GRUMMAN

LONG DURATION
EXPOSURE FACILITY
ST-01-A
AUTOMATED PAYLOAD
Volume I of VI

Prepared for

National Aeronautics and Space Administration
Marshall Space Flight Center
Huntsville, Alabama

by

Grumman Aerospace Corporation
Bethpage, New York 11714

Contract No. NAS 8-31102

Mission No. 4
March 1974 Traffic Model

OPERATIONS PLANNING SIMULATION

MODEL EXTENSION STUDY

FINAL REPORT

REPORT NO. SU OPS-RP-75-0001

PREPARED FOR

THE GEORGE C. MARSHALL SPACE FLIGHT CENTER

HUNTSVILLE, ALABAMA

CONTRACT NUMBER

NAS8-31102

PREPARED BY

GRUMMAN AEROSPACE CORPORATION

PRODUCT SUPPORT DEPARTMENT

BETHPAGE, NEW YORK

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OPERATIONS PLANNING SIMULATION MODEL STUDY
(Contract NAS8-31102)

This is the final report of Contract NAS8-31102 and is submitted by the Grumman Aerospace Corporation, Bethpage, N. Y., in accordance with the terms and conditions of the contract.

The final report is packaged in six (6) volumes, entitled:

Volume I   -   Long Duration Exposure Facility (LDEF), Payload No. ST-01-A

Volume II   -   Life Sciences Shuttle Laboratory, Payload No. LS-09-S

                             Biomedical Experiments Scientific Satellite, Payload No. LS-02-A

Volume III   -   Dedicated Solar Sortie Mission (DSSM), Payload No. SO-01-S

Volume IV   -   Magnetic Spectrometer, Payload No. HE-15-S

Volume V   -   Mariner Jupiter Orbiter (MJO), Payload No. PL-12-A

Volume VI   -   Expanded Functional Flows and Descriptions

SUMMARY

I Study Objective

The objective of the Study was to evaluate the Launch Site Facility
Requirements Data Sheets for selected Automated and Sortie Payloads.

The Study achieved the objective by:

o Expanding the NASA launch site Level O functional flow activities to
a depth required to identify payload launch site facility and support
requirements (Volume VI contains the generic functional flow activities
for Automated and Sortie payloads).

o Conducting analyses of the payload definitions contained in the Level B
Data issued by SSPD from the launch site ground processing viewpoint.

o Processing the payloads through the expanded functional flow activities,
and identifying the launch site facility and support requirements.

o Comparing the generated requirements with those contained in the Launch
Site Facility Requirements Data Sheets.

II Study Recommendations

Recommendations from the Study include:

o Expansion and revision as appropriate of the Level B Data (SSPD) to
define in detail the payload ground requirements, based upon the
launch site functional flow activities, as well as performing Level II
(not Level III) integration at the launch site.

Specific data sheets involved are:

- On-Orbit Checkout/Monitor/Control Equipment (Data Sheet No. A-9 and
A-12)

- SKETCHES (Data Sheets No. A-10, S-5, and S-6), with emphasis on the
configurations at launch site arrival and installed in Orbiter cargo
bay.

- Interface Diagrams (Data Sheet No. S-7) showing the interfaces for
monitoring and checkout during launch site ground processing.

- Data and Communications Checkout and Deployment Support/On-orbit
Operations Support (Data Sheets No. A-14, A-15, S-19, and S-20).

- Launch/Landing Support Requirements (Data Sheets No. A-18 and S-22).

- Ground Facility Requirements (Data Sheets No. A-19 and S-23).

- Ground Environmental Limits (Data Sheets No. A-20 and S-24).

II Study Recommendations (Cont'd.)

o Definition and descriptions to Level 4 or 5 of the launch site functional flow activities.

o Investigation of payload ground requirements at the launch site which are identified as cost drivers for ground processing in this report.

III Future Investigative Areas

Cost effective processing of payloads at the launch site requires further studies and analyses. One area which would provide fruitful results is the generation of detail scenarios of representative payloads by disciplines for Payload Working Groups approval/modification. These detail scenarios would include the ground processing for:

o Block 1.0 Activities - Payload Premission Processing
o Block 2.0 Activities - Orbiter/Payload Integration and Checkout
o Block 3.0 Activities - Prelaunch and Launch Operations
o Block 4.0 Activities - Recovery Operations
o Block 5.0 Activities - Post Mission Processing

Descriptions and required outline drawings would be provided to define in detail such ground functions and configurations as:

o Payload and associated ground control and support equipment launch site arrival configurations, transportation and environmental modes, and arrival servicing and inspection/monitoring requirements.

o Payload calibration
o Monitoring
o Checkout
o Servicing
o Intra-launch site transportation

The Grumman Aerospace Corporation would be pleased to assist the NASA/MSFC in performing additional studies and analyses to implement effective payload ground processing.

MISSION #4 - LONG DURATION EXPOSURE FACILITY (LDEF)

AUTOMATED PAYLOAD

FUNCTIONAL FLOW DESCRIPTIONS AND PAYLOAD REQUIREMENTS

FOR GROUND AND LAUNCH SUPPORT FACILITIES

Block 1.0 - Activities - Payload Premission Processing

Block 1.1   Receive and Inspect Payload Elements

Block 1.1.1   Payload elements arrive at launch site via barge for the shell and via truck for the rack-mounted experiment equipment (Data Sheet No. A-9 of Level B Definition and Requirements Data - P/L #ST-01-A, dated 6/18/74, defines equipment). Estimate is made that this equipment is rack-mounted in Orbiter Cargo Bay. Figure 1-1 shows anticipated configuration upon arrival at launch site, and Figure 1-2 shows anticipated configuration in Orbiter Cargo Bay.

The logic of selecting barge transportation for the shell from the NASA LDEF Development Center to the launch site is based upon the size of shell shipping container which is approximately 18 feet in diameter and 33 feet long. The ground rule that the Guppy-Type Aircraft is not available and the C5A aircraft is limited to a maximum diameter of about 13.2 feet, eliminates air transportation. It is not feasible to transport this size object via land transportation, thus sea (or barge) transportation appears to be the logical transportation mode for the shell.

Ground and Launch Support Facility Requirements

This block establishes the initial conditions of the experiments upon arrival at the launch site, and does not involve ground and launch support facility requirements.
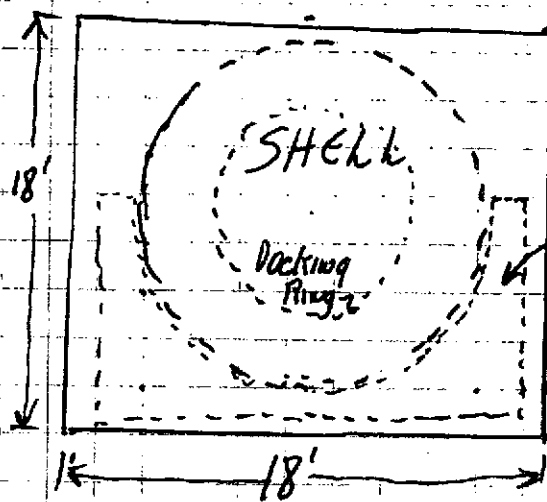
LDEF Anticipated Configuration upon Arrival at launch site

WT = 8300 lbs

SHELL

Docking Ring

Shipping CRADLE

SHipping CoNTAiNER
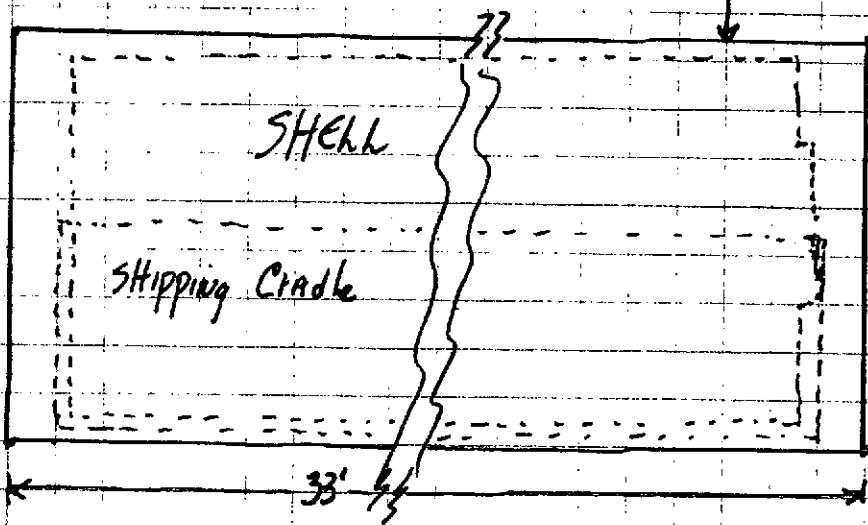
18'

18'

1'

SHELL

Shipping Cradle

33'

(Flight Cable Set?)

Rack Equipment (Two racks)

Shipping Container

Rack-Mounted Equipment

3'

5'

Weight = 200 lbs

4'
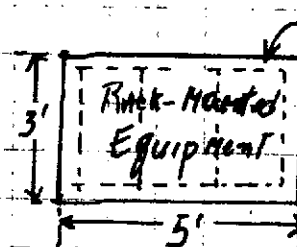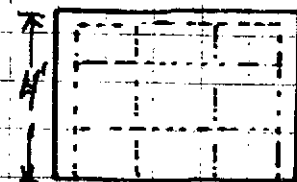
Ground Support Equipment
(Two racks of GSE)

Shipping Container

GSE

3'

5'
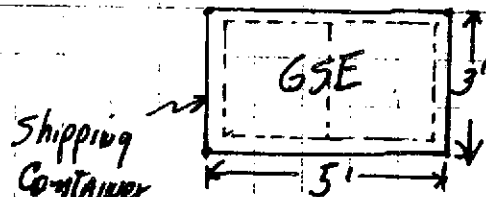
Weight = 200 lbs
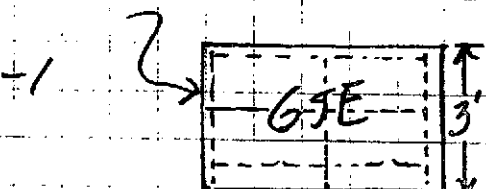
(Verification Tests Cable Set?)

