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Summary Report

ASSESSMENT OF LAUNCH SITE ACCOMMODATIONS VERSUS SPACELAB PAYLOAD REQUIREMENTS

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ASSESSMENT OF LAUNCH SITE ACCOMMODATIONS VERSUS SPACELAB PAYLOAD REQUIREMENTS

DECEMBER 1977

PREPARED FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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ABSTRACT

This report summarizes the study of the KSC launch site accommodation for Spacelab payloads. Four payloads were considered: Spacelab III (Strawman), OA Mission 83-2, Dedicated Life Sciences and Combined Astronomy. Anomalies between accommodations described and requirements are noted. Recommendations for revision of the accommodations handbook were made to KSC and are summarized here.

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LIST OF SYMBOLS AND ACRONYMS

AFD	Aft Flight Deck
ATE	Automatic Checkout Equipment
ATMOS	Atmospheric Trace Molecules Observed by Spectroscopy
AMPA	Adaptive Multibeam Phased Array
CDMS	Command Data Management System
CIMATS	Correlation Interferometric Measurements of Atmospheric Trace Species
CITE	Cargo Integration Test Equipment
DDM	Drop Dynamics Module
ECLSS	Environmental Cotnrol Life Support System
ECU	Environmental Control Unit
EGSE	Electrical Ground Support Equipment
EMI	Electro-magnetic Interference
ET	External Tank
EVA	Extravehicular Activity
GPR	Ground Processing Requirments
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HALOE	Halogen Occultation Experiment
I/F	Interface
IR	Infrared
ITE	Intersite Transportation Equipment
JPL	Jet Propulsion Laboratory
KSC	Kennedy Space Center

LIST OF SYMBOLS AND ACRONYMS (CONTINUED)

LaRC	Langley Research Center
LFC	Large Format Camera
LH_2	Liquid Hydrogen
LHe	Liquid Helium
LIDAR	Lidar Measurement of Cirrus Clouds and Aerosols
LIMS II	Advanced Limbs IR Monitoring of Stratosphere
LN_2	Liquid Nitrogen
LO_2	Liquid Oxygen
LPS	Launch Processing System
LRU	Line Replaceable Unit
MAPS	Measurement of Air Pollution from Satellites
MCC	Mission Control Center
MLP	Mobile Launch Platform
MSFC	Marshall Space Flight Center
NASCOM	NASA Communications
O&C	Operations and Checkout Building
OA	Office of Applications
OCE	Ocean Color Experiment
OFT	Orbiter Flight Test
OIA	Orbiter Interface Adapter
OMS	Orbiter Maneuvering System
OPF	Orbiter Processing Facility
P/L	Payload

LIST OF SYMBOLS AND ACRONYMS (CONCLUDED)

PCR	Payload Changeout Room
POCC	Payload Operations Control Center
S/L	Spacelab
S/W	Software
SER	Solar Extinction Radiometer
SGRS	Shuttle Geodynamics Ranging System
SIPS	Small Instrument Pointing System
SIR-B	Shuttle Imaging Radar-B
SIRTF	Shuttle Infrared Telescope Facility
SMIRR	Shuttle Multispectral IF Radiometer Experiment
SOSU	Standard Ozone Sounding Unit
SRB	Solid Rocket Booster
STS	Space Transportation System
TBE	Teledyne Brown Engineering
TETHER	Tethered Satellite
THIR	Temperature Humidity Infrared Radiometer
VAB	Vehicle Assembly Building
VFR	Vestibular Function Research
VTPR	Vertical Temperature Profile Radiometer
Xport	Transport

SUMMARY

The overall purpose of this study was to compare the KSC launch site accommodations with Spacelab payload requirements. The KSC accommodations were defined, for the purpose of this study, by the KSC Launch Site Accommodations Handbook for STS Payloads. The study had three goals:

- Assess KSC accommodations versus requirements of four selected Spacelab payloads
- Provide a critical review of the KSC accommodations handbook
- Define the provisions for payload checkout at KSC.

In order to meet the goals of this study, several tasks were undertaken. First criteria for evaluation of the experiment accommodations described in the handbook were developed. These criteria consist of basic questions a payload planner or instrument developer would ask about ground operations. A detailed description of the ground process flow was also defined to show all the operational functions the payload would be subjected to at KSC. The questions and flow functions were combined in a matrix for rapid identification of accommodations versus process flow functions.

The second task was to develop the ground processing requirements for the Spacelab III (Strawman), Office of Applications Mission 83-2, Dedicated Life Sciences and Combined Astronomy payloads. From the basic payload definitions supplied, instrument requirements were collected into payload requirements. The payload requirements were delineated using the same matrix developed for accommodation assessment.

By comparing the payload requirements with the stated KSC accommodations, a number of anomalies were identified. In attempting to resolve the anomalies both KSC and experiment cognizant people were contacted. In some cases, the handbook could be clarified to show accommodation for a requirement. In other cases, the lack of accommodation was flagged to the experimenter. This resulted in clarification and elimination of several experiments requirements which were not critical, but which would have created problems in making the accommodations available.

Two significant results of this study were the flagging of unaccommodated requirements to experimenters and the development of constructive suggestions which have been given to KSC for revision of the handbook. A summary of the study findings is given in Table 1, Anomalies of Spacelab Payload Requirements Versus KSC Launch Site Accommodations.

Several ground rules for payload accommodation at KSC became apparent in the course of this study that should be stated in the handbook in its revision. These are listed in Table 2, Payload Accommodation Ground Rules.

It was not possible, in the time frame of this study, to define the payload checkout provisions at KSC. This was because the basic requirements for checkout are not agreed upon by KSC and other NASA centers. Until agreement is reached KSC cannot define the checkout hardware capability.

TABLE 1. ANOMALIES OF SPACELAB PAYLOAD REQUIREMENTS VERSUS KSC LAUNCH SITE ACCOMMODATIONS

ANOMALY	PAYLOAD	COMMENTS
• * Cryogenic servicing with LN_2 and LHe required at O&C for LIMS, CIMATS AND SIRTF instruments.	OA 83-2 Combined Astronomy	Cryogenic servicing not available at O&C according to manual. Requirement can be met by portable Dewar. Change in manual suggested to define capability.
• * Class 100 clean area required for offline service of Medium Energy Gamma Ray Telescope	Combined Astronomy	KSC normally supplies Class 100 K facility. Experiment developer contacted. He will supply a "clean tent" for use in Class 100 K facility.
• * Class 10 K cleanliness required by MAPS and Passive Microwave instruments	OA 83-2	Passive Microwave deleted from payload after OA contacted. Requirement deleted after experimenter contacted.
• * 40 percent Maximum Relative Humidity required by Passive Microwave	OA 83-2	KSC provides 50 percent maximum relative humidity - requirement deleted after experimenter contacted.
• * Continuous power required by payload during ground operations by LFC, SIRTF and UV Photometer/Telescope	OA 83-2 Combined Astronomy	Power not normally available to payload on a continuous basis. LFC dropped requirement. SIRTF and UV Photometer Telescope will provide own battery supply.
• * Large offline laboratory required for care and testing of specimens	Life Sciences	Laboratory under consideration by KSC. Will be defined in revision.
• * Ne replenishment required at landing site by Medium Energy Gamma Ray Telescope	Combined Astronomy	Access to payload not available at landing site. Instrument capacity is sufficient to cover period from landing to instrument removal at O&C per experimenter.
• Time and access required for payload operations (VFR requires post landing testing; SIRTF requires 24 hours chill down during Levels III/II integration)	SL-3 Combined Astronomy	Time required for special payload operations not clearly available according to handbook. KSC is reviewing time allocations for process functions.
• Payload bay may require venting because of cryogen boiloff.	OA 83-2 Combined Astronomy	Quantity of cryogen boiled off is still to be determined. This depends mainly on operational times which are still TBD.
• Cryogen LHe top off required at pad	Combined Astronomy	Access through payload bay doors is required. Umbilical interface unacceptable for topping off.
• * Continuous dry N_2 purge required by SIRTF and UV Schmidt Camera	Combined Astronomy	KSC cannot provide continuous N_2 purge from Levels III/II integration on through launch. Experimenter will provide capability as part of instrument.
• ATMOS to module airlock alignment method is TBD	SL-3	Alignment method may cause a time of access problem in Levels III/II integration.

* Anomaly resolved, no longer a problem.

TABLE 2. PAYLOAD ACCOMMODATION GROUND RULES

1. INSTRUMENT PERFORMANCE WILL NOT NORMALLY BE VERIFIED AT LAUNCH SITE.

2. TIME FOR CARGO INTEGRATION WITH ORBITER IS LIMITED TO 12 HOURS ENDING AT T-78 HOURS.

3. AFTER PAYLOAD CLOSE OUT AT OPF
   NO PERSONNEL ACCESS TO MODULE AT VAB OR PAD.
   PAD ACCESS TO PALLETS COST PAYLOADS 6 HOURS PLUS ACTION TIME.

4. PURGE AIR NOT AVAILABLE AFTER LEAVING OPF UNTIL ORBITER IS MATED TO MLP (APPROXIMATELY 12 HOURS).

5. PAYLOAD POWER NOT AVAILABLE FROM OPF POWER-DOWN UNTIL MLP IS MATED TO PAD (APPROXIMATELY 50 HOURS).

6. LAST CRYOGEN SERVICING AT PAD MUST BE THROUGH MIDBODY UMBILICAL.

7. SPECIMENS TO BE REMOVED AT LANDING SITE MUST BE IN ORBITER MID DECK OR AFD ON RETURN. NO ACCESS TO PAYLOAD BAY OR MODULE AT LANDING SITE.

1. INTRODUCTION

Predefinition of accommodations to a sufficient level of detail will influence instrument design and payload planning to prevent the occurrence of STS launch site requirements/accommodation incompatibilities which could be costly and require time consuming work-arounds. The purpose of this study is to contribute to three related activities regarding KSC launch site accommodations for payloads.

- A review and assessment of selected Spacelab payload requirements versus KSC ground operations accommodations.
- Definition of requirements for and critical review of the KSC Launch Site Accommodations Handbook for STS Payloads (Reference 1) and current revisions from the point of view of the Spacelab experiment developer/payload planner.
- Definition of provisions for payload checkout at KSC to include end-to-end communication checks, quality checks on data, and Payload Operations Control Center (POCC) verification.

This study considers the requirements for KSC accommodations of four Spacelab missions. The requirements for KSC accommodations includes the entire process flow from unloading the payload elements at KSC through launch, landing and shipment back to the payload user. The study compares those requirements against the KSC accommodations as outlined in the current and proposed revisions of the KSC handbook. The analysis considers what will be done and what will not be done for payloads at the launch site. The study considers available and allocated resources such as power, purge, environmental control and checkout provisions versus the functional flow through the launch facilities.

The current issue of the KSC handbook is being revised by KSC. TBE was furnished a marked-up copy and current revision notes. The goal was to compare launch site operations requirements of four missions with the handbook. Expected results were the clarification of launch site accommodations descriptions in terms easily understood by the payload user and the identification of anomalies in launch site accommodations. If the problem was one of clarification, it was worked with KSC directly. If it was a problem of accommodations, it was flagged for resolution by the parties involved. Discussions with experiment/payload sponsors or other cognizant personnel were used to clarify payload requirements and/or resolved several accommodation anomalies. Recommendations were forwarded to KSC as they were generated.

Four missions were considered: Mission 83-2 for OA, a Spacelab III Strawman mission including a pallet, a combined astronomy mission including the Shuttle Infrared Telescope Facility (SIRTF), and a dedicated life sciences mission from JSC. OFT-2 was eliminated from consideration because of a lack of timely information on its launch site requirements. Information on launch site operations requirements were solicited through contact with the cognizant payload sponsors/principal investigators. Data for the first two missions were presented on November 8, 1977. This document covers those two missions with revisions made since the November report and our findings on the combined astronomy and life sciences payloads. Section 2 of this report outlines the methodology we used to apply payload requirements to the KSC accommodations for certain resources (review criteria) as a function of the operations performed on the payload at the launch site. Sections 3 through 6 describe the payloads individually, their apparent launch site accommodation problem, and their requirements for resources as a function of the process flow. Section 7 summarizes the comments and recommendations for the KSC Launch Site Accommodations Handbook for STS Payloads that have already been communicated to KSC.

2. METHODOLOGY

This section outlines the method used to compare payload launch site requirements with launch site accommodations and to evaluate the description of those accommodations contained in the proposed revisions to the KSC Launch Site Accommodations Handbook for STS Payloads (Ref. 1). The analysis was limited to Spacelab payloads. The method involved three steps: Definition of review criteria for resources and capability, definition of applicable functional flow operations for Spacelab payloads, and an assessment of payload requirements using a matrix of review criteria for each functional operation.

The first step was to develop a list of review criteria or questions likely to be asked by an experiment developer or payload planner concerning the ground processing of his equipment at KSC. Twenty review criteria were defined and then developed into a series of questions.

The second step was to define all of the functions which are likely to occur to a Spacelab payload during its normal processing flow at Levels III/II and I integration, during prelaunch, and through post landing activities until the payload is removed from the Spacelab in the O&C Building. The method used to define these activities was to expand all of the ground operations, as listed in the KSC handbook (Ref. 1) and also in the Spacelab Level II Ground Operations Requirements Document (Ref. 2) into a detailed list of process functions. The final list contained 100 specific process functions.

The third step, an assessment was performed comparing each of the process functions with the review criteria for specific payloads. To facilitate this process, a matrix was constructed with the process functions as the horizontal element and the review criteria as the vertical element. It should be pointed out that the process functions do not represent a timeline of flow, but rather, represent specific individual tasks. All of the functions will not necessarily apply to each payload. The list of functions is also quite detailed except where complete definitions of the overall tasks to be performed were not available. The completed matrix shows:

- Those areas where the accommodations document is not clear or specific
- Those areas where payload requirements may not be satisfied
- Which functions are not applicable to the payload.

Using this matrix, four payloads have been analyzed in sufficient detail to develop their ground processing flow requirements. These requirements have been compared with the applicable review criteria. The results of this comparison indicate accommodation anomalies for resolution by clarification through the handbook or by negotiation with the experiment/payload sponsors.

2.1 REVIEW CRITERIA

The review criteria are presented in the order of their appearance in the matrix and are identified with the same alphabetic symbol.

2.1.1 Time - A

For those activities during which payload services are not provided, is the length of time clearly specified? Are there fixed time limitations on any activities involving payloads and, if so, are they specified?

2.1.2 On Site Transportation - B

If transportation to KSC terminates at a commercial facility which is "off site" can transportation be arranged through KSC? What types of transportation are available to move the payload from the receiving point to the O&C Building or to a storage area? How are arrangements made to utilize this transportation? Are there any size, weight, or other restrictions on any of the available modes of transportation?

2.1.3 Experiment Transportation/Storage Environment Status Monitoring - C

Is there a device or equipment available to monitor, record, and display temperature, humidity, and acceleration to which experiment or payload equipment is subjected while it is in storage, in transit from one KSC location to another, or being processed? Can this equipment be used while Spacelab payload equipment is in a container? While it is not in a container? Are there any times when this equipment is not available or cannot be used? In what form is the data output (strip chart, magnetic tape, etc.)? Are there any payload developer transducer installations required to use this equipment?

2.1.4 Thermal Control - D

What is the range over which the environment temperature can be controlled? What is the tolerance or regulation to which any set temperature can be maintained? At what times or places during the normal payload flow is regulated temperature control not available?

2.1.5 Humidity - E

Over what range can relative humidity be controlled? To what degree of accuracy can any level of relative humidity be maintained? At what points during the normal flow will relative humidity control not be available?

2.1.6 Cleanliness - F

What classes of cleanliness are available and where? What are the time and space restrictions on its use? At what times or places during the normal flow is cleanliness control not available or maintained? Are facilities available for cleaning equipment which may become contaminated?

2.1.7 ATE Support - G

What types of tests will be done using the ATE (or EGSE)? Will it be interface verification, will it be operational testing of Spacelab CDMS equipment, or will it be testing of individual experiments?

To what extent will the payload owner/operator or the experiment developer participate in this testing?

What special interfaces are required on the experiment equipment or its associated GSE for use with the ATE (EGSE) and what special software if any is required?

2.1.8 Data Processing - H

What are the available data processing equipment and services at KSC? Can they be utilized in a "real time" test environment or are they available only for post test data reduction? What types of data can be processed and in what format will the output be?

What data recording capabilities are available over and above those provided by the Spacelab EGSE? What steps must be taken to utilize this equipment or services?

2.1.9 Experiment Testing - I

What type testing, interface verification, experiment operation, or simulated missions will be performed at each location? At what points will payload peculiar GSE be required to support testing and to what level will the payload owner or experiment developer be required or allowed to participate?

2.1.10 Experiment Calibration - J

Is any time provided in the normal online flow for recalibration or adjustment of experiment equipment? Is time allocated for final alignment checks or adjustments?

2.1.11 Offline Lab Space - K

What offline lab space is available? What is its size (area and volume)? What type of environmental and cleanliness control does it have? What type of power is available? Are there any special features, provisions or limitations such as access limitations or entry limitations? Are special labs such as a screen room available? How is use of special areas or labs arranged for?

2.1.12 Physical Access - L

What are the restrictions on physical access to the experiment equipment and its related GSE at each phase of the ground operations? At what times is access prohibited?

2.1.13 Electrical Power - M

What types of electrical power are available for use at each of the ground processing stations or other areas which may be used by the payload owner or experiment developer?

What are the characteristics of the available power such as: regulation, current capacity, frequency for ac power, number of phases, and EMI characteristics? What are the locations where the various types of power are available, when is it available, and when is it not available?

2.1.14 Spacelab Standard GSE - N

What standard Spacelab or facility mechanical or electrical GSE is available for use by the payload owner/operator or the experiment developer? What are its functional capabilities and limitations? When and where is it available and when and where is it not available?

2.1.15 Mechanical Servicing - O

What tools and equipment are available for making alignment adjustments? Are special tools such as optical transits, laser transits, etc., available on an as needed basis? What type cranes or other fixed lifting devices are available and where? What portable lifting or handling devices are available? When are they not available? Are there any constraints on using this equipment in a clean room? What special purpose tools such as calibrated torque wrenches or measuring devices are available?

2.1.16 Cryogenic Servicing - P

What common cryogenics are available--LN_2, LHe, LO_2, LH_2? Are any others available? Can provisions be made to obtain special types if required?

