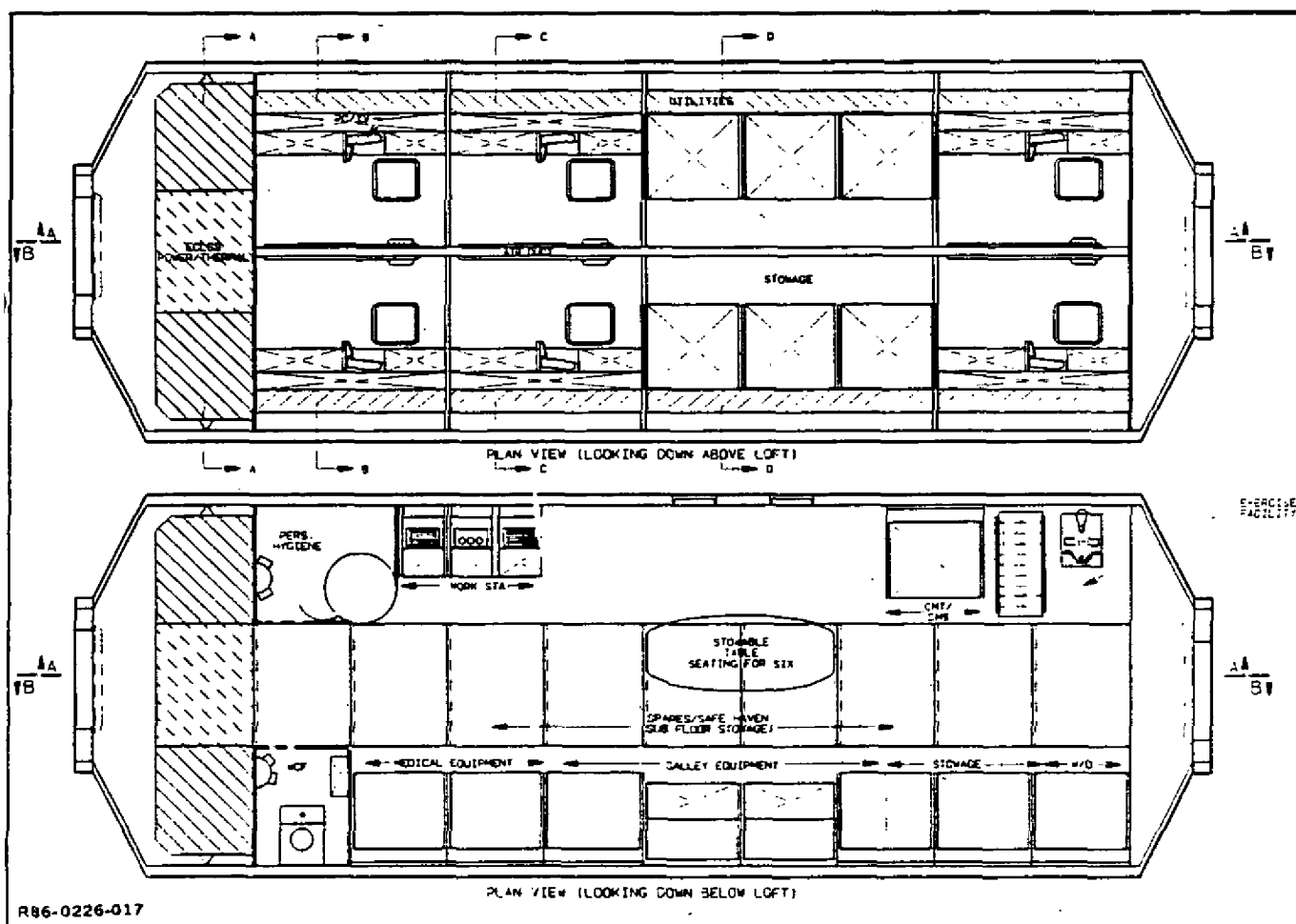


Fig. 4-3 Loft Architecture - Combined Habitat View A

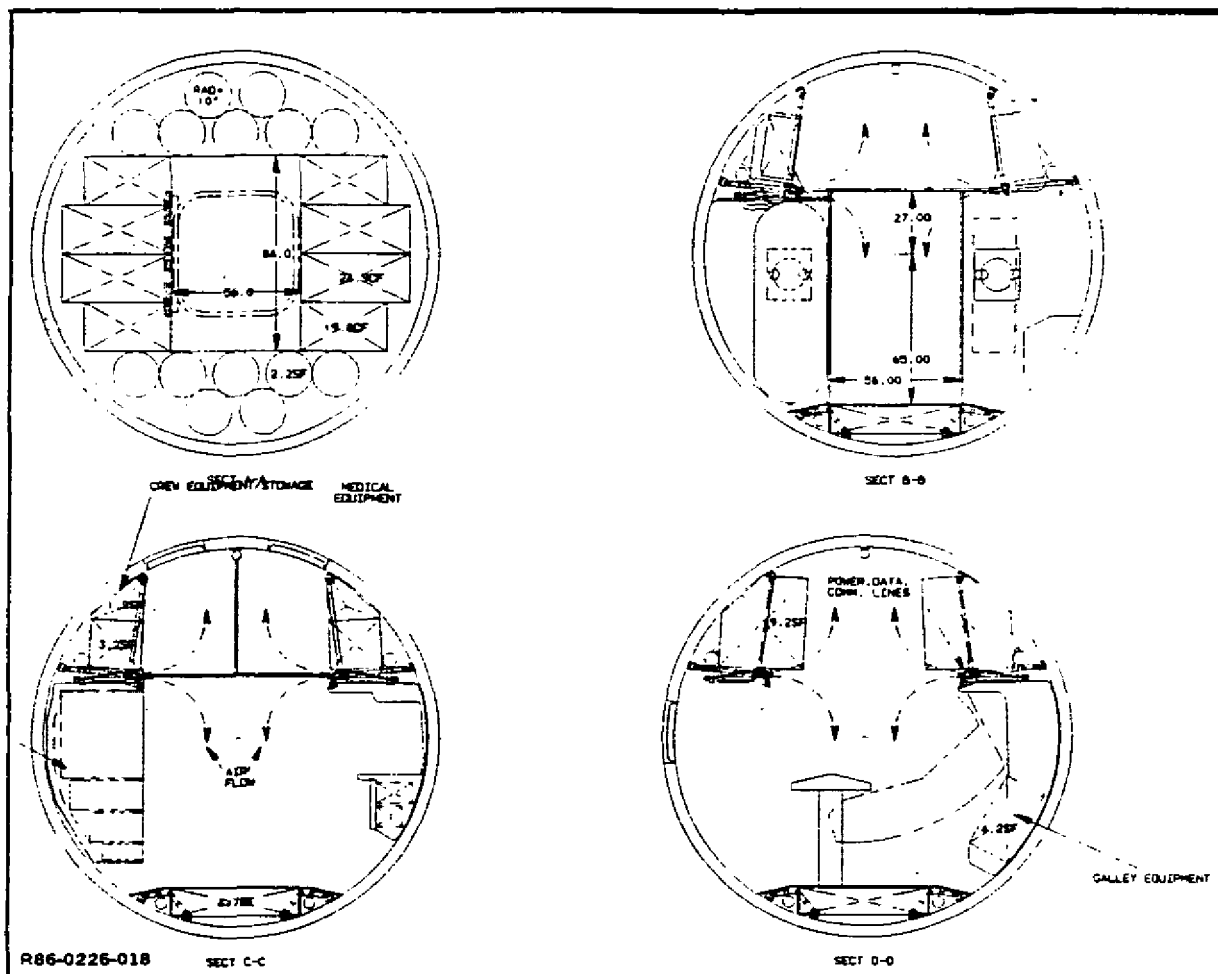


Fig. 4-4 Loft Architecture - Combined Habitat View B

5 - MOCKUP PLAN

To aid in the development of man/machine interfaces at functional sites, full and partial full-scale, higher fidelity mockups as well as 1/24th scale models are planned to be fabricated in 1986. These mockups will be of sufficient fidelity to afford confidence in the results of evaluations and demonstrations.

The mockups planned have been selected because they are needed to either depict three-dimensionally a key interface such as utilities attached to a hinged rack, proximity of personnel in motion (e.g., exercise), evaluate timeline-critical functions as in a galley, patient - attendant relationship issues (as in the health medical diagnostic and treatment facility), assess volume constraints in crew quarters and waste collection facilities, and evaluate traffic flows, access volume, maintainability, and reconfigurability in the full modules.

A plan has been developed and is presently in operation to provide these mockups so that issues, solutions, and conclusions can be included in the final report. Figure 5-1 depicts the mockup plan.

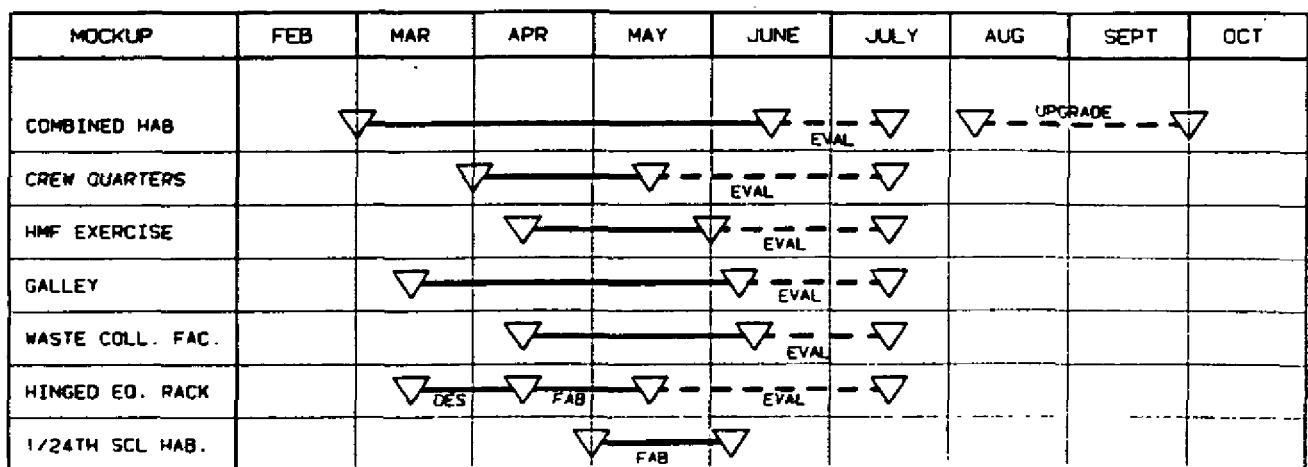


Fig. 5-1 Mockup Plan

6 - REFERENCES

- (1) Advanced Development Plan, WP-2 Space Station Definition and Preliminary Design Phase, 751B1GR05-01 Grumman Aerospace Corporation, 1 May 1985.**
- (2) Internal Architecture Concept Study, "The Four Corner Modular Truss Concept," SS005/ATD-04, 22 October 1985.**
- (3) Manned Space Systems Habitability Habitat Module Interior Architecture and Mockups Initial Report, SS005/ATD-02, 29 August 1985.**

APPENDIX I

Preface - Report SS005/ATD-04

The Interior Architecture Concept Study is being performed as part of Grumman's Independent Research and Development (IR&D) effort on generic Manned Space Systems Habitability. This project is described in the following document: Advanced Development Plan, Space Station WP-2, Definition and Preliminary Design Phase, Rockwell International Report SSS 85-0011, NAS9-17365, DR-05, 3 May 1985, Project 30.

I. INTERNAL ARCHITECTURE CONCEPT STUDY

"The Four Corner Modular Truss Concept"

I.1.0 INTRODUCTION

For the past year the Rockwell/Grumman team has been studying architectural arrangements for outfitting the habitats on the Space Station. To date, trade study #11 has devoted all its effort on two concepts, one called the "central core" and the other the "interstitial deck", defined as a derivative of the Service Deck concept. Recently a third concept called the "Loft" has been investigated. These three concepts were developed into low fidelity mock-ups of the "Loft" and "Central core" and a semi hi-fidelity 1/25th scale model of the "Interstitial Deck".

During the past months, NASA developed the "Central Beam" and the "Quadrant Beam Modular" concepts. Their requirement was to define an architectural concept which satisfies the habitats, laboratories and logistic modules. In doing so, the primary object would be to define the common module which could be provided by the Work Package #1 team members.

The "Quadrant Beam Modular" concept was investigated as part of Grumman's Internal Architecture Concept Study (IR&D). The enclosed material was developed using the expertise gained from Trade Study #11. This architectural arrangement has been entitled "The Four Corner Modular Truss Concept".

I.2.0 DESIGN GOALS

I.2.1 Primary

The primary goal of this study was to develop an architectural concept which satisfies the requirements for habitats, laboratories and logistic modules. The material contained herein has detailed the configuration of the architectural concept as applicable to habitats with various crew sizes and module lengths.

Only preliminary sketches have been made to determine how this architecture is used to outfit the laboratories and logistics modules. The secondary support structure developed seems to be compatible to the installation requirements of the laboratories and logistics modules. Additional work needs to be accomplished either by Grumman under the IR&D study or by Work Package #1 outfitters.

I.2.2 Secondary

I.2.2.1 Definition of an Architectural Concept - "Four Corner Modular Truss"

The first goal in this exercise was to develop an architectural scheme that meets the primary goal of one system for all module outfitting. The "Four Corner Modular Truss" concept is an attempt to achieve this goal. Drawings #2, 3 & 4 establish the basic internal geometry for this system,. With this system, all internal furnishings in the habitats are interfaced with the WP #1 secondary structure provided. Except for clips, to tie down wire routing and ducting, the pressure shell is never used for mounting the facilities in the habitat.

The utilities run, air circulation patterns and gross module packaging for ECLSS, power/thermal and safe haven are defined as common units for all modules.

I.2.2.2 Definition of Work Package #1 Hardware

In the interest of commonality, producibility and cost, a logical breakdown of work package responsibilities has to be established. One common completely assembled and checked out pressure vessel with a network of secondary support structure for mounting of internal furnishings in each Space Station module would be ideal. Drawings # 5 and 6 define the WP #1 pressure shell and the four corner upper and lower truss structure. The ECLSS, power/thermal and safe haven modules could be checked out as a bench assembly and shipped separately to the other work package outfitters for installation at their facility. In this fashion the delivery schedule of the module and separate sub-systems have more flexibility.

I.2.2.3 Definition of Equipment "Common" Modules

All facilities, equipment, stowage articles will have to be delivered to space and eventually returned to earth via the logistics module. For this reason a common mounting system has to be established between all modules being serviced. Therefore the variation in "W" x "D" x "L/H" dimensions of all equipment installed should be minimized and standardized. Since most equipment used is rack mounted the "W" (width) dimension must be standardized. The system shown in this report selects 21.0" as the incremental distance between adjacent racks. (This dimension may have to be increased to 22.0 " in future design layouts). This spacing should accept a module box width of 19.0". All module units shown in this study have been standardized to this "W" dimension. The "D" x "L/H" dimensions can be varied to suit the volume requirements of each facility. However, the variations in these two dimensions should be minimized so that rearrangement of facilities can be more easily accomplished.

I.2.2.4 Definition of Compartmentation

The "Four Corner Modular Truss" concept utilizes the interstitial deck as the divider between the upper "active" compartments and the lower "quiet" compartments. The deck is configured in 42.0" (2 x 21.0") incremental units. Below deck two (2) of these units define the length of a crew compartment (42.0" x 2 = 84.0"). One unit, (42.0"), defines the hole opening in the deck to get below to the vestibule area leading to the crew compartments. Above the deck each unit of 42.0" is equal to two (2) 21.0" rack width dimensions described in Section I.2.2.3.

The incremental arrangement has been used in this study to determine the various module lengths associated with variations in crew size and facilities.

In the case of the laboratories and logistics modules a whole deck, partial deck or no deck could be utilized in the installation of internal facilities.

Figures # 7, 8 and 9 demonstrate the interstitial deck arrangement installation and interfacing to WP # 1 secondary support structure.

I.2.2.5 Definition of Functional Cross Sections

In keeping with the requirements of "Commonality" and "Modularity", functional cross sections for the habitat at each type of work station need to be developed. If the cross sections are coordinated with the definitions in Sections I.2.2.3, I.2.2.4 and I.2.2.5, then it will be possible to meet the requirements in the Habs and Labs.

Figures # 10 thru 19 show the cross sections for each type of work station or facility required in the habitat. With these cross sections established, commonality and modularity of equipment is achieved. All layouts of habitats shown in this report utilize these basic cross sections in determining the various arrangements shown.

I.3.0 CREW SIZE VERSUS MODULE LENGTH

One of the burning issues to date is what module length is required to house finite crew sizes. Previous to this study parametric studies using raw volume data was used. In this report actual layouts using the principals described were used. It is felt that this technique better defines the module length question.

The drawing all represent a strawman design representing a starting baseline from which more detailed studies can be developed as additional information on each subsystem becomes available.

Figures # 20 thru 92 show six (6) possible combinations of crew size and module lengths using the Habitat #1 "Active" and #2 "Quiet" concept for the IOC Space Station.

Figures #92 thru 107 show one (1) possible arrangement of a combined #1 and #2 Habitat for the IOC Space Station.

CREW SIZE VERSUS MODULE LENGTH SUMMARY

<u>Config</u>	<u>Crew Size</u>	<u>Cylinder (L ft)</u>	<u>Module (L ft)</u>	<u>Equip Vol (ft³)</u>		<u>Fig. #</u>
				<u>Hab #1</u>	<u>Hab #2</u>	
A1	0 + 6 = 6	31.5	37.5	1309	1441	21-37
A2	4 + 4 = 8	31.5	37.5	1272	1390	38-55
A3	0 + 8 = 8	38.5	44.5	TBD	TBD	56-73
A4	6 + 4 = 10	38.5	44.5	TBD	TBD	74-91
A5	0 + 8 = 8	42.0	48.0	TBD	TBD	92
A6	6 + 4 = 10	42.0	48.0	TBD	TBD	92
B1	6 = 6	42.0	48.0			93-107

Additional layouts need to be accomplished to evaluate:

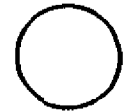
- a. Hab/Lab combination.
- b. Addition of modules to achieve growth version of Space Station.

I.4.0 FUTURE WORK

To complete this study the following tasks should be accomplished:

1. Provide layouts of Lab #1 using this concept.
2. Provide layouts of Lab #2 using this concept.
3. Provide layouts of logistics module using this concept.
4. Hab/Lab layouts.
5. Update layouts using 168" internal dia (165" used).
6. Define common module with all windows shown.
7. Expand study to show growth Space Station
8. Show module arrangement on tower to determine visibility angles available to crew.
9. Develop tool pass-out airlock in one of the habitats.
10. Construct a 1/20th scale semi hi-fidelity model of this architectural concept.

ADVANCED DEVELOPMENT PROGRAM
GR-05



MANNED SPACE SYSTEMS HABITABILITY
PROJECT NO. 30

INTERNAL ARCHITECTURE CONCEPT
STUDY

REPORT NO. SS 005/ATD - 04

"THE FOUR CORNER MODULAR TRUSS CONCEPT"

PRESENTER: GENE W. HARMS - GRUMMAN

DATE: 10/22/85 TELEPHONE: (516) 575-4267

9-1



QUADRANT BEAM MODULAR CONCEPT
MAN-SYSTEMS DIVISION - NASA/JSC

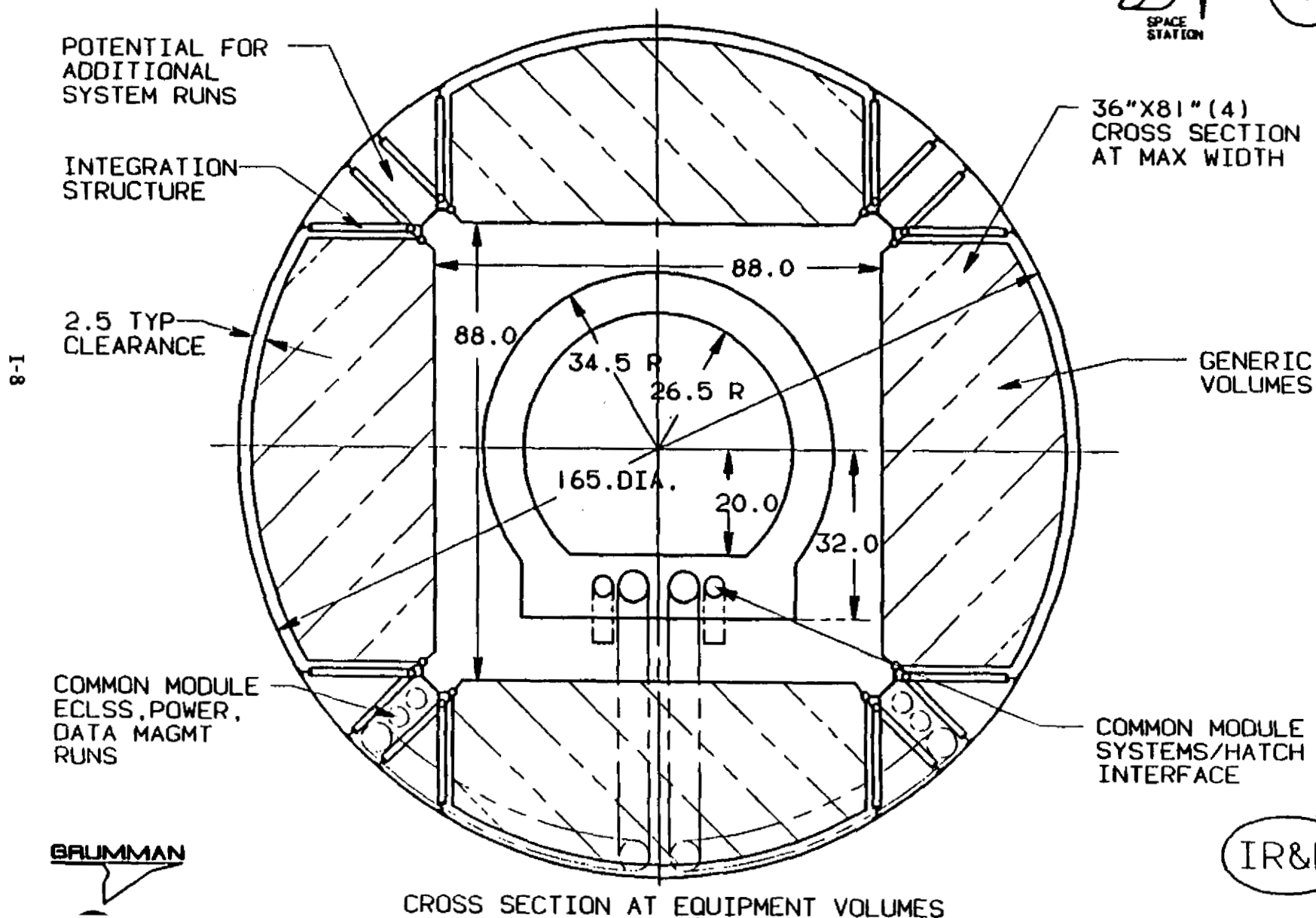
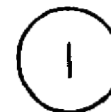
The cross section drawing shown, reflects the latest architectural concept devised by NASA/JSC, for outfitting habitats and laboratories. This system provides elements from WP #1 (pressure shell, integration structure & module system line runs) that are common to the habitats & laboratories. The truss structure can accept generic volumes, approximately 36" x 81" in cross section. This cross section can be passed thru the open hatch as a unit. The hatch opening shown scales 53.0" in diameter with a chord line 20.0" from center line. The common service lines enter the module below the hatch cord line and are routed inside the truss structure to various locations in the module.

The generic cross sections shown can satisfy equipment volumes, but are below standards for housing humans in crew quarters, waste collection compartments, personal hygiene compartments, health medical facilities and exercise area compartments.

The WP #1 interface concept shown is an excellent idea which should be pursued. The truss structure can be modified to provide interfaces to all the work packages that satisfies their internal architectural requirements.

The following pages depict a modification to this concept that could satisfy all work package requirements.

QUADRANT BEAM MODULAR CONCEPT MAN-SYSTEMS DIVISION - NASA/JSC



BRUMMAN

IR&D

FOUR CORNER MODULAR TRUSS SECTION

MODIFIED - GRUMMAN (GENE W. HARMS)

The cross section drawing shown, depicts a modified WP #1 truss structure that can accept the components for habitats, laboratories and logistic modules. The upper and lower truss members provide common interface points for all work packages similar to the NASA concept. However in this arrangement, the interface points shown provide a generic cross section which satisfies the packaging requirements for the human form in crew quarters, waste collection compartment, personal hygiene compartment, health medical & exercise facility compartments. It also provides a cross section which optimizes the galley/wardroom & work stations.

In addition it provides more flexibility in satisfying the volume package requirements for the laboratories and logistic modules.

This arrangement provides a larger hatch opening (was 50.0" dia) and greater surface area below the hatch chord line for inter-module services (power, ECLSS, etc.). The cross hatched areas shown provides more area than the quadrant beam concept for routing the WP #1 service lines. This expanded area can also be used for routing the WP #2 line runs.

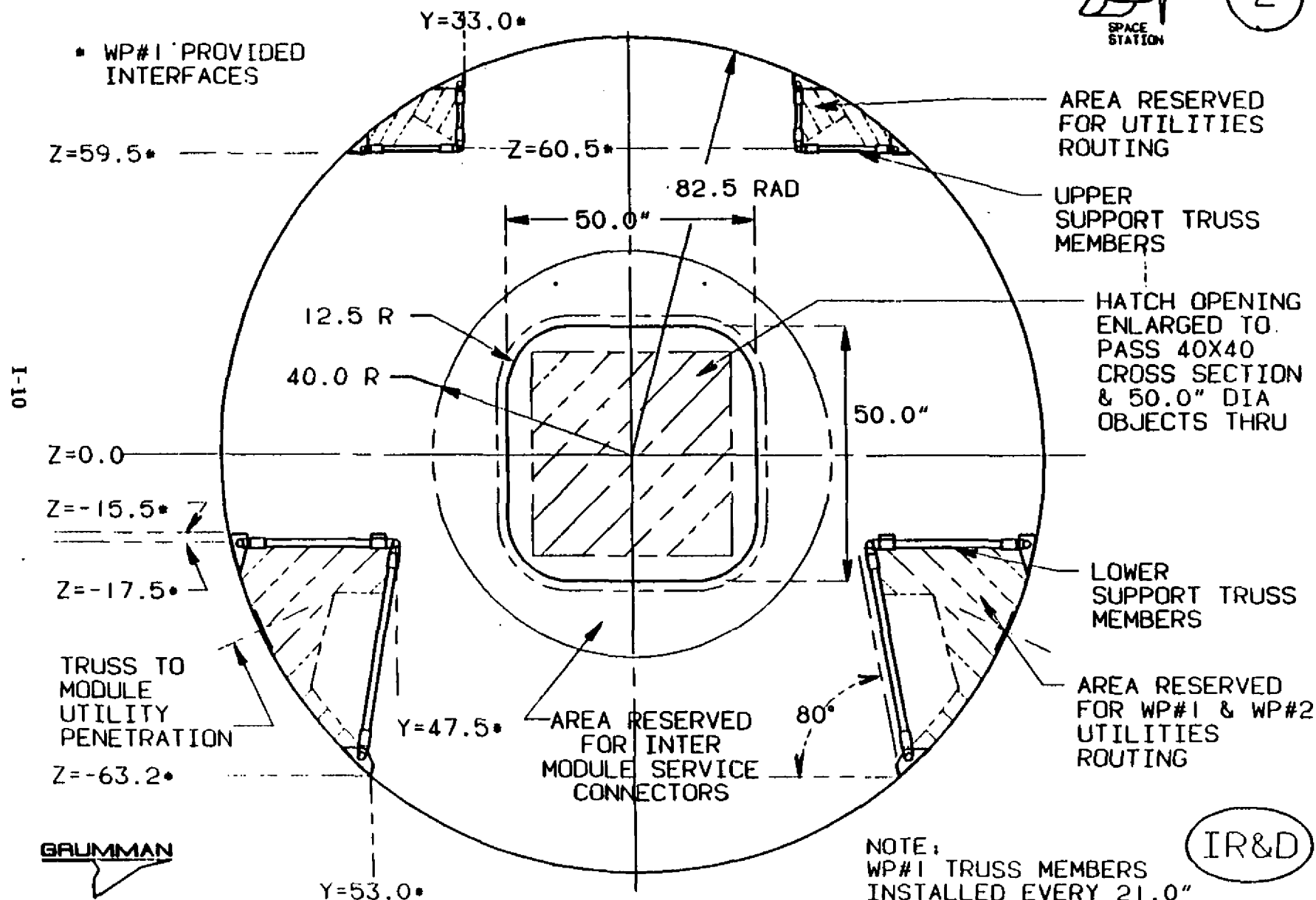
The upper & lower truss members are located at 21.0" intervals in the cylindrical portion of the module. (This spacing can be increased to 22.0"). This matrix is compatible with all habitat functional packaging units and laboratory racks.

The increased hatch opening allows a larger cross section unit (40" x 40") to be passed thru. The "D" ring type opening has been replaced with a 50" x 50" rectangular opening. It is felt this shape provides a hatch seal superior to that of the "D" ring.

FOUR CORNER MODULAR TRUSS CONCEPT MODIFIED - GRUMMAN(GENE W. HARMS)



2



GRUMMAN

IR&D

FOUR CORNER MODULAR TRUSS CONCEPT

ROUTING OF WP #1 UTILITIES

The rectangular hatch opening provides a larger surface area for installation of the required inter-module utility connectors. The utility line runs enter thru the cone end of the module and then make a right angle bend to the area of the lower support truss members. The shaded area shown, represents the total cross section of the module that is designated for routing the WP #1 utility lines in each module. A portion of this area can also be used by WP #2 outfitting for routing utilities which are unique to their module. The upper support truss members also contain a cross section area for routing additional WP #2 utilities thru the module. Utilities that are routed from the power tower truss structure penetrate the module in the area marked "WP #1 utilities". These utilities are located in the shaded area of the module lower truss structure and are routed in this area.