GSE

3'

Figure 1-1

LDEF Block Diagram

Rack Dimensions
Length = 1.22 m (4')
Width = .61 m (2')
Height = .92 m (3')
Weight = .66 Kg (≐ 150 lbs)
150

Shell Dimensions:
Length = 9.25 m (≐ 30.3')
Dia. = 4.32 m (≐ 14.2')
Weight = 3856 Kg (≐ 7800 lbs)

A-9 Equip't

Docking Ring

ORBITER
Payload specialist Station

Rack #1

Rack #2

SHELL

ORBITER CARGO BAY
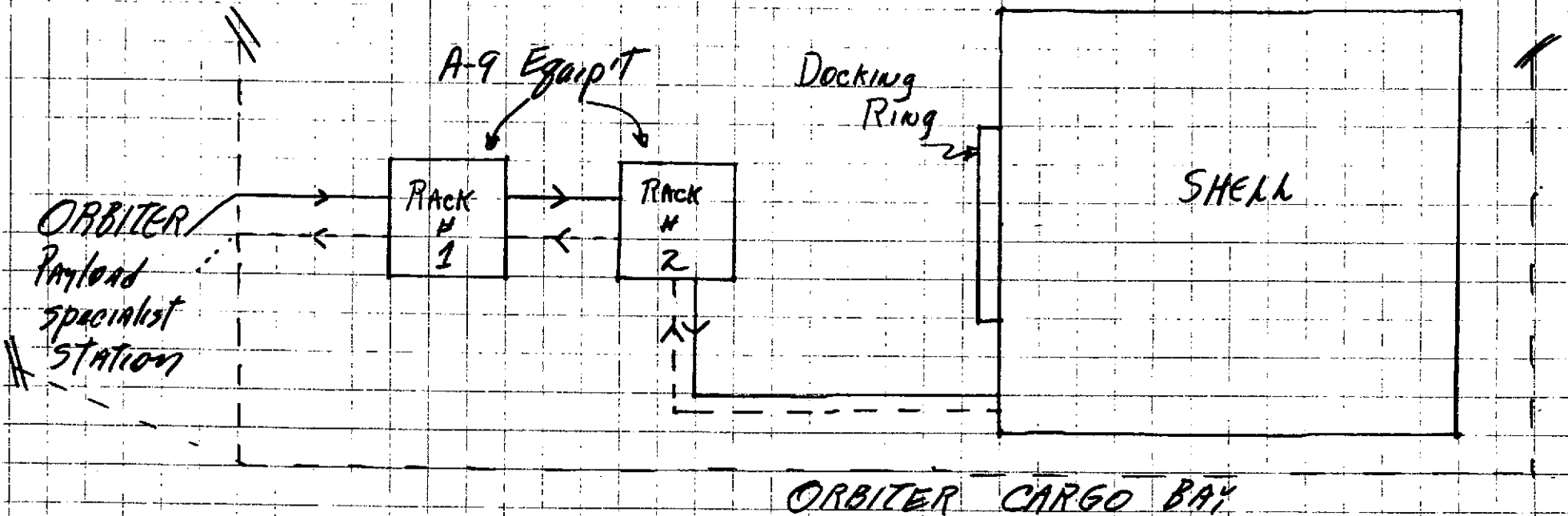
- Command Channels = ———
- Monitor/Record Channels = - - - -

1-2
Figure 1.4

Block 1.1.2   Unload Payload elements from commercial carrier and place in temproary storage

       The shell in its shipping container is hoisted from the barge which has been secured to the unloading dock at the launch site. The shell shipping container is lowered to a flat bed trailer and transported over existing launch site roadways to a temporary protected storage area where the rig remains until required in the Payload Processing Facility (PPF).

       The rack-mounted experiment equipment is removed from commercial truck/s and placed in temporary protected storage until required for PPF processing.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Dockside unloading crane (10,000 lbs. capacity, 20 feet vertical travel capability).

o   Flat bed trailer (10,000 lbs. capacity, 35 feet long, 10 feet wide).

o   Tow tractor.

o   Protected storage area (Hangar-type protection satisfactory).

    -   37 ft. long, 20 ft. wide, 24 ft. high for shell shipping container on flat bed trailer.

    -   15 ft. long, 10 ft. wide, 5 ft. high for rach-mounted experiment equipment.

o   Fork lift trucks.

Support Requirements

o   Shell shipping container hoisting sling.

o   Tie-down kit (shell shipping container to flat bed trailer).

o   Operators for dockside unloading crane, tow tractor, fork lift truck.

o   Traffic security personnel.

o   Wheel chocks for flat bed trailer.

Block 1.1.2 (Cont'd)

Support Requirements   (continued)

o   Safety instructions for handling and towing shell shipping container.

o   Inventory Management.

Block 1.1.3   Transport payload elements for temporary storage

to receiving area of PPF.

The shell shipping container on the flat bed trailer and the rack-mounted experiment equipments are removed from the temporary storage area, and transported to the receiving area of the PPF. Since the shell shipping container has not been removed from the flat bed trailer, there is no loading/unloading of the shell container required. A tow tractor is connected to the trailer for the required move.

The rack-mounted experiment equipment is removed from temproary storage, loaded in a closed body truck, and transported to the receiving area of the PPF.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Tow Tractor.

o   Trucks ($2\frac{1}{2}$ ton, closed body).

o   Fork lift trucks.

o   Receiving area of PPF.

-    37 ft. long, 20 ft. wide, 24 ft. high for shell shipping containers on flat bed trailer (entry door 24 ft. high (shipping container = 18 ft.; trailer height = 3 ft., clearance = 3 ft.) and 20 ft. wide (shipping container - 18 ft.; clearance = 2 ft.).

-    15 ft. long, 10 ft. wide, 5 ft. high for rack-mounted experiment equipment (less length and width suitable if height increased by vertical stacking, or if equipment is received and unpacked in series from temporary storage area).

Support Requirements

o   Operators for tow tractor, $2\frac{1}{2}$ ton truck, and forklift trucks.

o   Traffic Security personnel.

o   Safety instructions for towing shell shipping containers.

o   Inventory management.

Block 1.1.4   Unpack Payload Elements and Place in Holding Fixture

Several approaches are available for unpacking the shell. The one described below minimizes the horizontal area requirements of the receiving area in the PPF.

The selected unpacking procedure follows:

Step 1.   Remove the roof bulkhead of the shell shipping container, and hoist clear.

Step 2.   Attach hoisting sling to shell, and hoist shell vertically, clear of shipping container.

Step 3.   Open PPF doors, and tow shipping container out of PPF receiving area.

Step 4.   Tow Holding Fixture in position under shell.

Step 5.   Lower shell into Holding Fixture.

The recommended "Holding Fixture" for the shell is a Cargo Bay Simulator (CBS) and is conceptually defined as a movable fixture which duplicates the Orbiter Cargo Bay as concerns mounting provisions, mechanical clearances including Cargo Bay Doors, manipulator installation, and all electrical and fluid interface connections. The CBS is wheeled to permit movement within the PPF, and serves as the transporter for payload transfer from PPF to OPF. The CBS is modular in construction, that is, built up in sections (such as 10ft or 15 ft.), such that forward and aft bulkhead sections contain the wheels. Thus, for the LDEF whose total length in the Cargo Bay is estimated to be 38-40 ft., the CBS is built-up on one forward bulkhead section of 10 ft., one aft bulkhead section of 10 ft., and two 10 ft. middle sections for a total length of 40 ft. (ten foot sections used for illustration),

Based on the above, the shell is unpacked and placed in the CBS.

The rack-mounted experiment equipment is removed from their shipping containers and placed on movable utility dollies.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Overhead crane (10,000 l.

<u>Facility Requirements</u>   (continued)

o   Fork lift truck.

o   Receiving area of PPF

  -     37 ft. long, 32 ft. wide (shipping container = 18 ft., sling

        handling - 12 ft.) and 40 ft. hook height under overhead crane

        (Trailer & shipping container = 21 ft. shell = 15 ft. hoisting

        sling and clearance - 4 ft. total 40ft.).

  -     15 ft. long, 10 ft. wide, 5 ft. high for rack-mounted experiment

        equipment.

<u>Support Requirements</u>

o   ~~Riggers~~ Operators for crane and fork lift trucks.

o   *Riggers*

o   ~~Riggers~~ Slings for hoisting shell shipping container roof bulkhead and

      the shell.

o   Tools and procedures for removal of shell shipping container roof bulkhead.

o   Tools and procedures for shell hoisting.

o   Cargo Bay Simulator (CBS).

o   Utility dollies.

o   Tools and procedures for unpacking rack-mounted experiment equipment.

Block 1.1.4.1 Transport P/L Element Shipping Containers to

Temporary/Long Term Storage

This block removes the shipping containers clear of ~~the~~ *the* PPF. After

completion of Block 1.1.6, the flat-bed trailer which holds the shell shipping

container is towed back into the PPF receiving area, and the shell shipping

container roof bulkhead is installed, and then the trailer is towed to long

term protective storage (six months). The shell shipping container is used to

return the shell to the NASA LDEF Development Center upon retrieval of the

shell after its six months space operations.

As understood, the rack-mounted experiment equipment returns to earth in

the Orbiter Cargo Bay, and does not accompany the shell durings its six month

orbit operations. The equipment, however, is re-installed in the Orbiter Cargo

Bay for the recapture mission. Therefore, the rack-mounted experiment equipment

shipping containers are removed from the PPF receiving area for short term

protective storage (one to two months), and will be re-used to return the

equipment to the NASA LDEF Development Center upon Orbiter landing after placing

the shell in orbit. These shipping containers are moved to storage, using fork

lift trucks and closed body trucks.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Overhead crane (1,000 lbs. capacity, 20 ft. vertical travel capability).

o   Fork lift truck.

o   Trucks ($2\frac{1}{2}$ ton, closed body).

o   Receiving area of PPF.

    -   Same as Block 1.1.3.

Support Requirements

o   Operators for overhead crane, $2\frac{1}{2}$ ton trucks, and fork lift trucks.

o   Riggers.

o   Sling for hoisting shell shipping container roof bulkhead.

o   Tools and procedures for installing shell shipping container roof bulkhead.

Support Equipment   (continued)

o   Tools and procedures for re-assembly of rack-mounted experiment equipment
     shipping containers.

Block 1.1.5   Conduct Visual Inspection and Record Transport Sensor

Readings to Verify Post-Transportation Integrity

Neither the shell nor the rack-mounted experiment equipment has installed transport sensors, so no recordings are required.

A visual inspection of the shell and equipment is made to verify experiment integrity.

Ground and Launch Support Facility Requirements

Facility Requirements

o   None.

Support Requirements

o   Procedures and inspection tools (flash light, mirror, etc.) for performing visual inspection.

Block 1.1.6   Move Payload Elements to Checkout Area in PPF

The shell mounted in the Cargo Bay Simulator (CBS) is towed to the checkout area in the PPF, and the rack-mounted experiment equipment is moved on utility dollies to the same area.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Tow tractor.

o   Cleared passage way from receiving area to checkout area (passage way 19 ft. wide (estimated width of CBS)), 18 ft. high (exterior height of closed CBS doors), and suitable for passage of 40 ft. long CBS).

o   PPF checkout area.

 -    52 ft. long (CBS = 40 ft., GSE and workstand, forward = 6 ft., workstand, aft - 6 ft.), 27 ft. wide (CBS = 15 ft; workstand, port and starboard = 6 ft. each); and 26 ft. high (CBS = 18 ft; workstand, top = 8 ft.).

 -    12 ft. long, 8 ft. wide, 4 ft. high for utility dollies.

Support Requirements

o   Tow tractor operator.

Block 1.1.20   <u>Payload GSE arrives at Launch Site Via</u>

The payload GSE arrives at launch site via truck. It is anticipated
that the GSE is mounted in two racks, with dimensions as shown in Figure 1-1.

<u>Ground and Launch Support Facility Requirements</u>

This block establishes initial conditions of LDEF GSE upon arrival at
the launch site, and does not require ground and launch support facility
requirements.

Block 1.1.21   Unload GSE from Commercial Carrier and Place in Temporary Storage

The LDEF GSE in its shipping containers is removed from commercial trucks, and placed in temporary protected storage until required for PPF processing.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Fork lift trucks.

o   Trucks ($2\frac{1}{2}$ ton, closed body).

o   Protected storage area (hangar type satisfactory)

     -    12 ft. long, 8 ft. wide, 4 ft. high.

Support Requirements

o   Operators for fork lift trucks, and $2\frac{1}{2}$ ton trucks.

o   Inventory management.

Block 1.1.22   Transport GSE from temporary storage to receiving area of PPF

When required for PPF processing, the LDFF GSE is moved from temporary storage to the receiving area of PPF.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Fork lift trucks.

o   Trucks ($2\frac{1}{2}$ ton, closed body).

o   PPF receiving area

    -    12 ft. long, 8 ft. wide, 4 ft. high.

Support Requirements

o   Operators for fork lift trucks, and $2\frac{1}{2}$ ton trucks.

o   Inventory management.

Block 1.1.23   Unpack GSE, and Place on Dolly

Upon arrival in the receiving area of the PPF, the LDEF GSE is unpacked and placed on movable utility dollies.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Fork lift trucks.

o   Movable utility dollies (5 ft. long, 3 ft. wide)

Support Requirements

o   Operators for fork lift trucks.

o   Tools and procedures for uncrating LDEF GSE.