For those available, how is it supplied--from a portable service cart or a fixed tank? What are the restrictions on the use or movement of portable service carts and/or where are the fixed service points located? What quantity of normally stocked cryogenics is available?

2.1.17 Pneumatic Servicing - Q

What gases are normally available (N_2, He, O_2, air)? Are any other special gases available? In what type containers (portable tank, facility supply, etc.) are the normally supplied gases available? What are the quantities, delivery pressures, and flow rates? Is the delivery pressure regulated? Where are the gas supply interfaces located? What is the quality of the supplied gas (moisture, contamination, etc.)? What is the total available quantity? Are any facilities available for storing payload provided gases in high pressure containers? Are there any special precautions relating to the use and storage of high pressure gas containers?

2.1.18 Liquid/Hydraulic Servicing - R

What types of liquids are normally available (water, hydraulic oil)? Are any other special types available? What is the quality of the available liquids? Is it distilled, filtered, etc.?

How is it available? Is it in portable tanks, fixed tanks, or is it available from a facility supply system? Where are the supply interfaces located and what are the flow rates, pressures, and temperature of available liquids? What are the normally available quantities for liquids? Is there a purge capability for hydraulic systems such as a portable hydraulic servicer?

2.1.19 Pyrotechnic Servicing - S

What are the special safety precautions for the handling and storage of pyrotechnic devices? Is the necessary handling and grounding equipment available for use with pyrotechnic devices? What are the operational restrictions on other activities during pyrotechnic servicing?

2.1.20 Specimen Servicing (Live/Perishable) - T

Is there an offline lab or storage/maintenance area for use with live or perishable specimens? What are the physical boundaries and constraints of this area? What type environmental control does it have? What type waste control does it have?

At what time during the online processing is access to Spacelab available for carrying onboard live or perishable specimens or for securing same?

2.2 PAYLOAD PROCESS FUNCTIONS

Spacelab payloads will arrive from the Level IV integration site as individually packaged and completely integrated racks and pallets, except where additional experimental equipment may arrive independently because of characteristics prohibiting integration and shipment with the other Level IV assemblies. The shipments are received at the O&C Building and the first function is to unload the carrier. Functions 1 through 47 cover the receiving and Level III/II integration at the O&C Building and the transportation to the OPF. Functions 48 through 59 cover integration operations at the OPF and the move to the VAB, function 60 is at the VAB, functions 61 through 72 cover the move to the pad and the pad operations. After the Orbiter lands from its flight, functions 73 through 76 cover the payload landing site operations and the move back to the OPF, functions 77 through 87 cover the OPF payload operations and the subsequent move to the O&C, and functions 88 through 100 cover the O&C payload disassembly operations. The matrix is shown in Figure 1, parts A & B. Part A covers functions from receipt of the payload through its move to the OPF. Part B covers OPF, VAB, pad, and post landing functions. A solid bar on the matrix shows that the requirement would be met by the accommodations described in the KSC handbook. A broken bar shows that the handbook does not indicate that a requirement would be met. In some cases, this means that the handbook does not adequately describe available accommodations; in other cases, that the accommodations are lacking or that there is some problem in accommodating the requirement. A thin line indicates that the function is not applicable to the payload. A blank indicates criteria not applicable to a function. In the discussions on each payload (Sections 3 through 6), the nature of the problem is indicated with the action taken to negotiate its resolution. All 100 functions are described in the following subparagraphs in function number order.

2.2.1 Offload the Carrier - 1

Racks and pallets in the Intersite Transportation Equipment (ITE) shipped by air or barge are transferred to a low boy truck. Portable crane(s), slings and lifting adapters are required. Environmental control and monitor equipment must be deactivated before offloading and then reactivated after securing the load to the low boy.

2.2.2 Transport to the O&C Building - 2

The Intersite Transportation Equipment container can be split in two sections each of which can hold one pallet or two racks. Transportation is by air or barge if the container is shipped as one unit as when a two pallet train is shipped. A low boy truck (also ITE) can transport the container to the O&C. A single pallet or rack is shipped in one segment of the container by road directly to the O&C Building. Racks and pallets are shipped using the low boy to the O&C Building after function 1.

2.2.3 Clean and Remove Covers - 3

At the receiving dock, the exterior packaging will be cleaned to prevent contaimination of the class 100,000 clean area of the O&C Building. The dust protection will be removed to prepare for the attachment of handling GSE.

2.2.4 Transfer to Assembly Area - 4

Pallets will be lifted and translated from the ITE container and placed on the transfer dolly. Two cranes will be used in the lifting operation. The transfer dolly will be used to transport the pallets to the assembly workstand area.

2.2.5 Mount Racks on Rack Floor - 5

The experiment racks will be lifted and translated into position to mate with the rack floor plates. Mounting hardware will be installed.

2.2.6 Join Pallets in Trains - 6

Where two or more pallets are required for the mission, individual pallets will be joined to form a train. This is an offline function from the Spacelab processing. Flexible functional interfaces, e.g., electrical and fluid will be mated as part of this function.

2.2.7 Remove Xport Instrumentation - 7

Transportation instrumentation for monitoring shock and vibration will be removed in parallel with functions 3 and 4.

FOLDOUT FRAME 1

FOLDOUT FRAME 2

LEVEL III/II INTEGRATION AT O & C

KSC ACCOMMODATIONS DEFINITIONS AND REVIEW CRITERIA \ KSC SPACELAB PROCESS FUNCTIONS		1 OFFLOAD CARRIER	2 TRANSPORT TO O & C	3 POSTSHIP CLEAN & REMOVE COVERS	4 TRANSFER TO ASSEMBLY AREA	5 MOUNT RACKS ON RACK FLOORS	6 JOIN PALLETS IN TRAINS	7 REMOVE XPORT INSTRUMENTATION	8 INSTALL SHIPSHORT EQUIPMENT	9 JOIN RACK FLOORS	10 INSTALL INTERCONNECT LINES	11 ATTACH HANDLING GSE	12 TRANSFER TO WORKSTAND	13 INSTALL RACK SET ON WORKSTAND	14 REMOVE HANDLING GSE	15 INSTALL RACK SET IN MODULE	16 CONNECT & VERIFY INTERFACES	17 INSTALL AFT END CONE ON WORKSTAND	18 MATE CONE TO MODULE	19 CONNECT & VERIFY INTERFACES	20 INSTALL PALLET ON WORKSTAND	21 REMOVE HANDLING GSE	22 CONNECT & VERIFY INTERFACES	23 INSTALL AND P/L PECULIAR HDW	24 INSTALL EXP. PECULIAR GSE	25 VERIFY EXP. PECULIAR GSE I/F	26 PRE-POWER ON BUS ISOLATION TEST	27 POWER UP & VERIFY COOLANT SYSTEM	28 VERIFY S/L TO GSE I/F	29 LOAD S/W AND VERIFY ROUTINES	30 POWER UP & FUNCT. VERIFY I/F	31 FUNCTIONAL TEST & CAL. OF EXP.	32 S/L TO SIM. ORBITER I/F TEST	33 S/L ORBITER MISSION SEQ TEST	34 MAN-MACHINE INTERFACE TEST	35 POCC/PL CID RESPONSE TEST	36 STOW NON TIME CRITICAL ITEMS	37 REMOVE AND P/L PECULIAR HDW	38 PAYLOAD SERVICE AS REQUIRED	39 DISCONNECT GSE & ORBITER SIM.	40 SHAKEDOWN INSPECTION	41 WEIGHT & C.G. TEST (IF REQ'D)	42 PAYLOAD PREPARATION FOR MOVE	43 INSTALL STRONGBACK	44 INSTALL PAYLOAD IN CANISTER	45 REMOVE STRONGBACK	46 CLOSE CANISTER	47 TRANSPORT TO OPF
TIME	A																																															
ON SITE XPORT	B																																															
EXP XPORT/STORAGE ENVIRONMENT MONITOR	C																																															
THERMAL CONTROL	D																																															
HUMIDITY CONTROL	E																																															
CLEANLINESS	F																																															
ATE SUPPORT	G																																															
DATA PROCESSING	H																																															
EXP. TESTING	I																																															
EXP. CALIBRATION	J																																															
OFF-LINE LAB SPACE	K																																															
PHYSICAL ACCESS	L																																															
ELECTRICAL POWER	M																																															
SPACELAB STANDARD GSE	N																																															
MECHANICAL SERVICING	O																																															
CRYOGENIC SERVICING	P																																															
PNEUMATIC SERVICING	Q																																															
LIQUID/HYDR SERVICING	R																																															
PYROTECHNIC SERVICING	S																																															
SPECIMEN SERVICING	T																																															

LEGEND:

- (solid heavy line) REQUIREMENT SATISFIED
- (hatched line) REQUIREMENT NOT SATISFIED
- (thin line) FUNCTION NOT APPLICABLE FOR THIS PAYLOAD
- BLANK CRITERIA NOT APPLICABLE FOR THIS FUNCTION

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FIGURE 1A. REVIEW CRITERIA VERSUS PROCESS FUNCTIONS 1-47.

FOLDOUT FRAME 1

FOLDOUT FRAME 2

KSC SPACELAB PROCESS FUNCTIONS / KSC ACCOMMODATIONS DEFINITIONS AND REVIEW CRITERIA		LEVEL I INTEGRATION AT OPF												VAB		PAD OPERATIONS										
		48 OPEN CANISTER	49 INSTALL STRONGBACK	50 REMOVE P/L & INSTALL IN ORBITER	51 REMOVE STRONGBACK	52 INSTALL TUNNEL IN ORBITER	53 MATE SPACELAB TO ORBITER	54 INSTALL AFD P/L PECULIAR HDW	55 I/F VERIFICATION TEST	56 INTEGRATED ORBITER/SL TEST	57 PAYLOAD FINAL SERVICING (AS REQ'D)	58 PAYLOAD BAY CLOSEOUT	59 TOW TO VAB	60 VAB OPERATIONS	61 TRANSPORT FROM VAB TO PAD	62 MATE MLP TO PAD	63 EXTEND PCR	64 OPEN PAYLOAD BAY DOORS*	65 ORBITER POWER ON	66 LAUNCH READINESS VERIFICATION	67 CABIN CLOSEOUT	68 PAYLOAD SERVICING (IF REQ'D)*	69 VEHICLE CLOSEOUT & SECURE GSE	70 CLOSE PAYLOAD BAY DOORS*	71 RETRACT PCR	72 LAUNCH COUNTDOWN
TIME	A																									
ON SITE XPORT	B																									
EXP XPORT/STORAGE ENVIRONMENT MONITOR	C																									
THERMAL CONTROL	D																									
HUMIDITY CONTROL	E																									
CLEANLINESS	F																									
ATE SUPPORT	G																									
DATA PROCESSING	H																									
EXP. TESTING	I																									
EXP. CALIBRATION	J																									
OFF-LINE LAB SPACE	K																									
PHYSICAL ACCESS	L																									
ELECTRICAL POWER	M																									
SPACELAB STANDARD GSE	N																									
MECHANICAL SERVICING	O																									
CRYOGENIC SERVICING	P																									
PNEUMATIC SERVICING	Q																									
LIQUID/HYDR SERVICING	R																									
PYROTECHNIC SERVICING	S																									
SPECIMEN SERVICING	T																									

KSC SPACELAB PROCESS FUNCTIONS / KSC ACCOMMODATIONS DEFINITIONS AND REVIEW CRITERIA		LANDING SITE				OPF											O & C												
		73 DEACTIVATE & SECURE ORBITER	74 CREW EXCHANGE	75 REMOVE TIME-CRITICAL ITEMS	76 TOW TO OPF	77 TRANSFER TO FAC SERVICES	78 SAFE SPACELAB	79 OPEN PAYLOAD BAY DOORS	80 INSTALL ACCESS GSE	81 REMOVE OR COVER EXP. AS REQ'D	82 DEMATE AND REMOVE TUNNEL	83 INSTALL STRONGBACK	84 REMOVE S/L FROM ORBITER & PUT IN CANISTER	85 REMOVE STRONGBACK	86 CLOSE CANISTER	87 MOVE TO O & C	88 OPEN CANISTER, INSTL. STRONGBACK	89 MOVE S/L TO WORKSTAND	90 INSTALL PROTECTIVE GSE	91 INTERIOR INSPECTION	92 COMPLETE DESTOW	93 CORE SEGMENT GSE HOOKUP	94 POST FLIGHT SUBSYSTEM CHECKOUT	95 REMOVE PALLETS	96 DEMATE AFT BULKHEAD	97 INSTALL GSE FOR RACK REMOVAL	98 REMOVE EXPERIMENT RACKS	99 REMOVE EXP. FROM RACKS & PALLETS	100 PREP. EXP. FOR STORAGE/SHIPMENT
TIME	A																												
ON SITE XPORT	B																												
EXP XPORT/STORAGE ENVIRONMENT MONITOR	C																												
THERMAL CONTROL	D																												
HUMIDITY CONTROL	E																												
CLEANLINESS	F																												
ATE SUPPORT	G																												
DATA PROCESSING	H																												
EXP. TESTING	I																												
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PNEUMATIC SERVICING	Q																												
LIQUID/HYDR SERVICING	R																												
PYROTECHNIC SERVICING	S																												
SPECIMEN SERVICING	T																												

LEGEND:

- (heavy solid line) REQUIREMENT SATISFIED
- (hatched line) REQUIREMENT NOT SATISFIED
- (thin line) FUNCTION NOT APPLICABLE FOR THIS PAYLOAD
- BLANK — CRITERIA NOT APPLICABLE FOR THIS FUNCTION
- * — NOT A NORMAL PROCESS FOR SPACELAB PAYLOADS

FIGURE 1B. REVIEW CRITERIA VERSUS PROCESS FUNCTIONS 48-100

2.2.8 Install Shipshort Equipment - 8

Certain oversize or transportation sensitive experiment equipment will be shipped separately from the racks or pallets to KSC. This equipment must be installed and the functional interfaces mated and verified before integrating the major assembly with the Spacelab.

2.2.9 Join Rack Floors - 9

The individual rack floor plates are connected to form a complete floor set.

2.2.10 Install Interconnecting Lines - 10

The service lines, e.g., data, power, and fluid , between racks are connected and verified in this function.

2.2.11 Attach Handling GSE - 11

The integrated rack and floor assembly is handled with an overhead crane through a "rack and floor installation kit." Using the overhead crane, the kit is secured to the rack and floor assembly. The GSE to handle the pallet and aft end cone is also installed.

2.2.12 Transfer to Workstand - 12

The rack assembly, installed in the installation kit, is moved onto the workstand support structure.

2.2.13 Install Rack Set on Workstand - 13

The rack floor set is secured to the workstand support structure.

2.2.14 Remove Handling GSE - 14

The transport kit is disconnected from the rack set. The crane is used to lift and translate the transportation kit from the racks and return the kit to storage.

2.2.15 Install Rack Set in Module - 15

The complete rack assembly is translated into the module on rollers.

2.2.16 Connect and Verify Interface - 16

The power, data, and fluid interfaces between the complete experiments rack assembly and the Spacelab subsystems will be mated. Electrical tests for (1) bonding and (2) signal and power isolation will be performed. Leak tests will be performed on gas and fluid interfaces.

2.2.17 Install Aft End Cone on the Workstand - 17

The aft end cone will be lifted and translated into position for mating with the Spacelab module.

2.2.18 Mate the Aft End Cone to Module - 18

Mechanical alignment GSE will be used to mate the end cone with the open end of the module. The mechanical fasteners will be installed and the multilayer insulation replaced over the interface.

2.2.19 Connect and Verify Interfaces - 19

This function mates and functionally verifies the mechanical interface between the module and the aft end cone. The interface includes fluid, gas and electrical connections.

2.2.20 Install Pallet on the Workstand - 20

The lifting cradle was attached to the pallet train in function 11. In this function, a crane is used to lift and translate the pallets into position on the workstand.

2.2.21 Remove Handling GSE - 21

The interface hardware between the GSE and the pallet structure is removed. The crane is used to lift and translate the GSE to a storage area.

2.2.22 Connect and Verify Interfaces - 22

The pallet is mechanically secured to the workstand structure. The services interfaces, e.g., data, power and fluid between the pallet and the module are also connected in this function. For pallet only missions the igloo is installed in this function.

2.2.23 Install Aft Deck Payload Peculiar Hardware - 23

Payload peculiar hardware is installed in the racks provided in the simulated aft deck.

2.2.24 Install Experiment Peculiar GSE - 24

Experiment peculiar GSE is installed for use in the checkout and servicing of individual experiments.

2.2.25 Verify Experiment Peculiar GSE Interface - 25

Functional and physical interfaces between the experiments, the GSE and the Spacelab will be verified.

2.2.26 Prepower "On" Bus Isolation Test - 26

Prior to power turn on, this test will be performed. It is used to assure that the power bus is isolated from ground. GSE required is a resistance meter with a high resistance scale.

2.2.27 Power Up and Verify Coolant System - 27

After interface connections have been made to the payload cooling loop, the GSE Freon Cooling Unit will be powered up and readings of temperature, pressure and flow rates will be taken at the inlet and outlet of the payload cooling loop to verify proper operation.

2.2.28 Verify S/L to GSE I/F - 28

The Spacelab is connected, mechanically and electrically, to the Orbiter Interface Adapter (OIA) which duplicates all S/L to Orbiter interfaces. The OIA, part of the Integration Workstand, includes the Aft Flight Deck Simulator. All connections are made and verified. The Automatic Test Equipment is also connected to the S/L and connections verified.

2.2.29 Load S/W and Verify Routines - 29

The mission flight software will be loaded onto the mass memory unit. Then the flight software from the mass memeory unit is loaded into the computer memory. A check sum will be obtained from a computer readout verifying that the routine has been loaded successfully. For certain payloads there may be a requirement for validation of the flight software by confirming its operational acceptability.

2.2.30 Power Up and Functionally Verify I/F - 30

All fluid and electrical interface connections are checked under load conditions. Mechanical interfaces will have been checked previously. These tests involve module/pallet/rack interfaces with Spacelab and Shuttle.

2.2.31 Functional Test and Calibration of Experiment - 31

The user (experimenter) is responsible for a final functional test and calibration of his experiment at this point, if required. Normally, this is the last station at which the user has access to his equipment.

2.2.32 S/L to Sim Orbiter I/F Test - 32

The Spacelab was connected to the simulated Orbiter (OIA) in function 28. The I/F test will consist of inspection and test of the S/L to OIA power connections, the S/L to OIA signal/command electrical interfaces and the S/L to OIA fluid/gas line connections. Any mismatches or other problems must be corrected on the S/L side of the interface as the Orbiter side is inviolable.

