NASA CR-
151152

(NASA-CR-151152) PAYLOAD CREW INTERFACE DESIGN CRITERIA AND TECHNIQUES., TASK 1: INFLIGHT OPERATIONS AND TRAINING FOR PAYLOADS (Martin Co.) 177 p HC A06/MF A01 CSCL 22B

N77-15080

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G3/16 12518

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PAYLOAD CREW INTERFACE DESIGN
CRITERIA AND TECHNIQUES
TASK 1
CONTRACT NAS9-14676
INFLIGHT OPERATIONS AND
TRAINING FOR PAYLOADS

OCTOBER 6, 1976

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FOREWORD

This document has been prepared by the Martin Marietta Corporation for the NASA Lyndon B. Johnson Space Center. It is submitted in fulfillment of DRL Line Item 2 of Contract NAS 9-14676 and constitutes the final report for Task 1-Payload Crew Interface Design Criteria and Techniques of the Inflight Operations and Training for Payloads Study. All inquiries and comments should be submitted to:

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TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

Page

FIGURES

TABLES

INTRODUCTION

This study was initiated to develop and evolve a set of design criteria, considerations, and operational techniques which would be useful to payload organizations in the design of Shuttle payload controls and displays, the development of payload crew procedures, and the planning of flight crew operations. During the study's progression emphasis was directed toward the definition of specific design and operational requirements pertaining to the Shuttle's aft flight deck. Consistent with this emphasis, pallet-only payloads were given primary attention because of heavy demand on aft flight deck design efficiency.

Evaluations were conducted of various payload control and display concepts for the payload support stations at the Aft Flight Deck. An operational analysis was performed on the selected payloads from which an event sequence and detailed procedures were developed for the payload operating phase to be simulated.

The simulations were conducted in the Orbiter one-g mockup located in building 9A at the Johnson Space Center. The mockup contained cardboard representations of the Mission Station, Onorbit Station, Payload Station, and Closed Circuit Television (CCTV). In addition, wooden mockups of the Commander (CDR) and Pilot (PLT) couches were utilized. The Orbiter systems and Spacelab systems controls and displays (C&D) constructed with paper and cardboard were located according to the latest information.

The principal outputs of this task are the primary and secondary recommendations and conclusions which resulted from the simulations and analyses. Secondary outputs include a description of various centers' understanding of and thoughts on the Mission Specialist (MS) crew functions, a general discussion of the utilization of payload operators, and the results of the evaluation and evolvement of payload C&D's. The appendices include simulation details, personnel contacted, and reference materials.

SUMMARY

The primary results of this study task were the development of guidelines to be used in control and display panel design, the definition of preliminary payload procedures, and the derivation of crew operational concepts. The primary objective of the task was the optimization of payload operations performed on the Aft Flight Deck of the Orbiter.

From the original selection of candidate payloads, eight payloads were selected for further analysis. The eight payloads were primarily pallet-only payloads requiring the location of all controls and displays in the Orbiter's Aft Flight Deck. Three of these payloads were selected for operational simulations and one for a detailed evaluation. The three payloads selected for simulation were the Shuttle UV Optical Telescope (SUOT), Deep Sky UV Survey Telescope (DUST), and the Shuttle UV Stellar Spectrograph (SUSS)--all representing the stellar astronomy discipline. Their selection was based on their compatibility for combination into a single payload, the availability of operational data, and their operational complexity. The Advanced Technology Laboratory payload consisting of 11 experiments was selected for a detailed evaluation because of the availability of operational data and its operational complexity. Time and manpower limitations did not permit the evaluation and simulation of other payloads of interest.

Considerable time was expended to acquire a reasonable understanding of Shuttle systems interfacing with or limiting payload operations. The results of this initial work are discussed in Section III, Assumptions and Constraints, which includes specific design and operational requirements identified for the various payloads.

Payload control and display designs obtained from the associated payload organization personnel were evaluated and modified as required prior to the simulation and during the simulation, as necessary. The final payload C&D designs utilized the Spacelab CRT and keyboard and other elements such as a pointing controller and event timer as standard C&D. The Spacelab CRT and keyboard were used as the primary means of sending commands to and receiving data from payloads which resulted in the conservation of panel space and the optimization of crew operations. Each element of payload dedicated C&D was reviewed to determine whether it could be effectively replaced by a CRT and keyboard operation.

To optimize payload operations it was determined that a Spacelab CRT and keyboard should be located at both the Payload Station and Mission Station. This hardware would allow two payload operators to simultaneously operate different experiments or payloads. The use of Spacelab CRT's rather than multifunction display devices necessitates the use of CCTV's for display of payload video for fine pointing and other purposes. Control and display designs are discussed in Section VI and the recommendations and conclusions resulting from the simulations and analyses are listed in Section IV.

The simulations strongly indicated the need for a minimum of two payload operators per shift. During peak activity periods a third payload operator (in some cases a CDR or PLT could be utilized) could be effectively utilized to provide the other two payload operators with additional time for payload

planning and data analysis. The use of the crewmen in payload operations is described in Section VI and parts of Appendix A and B.

AC power is required at the Mission Station before the operational concepts developed in this study can be implemented. The Spacelab CRT and keyboard require the use of AC power. Other concerns and recommendations for future follow-on activity are described in Section VII.

ACRONYMS/ABBREVIATIONS

AC	-	Alternating Current
ACQ	-	Acquisition
ACT	-	Activate or Activation
ADJ	-	Adjust
AFD	-	Aft Flight Deck
APPLIC	-	Application
ATL	-	Advanced Technology Lab
ATT	-	Attitude
ASPS	-	Annular Suspension Pointing System
CAT	-	Category
C&D	-	Control and Display
C&W	-	Caution and Warning
CCTV	-	Closed Circuit Television
CDR	-	Commander
C/O	-	Checkout
COORD	-	Coordinate
CRT	-	Cathode Ray Tube
DEC	-	Declination
DEG	-	Degree
DIC	-	Direct Imaging Camera
DRL	-	Document Requirements List
DUST	-	Deep Sky UV Survey Telescope
ERNO	-	Company of VFW-Fokker Group
ESA	-	European Space Agency
EXP	-	Experiment
EXPMT	-	Experiment
FUS	-	Far UV Spectrograph
FWD	-	Forward
GMT	-	Greenwich Mean Time
GPC	-	General Purpose Computer
HO	-	Handover
HR	-	Hour
i	-	Inclinator
IMU	-	Inertial Measurement Unit
INCRE	-	Increment
INIT	-	Initiate
INDIC	-	Indicator