Block 1.1.23.1   Transport GSE Shipping Containers to Temporary Storage

After uncrating the LDFF GSE, the GSE shipping containers are moved clear of the PFF receiving area to temporary storage. It is anticipated that the LDEF GSE will re-use the shipping containers after Orbiter launch for return of LDEF GSE to the NASA LDEF Development Center.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Fork lift trucks.

o   Trucks ($2\frac{1}{2}$ ton).

o   Temporary storage area.

    -     12 ft. long, 8 ft. wide, 4 ft. high.

Support Requirements

o   Operators for fork lift truck and $2\frac{1}{2}$ ton truck.

o   Inventory management.

o   Tools and procedures for reassembly of LDEF shipping containers.

Block 1.1.24   Conduct Visual Inspection and Record Transport Sensor

Readings to Verify Post-Transportation Integrity

LDEF GSE has no installed transport sensors, so recordings are not
required.

A visual inspection of the LDEF GSE is made to verify post-transportation
integrity.

Ground and Launch Support Facility Requirements

Facility Requirements

o   None.

Support Requirements

o   Procedures and inspection tools (flash light, mirrors, etc.) for performing
visual inspection.

Block 1.1.25   <u>Move GSE to Checkout Area of PPF</u>

     The LDEF GSE mounted on utility dollies is moved from the receiving area to the checkout area in the PPF.

<u>Ground and Launch Support Facility Requirements</u>

<u>Facility Requirements</u>

o   PPF Checkout Area.

    -   12 ft. long, 8 ft. wide, 3 ft. high for utility dollies.

<u>Support Requirements</u>

o   None.

Block 1.2   <u>Verify Payload Experiments</u>

For the LDEF, this block verifies the interfaces of the shell, and rack-mounted experiment equipment (Rack #1 and Rack #2), using LDEF GSE. In block diagram form, the verification of interfaces is shown below:

```
                                    Facility Power
                                         |
                                         v
 ┌─────────────────────┐      ┌─────────────────────────────────┐
 │                     │ <────│ GSE:                            │
 │       Shell         │      │                                 │
 │                     │ ────>│  o  Verification of interface   │
 │                     │      │     between Shell and Rack #2    │
 └─────────────────────┘      └─────────────────────────────────┘
```

```
                                    Facility Power
                                         |
                                         v
 ┌──────────────┐             ┌─────────────────────────────────┐
 │              │ <───────────│ GSE:                            │
 │   Rack #2    │             │                                 │
 │              │ ───────────>│  o  Verification of interfaces: │
 │              │             │     -  Between Rack #2 and Shell │
 └──────────────┘             │     -  Between Rack #2 and Rack #1│
                              └─────────────────────────────────┘
```

```
                          Facility Power, Computer Support
                                         |
                                         v
 ┌──────────────┐             ┌─────────────────────────────────┐
 │              │ <───────────│ GSE:                            │
 │   Rack #1    │             │                                 │
 │              │ ───────────>│  o  Verification of interfaces: │
 │              │             │     -  Between Rack #1 and Rack #2│
 └──────────────┘             │     -  Between Rack #1 and Orbiter PSS│
                              └─────────────────────────────────┘
```
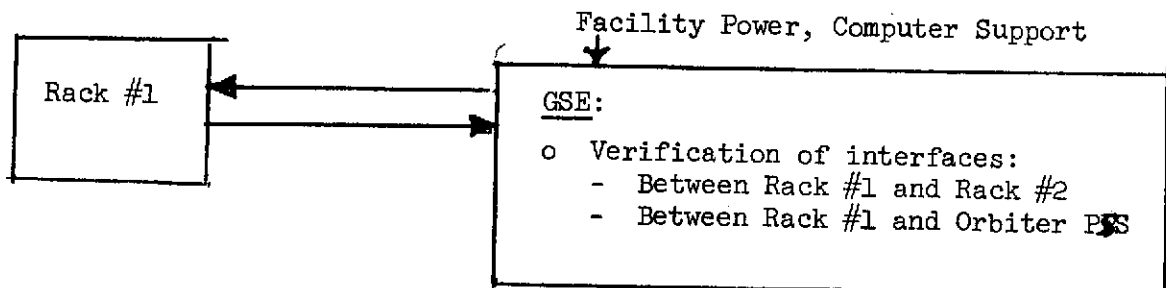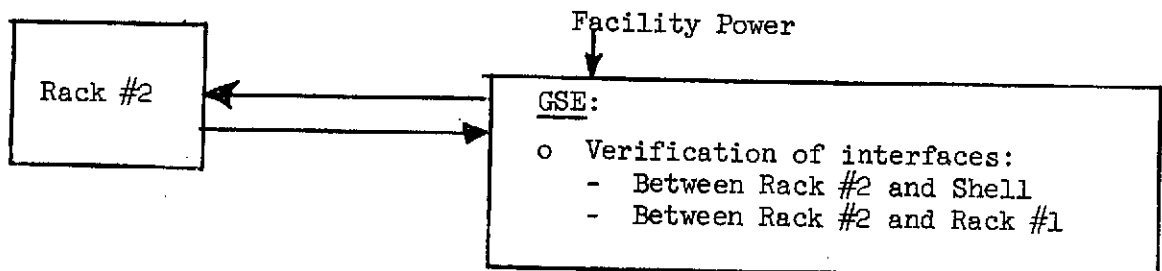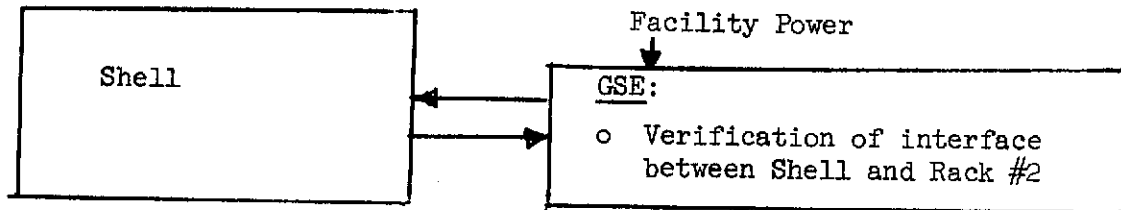
Block 1.2.1   Perform Functional Check and Calibration of GSE

Level B Definition and Requirements Data for the LDEF does not define LDEF GSE, therefore, functional check and calibration of LDEF GSE is TBD.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Electrical power - TBD

o   Calibration Lab - TBD

Support Requirements

o   Checkout/calibration procedures - TBD.

Block 1.2.2   Connect GSE to Payload Experiments Requiring

Calibration, and Calibrate Payload Experiments

Level B Definition and Requirements Data for LDEF does not identify calibration requirements for the experiment equipment, therefore, those requirements are TBD.

Ground and Launch Support Facility Requirements

o   TBD.

Block 1.2.3   Connect GSE to Payload Experiment Interfaces

The LDEF interfaces are electrical in nature, and the LDEF GSE is connected to these interfaces as shown in Block 1.2 above.

Ground and Launch Support Facility Requirements

Facility Requirements

o   None.

Support Requirements

o   Tools and procedures for connecting the electrical interfaces.

o   Electrical Technicians.

Vlock 1.2.4   Perform Verification Tests of Payload Experiment

Interface verification tests are performed separately on the shell, Rack #1 and Rack #2.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Electrical Power - TBD (A-9 equipment - Racks #1 and #2 - require 260 watts DC 28 volts operating).

o   Battery Lab - TBD.

Support Requirements

o   Computer Support (Data formatting; parameters are TBD).

o   Verification test procedures for shell, Rack #1, and Rack #2.

o   Electrical Technicians.

Block 1.2.5   Remove Payload Experiment Verification GSE

After completion of interface verification tests, the LDEF GSE is disconnected, and moved clear of the LDEF equipment.

Ground and Launch Support Facility Requirements

Facility Requirements

None.

Support Requirements

o   Tools and procedures for disconnecting GSE.

o   Electrical technicians.

Block 1.3   Prepare Payload Experiment for Integration

Block 1.4   Verify Tug Carrier

Block 1.5   Prepare Tug Carrier for Integration

        The LDEF payload does not involve the above activities.

Block 1.6   Mate Payload Elements

This block installs the LDEF elements into the Cargo Bay Simulator (CBS).
Since the shell has already been installed, only the A-9 equipment (Racks #1 and
#2) require installation in the CBS. All interfaces between LDEF elements
(electrical connections between shell, Rack #1 and Rack #2) are mated during
this block, as well as the electrical interface between Orbiter and Rack #1.

Block 1.6.1   Prepare Holding Fixture for Receipt of Payload

Experiment and Upper Stage

The LDEF "Holding Fixture" is the Cargo Bay Simulator (CBS), and the Upper Stage is not involved.

The shell has been installed in the CBS, so there are no CBS preparation activities associated with the shell.

Visual inspection of the CBS is made to verify that the configuration of the CBS is correct for receipt of Racks #1 and #2. Mounting surfaces for electrical cable bracket holding fixtures are inspected for proper configuration. The electrical interface connector to PGS station in checked for proper configuration.

Ground and Launch Support Facility Requirements

Facility Requirements

o   None.

Support Requirements

o   Visual inspection procedures and configuration descriptions/drawings of CBS mechanical/electrical interfaces with LDEF equipment.

o   Mechanical/electrical technicians.

Block 1.6.2   <u>Position and Secure Holding Fixture</u>

This block has been accomplished since the CBS (Holding Fixture) is in
position and secure.

Block 1.6.3   Attach Handling Equipment to Payload Experiment and Position

in Holding Fixture

The racks are estimated to weigh about 150 lbs. each, with dimensions being 4 ft. long, 2 ft. wide, and 3 ft. high. Several loading concepts are available; however, the selected one, described below, uses an overhead crane and lowers the racks vertically into the Cargo Bay Simulator (CBS).

Hoisting slings are attached to the rack, and using the overhead crane, the racks are hoisted above the CBS, translated into position over the CBS, then lower into the securing position in the CBS.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Overhead Crane.

Support Requirements

o   Hoisting slings for racks.

o   Crane operator.

o   Riggers.

o   Procedures and tools for sling attachment and hoisting rack.

Block 1.6.4   Attach Handling Equipment to Upper Stage and position in

Handling Fixture

This block is not applicable to LDEF.

Block 1.6.5   Connect Interfaces between Payload Experiment and Upper Stage

The Upper Stage is not applicable to the LDEF, and the interfaces between LDEF and Cargo Bay Simulator (CBS) are secured.

Block 1.6.5.1 Connect Mechanical Interfaces

The mechanical interfaces between Rack #1 and the CBS, and those between Rack #2 and the CBS are made.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Portable lighting to illuminate mating interface area.

o   Work stands for access to interior of CBS.

Support Requirements

o   Loose hardware (nuts, bolts, etc.), tools, and procedures for securing mechanical interfaces.

o   Mechanical technicians.

Block 1.6.5.2   Connect Fluid Interfaces

LDEF has no fluid interfaces.

Block 1.6.5.3   Connect Electrical Interfaces

The inter-connecting cables between shell, Racks #1 and #2, and Orbiter PPS are installed; and the interface connectors are mated and secured.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Portable lighting for interior of CBS.

o   Work Stands for access to interior of CBS.

Block 1.6.5.3   (continued)

Support Requirements

o   Brackets, loose hardware, tools, and procedures for installation of

     interconnectiong cables.

o   Mechanical technicians.

o   Tools and procedures for mating electrical interfaces.

Block 1.7   Verify Integrated Payload

This block verifies the interface between an Upper Stage and the experiment payload. As the LDEF has no Upper Stage, there are no activities in LDEF processing in this block.