For this exercise 4.0" ducts are shown entering the module at the cone end and are routed to the area below each lower support truss member. The 4.0" duct is routed horizontally thru the entire module to the opposite end cone. 3.0" spur ducts are tapped off the main line at designated areas (crew quarters, medical facility, exercise area, etc.) to supply fresh air to that facility. The spurs are routed down to the volumes below the deck and up to the ceiling area for fresh air supply to the large open areas above the deck.

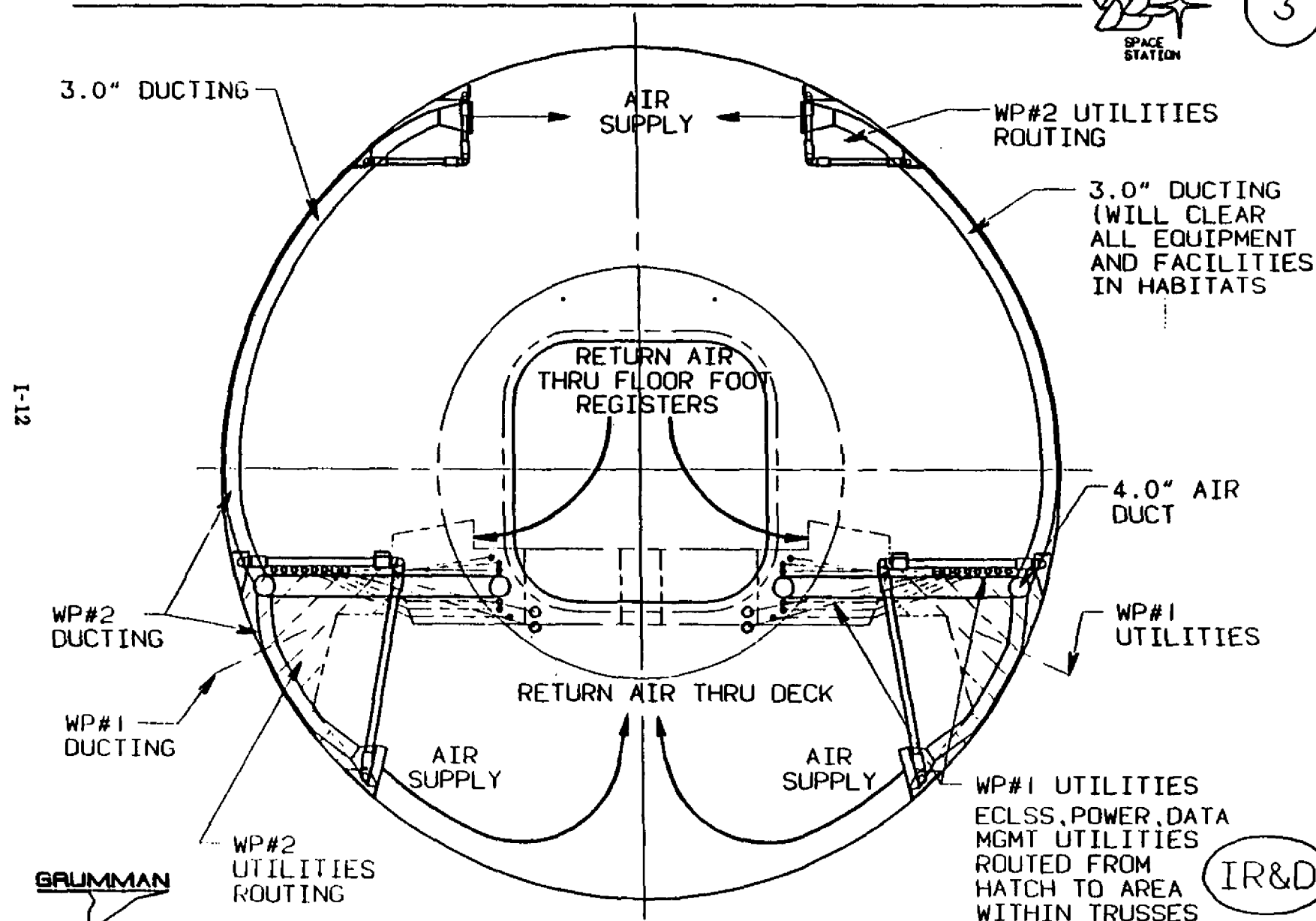
The interstitial deck contains a plenum down the center line for returning the circulated air back to the ECLSS units. In the upper living area the outboard edge of the deck contains foot restraint/return air registers for routing this air back to the ECLSS.

The 3.0" ducts running along the inner pressure shell clear all hardware items installed in the module.

FOUR CORNER MODULAR TRUSS CONCEPT ROUTING OF WP#1 UTILITIES



3



FOUR CORNER MODULAR TRUSS CONCEPT

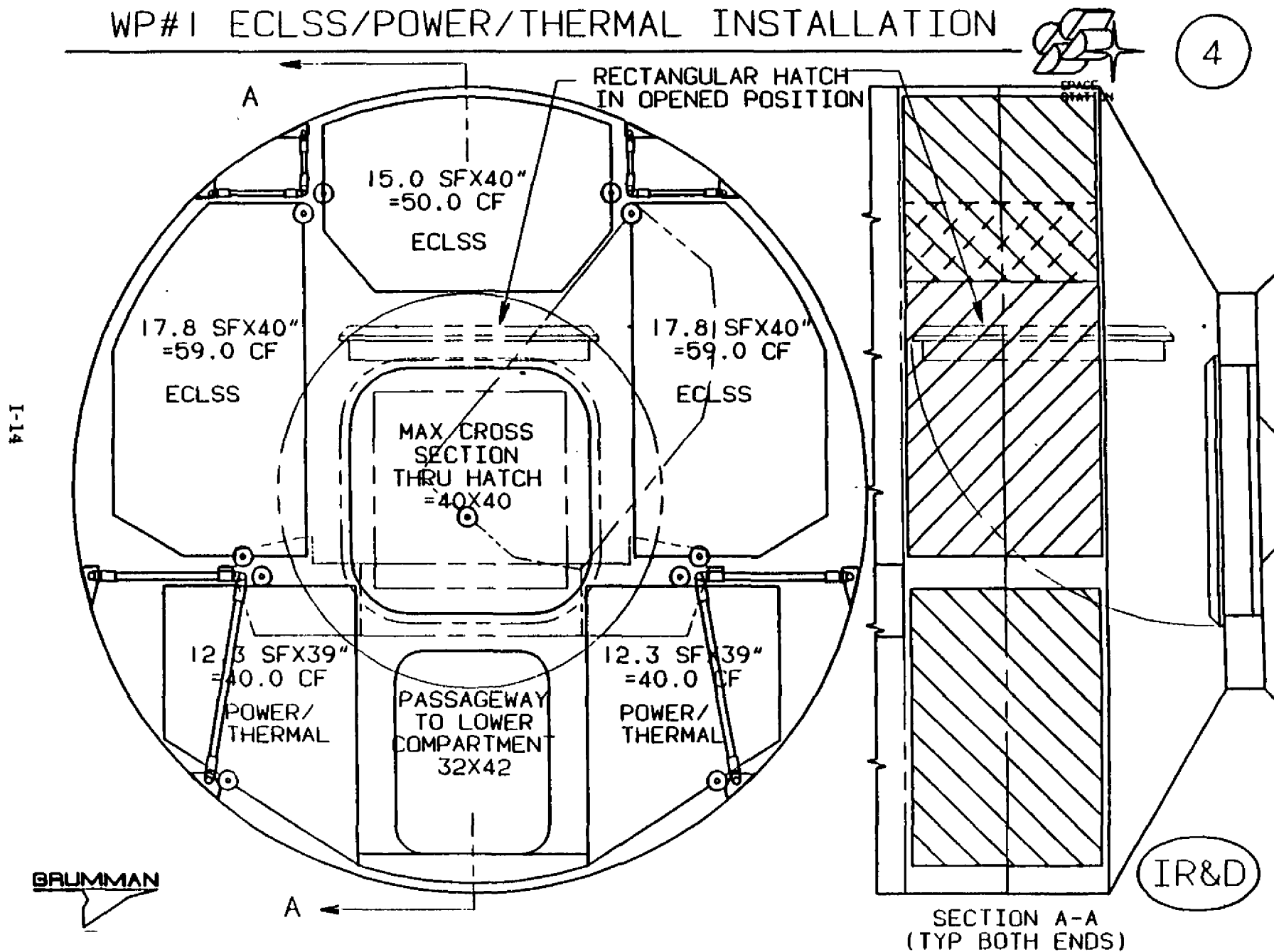
WP #1 ECLSS/POWER/THERMAL INSTALLATION

The packaging shown represents modular units which can be removed and passed thru the rectangular hatch opening. The ECLSS is contained in three separate volumes in the upper quadrant of the shell. Each unit is independently mounted from machine fittings attached to the WP#1 truss members. The units are 40" long (Y direction) and therefore are contained within three rows of truss members (spaced every 21.0" in the cylindrical part of the module). The top unit can be lowered down and out thru the hatch without moving the side units. Each ECLSS unit has a 40" x 40" cross section which will allow them to be passed thru the hatch opening with a 2.0" clearance all around. The three ECLSS packages provide a total of 168.0 cu ft. volume at one end of the module. To achieve the NASA baseline of 331 cu. ft., the three unit sizes are duplicated on the other end of the module. For the laboratories & logistic modules the volume requirements can be met with only one end "stuffed". The other end can be used for additional lab units or in the case of the logistics module, additional deliverable hardware.

The volume in the lower quadrant is occupied by two modular units used to package power/thermal hardware. They are mounted within the lower support trusses and can be removed independently from each other. The units will pass thru the open hatch. The two units total 80 cu. ft. of volume. The same volume is available for packaging the safe haven hardware at the other end of the module. A clear 32" x 42" opening is provided between these two modules, providing passages to the lower compartments.

The hatch can hinge upward, as shown, stowing below the upper ECLSS module. In the open position it does not restrict passage of large modules thru the opening.

FOUR CORNER MODULAR RUSS CONCEPT WP#1 ECLSS/POWER/THERMAL INSTALLATION



FOUR CORNER MODULAR TRUSS CONCEPT

WP #1 COMPONENTS

The three view drawing shows the components installed by WP #1 and the configuration of the module delivered to the other work packages for "stuffing". In this concept the entire upper & lower truss members network is installed every 21.0". This network of support members will accommodate the equipment installations in the habitats, laboratories & logistic modules. At the present time, the cylindrical portion of the module is sized for 6 crew members, the minimum length for this is 378" (31.5'). (Subsequent studies for larger crews & combined Hab #1/#2, Hab/Lab arrangements show longer module lengths.)

The ECLSS, thermal & power modules are installed in one end of all modules and is optional on the other end. At the present time, the units are required on both ends for the habitats and only on one end for the laboratories and logistics modules.

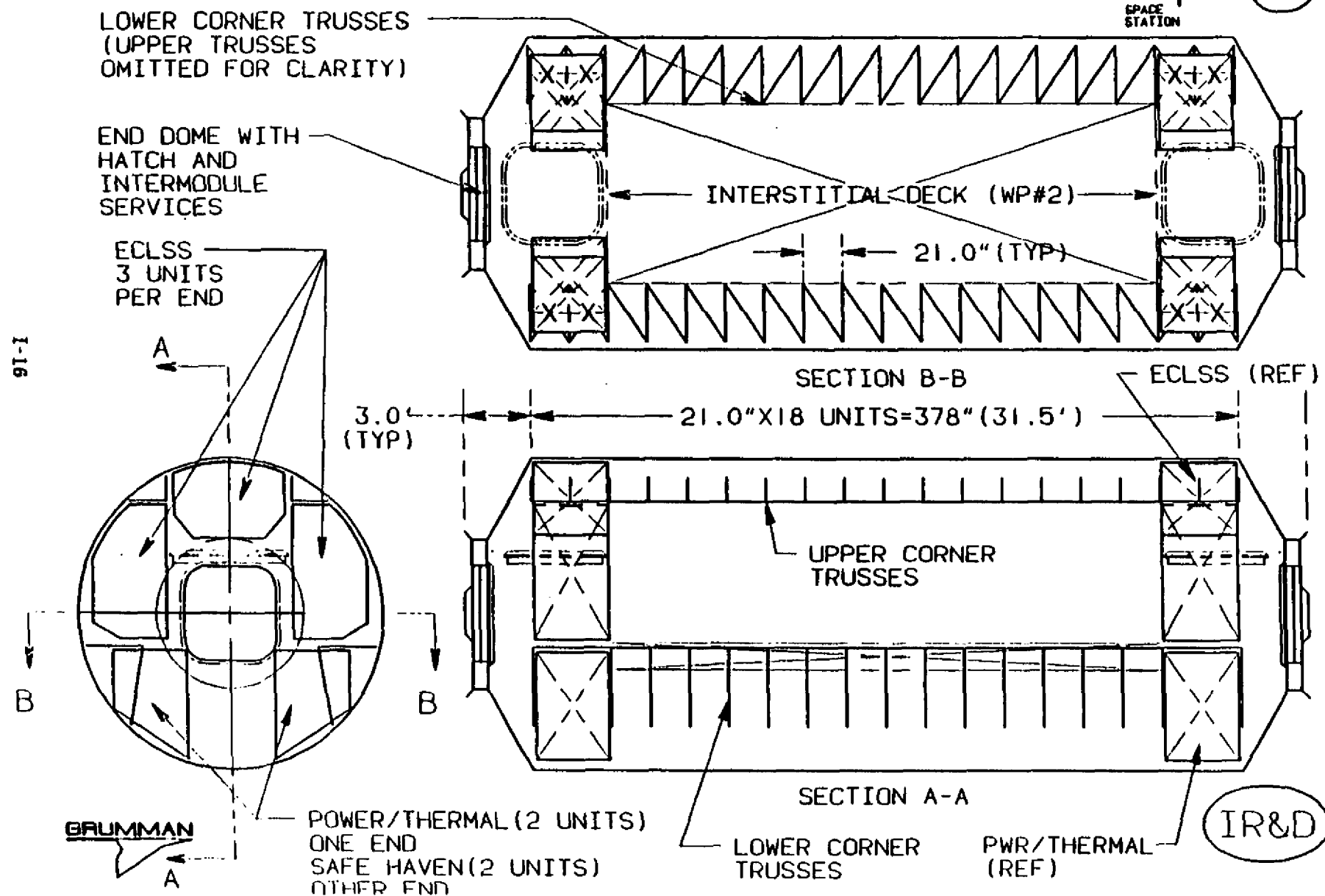
The utilities are routed thru the lower corner trusses and made available for other work package interfaces at desired locations.

The large rectangular hatch can hinge upward as shown, and stow below the upper ECLSS module at either end. The stowed position of the hatch does not restrict passageway of equipment, bulk modules, or people thru the opening provided.

FOUR CORNER MODULAR TRUSS CONCEPT THREE VIEW DRAWING OF WP#1 COMPONENTS



5



FOUR CORNER MODULAR TRUSS CONCEPT

ISOMETRIC OF WP #1 COMPONENTS

The isometric drawing shown depicts the same WP #1 components as described in the previous chart. The ECLSS, power & thermal modular units are shown on both ends of the cylinder. As stated before the laboratories & logistic modules require only one end with these units. The volume vacated can be used to accommodate additional facilities for the laboratory or stowage volume for the logistics module.

An ideal situation would be where the windows, radiators, meteor protection & insulation installations are identical for all modules. Layouts of the habitat are being developed to show that all habitats can have the same external configuration. Laboratory layouts will have to be produced to see how close this goal can be achieved. In the case of the logistics module the windows could be omitted by replacing the void with a plate closure.

I JUR CORNER MODULAR TRUSS CONCEPT ISOMETRIC OF WP#1 COMPONENTS



6

PART OF UPPER
CORNER TRUSSES
OMITTED FOR CLARITY

INTERSTITIAL DECK
INSTALLED BY WP#2

THESE UNITS NOT
ROD FOR LABS
AND LOG MOD

END DOME WITH
HATCH AND
INTERMODULE
SERVICES

81-1

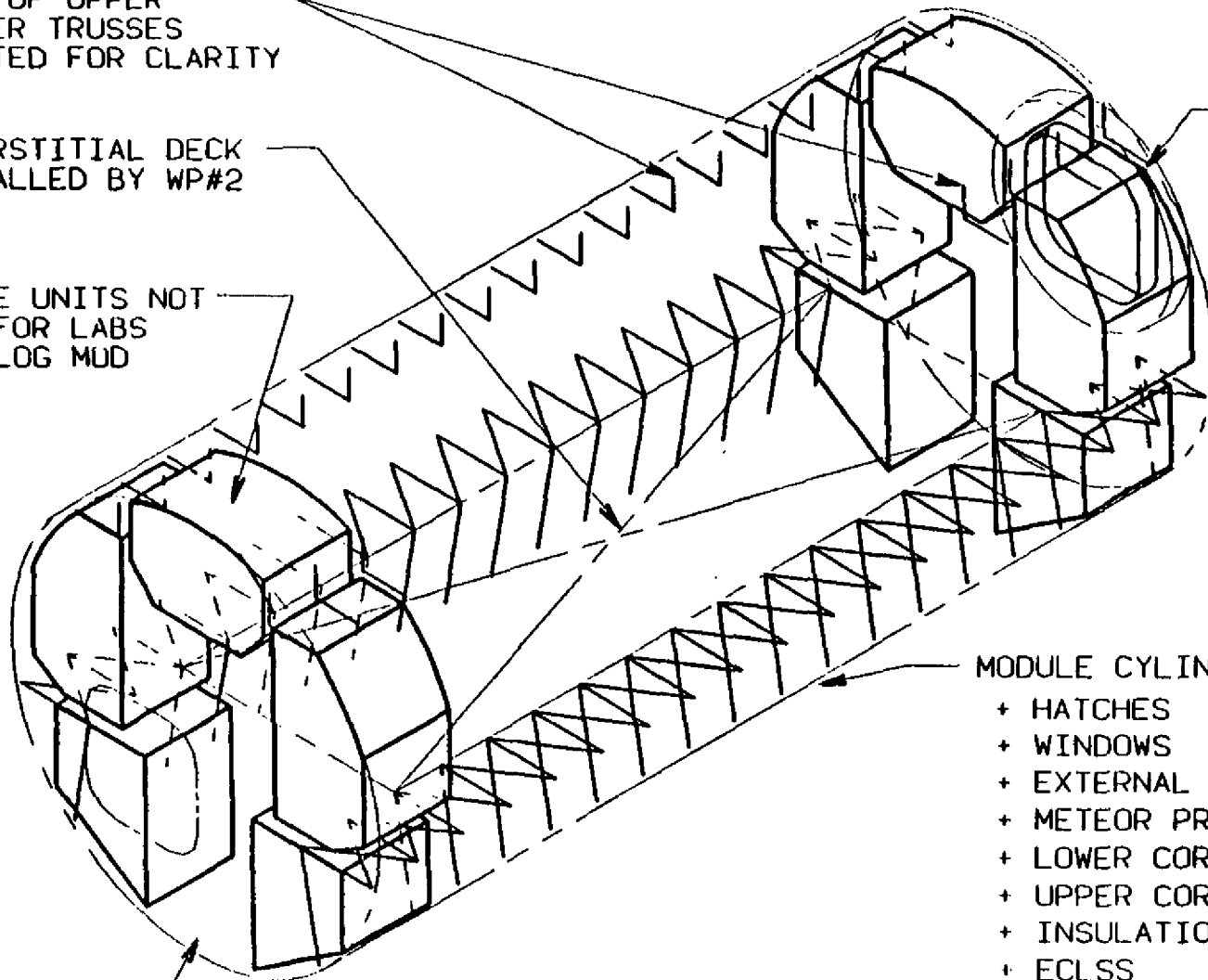
MODULE CYLINDER WITH:

- + HATCHES
- + WINDOWS
- + EXTERNAL RADIATORS (OPTIONAL)
- + METEOR PROTECTION
- + LOWER CORNER TRUSSES
- + UPPER CORNER TRUSSES
- + INSULATION
- + ECLSS
- + POWER/THERMAL
- + UTILITY RUNS

GRUMMAN

END DOME OMITTED
FOR CLARITY

IR&D



FOUR CORNER MODULAR TRUSS CONCEPT

INTERSTITIAL DECK MODULAR ASSEMBLY

The deck shown can be constructed as a complete assembly and installed in the module if one end is open. This assumes the module is delivered to WP#2 with the cone end and the ECLSS, power thermal units not installed. After the floor is installed the cone end and modular units are installed. This manufacturing cycle tends to complicate the WP#1/WP#2 flow.

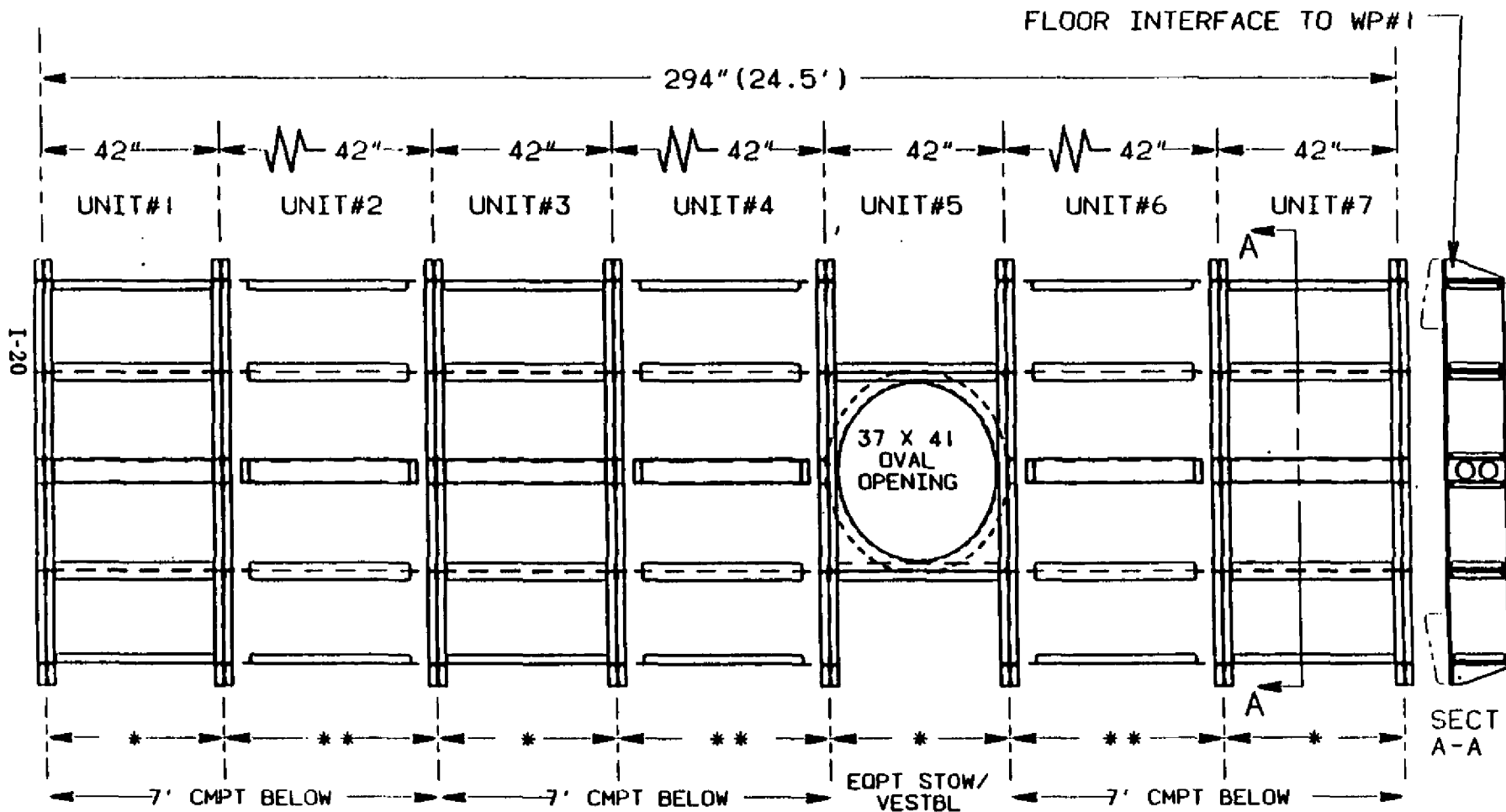
For this reason the interstitial deck has been reconfigured as a modular assembly. It can be bench assembled in 42" lengths as shown on the drawing. Each compartment below the deck is 84" long (two multiples of 42"). The first, third, fifth and seventh modular deck units can be installed in the module picking up the work package #1 lower truss assembly structure. Each of these modular deck units will pass thru the hatch opening at either end of the module. After the units have been secured in place the longitudinal deck members (second, fourth & sixth deck elements can be installed. In this fashion a complete deck with all its mounting provisions for modular containers and passage way between decks have been installed. The modular concept makes it possible to install the deck in other arrangements than that shown. In the case of the laboratories a partial deck can be installed, or completely omitted.

The deck module with the oval machine structure is configured to allow passage of crew members. It also is shared to provide passage of crew members. It also is shared to provide passage for the return air flow from the compartments below the deck. It can also support a pleated type of folding door for each of the four crew quarters abutting on this volume.

FOUR CORNER MODULAR TRUSS CONCEPT INTERSTITIAL DECK MODULAR ASSEMBLY



7



- MODULAR DECK UNITS FIT THRU HATCH AND CAN BE INSTALLED IN MODULE PICKING UP FOUR LOWER TRUSS SUPPORT MEMBERS
- LONGITUDINAL FLOOR MEMBERS INSTALLED IN MODULE AFTER MODULAR DECK UNITS ARE SECURED

GRUMMAN

IR&D

FOUR CORNER MODULAR TRUSS CONCEPT

INTERSTITIAL DECK INSERTION

As shown on the previous drawing, the interstitial service deck is designed as a modular structure. This drawing demonstrates how each module deck unit is inserted thru the hatch opening with substantial clearance. When it is inside the module, the unit is rotated 90° and lowered into the work package #1 lower truss support structure and secured at four interface points.

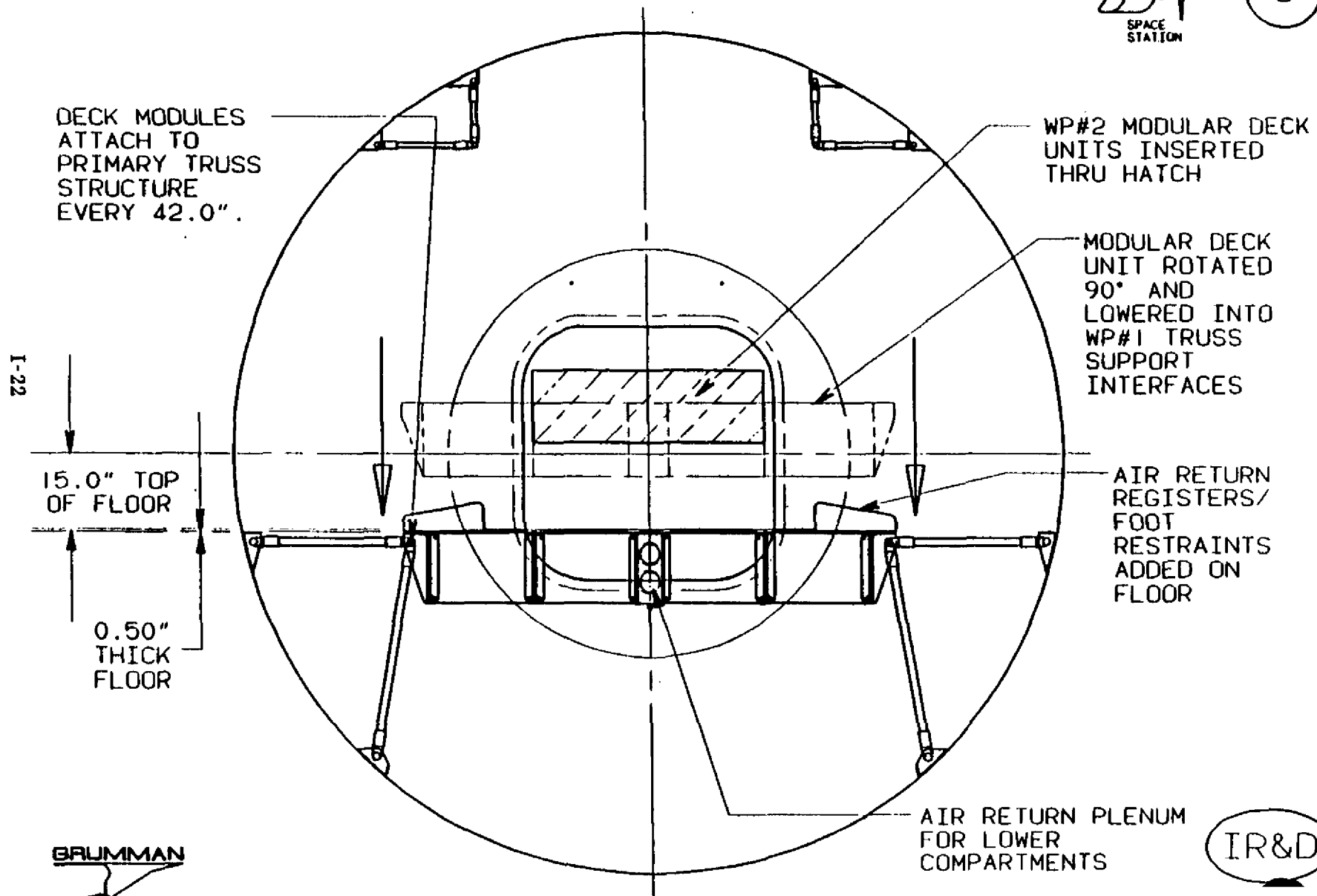
The air return registers/foot restraint machine parts can be installed on top of the deck at those stations having work stations which place the crew person at this position (see subsequent drawings).