INSTR	-	Instrument
I/O	-	Input/Output
IPS	-	Instrument Pointing System
IRU	-	Inertial Reference Unit
IUS	-	Interim Upper Stage
KB	-	Keyboard
Kybd	-	Keyboard
MCDS	-	Multifunction Cathode Ray Tube Display System
MDM	-	Multiplexer/Demultiplexer
MET	-	Mission Elapsed Time
MGT	-	Management
MIN	-	Minute
MMC	-	Martin Marietta Corporation
MNVR	-	Maneuver
MOCC	-	Mission Operations Control Center
MPM	-	Minipointing Mount
MS	-	Mission Specialist
MUX	-	Multiplex
NMI	-	Nautical Mile
OOS	-	Onorbit Station
OPS	-	Operations
ORB	-	Orbiter
PCM	-	Pulse Code Modulation
PCS	-	Precisely Calibrated Spectrophotometer
PDR	-	Preliminary Design Review
PIC	-	Planetary Imaging Camera
P/L	-	Payload
PLT	-	Pilot
POCC	-	Payload Operations Center
POS	-	Position
PS	-	Payload Specialist
PTG	-	Pointing
PWR	-	Power
RA	-	Right Ascencion
RAU	-	Remote Acquisition Unit
REV	-	Revolution
RID	-	Review Item Discrepancy
RMS	-	Remote Manipulator System
RT	-	Right
RTOP	-	Research and Technology Objectives and Plans

SAO	-	Smithsonian Astrophysical Observatory Catalogue
SEC	-	Second
SEQ	-	Sequence
SIG	-	Signal
SIPS	-	Small Instrument Pointing System
S/L	-	Spacelab
SMS	-	Spacelab Mission Simulator
S/R	-	Sunrise
S/S	-	Sunset
STDBY	-	Standby
SUOT	-	Spacelab UV Optical Telescope
SUSS	-	Shuttle UV Stellar Spectrograph
SYS	-	System
TARG	-	Target
TBD	-	To Be Determined
TDRS	-	Tracking and Data Relay Satellite
TEL	-	Telescope
TV	-	Television
UT	-	Universal Time
UV	-	Ultraviolet
VCU	-	Video Control Unit
XLATE	-	Translate
Z	-	Zenith

COMPUTER USER LANGUAGE TRANSLATION

(As Used in the Procedures in Appendices A and B)

ACAM	-	Acquisition Camera
C	-	Coarse
CAL	-	Calibration
CAM	-	Camera
CCTV	-	Closed Circuit Television
COMP	-	Comparison Exposure
COV	-	Cover
C/R	-	Carriage Return Key
D	-	DUST
EXEC	-	Execute
EXPM	-	Exposure Meter
F	-	Finder Telescope
F	-	Fine
FIND	-	Finder Telescope
GP	-	Guide Probe
INCRE	-	Increment
L	-	Left
M	-	Minute
MN	-	Main
MON	-	Monitor
OBJ	-	Object
OPS	-	Operations
PL	-	Payload
PRI	-	Primary
PRO	-	Proceed
PWR	-	Power
R	-	Right
S	-	Second
S	-	Sign on
S	-	SUOT
SET1	-	Initial Setup
SET2	-	Final Setup
SMIR	-	Slit Mirror
SPEC	-	Special
TV1L	-	Television Monitor 1 - Left Side of Screen
TV2R	-	Television Monitor 2 - Right Side of Screen
VIDEO2	-	Video Signal to TV Monitor 2
Z	-	Zenith
Ø	-	Open
ØDCOV	-	Open DUST Facility Cover
ØFCOV	-	Open Finder Telescope Cover
ØFSHUT	-	Open Finder Telescope Shutter
ØSCOV	-	Open SUOT Facility Cover

I. TASK 1 OBJECTIVES, GUIDELINES, AND MILESTONES

A. BACKGROUND

The Payload Crew Interface Design Criteria and Technique Task is part of a three task study entitled Inflight Operation and Training for Payloads. The initial objectives of Task 1 as specified in the statement of work were:

1. The verification, modification, and expansion of the JSC document "Payload Operation Design Criteria and Techniques.

2. Determination of the interfaces required between payload organizations and JSC (Crew Training and Procedures Division) to insure efficiency and effectiveness in payload design, procedures development, and payload crew training.

These objectives were subsequently modified by agreement with the assigned JSC representative, resulting in deletion of the "Payload Operation Design Criteria and Techniques" document. In January, by request of NASA STS/Payload Steering Group Chairman, Task 1 objectives were expanded to include assessment of the Mission Specialist's role with the various NASA Payload Development Centers. By February the Task's primary emphasis had been directed toward the analysis of pallet-only payloads which were considered the greatest drivers to the design of payload controls and displays at the Orbiter's Aft Flight Deck (AFD).

B. OBJECTIVES AND EMPHASIS AREAS

The primary objectives as they evolved thru the first several months of the task are as follows:

1. Develop crew interface design criteria for the payload operating stations at the AFD based on a detailed functional analysis of selected payloads to support:

   a. Control and Display Design
   b. Crew Procedures Development
   c. Payload Operations Planning

2. Identify responsible contacts at the payload organizations and assess plans for the coordination and development of displays and controls, crew procedures, and training programs.

C. GUIDELINES

Guidelines were written regarding the selection of payloads to be studied, major emphasis areas, and the exchange of information with related study groups.

1. Payload Selection

a. Focus on attached pallet-only payloads which are currently best defined and which represent maximum operational complexity and maximum control and display requirement at the payload station.

b. Select payloads which represent the majority of payload centers including ESA.

c. Include payloads studies by Task 2 for maximum data interchange within the RTOP Study.

2. Emphasis Areas

Perform indepth analysis of payload activation and operating requirements to evaluate:

a. Automated versus manual payload functions and effect on crew workload

b. Crew/computer interaction for selected activation and operating sequences

c. Labor division between Mission Specialist and Payload Specialist

d. Crew coordination requirements for attitude maneuvering and experiment pointing and subsystem/facility and instrument management

e. Selection and arrangement of controls and displays for efficient management of the payload elements

Simulate operations for selected payload sequences to verify (and further derive) requirements and criteria for crew function development and control and display design and station location.

The costs associated with the controls and displays including software were not considered as part of the indepth study process nor were avionics packaging and volume requirements. General and practical cost and packaging constraints were considered to some extent, but as stated above the primary emphasis was the optimization of crew operations.

3. RELATED STUDIES

   a. Exchange acquired information and results with MMC/MSFC payload station study team.

   b. Payload information will be exchanged with FOD aft crew station team and results will be used in Task 1 payload simulations.

   c. ASSESS program experience and SMS II results will be reviewed and utilized where applicable.