Block 1.8   Perform Interface Check of Integrated Payload

This block verifies the interface between the Orbiter and LDEF, using the
Orbiter Simulator.

The concept of the Orbiter Simulator is that it duplicates the functions
of the PSS, the Mission Specialists Station (MSS) that involve the payload,
and payload equipment located in the Orbiter cabin during the flight mission.
The concept includes the use of GSE as a portion of the Orbiter Simulator,
depending upon the functional requirements to conduct the Orbiter/Payload
interface verification tests.

In block diagram form, the intergrated interface verification tests of
LDEF is shown below:
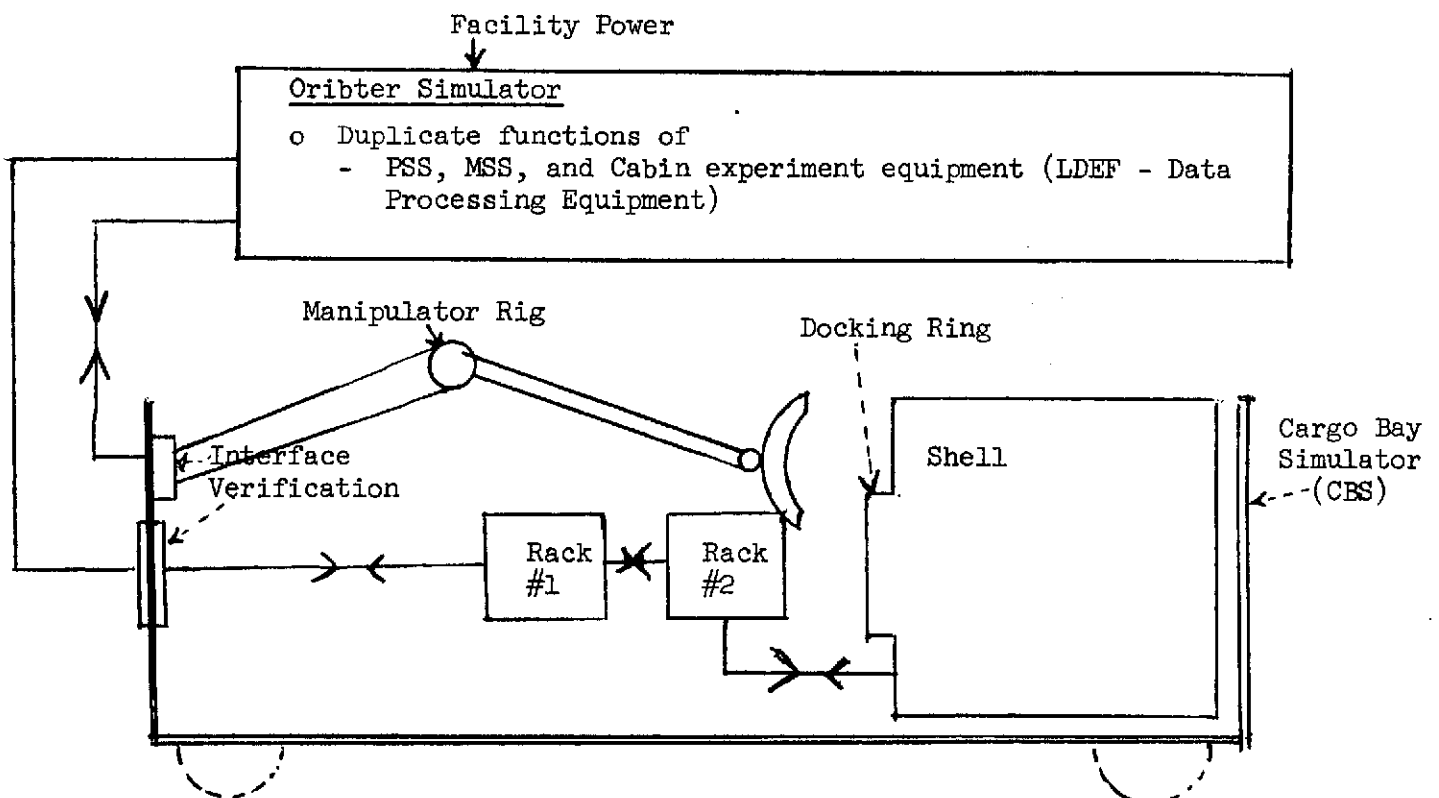
ADDED

~~Add~~ Block after Block 1.8   Configure and Position Orbiter Simulator
Adjacent to Cargo Bay Simulator (CBS)

This added block configures, services, positions the Orbiter Simulation
to conduct the interface verifications tests between the integrated payload
and the Orbiter.   Blocks 1.8.1 through 1.8.4 cover these activities, and are
not detailed here since they do not involve experiment processing.

Block 1.8.5   Connect Orbiter Simulator and Integrated Payload

Electrical connections are made at the feed through interface connector located in the forward bulkhead of the Cargo Bay Simulator.

It is recommended that the manipulator rig be exercised during the interface verification tests to verify clearances and mechanical fit of the manipulator extremities and the shell docking ring. For this purpose, the electrical connections between the Orbiter Simulator and the CBS interface connector are mated.

Ground and Launch Support Facility Requirements

Facility Requirements

o   None.

Support Requirements

o   Work stands for access to CBS forward bulkhead.

o   Tools and procedures for mating electrical connectors.

o   Electrical technicians.

Block 1.8.6   Perform Verification Tests of Interfaces between

Integrated Payload and Orbiter Simulator

The Orbiter Simulator is powered up, and interface verification tests are conducted. The Orbiter Simulator orginates command signals to the LDEF, and receives and evaluates the LDEF response. The Orbiter Simulator furnishes power to the LDEF, and receives any monitoring signals generated by the LDEF.

The manipulator rig interface verification tests involve powering up the manipulator rig, and exercising the manipulator rig from the Orbiter Simulator to verify Cargo Bay clearance, and compatibility of manipulator extremities and the shell docking ring.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Power - TBD.

Support Requirements

o   Verification Test Procedures.

o   Electrical and mechanical test technicians.

Block 1.8.7   Disconnect and Move Clear the Orbiter Simulator from

Holding Fixture

The electrical connections between the Orbiter Simulator and the Cargo Bay Simulator (CBS) are unmated, and the Orbiter Simulator is moved clear of the CBS.

The Orbiter Simulator equipment includes the LDEF Data Processing Equipment and this equipment is removed from the Orbiter Simulator, and transported to the Orbiter Processing Facility (OPF) for installation in the Orbiter as scheduled in the Orbiter OPF processing flow.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Tow tractor.

o   Truck, $2\frac{1}{2}$ ton.

Support Requirements

o   Work Stands for access to CBS forward bulkhead.

o   Tools and Procedures for disconnecting electrical connectors.

o   Electrical technicians.

o   Tow tractor and truck operators.

o   Protective covers for LDEF Data Processing Equipment.

o   Inventory Management.

Block 1.9   Move Integrated Payload to OPF (Orbiter Processing Facility)

Added Block after Block 1.9   Service Non-Time Critical Items in

Integrated Payload

This block has been added to complete servicing of non-time critical items of Automated Payloads. This block is included in Sortie Payload processing, and it is felt that the activity is also applicable to the Automated Payload processing.

There are no non-time critical items requiring service in the LDEF Level B Definition and Requirements Data.

The Cargo Bay Simulator contains the manipulator rig which has no functional use in the Orbiter Processing Facility and which may impede the LDEF unloading operations in the OPF. Therefore, the manipulator rig is removed from the CBS at this time.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Overhead crane (1 ton capacity).

o   Manipulator rig storage area: 12 ft. long, 2 ft. diameter.

Support Requirements

o   Tools and procedures for removing manipulator rig.

o   Overhead crane operator.

o   Riggers.

o   Mechanical technicians.

Block 1.9.1   Install Protective Environmental Covers

This block places protective covers over the shell, and Racks #1 and #2. The purpose of the covers is to protect the LDEF equipment in the Cargo Bay Simulator during tow from PPF to OPF.

Ground and Launch Support Facility Requirements

Facility Requirements

o   None.

Support Requirements

o   Protective covers.

o   Tools and installation procedures for protective covers.

o   Mechanical technicians.

Block 1.9.2   <u>Install and Actuate Portable GSE to Provide Environmental</u>

<u>Control and Other Support as Required During Tow from PPF to OPF</u>

The LDEF requires no GSE nor other support during tow operations, therefore there are no requirements for this block.

Block 1.9.3   Attach Tractor to Holding Fixture

Tow tractor is connected to the Cargo Bay Simulator(CBS), the Cargo Bay doors of simulator are closed, and inspection is made to verify that LDEF and CBS are ready in all respects for tow to OPF.

Ground and Launch Support Facility Requirements

Facility Requirements

o   Tow tractor.

o   Overhead crane (1 ton capacity) for closing cargo bay doors.

Support Requirements

o   Operators for tow tractor and overhead crane.

o   Riggers.

o   Inspection procedures.

o   Mechanical technicians.

Block 1.9.4   Open PPF Doors and Tow to OPF

The LDEF in the Cargo Bay Simulator is towed to the OPF.

Ground and Launch Support Facility Requirements

Facility Requirements

o   None.

Support Requirements

o   Traffic security personnel.

Block   2.0   Orbiter/Payload Integration and Checkout - Mission 4

The activities in this functional block begin with the arrival of the integrated payload elements at the mating area of the Orbiter Processing Facility and include all those efforts required to physically and functionally mate the payload to the Orbiter Payload Bay, and install any equipment required for the mission in the Payload Specialist Station. Figure 2.2-1 graphically depicts this flow.

The prerequisites of entering this block are as follows:

o   All elements requiring integration have been integrated.

o   Required GSE, STE, facility services, and personnel are available.

o   Orbiter processing has progressed to the required point in its turnaround flow and is ready to accept the Payload.

Block   2.1   Install LDEF and Instrument Pallet in Orbiter Payload Bay

Conditions: LDEF and instrument pallet are in position and access stands are in place.

Block   2.1.1   Lock transporter in psoition and remove all transport covers.

Block   2.1.2   Verify no transport damage has been incurred and payload and associated hardware is in a mate condition (visual inspection).

Block   2.1.3   With the overhead crane in position, attach the auxiliary crane control to the hook and the hoisting GSE to the crane control. Raise the assembled functional set and attach to LDEF hoist points.

Block   2.1.4   Using the auxiliary control, apply a load of TBD pounds as indicated on the dial face. Unlatch all transporter hold down points and raise LDEF clear of the transport unit.

Block   2.1.5   Hoist and position in payload bay. Using the auxiliary control lower onto the orbiter support points.