The bottom of the deck is constructed to accept 4 rows of standardized 19" black boxes its entire length.

FOUR CORNER MODULAR TRUSS CONCEPT INTERSTITIAL DECK INSERTION



8



IR&D

INTERSTITIAL DECK/TANKAGE INSTALL

This drawing shows how the entire interstitial deck interfaces with the work package #1 lower support truss structure. The deck modules attach to the WP #1 structure at 16 points along its entire length. The deck nestles between the ECLSS & power thermal installations.

The 84" dimension defines the open volume below the deck used for either crew quarters, health maintenance, health exercise, or control station compartments. The 84" dimension above the deck represents four (4) linear module lengths of 21". Any combination of modular facilities can be accommodated to suit the many arrangements of habitats or laboratories.

The 42" dimension which contains the oval hole in the deck structure provides passageway to the lower compartments. The central area below the deck is the vestibule. From this point the crew can enter into four of the crew quarters. In addition, access can be obtained to the four tanks that service the waste collection and shower systems. The fecal/toilet paper collection tank shown is 10.9 cu. ft., when full it can be removed and placed in the logistics module. A new tank is installed, thus minimizing maintenance. The adjacent tank, also 10.9 cu. ft, can house 80 gallons of urine which can be reprocessed into useable water. On the other side of the vestibule are two additional tanks. One provides clean water for the shower and hand wash (it can also service the galley), the other collects the soapy water from the shower.

FOUR CORNER MODULE TRUSS CONCEPT INTERSTITIAL DECK/TANKAGE INSTALL

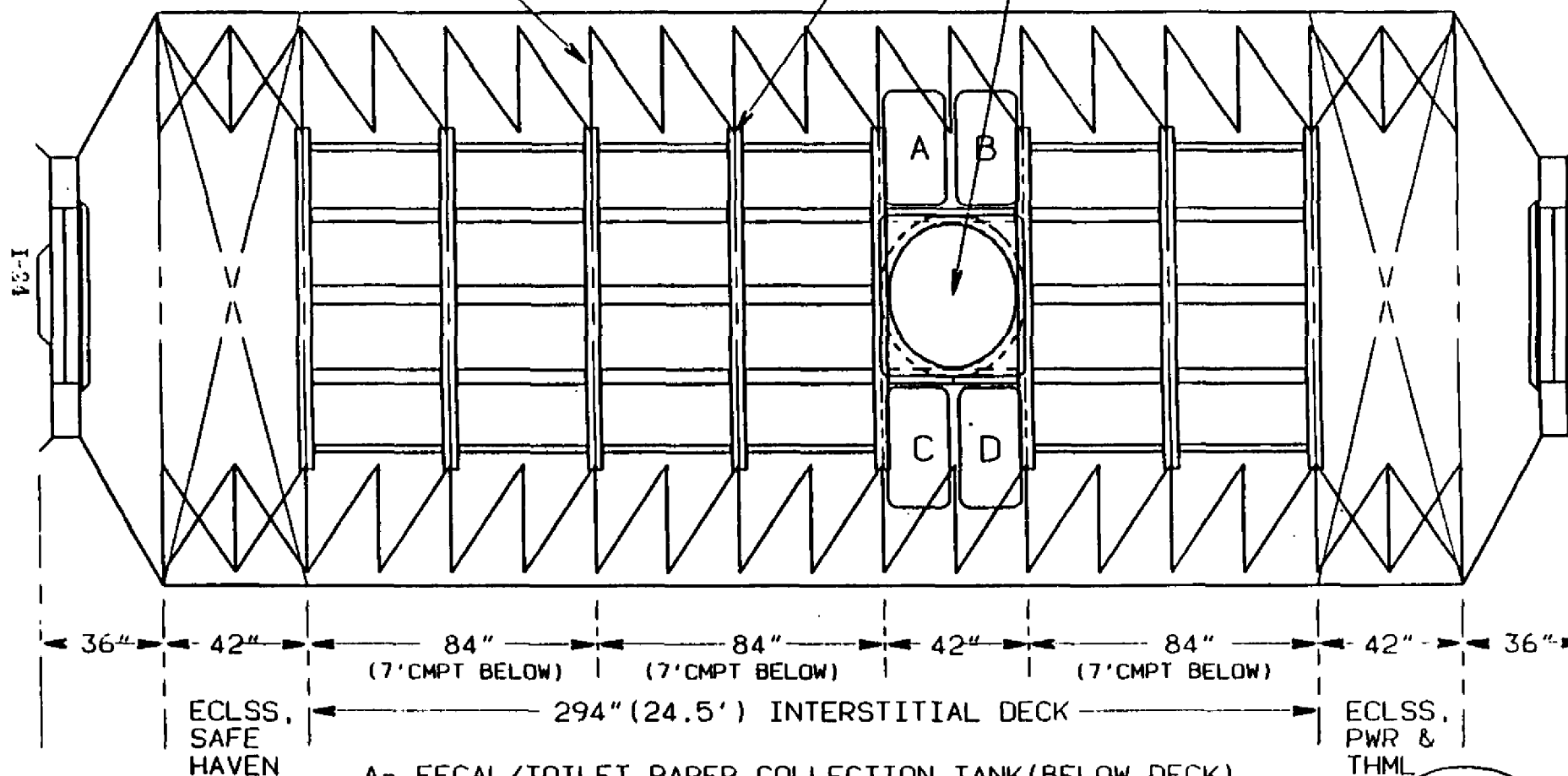


9

WP #1 LOWER
TRUSS STRUCTURE

WP #1 INTERFACE
POINTS(16)

VESTIBULE AREA
BELOW DECK



GRUMMAN

IR&D

INSTALLATION OF EQUIPMENT RACKS

The machine part rack shown is configured to mount 19.0" wide modular units. These modules can be galley units, electronic boxes (DMS, C&T, etc), spare parts, or miscellaneous stowage items. The heavy line represents the three mounting surfaces of all units mounted on the rack.

The machine rack mounts to the WP #2 fitting on the deck and the WP#1 truss structure overhead. These racks are mounted every 21.0" where this type an installation is required.

The vertical inboard part of each rack is shaped as a handgrip and provides a convenient handhold for the operator facing this equipment. The bottom mounting fitting on the deck serves as the return air outlet and also as a foot restraint.

Two racks with its equipment can be removed as a unit to gain access to the skin. (The top module may have to be removed first).

These racks can also be used in the laboratory and logistics modules. If required, longer rack configurations can be installed in the laboratories & logistic modules (picking up the same interfaces) to provide more frontal area for installed equipment.

FOUR CORNER MODULAR TRUSS CONCEPT INSTALLATION OF EQUIPMENT RACKS

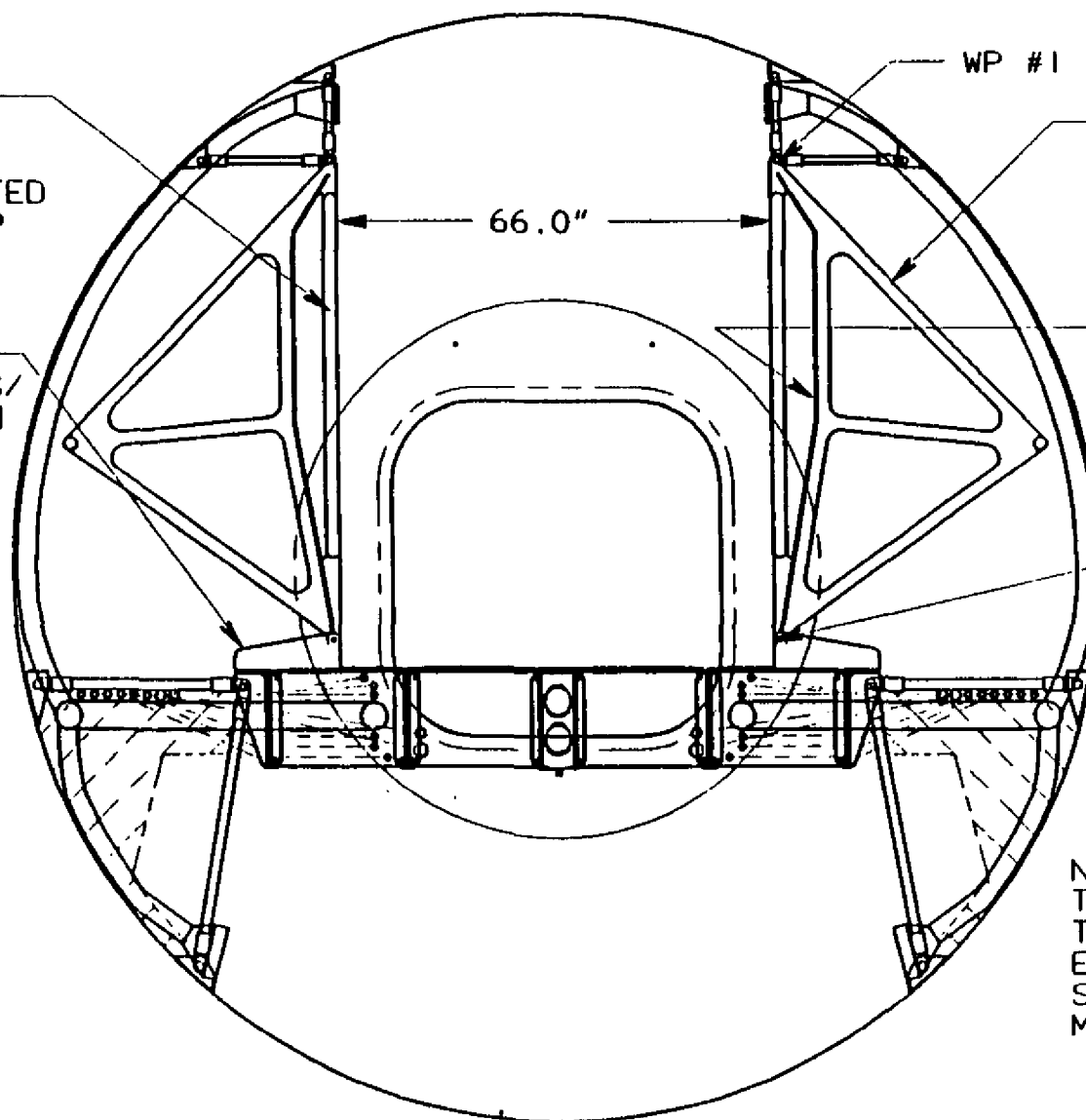


10

I-26

CONTOURED
VERTICAL
HANDGRIPS
INCORPORATED
INTO EQUIP
RACKS

FOOT
RESTRAINTS/
AIR RETURN
OUTLET



WP #1 INTERFACE

EQUIPMENT
SUPPORT RACKS
INSTALLED EVERY
21.0" WHERE
REQUIRED

MOUNTING
SURFACE FOR
19" WIDE
MODULAR UNITS

WP #2
INTERFACE

NOTE:
THIS RACK USED
TO MOUNT GALLEY
ELECTRONIC,
SPARES &
MISCL EQUIP

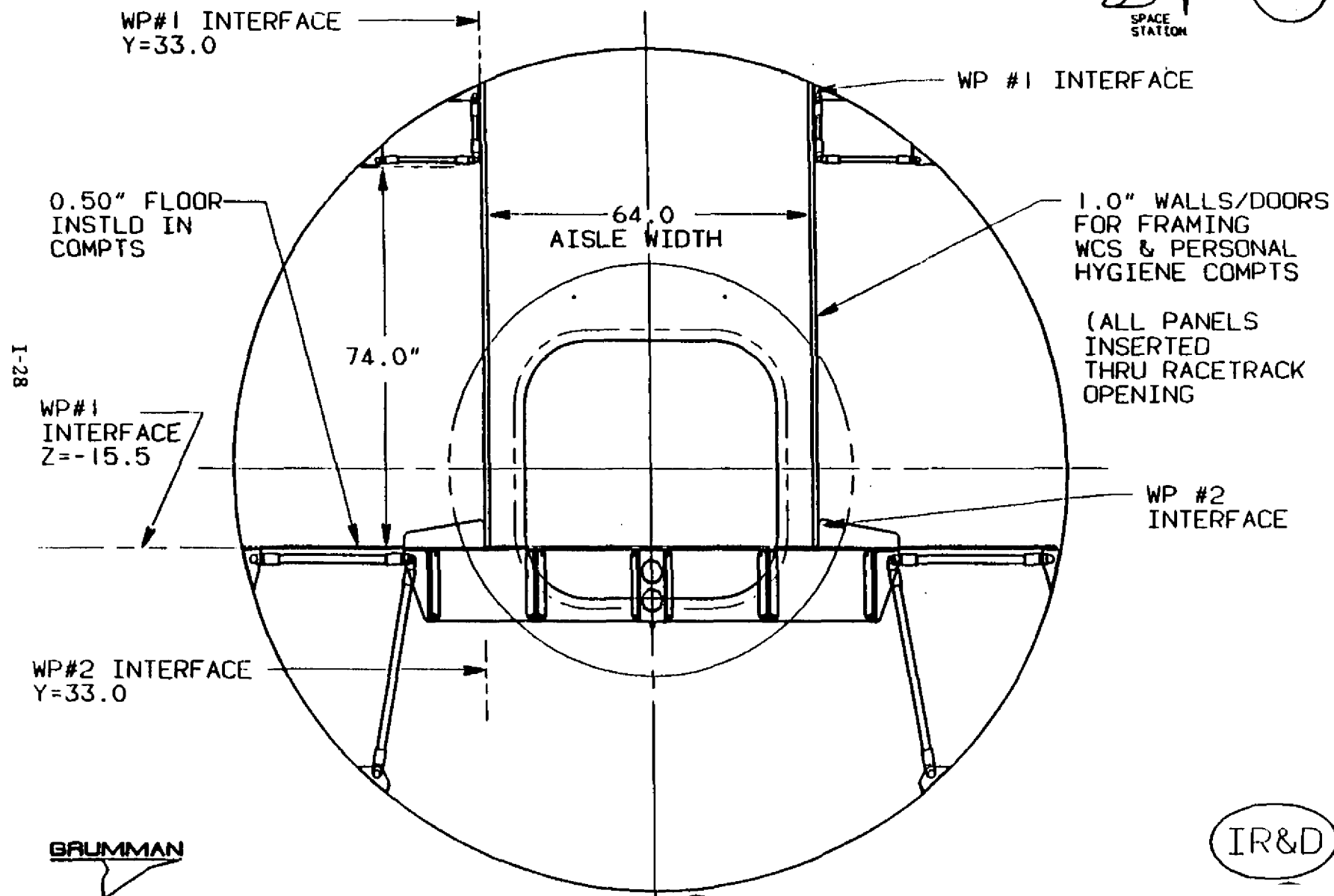
IR&D

GRUMMAN

INSTALLATION OF WCS & PERSONAL HYGIENE COMPARTMENTS

The waste collection compartment & personal hygiene compartments are identical in shape and size and are located opposite each other. The compartment walls are constructed with 1.0" thick honeycomb panels (or equivalent). The inboard walls are installed as three 21.0" wide floor to ceiling panels picking up the WP #1 truss structure at the top and the WP #2 deck fittings at the bottom. The fore and aft compartment walls can be installed as single panels picking up top and bottom interfaces. The interiors of both compartments can be made totally accessible by removing the inboard sectionalized wall panels. The floor to ceiling height of each compartment is 74.0". The central aisle width between the compartments is 64.0".

FOUR CORNER MODULAR .RUSS CONCEPT INSTALL OF WCS & PERS HYGIENE COMPTS



INSTALLATION OF LOWER COMPARTMENT RACKS

The lower volume has been sized to contain the following:

- a) two side by side crew quarter compartments
- b) one single compartment housing the health medical facility
- c) one single compartment housing the health exercise facility
- d) one single compartment housing a command & control work station

The interstitial deck provides a floor to ceiling wall in each of the above named compartments. It presents the occupant with a densely arranged installation of modular containers. All units are 19.0" wide and are designed to fit into the cavities of the deck in any arrangement desired.

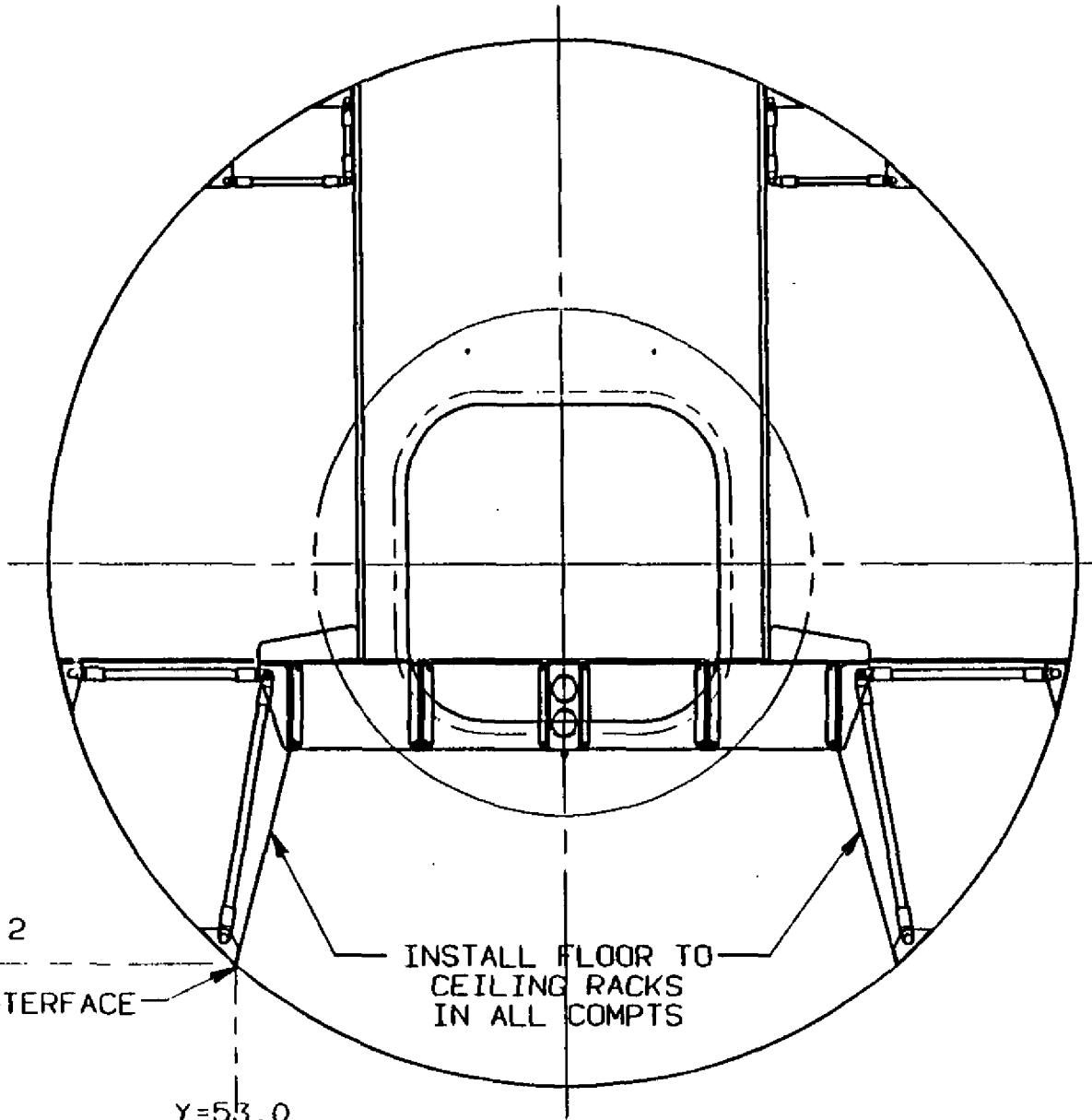
In addition to the deck stowage, side racks are installed from floor to ceiling in each compartment. These racks contain the same mounting provisions, for 19.0" modular boxes as are in the deck. The side racks pick up the WP #1 interface on the cylinder and the WP #2 interfaces on the deck.

FOUR CORNER MODULAR TRUSS CONCEPT INSTALLATION OF LOWER COMPT RACKS



12

I-30



IR&D

INSTALLATION OF WORK STATIONS & DISPLAY PANELS

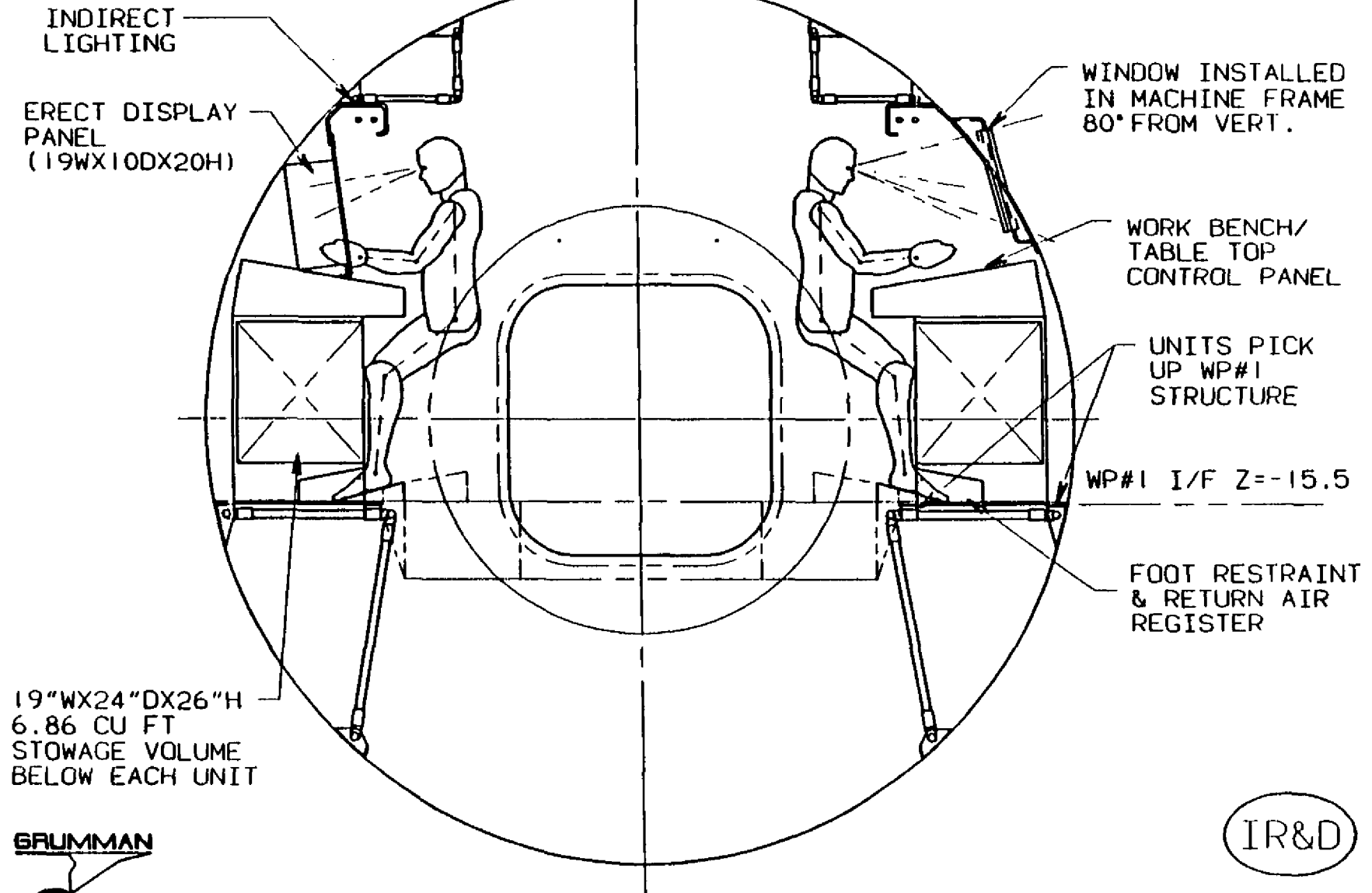
Outboard facing work stations are provided in this arrangement. The work stations shown are configured to accommodate the zero "g" body form with the foot perch in the return air register. Each work station consists of a 21.0" modular stowage unit mounted to the top surface of the lower truss structure. The width requirement of each work station determines the quantity of modular stowage units installed. The work bench table top control panel is installed on top of the stowage units. This work surface can be either 21.0" wide modules or full length units. A structural trough, containing the indirect lighting for the work station, is mounted below the upper truss structure. This assembly not only provides light but also serves as the upper mounting surface for the vertical type display panels. The lower part of the panel fastens to the table top work surface. The panel shown is 19.0" wide x 10.0" deep x 20.0" high. At those locations where a vertical panel is not installed, a machined frame with glass is installed. The flat glass is ideally located for external viewing.

FOUR CORNER MODULAR TRUSS CONCEPT INSTALL OF WORK STAS & DISPLAY PANELS



13

I-32



INSTALLATION OF TABLE & COUNTER TOP GALLEY

It should be noted that the outboard facing counter top work surfaces in the galley/wardroom area are the identical shape, & size as the work stations shown on the previous drawing. The modular stowage unit below the counter top is identical to the work station units in shape & mounting. The counter top provides a large surface for food preparation & cleanup. The top surface hinges up to gain access to the miscellaneous items stowed therein. The identical window size, shape & viewing angles are provided as shown at the work stations.

The dining table is mounted to the interstitial deck and is configured to seat six persons at one time. (On certain layouts the table has been configured to seat eight persons).

An optional overhead canteen is shown located above the table. It is supported with structure attached to the WP #1 upper truss structure.

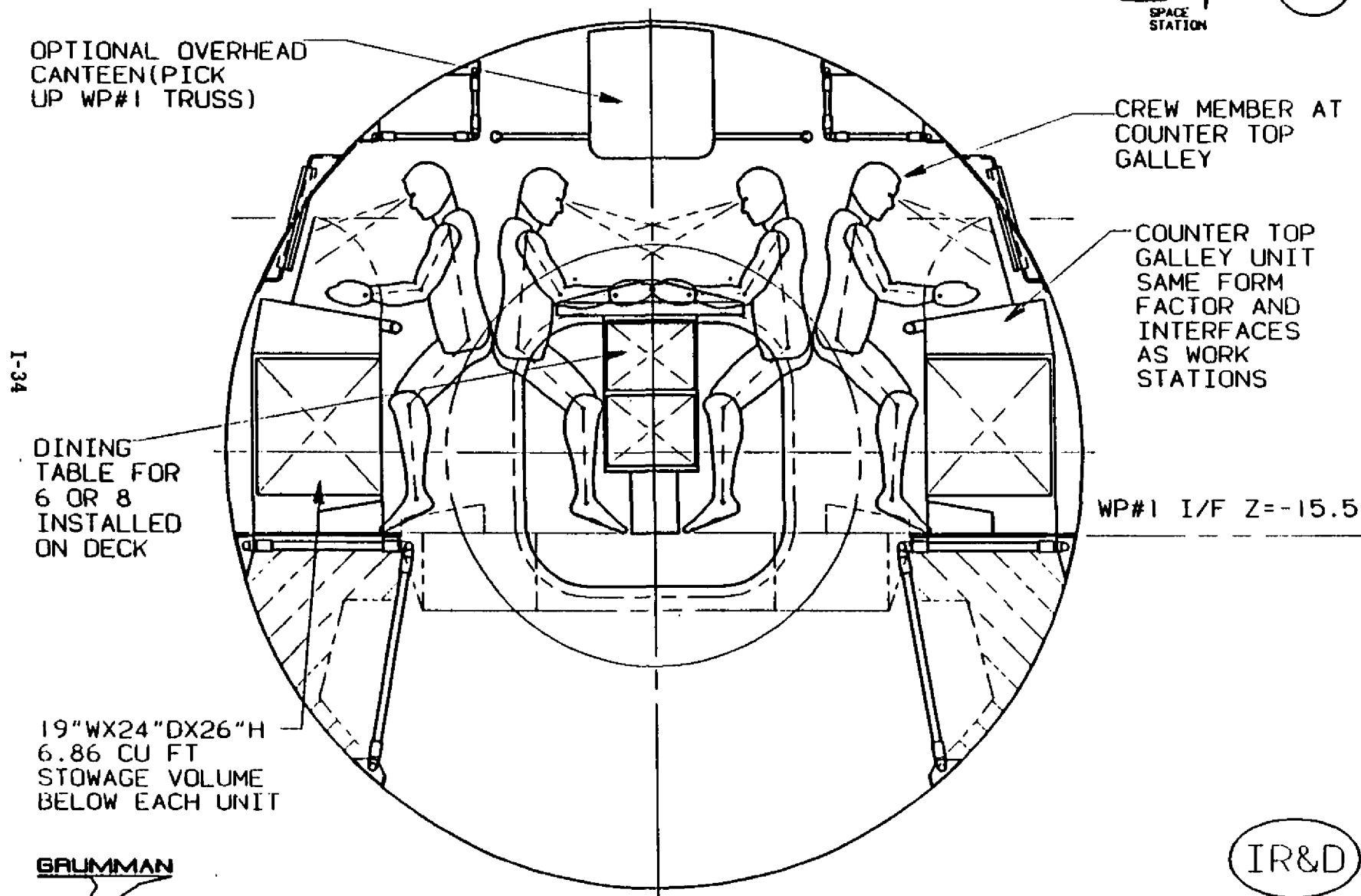
In this arrangement the crew can rotate 180° from the dining table to gain access to the food preparation/clean up areas.

The windows shown can be installed every 21.0" to provide a cluster of windows for group viewing.