D. MILESTONE ACTIVITIES

A study plan was written which enumerated the milestones or subtasks required to accomplish task objectives. During implementation of this plan the task schedule was revised resulting in completion of activities in June 1976. The milestones were:

1. Obtain, review payload documentation--organize material

2. Determine preliminary listing of candidate payloads for study

3. Identify data sources/contacts at JSC and payload centers for selected payloads

4. Develop checklist of information to be requested/discussed with payload personnel

5. Interface with JSC and payload center personnel--collect payload requirements and planning information

6. Finalize payload listing

7. Organize crew functions and procedures for selected payloads

8. Develop controls and displays (C&D's) for selected payloads and simulate crew activities

9. Conduct payload simulations

10. Document simulation results, identify design criteria, and disseminate

11. Prepare final report

II. PAYLOADS STUDIED

Eighteen payloads were initially identified as candidates for study. These represented the four payload types--pallet-only, attached with habitable module, free-flyer (including retrieve/reservice), and IUS/free-flyer. Additionally they included the full spectrum of operational complexity and represented all of the payload centers including ESA. Fifteen of the eighteen payloads were reviewed for basic configuration, state of development, availability of operational requirements, applicability to the study task, and interest by the sponsoring center in supporting task objectives. As the task progressed the payload listing was narrowed until prime emphasis was placed on the pallet-only payloads.

A. STUDY PAYLOADS

In March of 1976 the study payload listing numbered 12. These are shown in Table II-1. Payloads were divided by Attached or Unattached Configuration and then into a Primary or Secondary classification based on their priority, availability of operational information and development center interest in pursuing the study objectives. The listing was further reduced and a new payload (SUSS) added in April based on final planning for the payload simulations and current availability of operational information. This final Task 1 study listing is shown in Table II-2.

B. PAYLOADS SIMULATED

The Spacelab UV Optical Telescope (SUOT) Facility was the first payload selected for evaluation by simulated operation. Details of this simulation which included Spacelab Power Up, CCTV activation, and Orbiter maneuvering, may be reviewed in Appendix B. Results of the SUOT simulation are listed in Section IV. SUOT is a two pallet astronomy facility and, as such, did not represent the total workload nor crew labor division as would be expected from a full payload complement.

The Deep Sky UV Telescope (DUST) facility and Spacelab UV Stellar Spectrograph (SUSS) were then chosen for simulation along with SUOT. DUST and SUSS are each single pallet astronomy facilities and, like SUOT, each requires its own pointing system. A preliminary analysis of the operational requirements for these two facilities indicate that if they are flown with SUOT, the crew would have difficulty handling a fourth active facility. For the purposes of the second simulation the fifth pallet was assumed to be occupied by a relatively passive experiment primarily controlled by ground command. Results of this simulation are also included in Section IV and details of the simulation are covered in Appendix A.

TABLE II-1 STUDY PAYLOADS

(Attached Pallet-Only Payloads are receiving Greatest Emphasis)

Attached Payloads

Primary	Secondary
DEDICATED SOLAR SORTIE MISSION - GSFC/MSFC	SPACELAB MISSION SIMULATION (SMS) II - JSC
ATMOSPHERIC MAGNETOSPHERIC PLASMAS IN SPACE (AMPS) - ATMOSPHERIC SCIENCE FACILITY - Pallet-Only - JSC	FLIGHT 8 - FIRST SPACELAB MISSION - NASA/ESA
SHUTTLE INFRARED TELESCOPE FACILITY (SIRTF) ARC	DEEP SKY UV SURVEY TELESCOPE - JSC
SPACELAB UV OPTICAL TELESCOPE (SUOT) - GSFC	
ADVANCED TECHNOLOGY LAB (ATL) - LRC	

Unattached Payloads

Primary	Secondary
MULTI-MISSION MODULAR SPACECRAFT (MMS) - WITH TECHNOLOGY DEMONSTRATION SAT (TDS) AS PAYLOAD - GSFC	MARINER JUPITER ORBITER (MJO) 81 - JPL
SOLAR OUT-OF-ECLIPTIC MISSION (OOE) - NASA/ESA - ARC	SPACE TELESCOPE (ST) - MSFC

TABLE II-2 STUDY PAYLOADS - FINAL LISTING

(Attached Pallet-Only Payloads are receiving Greatest Emphasis)

Attached Payloads

Primary	Secondary
SPACELAB UV OPTICAL TELESCOPE (SUOT) - GSFC	DEDICATED SOLAR SORTIE MISSION - GSFC/MSFC
DEEP SKY UV SURVEY TELESCOPE (DUST) - JSC	SHUTTLE INFRARED TELESCOPE FACILITY (SIRTF) ARC
SHUTTLE UV STELLAR SPECTROGRAPH (SUSS) - JSC	
ADVANCED TECHNOLOGY LAB (ATL) P/L #3 - LRC	

Unattached Payloads

Primary	Secondary
MULTI-MISSION MODULAR SPACECRAFT (MMS) - WITH TECHNOLOGY DEMONSTRATION SAT (TDS) AS PAYLOAD - GSFC	MARINER JUPITER ORBITER (MJO) 81 - JPL

C. PAYLOAD EVALUATED

The ATL (Advance Technology Laboratory) pallet-only configuration was selected for payload operations C&D evaluation. This payload consists of eleven experiments ranging from one automatically operated experiment to four deployable (but attached) experiments. A brief description of the mission profile and the experiment operation is contained in Figures II-1, 2, and 3 as extracted from a Rockwell presentation on the ATL missions.

The starting point for the evaluation was a set of C&D's consisting totally of discrete switches and displays. A preliminary review of the total space required for the proposed experiment C&D's indicated that an overcrowding of the most desirable operational locations, i.e., panels L10, L11, A6, and A7, would occur with this design approach. Therefore, it was decided to reduce the panel space requirements by allocating functions to the KB/CRT and software operation.

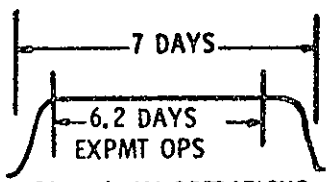
This chart presents a brief overview of the mission profile for Payload 3. The principal orbit features and key drivers are shown along with a summary of experiment utilization characteristics.

Orbit selection was centered on maximizing ocean surveillance for EO-4 and global coverage for EO-1. Global coverage is maximized with the highest orbit inclination attainable from KSC ($i_{max} = 57$ deg). Ocean surveillance is enhanced with a shifting ground trace pattern which produces the 200-nmi grid pattern illustrated on the chart. The selected orbit resulting from these considerations is pictured on the lower left of the chart.

