SHUTTLE ORBITER HABITABILITY STUDY

CONTRACT SUMMARY REPORT

NASA-CR-128863

73-19162

JANUARY 1972/DECEMBER 1972

RAYMOND LOEWY/WILLIAM SMITH, INC.

REPREATED FOR NASA BY

140 EAST 59 STREET, NEW YORK, N.Y. 10022
**PREFACE**

**TABLE OF CONTENTS**

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Section A - Shuttle Orbiter Crew Compartment</td>
</tr>
<tr>
<td>2</td>
<td>Section B - Shuttle Orbiter Passenger Compartment/Flight Deck</td>
</tr>
<tr>
<td>3</td>
<td>Section C - Restroom for Hygiene Facility (Phase I)</td>
</tr>
<tr>
<td>4</td>
<td>Section D - Small Passenger Coach</td>
</tr>
<tr>
<td>5</td>
<td>Section E - Food System and Galley</td>
</tr>
<tr>
<td>6</td>
<td>Section F - Temporary Restrooms</td>
</tr>
<tr>
<td>7</td>
<td>Section G - Restroom System for Hygiene Facility (Phase I)</td>
</tr>
<tr>
<td>8</td>
<td>Section H - Skewed Z-Axis Dock/Alitdock System Shuttle Coach</td>
</tr>
<tr>
<td>9</td>
<td>Section I - Positive Restrooms (Phase I)</td>
</tr>
<tr>
<td>10</td>
<td>Section J - Positive Restrooms (Phase II)</td>
</tr>
<tr>
<td>11</td>
<td>Section K - Shuttle Orbiter Passenger Coach</td>
</tr>
<tr>
<td>12</td>
<td>Section L - Data Format Card</td>
</tr>
<tr>
<td>13</td>
<td>Section M - Housekeeping Equipment Storage</td>
</tr>
<tr>
<td>14</td>
<td>Section N - Storage Locker System</td>
</tr>
<tr>
<td>15</td>
<td>Full Scale Model</td>
</tr>
<tr>
<td>16</td>
<td>Table of Contents</td>
</tr>
</tbody>
</table>
Flite orientation
Convenient access to hygiene compartment throughout entire
calley location which is readily accessible to space couches.
with flight deck personnel.
Flight engineer provided with ability to maintain visual contact
social orientation of space couches.
Reorientation of crew compartment component to improve
Emergency hatch.
Provisions for adequate escape aisle (passageway) from couches to
in the mock-up for this configuration were as follows:
The design recommendations which were developed and incorporated
and full compartment model.
evaluated by fabricating a full-scale, partial compartment mock-up
X-axis docking crew compartment/ X-axis Docking
Shuttle Orbiter Crew Compartment/X-Axis Docking
A3 - Full Size Mock-Up of Food Management

In the Launch Orientation

A2 - Lowry/Smart Shuttle Orbiter Model of Couches

A1 - Lowry/Smart Crew Compartment Configuration

of X-axis Docking Concept
deck area with much more versatile hardware. We illustrated that to accomplish this goal would require a larger flight

mean of separate leisure and sleep facilities in that area. area we were requested to look into with the objective being the establishment

The isolation of the flight deck from the crew compartments was another

convenience during launch, reentry and zero-G flight.

convenient to consider less strenuous techniques of maneuverability through.

With the knowledge that future space flights may include the elderly, it was

during the various flight modes.

In developing concepts aimed at solving the problems of space craft access

In the passenger compartment study, Loewy/Sanft was primarily interested

Shuttle Orbiter Passenger Compartment and Flight Deck Flexibility

DESCRIPTION

TASK

SECTION

3
The design of various restroom systems was pursued after the hygienic concept less space was utilized and component replacement was simplified. By placing the fecal/urinal collector and hand wash units on adjacent walls, running in stature from a 95% male to 5% female, the adjustments in the layout were required to accommodate women. Preliminary analysis of the WC compartment configuration demonstrated the relative merits of various restroom concepts under identical conditions. It is important to first base line a hygienic compartment design to determine the best possible design from a restroom study, lowest/smallest, etc. considered.