FOUR CORNER MODULAR .RUSS CONCEPT INSTALL OF TABLE & COUNTER TOP GALLEY



14



GRUMMAN

IR&D

INSTALLATION OF RACK MOUNTED GALLEY UNITS

The floor to ceiling rack is configured to mount 19.0" wide modular units. The mounting surfaces are divided into three planes to provide optimum vision to the user and also to maximize the volume of the modules being installed. The lower portion of the rack will accept volumes up to 40.0" deep x 32.0" long. Units such as refrigerators, freezers, compactors, clothes washer & drier are prime candidates for this large module package. The central portion of the rack can accept many combinations of modules up to 28.0"L with various depths. This area is ideal for frequently used items such as ovens, handwasher, utilities, ambient food, etc. The upper portion of the rack can accommodate modules up to 14.0" deep x 10.0" long.

In all cases shown, a 3.0" clearance to the skin behind each mounted unit is provided.

The same racks are used to mount electronic equipment (DMS, Comm & Tracking), spares, & Miscellaneous stowage.

The entire rack with its components can be removed, if necessary, to gain access to the skin.

The configuration shown provides 48.54 cu. ft. of modular stowage/installation per every 21.0" of module length where this cross section is in effect.

FOUR CORNER MODULAR TRUSS CONCEPT INSTALL OF RACK MOUNTED GALLEY UNITS



15

RACK INSTALLED BETWEEN
WP#1 & WP#2 INTERFACES

(IDENTICAL RACK
USED FOR
ELECTRONIC
EQUIPMENT)

GALLEY UNITS
MOUNTED ON RACKS

RACKS WILL ACCEPT:

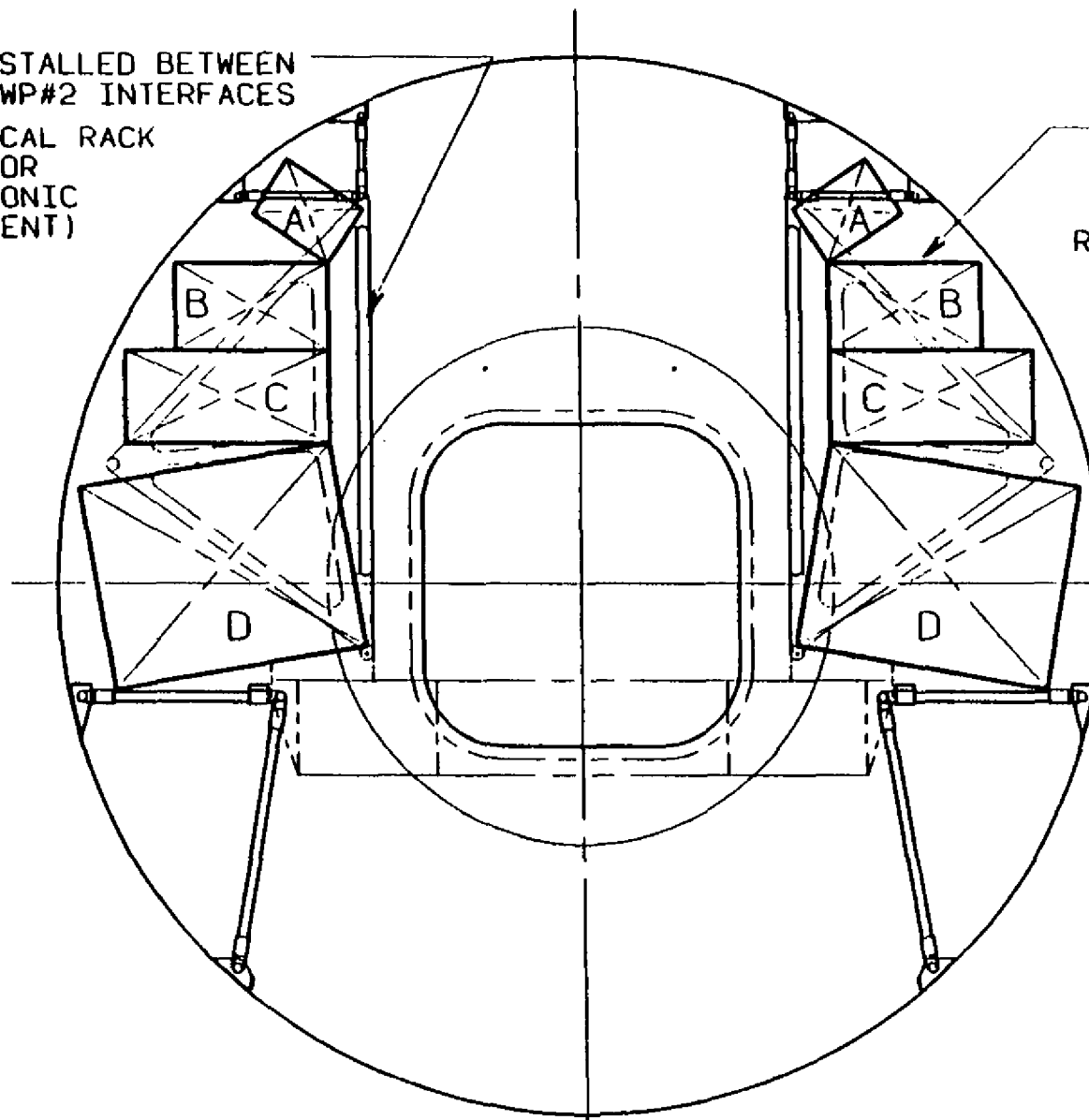
A-19WX14DX10.0L
(1.54 CU.FT.)

B-19WX24DX13.6L
(3.59 CU.FT.)

C-19WX32DX14.4L
(5.07 CU.FT.)

D-19WX40DX32.0L
(14.07 CU.FT.)

TOTAL VOLUME PER
21" OF HABITAT
MODULE LENGTH=
48.54 CU.FT.



I-36

GRUMMAN

IR&D

HEALTH MEDICAL FACILITY INSTALLATION

In this configuration the health medical facility is located below the interstitial deck. The compartment is 21.0" x 4 units long thus providing a floor to ceiling height of 84.0" (7.0'). The interstitial deck and the side racks provide 70.0 cu. ft. of stowage for 19.0" wide modular units.

A 20.0" wide examining table is mounted off the deck structure. The 32.0 square feet of open floor area provides sufficient room for two attendants working on a patient.

A single entrance is provided thru a 24.0" x 32.0" opening in the ceiling of this compartment. The single entry isolates this compartment from the normal traffic flow thus providing a quiet area for the patient.

As shown on earlier drawings, this compartment has its own air circulation system.

Windows identical to the ones in the galley, can be located in this compartment to provide recreational viewing for occupants of this room.

FOUR CORNER MODULAR RUSS CONCEPT HEALTH MEDICAL FACILITY INSTALL



16

MODULAR UNITS
INSTALLED IN
HEALTH MEDICAL
FACILITY

19WX14DX19L (24)
2.92 CU.FT EACH

TOTAL VOLUME
=70.0 CF FT

HEALTH MED
FACILITY
32.0 SQ.FT
OPEN FLOOR
AREA
216.0 CU.FT.
FREE VOLUME

20" WIDE
ADJUSTABLE
EXAMINING
TABLE

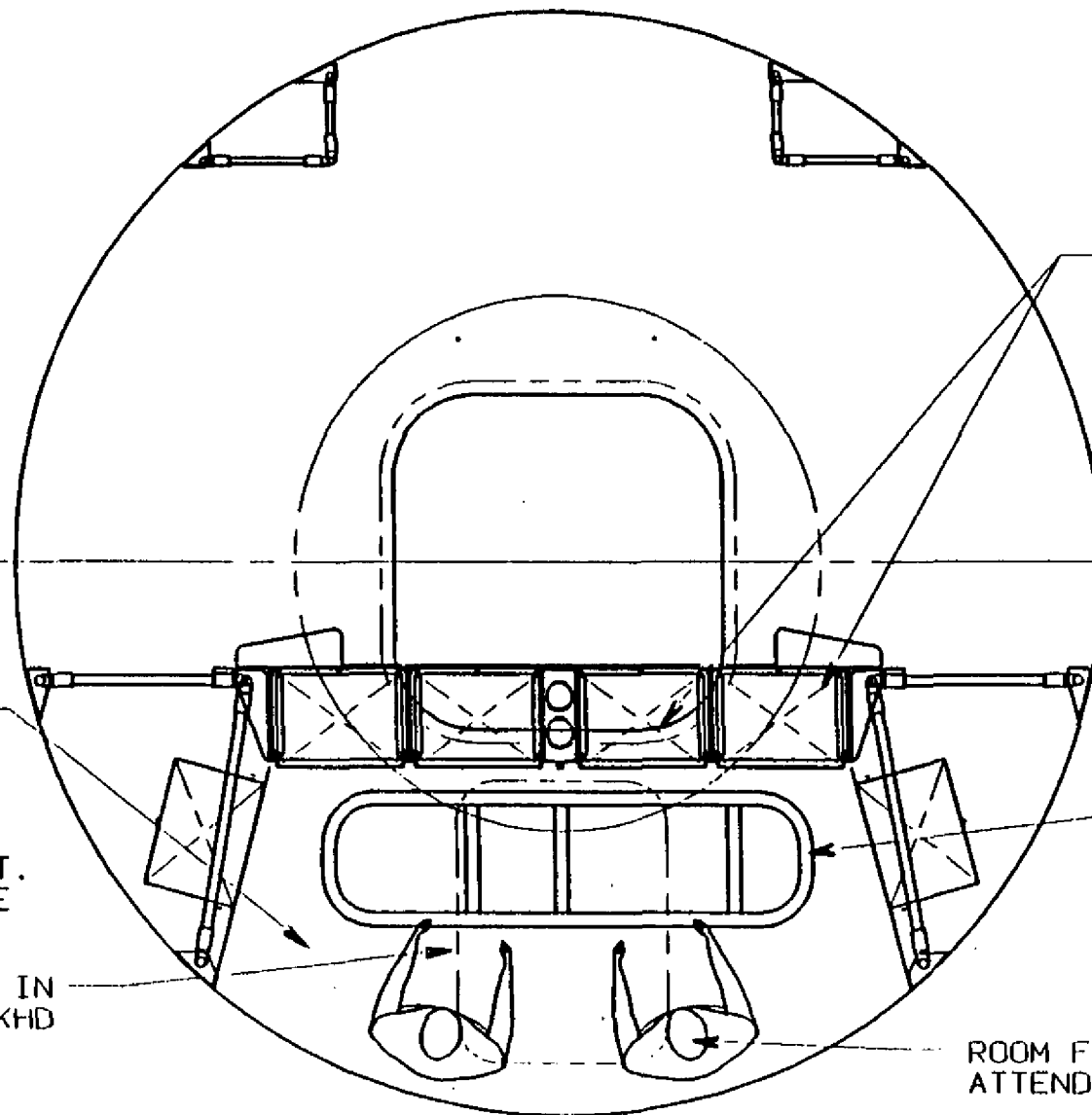
CMPT ENTRY IN
CEILING BLKHD

ROOM FOR TWO
ATTENDENTS

IR&D

GRUMMAN

I-38



HEALTH EXERCISE FACILITY INSTALLATION

The compartment shown is identical in shape & volume as the health medical facility. It provides the identical modular stowage volume and installation techniques as in the HMF. This compartment, because of its high activity, has two entry ways. One is in the floor which leads to the end cone area and the other is in the ceiling which leads to the vestibule area (described later on). The floor with its cutout for the entry way is large enough to mount two exercise devices (treadmill & ergometer shown here).

Windows can be installed in the shell to provide recreational viewing.

The 70.0" cu. ft. of stowage in this compartment is probably more than required. After the required units are installed (TV, Radio, PC computer, books, games, telephone, etc). The remaining volume can be used to supplement the miscellaneous stowage volume requirements.

FOUR CORNER MODULAR TRUSS CONCEPT HEALTH EXERCISE FACILITY INSTALL



17

MODULAR UNITS
INSTALLED IN
HEALTH MEDICAL
FACILITY

19WX14DX19L (24)
2.92 CU.FT EACH

TOTAL VOLUME
=70.0 CF FT

1-40

TREADMILL

EXERCISE
FACILITY
32.0 SQ.FT
OPEN FLOOR AREA
216.0 CU.FT.
FREE VOLUME

ERGOMETER

CMPT ENTRY THRU
OPENING IN
FLOOR BLKHD

IR&D

GRUMMAN

INSTALLATION OF EQUIPMENT IN CREW QUARTERS

The total volume and stowage provisions in this area are identical to that shown in the HMF and exercise area. However, in this case a partition dividing this volume in half is installed. The volume provides two side by side crew quarters facilities. Each compartment is provided with 35.0 cu. ft. of modular stowage in the deck and side rack. The free open volume of each quarter is 108. cu. ft.

Each compartment has its own entry way and window, air circulation and lighting system.

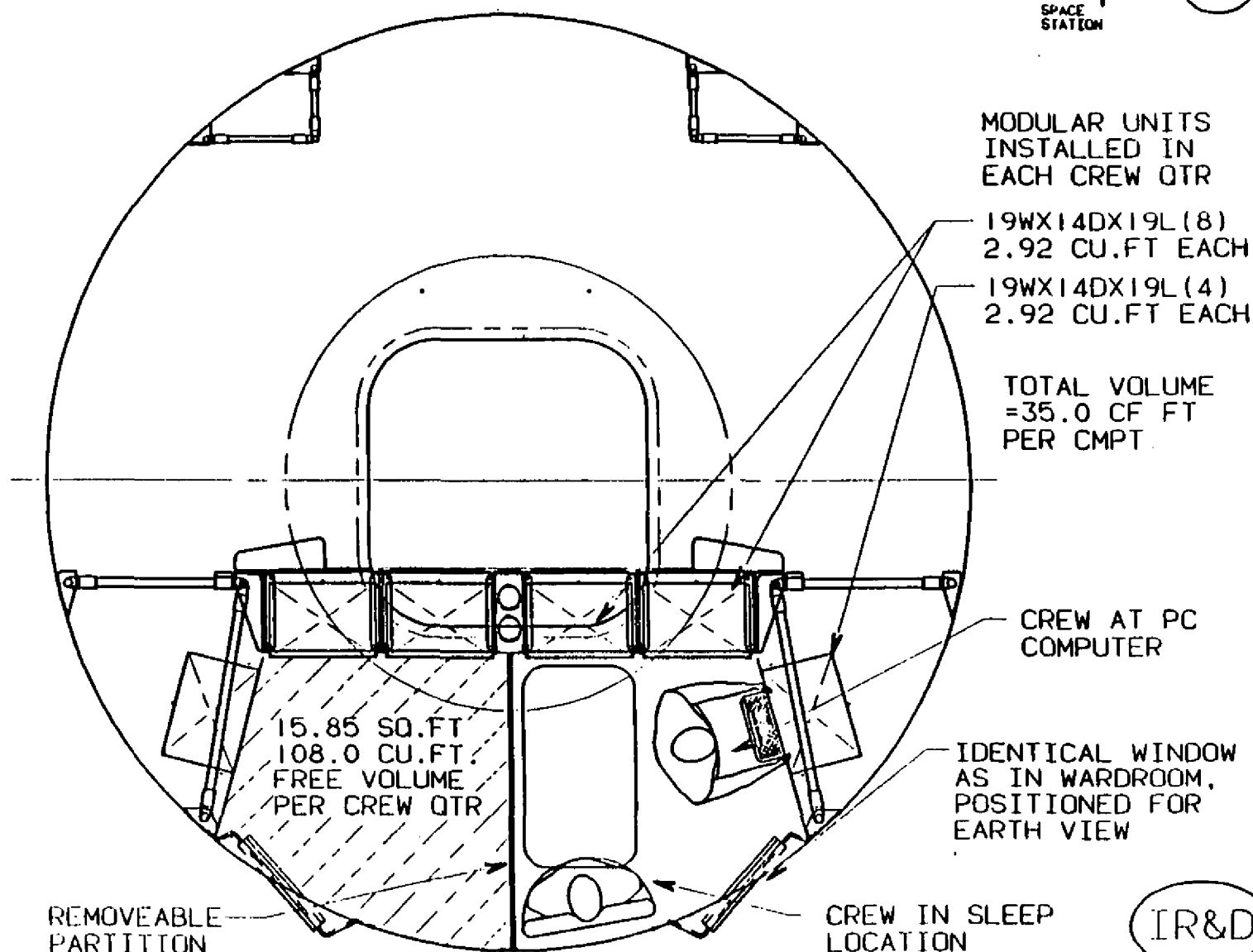
The 14.0" thick interstitial deck with all the mass of the modular stowage units should provide a high degree of noise suppression from the upper activity area. Koon has been provided between the deck floor panels and the back of the modular stowage units to add sound dampening insulation if required.

FOUR CORNER MODULAR RUSS CONCEPT INSTALL OF EQUIPT IN CREW QUARTERS



18

I-42



GRUMMAN

IR&D

WASTE COLLECTION & PERSONAL HYGIENE INSTALLATION

These compartments have been sized for one occupant at a time. The waste collection compartment consists of 3 rows of 19.0" wide modular units. The first row contains 2 stowage containers and handwash unit. The second row is the urine/fecal assembly unit and the third row contains 3 more modular stowage units. All 3 rows of units are fastened to the WP #1 lower truss structure. Below the waste collection compartment, two 10.9 cu. ft tanks are located. One is used to collect the feces & toilet paper deposited in the fecal assembly. The other tank is used to collect the urine deposited in the urine collector. Both these tanks are accessible from the vestibule area below the interstitial deck. The fecal tank can be replaced with a fresh tank when full. The urine in the other tank can be reprocessed for other uses on the Space Station.

The personal hygiene compartment has one row of units consisting of 2 stowage containers and one handwash unit. The remaining volume in the compartment houses a 32.0" I.D. x 74.0" high domed shower assembly. Two 10.9 cu. ft tanks are located below this compartment. One tank supplies the fresh water for the shower and the three handwashers in the habitat, the other tank collects the soapy water from these devices. These tanks also accessible from the vestibule area below the deck.

FOUR CORNER MODULAR RUSS CONCEPT WASTE COLLECT & PERS HYGIENE INSTALL



19

MODULAR UNITS
+HANDWASH(1)
+19WX14DX19L(1)
+19WX14DX19L(4)

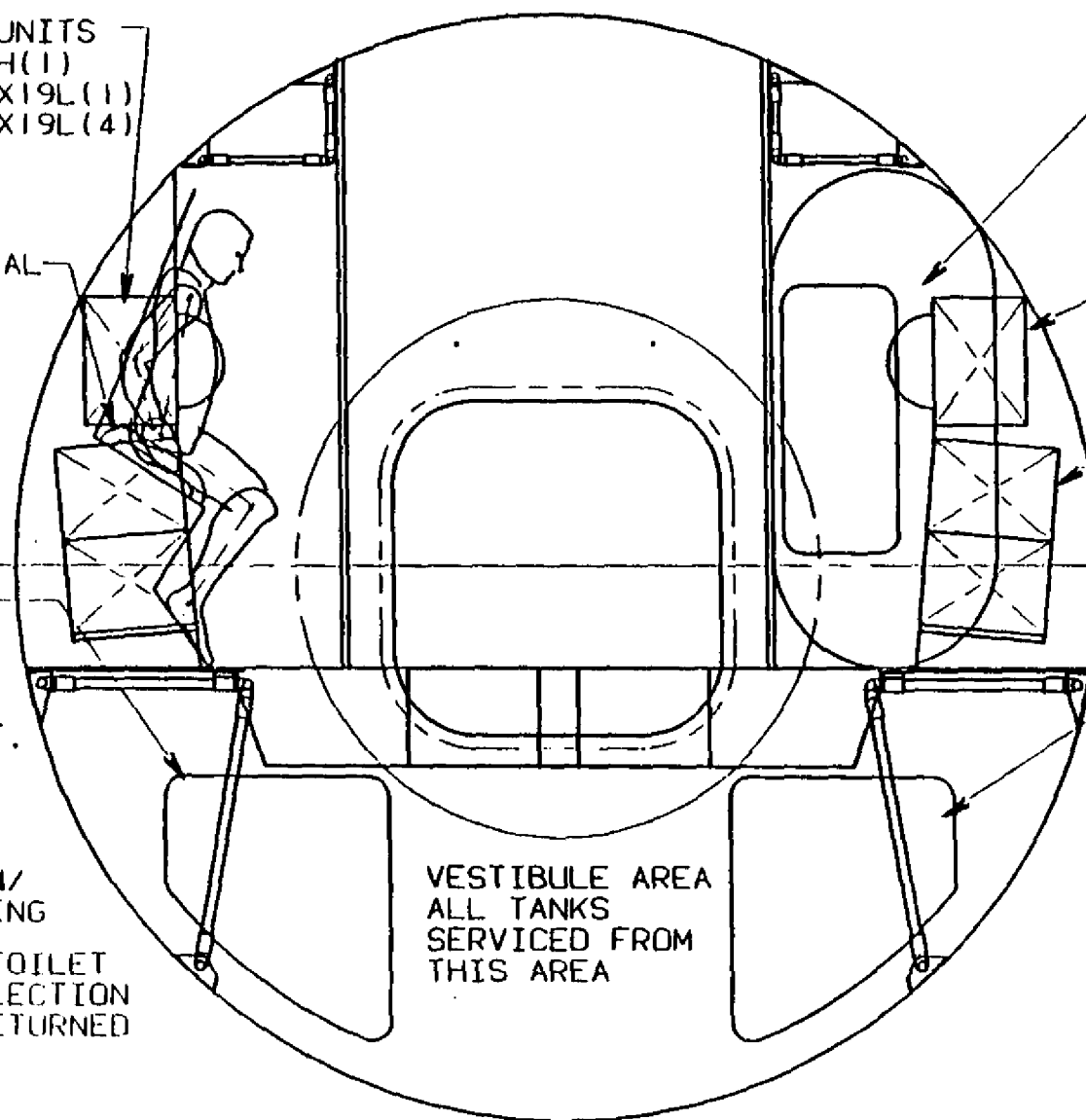
URINE/FECAL
ASSEMBLY

WASTE
PRODUCTS
COLLECTOR
TANKS(2)
10.9 CU.FT.
EACH

#B-URINE
COLLECTION/
REPROCESSING

#A-FECAL/TOILET
PAPER COLLECTION
(MODULE RETURNED
TO EARTH)

GRUMMAN



32" ID/34" OD
X74" HIGH
SHOWER
20"WX40"
HIGH DOOR

HANDWASHER
19WX14DX19L
2.92 CU.FT.

HYGIENE
STOW UNITS(2)
19WX19DX14L
5.84 CU.FT.

SHOWER WATER
TANKS (2)
10.9 CU.FT.
(80 GALS)

#C-FRESH WATER
SUPPLY
#D-COLLECTION/
REPROCESSING
TANK

IR&D

CREW SIZE VERSUS MODULE LENGTH

Arrangement A1 (0 x 6), shown on the left, represents the minimum length module required to house a crew of six in two modules. Habitat #1 represents the "active" module and Habitat #2 depicts the "quiet" module where all six crew persons sleep. The module cylinder length is predicated on 18 incremental lengths of 21.0" (378"). It can be seen that this arrangement produces volumes at either end of the cylinder for the ECLSS, safe haven, and power/thermal modular unit. In between, 3 seven foot long compartments and a 42" vestibule are provided below the deck. The functions of each compartment is noted on the drawing.

Above the deck 14 incremental lengths of 21.0" are provided for the crew functional hardware & utilities required for a habitat. The letters below the plan view (A-6) represent the cross sections of this arrangement at each incremental length. These cross sections are shown in simplified fashion on the next four (4) pages of drawings. The incremental scheme shown lends itself to re-arrangements & updating.

Four (4) windows are shown in sections M-M & N-N in the galley/wardroom area. Similar windows are duplicated in sections 1-1 & 2-2 in Habitat #2.

This arrangement provides a generous central aisle and a clear path between connecting modules.

Other arrangements of habitats are shown on subsequent drawings.

FOUR CORNER MODULA.. TRUSS CONCEPT CREW SIZE VERSUS MODULE LENGTH



20

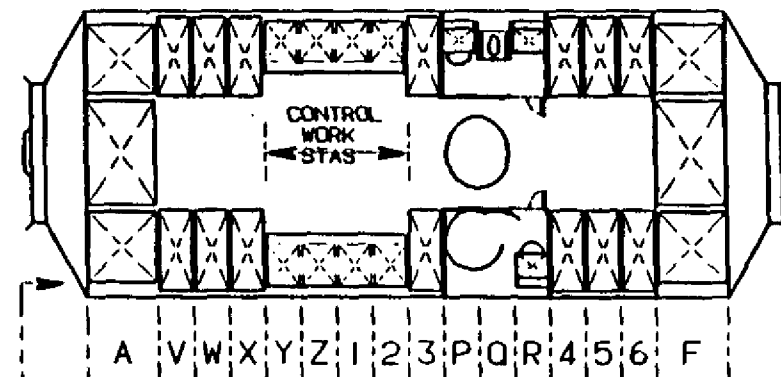
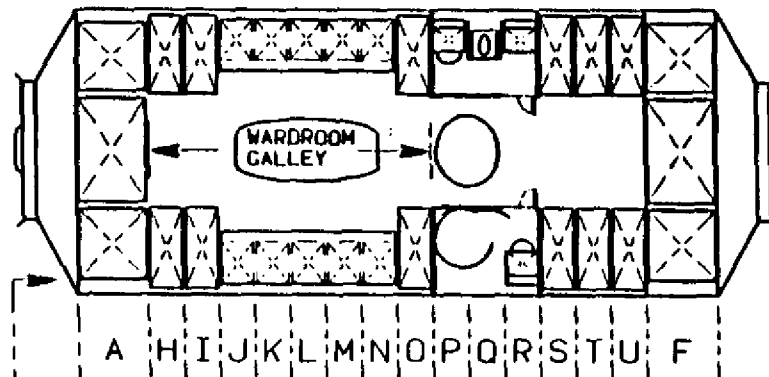
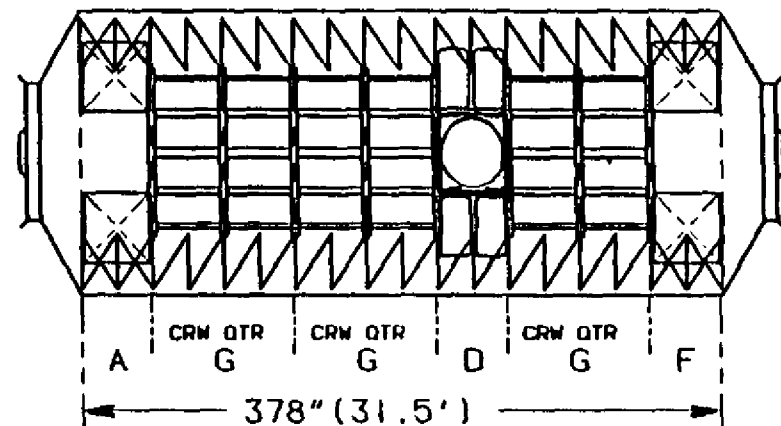
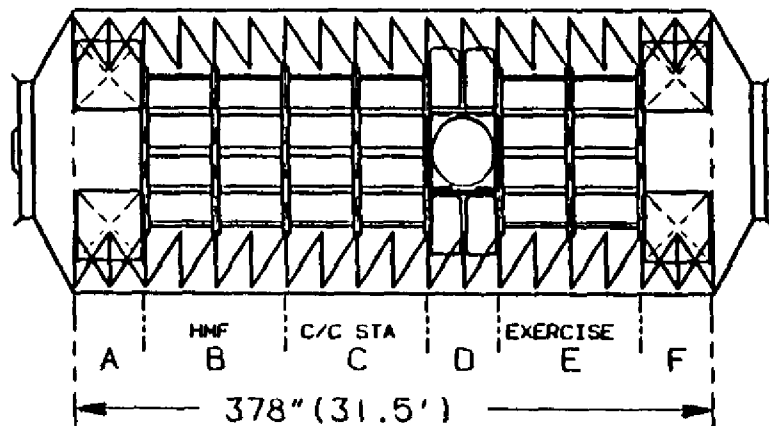
ARRANGEMENT A1 - 0 X 6