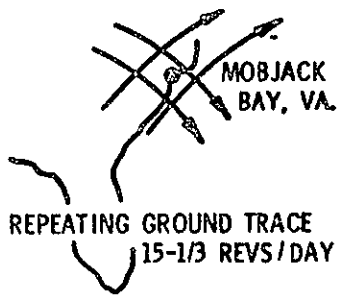
Utilization characteristics are also shown for each of the 11 experiments carried in Payload 3. Operating times and terrestrial coverage patterns are noted along with other conditions related to individual experiment requirements. The potential mission yield approaches 800 hours of experiment operations, based on an average daily crew availability of 10 hours per man. This includes the continuous and semi-continuous operations of the highly automated experiments. This high potential yield substantiates the operational feasibility of the Payload 3 experiment grouping.

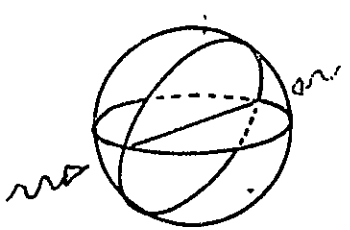
FIGURE II-1.

PRELIMINARY MISSION PROFILE - ADVANCED TECHNOLOGY LABORATORY



24-HR/DAY OPERATIONS
2 MEN/2 SHIFTS





h - 215 X 215 NMI
i - 50 DEG
T_n - 1.54 HR
DATE - MARCH 1982
TIME - TBD
≈2.5 REVS IN PHASING ORBIT

EXPERIMENT		UTILIZATION/CHARACTERISTICS
CS-X	CONTAMINATION MONITOR	AUTOMATIC OPERATION ≈170 HR
BR-15	FLUID PHYSICS & HEAT TRANSFER	24-HR TOTAL, TWO 60-MIN CYCLES, ONE 30-MIN CYCLE, BALANCE OF TIME FOR THERMAL STAB.
SD-8C	RADAR CONDUCTIVITY	12 PERIODS OF OPERATION, 35 HOURS, UP TO 90 TARGET ENCOUNTERS
DT-5	DATA PREPROCESSOR	OPTIONAL WITH SD-8C (MAX. TIME - 35 HR)
MA-20	LUBRICANT RETENTION	AUTOMATIC OPERATION, ≈149 HR
EN-1	PARTICLE SAMPLING	3 CYCLES, ORBITER CABIN 3 CYCLES, SPACELAB MODULE
SD-6D	FACSIMILE SCANNER	5 PERIODS OF OPERATION, 20 HR 15 COASTAL ZONE OVERFLIGHTS
SD-9	METEOROLOGICAL RADAR	44 HR, GLOBAL COVERAGE
NV-1	MICROWAVE INTERFEROMETER	9 PERIODS OF OPERATION, 9 HR, 9 ENCOUNTERS WITH SPECIFIED TARGET
NG-3	STRAY LIGHT REJECTION	1 PERIOD OF OPERATION, 21 HR AT PREFERRED ORIENTATIONS
TC-6	ZERO-G HEAT PIPE	24 HR PREFERRED ORIENTATION & QUIESCENT ENVIRONMENT; ADDITIONAL 126 HR OF OPERATION AT OTHER ORIENTATIONS
PW-24	SOLAR COLLECTOR	5 HOURS

FIGURE II-2

GENERAL ARRANGEMENT - ADVANCED TECHNOLOGY LABORATORY

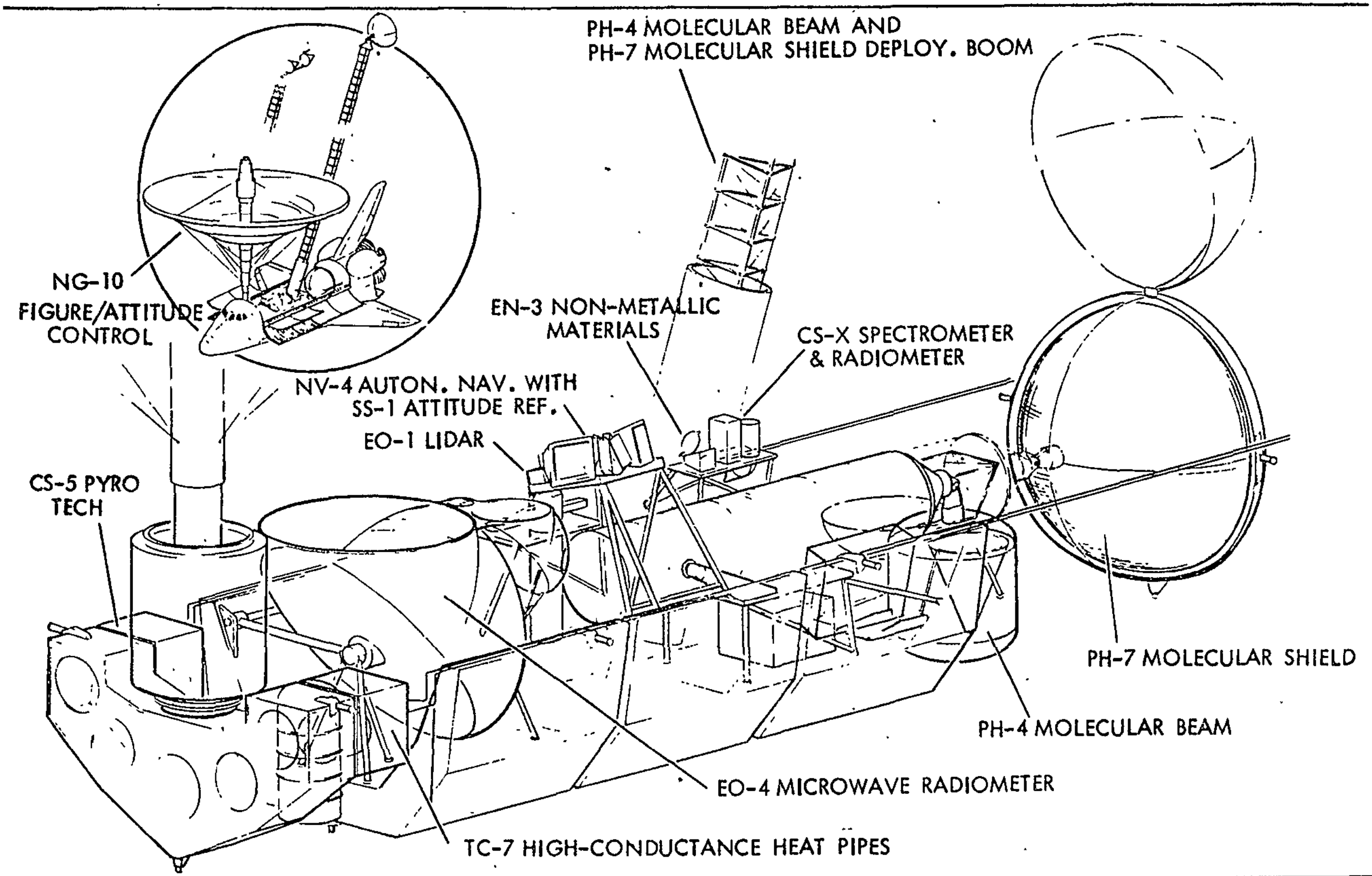


FIGURE II-3

III. ASSUMPTIONS/CONSTRAINTS

The following assumptions and constraints have been derived from Shuttle Orbiter and payload documentation and discussions with JSC and NASA payload development personnel. This information may not necessarily reflect current Orbiter and Spacelab configurations in all instances, but was documented to provide a framework for the development and evaluation of payload operating functions and control/display designs required for this study. Assumptions and constraints are treated synonymously and are divided into those which are considered standard to the pallet-only payloads studies and those which are unique to each of the pallet-only payloads.