2.2.33 Mission Sequence Test - 33

This test is used to determine that the peak demands of the payload are compatible with Spacelab services. The mission sequence test will assure that the maximum (1) data rate, (2) power consumption and (3) heat loads are compatible with Spacelab.

2.2.34 Man/Machine Interface Test - 34

At this point, the Payload Specialists assigned to the payload being processed will simulate all dialing, switching, readout operations and other human activities required for experiment performance to assure that such activities can be performed in space in an efficient manner.

2.2.35 Payload/POCC Command Response Test - 35

This test is a closed loop evaluation of the POCC ability to command the payload. Commands are initiated in the POCC, travel by the NASCOM network to the Spacelab through automatic test equipment and activate elements of the payload. Payload response data from the high rate multiplexer is routed through NASCOM to the POCC.

2.2.36 Stow Non Time-Critical Items - 36

All stowage items that are not time-critical will be stowed aboard the Spacelab at this time. A stowage chart will be maintained showing all stowage items, time stowed, location and purpose.

2.2.37 Remove AFD P/L Peculiar Hardware - 37

The Payload Peculiar Hardware which was installed in the Aft Flight Deck simulator of the Orbiter Interface Adapter (OIA) for the O&C tests will be removed in preparation for the P/L move to the OPF.

2.2.38 Payload Service as Required - 38

The required servicing of the payload in preparation for the move to the OPF will be performed at this point.

2.2.39 Disconnect GSE and Orbiter Simulator - 39

GSE electrical and mechanical connections between the payload and GSE and the payload and Orbiter simulator (OIA) will be broken. Action will be taken to ensure that the disconnected ends are protected and tagged prior to movement to the OPF.

2.2.40 Shakedown Inspection - 40

A complete top-to-bottom inventory check of the payload will be made to ensure that all experimental equipment, connectors, bracketry, stowage items, etc., are present and have undergone required tests. Tags will be checked on all interface items to be mated at final assembly in the OPF.

2.2.41 Weight and C.G. Test (if required) - 41

With the strongback installed a weight and center of gravity test can be conducted for the x and y axis of the payload using the horizontal sling kit and the vertical sling kit available in the O&C Building. These kits utilize movable "eyes" to locate the c.g. exactly.

2.2.42 Payload Preparation for Move - 42

The strongback and crane will be moved into position. The GSE transporter loaded with the empty canister will be moved alongside the Spacelab Assembly Stand. All loose material, tools, etc., will be removed from the payload and assembly stand. Cabling and fluid lines and connectors will be secured for the move. Installed experimental equipment will be in the launch position. Cleaning and bagging of equipment requiring cleaner than Class 100 K will be accomplished at this time.

2.2.43 Install Strongback - 43

The strongback is moved into position over the Spacelab Assembly Stand by cranes, lowered into position above the payload and attached to the payload.

2.2.44 Install Payload In Canister - 44

The strongback, with payload attached, is lifted from the Spacelab Assembly Stand by the crane, positioned above the canister, and lowered into position.

2.2.45 Remove Strongback - 45

The strongback is disconnected from the payload, lifted to clear any obstructions, and moved away from the payload. The crane slings are detached and removed from the strongback.

2.2.46 Close Canister - 46

After the strongback has been moved away, shock and vibration monitors are installed. The canister doors are then closed, sealing the payload in a Class 100 K clean environment.

2.2.47 Transport to OPF - 47

The transporter carrying the canister is driven to the OPF. Environmental conditioning is provided to the payload during this move using a trailer mounted Environmental Control Unit (ECU) pulled by the transporter.

2.2.48 Open Canister - 48

A crane with hook and sling is positioned over the canister, connected to the door handles and the doors are opened. The ECU is disconnected.

2.2.49 Install Strongback - 49

An identical strongback to the one used in the O&C is positioned via crane and sling over the canister, lowered to the payload and strongback/payload connections secured.

2.2.50 Remove P/L and Install in Orbiter - 50

The payload is lifted from the canister, moved above the payload bay in the Orbiter and lowered into position.

2.2.51 Remove Strongback - 51

The strongback is disconnected from the payload, raised via the crane to clear all obstructions, and moved to its holding area.

2.2.52 Install Tunnel in Orbiter - 52

The tunnel, which has arrived at the OPF inside a canister, is transferred from the canister to its position in the Orbiter payload bay utilizing the available crane and slings. After lowering into position, the slings are detached and removed. The tunnel is now connected to the opening in the Orbiter crew compartment rear bulkhead and to the tunnel opening in the module. A leak test is conducted to check the interfaces.

2.2.53 Mate Spacelab to Orbiter - 53

The Spacelab (connected tunnel, module, and pallets) is now mated electrically (cable connectors) and mechanically (hard point connections, fluid lines, braces) to the Orbiter. Interface connectors on the Spacelab side will have been previously tagged for quick identification and connection to the Orbiter side.

2.2.54 Install AFD P/L Peculiar Hardware - 54

The payload peculiar hardware will be installed in predesignated racks in the Orbiter Aft Flight Deck. Necessary interface connections will be made.

2.2.55 I/F Verification Test - 55

This test verifies the power and data lines which cross over the Orbiter/Spacelab interface. It also verifies the mechanical interfaces between the tunnel and the Orbiter and between the tunnel and Spacelab.

2.2.56 Integrated Orbiter/SL Test - 56

This test functionally verifies the interfaces between the Orbiter and Spacelab. Testing will consist of operating and monitoring the Spacelab CDMS and selected experiment equipment through the Orbiter

Avionics System. An open loop end-to-end test involving the CDMS, Orbiter Avionics, TDRSS RF links and the MCC/POCC will be conducted.

2.2.57 Payload Final Servicing (as required) - 57

Payload fluids and gases may have to be topped off at this point if testing or leakage has brought consumption down to critical values. This is normally the last processing point to service the payload.

2.2.58 Payload Bay Closeout - 58

A final inspection of the payload bay is conducted for observable deficiencies. GSE, test equipment, tools, and debris are removed. Equipment requiring a 10 K clean environment are bagged after maintaining this cleanliness using a portable clean facility (ECU). Finally, the Orbiter payload bay doors are closed. There will be no planned access to the payload after Orbiter doors are closed in the OPF (up to 10 days before launch).

2.2.59 Tow to VAB - 59

The Orbiter, still in the horizontal position, is towed from the OPF to the VAB using the KSC provided tow vehicle. Power or environmental conditioning will not be provided to the payload during this transit.

2.2.60 VAB Operations - 60

There are no payload operations or access planned at the VAB. The Orbiter is oriented to the vertical position for mating with the ET and SRBs. The Spacelab will be in the vertical position up to 9 days. The payload will remain in this vertical orientation until after launch. A cargo bay purge is in continuous operation after mating of the Orbiter with the ET. No power is supplied to the payload, however.

2.2.61 Transport from VAB to Pad - 61

The integrated Shuttle is transported on the mobile launch platform (MLP) from the VAB to the launch pad. During this move there is cargo bay purge to provide environmental conditioning. No power is supplied to the payload.

2.2.62 Mate MLP to Pad - 62

While the mobile launch platform is being mated to pad the cargo bay will receive environmental conditioning, but no external power will be supplied to the payload until mating has been completed (approximately 7 hours). Activities include connection and verification of pad-to-MLP and tower-to-vehicle interfaces and access provisions.

2.263 Extend PCR - 63

The Payload Changeout Room (PCR) will be moved on its rails to a position next to the Orbiter. The PCR provides certain services to the Orbiter during final checkout. It also is in readiness in case access to Spacelab is required. The PCR's prime function is installation of vertically assembled payloads into the Orbiter cargo bay and for fast changeout of payloads if required.

2.2.64 Open Payload Bay Doors - 64

If access to the payload is required, the Orbiter cargo doors are opened using the PCR equipment installed for this purpose. Three hours must be allowed for opening the doors.

2.2.65 Orbiter Power On - 65

The Orbiter power is turned on as the ground supplied power servicing the Orbiter is turned off.

2.2.66 Launch Readiness Verification - 66

The Launch Readiness Verification test is conducted to assure that all Shuttle launch systems are in the "GO" posture. No payload checks are made during this test. The LRV test verifies (1) newly connected MLP-to-LPS interfaces, (2) Shuttle launch-critical functional paths, and (3) Shuttle launch readiness. The Shuttle is committed to launch after successful completion of the Launch Readiness Verification test.

2.2.67 Cabin Closeout - 67

Payload carry-ons are stowed in the cabin at this point and the crew enters. The cabin door is closed and the crew prepares for liftoff.

2.2.68 Payload Servicing (if required) - 68

If the cargo doors were opened after the PCR was positioned adjacent to the Orbiter, final payload servicing requirements are completed.

2.2.69 Vehicle Closeout and Secure GSE - 69

Laoding of hypergolic propellant and high pressure gases is completed and servicing interfaces are disconnected. All other servicing GSE required at the pad is removed to the storage areas provided in the PCR.

2.270 Close Payload Bay Doors - 70

The Orbiter cargo doors are closed using PCR facilities. Allowance of 3 hours must be made for this operation. While 6 hours are budgeted for opening and closing the payload bay doors only, additional hours are used in servicing payload equipment, changeout, etc. All such hours are charged to the payload equipment users.

2.2.71 Retract PCR - 71

After disconnecting all interfaces between PCR-to-Orbiter and PCR-to-Pad, the PCR is moved back to initial launch pad position.

2.2.72 Launch Countdown - 72

After the PCR has been retracted from the Orbiter, the Shuttle prelaunch countdown continues until liftoff. Payload bay purging and power requirements are furnished by the Orbiter. No other payload operations are involved. Main propellant loading is completed, remaining pad/Shuttle interfaces are disconnected, and final sequencing and status checks are conducted.

2.2.73 Deactivate and Secure the Orbiter - 73

The Orbiter will be deactivated by (1) a shutdown of all flight systems and (2) removal of the residual consumables from the propulsion system.

2.2.74 Exchange Crew - 74

This function occurs immediately after landing. The flight crew departs and is replaced with a ground crew which will move the Orbiter to the OPF.

2.2.75 Remove Time-Critical Items - 75

Carry-off specimens will have been stored on the mid deck. These will be removed at crew egress.

2.2.76 Tow to OPF - 76

This function includes (1) connection of the towing equipment, (2) connection and activation of support equipment (e.g., electrical power source, ECLSS coolant, and communications) and the towing of the Orbiter to the OPF.

2.2.77 Transfer to Facility Services - 77

The services provided by mobile support equipment in function 76 are transferred to facility systems in the OPF.

2.2.78 Safe the Spacelab - 78

All Spacelab subsystems will be deactivated through the mission specialist station in the Orbiter.

2.2.79 Open Payload Bay Doors - 79

The payload bay doors will be opened using two cranes. The facility services listed in function 76 will be maintained. This function includes (1) removal of locks from payload bay doors, (2) attachment of door opening GSE, and (3) unlatching of the doors.

2.2.80 Install Access GSE - 80

The horizontal payload bay access stands are installed. Two cranes are required to lift and translate the sections of the access stands into position. The mechanical fasteners which secure the sections together and secure the stand to the payload are installed.

2.2.81 Remove or Cover Experiments (as required) - 81

Consumables including cryogens are removed. Individual sensitive instruments or data which may be damaged will be protected or removed before proceeding with further OPF operations.

2.2.82 Demate and Remove Tunnel - 82

The tunnel is removed from the payload bay and placed in the transport canister for shipment to the O&C Building.

2.2.83 Install the Strongback - 83

The strongback is secured to the Spacelab using two overhead cranes with slings and adapters.

2.2.84 Remove Spacelab from the Orbiter and Put in Canister - 84

The mechanical fasteners which tie elements of the Spacelab to the Orbiter are removed. The Spacelab is put into the transportation canister and secured to the canister support structure.

The payload horizontal access kit provides access to the tie points. After the Spacelab is secured to the canister the horizontal access platforms are removed.

2.2.85 Remove the Strongback - 85

The strongback is removed from the Spacelab and put in the storage area.

2.2.86 Close Canister - 86

The canister doors will be closed using two cranes. The canister will be resting on the horizontal transporter structure during this function. After the doors are closed the Environmental Conditioning Unit and the Transportation Instrumentation Set will be activated in preparation for transportation to the O&C Building.

2.2.87 Move to the O&C Building - 87

The Spacelab in the payload canister is moved by canister transporter to the O&C Building. Provisions for environmental control and the monitoring of shock and vibration are provided during this function.

2.2.88 Open Canister and Install Strongback - 88

Two overhead cranes are used to open the canister doors. The canister horizontal access kit is installed. The strongback is lifted and translated into position over the Spacelab assembly and attached to the payload.

2.2.89 Move the Spacelab to the Workstand - 89

Using the canister horizontal access kit, the interface between the Spacelab and the canister is demated. The Spacelab and strongback are lifted and positioned in the workstand. The strongback is removed and returned to storage in the O&C Building.

2.2.90 Install Protective GSE - 90

The GSE necessary to protect the Spacelab from damage during subsequent operations is installed.

2.2.91 Interior Inspection - 91

A complete inspection of the interior of the Spacelab module is performed. Damage is identified and scheduled for correction during maintenance.

2.2.92 Complete Destow - 92

All items which were stowed during the flight mission are removed. Included are portable mission support equipment, some experiment hardware, and human waste products.

2.2.93 Core Segment GSE Hook-Up - 93

The GSE necessary to perform post-flight checkout of the Core Segment is installed. This includes power, data, and fluid sources and Automatic Test Equipment (ATE).

2.2.94 Post-Flight Checkout - 94

The purpose of this function is to identify maintenance and refurbishment functions necessary to return the core segment to flight readiness. Flight data on the performance of the Spacelab subsystems will be evaluated to isolate failures. Supplemental tests with portable or inline test equipment will be conducted to complete the evaluation of the core segment status.

2.2.95 Remove Pallets - 95

Overhead cranes will be attached to the pallets through slings and adapters. The mechanical interface of the pallets to the workstand and Spacelab will be broken. The pallets will be lifted, translated, and lowered to the pallet disassembly area.

2.2.96 Demate Aft Cone Bulkhead - 96

The mechanical fasteners holding the bulkhead to the module cylinder will be removed. The aft end cone will be translated and lifted to the refurbishment area.

2.2.97 Install GSE for Rack Removal - 97

The fasteners securing the rack floor set to the module will be removed. The rack floor set will be translated to the workstand support structure.

2.2.98 Remove the Experiment Racks - 98

The rack floor sets will be moved to the payload processing area with overhead cranes. The individual experiment racks will be removed from the floor.

2.2.99 Remove the Experiment Hardware - 99

Rack and pallet experiment handling equipment will be used to remove the individual experiments from the racks and pallets. The hardware will be segregated in preparation for return to each owner.

2.2.100 Prepare Experiments for Storage/Shipment - 100

The experiment hardware will be packaged for storage/shipment per MIL-P-116 to protect against the storage/transportation environments.

2.3 ASSESSMENT OF PAYLOAD REQUIREMENTS

The requirements for two of the payloads, SL-3 Strawman and OA 83-2, were furnished in the form of preliminary experiment requirements descriptions and payload concept layouts. For these two payloads, it was necessary to analyze the individual experiment requirements and then synthesize integrated payload launch site ground operation requirements prior to evaluating requirements versus accommodations using the matrix of Figure 1.

For the remaining two payloads considered, Dedicated Life Sciences and Combined Astronomy, both experiment descriptions and some payload ground operations requirements were furnished (Reference 3). Some synthesis of launch site ground operations requirements was required to complete the comparison with accommodations.

As anomalies in accommodation descriptions and/or accommodations were discovered, an attempt was made to classify the anomalies in terms of accommodation descriptions, accommodation discrepancies, or understanding of payload requirement. Accommodation description anomalies were noted in our comments to KSC on the handbook. Accommodation discrepancies were brought to the attention of payload data source and to KSC. In several cases, feedback to payload data sources led to clarification and/or elimination of unaccommodated requirements. Specific anomalies and action taken are discussed in the sections on each individual payload.

2.4 HANDBOOK ASSESSMENT

Using results of payload requirements reviews, the functional flows for Spacelab payloads at the launch site and the review criteria for evaluating resources, we assessed the existing KSC Launch Site Accommodation Handbook for STS Payloads (Ref. 1) contents for clarity, completeness, and pertinence. The handbook sections were reviewed in order of technical importance to the payload user. Specific suggestions for changes were made wherever possible. In some cases, suggested text and illustrations were provided to KSC.

3.0 SPACELAB III (STRAWMAN)

3.1 PAYLOAD DEFINITION

The payload presented in this section is one of several "strawmen" versions for Spacelab III (SL-3). The payload is a long module with a single three meter pallet as shown in Figure 2.

There are three Office of Applications (OA) instruments on the pallet and seven OA instruments in the module. The module also contains two non-OA instruments, and a single spare rack. The instruments, their location and source of instrument definition data are listed in Table 3. It should be noted that the Atmospheric Trace Molecules Observed by Spectroscopy (ATMOS) experiment was added and the Materials Experiments Assembly deleted per NASA direction. In the drawing of Figure 2, the ATMOS is shown in what was a spare rack and is not necessarily the true location. Also not shown is an N_2 sphere located on the pallet which supports the ATMOS sensor when it is in the airlock.

3.2 SUMMARY OF SPACELAB III (STRAWMAN) ANOMALIES

It should be noted that data were not available for three experiments due to their status of "out of bid". These three are (1) Polymer Reaction, (2) Unique Bio. System, and (3) Unique Two-Zone Low Temperature Furnace. Data were used from a three-zone furnace experiment in place of (3). The extraordinary requirements of this payload mainly involve time of access.

The Vestibular Function Research (VFR) experiment requires intermittent testing for five days prior to launch. Since the flight equipment will be integrated into the Spacelab module during this time, access to it will not be available. The data source states that this problem has not been addressed at this time but that the back-up set of equipment will probably be utilized for this testing at KSC.