2.1
INSTALL P/L
IN ORBITER
P/L BAY

2.2
CONNECT &
VERIFY I/F

2.3
PAYLOAD
PRELIMINARY
CLOSE OUT

2.4
O.I.T.

2.5
P/L FINAL
CLOSE OUT

2.1.1
REMOVE
COVERS

2.1.2
VERIFY
PROPER
CONDITION
FOR MATE

2.1.3
ATTACH
HOISTING
GSE

2.1.4
DEMATE
P/L FROM
TRANSPORTER

2.1.5
HOIST &
POSITION IN
ORBITER
P/L BAY

2.1.7
SECURE
P/L BAY
LATCHES

2.2
CONNECT &
VERIFY I/F

3.0
PRELAUNCH
& LAUNCH
OPERATIONS

2.2.1
CONNECT
& VERIFY
ELECTRICAL
UMBILICAL(S)

2.2.2
CONNECT
& VERIFY
GAS & FLUID
UMBILICAL

2.2.3
REMOVE
HOISTING
GSE & STOW

2.3
PAYLOAD
PRELIMINARY
CLOSE OUT

2.3.1 REF.
REMOVE RMS
COVER &
POSITION

2.3.2 REF.
REMOVE RAD
COVERS

2.3.3
REMOVE
NON-ESSENTIAL
GSE

2.4
O.I.T.

2.4.1
CONFIGURE
ORBITER &
PAYLOAD FOR
O.I.T.

2.4.2
POWER-UP
REQUIRED
SYSTEMS

2.4.3
VERIFY
ORBITER/
PAYLOAD
INTERFACES

2.4.4
VERIFY
PROPER P/L
OPERATION
(AMBIENT)

2.4.5
SECURE
FROM O.I.T.

2.5
PAYLOAD
FINAL
CLOSE OUT

2.5.1
SERVICE
FLIGHT
ITEMS
AS REQUIRED

2.5.2
REMOVE ALL
NON-FLIGHT
HARDWARE

2.5.3 REF.
CLOSE &
LATCH P/L
BAY DOORS

2.5.4 REF.
REMOVE GSE
FROM DOORS

2.5.5
ESTABLISH
P/L BAY
CONDITION
VERIFY PURGE

FIGURE 2.2-1 ORBITER/PAYLOAD INTEGRATION & CHECKOUT ALL MISSIONS

Block 2.1.6   Install all related mission equipment in the Payload Specialist Station.

Block 2.1.7   Secure all payload bay latches and verify.

NOTE: Repeat steps 2.2.1.1 - 2.2.1.7 for the instrumentation pallet.

Support Requirements Functional Block 2.1

Facilities

Floor space 3000 sq. ft. (100 x 30)

Overhead crane 5 ton capacity

Ground Support Equipment

Hoist, Functional Set

Stands, Access

Auxiliary Crane Control

Support

Crane Operator

Personnel

Technicians

Q.C.

Safety

Engineer/Scientist

Logistics

Procedures

Block 2.2   Connect and Verify Orbiter/Payload Interfaces

Conditions: Payload is mechanically mated to the Orbiter and latch down has been verified.

Block 2.2.1   Verify power off on both sides of the electrical interface. When verified, mate the Orbiter to Payload umbilical(s).

Block 2.2.2   Disconnect hoisting GSE and hoist clear of payload bay, retain in the area.

Support Requirements for Functional Block 2.2

Facilities

Same as 2.1.

Ground Support Equipment

Same as 2.1.

Support

Crane Operator

Personnel

Technicians

Q.C.

Safety

Engineers/Scientists

Logistics

Procedures

Block 2.3   Payload Preliminary Closeout

Conditions: Payload has been physically and functionally mated to the Orbiter.

Block 2.3.1   Remove protective covers from the Remote Manipulator System (RMS) arms. (Reference only not a payload function).

Block 2.3.2   Remove protective covers from the payload bay door mounted radiators. (Reference only, not a payload function).

Block 2.3.3   Remove all non-essential GSE and stow. Retain in area.

Support Requirements for Functional Block 2.3

Same as 2.2.

Block 2.4   Perform Orbiter Integrate Test (OIT)

Conditions: Preliminary payload closeout has been completed. Orbiter support available and verified.

Block 2.4.1   Configure orbiter, payload and associated GSE to support OIT position switches and circuit breakers per test procedures and verify.

Block 2.4.2   Apply ground power to the required systems and verify proper level and distribution.

Block 2.4.3   Verify functional path through Orbiter/Payload interface paths.

Block 2.4.4   Verify proper signal format and level for all operating payload elements.

Block 2.4.4.1   Figure 2.2-2 is a graphic representation of a typical anomaly loop and indicates various options in effecting corrective action. Once the anomaly has been isolated, the decision on which path to follow will be a "real time" decision based on repair requirements and/or mission criticality. It is assumed that any anomaly associated with the Orbiter or the Institutional Ground Support Equipment will be the responsibility of KSC operational personnel, while anomalies within the payload elements or Peculiar Ground Support Equipment will be corrected by the payload operations personnel.

Block 2.4.5   Upon final verifications of the correct readouts and functional interface, secure from OIT power down active systems and position all switches and circuit breakers as called for in the OIT procedures.

Support Requirements for Functional Block 2.4

Facilities

Same as 2.1 plus 115VAC, 1ϕ, 60Hz (TBD KW)

28VDC (TBD KW)

Ground Support Equipment

Cable set(s)

HIM's, LPS interface TBD

Support

None

Personnel

Technicians

Q.C.
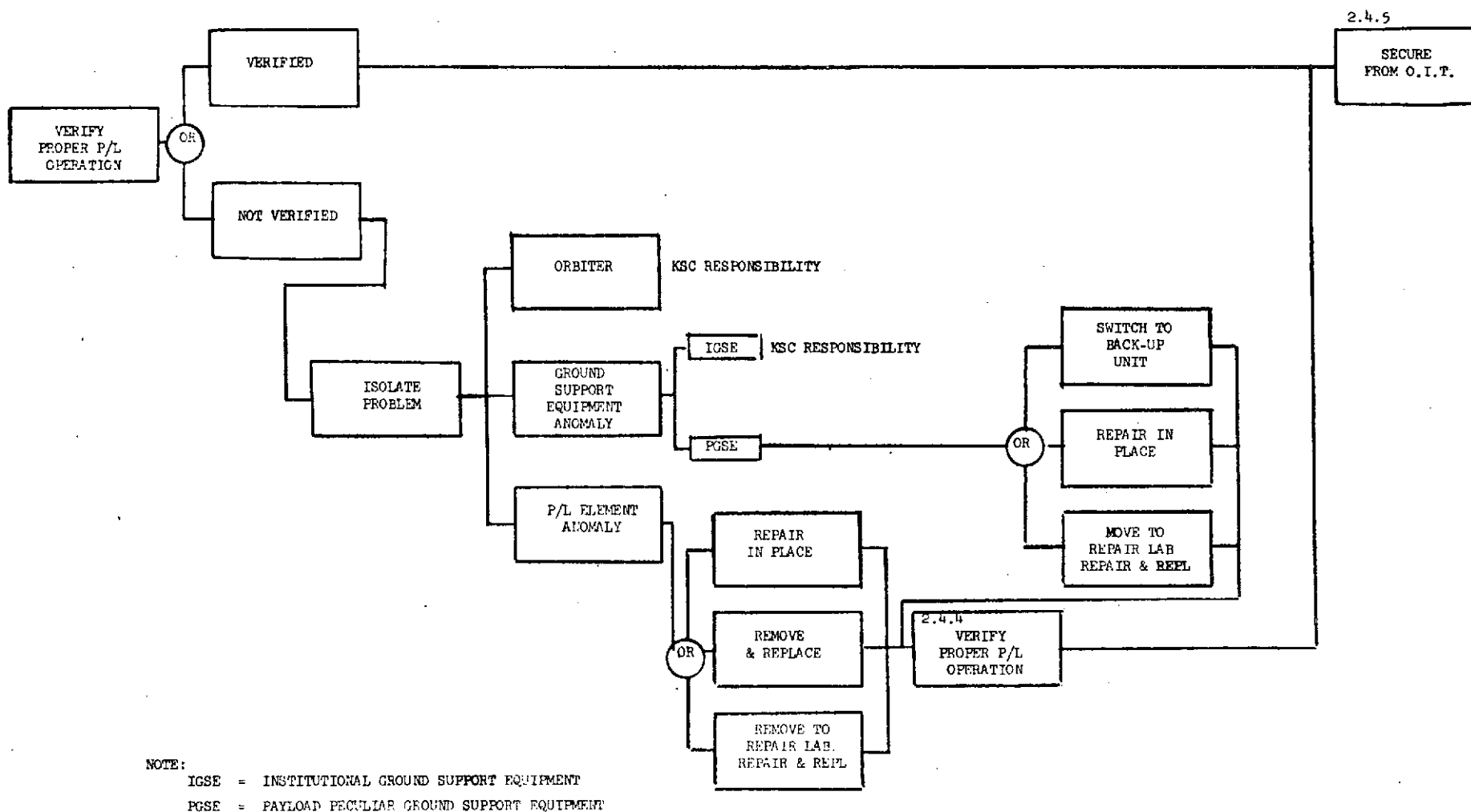
FIGURE 2.2-2 TYPICAL ANOMALY FUNCTIONAL LOOP

NOTE:
  IGSE = INSTITUTIONAL GROUND SUPPORT EQUIPMENT
  PGSE = PAYLOAD PECULIAR GROUND SUPPORT EQUIPMENT

Personnel   (continued)

Safety

Engineers/Scientists

Logistics

Procedures

Block 2.5   Payload Final Closeout

Conditions: Orbiter Integrated Test has been completed. Orbiter and Payload have been secured.

Block 2.5.1   Remove all non-flight hardware from the payload bay and any non-flight equipment from the payload specialist station.

Block 2.5.1.1 Return all payload handling/checkout GSE to its proper position.
NOTE: This PGSE may be stored at the launch site or returned to the PI or CIS facility.

Block 2.5.2   Close and latch payload bay doors, (Reference only, not a payload function).

Block 2.5.3   Remove payload bay doors GSE and return to storage (Reference only, not a payload function).

Block 2.5.4   Establish payload bay conditioning purge, verify payload bay conditioning within specification (Joint responsibility, Orbiter and Payload.

Support Requirements for Functional Block 2.5

Facilities

Same as 2.1

Ground Support Equipment

GN$_2$ Purge Unit

Support

Personnel

Technicians

Q.C.

<u>Personnel</u>   (continued)

Safety

Engineers/Scientists

<u>Logistics</u>

Transportation

Procedures

Warehousing

This function ends with the Orbiter/Payload ready to prepare for transfer
to the VAB.

All payload operations are covered in this activity from tow of orbiter to VAB, mating orbiter in VAB, and preparations at PAD until liftoff. The LDEF is a "passive" experiment, therefore the only verifications performed during this activity will be an operational check between payload (LDEF) and the electrical interfaces with the carry-on scientific and DFI Support equipment.

Block   3.1   Monitor Payload

Non-applicable

Block   3.2   Launch Readiness Verification

Begins with arrival at MLP at launch pad and MLP hard down on PAD mounts, and ends with cabin hatch in closed position. During this period the launch readiness payload verification checks will be performed.

Block   3.2.1   Payload Status Verification

After arrival at PAD, access to the Orbiter Payload Specialist Station to perform an orbiter to payload interface verification. The verification would check the operational capabilities of the controls and switches required to operate the payloads on-orbit, and the electrical interfaces with the carry-on scientific and DFI experiments.

Facility Requirements

o   Data Processing - via Orbiter Data Computer & Data Acquisition System.

o   Power - TBD

o   Monitoring -LPS

Support Requirements

o   None

Block   3.2.1.1   Payload Status Anomaly

During verification an anomaly could appear which could jeopardize

Block   3.2.1.1   (continued)

the mission. The anomaly could be lack of control or switches in OPSS for operation of payload/experiments, or the data processing/recording system are inoperative due to interface problem or equipment failure. Whatever the anomaly we would proceed to resolve anomaly prior to liftoff.

Facility Requirements

o   Data Processing - via Orbiter Ground Link

o   Power - TBD

o   Monitoring - LPS

Support Requirements

o   None

Block   3.2.1.2   Isolate Anomaly

The technicians/engineers performing the verification checks would isolate the anomaly to either Ground Support Equipment, Payload/Experiment or Orbiter Systems. After the anomaly has been isolated a typical approach to resolution of problem is shown on Figure 3.1 . The GSE/Payload/Experiment - Off-Line maintenance would be performed by experimenter. Orbiter Systems maintenance resolution would be KSC responsibility.

Facility Requirements

o   Data Processing - via Orbiter Ground Link

o   Power - TBD

o   Monitoring - LPS

Support Requirements

o   None

Block   3.2.1.3   Troubleshoot and Repair

A typical approach is shown on Figure 3.1 .