A. STANDARD ASSUMPTIONS AND CONSTRAINTS FOR PALLET-ONLY PAYLOADS

1. Orbiter Interfaces

a. Spacelab systems require a minimum of power until activation is performed. This minimum power is drawn from the Orbiter Main C Bus. Switches utilized are on panels R1 and R7. Meters for monitoring power voltage and current are located on panel F9. The crew function will be to monitor the bus load condition.

b. The application and sequencing of Spacelab power will be performed with the Orbiter Multi-Cathode Ray Tube Display System (MCDS) located at panel R12 inconjunction with the Orbiter's General Purpose Computer (GPC). Spacelab power utilization will be monitored via MDCS.

c. Payload electrical power required during launch and/or entry (such as for telescope heaters) will be provided from an Orbiter fuel cell to Main Bus C and through the Spacelab Subsystem Inverter.

d. Fuel Cell 3 will be dedicated for Spacelab electrical power after the load level has exceeded 2 KW.

e. The Orbiter will allow the display of Spacelab Caution and Warning (C&W) parameters during all phases of flight. The capabilities provided are:

(1) Display for launch considerations until activation while Spacelab subsystems are powered down.

(2) Display for on-orbit operations following activation while Spacelab subsystems are powered up.

(3) Display for on-orbit operations with the Spacelab CDMS powered down.

f. Spacelab subsystems activation and management will be performed with the Orbiter GPC. Primary control for this function will be the responsibility of the Commander/Pilot using the MCDS and dedicated controls and displays provided at the Mission Station (panels R7, R11, and R13).

g. Communications among the crew and with the ground require headset and cord. Three Audio Terminal Units are provided at the Orbiter's AFD for this function.

h. Sufficient AC electrical power will be available at the Mission Station to support a Spacelab provided multifunctional (analog/digital) CRT and keyboard.

i. Sufficient cooling is available at the AFD to remove the heat load of up to three Spacelab provide multifunctional computer terminals (CRT and keyboard) and maintain the flight deck within the comfort level.

j. The Orbiter CCTV subsystem will be used in conjunction with payload sensors for target verification and alignment.

2. Spacelab Command and Data Management Configuration

a. Three computers (experiment, subsystem, and backup) are provided by Spacelab. The experiment and subsystem computer each have an I/O unit and data buses. The computers share a common mass memory.

b. The experiment computer will be shared amoung all the payload experiments. This computer will be used for instrument control and scientific data processing and monitoring.

c. Remote Acquisition Units (RAU's) interface the experiment computer's data bus with the experiment instruments and the subsystem computer's data bus with the subsystems. Commands and data are acquired and routed through the ARU's to and from the experiments and subsystems.

d. The subsystem computer will provide command and data signal formatting and routing through the RAU's.

e. A Hi-Bit Rate Digital Recorder and an Analog/Video Tape Recorder are included in the Spacelab subsystem inventory.

f. The Spacelab computer terminals (CRT/keyboards) are not dedicated to any one Spacelab computer nor to any one payload facility or experiment. The terminal operator must address the computer to which a particular subroutine, computational logic, target field, checklist, etc., has been assigned.

g. Talkback indicators will be provided for each onboard recorder to advise the crew when the ground is exercising command control.

3. Launch and Initial On-Orbit Operations

a. The following Orbiter avionics are activated prior to the Spacelab activation sequence:

(1) GPC, I/O, and Memory
(2) PCM Master Unit
(3) Network Signal Processor
(4) Maintenance PCM Recorder
(5) Loop Recorder
(6) Payload Data Interleaver
(7) MS MCDS
(8) MDM
(9) C&W Electrical Unit
(10) C&W Annunciator
(11) Master Alarm/Audio
(12) C&W Status Board
(13) S-Band PM System
(14) Payload Signal Processor
(15) Audio Central Control Unit

b. The following operations will have been completed prior to Spacelab subsystem activation:

(1) Final orbital maneuvers accomplished
(2) Payload bay doors are fully opened
(3) Ku-Band antennas are deployed
(4) AFD overhead and panel lights have been activated and adjusted
(5) Necessary loose equipment including star charts, flight plans, checklists, and other aids have been removed from stowage and are available at the AFD
(6) Personal communication systems have been deployed, donne, and the AFD audio control systems are activated

4. Spacelab Activation and Operation

a. Spacelab subsystem activation and management will be performed by the Pilot or Commander. The Mission Specialist will perform experiment facility activation and deployment where required and may assist in experiment pointing mount activation.

b. Command and data management subsystems initial mode settings will be performed by the crew. Therefore, data management--including data routing, recorder selection, and dumps--will be primarily the responsibility of the POCC or MOCC.

B. SPACELAB UV OPTICAL TELESCOPE (SUOT) - ASSUMPTIONS AND CONSTRAINTS

1. Pointing

a. A standard IPS will be used.

b. The subsystems computer will be used for automatic pointing sequences.

c. For boresight calibrations the SUOT facility will be deployed to the Orbiter's +Z axis.

d. SUOT slewing may be initiated prior to the completion of the Orbiter attitude maneuver.

e. SUOT retraction will not be required during Orbiter maneuvers.

f. As an aid to fine pointing, guide star fields will be entered in the experiment computer for display on the CCTV monitor(s) during target acquisition.

g. The initial coarse pointing will be accomplished by the Mission Specialist. Either the Mission Specialist or Payload Specialist may perform SUOT fine pointing.