CREW SIZE = 6

LAYOUT 751B-B3A-110 HABITAT MODULE #1

LAYOUT 751B-B3A-210 HABITAT MODULE #2

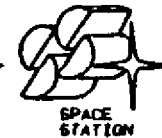
1-46



GRUMMAN

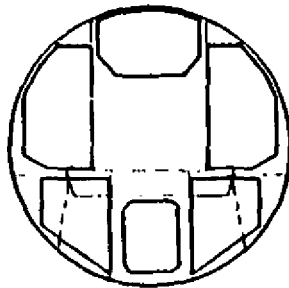
IR&D

FOUR CORNER MODULAR TRUSS CONCEPT CONFIG A1(0-6) HAB#1 CROSS SECTIONS

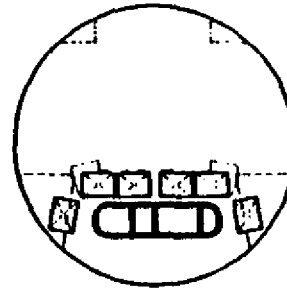


21

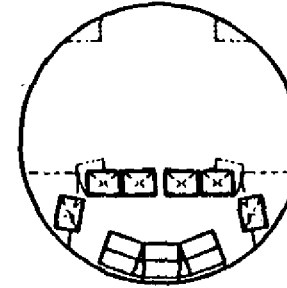
CROSS SECTIONS SHOWING LOWER
LEVEL CONFIGURATION



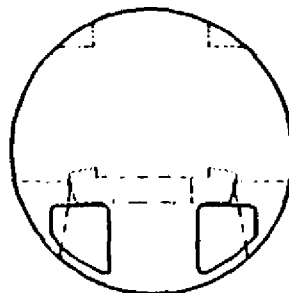
SECT A-A



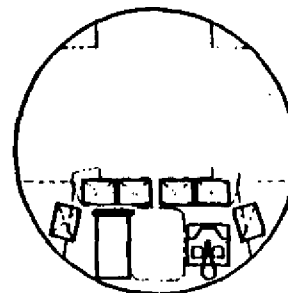
SECT B-B



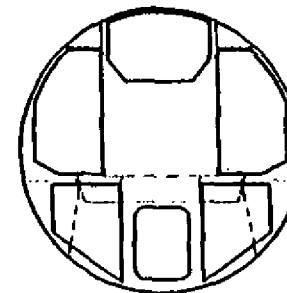
SECT C-C



SECT D-D



SECT E-E



SECT F-F

I-47



DRAWING 751B-B3A-110

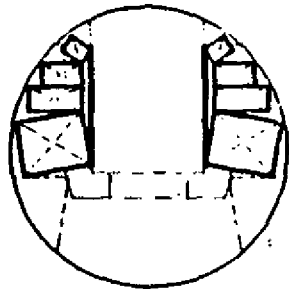
IR&D

FOUR CORNER MODULAR TRUSS CONCEPT CONFIG A1(0-6) HAB#1 CROSS SECTIONS

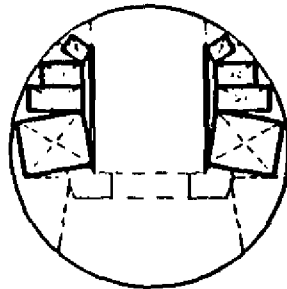


22

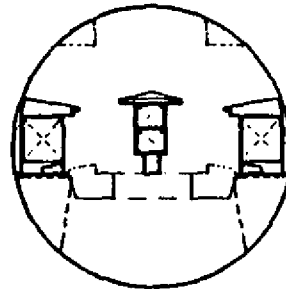
CROSS SECTIONS SHOWING UPPER
LEVEL CONFIGURATION



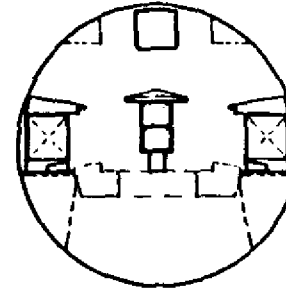
SECT H-H



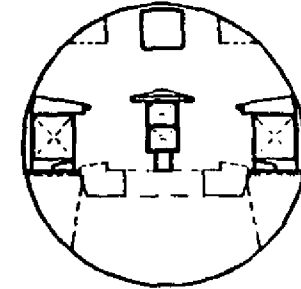
SECT I-I



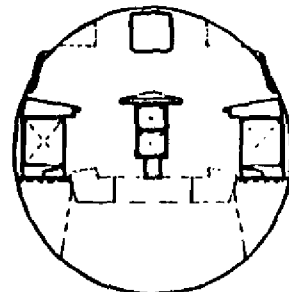
SECT J-J



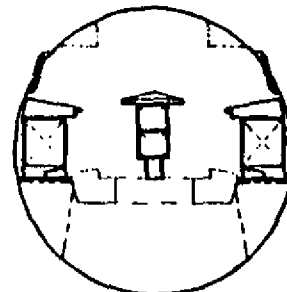
SECT K-K



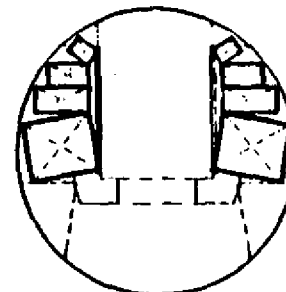
SECT L-L



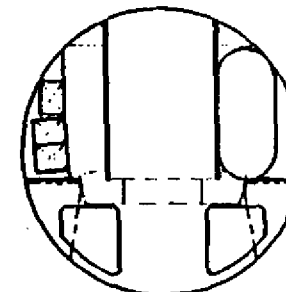
SECT M-M



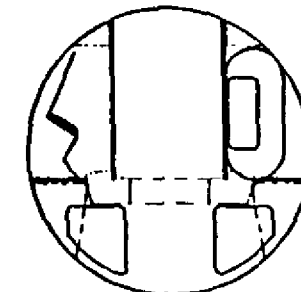
SECT N-N



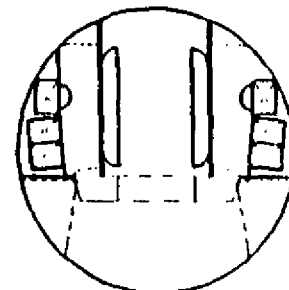
SECT O-O



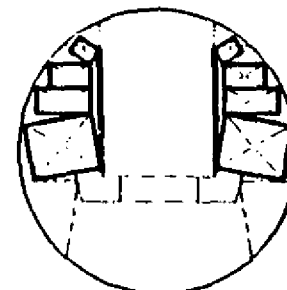
SECT P-P



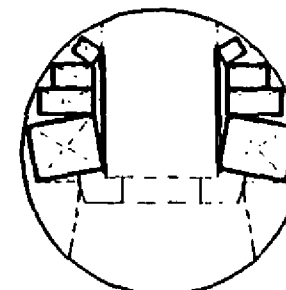
SECT Q-Q



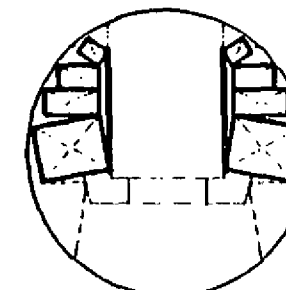
SECT R-R



SECT S-S



SECT T-T



SECT U-U

I-48



IR&D

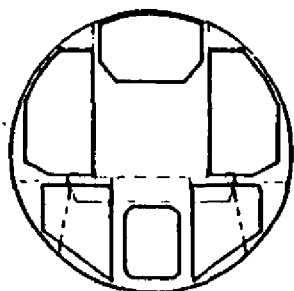
DRAWING 751B-B3A-110

FOUR CORNER MODULAR TRUSS CONCEPT
CONFIG A: (0-6) HAB#2 CROSS SECTIONS

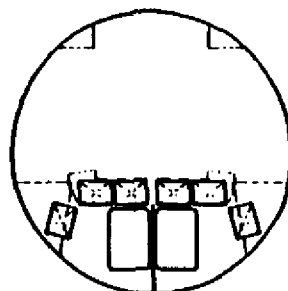


23

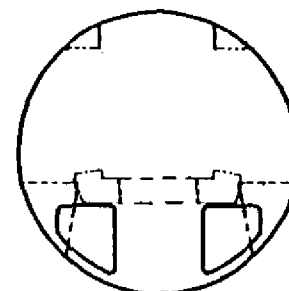
CROSS SECTIONS SHOWING LOWER
LEVEL CONFIGURATION



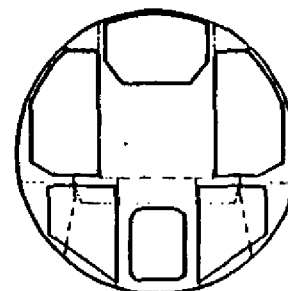
SECT A-A



SECT G-G



SECT D-D



SECT F-F

I-49



DRAWING 751B-B3A-210

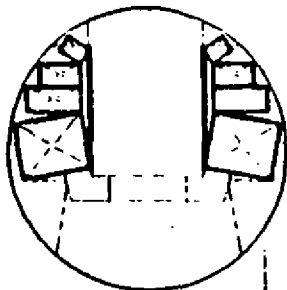
IR&D

FOUR CORNER MODULAR TRUSS CONCEPT CONFIG A1(0-6) HAB#2 CROSS SECTIONS

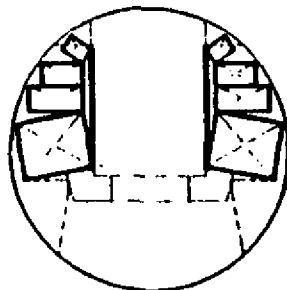


24

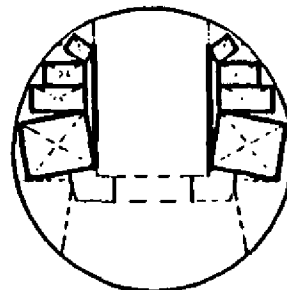
CROSS SECTIONS SHOWING UPPER
LEVEL CONFIGURATION



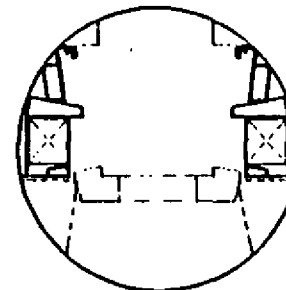
SECT V-V



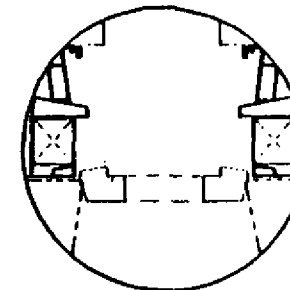
SECT W-W



SECT X-X

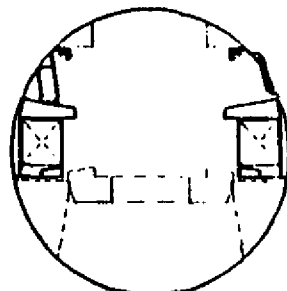


SECT Y-Y

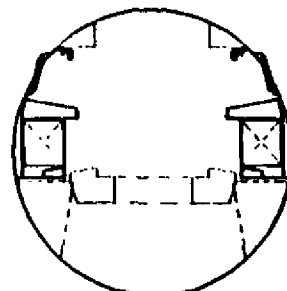


SECT Z-Z

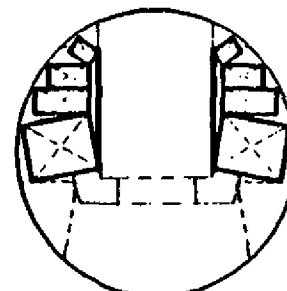
I-50



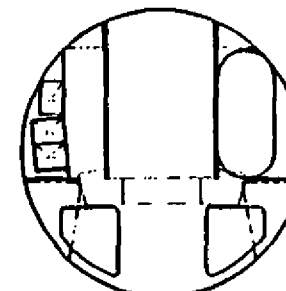
SECT I-I



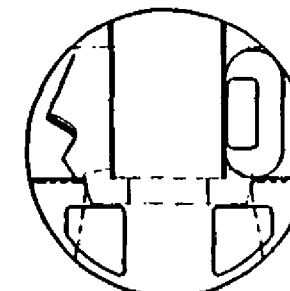
SECT 2-2



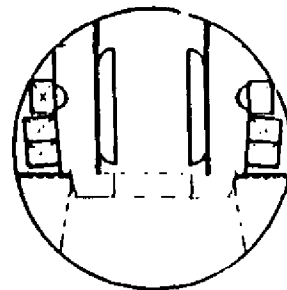
SECT 3-3



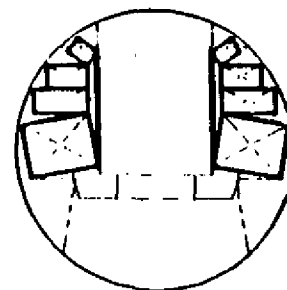
SECT P-P



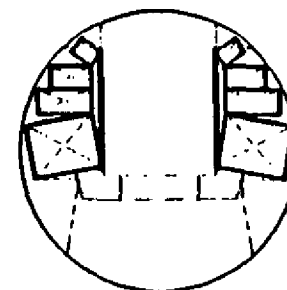
SECT Q-Q



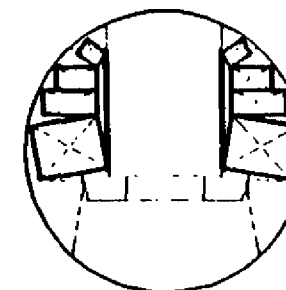
SECT R-R



SECT 4-4



SECT 5-5



SECT 6-6



IR&D

DRAWING 751B-B3A-210

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

The following twelve (12) pages list the quantity, sizes & volumes of all facilities, equipment & stowage containers located in configuration A1. The facilities have been grouped into nine (9) basic areas, they are:

- 1 - Galley/Wardroom
- 2 - Crew Quarters
- 3 - Health Maintenance Facility
- 4 - Health Exercise Facility
- 5 - Personal Hygiene Facility
- 6 - Waste Collection Facility
- 7 - Work Stations
- 8 - Equipment
- 9 - Miscellaneous Stowage

The column labeled "sect ltr" depicts which section letter(s) on the preceeding five (5) drawings show where each piece of hardware is located. It should be noted that all stowage/equipment hardware has a 19.0" W dimension, denoting that they are rack mounted units. The variation in D (depth) and L/H (Length/Height) dimensions have been minimized for the sake of commonality. In this fashion the logistics module mounting pattern can be optimized for bringing up this equipment.

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A1 (0-6) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 21
 LAYOUT NO. 751B-B3A-110 & -210 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION (")			UNIT VOL (C.F.T.)	QTY	TOTAL VOL (C.F.T.)	REMARKS
	#1	#2		W	D	L/H				
2-CREW QUARTERS	-	X	G							VOL PER CREW QTR-SEE SECT G-G, PG 23
•DECK UNITS										
-CREW STOW UNITS				19.0	14.0	19.0	2.92	7	20.44	UNITS RETURNED TO EARTH WITH CREW
-TV/PC COMP				19.0	14.0	19.0	2.92	1	2.92	SINGLE UNIT-KEY BOARD NOT SHOWN
-DESK (FOLDING)										NOT SHOWN AT THIS TIME
•SIDE UNITS										
-CREW STOW UNITS				19.0	14.0	19.0	2.92	4	11.68	STACKED FROM FLOOR TO CEILING
-SLEEP BAG				20.0	2.0	73.0				CAN BE REPOSITIONED OR STOWED
-BULLETIN BOARD										NOT SHOWN AT THIS TIME
-WINDOW								1		WINDOW IN EACH CREW QUARTER
•FACILITY VOL SUM										
-MODULAR UNITS								11	32.12	
-MISC VOLS								1	2.92	
-STR/MISC										
-FREE VOLUME									108.00	24W X36L ENTRANCEWAY INTO EACH QTR
-TOTAL VOL									143.04	TOTAL FOR EACH CREW QTR-6 SHOWN

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A1 (0-6) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 23
 LAYOUT NO. 751B-B3A-110 & -210 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION (")			UNIT VOL (C. FT)	QTY	TOTAL VOL (C. FT)	REMARKS
	#1	#2		W	D	L/H				
3-HEALTH MAINT FACIL	X	-	B							SEE PG 20 & SECT B-B ON PG 21
•DECK UNITS				19.0	14.0	19.0	2.92	16	46.72	MODULAR UNITS-FLOOR TO CEILING
-MED MOD UNITS										
•SIDE UNITS										
-MED MOD UNITS				19.0	14.0	19.0	2.92	8	23.36	MODULAR UNITS-FLOOR TO CEILING
•MISC ITEMS										
-EXAM TABLE				20.0				1		INCLUDED IN FREE VOLUME TOTAL
-WINDOW								2		2 WINDOWS IN HWF COMPARTMENT
•FACILITY VOL SUM										
-MODULAR UNITS								24	70.08	
-MISC VOLS										
-STR/MISC										
-FREE VOLUME									216.00	32W X 42L ENTRANCEWAY INTO COMPT
-TOTAL VOL									286.08	

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A1 (0-6) HAB #1 & #2 -31.5' CYLINDER

SHEET NO. 69

LAYOUT NO. 751B-B3A-110 & -210 DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION (")			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
	#1	#2		W	D	L/H				
4-HEALTH EXER FACIL	X	-	E							SEE PG 20 & SECT E-E ON PG 21
•DECK UNITS										
-MOD STOW UNITS				19.0	14.0	19.0	2.92	(6)	(17.52)	
-TV/PC COMP				19.0	14.0	19.0	2.92	2	5.84	
-SPEAKERS				19.0	14.0	19.0	2.92	2	5.84	
-BOOK UNITS				19.0	14.0	19.0	2.92	6	17.52	
•SIDE UNITS										
-MOD STOW UNITS				19.0	14.0	19.0	2.92	(8)	(23.36)	
•MISC ITEMS										
-ERGOMETER				24.0	36.0	48.0		1	24.00	SHOWN AS FIXED EQUIP IN FREE VOLUME
-TREADMILL				24.0	48.0	60.0		1	40.00	SHOWN AS FIXED EQUIP IN FREE VOLUME
•FACILITY VOL SUM										
-MODULAR UNITS								(14)	(40.88)	LISTED ON PG 35 AS MISC STOWAGE
-MISC VOLS								10	29.20	
-EQUIPMENT									(64.00)	FIXED UNITS PART OF FREE VOLUME
-STR/MISC										
-FREE VOLUME									216.00	TWO ENTRANCEWAYS INTO THIS COMPT
-TOTAL VOL									245.20	

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A1 (0-6) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 30
 LAYOUT NO. 751B-B3A-110 & -210 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION(")			UNIT VOL (C.F.T)	QTY	TOTAL VOL (C.F.T)	REMARKS
	#1	#2		W	D	L/H				
5-PERS HYGIENE FAC	X	X	P-R							SEE PG 20 & SECT P-P.Q-Q,R-R, ON PG 22
•MODULAR UNITS										VALUES ARE PER HYGIENE FACILITY
-GENERAL STOW			R	19.0	19.0	14.0	2.92	2	5.84	
-HAND WASH			R	19.0	14.0	19.0	2.92	1	2.92	
•SHOWER			P,Q	34 OD	----	74.0	32.0	1	32.0	DOMED ON BOTH ENDS-20" WIDE DOOR
•MISCELLANEOUS										
-WATER SUP TANK			D	19.0	34.0	----	10.9	1	10.9	APPROX 80 GALS OF WATER
-WATER COL TANK			D	19.0	34.0	----	10.9	1	10.9	APPROX 80 GALS OF WATER
•FACILITY VOL SUM										VALUES ARE FOR 2 HYGIENE FACILITIES
-MODULAR UNITS								6	17.52	
-MISC VOLS								4	43.6	
-SHOWER								2	64.0	
-STR/MISC										
-FREE VOLUME									28.0	(VOLUME PER FACILITY)
-TOTAL VOL									300.54	(HYG CMPT=256.94 CF, TANKS=43.6 CF)

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HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A1 (0-6) HAB #1 & #2 -31.5' CYLINDER

SHEET NO. 51

LAYOUT NO. 751B-B3A-110 & -210 DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION (")			UNIT VOL (C.F.T.)	QTY	TOTAL VOL (C.F.T.)	REMARKS
	#1	#2		W	D	L/H				
6-WASTE COLL FAC	X	X	P-R							SEE PG 20 & SECT R-R.S-S.T-T.ON PG 22
*MODULAR UNITS										VALUES ARE PER WC FACILITY
-GENERAL STOW			P	19.0	19.0	14.0	2.92	2	5.84	
-HAND WASH			P	19.0	14.0	19.0	2.92	1	2.92	
-GENERAL STOW			R	19.0	19.0	14.0	2.92	2	5.84	
-GENERAL STOW			R	19.0	14.0	19.0	2.92	1	2.92	
*MISCELLANEOUS										
-URINE/FECAL COL			D	19.0	----	----	12.6	1	12.6	SHAPED FOR ZERO G OCCUPANTS
-FECAL COLL MOD			D	19.0	34.0	----	10.9	1	10.9	REMOVABLE UNIT-RETURN TO EARTH
-URINE COLL MOD			D	19.0	34.0	----	10.9	1	10.9	CAN BE USED TO REPROCESS WATER
*FACILITY VOL SUM										VALUES ARE FOR TWO WC FACILITIES
-MODULAR UNITS								12	35.04	
-URINE/FECAL COL								2	25.2	
-MISC VOLS								4	43.6	(TANKS LOCATED BELOW DECK)
-STR/MISC										
-FREE VOLUME									61.5	(VALUE PER COMPARTMENT)
-TOTAL VOL									300.54	(WC CMPT=256.94 CF, TANKS=43.9 CF)

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A1 (0-6) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 02
 LAYOUT NO. 751B-B3A-110 & -210 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION(")			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
	#1	#2		W	D	L/H				
7-WORK STATIONS										
•OPS CONTROL STA	X	-	C							SEE PG 20 & SECT C-C ON PG 21
-VERT DISP PNLS			C	19.0	10.0	20.0	2.2	2	4.40	ONE VIEWING WINDOW PROVIDED
-HORIZ CNTL PNLS			C	19.0	6.0	10.0	0.7	2	1.40	
-HORIZ CNTL PNLS			C	19.0	6.0	30.0	2.0	1	2.00	
-MOD STOW UNIT			C	19.0	24.0	26.0	6.86	3	20.58	
-DECK MOD UNITS				19.0	14.0	19.0	2.92	16	146.72	LISTED ON PAGE 35 AS MISC STW VOL
-SIDE MOD UNITS				19.0	14.0	19.0	2.92	8	23.36	LISTED ON PAGE 35 AS MISC STW VOL
•PAYLOAD OPS STA	-	X								
-VERT DISP PNLS			Y-1	19.0	10.0	20.0	2.2	3	6.60	ONE VIEWING WINDOW PROVIDED
-HORIZ CNTL PNLS			Y-1	19.0	6.0	10.0	0.7	3	2.10	
-HORIZ CNTL PNLS			2	19.0	6.0	30.0	2.0	1	4.00	
-MOD STOW UNIT			Y-2	19.0	24.0	26.0	6.86	4	27.44	
•MTN/REPAIR STA	-	X								
-VERT DISP PNLS			Y,Z	19.0	10.0	20.0	2.2	2	4.40	TWO VIEWING WINDOWS PROVIDED
-HORIZ CNTL PNLS			Y,Z	19.0	6.0	10.0	0.7	2	1.40	
-WORK BENCH			1,2	42.0	----	30.0	5.8	1	5.80	
-MOD STOW UNIT			Y-2	19.0	24.0	26.0	6.86	4	27.44	
•FACILITY VOL SUM										
-MOD UNITS-HAB#1								3	20.58	
-MOD UNITS-HAB#2								8	54.88	
-MISC VOLS										
-TOTAL VOL										

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A1 (0-6) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 33
 LAYOUT NO. 751B-B3A-110 & -210 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION (")			UNIT VOL (C. FT)	QTY	TOTAL VOL (C. FT)	REMARKS
	#1	#2		W	D	L/H				
8-EQUIPMENT										
•ECLSS			A,F							MOD REMOVABLE/REPLACEABLE UNITS
-MOD UNIT #1	X		A,F	40.0	40.0	----	50.0	2	100.0	
-MOD UNIT #2	X		A,F	40.0	40.0	----	59.0	2	118.0	
-MOD UNIT #3	X		A,F	40.0	40.0	----	59.0	2	118.0	
-SUB TOTAL ()								(6)	(336.0)	IDENTICAL INSTALL IN HAB #1 & #2
-MOD UNIT #1		X	A,F	40.0	40.0	----	50.0	2	100.0	
-MOD UNIT #2		X	A,F	40.0	40.0	----	59.0	2	118.0	
-MOD UNIT #3		X	A,F	40.0	40.0	----	59.0	2	118.0	
-SUB TOTAL ()								(6)	(336.0)	
•DATA MGMT										MODULAR RACK MOUNTED UNITS
-MOD UNIT #1	X		S	19.0	14.0	10.0	1.54	1	1.54	
-MOD UNIT #2	X		S	19.0	24.0	13.6	3.59	1	3.59	
-MOD UNIT #3	X		S	19.0	32.0	14.4	5.07	1	5.07	
-MOD UNIT #4	X		S	19.0	40.0	32.0	14.07	1	14.07	
-SUB TOTAL ()								(4)	(24.27)	
-MOD UNIT #1		X	4	19.0	14.0	10.0	1.54	1	1.54	
-MOD UNIT #2		X	4	19.0	24.0	13.6	3.59	1	3.59	
-MOD UNIT #3		X	4	19.0	32.0	14.4	5.07	1	5.07	
-MOD UNIT #4		X	4	19.0	40.0	32.0	14.07	1	14.07	
-MOD UNIT #1		X	5	19.0	14.0	10.0	1.54	2	3.08	
-MOD UNIT #2		X	5	19.0	24.0	13.6	3.59	2	7.18	
-MOD UNIT #3		X	5	19.0	32.0	14.4	5.07	2	10.14	
-MOD UNIT #4		X	5	19.0	40.0	32.0	14.07	2	28.14	
-SUB TOTAL ()								(12)	(72.81)	

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A1 (0-6) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 34
LAYOUT NO. 751B-B3A-110 & -210 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION (")			UNIT VOL (C. FT)	QTY	TOTAL VOL (C. FT)	REMARKS
	#1	#2		W	D	L/H				
8-EQUIPMENT (CONTD)										
•COMM/TRACKING										MODULAR RACK MOUNTED UNITS
-MOD UNIT #1	X		S	19.0	14.0	10.0	1.54	1	1.54	
-MOD UNIT #2	X		S	19.0	24.0	13.6	3.59	1	3.59	
-MOD UNIT #3	X		S	19.0	32.0	14.4	5.07	1	5.07	
-MOD UNIT #4	X		S	19.0	40.0	32.0	14.07	1	14.07	
-SUB TOTAL ()								(4)	(24.27)	
-MOD UNIT #1		X	4	19.0	14.0	10.0	1.54	1	1.54	
-MOD UNIT #2		X	4	19.0	24.0	13.6	3.59	1	3.59	
-MOD UNIT #3		X	4	19.0	32.0	14.4	5.07	1	5.07	
-MOD UNIT #4		X	4	19.0	40.0	32.0	14.07	1	14.07	
-SUB TOTAL ()								(4)	(24.27)	
•POWER/THERMAL	X		F	40.0	40.0	----	40.0	2	80.0	MODULAR RACK MOUNTED UNITS
•POWER/THERMAL		X	F	40.0	40.0	----	40.0	2	80.0	MODULAR RACK MOUNTED UNITS
•SAFE HAVEN PROV	X		A	40.0	40.0	----	40.0	2	80.0	
•SAFE HAVEN PROV		X	A	40.0	40.0	----	40.0	2	80.0	
•CLOTHES WASHER		X	3	19.0	40.0	32.0	14.07	1	14.07	FRONT LOADED UNIT
•CLOTHES DRIER		X	3	19.0	40.0	32.0	14.07	1	14.07	FRONT LOADED UNIT
•OXYGEN MASKS	X		U	19.0	14.0	10.0	1.54	2	3.08	
•OXYGEN MASKS	X		U	19.0	24.0	13.6	3.59	2	7.18	
•OXYGEN MASKS		X	6	19.0	14.0	10.0	1.54	2	3.18	
•OXYGEN MASKS		X	6	19.0	24.0	13.6	3.59	2	7.18	

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A1 (0-6) HAB #1 & #2 -3.5' CYLINDER

SHEET NO. 5

LAYOUT NO. 751B-B3A-110 &-210 DESIGN ENGR: GENE W. HARMS

DATE: _____

[illegible]

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFUGRATION: A1 (0-6) HAB #1 & #2 -3.5' CYLINDER

SHEET NO. 56

LAYOUT NO. 751B-B3A-110 &-210 DESIGN ENGR: GENE W. HARMS

DATE:

[illegible]

HABITAT EQUIPMENT & STOWAGE VOLUME DATA SUMMARY SHEET

This chart summarizes the information contained on the preceeding twelve (12) pages. The nine(9) basic habitat functional areas are listed on the left with a listing of NASA's baesline requirements for each module noted.

The galley/wardroom shown exceeds NASA's requirements, except for vegetable bulk stowage. Only 27 cu. ft. is provided in this configuration, it is assumed the remaining 90 day supply can be left in the logistics module until required onboard the habitat. The galley shown provides two (2) regrigerators & freezers, to cover the situation where one unit fails. Two (2) compactors are provided to optimize the waste collection system. Since two (2) compactors are provided the volume for simple trash stowage was reduced.

The crew quarters are identical in shape, size & furnishings provisions. A total of 35.0 cu. ft. of equipment/stowage volume has been provided for each crew quarter, exceeding NASA's requirements by 40%.

The health maintenance & health exercise facilities have been shown as two separate compartments, rather than one as shown in NASA's reference configuration. In addition the exercise devices are shown as fixed units, rather than fold-up stowable units. These facilities are shown in separate modules.

The personal hygiene & waste collection facilities are shown as two separate compartments rather than one connected compartment. Four collection/service tanks are located below thus facilities thus minimizing pipe runs to the units being serviced. The stowage volumes in each compartment equal or exceed NASA's requirements.

The three work stations shown provide a full complement of vertical & horizontal display/control panels, external viewing windows, long work bench surface areas, and large stowage volumes below each work station. The modular concept produces identical geometries for each work station.

The equipment volumes shown are all modular units. The ECLSS, power/thermal and safe haven provisions have 40.0" x 40.0" cross sections and are readily accessible for service or replacement. The remaining equipment are all 19.0" wide rack mounted units.

Miscellaneous stowage volumes are a combination of rack mounted units and those areas inside the dining table and counter top galley work areas.

The utilities volume represents the four areas within the upper & lower truss structures set aside for the routing of all WP #1 & WP #2 utilities.

The total volumes shown for this arrangement have been calculated on well defined form factors for each element in the habitats. Each volume form factor listed has been shown mounted to realistic secondary support structure. The totals listed for each habitat exceed NASA's requirement by a considcrable amount.