Facility Requirements

o   Clean lab

3.1   N/A
MONITOR
PAYLOAD

3.2
LAUNCH
READINESS
VERIFICATION

3.2.1
PAYLOAD
STATUS
VERIFICATION

3.2.3
SECURE OPSS/
PAYLOAD BAY
AREAS

3.2.1.1
PAYLOAD
STATUS
ANOMALY

3.2.1.2
ISOLATE
PROBLEM

3.2.1.3
TROUBLESHOOT
& REPAIR

3.2.1.4
VERIFY PAYLOAD
STATUS NORMAL

3.3   N/A
FINAL PAYLOAD
SERVICING

REF.
COUNTDOWN
& LAUNCH
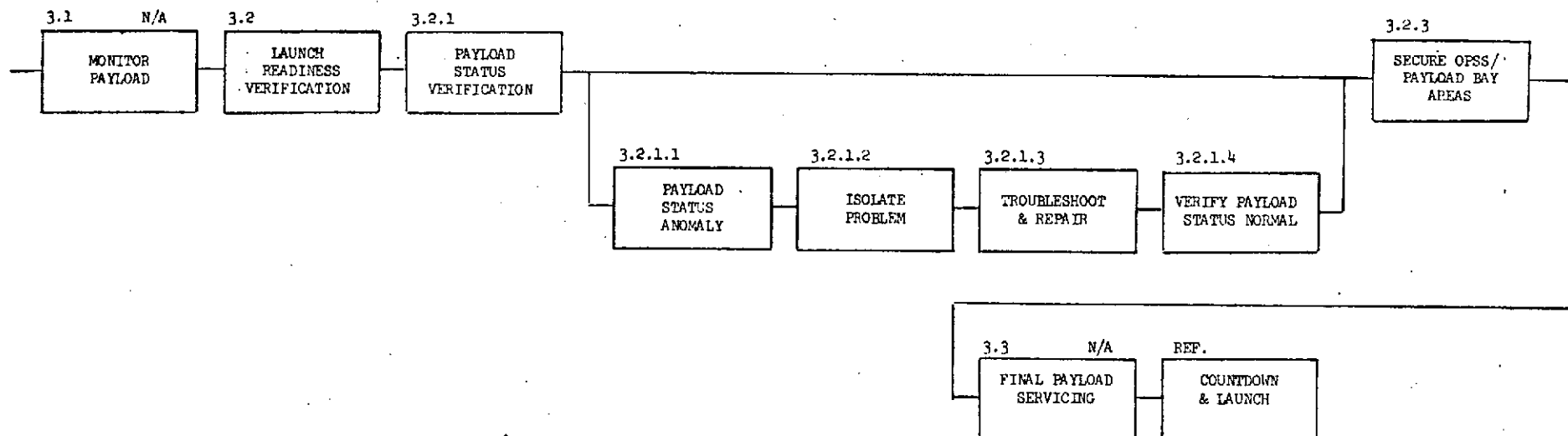
ACTIVITY 3.0   PRELAUNCH AND LAUNCH OPERATIONS

FIGURE 3.1

Block 3.2.1.3 (continued)

- o Calibration
- o Radiological lab
- o Machine lab
- o Mech. lab
- o Elect. lab

Support Requirements

- o Transportation
- o X-Ray

Block 3.2.1.4 Verify Payload Status - Off-Line

After the resolution of the payload/experiment/GSE anomaly a verification check would be made prior to installation in payload bay to show that it can now support the defined performance requirements of the mission.

Facility Requirements

- o Clean lab
- o Calibration lab
- o Bio lab
- o Machine lab
- o Mech. lab
- o Elect. lab
- o Battery lab.

Support Requirements

- o GSE - TBD
- o Special test equipment - TBD
- o Transportation

Support Requirements

- o None

Block 3.2.3 Secure OPSS/Payload Bay Areas

Secure OPSS and Payload Bay Areas and proceed to Fall-Back Areas.

Facility Requirements

- o None

Block   3.2.3   (continued)

Support Requirements

o   TBD

Block   3.3   Final Servicing

N/A

Block   3.4   Typical Off-Line Maintenance - Experiment/Payload

The off-line maintenance for experiment and payload in direct sup-
port of the experiment is the responsibility of the experimenters. The
maintenance is performed in the support facilities, required for trouble-
shooting, repair and verification, as defined in Facilities Requirements
for their particular experiment/payload. A typical off-line maintenance
flow is shown in Figure __3.2____.

Block   3.4.1   Transfer to Repair Facility

Initial step in off-line maintenance is to transfer experiment/
payload to specific facility required to support maintenance of anomaly.

Facility Requirements

o   Film Lab.

o   Data Processing

o   Clean Lab.

o   Calibration Lab.

o   Biolog Lab.

o   Elect. Lab.

o   Machine Shop

o   Mech. Lab.

o   Battery Lab.& Storage

Support Requirements

o   Transportation

o   Handling Fixtures

Block   3.4.2   Trouble-Shoot and Repair

Perform all steps necessary for trouble-shooting and repair of ex-
periment/payload anomaly.

Facility Requirements

o   Cleaning Lab.

3.4	3.4.1	3.4.2	3.4.3	3.4.4	3.4.5	3.1
OFF-LINE MAINTENANCE	TRANSFER TO REPAIR FACILITY	TROUBLESHOOT & REPAIR	VALIDATE EQUIPMENT	PREPARE (*) FOR TRANSFER TO ORBITER P/L BAY	RETURN TO SYSTEM/ EXPERIMENT CONFIGURATION	LAUNCH READINESS/ MONITORING
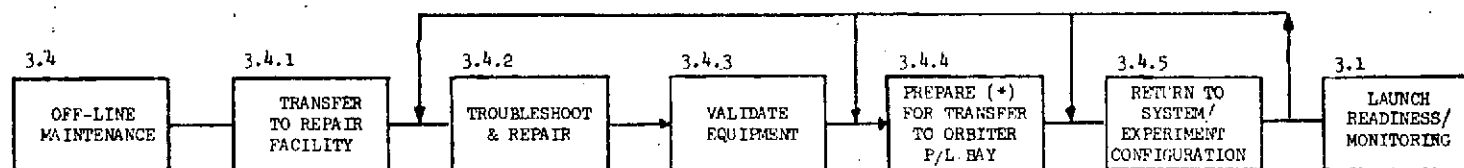
TYPICAL EXPERIMENT/PAYLOAD/GSE - OFF-LINE MAINTENANCE FLOW

FIGURE 3.2

Block   3.4.2   (continued)

     o   Calibration Lab.

     o   Film Lab.

     o   Biolog Lab.

     o   Battery Lab. & Storage

    Support Requirements

     o   TBD

Block   3.4.3   Validate Equipment

Performance of test to verify anomaly has been repaired and experiment/payload is ready to support mission.

    Facility Requirements

     o   Power - TBD

     o   Fluids - TBD

     o   Gases - TBD

    Support Requirements

     o   Test Equipment - TBD

     o   Support GSE - TBD

Block   3.4.4   Transfer to Orbiter Payload Bay

Perform all steps necessary to prepare experiment, payload for transfer back to Orbiter Payload Bay, while still maintaining integrity of experiment.

    Facility Requirements

     o   Power - TBD

     o   Fluids - TBD

     o   Gas - TBD

    Support Requirements

     o   Transportation

     o   Handling Fixtures

Block   3.4.5   <u>Return to System/Experiment Verification</u>

Reinstall experiment payload, GSE back to configuration to support mission. Verify electrical/mechanical interfaces as required, and verify mission support capabilities of system.

<u>Facility Requirements</u>

o   Power - TBD

o   Fluids - TBD

o   Gas - TBD

o   Data Processing

o   Monitoring - LPS

<u>Support Requirements</u>

o   TBD

Block   3.5   ~~Kel~~ - Payload/Orbiter - Maintenance

The Orbiter Support System for Payloads are Orbiter (KSC) responsibility. If an anomaly occurs between the interfaces, such as in the Data Processing System or Environmental System, the appropriate Orbiter (KSC) representative would be notified and KSC would proceed with resolving anomaly. After resolution, interfaces would be verified to determine if now payload is ready to support its mission in orbit.

<u>Facility Requirements</u>

o   KSC Responsibility

<u>Support Requirements</u>

o   KSC Responsibility

<u>Scenario - Activity</u>

Block   4.0   <u>Post Landing Operations</u>

With the Orbiter hard mounted in the OPF, the Orbiter Support Systems are switched to facility services and preparation for safing and removal of payload carry-on scientific and DFI support equipment begins. Safing completed, the GSE processing for removal of payload doors and payload support equipment proceed until payload support equipment is transported to the Payload Post-Mission Processing Area for data processing and storage.

Block   4.1   <u>Switch to Facility Services and Safe Payload</u>

The Orbiter Support Systems are switched to facility services; such as, power, colling and instrumentation. Purge and Dry Payload elements (as applicable) commences until payload bay is environmentally safe for personnel access.

Block   4.1.1   <u>Payload Support System Verification</u>

Non-Applicable

Block   4.1.2   <u>Payload Environment Safe</u>

A verification by safety that the payload area is environmentally safe for personnel access.

<u>Facility Requirements</u>

o   None

<u>Support Requirements</u>

o   Safety

Block 4.2   <u>Remove Time Critical Flight Experiments</u>

Non-Applicable

Block 4.2.1   <u>Place Items in Applicable Containers/Carriers</u>

Non-Applicable

Block 4.2.2   <u>Remove from Orbiter Payload Bay</u>

Non-Applicable

Block 4.3   <u>Open Payload Bay Doors and Install Payload GSE</u>

After the thermal protection system, the Payload Bay Doors are re-moved and the manipulator arm deployed, the experimenter is respons-ible for installation of payload bay access stands.

Block 4.3.1   <u>Install Payload Bay Access Stands</u>

The experimenter install payload access stands, as required for re-moval of payload from Orbiter Payload Bay.

<u>Facility Requirements</u>

None

<u>Support Requirements</u>

None

Block 4.4   <u>Remove Payload</u>

The removal of Payload includes all the tasks; such as, attaching payload support equipment handling GSE, demating of the Payload Support Equipment/Pallet/Orbiter interfaces, the removal of access stands, and finally the removal from payload bay and placement on payload transporter/handling fixture.

Block 4.4.1   <u>Attach Payload Support Equipment/Pallet Handling GSE</u>

The Payload Handling GSE; such as, slings are now moved into place and connected to lifting points on Payload Support Equipment/Pallet.

<u>Facility Requirements</u>

Crane - 15000 lbs. capability

<u>Support Requirements</u>

None

Block 4.4.2   <u>Demate Payload Support Equipment/Pallet/Orbiter Interfaces</u>

The Payload Support Equipment/Pallet/Orbiter Interfaces are disconnected and is inspected for approval for removal from Orbiter.

<u>Facility Requirements</u>

Crane - 15000 lbs.

<u>Support Requirements</u>

None

Block 4.4.3   <u>Remove Access Stands from Payload Bay</u>

The experimenters remove the access stands in order to clear the payload bay area for removal of Payload Support Equipment/Pallet.

<u>Facility Requirements</u>

None

<u>Support Requirements</u>

None

Block 4.4.4   <u>Remove Payload Support Equipment/Pallet from Payload Bay</u>

The Payload Support Equipment/Pallet is lifted from the payload bay and installed/mounted on a transporter for transfer to Post Mission Processing area.

<u>Facility Requirements</u>

Crane - 15,000 lbs.

<u>Support Requirements</u>

Safety

Block 4.5   <u>Move Payload Support Equipment/Pallet to Post Mission Processing Area</u>

After Payload Support Equipment/Pallet is secure, proceed with transfer to Post Mission Processing Area.