To obtain useful data from a restroom facility (Phase I) task description.
The privacy screen is in place, all are located within arms length of the crewman and operable while mental controls and emergency equipment are organized for quick retrieval. Immediate access items, such as personal gear, environment, \[ \text{This change allows the support planes to be designed to the maximum allowed space.} \]

Frame rather than being contained within it as in earlier concepts, the small passenger coach body support planes ride on top of the structural launch, adjusting from flat for sleeping, to upright, for in-flight leisure and then the larger coach maneuvers into the same orbitations, and contains more storage space limited to 77.5” X 27” X 14”. It performs the same functions and couch helped establish the design direction for the smaller one which was experience and knowledge gained from the development of a large passenger
description
task
dsection
concepts as explained in the final report. Partition were achieved by incorporating specialized packaging and graphics. By cubic feet, the desired goal. Reductions in food retrieval and preparation minimized dead air space and reduced the overall volume to less than 80 cubic feet. This modification than realized U-shaped facades as in the MSG system. This modification resulted in three concept systems. A significant change in the system preparation process. Two-dimensional sketch and layout studies conducted a reduction in overall volume and a simplification of the food retrieval/operation. MSC requested that Raymond Loewy/William Snell, Inc. Review Order Food System and Callery.
when not in use.

and collapsible units which would totally or partially fold out of sight

Concerns for the overhead clothing storage units included both fixed units

and ease of access.

The clothing restorers were organized for maximum seasonal efficiency

areas by order level to prevent soiling of relatively cleaner items.

recommended that the garments should be segregated into isolated

placed on the prevention of odor transfer between garments. The

in the development of the overhead clothing storage unit, emphasis was

Temporary Clothing Restorer

DESCRIPTION

TASK

SECTION
Concepts presented included the use of non-porous, easily cleaned belts, and disposable tissue underlays between the belt structure and the user's skin.

Physical access and Minimun body contact, area of the restraint across the chest area for optimal visual and were established and emphasis was placed on minimizing the surface parameters for an efficient seat belt to be used in the hygiene facility.

The system, which was maximum simplicity, an adjustable restraint device which we felt defined the objective of variances in their elbow and shoulder widths, necessitated the design of a dimensional system to accommodate a full range of body sizes. The dimensional study demonstrated that the concept was unrealistic if the 95% make crew personnel when a seat belt restraint was not required, an elbow and shoulder restraint was only by 5% female through and including.

As a result of the Phase I study, interest was developed in investigating...

DESCRIPTION

TASK

SECTION
C1 - Clothing Coupler to Side Wall of Head

C2 - Dimensions of Seated Personnel - 50% and 95%

C3 - Semi-Rigid Belt restraint with Velcro Fastener

BIBBOW/Shoulder Variations in Location

GL - Loewy/Swath Hygiene Compartment Showing
recognition.

needed to their fullest extent because of present requirements placed on
able relationship between compartments. Special volumes have not been
lowery/Sheath does not feel that this solution adequately produces a work-

cored. If prevents effective of the available spacevolume.
useable space in the compartment. Positioned in the center of the
able chemical to analyze the impact of the skewed Z-axes in the
Orbiter was constructed to analyze the impact of the skewed Z-axes in
A 1/20 scale model of an MSC layout of the Z-Axis Docking Airlock Shuttle

DESCRIPTION

TASK

SECTION
The concepts developed were to allow the restricted individual to walk parallel to a work bench utilizing various movable or random access points selected, therefore, were the wrist and both feet. It was decided that a three point restraint was necessary for stability.

Both areas are required to adequately produce a positive restraint. Although individual illustrations centered on either the foot or wrist area, as necessary to complete a particular task.