The specimens for the VFR experiment (four instrumented, constrained frogs) will have to be a "carry on" item just prior to launch due to the

TABLE 3. SPACELAB III STRAWMAN INSTRUMENTS

INSTRUMENTS	LOCATION	DATA SOURCE
LARGE FORMAT CAMERA (LFC)	PALLET	JSC PROPOSAL 0136 FOR OFT-2, 29 NOV 76
HALOGEN OCCULTATION EXPERIMENT (HALOE)	PALLET	HALOE PROJECT PLAN, JULY 1977
LASER RANGING	PALLET	EVAL MISSION REQUIREMENTS, MAY 1976
MULTIFLUIDS PROCESSING FACILITY	MODULE	SL-3-ERD-3NA002, MARCH 1977
FLOAT ZONE REFINING SYSTEM	MODULE	SPACE PROCESSING P/L EQUIPMENT STUDY (GE), APRIL 1977
POLYMER REACTION	MODULE	NONE
UNIQUE BIOLOGICAL SYSTEM	MODULE	NONE
UNIQUE 2-ZONE LOW TEMP. FURNACE	MODULE	SPACE PROCESSING P/L EQUIPMENT STUDY (GE), APRIL 1977
ATMOSPHERIC CLOUD PHYSICS LAB. (ACPL)	MODULE	SL-3-ERD-3NA003, MARCH 1977
VESTIBULAR FUNCTION RESEARCH (VFR)	MODULE	SL-3-ERD-3NS005, JUNE 1977
DROP DYNAMICS MODULE (DDM)	MODULE	SL-3-ERD-3NA004, JUNE 1977
ATMOSPHERIC TRACE MOLECULES OBSERVED BY SPECTROSCOPY (ATMOS)	MODULE	ERD-INA009, JULY 1, 1977

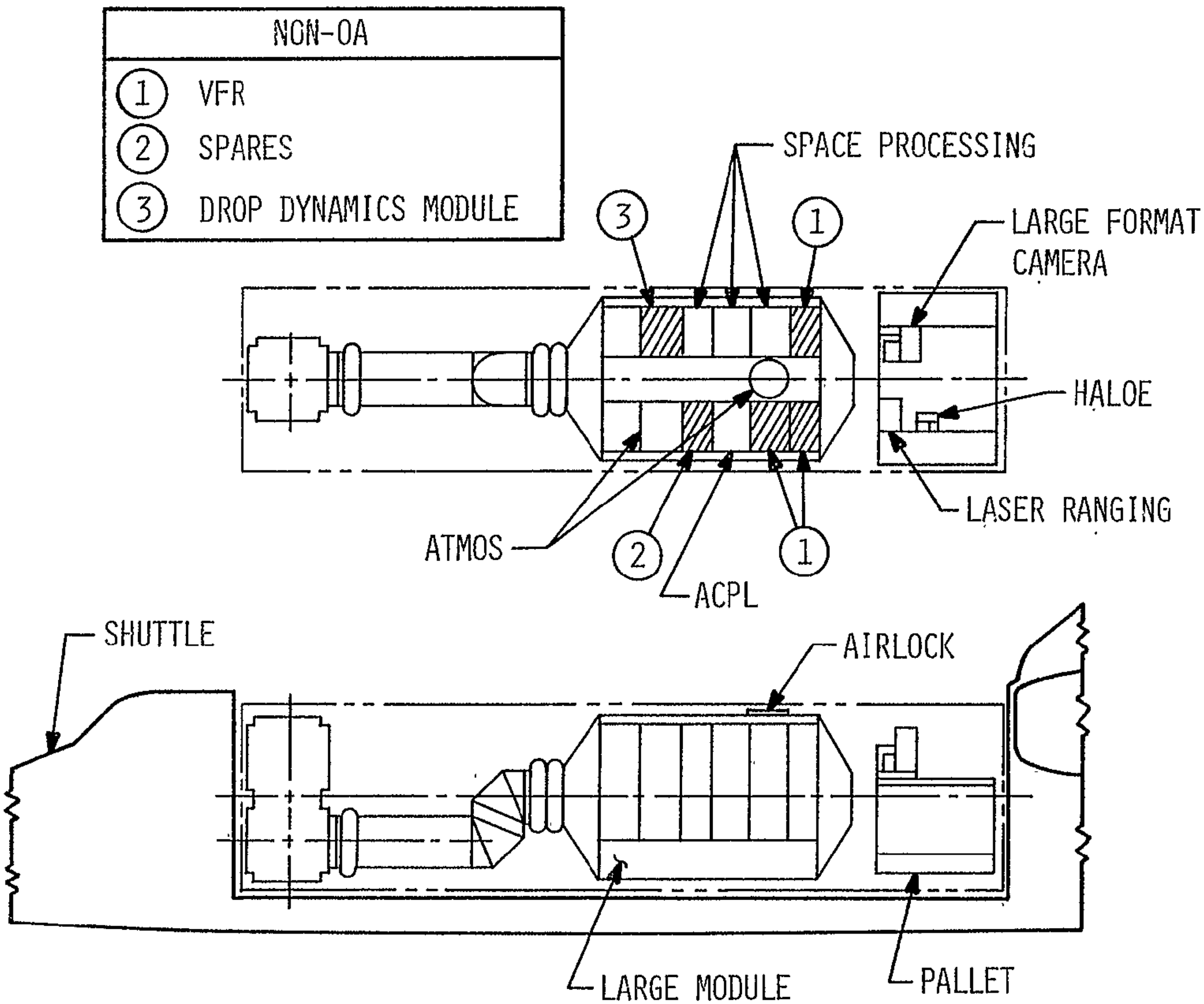

FIGURE 2. SPACELAB III STRAWMAN PAYLOAD CONFIGURATION

requirements that they remain belly down. Also specimen testing or data taking is performed for 30 minutes just before launch, through injection into orbit, during descent and upon touchdown (10 minutes before and 30 minutes after touchdown).

The ATMOS sensor will be installed in the module airlock for experimentation during orbital operation. The instrument must be extended from the airlock and boresighted during ground operations. The airlock experiment table deployment mechanism is not designed for 1-g operation. Since the table will require deployment into the module for equipment mounting prior to boresighting, a user supplied 1-g table support kit (GSE) will be utilized. This function should be performed prior to mating the module aft end cone for ease of access with the GSE.

3.3 SPACELAB III REQUIREMENTS VERSUS PROCESS FUNCTIONS

Figure 3A is a matrix showing the payload requirements versus the process functions from receipt of the instruments at KSC from the Level IV integration facility through towing the integrated Spacelab to the OPF. This includes instrument integration and testing with the Spacelab in the O&C Building.

All requirements are met by the KSC facilities/resources as indicated by the solid bars.

The bars of A-8 and J-8 pertain to the boresighting in the airlock for the ATMOS experiment. This is not considered a true anomaly since this requirement can be met by proper coordination of time of access.

Figure 3B is a matrix showing the payload requirements versus the process functions from arrival of the integrated Spacelab at the OPF through launch and subsequent Spacelab return to the O&C after landing. Note that no payload operations are planned during VAB operations which include rotating the Orbiter from horizontal to vertical and subsequent mating to other Shuttle elements and the mobile launch platform.

The anomalies indicated by the dashed lines starting at I-48 are not tied to a specific function, but are for intermittent off-line testing for approximately five days prior to launch. The dashed line of T-72 indicates the case of specimen carry on as late in the count as possible and stowed in the Orbiter. Should an extended hold occur after specimen installation, it may be necessary to remove them for care and maintenance.

The solid bars indicate requirements which the KSC facilities/ resources met.

It appears that with proper coordination of time of access this payload will present no major problems for integration at KSC.

FOLDOUT FRAME 1

FOLDOUT FRAME 2

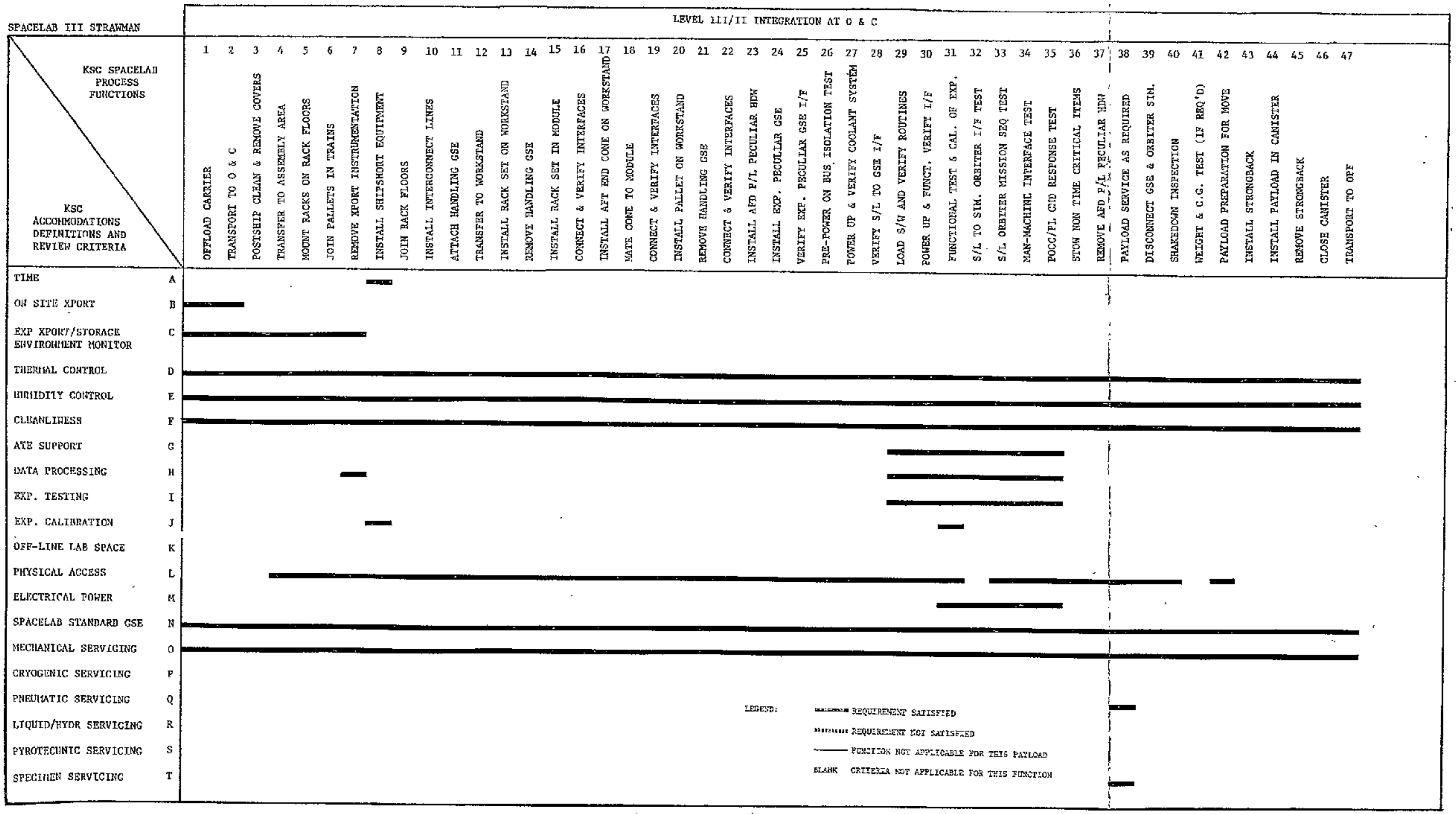

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FIGURE 3A. SPACELAB III GROUND OPERATIONS REQUIREMENTS (FUNCTIONS 1-47)

FOLDOUT FRAME 1

FOLDOUT FRAME 2

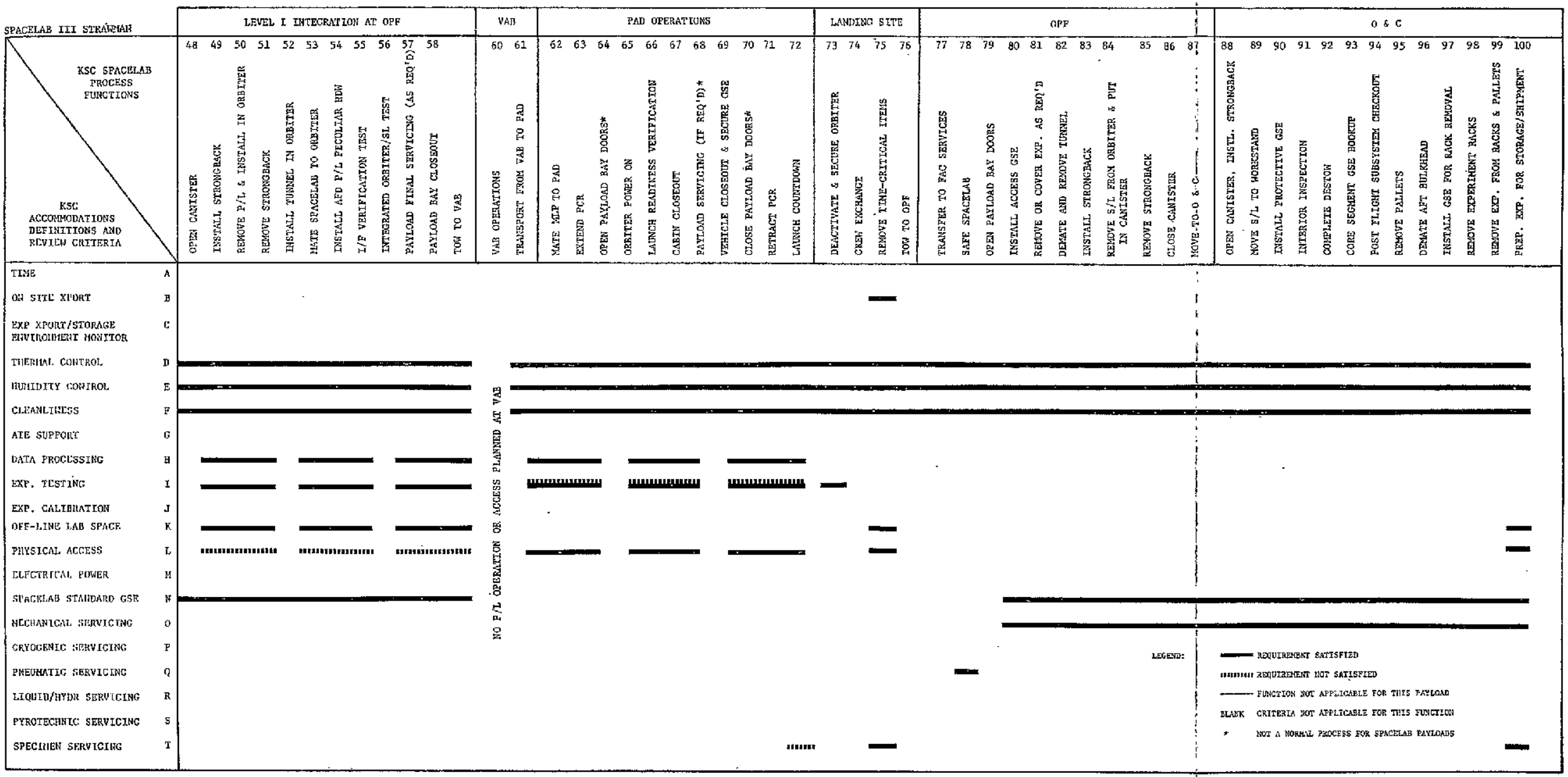

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FIGURE 3B. SPACELAB III GROUND OPERATIONS REQUIREMENTS (FUNCTIONS 48-100)

4. OFFICE OF APPLICATION MISSION 83-2

4.1 PAYLOAD DEFINITION

The 16 earth pointing instruments of the OA 83-2 mission are mounted on five standard 3-m pallets as shown in Figure 4, OA Mission 83-2 Payload Configuration. Originally the Passive Microwave instrument which attached directly to the Orbiter at the forward end of the payload bay was included in the payload. The Passive Microwave was later deleted and the Standard Ozone Sounding Unit (SOSU), Shuttle Geodynamics Ranging System (SGRS), Temperature Humidity Infrared Radiometer (THIR) and Vertical Temperature Profile Radiometer (VTPR) instruments were added. These were assumed to be pallet mounted in the forward end of the payload bay. These experiments controlled from the aft flight deck, are semi-automatic in their operation, i.e. little more than on-off commands are required. Both the AMPA and TETHER are deployed beyond the payload bay envelope during operation. The list of experiments, acronyms, and sources of experiment data are given in Table 4, OA Mission 83-2 Instruments.

The paucity of information on some of the experiments demanded the synthesis of integrated payload requirements. These experiments are indicated in Table 4 with an asterisk. All experiments needed some synthesis of requirements for ground operations since even the most detailed experiment definitions did not sufficiently detail the ground operations. Some confusion was caused by the Limb Scanning Radiometer being called LIMS II, LACATE, and advanced LIMS.

4.2 SUMMARY OF OA 83-2 ANOMALIES

Since both AMPA and TETHER are deployed beyond the payload bay envelope, they must be provided with release devices to allow emergency jettisoning. These release devices were assumed to be pyrotechnic. However, they may not be pyrotechnic in the final design.