HABITAT EQUIPMENT AND STOWAGE VOLUME DATA SUMMARY SHEET

CONFIGURATION: AI (0-6) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 7
 LAYOUT NO. 751B-B3A-110 & -210 DESIGN ENGR: GENE W. HARMS DATE: _____

FACILITY/EQUIPMENT	NASA BASELINE		CONFIG AI TOTALS		REMARKS	Δ	
	HAB#1	HAB#2	HAB#1	HAB#2		HAB#1	HAB#2
1-WARDROOM/GALLEY							
+MODULAR UNITS	108.0	-----	159.34	-----	SOME REDUNDANCY OF UNITS PROVIDED	+51.34	----
+VEG BULK STOWAGE	117.3	-----	27.44	-----	EXCESS VEG STOWED IN LOGISTICS MODULE	-89.86	----
+STOWAGE CONTAIN	20.0	-----	27.44	-----		+ 7.44	----
2-CREW QUARTERS(6)	-----	150.0	-----	210.24	35.04 CU.FT. PER QTR PROVIDED	----	+60.24
3-HEALTH MAINT FACIL	88.0	-----	70.08	-----	COULD USE VOL IN EXER FACILITY	-17.92	----
4-HEALTH EXER FACIL	64.0	-----	93.20	-----	NASA UNIT FOLD-UP, FIXED UNITS SHWN HERE	+29.20	----
5-PERS HYGIENE FACIL	7.0	7.0	30.56	30.56	INCLUDES 21.8 CF OF WATER TANKS	+23.56	+23.56
6-WASTE COLL FACIL	7.0	7.0	39.32	39.32	INCLUDES 21.8 CF OF COLLECTION TANKS	+32.32	+32.32
7-OPS CONTROL STA	20.0	-----	28.38	-----		+ 8.38	----
7-PAYLOAD OPS STA	-----	39.0	-----	40.14		----	+ 1.14
7-MTN/REPAIR STA	-----	96.0	-----	39.04		----	-56.96
8-EQUIPMENT							
+ECLSS	331.0	331.0	336.0	336.0	SHOWN AS 6 MODULAR REMOVEABLE UNITS	+ 5.00	+ 5.00
+DATA MANAGEMENT	24.0	73.0	24.27	72.81	SHOWN AS 19" RACK MOUNTED MODULAR UNITS	+ 0.27	- 0.29
+COMM/TRACKING	8.0	24.0	24.27	24.27	SHOWN AS 19" RACK MOUNTED MODULAR UNITS	+16.27	+ 0.27
+POWER/THERMAL	96.0	96.0	80.0	80.0	SHOWN AS 2 MODULAR REMOVEABLE UNITS	-16.00	-16.00
+SAFE HAVEN PROV	50.0	50.0	80.0	80.0	SHOWN AS 2 MODULAR REMOVEABLE UNITS	+30.00	+30.00
+WASHER/DRYER	-----	39.0	-----	28.14	SHOWN AS 2 FRONT LOADED UNITS	----	-10.86
+OXYGEN MASK STOW	8.0	8.0	10.26	10.26	SHOWN AS RACK MOUNTED MODULES	+ 2.26	+ 2.26
9-MISCELLANEOUS							
+CREW RESTR STOW	-----	-----	-----	10.26		----	+10.26
+EQUIPT RESTR STOW	6.0	6.0	-----	10.26		- 6.00	+ 4.26
+SPARES MOD STOW	100.0	100.0	97.08	135.36	NASA NOT SHOWN-SHWN HERE AS RACK UNITS	- 2.92	+35.36
+MISCEL MOD STOW	90.0	90.0	181.36	48.54	NASA NOT SHOWN-SHWN HERE AS RACK UNITS	+91.36	-41.46
+UTILITIES	73.0	73.0	246.00	246.00	WP#1&2 UTILITIES IN FOUR CORNER TRUSSES	+168.0	+168.0
+LIGHTING	19.0	19.0	-----	-----	NOT CALCULATED	-19.00	-19.00
TOTALS	1236.3	1208.0	1308.99	1441.12			

CREW SIZE VERSUS MODULE LENGTH

Arrangement A2 (4 x 4) is similar to A1 (0-6), with one basic exception. In an attempt to minimize the differences between Habitat #1 & #2 the crew quarters arrangement has been modified. In this concept four (4) quarters are located in Hab #1 and four (4) identical crew quarters are in Hab #2. The vestibule areas with its support tanks for the WCS & personal hygiene compartments are identical. The left hand compartment below the deck is identical in shape, size & stowage provisions but differ in functional useage. One hab contains the HMF while the other contains the exercise facility. The ECLSS, power/thermal & safe haven installations are identical in form factor (differences in functions will probably exist.)

The interstitial deck structural configuration in both habitats is identical, while the WP #1 & WP#2 utilities runs are the same (with some tailored differences).

Above the deck the plan view of both habitats are the same. In Habitat #1 the racks and work stations support the galley functions on the left hand portion of the module. In Habitat #2 identical racks and work stations are used to mount equipment and provide payload operations & maintenance/repair control stations. The WCS & personal hygiene facilities are replicated. On the RH side of the module the rack/work station geometries are similar.

This arrangement can support a crew of 8 as compared to the six (6) show in arrangement A1. It optimizes the degree of commonality between the two habitats. This arrangement has interesting possibilities for growth with larger crew sizes.

FOUR CORNER MODULAR TRUSS CONCEPT CREW SIZE VERSUS MODULE LENGTH



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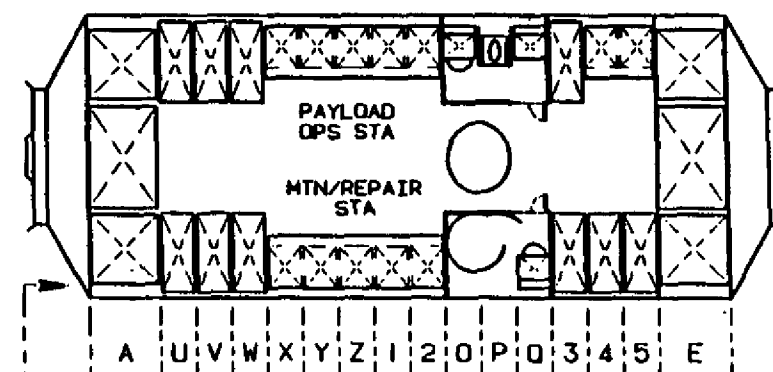
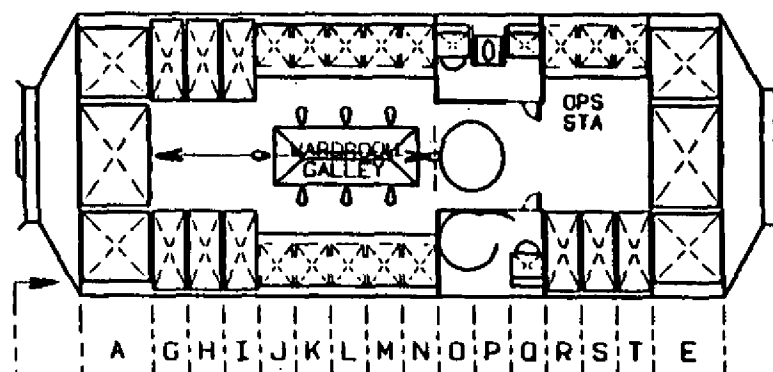
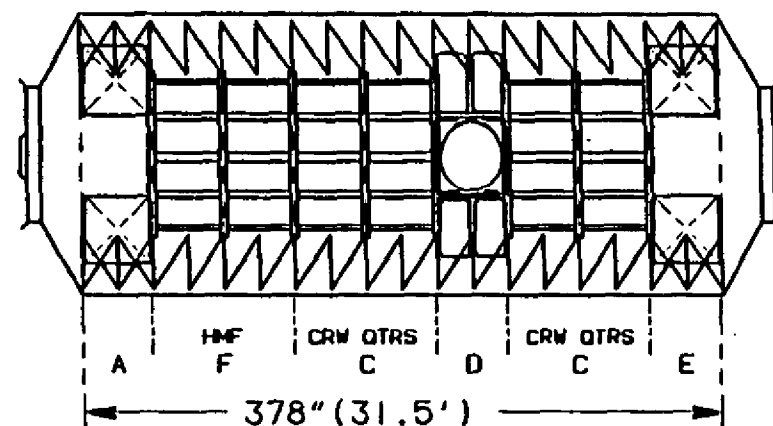
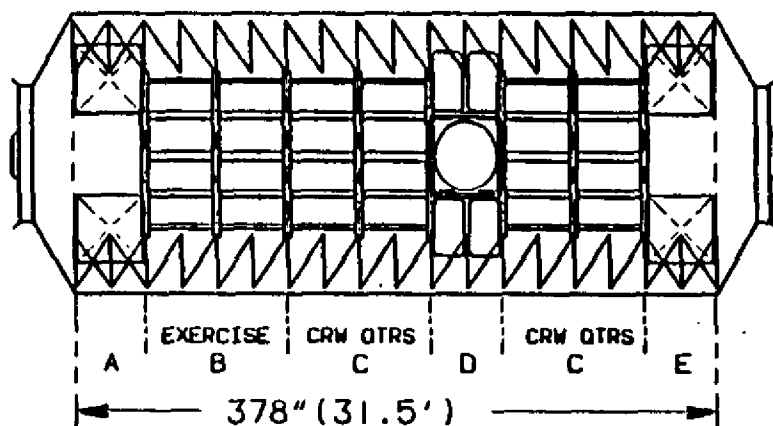
I-65

ARRANGEMENT A2 - 4 X 4

CREW SIZE = 8

LAYOUT 751B-B3A-111 HABITAT MODULE #1

LAYOUT 751B-B3A-211 HABITAT MODULE #2



BRUMMAN

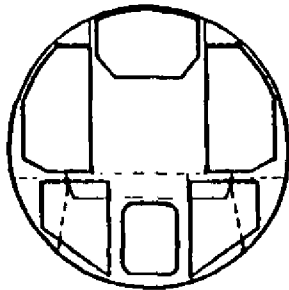
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FOUR CORNER MODULA, TRUSS CONCEPT CONFIG A2(4X4) HAB#1 CROSS SECTIONS

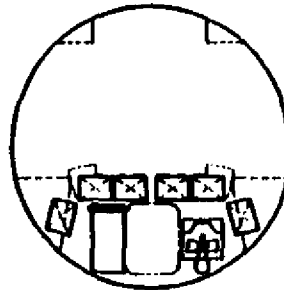


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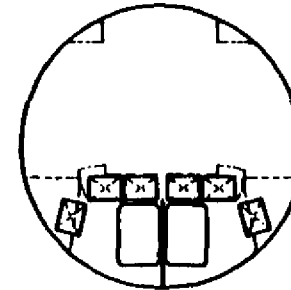
CROSS SECTIONS SHOWING LOWER
LEVEL CONFIGURATION



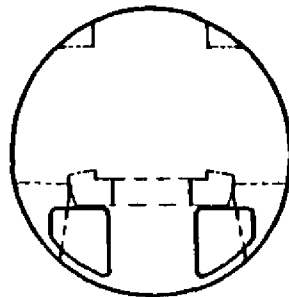
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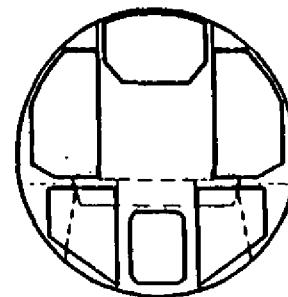
SECT B-B



SECT C-C



SECT D-D



SECT E-E

I-66



DRAWING 751B-B3A-111

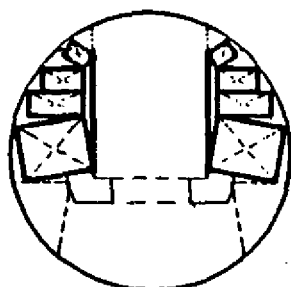
IR&D

FOUR CORNER MODULAR TRUSS CONCEPT CONFIG A2(4X4) HAB#1 CROSS SECTIONS

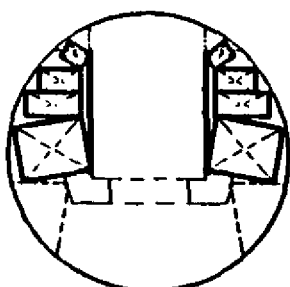


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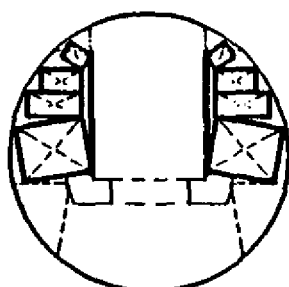
CROSS SECTIONS SHOWING UPPER
LEVEL CONFIGURATION



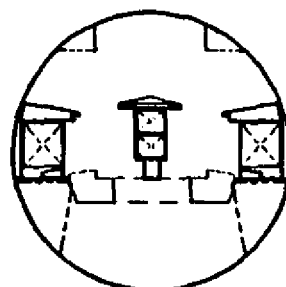
SECT G-G



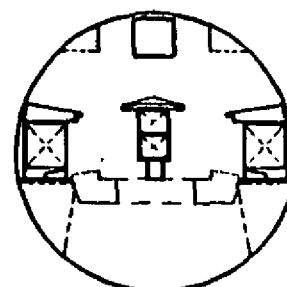
SECT H-H



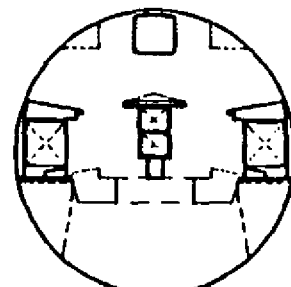
SECT I-I



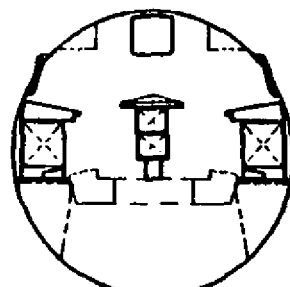
SECT J-J



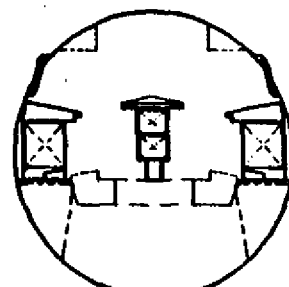
SECT K-K



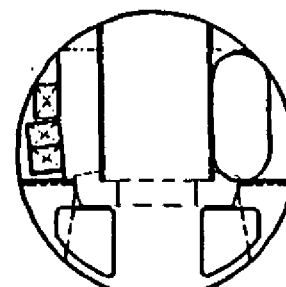
SECT L-L



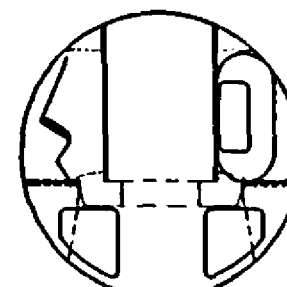
SECT M-M



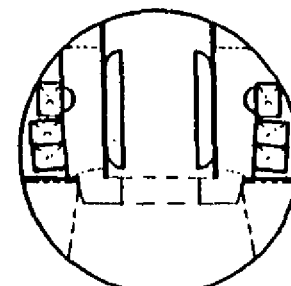
SECT N-N



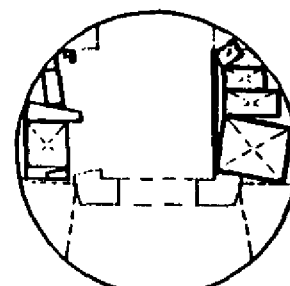
SECT O-O



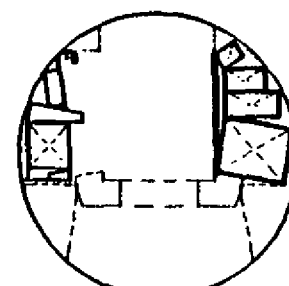
SECT P-P



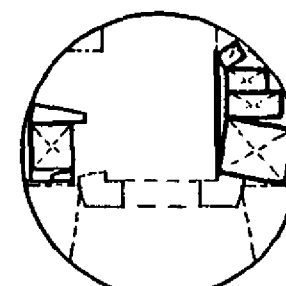
SECT Q-Q



SECT R-R



SECT S-S



SECT T-T

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DRAWING 751B-B3A-111

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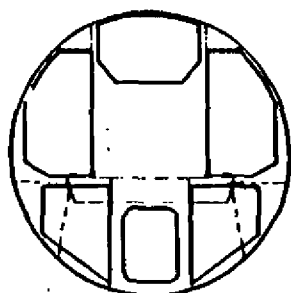
1-67

FOUR CORNER MODULAR TRUSS CONCEPT CONFIG A2(4X6) HAB#2 CROSS SECTIONS

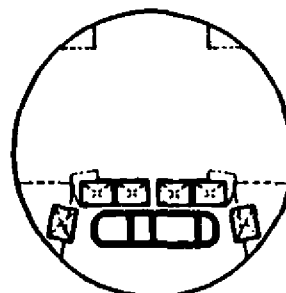


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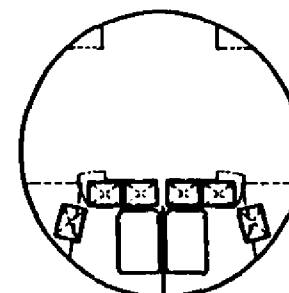
CROSS SECTIONS SHOWING LOWER
LEVEL CONFIGURATION



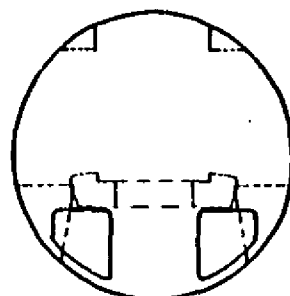
SECT A-A



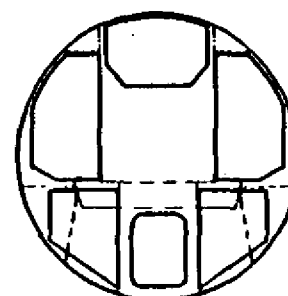
SECT F-F



SECT C-C



SECT D-D



SECT E-E

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DRAWING 751B-B3A-211

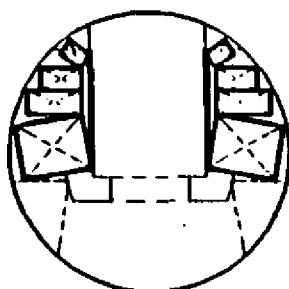
IR&D

FOUR CORNER MODULAR TRUSS CONCEPT CONFIG A2(4X4) HAB#2 CROSS SECTIONS

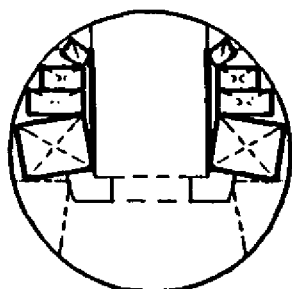


42

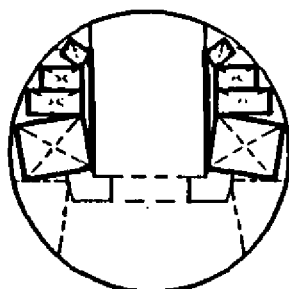
CROSS SECTIONS SHOWING UPPER
LEVEL CONFIGURATION



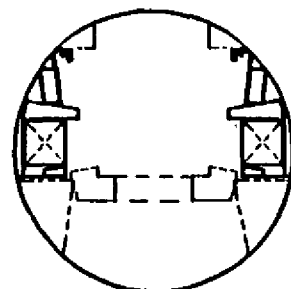
SECT U-U



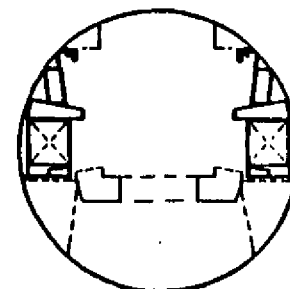
SECT V-V



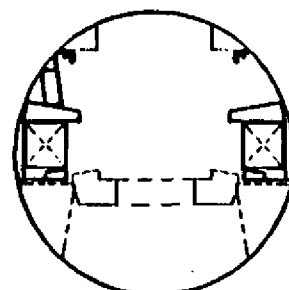
SECT W-W



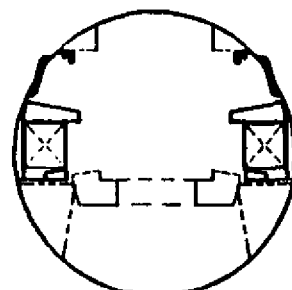
SECT X-X



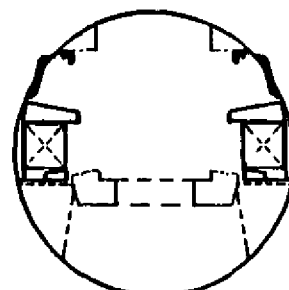
SECT Y-Y



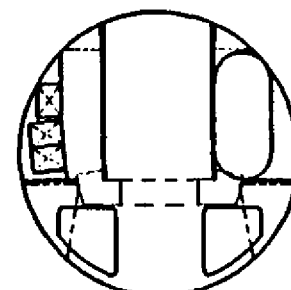
SECT Z-Z



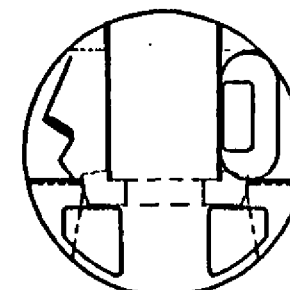
SECT 1-1



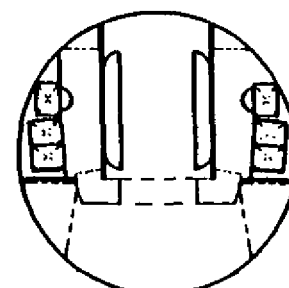
SECT 2-2



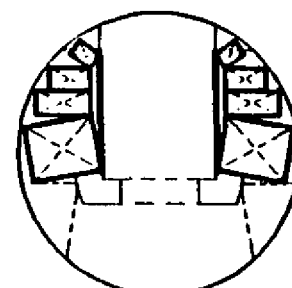
SECT O-O



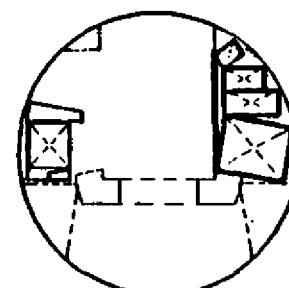
SECT P-P



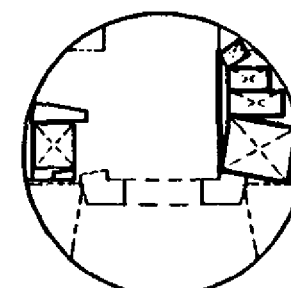
SECT Q-Q



SECT 3-3



SECT 4-4



SECT 5-5

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IR&D

DRAWING 751B-B3A-211

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

The following twelve (12) pages list the quantity, sizes & volumes of all facilities, equipment & stowage containers located in configuration A2. The facilities have been grouped into nine (9) basic areas, they are

- 1 - Galley/Wardroom
- 2 - Crew Quarters
- 3 - Health Maintenance Facility
- 4 - Health Exercise Facility
- 5 - Personal Hygiene Facility
- 6 - Waste Collection Facility
- 7 - Work Stations
- 8 - Equipment
- 9 - Miscellaneous Stowage

The column labeled "sect ltr" depicts which section letter(s) on the preceeding five (5) drawings show where each piece of hardware is located. It should be noted that all stowage/equipment hardware has a 19.0" dimension, denoting that they are rack mounted units. The variation in D (depth) and L/H (Length/Height) dimensions have been minimized for the sake of commonality. In this fashion the logistics module mounting pattern can be optimized for bringing up this equipment.

This data list is essentially the same as that shown for arrangement A1, the locations in some cases differ.

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 43
 LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION(*)			UNIT VOL (C.F.T)	QTY	TOTAL VOL (C.F.T)	REMARKS
	#1	#2		W	D	L/H				
I-GALLEY/WARDROOM	X	-	G-N			168.0				DESIGNED FOR CREW OF EIGHT-SEE PG 38 & 40
*TABLE			I-M			84.0	40.0	1	(40.0)	LISTED ON PG 54 AS MISC STW
*OVERHEAD CANTEEN			J-L			60.0	18.0	1	18.0	CONTAINS ALL FLUIDS FOR CREW
*COUNTER TOP UNIT			I-M	30.0	----	105.0	15.2	2	(30.4)	LISTED ON PAGE 54 AS MISC STW VOL
*WINDOW			L,M							4 WINDOWS FOR GROUP VIEWING,ETC.
*GALLEY UNITS										
-REFRIGERATOR			G	19.0	40.0	32.0	14.07	2	28.14	FOOD VOL APPROX 6 CF(2 UNITS FOR FAIL)
-FREEZER			H	19.0	40.0	32.0	14.07	2	28.14	FOOD VOL APPROX 6 CF(2 UNITS FOR FAIL)
-CONVECTOR OVEN			I	19.0	32.0	14.4	5.07	1	5.07	
-MICRO WAVE OVEN			I	19.0	32.0	14.4	5.07	1	5.07	
-AMBIENT FOOD #1			G	19.0	14.0	10.0	1.54	2	3.08	VOL ALSO PROVIDED FOR BULK VEG-SEE PG 44
-AMBIENT FOOD #2			G	19.0	24.0	13.6	3.59	2	7.18	
-AMBIENT FOOD #3			G	19.0	32.0	14.4	5.07	2	10.14	(TOTAL = 20.4 CF)
-COMPACTOR			I	19.0	40.0	32.0	14.07	2	28.14	TWO UNITS PROVIDED(FAILURE OF ONE)
-DISHWASHER			J	19.0	24.0	26.0	6.86	1	6.86	BELOW COUNTER TOP LOCATION
-HAND WASHER			H	19.0	32.0	14.4	5.07	1	5.07	LOCATED WAIST HIGH-NEAR TABLE
-WATER HEATER			H	19.0	14.0	10.0	1.54	2	3.08	ONE UNIT ONE EACH SIDE OF GALLEY
-CHILLER/REHYDR			H	19.0	24.0	13.6	3.59	2	7.18	ONE UNIT NEAR EACH FREEZ/REFR PAIR
-HOUSE KP SUP			I	19.0	14.0	10.0	1.54	2	3.08	
-HOUSE KP SUP			I	19.0	24.0	13.6	3.59	2	7.18	(TOTAL = 10.26 CF)
-UTENS/APPL			H	19.0	32.0	14.4	5.07	1	5.07	(TOTAL = 5.07 CF)

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER

SHEET NO. 4 +

LAYOUT NO. 751B-B3A-111 &-211 DESIGN ENGR: GENE W. HARMS

DATE: _____

[illegible]

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HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONF1..JURATION: A2 (4X4) HAB #1 & #2 -3..5'CYLINDER SHEET NO. 45
LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION(*)			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
	#1	#2		W	D	L/H				
2-CREW QUARTERS	X	X	C							OL/CRM QTR-SEE PG 38 & SECT C-C.PG 39.41
•DECK UNITS										
-CREW STOW UNITS				19.0	14.0	19.0	2.92	7	20.44	UNITS RETURNED TO EARTH WITH CREW
-TV/PC COMP				19.0	14.0	19.0	2.92	1	2.92	SINGLE UNIT-KEY BOARD NOT SHOWN
-DESK(FOLDING)										NOT SHOWN AT THIS TIME
•SIDE UNITS										
-CREW STOW UNITS				19.0	14.0	19.0	2.92	4	11.68	STACKED FROM FLOOR TO CEILING
-SLEEP BAG				20.0	2.0	73.0				CAN BE REPOSITIONED OR STOWED
-BULLETIN BOARD										NOT SHOWN AT THIS TIME
-WINDOW								1		WINDOW IN EACH CREW QUARTER
•FACILITY VOL SUM										
-MODULAR UNITS								11	32.12	
-MISC VOLS								1	2.92	
-STR/MISC										
-FREE VOLUME									108.00	24W X36L ENTRANCEWAY INTO EACH QTR
-TOTAL VOL									143.04	TOTAL FOR EACH CREW QTR-4/MODULE SHOWN

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER

SHEET NO. 40

LAYOUT NO. 751B-B3A-111 &-211 DESIGN ENGR: GENE W. HARMS

DATE: _____

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I-7A

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 47
 LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION (")			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
	#1	#2		W	D	L/H				
4-HEALTH EXER FACIL	X	-	B							SEE PG 38 & SECT B-B ON PG 39
•DECK UNITS										
-MOD STOW UNITS				19.0	14.0	19.0	2.92	(6)	(17.52)	
-TV/PC COMP				19.0	14.0	19.0	2.92	2	5.84	
-SPEAKERS				19.0	14.0	19.0	2.92	2	5.84	
-BOOK UNITS				19.0	14.0	19.0	2.92	6	17.52	
•SIDE UNITS										
-MOD STOW UNITS				19.0	14.0	19.0	2.92	(8)	(23.36)	
•MISC ITEMS										
-ERGOMETER				24.0	36.0	48.0		1	24.00	SHOWN AS FIXED EQUIP IN FREE VOLUME
-TREADMILL				24.0	48.0	60.0		1	40.00	SHOWN AS FIXED EQUIP IN FREE VOLUME
•FACILITY VOL SUM										
-MODULAR UNITS								14)	(40.88)	LISTED ON PG 54 AS MISC STOWAGE
-MISC VOLS								10	29.20	
-EQUIPMENT									(64.00)	FIXED UNITS PART OF FREE VOLUME
-STR/MISC										
-FREE VOLUME									216.00	TWO ENTRANCEWAYS INTO THIS COMPT
-TOTAL VOL									245.20	

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER

SHEET NO. 48

LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION(*)			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
	#1	#2		W	D	L/H				
5-PERS HYGIENE FAC	X	X	0-0							SEE PG 38 & SECT 0-0.P-P,0-0,ON PG 40
•MODULAR UNITS										VALUES ARE PER HYGIENE FACILITY
-GENERAL STOW			0	19.0	19.0	14.0	2.92	2	5.84	
-HAND WASH			0	19.0	14.0	19.0	2.92	1	2.92	
•SHOWER			0,P	34 OD	----	74.0	32.0	1	32.0	DOMED ON BOTH ENDS-20" WIDE DOOR
•MISCELLANEOUS										
-WATER SUP TANK			D	19.0	34.0	----	10.9	1	10.9	APPROX 80 GALS OF WATER
-WATER COL TANK			D	19.0	34.0	----	10.9	1	10.9	APPROX 80 GALS OF WATER
•FACILITY VOL SUM										VALUES ARE FOR 2 HYGIENE FACILITIES
-MODULAR UNITS								6	17.52	
-MISC VOLS								4	43.6	
-SHOWER								2	64.0	
-STR/MISC										
-FREE VOLUME									28.0	(VOLUME PER FACILITY)
-TOTAL VOL									300.54	(HYG CMPT=256.94 CF,TANKS=43.6 CF)