It was necessary to familiarize him with the restraint, thus allowing him to concentrate fully on the task. The development of a flexible positive restraint which will allow a crewman...
Adjustment
10 - Foot Restraint with Foam Pad and Tension

13 - Matching Protrusion Devices on Sole of Shoe and

Foot Area of Workbench

Couplings with Belt Loops
12 - Horizontally adjustable Restraint Arm which

Restraint on Belt
11 - Flexible Restraint Arm which adjusts to Butto
An adjustable toe bar located near the base of the unit allows forward

bench. Length adjustment allows the cremator to adjust the distance from the

The track allows the arms to slide the length of the bench while the arm

in use, the arms fold out a recess and couple into the cremator's belt.

sliding track with coupled located on adjustable fold away arms. When

from the bench. The front surface of the bench also incorporated a

tee lateral movement with slack adjustment to enable movement away

belts system was located on the front surface of the bench which allowed

was constructed incorporating all of the selected concepts. A closed loop

To better evaluate the effectiveness of each system, a presentation model

selected location.

reorienting back and an adjustable toe bar resistant to restraint feet in a

In Phase I, 'Letter/Swath illustrated the practicability of several concepts

DESCRIPTION

TASK

SECTION
The purpose of this model was to demonstrate and evaluate the features in the original couch concept and was constructed for compatibility with neutral buoyancy testing.

The couch is designed to provide all immediate needs of the crewman during leisure, sleeping, eating periods in zero-G and provide proper support for crew members during launch and reentry. Storage provisions, which are accessible while on the space couch are included to house garments and personal effects. Privacy is provided for by a roll out screen which folds away when not in use.
the card, the models developed stress simply of form of organization.

phonations to personalize the responses. To prevent crew impression with ex-

It is lowey/lowly feeling that all answers should be brief, but allow ex-

Recorded and transferred to ground control for analysis for future missions. All responses to questions on the data form sheet are voice-

for evaluation of tasks and equipment at scheduled intervals in the Skylon.

The data format card is designed to serve as a guide to Skylab astronauts.

DESCRIPTI

DATA FORMAT CARD

TASK

SECTION
A light visual scale model of the selected concept was fabricated and pre-tested.

The design of the unit was developed with the aid of full scale human subject mock-ups.

It was decided that the unit would be modular, and that it would be encased to prevent dispersion of cleaning agents and waste. The storage units within the caddy are separate, and the caddy may be carried as one or separately. The caddy and vacuum unit were designed as two interlocking units which

act together.

The three basic parts: a master storage unit for central supply, a portable vacuum unit and a portable "caddy" section equipped with a limited supply of wipes, disinfectants, etc. to support general housekeeping.

The housekeeping equipment stored in the galley facility consists of:

- Housekeeping Equipment Storage
Threaded liftings are arranged in a matrix in the structure.

Are attached to the same structure by launching threaded fasteners into locations based on the physical constraints of that location. The outer cases are able to provide the largest storage unit possible for each storage option would be to provide the largest storage unit possible for each storage option. The object of the master locker size is to be able to various sizes based on a set modular growth pattern (i.e., 24" X 24" X 16", etc.)

The system developed utilizes standard storage locker which would be available.

The methods of testing are interchangeable, tray sizes are dependent on the size of the storage locker being used, however, the components on the trays are restricted using various techniques. The unit to a location within the space does not go beyond being a unit, it necessary, to transport that particular unit, or a group of units, or a module, as a unit or individually.

Inside the storage lockers is a system of trays (slid into "C" shaped ex-

Mission storage requirements vary from one mission to another,
contain, may be removed as desired.

A system from which individual trays in total groups and the items they
required. The end result of this system is that a totally flexible storage
between horizontal trays allows one to subdivide the case horizontally as
- without further additions. Stacking various width trays into the locker vertically be-
- increments into any propositions desired relative to mission storage ex-
and interlock with each other in the same manner. Using trays as wide
by using flat tray inserts which interlock with the extruded inside walls.
The interior of the master storage locker is then divided up as required.
SUMMARY

This report summarizes each study which are more thoroughly covered in the final report. Each study is completed during the 1972 contract period for the Houston, Texas, Spacecraft Center. Selected illustrations and copies of all tasks completed during the 1972 contract period for the contract summaries of this report are required by NASA contract #NASA-9-12479. This report summarizes the

FOREWORD