2. Facility and Instruments

a. The SUOT facility will be mated to the IPS platform on-orbit. This will be accomplished before the facility is released from the payload bay launch/entry restraints. Conversely, facility/IPS separation will precede Shuttle entry.

b. Mirror positioning (metering) within the telescope will be accomplished prior to facility/IPS mating. In preparation for entry, mirror stowage will follow facility separation from the IPS platform.

c. The instruments provided with the SUOT facility are: Direct Imaging Camera (DIC), Far UV Spectrograph, Precisely Calibrated Spectrophotometer (PCS), and a Planetary Camera.

d. Only the DIC and Spectrograph may be operated concurrently depending on target selection.

e. No active pressure control is required for the telescope.

f. A heater (or heaters) will be used for telescope mirror temperature control and will be activated on-orbit following Spacelab power-up.

g. A cover (door) will be provided with the SUOT facility. The cover will be closed after each exposure sequence prior to Orbiter attitude maneuvering.

h. A finder telescope and an acquisition camera will be used to support target acquisition. This telescope is mounted externally to the SUOT facility and includes a protective cover (door) which will be open only during the target acquisition sequence.

i. Instruments will be checked out and calibrated sequentially.

j. The initial exposure sequences will require IPS and instrument calibration during which scientific data will be collected.

k. The SUOT facility and IPS will require two Shuttle payload pallets. It is assumed that other experiments of the astronomy discipline will be assigned for flight with SUOT to complete the payload complement.

3. Crew Operations

a. Experiment operations will require continuous crew attendance for 96 revolutions (approximately 6 days).

b. Each experiment day will be split into two 12-hour shifts and one Mission Specialist and one Payload Specialist will be assigned to each shift.

C. DEEP SKY UV SURVEY TELESCOPE (DUST) - ASSUMTIONS AND CONSTRAINTS

1. Pointing

The assumptions and constraints listed for SUOT pointing (ref. B.1 this section) exeept items a and g apply to DUST.

a. An IPS was assumed for pointing; however, a small experiment pointing mount such as the Small Instrument Pointing System (SIPS), Mini-Pointing Mount (MPM), or Annular Suspension Pointing System (ASPS) could also be used. If the SIPS is used, the mating and demating requirement would be eliminated.

b. DUST has no active mirror systems and all pointing of the instrument is performed by the pointing system gimbals.

c. Pointing accuracy is within 1 second.

2. Facility/Instrument

a. As with SUOT, the DUST facility must be mated and separated from the IPS pointing platform in orbit.

b. Three mirrors must be metered prior to instrument operation and stowed before entry.

c. When DUST is operating, slewing of other pointable facilities must be minimized.

d. The instrument has a 5° conical field-of-view.

e. No active pressure nor temperature control is required for the facility.

f. A finder telescope will be used for target acquisition and alignment.

g. DUST target acquisition and film exposure will be conducted on the night side only.

h. The facility occupies a single pallet.

3. Crew Operations

DUST operation requires crew attendance on each night pass for up to 96 revolutions (assuming 7-day mission).

D. SHUTTLE UV STELLAR SPECTROGRAPH (SUSS) - ASSUMPTIONS AND CONSTRAINTS

1. Pointing

Reference SUOT pointing (B.1 this section) items b through g.

a. SUSS fine pointing is accomplished by a movable secondary mirror.

b. The instrument has a single star tracker which may be fine pointed by the operator through the experiment computer.

2. Facility/Instrument

a. Facility mating (and separation) with the pointing facility must be performed in orbit if the IPS is used.

b. The primary mirror must be metered prior to instrument operation and stowed before entry.

c. When SUSS is operating, slewing of other pointable facilities is acceptable.

d. No active pressure nor temperature control is required for the facilities.

e. A finder telescope will be used for target acquisition and centering.

f. Exposure periods may be con-rolled by time reference or photon count.

g. The facility occupies a single pallet.

h. A protective door or cover will be provided with the facility and the finder telescope and each will be closed after an exposure sequence and prior to Orbiter attitude maneuvering.

i. Exposures may be made on both day and night passes.

3. Crew Operations

SUSS operation requires crew attendance during each revolution for up to 96 revolutions (7-day mission).

E. ADVANCE TECHNOLOGY LABORATORY (ATL) - ASSUMPTIONS AND CONSTRAINTS

1. Orbiter interfaces and Spacelab operational assumptions and constraints for the ATL study were given in paragraph A of this section.

2. ATL peculiar assumptions and constraints

a. Assume that there will be 24-hour on-orbit operation with two crewmen on each of two 12-hour shifts.

b. Assume that each crewman will operate a Spacelab CRT and keyboard at the Payload Station or Mission Station.

c. The CCTV's will be used to view experiment displays.

3. Additional Ground Rule after First Evaluation

Locate C&D such that crewman one operates primarily at the Payload Station using the KB/CRT and crewman two operates primarily at the On-Orbit Station and Mission Station KB/CRT.

IV. RECOMMENDATIONS AND CONCLUSIONS

This section contains the results, recommendations, and conclusions derived from the simulations and analyses conducted. Items which could have the greatest impact on Orbiter and Spacelab design and operations and payload crew operations are listed under primary recommendations and conclusions. Listed in parentheses after each recommendation and conclusion are those simulations or evaluations which significantly support the recommendation or conclusion.

Recommendations 3, 6, 8, and 9 resulted in the submission of RID's to the Orbiter Delta PDR and the approval of a PCIN to add additional wiring to the Mission and Onorbit Stations. The additional wiring provides for most of the capability required to satisfy recommendations 3 and 6. The requirement for AC power at the Mission Station has been generally accepted and implementation is expected. Recommendation 1 has been satisfied according to recent communications with ESA and recommendation 8 has been forwarded to those involved in the design of the CDR and PLT seats.

A. PRIMARY RECOMMENDATIONS AND CONCLUSIONS

1. The Spacelab CRT and alphanumeric keyboard (or other system provided by the payload sponsor) must fit into one 19 x 21.8 inch panel. This design configuration will permit the location of one or two Spacelab CRT's and keyboards at the Payload Station and one at the Mission Station. (SUOT and SUOT/SUSS/DUST)

2. Concurrent operations of the SUOT, DUST, and SUSS payloads require the full-time support of a second payload operator to efficiently operate these payloads and to maximize the quantity and quality of the data collected. The second crewman can increase the amount of useful data collected by 50-100 percent. (SUOT/SUSS/DUST)

3. The payload panel at the Mission Station (R11 or R12) should be capable of supporting a Spacelab CRT and keyboard. (SUOT and SUOT/SUSS/DUST)
   - Additional wiring has been provided; AC power is not yet available.

4. The Spacelab CRT and keyboard should be repackaged to provide some space on the panel for payload unique C&D. (SUOT, SUOT/SUSS/DUST, and ATL)

5. To optimize the use of panel space, switches and indicators smaller than the standard type which are used in the Orbiter should be used at the Mission, Onorbit, and Payload Stations for payload C&D. For example, switches the size of the caution and warning inhibit SWS in the airlock module could be used. (SUOT/SUSS/DUST and ATL)

6. Designated payload panel areas at the On-Orbit Station must be capable of supporting payload unique C&D. Additional wiring and cooling may be required. (SUOT and SUOT/SUSS/DUST)
   - Additional wiring has been provided.