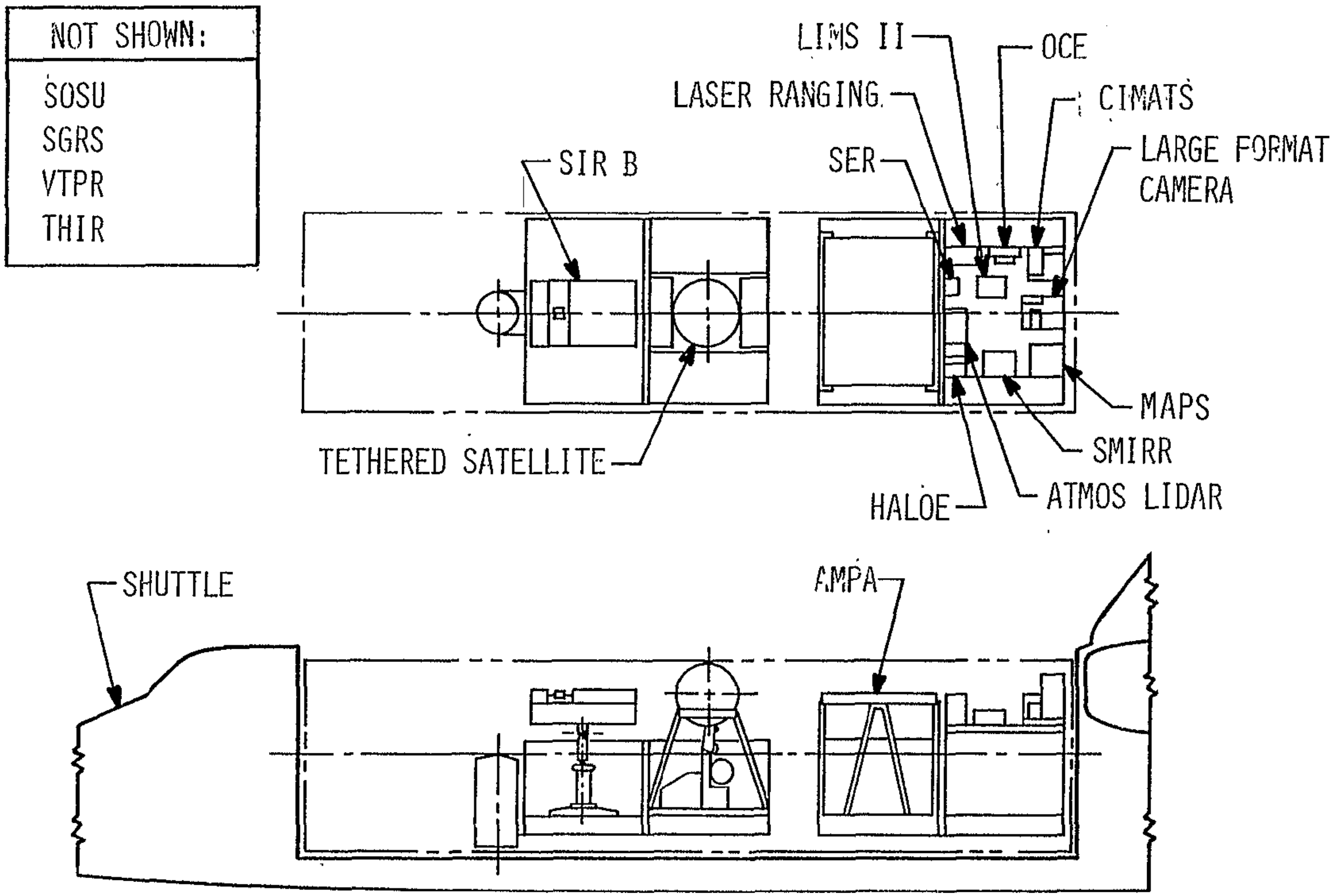

FIGURE 4. OA MISSION 83-2 PAYLOAD CONFIGURATION

TABLE 4. OA MISSION 83-2 INSTRUMENTS

INSTRUMENT	ACRONYM	DATA SOURCE
Shuttle Imaging Radar-B	SIR-B	Eval Mission Requirements, 76SDS4284, 27 Dec 76
Tethered Satellite	TETHER	Shuttle/Tethered Satellite System Conceptual Design Study, TMX-73365, Dec 76
Adaptive Multibeam Phased Array*	AMPA	Eval Mission Requirements, 76SDS4227, 7 May 76
Measurement of Air Pollution from Satellites	MAPS	LaRC Proposal, 3 Dec 76
Correlation Interferometric Measurements of Atmospheric Trace Species*	CIMATS	Eval Mission Requirements, 76SDS4227, 7 May 76
Halogen Occultation Experiment	HALOE	Haloe Project Plan, July 1977
Solar Extinction Radiometer	SER	Eval System Concept Definition-Partial Payload, 76SDS4269, 30 Sept 76
Advanced Limb IR Monitoring of Stratosphere* (use information from lower atmospheric composition and temperature experiment)	LIMS II	Eval System Concept Definition-Partial Payload, 76SDS4269, 30 Sept 76
Ocean Color Experiment	OCE	A Proposal for an Ocean Color Experiment for Orbital Flight Test 2, GSFC
Shuttle Multispectral IR Radiometer Experiment	SMIRR	Shuttle Multispectral IR Radiometer Experiment Proposal for OFT-2 Mission, JPL 3 Dec 76
Large Format Camera	LFC	JSC Proposal 0136 for OFT-2, 29 Nov 76
Lidar Measurement of Cirrus Clouds and Aerosols	ATMOS LIDAR	Lidar Measurement of Cirrus Clouds and Aerosols on the Spacelab 2 Mission, ERU-76-280, 2 Dec 76
Shuttle Geodynamics Ranging System*	SGRS	GSFC X-734-75-307, November 1975
Standard Ozone Sounding Unit*	SOSU	Eval Report 76SDS4269, Sept. 30, 1976
Temperature Humidity Infrared Radiometer	THIR	MSFC Contact
Vertical Temperature Profile Radiometer*	VTPR	MSFC Contact

*Experiment Requirements Synthesized

Both CIMATS and LIMS use LN_2. This use generated the requirements for cryogenic servicing at function 31 and again at function 81. LN_2 servicing was not indicated as being normally available in the O&C. It was assumed that pre-flight cryogenic filling occurred at function 31 to permit testing at Level II and post-flight unloading occurred at function 81. Post-flight servicing of the LFC at function 81 is required to vent the high pressure GN_2 tank.

4.3 OA 83-2 REQUIREMENTS VERSUS PROCESS FUNCTIONS

The ground operations requirements for the OA 83-2 payload versus process functions are shown in Figure 5. Generally, this payload's requirements are met by KSC's ground accommodations except for the cryogenic servicing.

FOLDOUT FRAME 1

FOLDOUT FRAME 2

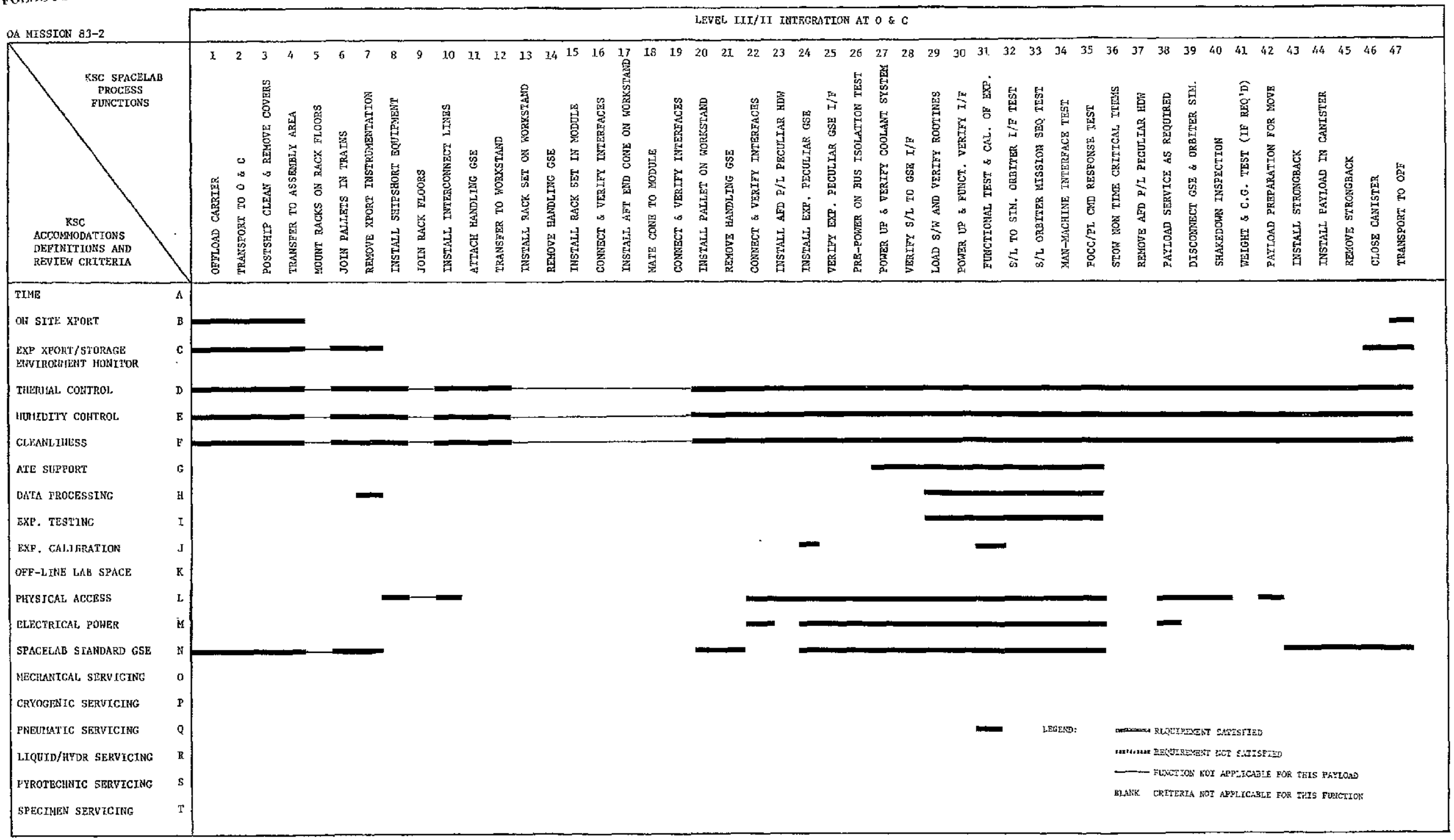

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FIGURE 5A. OA MISSION 83-2 GROUND OPERATIONS REQUIREMENTS (FUNCTIONS 1-47)

FOLDOUT FRAME 1

FOLDOUT FRAME 2

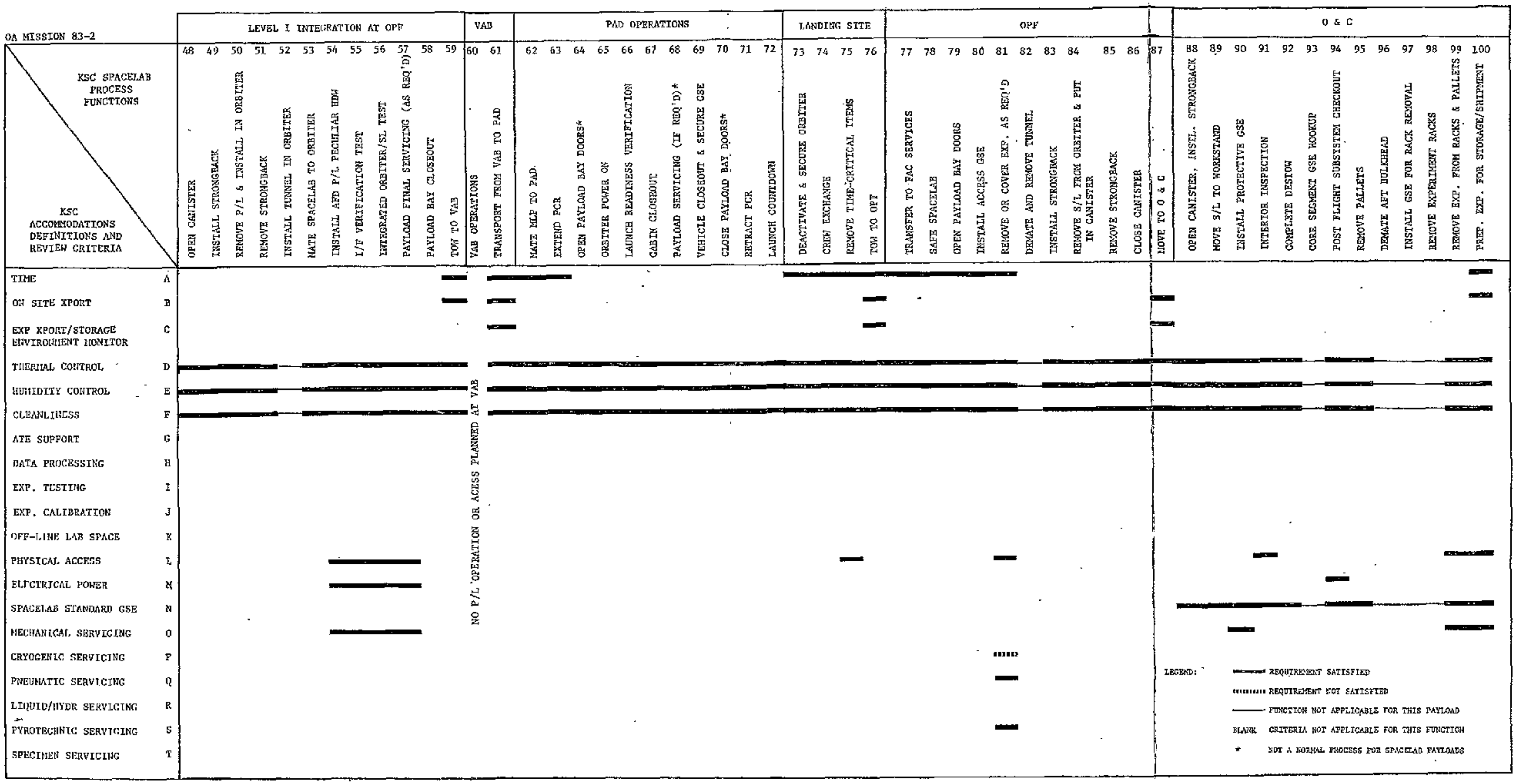

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FIGURE 5B. OA MISSION 83-2 GROUND OPERATIONS REUQIREMENTS (FUNCTIONS 48-100)

5. DEDICATED LIFE SCIENCES

5.1 PAYLOAD DEFINITION

The Dedicated Life Sciences payload consists of a long module containing instruments to carryout 24 experiments in the life sciences discipline. As shown in Figure 6, racks 1 and 2 contain Spacelab equipment and all remaining racks are dedicated to life sciences. Additional instruments are mounted in the center isle of the module, and in the Orbiter. The matrices of Tables 5, 6 and 7 list the location, name, and the experiments on which the instruments are used. Table 8 lists the 24 life sciences experiments.

The specimens utilized for experimentation in this payload consist of approximately 500 fruit flies, 98 rats, 39 mice, 6 frogs, 3 monkeys, and the crew members. The data source for this analysis is the Ground Processing Requirements (GPR) Experiment Definition Package prepared by Rockwell International Space Division under contract to NASA, dated July 1977 (Ref. 3).

5.2 SUMMARY OF DEDICATED LIFE SCIENCES ANOMALIES

The extraordinary requirements of this payload mainly involve the handling of the specimens. Considerable space and resources will be required in a KSC laboratory to maintain the many specimens in a flight worthy condition prior to launch. Periodic testing, injections, and surgery are carried out prior to launch and after landing. The KSC Handbook (Ref. 1) does not clearly define capabilities of this type off-line laboratory. This problem has been coordinated with KSC.

The live specimens used must be put on as late as possible prior to launch and removed as soon as possible after landing respectively. This indicates that they must be carried on and off by the crew. The KSC Handbook does not treat the cases in which items are carried on and stored in the Orbiter for launch and reentry. This is also a problem in quick removal of live or frozen specimens after landing. This type of problem requires

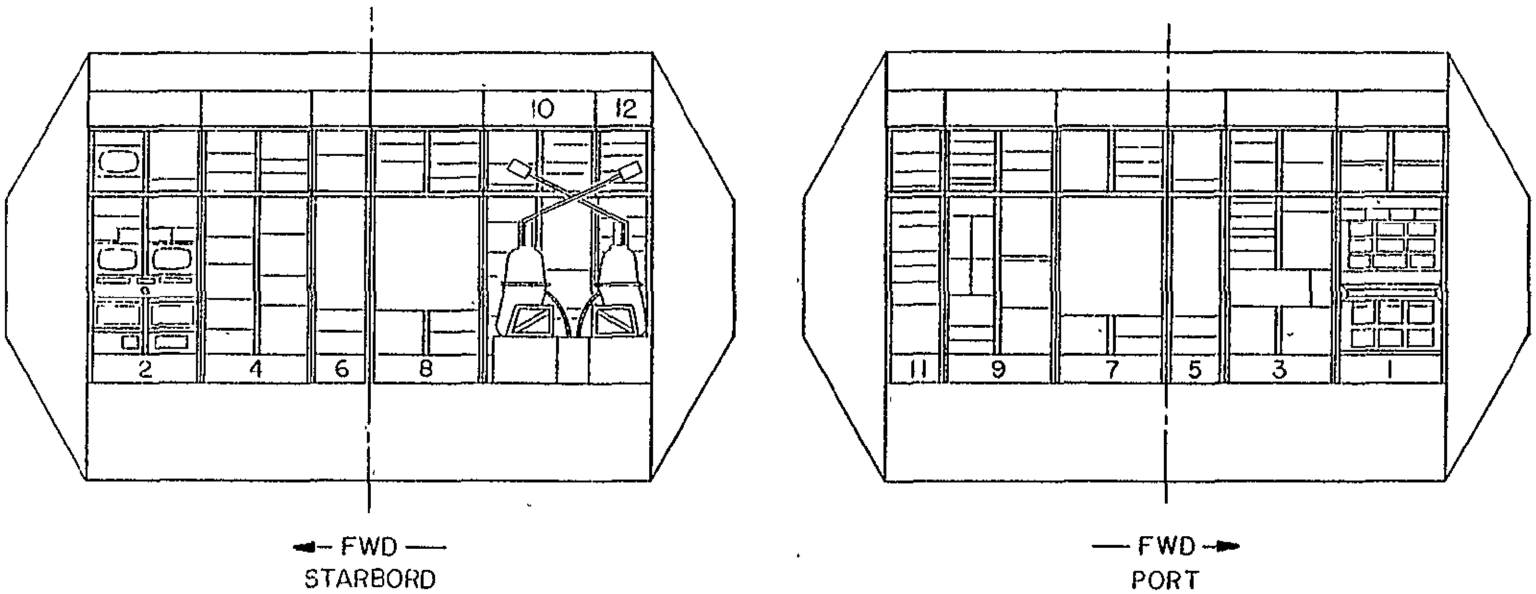

FIGURE 6. DEDICATED LIFE SCIENCES PAYLOAD CONFIGURATION.