Block 4.5.1   <u>Verify Payload Secure on Transporter</u>

Non-Applicable

Block 4.5.2   <u>Move Payload Support Equipment/Pallet to Post Mission Processing Area</u>

With Payload Support Equipment/Pallet secure in transporter, proceed to Post Mission Processing Area.

Block 4.5.2   (continued)

Facility Requirements

None

Support Requirements

Transportation - Tractor

4.1

```
┌─────────────────┐
│   SWITCH TO     │
│   FACILITY      │
│  SERVICES & │
│ SAFE PAYLOAD    │
└─────────────────┘
```

4.1.1

```
┌─────────────────┐
│ PAYLOAD SUPPORT │
│     SYSTEM      │
│  VERIFICATION   │
└─────────────────┘
```

4.1.2

```
┌─────────────────┐
│    PAYLOAD      │
│  ENVIRONMENT    │
│     SAFE        │
└─────────────────┘
```

4.2

```
┌─────────────────┐
│  REMOVE TIME    │
│   CRITICAL      │
│  EXPERIMENTS    │
└─────────────────┘
```

4.2.1

```
┌─────────────────┐
│ PLACE ITEMS IN  │
│  APPLICABLE     │
│ CONTAINERS/     │
│  CARRIERS       │
└─────────────────┘
```

4.2.2

```
┌─────────────────┐
│  REMOVE FROM    │
│  ORBITER BAY    │
└─────────────────┘
```

4.3

```
┌─────────────────┐
│  OPEN P/L BAY   │
│ DOORS & INSTALL │
│  PAYLOAD GSE    │
└─────────────────┘
```

4.3.1

```
┌─────────────────┐
│ INSTALL PAYLOAD │
│  BAY ACCESS     │
│    STANDS       │
└─────────────────┘
```

4.4

```
┌─────────────────┐
│    REMOVE       │
│   PAYLOAD       │
└─────────────────┘
```

4.4.1

```
┌─────────────────┐
│ ATTACH PAYLOAD  │
│  HANDLING GSE   │
└─────────────────┘
```

4.4.2

```
┌─────────────────┐
│    DEMATE       │
│ PAYLOAD/ORBITER │
│  INTERFACES     │
└─────────────────┘
```

4.4.3

```
┌─────────────────┐
│ REMOVE ACCESS   │
│  STANDS FROM    │
│  PAYLOAD BAY    │
└─────────────────┘
```

4.4.4

```
┌─────────────────┐
│ REMOVE PAYLOAD  │
│ FROM PAYLOAD    │
│     BAY         │
└─────────────────┘
```

4.5

```
┌─────────────────┐
│  MOVE P/L TO    │
│ POST MISSION    │
│ PROCESSING AREA │
└─────────────────┘
```

4.5.1

```
┌─────────────────┐
│ VERIFY PAYLOAD  │
│   SECURE ON     │
│  TRANSPORTER    │
└─────────────────┘
```

4.5.2

```
┌─────────────────┐
│  MOVE P/L TO    │
│ POST MISSION    │
│ PROCESSING AREA │
└─────────────────┘
```

4.0   POST LANDING OPERATIONS

Block　5.0　　　Post Mission Processing - (Mission #4)

The activities contained within this functional block deal with the processing required following flight and prepares the various payload elements for refurbishment or return to PI.

Two cases are contained in this function as is shown in Figure 2.5-1. The following assumptions were made in defining tasks within this function:

o　　Vehicle has been safed and verified.

o　　All exposed electrical connectors have been capped.

o　　All other activity in Functional Block 4.0 has been completed.

Block　5.1　　　Inspect Payload

Conditions:　Instrument pallet has been delivered to the Premission Processing Facility and wiped down in the airlock.

Block　5.1.1　　Position pallet and access GSE in the proper area.

Block　5.1.2　　Remove all protective covers and/or panels to gain visual access to all instruments/sensors.

Block　5.1.3　　Visually inspect all elements for physical damage and document the discrepancy.

Block　5.1.4　　Remove any remaining flight data and deliver to the proper agency.

Block　5.1.5　　Clean instruments/sensors as required.

Support Requirements for Functional Block 5.1

Facilities

Floor space 1200 sq. ft. (40 x 30)

O/H crane 1 ton capacity

Ground Support Equipment
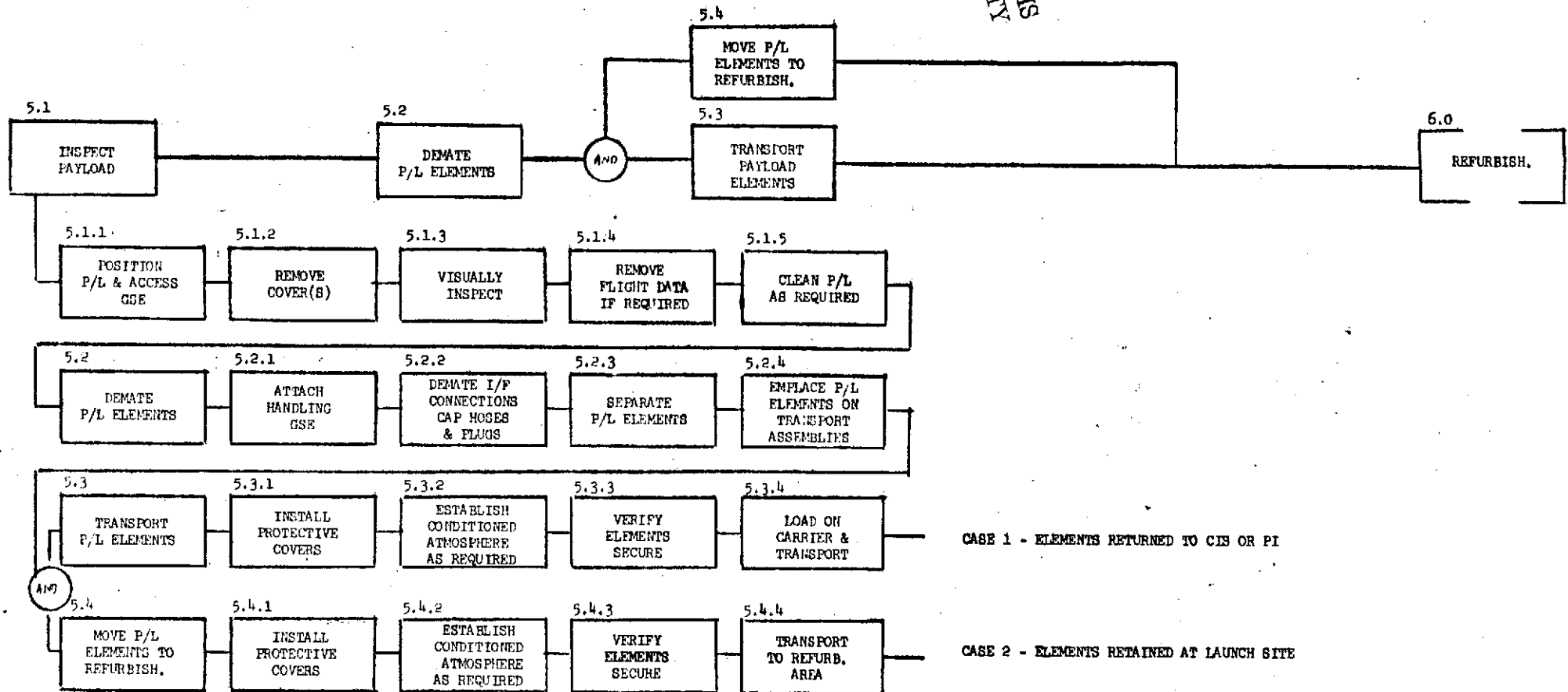
Access stands functional set

Handling equipment, protective covers.

Support

crane operator

FIGURE 2.5.1   POST MISSION PROCESSING MISSION #

```
                                                              ┌─────────────┐
                                                         5.4  │   MOVE P/L  │
                                                              │ ELEMENTS TO │
                                                              │  REFURBISH. │
                                                              └─────────────┘
  5.1                        5.2                              5.3  ┌──────────┐                              6.0
┌──────────┐              ┌──────────┐                            │ TRANSPORT│                            ┌──────────┐
│ INSPECT  │              │  DEMATE  │        (AND)               │  PAYLOAD │                            │ REFURBISH│
│ PAYLOAD  │              │P/L ELEMENTS│                          │ ELEMENTS │                            │          │
└──────────┘              └──────────┘                            └──────────┘                            └──────────┘
```

5.1.1	5.1.2	5.1.3	5.1.4	5.1.5
POSITION P/L & ACCESS GSE	REMOVE COVER(S)	VISUALLY INSPECT	REMOVE FLIGHT DATA IF REQUIRED	CLEAN P/L AS REQUIRED

5.2	5.2.1	5.2.2	5.2.3	5.2.4
DEMATE P/L ELEMENTS	ATTACH HANDLING GSE	DEMATE I/F CONNECTIONS CAP HOSES & PLUGS	SEPARATE P/L ELEMENTS	EMPLACE P/L ELEMENTS ON TRANSPORT ASSEMBLIES

5.3	5.3.1	5.3.2	5.3.3	5.3.4
TRANSPORT P/L ELEMENTS	INSTALL PROTECTIVE COVERS	ESTABLISH CONDITIONED ATMOSPHERE AS REQUIRED	VERIFY ELEMENTS SECURE	LOAD ON CARRIER & TRANSPORT

CASE 1 - ELEMENTS RETURNED TO CIS OR PI

(AND)

5.4	5.4.1	5.4.2	5.4.3	5.4.4
MOVE P/L ELEMENTS TO REFURBISH.	INSTALL PROTECTIVE COVERS	ESTABLISH CONDITIONED ATMOSPHERE AS REQUIRED	VERIFY ELEMENTS SECURE	TRANSPORT TO REFURB. AREA

CASE 2 - ELEMENTS RETAINED AT LAUNCH SITE

Personnel

Technicians

Q.C.

Safety

Engineers

Logistics

Procedures

Block 5.2   Demate Payload Elements

Conditions: Post Mission cleaning and inspection have been completed.

Block 5.2.1   Attach handling GSE to the element to be demated.

Block 5.2.2   Demate all interface connections; cap all plugs.

Block 5.2.2.1   Break mechanical attachments between the instrument/sensor and supporting
structure.

Block 5.2.3   Using the auxiliary crane control, inch the payload element clear of
the mechanical attachments; then use the crane to complete demate.

NOTE: Repeat steps 5.2.1 through 5.2.3 for each element.

Block 5.2.4   Position instruments/sensors on their transporters or shipping containers
and secure.

Support Requirements for Functional Block 5.2

Facility Requirements

Same as 5.1

Ground Support Equipment

Handling equipment, instruments/sensors

Transporters/containers

Support

Crane Operator

Personnel

Technicians

Q.C.

Personnel (continued)

Safety

Engineers

Block 5.3 Transport Payload Elements

Conditions: All instruments/sensors have been demated as required and are ready for transport to the Central Integration Site or to the Experimenters Facility.

Block 5.3.1 Install all protective covers, bags or other protective equipment.

Block 5.3.2 Establish conditioned atmosphere as required.

Block 5.3.2.1 Purge containerized equipment with dry GN_2 until a satisfactory concentration is verified; close vents.

Block 5.3.3 Verify all elements secure and all monitoring devices are in place and operating.

Block 5.3.4 Load payload elements on their transporters and ship to the respective site.

Block 5.3.5 Return GSE to storage or return to home site.

Support Requirements for Functional Block 5.3

Facilities

Same as 5.1 plus prime mover.

Ground Support Equipment

Same as 5.2 plus

GN_2 Conditioning Unit

Support

Vehicle operator

Personnel

Technicians

Q.C.