7. Commander and Pilot's assistance in payload operations will significantly increase the quantity and quality of data collection. Such assistance gives the Payload and Mission Specialists more flexibility in conducting payload operations and given them more time to devote to data analysis and payload planning. (SUOT and SUOT/SUSS/DUST)

8. Consideration should be given to designing the CDR and PLT seats to have a swivel capability or hinged backrests to allow the CDR and PLT to more effectively participate in payload operations while operating from those areas. This capability would given them better aft viewing and reduce elbow-height interference for crewmen attending panels L10 or R11. (SUOT and SUOT/SUSS/DUST)

9. The CCTV monitors should be rotated towards the Payload Station or attached to a swivel mount to optimize target viewing by a crewman at the Payload Station. (SUOT and SUOT/SUSS/DUST)

10. If the Orbiter CCTV monitors are used for the display of payload video required for fine pointing tasks, portable pointing control units are required to enable a crewman at the Mission Station and/or Payload Station to effectively perform the tasks. The units should be designed to permit singlehanded operation and stowed near each payload operator's primary work station. (SUOT and SUOT/SUSS/DUST)

11. The use of multifunction display devices at the Mission and Payload Stations with the capability of displaying both video images and digital data provides a much greater flexibility in operating and pointing payloads. The use of such devices would lessen the otherwise necessary reliance on the CCTV monitors. (SUOT, SUOT/SUSS/DUST, and ATL)

12. The results of the mockup mini-sims strongly indicate that more in-depth simulations of a few representative payloads using simulated Orbiter systems (particularly the attitude control system), Spacelab systems, and experiment hardware and software would be quite valuable in establishing guidelines for the design of experiment C&D, the development of crew procedures, the planning of overall crew operations, and the development of crew training objectives. (SUOT and SUOT/SUSS/DUST)

B. SECONDARY RECOMMENDATIONS AND CONCLUSIONS

1. To effectively use the CCTV monitors for target confirmation and fine pointing, each crewman at the Payload Station requires access to a portable pointing controller to allow him to align the controller axes with the video monitor's axes. For a crewman operating at the Mission Station, a portable pointing controller is required to accomplish most pointing tasks using the CCTV's. The pointing controllers could be in paddle form with a cable which would allow unstowage from a position below or adjacent to the stations and subsequent use at a distance from the stations (see Figure V-11). (SUOT and SUOT/SUSS/DUST)

2. It would be desirable to have the capability of sending four payload video signals to the CCTV's for simultaneous display and to fully utilize the split screen format. (SUOT/SUSS/DUST)

3. With additional payload video input capability (four minimum) the CCTV video control panel at A7 is probably a more efficient means for directing video signals than via the S/L keyboard. (SUOT/SUSS/DUST)

4. CCTV's are required to view the payload and IPS prior to and during payload/IPS mating and IPS deployment. (SUOT and SUOT/SUSS/DUST)

5. C&D functions requiring CCTV monitoring are best performed from the On-Orbit Station and optimally from panels A6 and A7. The lower 13-31/32 inches of A6 and A7 are available for payload C&D's. The entire panel A8 is available if the RMS is not used. (ATL, SUOT, and SUOT/SUSS/DUST)

6. C&D operations requiring AFT window observations of Orbiter bay and extended items on booms above the bay should be located at A6 and A7 of the On-Orbit Station. (ATL, SUOT, SUOT/SUSS/DUST)

7. If C&D operations requiring use of the CCTV and AFT windows are located at the PS station, a second crewman will normally be required for observation assistance. The angle of the CCTV monitors and the protrusion over and outward from the PS station makes viewing while operating at L10 and L11 marginal and impractical from L12.

   The location of experiments with these functions will undoubtedly be necessary at L10 or L11 in order to preserve minimal crewman interference. Mounting the CCTV monitors on a swivel would greatly improve the suitation and allow considerably more flexibility of design of the PS station C&D's. (ATL)

8. A signal generator, controlled from the keyboard, is desired for displaying reference star fields on the video monitors; these would be generated from star catalogues stored in the computer and would facilitate target field verification and pointing alignment. (SUOT and SUOT/SUSS/DUST)

9. A portable floppy disk or random access storage device stowed beneath a panel on the Aft Flight Deck would be highly desirable for astronomy missions. Such a device would allow the storage and recall of star catalogue data for field identification and the storage of real time data for later onorbit comparisons; e.g., comparison of planetary and solar images. (SUOT and SUOT/SUSS/DUST)

10. If computer storage is not available, a Polaroid camera or other onboard copy device would be necessary for recording data or images off of the CRT's or CCTV's. (SUOT, SUOT/SUSS/DUST, and ATL)

11. During time critical sequences such as target acquisition and lock-on, a multichannel selector switch or function key is preferred over keyboard entry for the selection of video displays. The selector switch or function key should be located within easy reach of the crewman or crewmen who will be performing most of the pointing operations. (SUOT and SUOT/SUSS/DUST)

12. A TV camera operations selector switch should be centrally located for easy access by each payload operator. The selector switch would be a substitute for individual TV camera controls for TC-7, NG-10, and CS-5. (ATL)

13. If three Spacelab CRT and keyboards are available, the PLT or CDR could manage the relatively simple DUST from the Mission Station while the PS and MS manage the SUOT and SUSS from the two CRT and keyboards at the Payload Station. Or, instead of a third CRT and keyboard at the Payload station, the Orbiter CRT and keyboards at the mission or flight stations could be used by the CDR or PLT to support payload operations if the necessary interfaces existed. In either case, the CDR and PLT can substantially assist in payload operations allowing the MS and PS to spend more time in data analysis and payload planning resulting in a significant increase in the quality and quantity of the data collected. (SUOT/SUSS/DUST)

14. For the two CRT/keyboard configuration the PLT or CDR can support payload activities by following the checklist for the MS and PS to assure procedural compliance. This may be particularly useful during more critical and busy periods such as concurrent facility target acquisition and instrument setup. (SUOT and SUOT/SUSS/DUST)

15. A minimum of two CRT's and two keyboards are required for SUOT. Each CRT and keyboard should be integrated on a single panel. The preferred panels being L11 and R12 (or R11). (SUOT and SUOT/SUSS/DUST)

16. Overlapping or duplicate proficiency by the MS and PS on payloads like SUOT and SUSS will further enhance the crew's ability to respond to anomalies and should expedite facility and instrument checkout and pointing in preparation for data taking. (SUOT/SUSS/DUST)

17. Space on the flight deck is sufficient to accommodate two crewmen at the forward flight stations and one each at the Mission, On-Orbit, and Payload stations. Space for five crewmen may be required for handovers or complex operations. (SUOT and SUOT/SUSS/DUST)