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 49
LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION(*)			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
	#1	#2		W	D	L/H				
6-WASTE COLL FAC	X	X	0-0							SEE PG 38 & SECT 0-0.P-0-0.ON PG 40
•MODULAR UNITS										VALUES ARE PER WC FACILITY
-GENERAL STOW			0	19.0	19.0	14.0	2.92	2	5.84	
-HAND WASH			0	19.0	14.0	19.0	2.92	1	2.92	
-GENERAL STOW			0	19.0	19.0	14.0	2.92	2	5.84	
-GENERAL STOW			0	19.0	14.0	19.0	2.92	1	2.92	
•MISCELLANEOUS										
-URINE/FECAL COL			P	19.0	----	----	12.6	1	12.6	SHAPED FOR ZERO G OCCUPANTS
-FECAL COLL MOD			D	19.0	34.0	----	10.9	1	10.9	REMOVABLE UNIT-RETURN TO EARTH
-URINE COLL MOD			D	19.0	34.0	----	10.9	1	10.9	CAN BE USED TO REPROCESS WATER
•FACILITY VOL SUM										VALUES ARE FOR TWO WC FACILITIES
-MODULAR UNITS								12	35.04	
-URINE/FECAL COL								2	25.2	
-MISC VOLS								4	43.6	(TANKS LOCATED BELOW DECK)
-STR/MISC										
-FREE VOLUME									61.5	(VALUE PER COMPARTMENT)
-TOTAL VOL									300.54	(WC CMPT=256.94 CF,TANKS=43.9 CF)

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -3,5' CYLINDER SHEET NO. 50
 LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION(')			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
	#1	#2		W	D	L/H				
7-WORK STATIONS										
•OPS CONTROL STA	X	-	R-T							SEE PG 38 & SECT R-R,S-S,T-T ON PG 40
-VERT DISP PNLS			R,S	19.0	10.0	20.0	2.2	2	4.40	ONE VIEWING WINDOW PROVIDED
-HORIZ CNTL PNLS			R,S	19.0	6.0	10.0	0.7	2	1.40	
-HORIZ CNTL PNLS			T	19.0	6.0	30.0	2.0	1	2.00	
-MOD STOW UNIT			R-T	19.0	24.0	26.0	6.86	3	20.58	
•PAYLOAD OPS STA	-	X	X-2							
-VERT DISP PNLS			X-Z	19.0	10.0	20.0	2.2	3	6.60	TWO VIEWING WINDOWS PROVIDED
-HORIZ CNTL PNLS			X-Z	19.0	6.0	10.0	0.7	3	2.10	
-HORIZ CNTL PNLS			I	19.0	6.0	30.0	2.0	1	4.00	
-MOD STOW UNIT			X-I	19.0	24.0	26.0	6.86	4	27.44	
-TRASH STOW UNIT			2	19.0	24.0	26.0	6.86	1	6.86	UNDER THE COUNTER TRASH STOW PROVIDED
•MTN/REPAIR STA	-	X	X-2							
-VERT DISP PNLS			X,Y	19.0	10.0	20.0	2.2	2	4.40	TWO VIEWING WINDOWS PROVIDED
-HORIZ CNTL PNLS			X,Y	19.0	6.0	10.0	0.7	2	1.40	
-WORK BENCH			Z-2	63.0	----	30.0	8.7	1	8.70	
-MOD STOW UNIT			X-I	19.0	24.0	26.0	6.86	4	27.44	
-COMPACTOR			2	19.0	24.0	26.0	6.86	1	6.86	UNDER THE WORK BENCH MODULAR UNIT
•FACILITY VOL SUM										
-MOD UNITS-HAB#1	X							3	20.58	
-MOD UNITS-HAB#2		X						8	54.88	
-MISC VOLS		X						2	13.72	(TRASH STOW & COMPACTOR)
-TOTAL VOL										

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 01
 LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION(*)			UNIT VOL (C.F.T)	QTY	TOTAL VOL (C.F.T)	REMARKS
	#1	#2		W	D	L/H				
8-EQUIPMENT										
•ECLSS			A,E							MOD REMOVABLE/REPLACEABLE UNITS
-MOD UNIT #1	X		A,E	40.0	40.0	----	50.0	2	100.0	
-MOD UNIT #2	X		A,E	40.0	40.0	----	59.0	2	118.0	
-MOD UNIT #3	X		A,E	40.0	40.0	----	59.0	2	118.0	
-SUB TOTAL ()								(6)	(336.0)	IDENTICAL INSTALL IN HAB #1 & #2
-MOD UNIT #1		X	A,E	40.0	40.0	----	50.0	2	100.0	
-MOD UNIT #2		X	A,E	40.0	40.0	----	59.0	2	118.0	
-MOD UNIT #3		X	A,E	40.0	40.0	----	59.0	2	118.0	
-SUB TOTAL ()								(6)	(336.0)	
•DATA MGMT										MODULAR RACK MOUNTED UNITS
-MOD UNIT #1	X		R	19.0	14.0	10.0	1.54	1	1.54	
-MOD UNIT #2	X		R	19.0	24.0	13.6	3.59	1	3.59	
-MOD UNIT #3	X		R	19.0	32.0	14.4	5.07	1	5.07	
-MOD UNIT #4	X		R	19.0	40.0	32.0	14.07	1	14.07	
-SUB TOTAL ()								(4)	(24.27)	
-MOD UNIT #1		X	4	19.0	14.0	10.0	1.54	1	1.54	
-MOD UNIT #2		X	4	19.0	24.0	13.6	3.59	1	3.59	
-MOD UNIT #3		X	4	19.0	32.0	14.4	5.07	1	5.07	
-MOD UNIT #4		X	4	19.0	40.0	32.0	14.07	1	14.07	
-MOD UNIT #1		X	3	19.0	14.0	10.0	1.54	2	3.08	
-MOD UNIT #2		X	3	19.0	24.0	13.6	3.59	2	7.18	
-MOD UNIT #3		X	3	19.0	32.0	14.4	5.07	2	10.14	
-MOD UNIT #4		X	3	19.0	40.0	32.0	14.07	2	28.14	
-SUB TOTAL ()								(12)	(72.81)	

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONF1. JRATION: A2 (4X4) HAB #1 & #2 -3.5' CYLINDER SHEET NO. 02
 LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	HAB #		SECT LTR	UNIT DIMENSION (")			UNIT VOL (C. FT.)	QTY	TOTAL VOL (C. FT.)	REMARKS
	#1	#2		W	D	L/H				
8-EQUIPMENT (CONTD)										
•COMM/TRACKING										MODULAR RACK MOUNTED UNITS
-MOD UNIT #1	X		S	19.0	14.0	10.0	1.54	1	1.54	
-MOD UNIT #2	X		S	19.0	24.0	13.6	3.59	1	3.59	
-MOD UNIT #3	X		S	19.0	32.0	14.4	5.07	1	5.07	
-MOD UNIT #4	X		S	19.0	40.0	32.0	14.07	1	14.07	
-SUB TOTAL ()								(4)	(24.27)	
-MOD UNIT #1		X	5	19.0	14.0	10.0	1.54	1	1.54	
-MOD UNIT #2		X	5	19.0	24.0	13.6	3.59	1	3.59	
-MOD UNIT #3		X	5	19.0	32.0	14.4	5.07	1	5.07	
-MOD UNIT #4		X	5	19.0	40.0	32.0	14.07	1	14.07	
-SUB TOTAL ()								(4)	(24.27)	
•POWER/THERMAL	X		E	40.0	40.0	----	40.0	2	80.0	MODULAR RACK MOUNTED UNITS
•POWER/THERMAL		X	E	40.0	40.0	----	40.0	2	80.0	MODULAR RACK MOUNTED UNITS
•SAFE HAVEN PROV	X		A	40.0	40.0	----	40.0	2	80.0	
•SAFE HAVEN PROV		X	A	40.0	40.0	----	40.0	2	80.0	
•CLOTHES WASHER		X	4	19.0	24.0	26.0	6.86	1	6.86	FRONT LOADED UNIT+COUNTER TOP WORK AREA
•CLOTHES DRIER		X	5	19.0	24.0	26.0	6.86	1	6.86	FRONT LOADED UNIT+COUNTER TOP WORK AREA
•COUNTER TOP STOW		X	4,5	30.0	----	42.0	5.80	1	5.80	LOCATED ABOVE WASHER/DRIER UNITS+WINDOW
•OXYGEN MASKS	X		T	19.0	14.0	10.0	1.54	1	1.54	
•OXYGEN MASKS	X		T	19.0	24.0	13.6	3.59	1	3.59	
•OXYGEN MASKS		X	U	19.0	14.0	10.0	1.54	2	3.18	
•OXYGEN MASKS		X	U	19.0	24.0	13.6	3.59	2	7.18	

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 33
LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE: _____

[illegible]

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 54
LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE: _____

[illegible]

HABITAT EQUIPMENT & STOWAGE VOLUME DATA SUMMARY SHEET

This chart summarizes the information contained on the preceeding twelve (12) pages. The nine(9) basic habitat functional areas are listed on the left with a listing of NASA's baesline requirements for each module noted.

The galley/wardroom shown exceeds NASA's requirements, except for vegetable bulk stowage. Only 27 cu. ft. is provided in this configuration, it is assumed the remaining 90 day supply can be left in the logistics module until required onboard the habitat. The galley shown provides two (2) regrigerators & freezers, to cover the situation where one unit fails. Two (2) compactors are provided to optimize the waste collection system. Since two (2) compactors are provided the volume for simple trash stowage was reduced.

The crew quarters are identical in shape, size & furnishings provisions. A total of 35.0 cu. ft. of equipment/stowage volume has been provided for each crew quarter, exceeding NASA's requirements by 40%. This arrangement has four (4) crew quarters in each module.

The health maintenance & health exercise facilities have been shown as two separate compartments, rather than one as shown in NASA's reference configuration. In addition the exercise devices are shown as fixed units, rather than fold-up stowable units. These facilities are shown in separate modules.

The personal hygiene & waste collection facilities are shown as two separate compartments rather than one connected compartment. Four collection/service tanks are located below thus facilities thus minimizing pipe runs to the units being serviced. The stowage volumes in each compartment equal or exceed NASA's requirements.

The three work stations shown provide a full complement of vertical & horizontal display/control panels, external viewing windows, long work bench surface areas, and large stowage volumes below each work station. The modular concept produces identical geometries for each work station.

The equipment volumes shown are all modular units. The ECLSS, power/thermal and safe haven provisions have 40.0" x 40.0" cross sections and are readily accessible for service or replacement. The remaining equipment are all 19.0" wide rack mounted units.

Miscellaneous stowage volumes are a combination of rack mounted units and those areas inside the dining table and counter top galley work areas.

The utilities volume represents the four areas within the upper & lower truss structures set aside for the routing of all WP #1 & WP #2 utilities.

The total volumes shown for this arrangement have been calculated on well defined form factors for each element in the habitats. Each volume form factor listed has been shown mounted to realistic secondary support structure. The totals listed for each habitat exceed NASA's requirement by a considerable amount.

HABITAT EQUIPMENT AND STOWAGE VOLUME DATA SUMMARY SHEET

CONFIGURATION: A2 (4X4) HAB #1 & #2 -31.5' CYLINDER SHEET NO. 05
 LAYOUT NO. 751B-B3A-111 & -211 DESIGN ENGR: GENE W. HARMS DATE:

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FACILITY/EQUIPMENT	NASA BASELINE		CONFIG A1 TOTALS		REMARKS	△	
	HAB#1	HAB#2	HAB#1	HAB#2		HAB#1	HAB#2
1-WARDROOM/GALLEY							
+MODULAR UNITS	108.0	-----	159.34	-----	SOME REDUNDANCY OF UNITS PROVIDED	+51.34	----
+VEG BULK STOWAGE	117.3	-----	27.44	-----	EXCESS VEG STOWED IN LOGISTICS MODULE	-89.86	----
+STOWAGE CONTAIN	20.0	-----	27.44	-----		+ 7.44	----
2-CREW QUARTERS(8)	-----	150.0(6)	140.16	140.16	35.04 CU.FT. PER QTR PROVIDED	+ 9.84	+140.16
3-HEALTH MAINT FACIL	88.0	-----	-----	70.08	COULD USE VOL IN EXER FACILITY	-88.00	+ 70.00
4-HEALTH EXER FACIL	64.0	-----	93.20	-----	NASA UNIT FOLD-UP, FIXED UNITS SHWN HERE	+29.20	----
5-PERS HYGIENE FACIL	7.0	7.0	30.56	30.56	INCLUDES 21.8 CF OF WATER TANKS	+23.56	+23.56
6-WASTE COLL FACIL	7.0	7.0	39.32	39.32	INCLUDES 21.8 CF OF COLLECTION TANKS	+32.32	+32.32
7-OPS CONTROL STA	20.0	-----	28.38	-----		+ 8.38	----
7-PAYLOAD OPS STA	-----	39.0	-----	40.14		----	+ 1.14
7-MTN/REPAIR STA	-----	96.0	-----	41.94		----	-56.96
8-EQUIPMENT							
+ECLSS	331.0	331.0	336.0	336.0	SHOWN AS 6 MODULAR REMOVEABLE UNITS	+ 5.00	+ 5.00
+DATA MANAGEMENT	24.0	73.0	24.27	72.81	SHOWN AS 19" MODULAR UNITS	+ 0.27	- 0.29
+COMM/TRACKING	8.0	24.0	24.27	24.27	SHOWN AS 19" MODULAR UNITS	+16.27	+ 0.27
+POWER/THERMAL	96.0	96.0	80.0	80.0	SHOWN AS 2 MODULAR REMOVEABLE UNITS	-16.00	-16.00
+SAFE HAVEN PROV	50.0	50.0	80.0	80.0	SHOWN AS 2 MODULAR REMOVEABLE UNITS	+30.00	+30.00
+WASHER/DRIER	-----	39.0	-----	13.72	SHOWN AS 2 FRONT LOADED UNITS	----	-10.86
+OXYGEN MASK STOW	8.0	8.0	5.53	10.26	SHOWN AS RACK MOUNTED MODULES	+ 2.26	+ 2.26
9-MISCELLANEOUS							
+CREW RESTR STOW	-----	-----	-----	5.07		----	+ 5.07
+EQUIPT RESTR STOW	6.0	6.0	5.07	5.07		- 0.93	- 0.93
+SPARES MOD STOW	100.0	100.0	14.07	107.22	NASA NOT SHOWN-SHWN HERE AS RACK UNITS	-85.93	+ 7.22
+MISCEL MOD STOW	90.0	90.0	111.28	33.94	NASA NOT SHOWN-SHWN HERE AS RACK UNITS	+21.28	-56.06
+TRASH STOW(HAB#2)		-----		6.86	NOT SHOWN IN REFERENCE CONFIG	----	+ 6.86
+COMPACTOR(HAB#2)		-----		6.86	NOT SHOWN IN REFERENCE CONFIG	----	+ 6.86
+UTILITIES	73.0	73.0	246.00	246.00	WP#1&2 UTILITIES IN FOUR CORNER TRUSSES	+168.0	+168.0
+LIGHTING	19.0	19.0	-----	-----	NOT CALCULATED	-19.00	-19.00
TOTALS	1236.3	1208.0	1272.33	1390.28			

CREW SIZE VERSUS MODULE LENGTH

Arrangement A3 (0-8) depicts a longer module (38.5' cylinder length). In this arrangement, each habitat has an extra 7.0' section added, this length below the deck provides an additional compartment and four (4) increments of 21.0" above the deck for functional utilities and stowage. The added length provides some interesting possibilities. In this arrangement two (2) exercise and two (2) HMF compartments are shown in Hab #1, while four (4) double crew compartments (8 crew) are shown in Hab #2. In the upper volume of the module, a galley/wardroom seating 8 persons is shown. Each habitat has identical WCS & personal hygiene compartments. The work control stations are divided between the two modules as are the equipment racks.

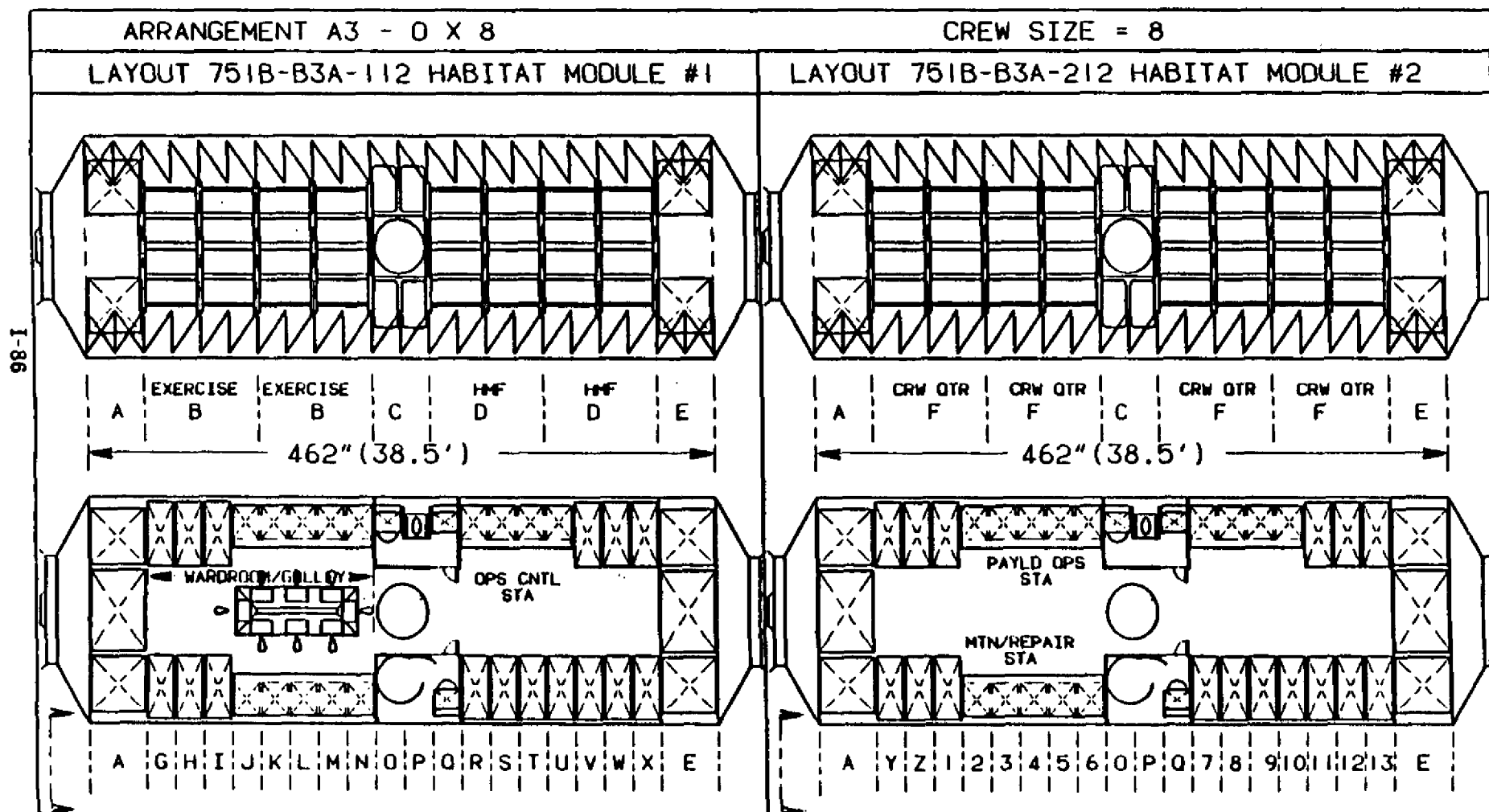
In the growth version only Hab #2 has to be added to the IOC Space Station. The additional 8 crew persons (total crew = 16) can use the HMF & exercise facilities already provided. The galley is large enough to seat 8 persons, for this reason it would not be unreasonable to assume that 8 persons will eat while the other 8 perform their tasks. The added Hab #2 could be configured on the upper deck to provide a meeting place for 16 people & also a snack bar.

The Habitat facility/equipment volume data list and summary sheet have not been prepared for this arrangement. If required, this information could be provided at the next update of this report.

FOUR CORNER MODULAR TRUSS CONCEPT CREW SIZE VERSUS MODULE LENGTH



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FOUR CORNER MODULE TRUSS CONCEPT CREW SIZE VERSUS MODULE LENGTH



PAGES 57 THRU 60 ARE ASSIGNED TO THE CROSS SECTION
DRAWINGS OF ARRANGEMENT A3 (0 X 8)-751B-B3A-112 & -212

PAGES 61 THRU 73 ARE ASSIGNED TO THE HABITAT FACILITY/
EQUIPMENT VOLUME DATA LISTS

THIS DATA WILL BE SUPPLIED AT A LATER DATE - IF REQUIRED.

1-87



CREW SIZE VERSUS MODULE LENGTH

Arrangement A4 (6 x 4) is similar to A3 (0 x 8) shown on the preceding drawing. In this arrangement the crew quarters are divided differently. Hab #1 contains six (6) crew quarters, while Hab #2 contains four (4). An exercise compartment is shown in each Habitat and only one (1) HMF is shown in Habitat #1.

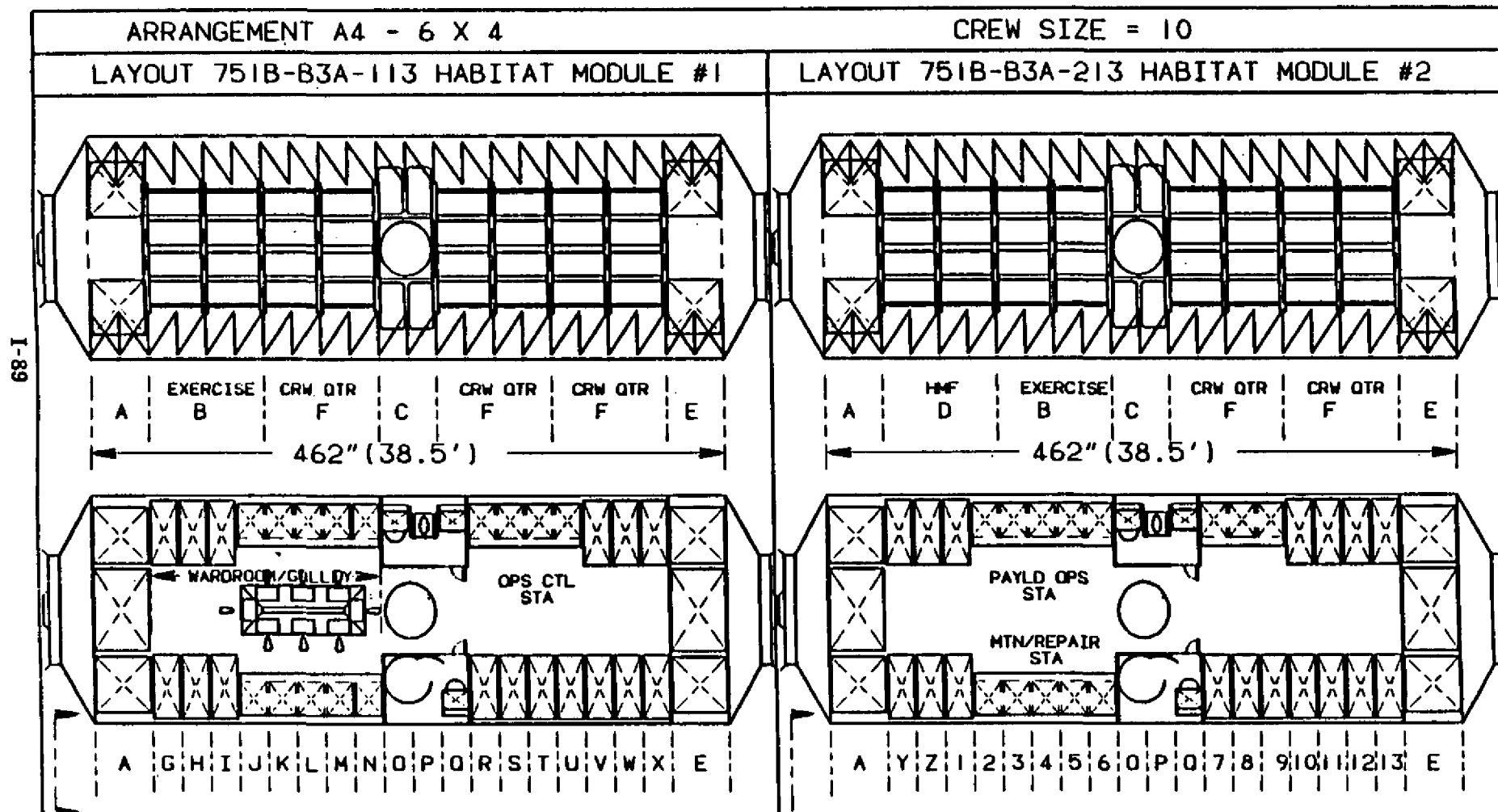
The arrangement above the deck is identical to that shown in A3 (0 x 8). The IOC crew size is now ten (10) rather than eight (8). When a third habitat is added at growth, this module could be configured to provide 4, 6 or 8 more crew compartments. Since the compartments below the deck all have the same geometries shapes & volumes, many interesting combinations can be provided.

The Habitat facility/equipment volume data list and summary sheet have not been prepared for this arrangement. If required, this information could be provided at the next update of this report.

FOUR CORNER MODULE, 2 TRUSS CONCEPT CREW SIZE VERSUS MODULE LENGTH



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FOUR CORNER MODULAR TRUSS CONCEPT CREW SIZE VERSUS MODULE LENGTH



PAGES 75 THRU 78 ARE ASSIGNED TO THE CROSS SECTION
DRAWINGS OF ARRANGEMENT A4 (6 X 4)-751B-B3A-113 & -213

PAGES 79 THRU 91 ARE ASSIGNED TO THE HABITAT FACILITY/
EQUIPMENT VOLUME DATA LISTS

THIS DATA WILL BE SUPPLIED AT A LATER DATE - IF REQUIRED.

I-90



CREW SIZE/MODULE LENGTH LWR COMPARTMENT

Configurations A5 (0 x 8) & A6 (6 x 4) are similar to the ones shown prior. In this case, another 7.0' compartment section and a second 42.0 vestibule section have been added for a cylinder length of 42.0". The crew sizes of 8 and 10 are the same as previously described, but more facilities for the crew and equipment can be provided.

FOUR CORNER MODULE TRUSS CONCEPT CREW SIZE/MODULE LENGTH-LWR COMPARTMENTS



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ARRANGEMENT CREW SIZE	MODULE #1	MODULE #2	FUNCTIONAL ALLOCATION
A5 (0X8)	<p>504" (42.0')</p>	<p>504" (42.0')</p>	<p>A-ECLSS/SAFE HAVEN</p> <p>B-ECLSS/POWER THERMAL</p> <p>C-LWR CMPT ACCESS AND EQUIP STW</p> <p>D-LWR CMPT ACCESS AND SERVICE TO: WCS TANKS & SHOWER TANKS</p>
A6 (6X4)	<p>504" (42.0')</p>	<p>504" (42.0')</p>	<p>E-HEALTH MED FACILITY</p> <p>F-HEALTH EXER FACILITY</p> <p>G-CREW QUARTERS (2)</p>

I-92

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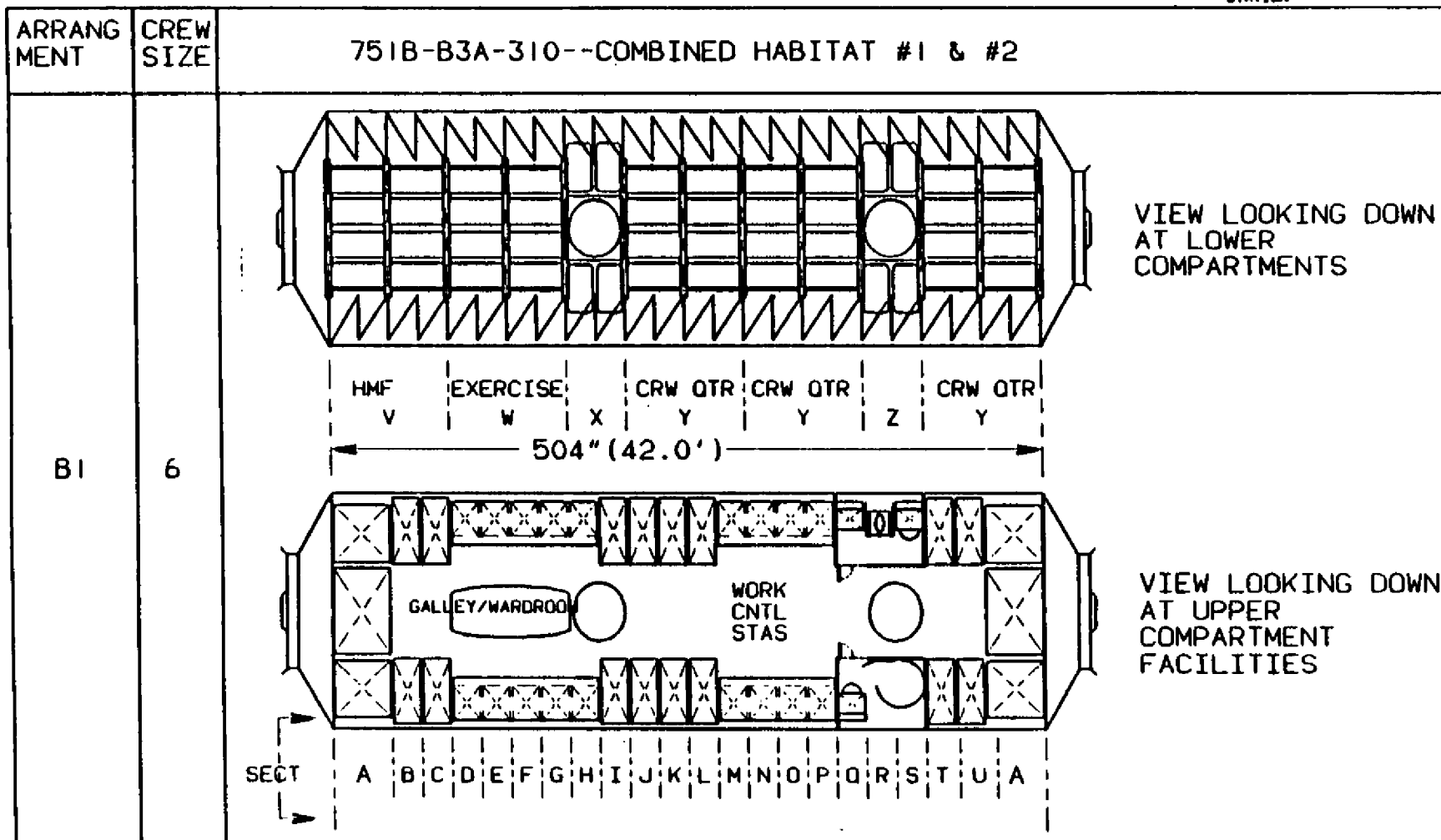
COMBINED HAB #1/#2 PLAN VIEWS

Arrangement B1(6) depicts one module (42.0' cylinder length) housing all the facilities and equipment for a crew of 6. The same concepts are utilized in locating all facilities above and below the deck. The cross section letters at each 21.0" increment depicts the cross section at that point. These cross sections are shown on the following two (2) pages. The two vestibule entry ways are required in this arrangement to gain access to the seven (7) compartments below the deck (each crew quarter length of 7.0" equals two (2) crew quarter compartments). The HMF facility is accessible thru the exercise compartment. This is not an ideal situation, but access from the other end is not possible.