TABLE 5. MATRIX, LIFE SCIENCES EQUIPMENT - PORT RACK INSTALLATION

RACK S/L	RACK L/S	NAME	END ITEM	OTR	CORE	3	5	8	10	11	12	13	15	21	23	27	39	42	49	51	58	59	60	66,68	68	74	75	76	77
11	1	STOWAGE - PERFUSION PUMP	21-1											X															
		DROSOPHILA STOWAGE	42-2															X											
		OSCILLOSCOPE (POD) SELECTOR	76-7																									X	
		DEMODULATOR PATCH PANEL	76-6																									X	
		TELEMETRY TUNE, RECEIVER	76-4																									X	
		DEMODULATOR	76-5																									X	
		UPPER POD A FLOW CONTROL	76-30																										
		TELEMETRY TUNE/RECEIVER	76-16																									X	
		DEMODULATOR	76-17																									X	
		UPPER POD B FLOW CONTROL	76-11																									X	
		(SPACELAB - EPSP)	-																										
9	2	ISOLATION AMPLIFIER	13-6									X	X																
		SIGNAL CONDITIONER	15-3										X																
		STRAIN GAUGE PWR SUPPLY	15-2										X																
		SCOPE SELECTOR	15-4										X																
		A.C. POWER FILTER	15-6										X																
		OSCILLOSCOPE	15-5										X																
		IR ANALYZER/OUTPUT MONITOR	13-2									X																	
		" " /GAS FLOW CALIB.	13-3									X																	
		RESPIRATORY CAGES	13-1									X																	
		VIBRATION REED ELECTROMETER	13-4									X																	
		" " "	13-5									X																	
	3	STOWAGE	-																										
		DIGITAL TAPE RECORDER	75-6																								X		
		DROSOPHILA CAMERA (STOW)	42-1															X											
		REFRIGERATOR - RAT FOOD	3-4			X			X	X	X	X		X	X	X							X	X		X					
		SLIDE TABLE	-																										
		FREEZER	8-5		X	X		X	X	X	X	X		X	X		X	X								X	X		X		
		(SPACELAB - EPSP & RAU)	-																										
7	4	BSHF WATER SUPPLY	15-11										X				X												
		STOWAGE - MONKEY PODS	76-26																									X	
	4/5	PRIMATE HOLDING UNIT	15-7	14/16									X				X												
	5	BLANK	-																										
		A-C INVERTER - 60 HZ	15-12			X		X	X			X	X						X		X	X		X	X		X	X	
		PRIMATE H.F. CTRLS/DISPL.	15-8										X				X												
		(SPACELAB - ICRS - - EPSP)	-																										
5	6	RODENT WATER SUPPLY	10-3						X			X				X							X		X				
		RODENT H.F. CTRLS/DISPLAY	10-2						X			X				X							X		X				
		RODENT HOLDING FACILITY	10-1	14/16					15			6				20							6		14				
		(SPACELAB - EPSP)	-																										
3	7	TV MONITOR	49-8																X										
		OSCILLOGRAPHIC RECORDER	49-2																X										
		TIME CODE GENERATOR	66-1																					X					
		AUDIO MONITOR	66-2																					X					
		MICRODRIVE	66-3																					X					
		POWER MODULE & STRIP	66-4																					X					
		OSCILLOSCOPE	66-5																					X					
		REFRIGERATED CENTRIF.	8-3.1		X			X	X								X								X	X			
		REFRIGERATOR	8-4		X	X		X	X			X		X	X	X		X						X	X	X		X	
	8	CARDIOTACH, FLOW MTR, PR, VIBR,	49-3																X										
		ECHOCARDIOGRAM & TV CAMERA	49-1																X										
		ISOLATION AMPLIFIER	66-10																X					X					
		ROTATING BASE CONTROL CONSOLE	49-5																X	X				X					
		OSC. RECORD & CHAIR CTRL	49-5																X	X				X					
		CENTRIF, REFRIG, & GAS SHUT.	8-3.2		X			X	X								X								X				
		(SPACELAB - EPSP & RAU)	-																										

TABLE 6. MATRIX, LIFE SCIENCES EQUIPMENT - STARBOARD RACK INSTALLATION

RACK		NAME	END ITEM	OTR	CORE	EXPERIMENT																							
S/L	L/S					3	5	8	10	11	12	13	15	21	23	27	39	42	49	51	58	59	60	66	68	74	75	76	77
4	13	CPU DATA REDUCT. & PRINTER	75-3	1																	X						X		
		(GAS BOTTLE ASSY) - BEHIND RACK	58-6																		X						X		
		CPU POWER SUPPLY	75-4	1																	X						X		
		FLOW-VOLUME ELECTRONICS	58-3																		X						X		
		SPIROMETER	75-5	1																	X						X		
		BLOOD PRESS. MEAS. SYST. (BPMS)	49-7	1															X										
		RADIO ISOTOPE SURV. MET. LIQ. SCIN.	68-4		X																				X				
		FLOW CONTROL UNIT	75-1	B																							X		
		MIXING CHAMBER	75-2																								X		
	14	RADIO ISOTOPE AIR MONITOR	76-28		X	X						X													X			X	
		INTERFACE PANEL	58-4	1																	X						X		
		(SPACELAB ICRS)	-																										
		MASS SPECTROMETER	58-1																		X						X		
		PNEUMOTACHOMETER	58-2																		X								
		STRIP CHART RECORDER	58-5																X		X								
		URINE ELECTROLYTE ANALYZER	77-1																										X
		(SPACELAB EPSP & RAU)	-																										
6	15	RODENT WATER SUPPLY	3-5			X	X	X		X	X			X	X														
		RODENT HF CONT./DISPLAY	3-7			X	X	X		X	X			X	X														
		RODENT HOLDING FACILITY	3-6			6	6	20		6	20			25	74														
8	16	INSTRUMENTS, SUPPLIES	3-3			X																							
		STOWAGE BLOOD ACQ. KITS	8-1					X	X																X	X			
		RADIO ISOTOPE SAMPLES	68-1																						X			X	
	16/17	SURGICAL WORKBENCH	68-3			X			X	X	X	X		X	X	X	X	X							X	X			
	17	STOWAGE ANGIO. & BALANCE PAN	23-1												X	X													
		STOWAGE - RADIOACTIVE WASTE	3-2			X						X																	
		STOWAGE - WASTE	59-13																			X	X						
		(SPACELAB-EPSP)	-																										
10	18	METABOLIC CAGE AIR FILTERS	59-11																			X							
		METABOLIC RCVR/PYROGEN TUNING	59-4																			X	X						
		OSCILLOSCOPE SELECTOR	59-10																			X	X						
		DATA LOGGER	59-1																			X	X						
		TAPE RECORDER-ANALOG	59-2										X						X			X	X	X				X	
		TORSION BALANCE (SLIDE)	23-2												X														
		METABOLISM FLOW METERS	59-3												X							X	X						
		CAGE AIR FLOW CONTROL	59-6												X							X	X						
		POWER SUPPLY	59-8																			X	X						
	19	RAT WATER SUPPLY/ACCESS	59-9																			X							
		OSCILLOSCOPE	59-14																			X						X	
		AIR (GAS) ANALYZER/M.S. SEQ.	59-5																			X							
		(SPACELAB - ICRS)	-																										
		METABOLIC CAGES	59-7			X				X					X							X							
		DRIERITE COLUMNS & CAGE CTRL.	59-12																			X							
		(SPACELAB-EPSP)	-																										
12	20	CTRL CALIBR. GASES	76-25																									X	
		M.S. CALIBRATION CONTROL	76-18																									X	
		SIGNAL CONDITIONER	76-2																									X	
		BUFFER AMPLIFIER	76-8																										
		BUFFER AMPLIFIER	76-19																									X	
		HEART RATE/DIFFER. PRESSURE	76-9																									X	
		MASS SPECTROM. & SAMPLE VALVES	76-20																			X						X	
		MASS SPECTROMETER CONTROLS	76-21																			X						X	
		LBNP CONTROLS	76-10																									X	
		BARATRON-AMP. PRESSURE	76-23																									X	
		PART. PRESS. RATIO COMPUTER	76-24																									X	
		(SPACELAB-EPSP)	-																										

TABLE 7. MATRIX, LIFE SCIENCES EQUIPMENT, NON-RACK INSTALLED

LOCATION	NAME	END ITEM NO.	OTR NO.	CORE	EXPERIMENT NO. 3	5	8	10	11	12	13	15	21	23	27	39	42	49	51	58	59	60	66	68	74	75	76	77
END	FROG GIMBAL PLATFORM (STOW)	66-8																					X					
AISLE	MONKEY PODS (A&B)	76-1/22																									X	
•	X-15 FLOOR MOUNT	15-9										X																
•	ROTATING BASE ASSEMBLY	49-4																X	X				X					
OMD	RODENT TRANSPORTERS	3-1	18		X			X	X	X	X		X	X	X						X	X						
•	PRIMATE TRANSPORTERS	15-10	18									X				X											X	
OVHD	HEMATOCRIT CENTRIFUGE (STOW)	8-2					X																	X	X			
REFRIG.	FROG-HOLDING FACILITY	66-7																					X					
AISLE	MICROSCOPE-APM MOUNT (STOWED)	66-9																					X					
•	MONKEY OSCILL. PLAT. & ACCEL.(STOW	15-1										X																
OAFD	RESPIRATION RATE MODULE	5-1				X																						
•	GALVANIC SKIN RESPONSE MOD.	5-2				X																						
•	ELECTROMYOGRAPH MODULE	5-3				X																						
•	BLOOD VOLUME PULSE ELEX.	5-4				X																						
•	HEART RATE MODULE	5-5				X																						
•	STOWAGE DRAWER	5-6				X																						
ORB. MID-DK	ULTRASONIC (DOPPLER) FLOW METER	49-6																X										
STOW	MICROSCOPE	68-2																						X				
•	MATING CAGE	68-5																						X				
POD ASSY	TEMPERATURE MULTIPLEXER	76-13																									X	
•	BASE, POD A	76-15																									X	
•	BASE, POD B	76-12																									X	
•	PODS INTERFACE PANEL	76-3																									X	
•	MONKEY POD FOOD DRAWER	76-27																									X	
•	H_2O COLLECTION/FILTER ASSY	76-29																									X	
•	FEEDER/WATER SUPL. SIGN. CONDIT.	76-31																									X	
•	CAMERA DRAWER, MONKEY POD	76-32																									X	
•	WATER STORAGE DRAWER	76-14																									X	
STOW	HAND HELD VOICE RECORDER	51-1																	X									
STOW	ELECTRODES & AMPLIFIER-STOWED	66-6																					X					
STOW	TILT TABLE/LITTER CHAIR	51-2																X	X									
STOW	TILT ANGLE TRANSDUCER	49-9																X										
BELOW FLOOR	PUMP ASSEMBLY	76-33																									X	

TABLE 8. LIFE SCIENCES EXPERIMENTS

EXP. NO.	TITLE	EXP. NO.	TITLE
x3	RAT COLLAGEN TURNOVER	x42	DROSOPHILA DEVELOPMENT AND AGING
x5	BIOFEEDBACK	x49	HUMAN CARDIOVASCULAR ALTERATION
x8	INSULIN RESISTANCE	x51	MOTION SICKNESS FACTORS
x10	RAT PLASMA SOMATOMEDIN CONCENTRATION	x58	HUMAN PULMONARY FUNCTION
x11	RAT URINARY EXCRETION OF 3-METHYL HISTIDINE	x59	RAT METABOLISM AND HEAT BALANCE
x12	RAT PROTEOLYTIC CONCENTRATION IN MUSCLE	x60	RATS PYROGENIC FEVER--SALICYLATE/ INTERACTION
x13	IN VIVO MUSCLE PROTEIN DEGRADATION	x66	OTOLITH RESPONSE ADAPTATION AS A FUNCTION OF CNS OUTPUT
x15	MONKEY STATIC-OTOLITH ACTIVITY CHANGE	x68	ERYTHROK-INETICS IN MAN
x21	MICE VESTIBULO-CEREBELLUM-VOMITING CENTER & HYPOTHALAMIC-PITUITARY-ENDOCRINE AXIS	x74	CELLULAR IMMUNE RESPONSE IN MAN
		x75	BASAL AND LIGHT ACTIVITY METABOLISM
x23	RAT BRAIN AND RENAL RENIN-ANGIOTENSIN FUNCTION	x76	MONKEY CARDIOVASCULAR DYNAMICS, HEMOLYSIS, METABOLIC CARDIOVASCULAR ADAPTATION
x27	RAT LYMPHOID TISSUE HISTOPATHOLOGICAL CHANGES	x77	URINE ELECTROLYTE DETERMINATION
x39	MONKEY RESORPTION RATE CHANGES		

coordination with Orbiter flow such that the specimen holding facility can be "bolted in" without affecting the Orbiter scheduled flow. The specimen transporters are then carried on and installed into the specimen holding facility at the launch pad.

An LN_2 flask of the LN_2 unit/freezer requires precooling, then emptying of the LN_2 just prior to installation in the Spacelab module. This must be completed prior to Spacelab closeout for access. Upon being contacted, the data source stated that it is acceptable to perform this task at the latest module interior access time in the OPF.

5.3 DEDICATED LIFE SCIENCES REQUIREMENTS VERSUS PROCESS FUNCTIONS

Figure 7A is a matrix showing the payload requirements versus the process functions from receipt of the instruments at KSC from the Level IV integration facility through towing of the integrated Spacelab to the OPF. This includes instrument integration and testing with the Spacelab in the O&C Building.

All requirements are met by the KSC facilities/resources as indicated by the solid bars.

Figure 7B is a matrix showing the payload requirements versus the process functions from arrival of the integrated Spacelab at the OPF through launch and subsequent Spacelab return to the O&C after landing. Note that no payload operations are planned during VAB operations, which include rotating the Orbiter from horizontal to vertical and subsequent mating to other Shuttle elements and the mobile launch platform.

The anomalies indicated by the broken bar all involve the care and handling of specimens. The specimens are delivered to KSC at various times. The broken bars starting at K-60 and T-60 are not tied to function 60 but rather indicate the need for off-line specimen testing. Considerable space and resources are required in an off-line bio lab for maintaining, servicing and testing the specimens prior to launch.

Broken bars A-72 and B-72 indicate the non-nominal case of the specimens being carried on as late in the count as possible and stowed in the Orbiter mid-deck. Unattended time should be not more than two hours. Should an extended hold occur after specimen installation, it may be necessary to remove them for care and maintenance.

Items A-75, B-75, I-75, K-75, L-75, T-75 and K-100 indicate the problem of removal of the returned live and frozen specimens and transporting them to the off-line bio-lab for subsequent testing. Frozen samples must be maintained in a frozen state, and specimens packaged for return to the experimenter facility.

The broken bar at L-57 indicates that the chilled LN_2 flask must be installed prior to closing the module; yet it should be done as late as interior access will allow.

The solid bars indicate requirements which the KSC facilities/ resources met.

Conversations with KSC contacts indicate that a laboratory being planned would be dedicated to the needs of the life sciences discipline. This may alleviate the major portion of the anomalies stated herein, but would require further study when the capabilities of the laboratory are more defined.

FOLDOUT FRAME 1

FOLDOUT FRAME 2

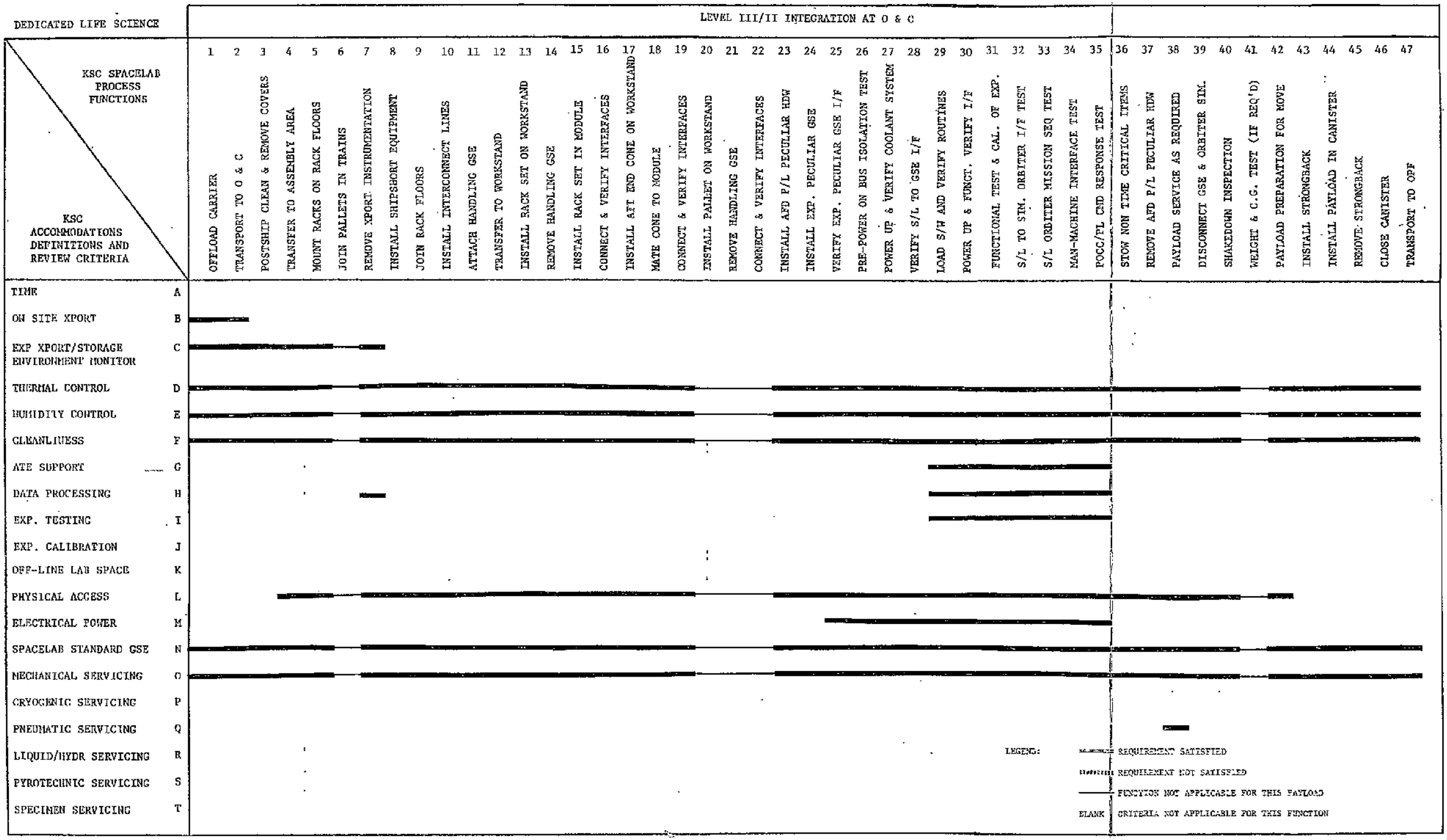

FIGURE 7A. DEDICATED LIFE SCIENCES GROUND OPERATIONS REQUIREMENTS (FUNCTIONS 1-47)