Safety

Engineers

Logistics

Procedures

Transportation

Warehousing

Long Duration Exposure Facility (LDEF)

ST-01-A

Differences Between

Launch Site Facility Requirements Data Sheet (Functional)

(Revision A - dated 9/10/74)

and

GAC Data

The differences in launch site requirements are included in the following
pages. The Data Sheet information is shown in parenthesis and followed by GAC
data and logic basis. Requirements solely generated by GAC and not reflected
in the Data Sheets have not been duplicated.

Block 1.1   Receive and Inspect Payload Elements

    A.   Payload Processing Area

Length(Ft)	Width(Ft)	Min Height(Ft)
(35)	(18)	(20)

o   40 ft. long, 32 ft. wide, and 40 ft. hook height.

Temp(°K)

(295 ± 5) (71°F ± 9)

o   Level B data (Data Sheets #A-20a and 20b - Ground Environmental Limits)
indicates non-operating and operating limits to be minimum = 278(41°F)
and maximum = 339(150°F). Under the assumption that the PPF will
maintain these limits for routine operations, there are no temperature
constraints for Block 1.1 processing.

Relative Humidity (%)

(50 + 10 - 20)

o   Level B data (Data Sheets A-20a and 20b - Ground Environmental Limits)
list a value of 95, both non-operating and operating. Under the
assumption that the PPF will maintain less than 95% relative humidity
for normal operations, there are no humidity constraints imposed by
the LDEF.

Cleanliness Class

(100K)

o   Level B data (Data Sheets A-20a and 20b - Ground Environmental Limits)
list cleanliness class as "N/A" - not applicable; therefore, the LDEF
imposes no cleanliness constraints in the PPF.

    B.   Payload Peculiar Equipment

(2000 ft^2)

o   12 ft. long, 8 ft. wide, and 4 ft. high for LDEF GSE.

Block   1.2   <u>Verify Payload Experiments</u>

     A.   <u>Payload Processing Area</u>

<u>Length (ft)</u>	<u>Width (ft)</u>	<u>Min Height (ft)</u>
(35)	(15)	(20)

     o   40 ft. long (cargo bay simulator - 40 ft. long), 23 ft. wide (cargo bay simulator - 15, with 4 ft. workstands each side), and 24 ft. high (cargo bay simulator - 18 ft., clearance - 6 ft.).

     o   15 ft. long, 12 ft. wide, 4 ft. high for A-9 equipment and GSE

<u>Temp(°K)</u> and <u>Relative Humidity (%)</u> and <u>Cleanliness Class</u>

(Same as paragraph 1.1A above).

     o   Same as paragraph 1.1A above.

Block   1.3   <u>Prepare Payload Experiments for Integration</u>

     A.   <u>Payload Processing Area</u>

        <u>Length (ft)</u> - (35)

        <u>Width (ft)</u> - (15)

        <u>Min Height (ft)</u> - (20)

        <u>Temp (°K)</u> - (295 ± 5)

        <u>Rel Hum (%)</u> - (50 + 10 - 20)

        <u>Cleanliness</u> - (100K)

     B.   <u>DC Power</u>

        <u>Volts (DC)</u> - (28)

        <u>Power (KW)</u> - (.30)

     C.   <u>AC Power</u>

        <u>Volts (AC)</u> - (115)

        <u>Hertz</u> - (60)

        <u>Phase</u> - (Single)

        <u>Power (KW)</u> - (2.0)

o   GAC processing does not identify tasks for Block 1.3; therefore, there are no PPF requirements. It may be that the above requirements are based upon type Level III integration tasks. The Study considers only Levels I and II integration tasks.

Block 1.6   <u>Mate Payload Elements</u>

    A.   <u>Payload Processing Area</u>

<u>Length (ft)</u>	<u>Width (ft)</u>	<u>Min Height (ft)</u>
(35)	(15)	(20)

o   40 ft. long, 23 ft. wide, and 24 ft. high for Cargo Bay Simulator, all LDEF equipment, LDEF GSE, and workstands.

<u>Temp(°K)</u> and <u>Relative Humidity(%)</u> and <u>Cleanliness Class</u>

(Same as paragraph 1.1A above)

o   Same as paragraph 1.1A above.

Block 1.7   <u>Verify Integrated Payload</u>

The definition of this block is to verify the interface between an Upper Stage and the experiment payload. As the LDEF has no Upper Stage, there are no activities in this block.

For this block, the basis for the requirements contained in the Data Sheet is not known.

Block 1.8   <u>Perform Interface Check of Integrated Payload</u>

    A.   <u>Payload Processing Area</u>

<u>Length (ft)</u>	<u>Width (ft)</u>	<u>Min Height (ft)</u>
(35)	(15)	(20)

o   40 ft. long, 23 ft. wide, and 24 ft. high for Cargo Bay Simulator, all LDEF equipment, LDEF GSE, and workstands.

o   Estimated space required by Orbiter Simulator for verification tests, is 8 ft. long, 6 ft. wide, and 5 ft. high.

<u>Temp (°K)</u> and <u>Relative Humidity(%)</u> and <u>Cleanliness Class</u>

(Same as paragraph 1.1A above)

o   Same as paragraph 1.1A above.

B.   <u>Special Handling</u>

(5 ton overhead crane)

o   Requirement for overhead crane not identified.

Block   1.9   <u>Move Integrated Payload to OPF</u>

A.   <u>Payload Processing Area</u>

<u>Length (ft)</u>	<u>Width (ft)</u>	<u>Min Height (ft)</u>
(35)	(15)	(20)

o   No area requirements associated with the move were identified. A
clear aisle from PPF checkout area to PPF exit door is required. Aisle
and exit door are the same as previously provided.

Long Duration Exposure Facility (LDEF)

Block 2.0   Orbiter/Payload Mate and Integrate

Block 2.1   Install Payload in Payload Bay.

(35L x 15W x 50H) (Blue Line Data)

o   LDEF shell and rack mounted instrumentation

45'L x 14'W x 14'H

Access stands fore and aft 4' each end, access aisle (sized for fork

lift and personnel) 6' each end. Space for work benches, roll around,

etc. 10' aft end.

45 + 12 + 8 + 10 = 75'long

14 + 12 + 8 = 34'wide

Block 2.4   Perform OIT

(28VDC, 0.20KW, 115VAC, 60Hz; 1$\emptyset$, 1.0KW)

GAC cannot find sufficient information to support power requirements.

Block 2.5   Payload Final Closeout

(Fluid Media N/A)

Although a firm requirement, except cleanliness level is not evident

in the Level B descriptions, it appears that a pad/purge of the cargo

bay, would ensure the 100K condition during subsequent operations.

Fluid media recommend GN_2 at 17PSIG

Flow rate and total volume TBD.

3.0   Prelaunch and Launch Operations

3.1   Monitor Payload (60 hours)

Function - The LDEF is a "passive" experiment which has no monitoring requirements. Therefore the time estimate of 60 hours should be deleted.

3.2   Launch Readiness Verification/Orbiter Cabin Closeout (8 hours)

During this period, an operational check to verify the monitoring capabilities of the A-9 equipment and the recorder located in the OBSS is recommended. Facility requirements to support this verification are as follows:

Power - 28VDC, (TBD)KW

Other - Monitor - LPS

       - Access required to OBSS

       - Data Processing via Orbiter Data Computer

3.3   Payload Final Servicing (4 hours)

Function - The LDEF is a "passive" experiment which has no final servicing requirements. Therefore, the time estimate of 4 hours should be deleted.

3.4   Off-line Support (Not on Functional Data Sheets)

On a contingency basis, the LDEF should have the capabilities to perform any maintenance, repair or checkout to support the launch mission. Although the requirement is on a contingency basis, the following requirements should be considered as part of the physical requirements.

Power - TBD

Fluids - TBD

Long Duration Exposure Facility (LDEF)

ST-01-A

Differences between

Launch Site Facility Requirements Data Sheet (Physical)

(Revision A - dated 9/10/74)

and

GAC data

The differences in launch site requirements are included in the following pages. The Data Sheet information is shown in parenthesis and followed by GAC data and logic basis. Requirements solely generated by GAC and not reflected in the Data Sheets have not been duplicated.

Block   1.0   Payload Premission Processing

A.   Storage Area

Area (ft^2)

.(2500)

o   37 ft. long, 20 ft. wide, 24 ft. high - for shell shipping
     container (area = 740 ft.^{2}).

o   15 ft. long, 10 ft. wide, 5 ft. high - for rack-mounted equipment
     (area = 150 ft.^{2}).

o   12 ft. long, 8 ft. wide, 4 ft. high - for LDEF GSE (area = 96 ft.^{2}).

o   Total area = 986 ft.^{2}.

TEMP (°K)

(295 ±20) (71°F ± 36)

o   In storage area, LDEF components are assumed to be in their shipping
     containers, and no temperature constraints are imposed. It is noted
     that Data Sheet #A-20a and 20b - Ground Environmental Limits - contain
     non-operating temperature minimum of 278K(41°F) and maximum 339K(150°F);
     however, these requirements appear to be incompatible with Data Sheet #6a
     note which reads, "Mission equipment is passive until after deployment
     from orbiter, no EMI problems are anticipated. No cooling is required".
     As well as Data Sheet #7a note which states, "These experiment equipments
     are designed to operate in or be exposed to the ambient environment
     existing at the selected orbital altitude. No limits will be imposed on
     the equipment".

Relative Humidity (%)

(50 ± 20)

o   In storage area, no relative humidity constraints are imposed. Please
     refer to TEMP(°K) paragraph above.

Cleanliness Class

(100K)

o   In storage area, no cleanliness class requirements are imposed.

Please refer to TEMP(°K) paragraph above.

B.   Maintenance and Repair

Calib Lab

(Yes)

o   No requirement identified in Level B data.

C.   Special Area Requirements

Biolog Lab

(Yes)

o   No requirement identified; however, an interpretation of Level II/III

integration and LDEF launch site processing may be involved. The

baseline data sheet lists Level III integration, whereas Study ground

rules addresses ℓonly Level II integration at the launch site. The

LDEF shell panels contain biology specimens. The Study assumes these

panels have been installed on the shell structure prior to arrival at

launch site, and therefore, the need for the Biolog Lab is not

established.

D.   Office

Number Engr/Scientists

(20)

o   Level B data does not identify personnel requirements. GAC estimates

six (6) engineers/scientists is maximum personnel loading at launch

site for Payload Premission Processing.

Number Technicians

(20)

o   Level B data does not identify requirement. GAC estimates eight (8)

     technicians is maximum loading for Payload Premission Processing.

Block 2.0   Orbiter/Payload Mate and Integrate

(Storage Area 2500ft^2, Temp 295 ± 20, Humid. 50%± 20, Cleanliness

Class 100K)

o In functional Block 2.0 no function for storage is defined; therefore,

the requirement for storage area does not exist.

o Since an anomaly may be discovered at any point in the flow,

requirements for Maintenance and Repair and/or other Special Area

Requirements is valid for 2.0.

Office

(20 Engineers and Scientists and 20 Technicians)

Due to the simplicity of the interface mating and verification, it

seems impossible to justify this crew for Function 2.0. GAC estimates

4 Engineers/Scientists and 8 Technicians.

3.0   Prelaunch and Launch Operations

A.   Storage Area - Non-Applicable for this functional flow. Storage
requirements are defined in functional activities 1.0 and 5.0.

B.   Office

o   Number Engineers/Scientists

(20)

During this activity, engineers are only required for the
verification checks, and therefore, minimum space would be
required in launch area. Assume two engineers at launch site,
and remaining support engineers in PPF. Total (6).

o   Number Technicians

(20)

During this activity, technicians are only required for the
verification checks, and therefore, minimum space would be
required in launch area. Assume requirement for four technicians
at launch site and remaining support technicians in PPF.
Total (8).