FOUR CORNER MODULAR TRUSS CONCEPT COMBINED HAB #1/#2 PLAN VIEWS



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I-94



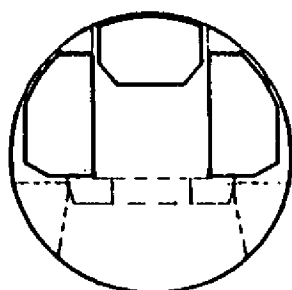
IR&D

FOUR CORNER MODULA. TRUSS CONCEPT COMBINED HAB #1/#2 CROSS SECTIONS

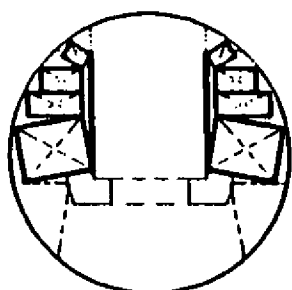


94

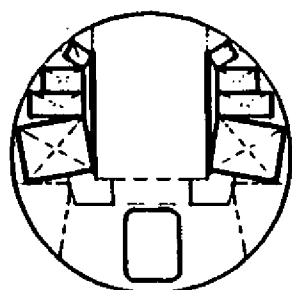
UPPER SECTION ARRANGEMENTS SHOWN



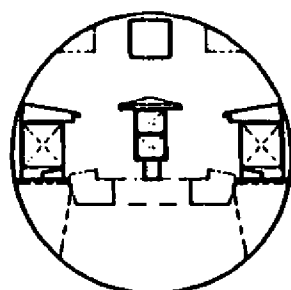
SECT A-A



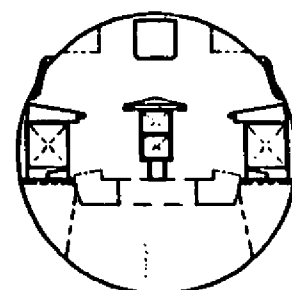
SECT B-B



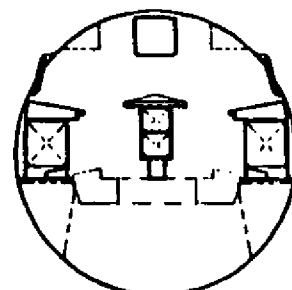
SECT C-C



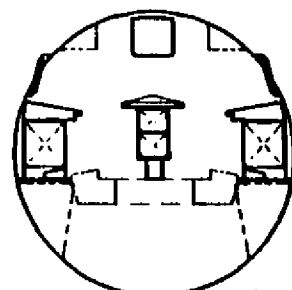
SECT D-D



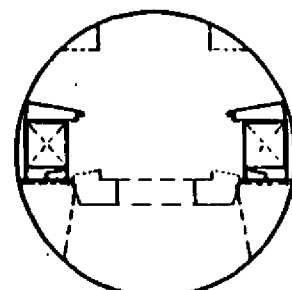
SECT E-E



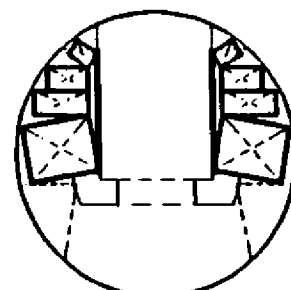
SECT F-F



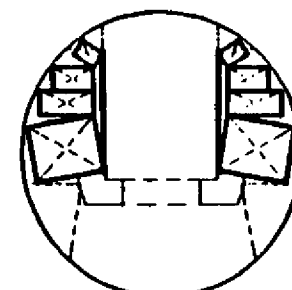
SECT G-G



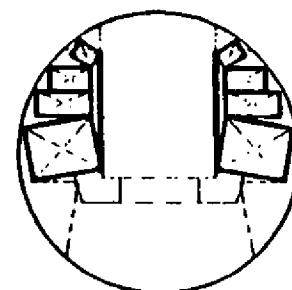
SECT H-H



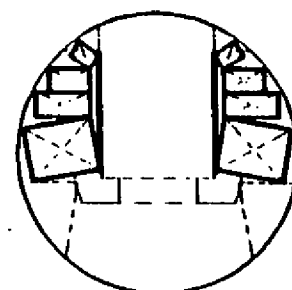
SECT I-I



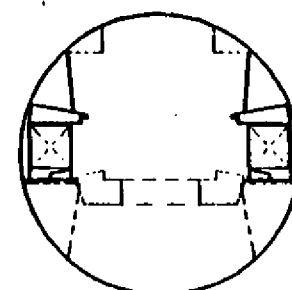
SECT J-J



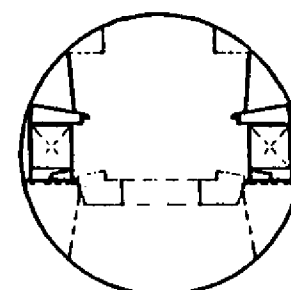
SECT K-K



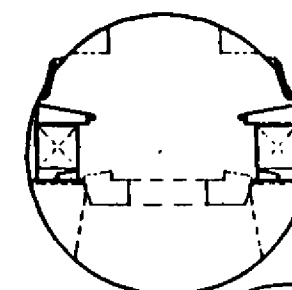
SECT L-L



SECT M-M



SECT N-N



SECT O-O

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DRAWING 751B-B3A-310

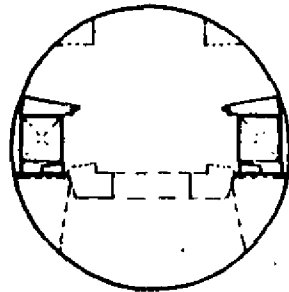
96-1

FOUR CORNER MODULAR TRUSS CONCEPT COMBINED HAB #1/#2 CROSS SECTIONS

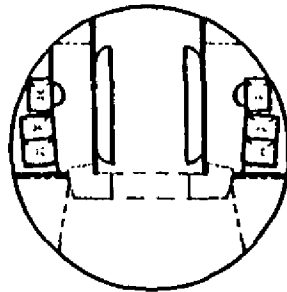


95

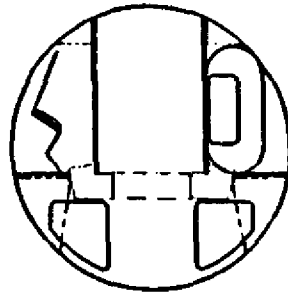
UPPER SECTION ARRANGEMENTS SHOWN



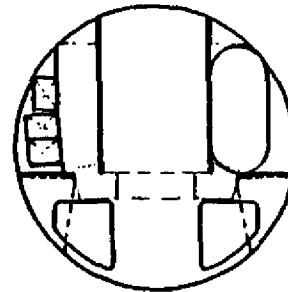
SECT P-P



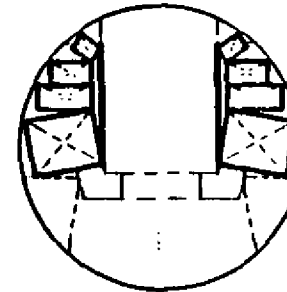
SECT Q-Q



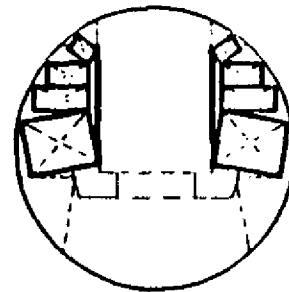
SECT R-R



SECT S-S

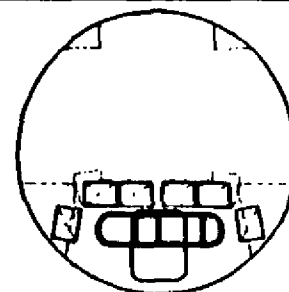


SECT T-T

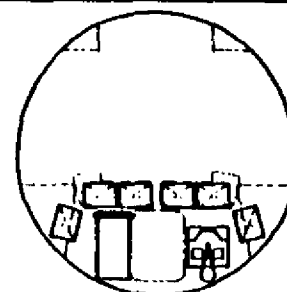


SECT U-U

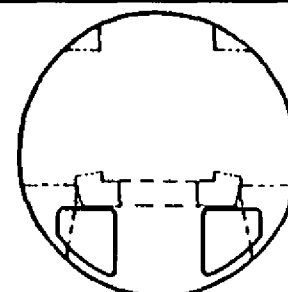
96-1



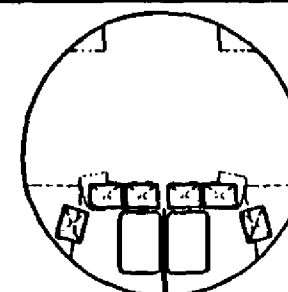
SECT V-V



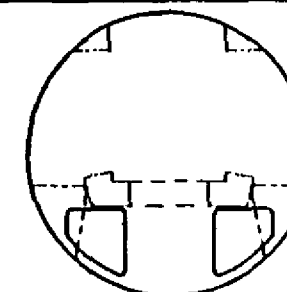
SECT W-W



SECT X-X



SECT Y-Y



SECT Z-Z

LOWER SECTION ARRANGEMENTS SHOWN

DRAWING 75JB-B3A-310

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HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

The following ten (10) pages list all the facilities located in arrangement B1(6) - Hab #1 & #2 combined. The column listed "SECT LTR" denotes in which cross section drawing the particular facility or stowage item is located. The same modular concept was utilized for all equipment located in the habitat. All modular units are 19.0" wide x a depth and length/height dimension. The quantity and volume of each item is listed. All facilities (except the operations control station) that were discussed previously have been accommodated in this arrangement.

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42' CYLINDER

SHEET NO. 6

LAYOUT NO. 751B-B3A-310

DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION(")			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
		W	D	L/H				
I-GALLEY/WARDROOM	B-I			168.0				DESIGNED FOR CREW OF SIX
•TABLE	D-G			84.0	40.0	1	(40.0)	13.68 CF MIS STW LISTED ON PG 105
•OVERHEAD CANTEEN	D-G			60.0	18.0	1	(18.0)	CONTAINS ALL FLUIDS FOR CREW
•COUNTER TOP UNIT	D-H	30.0	----	105.0	15.2	2	(30.4)	LISTED ON PAGE 105 AS MISC STW VOL
•WINDOW	E.F.G							6 WINDOWS FOR GROUP VIEWING,ETC.
•GALLEY UNITS								
-REFRIGERATOR	B	19.0	40.0	32.0	14.07	2	28.14	FOOD VOL APPR 6 CF(2 UNITS FOR FAIL)
-FREEZER	C	19.0	40.0	32.0	14.07	2	28.14	FOOD VOL APPR 6 CF(2 UNITS FOR FAIL)
-CONVECTOR OVEN	I	19.0	32.0	14.4	5.07	1	5.07	
-MICRO WAVE OVEN	I	19.0	32.0	14.4	5.07	1	5.07	
-AMBIENT FOOD #1	C	19.0	14.0	10.0	1.54	2	3.08	VOL PROVIDED FOR BULK VEG ON PAGE 97
-AMBIENT FOOD #2	C	19.0	24.0	13.6	3.59	2	7.18	
-AMBIENT FOOD #3	C	19.0	32.0	14.4	5.07	2	10.14	
-COMPACTOR	I	19.0	40.0	32.0	14.07	2	28.14	TWO UNITS PROVIDED(FAILURE OF ONE)
-DISHWASHER	D	19.0	24.0	26.0	6.86	1	6.86	BELOW COUNTER TOP LOCATION
-HAND WASHER	J	19.0	32.0	14.4	5.07	1	5.07	LOCATED WAIST HIGH-NEAR TABLE
-WATER HEATER	B	19.0	24.0	13.6	3.59	2	7.18	ONE UNIT ONE EACH SIDE OF GALLEY
-CHILLER/REHYDR	B	19.0	32.0	14.4	5.07	2	10.14	ONE UNIT NEAR EACH FREEZ/REFR PAIR
-HOUSE KP SUP #1	I	19.0	14.0	10.0	1.54	2	3.08	
-HOUSE KP SUP #2	I	19.0	24.0	13.6	3.59	2	7.18	

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42 CYLINDER

SHEET NO. 9 /

LAYOUT NO. 751B-B3A-310

DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION (")			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
		W	D	L/H				
I-GALLEY/WARDROOM								
•GALLEY UNITS								
-UTENS/APPL	B	19.0	14.0	10.0	1.54	2	3.08	
-TRASH STOW	D	19.0	24.0	26.0	6.86	1	6.86	UTILIZE COMPACTORS PROVIDED
-VEG BULK STW	G,H	19.0	24.0	26.0	6.86	4	27.44	LOCATED BELOW FOOD PREP COUNTERS
-GALLEY STOW	E,F	19.0	24.0	26.0	6.86	4	27.44	LOCATED BELOW FOOD PREP COUNTERS
•FACILITY VOL SUM								
-MODULAR UNITS							161.45	
-TABLE							(40.0)	
-CANTEEN							(18.0)	
-VEG BULK STOW							27.44	
-GALLEY STOW							27.44	
-MISCELL STOW							(44.08)	LISTED ON PG 105 AS MISC STOW VOL
-FREE VOLUME								
-TOTAL VOL								

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -4 1/2 CYLINDER

SHEET NO. 98

LAYOUT NO. 751B-B3A-310

DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION(")			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
		W	D	L/H				
2-CREW QUARTERS	Y							
•DECK UNITS								
-CREW STOW UNITS	Y	19.0	14.0	19.0	2.92	7	20.44	UNITS RETURNED TO EARTH WITH CREW
-TV/PC COMP	Y	19.0	14.0	19.0	2.92	1	2.92	SINGLE UNIT-KEY BOARD NOT SHOWN
-DESK(FOLDING)								NOT SHOWN AT THIS TIME
•SIDE UNITS								
-CREW STOW UNITS	Y	19.0	14.0	19.0	2.92	4	11.68	STACKED FROM FLOOR TO CEILING
-SLEEP BAG		20.0	2.0	73.0				CAN BE REPOSITIONED OR STOWED
-BULLETIN BOARD								NOT SHOWN AT THIS TIME
•FACILITY VOL SUM								
-MODULAR UNITS						11	32.12	
-MISC VOLS						1	2.92	
-STR/MISC								
-FREE VOLUME							108.00	
-TOTAL VOL							143.04	TOTAL FOR EACH CREW QTR-6 SHOWN

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42' CYLINDER

SHEET NO. 99

LAYOUT NO. 751B-B3A-310

DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION (")			UNIT VOL (C. FT.)	QTY	TOTAL VOL (C. FT.)	REMARKS
		W	D	L/H				
3-HEALTH MAINT FACIL	V							
•DECK UNITS								
-MED MOD UNITS	V	19.0	14.0	19.0	2.92	16	46.72	MODULAR UNITS-FLOOR TO CEILING
•SIDE UNITS								
-MED MOD UNITS	V	19.0	14.0	19.0	2.92	8	23.36	MODULAR UNITS-FLOOR TO CEILING
•MISC ITEMS								
-EXAM TABLE		20.0				1		INCLUDED IN FREE VOLUME TOTAL
•FACILITY VOL SUM								
-MODULAR UNITS						24	70.08	
-MISC VOLS								
-STR/MISC								
-FREE VOLUME							216.00	
-TOTAL VOL							286.08	

TOT-I

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42 CYLINDER

SHEET NO. 100

LAYOUT NO. 751B-B3A-310

DESIGN ENGR: GENE W. HARMS

DATE: _____

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION(*)			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
		W	D	L/H				
4-HEALTH EXER FACIL	W							
•DECK UNITS								
-MOD STOW UNITS	W	19.0	14.0	19.0	2.92	(6)	(17.52)	LISTED ON PG 105 AS MISC STOWAGE
-TV/PC COMP	W	19.0	14.0	19.0	2.92	2	5.84	
-SPEAKERS	W	19.0	14.0	19.0	2.92	2	5.84	
-BOOK UNITS	W	19.0	14.0	19.0	2.92	6	17.52	
•SIDE UNITS								
-MOD STOW UNITS		19.0	14.0	19.0	2.92	(8)	(23.36)	LISTED ON PG 105 AS MISC STOWAGE
•MISC ITEMS								
-ERGOMETER		24.0	36.0	48.0		1	24.00	SHOWN AS FIXED EQUIP IN FREE VOLUME
-TREADMILL		24.0	48.0	60.0		1	40.00	SHOWN AS FIXED EQUIP IN FREE VOLUME
•FACILITY VOL SUM								
-MODULAR UNITS						(14)	(40.88)	LISTED ON PG 105 AS MISC STOWAGE
-MISC VOLS						10	29.20	
-EQUIPMENT							(64.00)	
-FREE VOLUME							216.00	
-TOTAL VOL							245.20	

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42' CYLINDER

SHEET NO. 101

LAYOUT NO. 751B-B3A-310

DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION (")			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
		W	D	L/H				
5-PERS HYGIENE FAC	O,R,S							
•MODULAR UNITS								
-GENERAL STOW	O	19.0	19.0	14.0	2.92	2	5.84	
-HAND WASH	O	19.0	14.0	19.0	2.92	1	2.92	
•SHOWER	R,S	34.00	----	74.0	32.0	1	32.0	DOMED ON BOTH ENDS-20" WIDE DOOR
•MISCELLANEOUS								
-WATER SUP TANK	Z	19.0	34.0	----	10.9	1	10.9	APPROX 80 GALS OF WATER
-WATER COL TANK	Z	19.0	34.0	----	10.9	1	10.9	APPROX 80 GALS OF WATER
•FACILITY VOL SUM								
-MODULAR UNITS						3	8.76	
-MISC VOLS						2	21.8	
-SHOWER						1	32.0	
-STR/MISC								
-FREE VOLUME							28.0	(ROOM FOR ONE OCCUPANT ONLY)
-TOTAL VOL							150.27	(HYG CMPT=128.47 CF, TANKS=21.8 CF)

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42' CYLINDER

SHEET NO. 102

LAYOUT NO. 751B-B3A-310

DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION(*)			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
		W	D	L/H				
6-WASTE COLL FAC	O.R.S							
•MODULAR UNITS								
-GENERAL STOW	O	19.0	19.0	14.0	2.92	2	5.84	
-HAND WASH	O	19.0	14.0	19.0	2.92	1	2.92	
-GENERAL STOW	S	19.0	19.0	14.0	2.92	2	5.84	
-GENERAL STOW	S	19.0	14.0	19.0	2.92	1	2.92	
•MISCELLANEOUS								
-URINE/FECAL COL	R	19.0	----	----	12.6	1	12.6	FORMED FACTORED TO ZERO G OCCUPANTS
-FECAL COLL MOD	Z	19.0	34.0	----	10.9	1	10.9	REMOVABLE UNIT-RETURN TO EARTH
-URINE COLL MOD	Z	19.0	34.0	----	10.9	1	10.9	CAN BE USED TO REPROCESS WATER
•FACILITY VOL SUM								
-MODULAR UNITS						6	17.52	
-URINE/FECAL COL						1	12.6	
-MISC VOLS						2	21.82	(TANKS BELOW DECK)
-STR/MISC								
-FREE VOLUME							61.5	(ROOM FOR TWO OCCUPANTS)
-TOTAL VOL							150.27	(WC CMPT=128.47 CF, TANKS=21.8 CF)

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HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42 CYLINDER SHEET NO. 103
 LAYOUT NO. 751B-B3A-310 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION (")			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
		W	D	L/H				
7-WORK STATIONS								COMBINED WTH PAYLOAD OPS STA
•OPS CONTROL STA								
-VERT DISP PNLS								
-HORIZ CNTL PNLS								
-MOD STOW UNIT								
•PAYLOAD OPS STA	M,N,O,P							
-VERT DISP PNLS	M,N	19.0	6.0	30.0	2.0	2	4.00	ONE VIEWING WINDOW PROVIDED
-HORIZ CNTL PNLS	O,P	19.0	6.0	30.0	2.0	2	4.00	
-MOD STOW UNIT	M,N	19.0	24.0	26.0	6.86	2	13.72	
•MTN/REPAIR STA	M,N,O,P							
-VERT DISP PNLS	M,N	19.0	6.0	30.0	2.0	2	4.00	ONE VIEWING WINDOW PROVIDED
-HORIZ CNTL PNLS		----	----	----	----			
-WORK BENCH	O,P	30.0	----	40.0	5.7	1	5.70	
-MOD STOW UNIT	M,N	19.0	24.0	26.0	6.86	2	13.72	
•FACILITY VOL SUM								
-MODULAR UNITS						4	27.44	
-MISC VOLS						7	17.70	
-TOTAL VOL								

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42' CYLINDER SHEET NO. 104
 LAYOUT NO. 751B-B3A-310 DESIGN ENGR: GENE W. HARMS DATE:

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION (")			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
		W	D	L/H				
8-EQUIPMENT								
•ECLSS								MODULAR REMOVABLE/REPLACEABLE UNITS
-MOD UNIT #1	A	40.0	40.0	----	50.0	2	100.0	
-MOD UNIT #2	A	40.0	40.0	----	59.0	2	118.0	
-MOD UNIT #3	A	40.0	40.0	----	59.0	2	118.0	
-SUB TOTAL ()						(6)	(336.0)	
•DATA MGMT	T,U							MODULAR RACK MOUNTED UNITS
-MOD UNIT #1	T,U	19.0	14.0	10.0	1.54	4	6.16	
-MOD UNIT #2	T,U	19.0	24.0	13.6	3.59	4	14.36	
-MOD UNIT #3	T,U	19.0	32.0	14.4	5.07	4	20.28	
-MOD UNIT #4	T,U	19.0	40.0	32.0	14.07	4	56.28	
-SUB TOTAL ()						(16)	(97.08)	
•COMM/TRACKING	L							MODULAR RACK MOUNTED UNITS
-MOD UNIT #1	L	19.0	14.0	10.0	1.54	1	1.54	
-MOD UNIT #2	L	19.0	24.0	13.6	3.59	1	3.59	
-MOD UNIT #3	L	19.0	32.0	14.4	5.07	1	5.07	
-MOD UNIT #4	L	19.0	40.0	32.0	14.07	1	14.07	
-SUB TOTAL ()						(4)	(24.27)	
-TOTAL VOL.								

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42 CYLINDER

SHEET NO. 105

LAYOUT NO. 751B-B3A-310

DESIGN ENGR: GENE W. HARMS

DATE:

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION(")			UNIT VOL (C. FT)	QTY	TOTAL VOL (C. FT)	REMARKS
		W	D	L/H				
9-MISCELLANEOUS								
•CLOTHES WASHER	J	19.0	40.0	32.0	14.07	1	14.07	FRONT LOADED UNIT
•CLOTHES DRIER	J	19.0	40.0	32.0	14.07	1	14.07	FRONT LOADED UNIT
•OXYGEN MASKS	J	19.0	14.0	10.0	1.54	2	3.08	
•OXYGEN MASKS	J	19.0	24.0	13.6	3.59	2	7.18	
•CREW RESTRAINTS								
•EQUIP RESTRAINTS								
•SAFE HAVEN MODS	X	19.0	34.0	----	10.9	4	43.6	SHOWN AS 4 REMOVEABLE MODULAR UNITS
•SPARES MOD STOW	K,L	19.0	14.0	10.0	1.54	3	4.62	
•SPARES MOD STOW	K,L	19.0	24.0	13.6	3.59	3	10.77	
•SPARES MOD STOW	K,L	19.0	32.0	14.4	5.07	3	15.21	
•SPARES MOD STOW	K,L	19.0	40.0	32.0	14.07	3	42.21	
•SPARES MOD STOW	O,P	19.0	24.0	26.0	6.86	4	27.44	
(SPARES SUB TOTAL							(100.25)	
•MISC STOWAGE								
-COUNT TOP CABINT	D-H				15.2	2	30.4	VOL IN GALLEY COUNTER TOP CABINETS
-TABLE BASE STR		19.0	16.0	13.0	2.28	6	13.68	VOL IN BASE STRUCT OF TABLE
-HEALTH EXER AREA		19.0	14.0	19.0	2.92	14	40.88	THESE MODS IN HEALTH EXERCISE FACIL
(MISCL SUB TOTAL)							(84.86)	
-TOTAL VOL								

HABITAT FACILITY/EQUIPMENT VOLUME DATA LIST

CONFIGURATION: COMBINED HAB #1 & #2 -42 CYLINDER

SHEET NO. 106

LAYOUT NO. 751B-B3A-310

DESIGN ENGR: GENE W. HARMS

DATE: _____

FACILITY/EQUIPMENT	SECT LTR	UNIT DIMENSION(*)			UNIT VOL (C.FT)	QTY	TOTAL VOL (C.FT)	REMARKS
		W	D	L/H				
9-MISCELL (CONTD)								
•UTILITIES RUN								4 SECTORS PROVIDED IN CROSS SECTION
•LIGHTING								NOT SHOWN
-TOTAL VOL								


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HABITAT EQUIPMENT AND VOLUME DATA SUMMARY SHEET

The values listed on the previous ten (10) pages have been summarized and listed on this table. The NASA reference baseline values are also listed for comparison purposes. In general all volumes have been met or exceeded.

HABITAT EQUIPMENT AND VOLUME DATA SUMMARY SHEET

CONFIGURATION: COMBINED HAB #1 & #2 -42 CYLINDER SHEET NO. 107
 LAYOUT NO. 751B-B3A-310 DESIGN ENGR: GENE W. HARMS DATE: _____

FACILITY/EQUIPMENT	NASA BASELINE		COMBINED HABITAT	REMARKS	
	HAB#1	HAB#2	TOTAL VOL(CU.FT)		
1-WARDROOM/GALLEY					
•RACK MTD EQUIP	108.0	-----	161.45	REDUNDANCY OF FACILITIES PROVIDED	+ 53.45
•BULK VEG STOW	117.3	-----	27.44	REMAINDER OF BULK STW IN LOG MOD	-----
•GALLEY STOW	20.0	-----	27.44		+ 7.44
2-CREW QUARTERS	-----	150.0	210.24	TOTALS FOR 6 CREW QUARTERS	+ 60.24
3-HEALTH MAINT FACIL	88.0	-----	70.08		- 17.92
4-HEALTH EXER FACIL	64.0	-----	93.20	NASA UNITS FOLD-UP.THESE ARE FIXED	+ 29.20
5-PERS HYGEINE FACIL	7.0	7.0	30.56	INCLUDES 21.8 CF OF WATER TANKS	+ 16.56
6-WASTE COLLEC FACIL	7.0	7.0	39.32	INCLUDES 21.8 CF OF COLL TANKS	+ 25.32
7-WORK STATIONS	20.0	125.0	45.14	COMBINED WORK STAS & STOW	- 99.86
8-EQUIPMENT					
•ECLSS	331.0	331.0	336.00	SHOWN AS MODULAR REMOVEABLE UNITS	+ 5.00
•DATA MGMT	24.0	73.0	97.08	BASELINE EQUIP TOTALS COMBINED	+ 0.08
•COMM/TRACKING	8.0	24.0	24.27	BASELINE EQUIP TOTALS COMBINED	- 7.73
•POWER/THERMAL	96.0	96.0			
9-MISCELLANEOUS					- 8.60
•WASH/DRIER/MASKS	8.0	47.0	38.40		
•SAFE HAVEN	50.0	50.0	43.60		
•EQUIP RESTRAINTS	6.0	6.0	-----	NOT CALCULATED	
•SPARES	100.0	100.0	100.25	USE 100 CF AS REQMT FOR SPARES	+ 0.25
•MISCELL STOW	90.0	90.0	84.96	USE 90 CF AS REQMT FOR MISC STW	- 5.04
•UTILITIES	73.0	73.0	327.60	WPM.#2 UTILITIES IN 4 CORNER TRUSSES	+ 254.6
•LIGHTING	19.0	19.0	-----	NOT CALCULATED	
(TOTALS)	1236.3	1208.0	1757.03		

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