FOLDOUT FRAME 1

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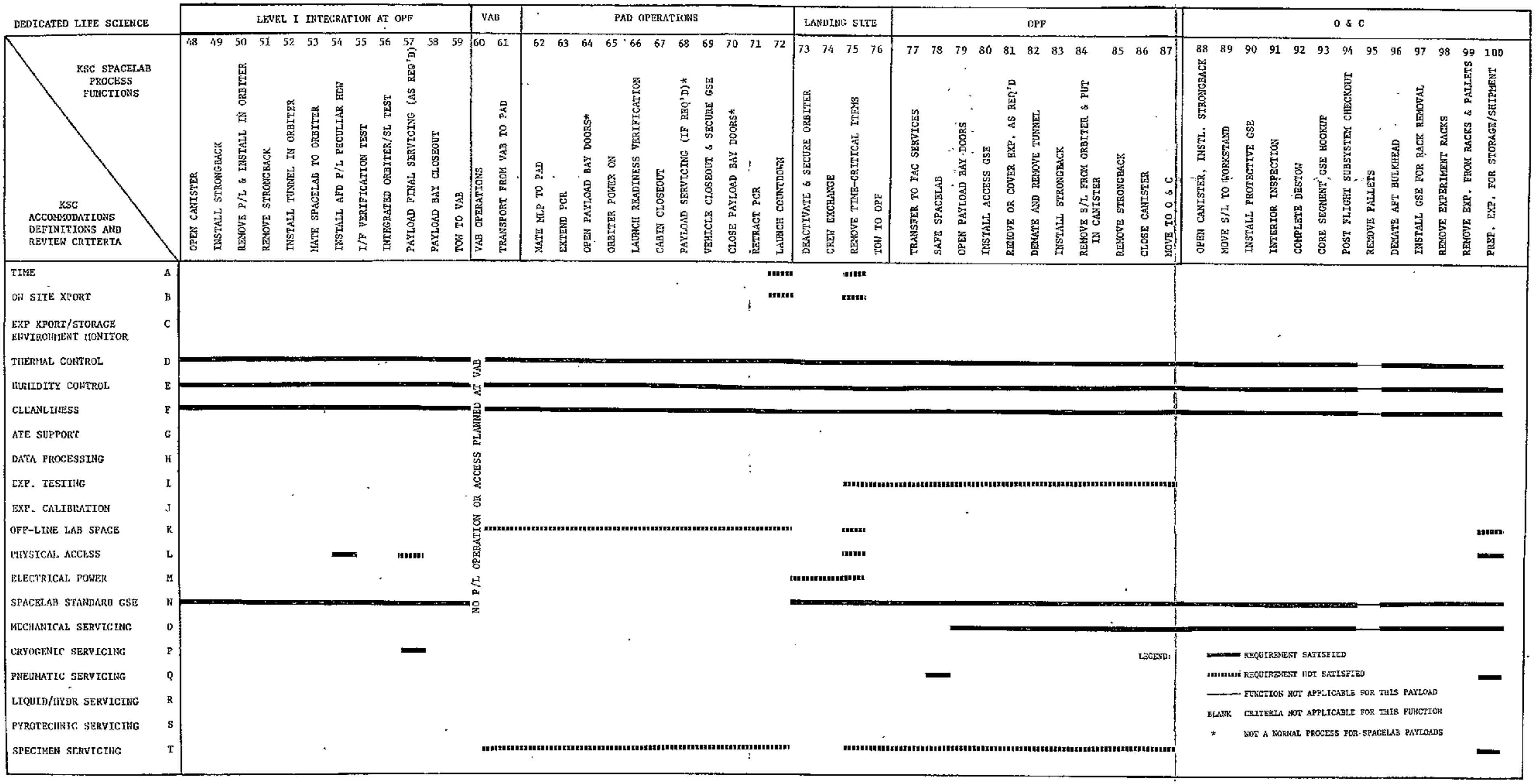

TELEDYNE BROWN ENGINEERING

FIGURE 7B. DEDICATED LIFE SCIENCES GROUND OPERATIONS REQUIREMENTS (FUNCTIONS 48-100)

6. COMBINED ASTRONOMY

6.1 PAYLOAD DEFINITION

The Combined Astronomy payload consists of five standard 3-m pallets as shown in Figure 8. The instruments mounted on the pallets are listed in Table 9. There is no Spacelab module involved in this payload and no planned EVA's. The Medium Energy Gamma-Ray Detector utilizes a single pallet. The Shuttle Infrared Telescope Facility uses a two pallet train. The Instrument Pointing System utilizes a single pallet. The Far UV Schmidt Camera/Spectrograph and UV Photometer/Telescope are contained in separate Small Instrument Pointing System (SIPS) canisters. These canisters are mounted on the SIPS pedestal which in turn is mounted on a single pallet.

6.2 SUMMARY OF COMBINED ASTRONOMY ANOMALIES

Many of the anomalies were solved by coordination with the experimenter. These anomalies and subsequent comments are listed in Table 1 of this report. The remaining definable anomalies follow.

Timelines for cryogenic chilldown and subsequent fill and topoff for SIRTF are not yet defined. Current thinking is that chilldown with LN_2 will be initiated approximately T-70 to 80 hours and will continue until approximately T-24 hours at which time supercritical helium chilldown and loading starts. Topoff will require access to the LHe tank, thus the payload bay doors will have to be opened at the pad. Use of an umbilical from the Orbiter midbody panel for topoff is not feasible due to the inherent instability of supercritical helium and its handling problems. Cryogenic boiloff from the tank may require that the payload bay vents be opened on the pad to prevent overpressure. Amount of boiloff is not known but the tank is being considered for redesign (triple wall) which should alleviate this problem.

6.3 COMBINED ASTRONOMY REQUIREMENTS VERSUS PROCESS FUNCTIONS

Figure 9A is a matrix showing the payload requirements versus the process functions from receipt of the instruments at KSC from the Level IV integration facility through the towing of the integrated Spacelab to the OPF.

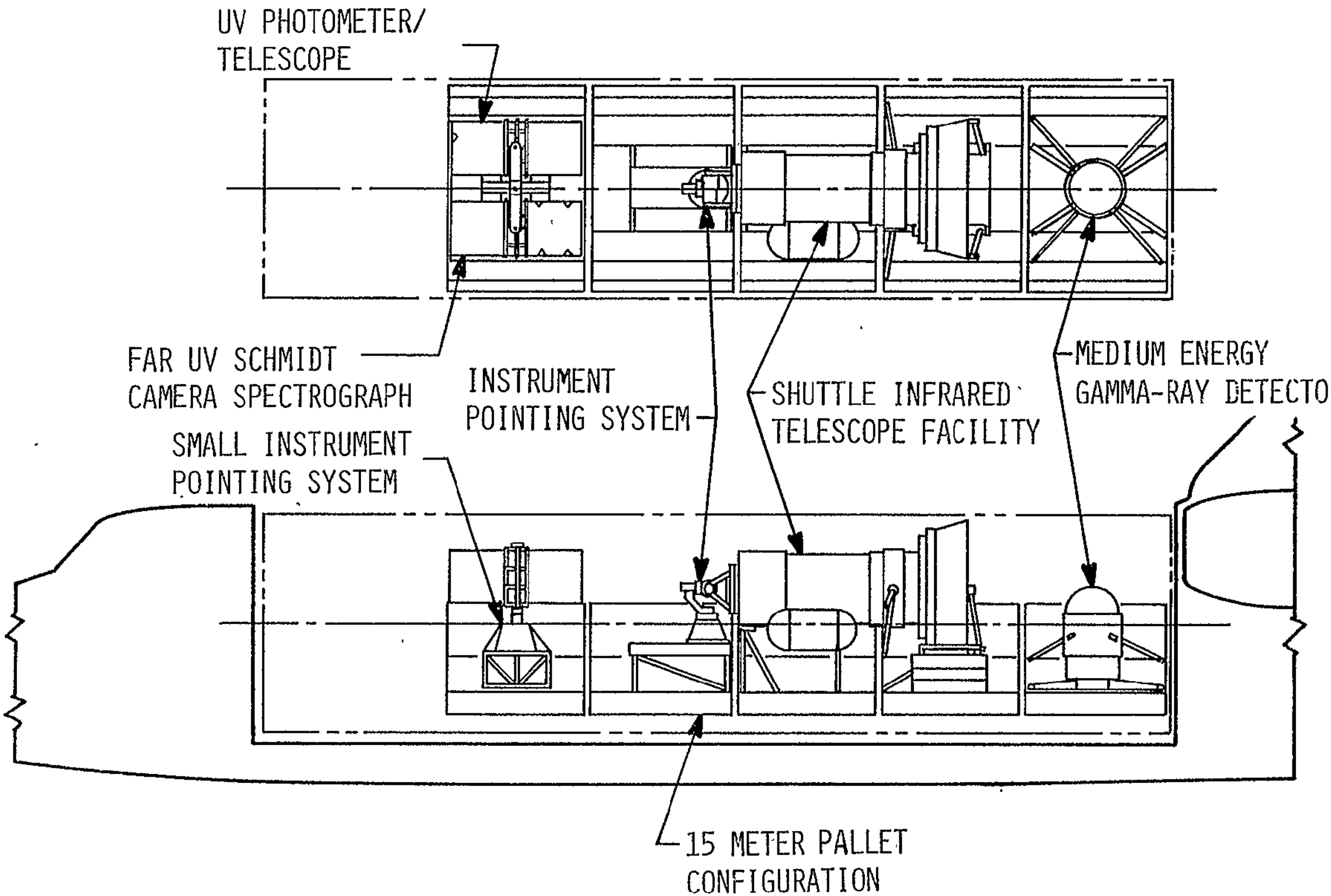

FIGURE 8. COMBINED ASTRONOMY PAYLOAD CONFIGURATION

TABLE 9. COMBINED ASTRONOMY INSTRUMENTS

INSTRUMENT	DATA SOURCE
SHUTTLE INFRARED TELESCOPE FACILITY (SIRTF), AS-01-S	ROCKWELL INTERNATIONAL REPORT, GPR EXPERIMENT DEFINITION PACKAGE
UV PHOTOMETER/TELESCOPE, UV-2	ROCKWELL INTERNATIONAL REPORT, GPR EXPERIMENT DEFINITION PACKAGE
MEDIUM ENERGY GAMMA RAY TELESCOPE, GR-1	ROCKWELL INTERNATIONAL REPORT, GPR EXPERIMENT DEFINITION PACKAGE
FAR UV SCHMIDT CAMERA/ SPECTROGRAPH, AS-05-S	ROCKWELL INTERNATIONAL REPORT, GPR EXPERIMENT DEFINITION PACKAGE

This includes instrument integration and testing with the Spacelab in the O&C Building. All requirements during this phase are met by the KSC facilities/resources as indicated by the solid bars.

Figure 9B is a matrix showing the payload requirements versus the process functions from arrival of the integrated Spacelab at the OPF through launch and subsequent Spacelab return to the O&C after landing. Note that no payload operations are planned during VAB operations which include rotating the Orbiter from horizontal to vertical and subsequent mating to other Shuttle elements and the mobile launch platform.

The anomalies indicated by the broken bars mainly involve access to the payload. The broken bar at P-57 indicates the problem of SIRTF cooldown in the OPF. Also broken bars at L-68 and P-68 indicate the access problem (i.e., opening payload bay doors) for topoff of the supercritical helium tank of SIRTF.

All other requirements are met by the KSC facilities/resources as indicated by the solid bars.

FOLDOUT FRAME 1

FOLDOUT FRAME 2

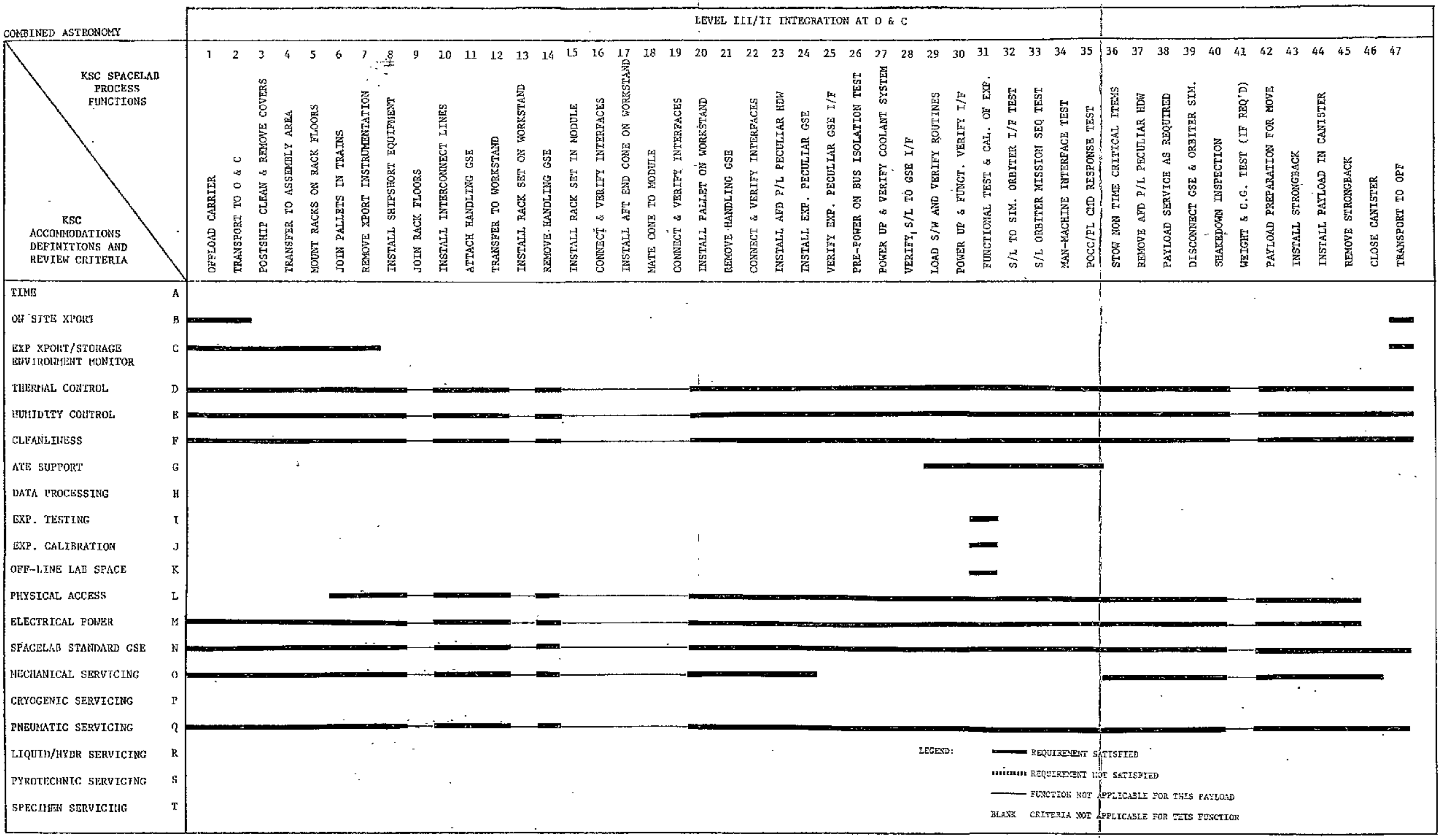

FIGURE 9A. COMBINED ASTRONOMY GROUND OPERATIONS REQUIREMENTS (FUNCTIONS 1-47)

FOLDOUT FRAME 1

FOLDOUT FRAME 2

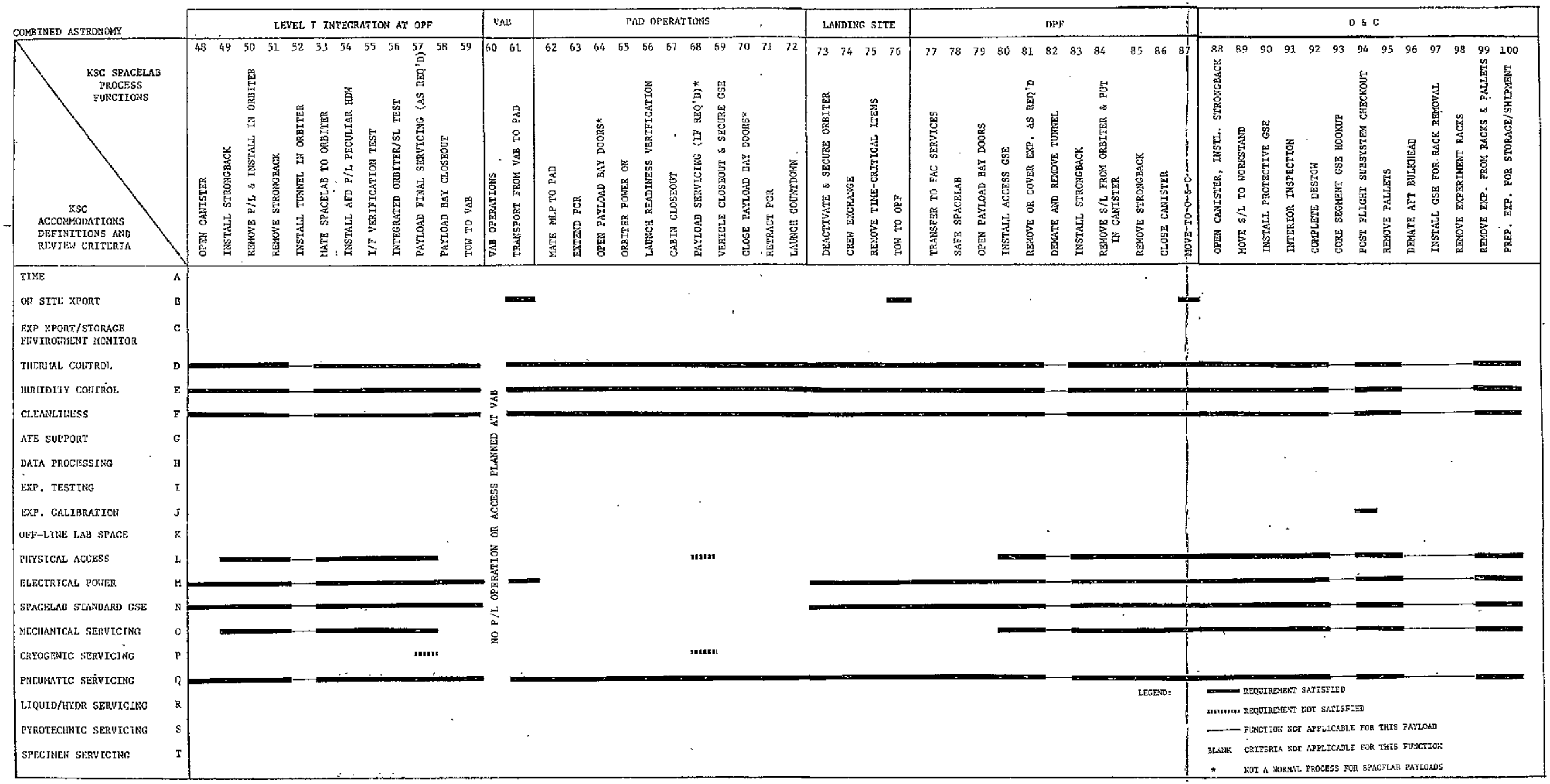

FIGURE 9B. COMBINED ASTRONOMY GROUND OPERATIONS REQUIREMENTS (FUNCTIONS 48-100)

7. LAUNCH SITE ACCOMMODATIONS HANDBOOK ASSESSMENT

7.1 ASSESSMENT SUMMARY

The accommodations handbook should provide the payload owner/ instrument developer with a clear picture of the functional flow and resource available for the ground operations. The normal or routine processing capability for payload ground operations should be baselined. Variations from this baseline which are allowable (usually at the expense of the payload owner) must be identified. Areas in the normal routine where variations are not allowed under any circumstances must also be described.

We have suggested a revision which puts more emphasis on the payload processing while maintaining adequate treatment of the Shuttle turn around process. We recommended that some information be eliminated from the current issue of the handbook in favor of including information of more concern to the payload user. This change would help shorten the handbook and make it easier to read. The manual referred to all non-KSC organizations as the payload owner. The responsibilities of the experiment developer and integrated payload owner/operator are distinctly different. We have taken the integrated payload owner/operator to mean the payload mission manager/sponsor or his delegated representative. The definition of experiment developer is the principal investigator or other person responsible for the design and use of a single instrument and its associated support equipment.

In areas where specific information could not be given in the handbook, using the host concept, the experiment developer is directed to coordinate with the Launch Site Support Manager (LSSM). Because in the early planning stages there is no LSSM, the handbook should show with clarity the launch site capability for non baselined accommodations.

To assess the handbook, a set of review criteria was developed. Using these as a basis for handbook review, specific suggestions for revising the handbook were generated. These suggestions, which included organization, content, and level of detail, were transmitted to KSC as they were generated. The key recommendations for handbook revision were to:

- Reorganize to present material from user viewpoint.
- Simplify to include only material pertinent to payload.
- Clearly define payload flow and flow operations.
- Be consistent and thorough in describing and noting availability of resources at each facility.

Specific suggestions were given to reorganize Section 3, Payload Ground Operations at KSC of the handbook. These were to define two payload functional flow paths, one for horizontally integrated payloads and another for vertically integrated payloads. A definite criteria for selection of the path taken by particular payloads was recommended. The flow paths should start at the payload arrival at KSC, continuing through integration, launch, landing and ending with the return of the payload to the owner or storage. Using the flow as an outline, the accommodations available and operations performed at each of the process functions should be given.

Suggestions for revision of Section 4, Facilities and Launch Site GSE of the handbook were given. These included simplification of the figures showing facilities locations, combining payload, facility and function information in a single matrix and standardizing the facility accommodation descriptions.

7.2 KSC ACCOMMODATIONS HANDBOOK VERSUS REVIEW CRITERIA

The KSC accommodation handbook defines a set of resources for each of the facilities which contribute to the processing of a Spacelab payload. The resources were compared with the review criteria (the questions developed in Section 2) to assess their adequacy. The results of the assessment for the O&C Building and the Orbiter Processing Facility are presented in Tables 10 and 11. The results of the assessment for the VAB and launch pad are presented in the remainder of this paragraph. Criteria not discussed in connection with a given facility were considered not applicable to that facility.

TABLE 10. O&C BUILDING ACCOMMODATIONS ASSESSMENT

ACCOMMODATIONS REVIEW CRITERIA	KSC ACCOMMODATIONS HANDBOOK	RECOMMENDED CHANGES	REFERENCE
Time	Time constraints not defined. Discussion of off-line processing indicates time may be critical.	Add-Time constraints should be identified.	
Onsite Transport	Canister covered for use between O&C and OPF.	Use of intersite transportation equipment between receiving area and O&C Building. Transportation coordination point is Office of Supply and Transportation Cranes (overhead lifting) at receiving dock.	Spacelab Transportation Plan, MDCG-68-22, KSC STS Transportation Plan
Experiment Transportation/ Storage Environment Monitor	Environmental monitor for transportation between O&C Building and OPF.	Expand to cover receiving dock to O&C Building.	Spacelab Transportation Plan, MDCG-6822, KSC STS Transportation Plan
Thermal Control	O&C Building Listed 21°C ±3° 70°F ±5°	None	
Humidity Control	O&C Building Listed R.H. 45% ±5	Change to R.H. 30% to 50%	
Cleanliness	100 K	Expand to cover cleaning of in-process equipment	
ATE Support	Undefined	Add-Definition of ATE capability. Define hardware and software interface with Spacelab CDMS/ experiments interface.	
Data Processing	Goal processing through CDMS Para 5.3.2.43	Add-Inline data processing through Spacelab/experiments hardware and applications software. Define software and hardware interface with post-test data processing equipment. Define data display capability. Define capability of KSC central data processing facility equipment.	
Experiment Testing	Undefined	Add-Experiments qualified and functional tested in Level IV Integration, interface verification, and data quality testing required in Level III/II Integration (O&C Building).	Payload test requirements document.
Experiment Calibration	Flight sensor calibration No Detail	Add-Payload system level calibration. Bench test area for LRV calibration.	Payload test requirements document.
Offline Lab Space	Biomedical Experimentation Lab Power 120/208V Cleanliness 100 K 3210 ft²	Define acceptable utilization. Complete definition of power, humidity, and thermal parameters.	
Physical Access	Access to payload during integration with Spacelab. Horizontal cargo integration equipment. Access to rack and pallets in payload assembly area.	Add-Access platform for canister	
Electrical Power	28 Vdc 480 V, 60 Hz 120 V, 60 Hz 208/230, 60 Hz	Change to: 120/208 V, 60 Hz ±2% 3 ϕ 120 V, 60 Hz ±2%, 1 ϕ 120 V, 400 Hz, 1 ϕ 28 Vdc 115/200, 400 Hz, 3 ϕ	ICD 2-5A-002 Sheet 10.
Spacelab Standard GSE	Six end items of multiuse mission support equipment are discussed in Para 4.7 and 4 8.	Spacelab standard GSE should be added Include NASA/ESA provided GSE.	
Mechanical Servicing	A crane capacity of 27.5 tons is listed in Table 4-10	Change to 2 cranes, 27.5 ton capacity, low bay and high bay Add-Definition of alignment equipment, and measuring devices.	ICD 2-5A-001
Cryogenic Servicing	Undefined	LN_2 through facility interface LO_2 and LHe through portable Dewars.	ICD 2-5A-001
Liquid/Hydraulic Servicing	Payload service equipment contains portable hydraulic carts Para 4.6 Water glycol Table 4-10.	Add-Potable water, distilled water, and Freon.	Sheet 17 ICD 2-5A-001.
Pneumatic Servicing	Table 4-10 mentions GN_2, GH_2, and GO_2.	Add-Freon; Air, Pressures, Flow rates on all gases.	ICD 2-5A-001 Sheet 17.
Pyrotechnic Servicing	Undefined	Safety, Checkout, and Installation Limitation.	
Specimen Servicing	Undefined.	Biomedical Experimentation Lab may be used to service live specimens (3210 ft²).	

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TABLE 11. ORBITER PROCESSING FACILITY ASSESSMENT

ACCOMMODATIONS REVIEW CRITERIA	KSC ACCOMMODATIONS HANDBOOK	RECOMMENDED CHANGES	REFERENCE
Time	o Time constraints not defined o Direct interface with Orbiter Activities indicates that time constraints may be critical	Time constraints between the payload/orbiter post mating activities needs to be defined. Examples are open loop end to end test and payload servicing functions.	Payload test requirements
Onsite Transportation	Canister covered for use between O&C and OPF	Use of intersite transportation equipment between receiving area and O&C Building. Transportation coordination point is Office of Supply and Transportation. Cranes (overhead lifting) at receiving dock.	Spacelab Transportation Plan, MDCG-68-22, KSC STS Transportation Plan
Experiment Transportation/ Storage Environment Monitor	Environmental monitor for transportation between O&C Building and OPF	None	
Thermal Control	70° ± 5 F	None	
Humidity Control	Relative Humidity 45% ± 5%	Relative Humidity 30% to 50%	
Cleanliness	100 K	Expand to cover cleaning of in-process equipment	
Data Processing	Goal processing through CDMS 5.3.2.4.3	Define data processing capability for end to end open loop test	
Physical Access	Access to orbiter payload bay	Add: Access platform for canister	
Electrical Power	120 V, 480 V 120 V/208 V	Change to: 120/208 V 60 Hz ±2%, 3 ϕ 120 V 60 Hz ±2%, 1 ϕ 120 V 400 Hz, 1 ϕ 28 VDC 48 0V 60 Hz, 3 ϕ	
Mechanical Servicing	Bridge Crane 40 Tons Hoist 5 Tons	None	
Cryogenic Servicing	LH_2 and LO_2 available in OPF	Add: Definition of availability to payload including facility/GSE interface. LH_2 and LHe available through Dewars.	
Pneumatic Servicing	GN_2 and GO_2	None	

Vehicle Assembly Building

When mating of the Shuttle elements on the Mobile Launch Platform are complete, the Mobile Launch Platform will provide purge air to the payload bay. This service will be maintained during transport to the launch pad. The KSC accommodations handbook adequately describes this purge air as Class 100 guaranteed Class 5000 air at 70° ± 5°F with a 30 to 50 percent relative humididty.

The handbook states that contingency access is provided via the Orbiter cabin through the transfer tunnel. This access statement should be deleted. The Spacelab tunnel vertical access kit has been deleted. No other payload operations are scheduled for the VAB.

Launch Pad

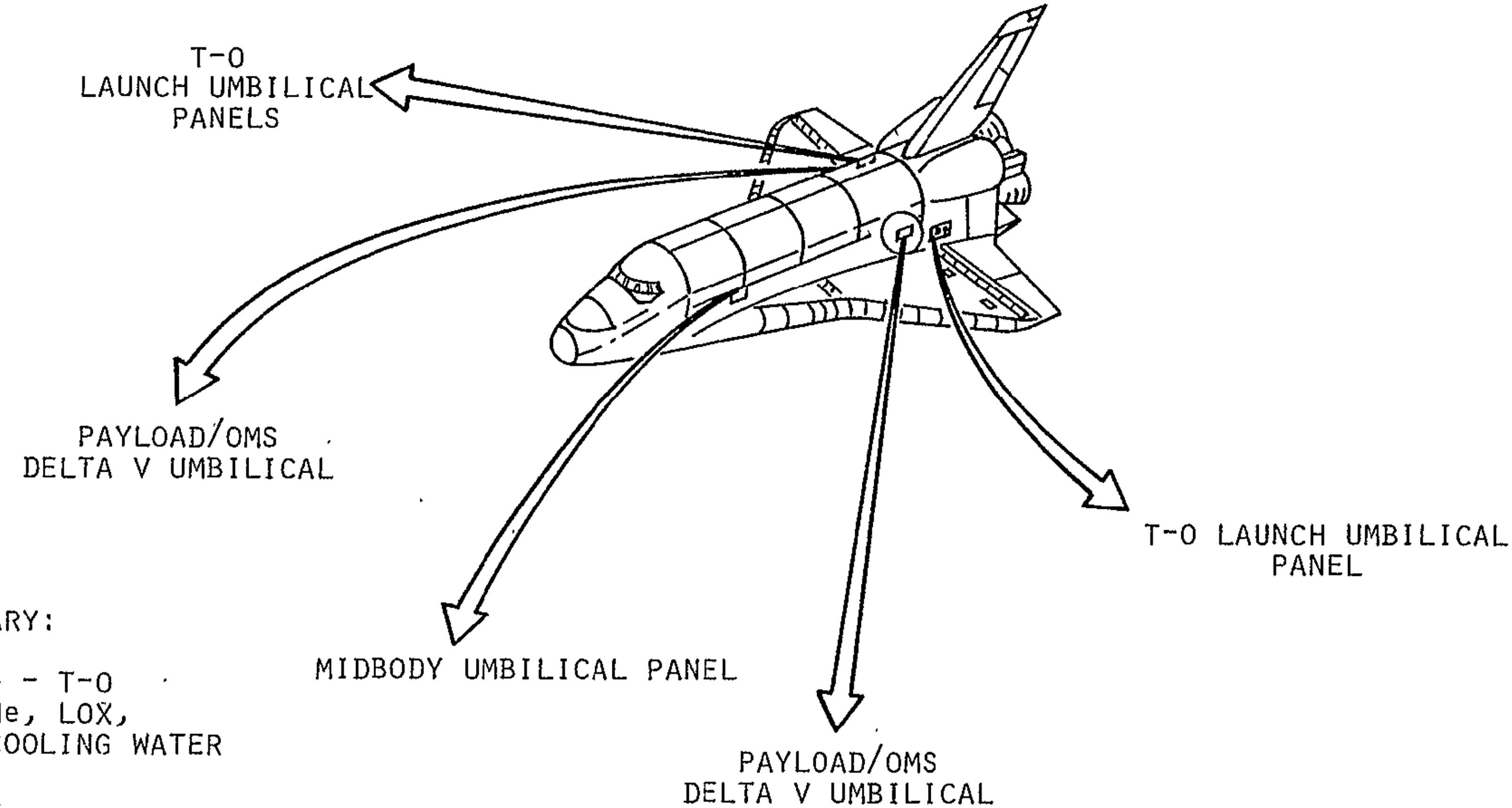
It is recommended that paragraph 3.3.4 of the handbook is modified to include the following data.

Payload operations on the pad are limited to (1) final servicing, (2) introduction of live specimens and (3) contingency activities.

Fluid, electrical, and electronic service are provided to the payload by ground support equipment through the T-0 launch umbilical panels, the midbody umbilical panel, and the payload/OMS Delta V umbilical as depicted in Figure 10. To utilize these services, the payload must provide the connecting hardware from the umbilical interface to the payload. Ambient Helium (He) and liquid oxygen can be supplied to the payload through the T-0 launch umbilical panel. In addition, cooling water with a heat rejection capacity of 50,000 BTU/hr is provided.

Until T-4 hours other servicing can be accomplished through the midbody umbilical panel. Two cryogen lines and six gaseous fluid lines are provided. This panel also contains provisons for eight electrical service connectors.

The payload/OMS Delta V umbilical can be used to provide fluid service to the payload and OMS Delta V kits at T-4 hours.



SUMMARY:

- T-4 - T-0
  - He, LOX, COOLING WATER
- T-4
  - CRYOGENS
  - FLUIDS
- UNTIL T-6
  - ACCESS TO PAYLOAD

FIGURE 10. PAD PAYLOAD SERVICES INTERFACES

Live specimens will be introduced at crew ingress and stored in the Orbiter mid deck area.

Access to the pallet area can be provided until T-11 hours. The time required to open and close the payload doors is six hours. Because of the time penalty and possible delay of launch, this operation should be avoided whenever possible.

For normal pad operations, access to the module is prohibited. Contingency access (emergency) can be provided through the 1.3 meter cover of the portholes in the module ceiling. This operation requires (1) the opening of the payload doors, (2) the installation of access equipment, and (3) the breaking of a man rated seal. This is not a normal operation and may require a recycle to the VAB.

8. REFERENCES

The references for this report are divided into two categories, documents and cognizant people contacted.

8.1 DOCUMENTS

No.	Title
1.	KSC Launch Site Accommodations Handbook for STS Payloads, K-STSM-14.1, June 1976 (With Revisions)
2.	Level II Spacelab Operations Requirements, Vol. II - Ground Operations Requirements SL-OP-031, April 8, 1977
3.	Rockwell International Report, GPR Experiment Definition Package (July 1977)
4.	ICD 2-5A002, Rev. B, 9/27/77, Spacelab Program Interface Control Document, Kennedy Space Center Facilities to Spacelab GSE (Electrical)
5.	ICD 2-5A001, Rev. B, 9/27/77, Spacelab Program Interface Control Document, Kennedy Space Center Facilities to Spacelab GSE (Mechanical)
6.	MDC-G 6822, Spacelab Transportation Plan (June 10, 1977)
7.	Eval Mission Requirements, 76SDS4284, 27 December 1976
8.	Shuttle/Tethered Satellite System Conceptual Design Study, TMX-73365, December 1976
9.	Eval Mission Requirements, 76SDS4227, 7 May 1976
10.	Haloe Project Plan, July 1977
11.	Eval System Concept Definition-Partial Payload, 76SDS4269, 30 September 1976
12.	A Proposal for an Ocean Color Experiment for Orbital Flight Test 2, GSFC
13.	Shuttle Multispectral IR Radiometer Experiment Proposal for OFT-2 Mission, JPL, 3 December 1976
14.	JSC Proposal 0136 for OFT-2, 29 November 1976
15.	LaRC Proposal, 3 December 1976

16. LIDAR Measurement of Cirrus Clouds and Aerosols on the Spacelab 2 Mission, ERU-76-280, 2 December 1976

17. GSFC X-734-75-307, November 1975

18. Sl-3-ERD-3NA002, March 1977

19. Space Processing P/L Equipment Study (GE), April 1977

20. SL-3-ERD-3NA003, March 1977

21. Sl-3-ERD-3NS005, June 1977

22. Sl-3-ERD-3NA004, June 1977

23. ERD-INA009, July 1, 1977

24. Spacelab Payload Accommodation Handbook, 30 June 1977

25. JSC 07700, Vol. XIV, SSS Payload Accommodations, Rev. E, June 17, 1977

8.2 COGNIZANT PEOPLE CONTACTED

Cunningham, Gary; GSFC; VTPR

Duroni, S.; GSFC; AMPA

Fitzmaurice, M. W.; GSFC; SGRS

Gianformaggio, Anthony; Rockwell International; Life Sciences

Hilsenrath, E.; GSFC; SOSU

Kraly, E. D.; Rockwell International; Combined Astronomy

Lawson, Lary; MSFC; Spacelab III

Lebel, P.; LaRC; CIMATS

Mookherji, Tripti; Teledyne Brown Engineering; Spacelab III

Reichle, Henry; LaRC; MAPS

Shapiro, Ralph; GSFC; THIR

Wirman, Nelson R.; KSC; KSC Handbook

Zimmerman, Dean; KSC; KSC Handbook