18. The allocation of C&D functions to a CRT and keyboard should be based , to a large extent, on panel space availability, working space requirements for payload operators, frequency of C&D use, complexity of tasks involved, location of CRT and keyboard with respect to required dedicated C&D, visibility of the CRT display from the primary work area, and the general capability of C&D discrete and keyboard functions to optimize crew operations. (ATL, SUOT, SUOT/SUSS/DUST)

19. The FORTH interactive computer language should be utilized to provide flexibility in payload operations and malfunction workarounds. Complex commands which slow down operations should be avoided. (SUOT and SUOT/SUSS/DUST)

20. Reasonable typing proficiency is required of payload operators to expedite computer keyboard entries. (SUOT, SUOT/SUSS/DUST, and ATL)

21. The computer user language requirement for a facility like DUST is estimated to be about 20 words, DUST's relatively simple operation would require little crew training making it a strong candidate for PLT/CDR operation. (SUOT/SUSS/DUST)

22. The array of buttons located to the right of the S/L alphanumeric keyboard should be analyzed for use as a discreet payload controls/indicators. (SUOT, SUOT/SUSS/DUST, and ATL)

23. Two operators cannot usefully share a single keyboard. (SUOT and SUOT/SUSS/DUST)

24. Panel L12 should not be used for controls and displays requiring frequent attention. The CCTV monitors protrude into the space above the panel limiting accessibility and viewing of any C&D which would be located there. (SUOT, SUOT/SUSS/DUST, and ATL)

25. Infrequently used switches and indicators such as those required for SUOT mating, mirror metering, initial deployment, stowage, or jettison should be located on panel L12, A6, or A7. (SUOT, and SUOT/SUSS/DUST)

26. Frequently used payload unique switches and indicators should be located adjacent to the CRT and keyboard considered primary for the respective payload's management. (SUOT, SUOT/SUSS/DUST, and ATL)

27. Monitoring of caution and warning (and alert) indicators and the management of Spacelab systems can best be performed at the forward flight stations when a MS or PS is performing payload operations at the Mission Station. (SUOT and SUOT/SUSS/DUST)

28. Payload alert indicators which are common to operations performed by crewmen positioned at both the Mission and Payload Stations should be located where both payload operators have visual access (for example, the On-Orbit Station).

29. It is highly desirable to have a set of experiment alert indicators and associated main power switches located as a group in a centralized location. The alert indicators would be driven by abnormal or malfunctioned states and used for equipment protection. (ATL)

30. Payload malfunction controls such as the jettison switch may be located with other infrequently used, and less visible, controls on panel L12. Panels A6 or A7 could also be used for these types of controls. (SUOT/SUSS/DUST)

31. A continuous, dedicated readout device displaying IPS gimbal angles, azimuth and elevation of IPS pointing, and right ascension and declination would facilitate pointing operations and preparations for a succeeding pointing operation. For payload operations requiring payload operators at the Payload Station and Mission Station, the readout device could be located at the On-Orbit Station for common visual access. (SUOT, SUOT/SUSS/DUST, and ATL)

32. Time to sunrise and sunset and universal time should be displayed continuously on either a dedicated display or on each CRT display. The rise and set times for selected celestial targets and satellites (if required) should be available for display on the CRT and/or on the payload flight plan. (SUOT, SUOT/SUSS/DUST, and ATL)

33. RA and DEC for each primary star field and alternates should be readily available to the MS and PS for the targets planned during the next 12 hours. The CDR and/or PLT should have Orbiter attitude maneuvering coordinates available in the GPC--or on paper--cross-referenced to the primary and alternate targets (payload flight plan). (SUOT and SUOT/SUSS/DUST)

34. Talk-back indicators should be used for payload parameters which are time critical (i.e., disabled star tracker, instrument high voltage out-of-tolerance, facility cover, or instrument shutter disabled). (SUOT and SUOT/SUSS/DUST)

35. Event timers should be provided and used for terminating or initiating events which may otherwise be forgotten. (SUOT, SUOT/SUSS/DUST, and ATL)

36. An event timer located near the Mission Station is desired for payload operations performed at panel R11 or R12. (SUOT, SUOT/SUSS/DUST, and ATL)

37. For the SUOT payload, the facility guide probe (star tracker) star acquisition may be confirmed by the video monitor; the Spacelab computer must have the capability for crew input to adjust guide probe position where necessary for fine alignment. (SUOT and SUOT/SUSS/DUST)

38. Tape recorder operations should be candidates for KB/CRT software control and monitoring. This includes payload data, voice, and video. (ATL)

39. Computer operations and control of individual experiment computers, such as micro processors, should be candidates for KB/CRT software. (ATL)

40. Candidate areas for affixing cue cards are:

    a. Unused OOS panels
    b. Back of CDR and PLT couches
    c. A panel attached over unused C&D's (such as RMS panel at A8)

    (SUOT, SUOT/SUSS/DUST, and ATL)

41. The initial IPS/Orbiter IMU bias determination could be accomplished as part of the first two SUOT data taking sequences. (SUOT and SUOT/SUSS/DUST)

42. Assuming the Orbiter utilizes an inertial attitude during payload operations, the thrusters should be reconfigured at or before facility cover opening to minimize contamination. (SUOT/SUSS/DUST)

V. CONTROL AND DISPLAY (C & D) ANALYSES

The following discussion represents the C & D design requirements as they evolved through the task period. Program requirements and ground rules were evoked after this evaluation had been initiated, resulting in a shift in emphasis toward the Spacelab CRT and keyboard while the SUOT simulation was in process.

Six C & D configurations were evaluated starting with the side by side-four CRT layout conceived by K. Henize and T. Gull at JSC. Three subsequent configurations were evaluated during the SUOT simulation and two more during the Dedicated UV Astronomy Simulation in May. The Spacelab CRT and keyboard was incorporated in the third layout and used from thereon as a baseline. Layout variations then consisted of changes in the number of CRT/keyboard terminals used and modifications in design, selection and location of payload unique controls and indicators.

A. C & D DESIGN APPROACH FOR SUOT

1. Henize/Gull Conceptual Layout

Several candidate panel configurations were initially reviewed for SUOT. These were the K. Henize/T. Gull 4 tube side by side approach (ref. Figure V-1) and the Ball Bros. concept illustrated in the GSFC Astronomy Spacelab Payloads Study Report. The Henize configuration was selected as a basis for evolution of a full scale display to be used in the mini-simulation in April. Study personnel met with Drs. Henize and Gull to clarify the functions, location and notations of elements on the design.

The panel as shown is subdivided into two panel segments-- left-hand segment providing SUOT facility control, monitoring, and safing features; the right-hand, instrument control and monitoring. Each segment approximates the standard AFD panel dimension of 19 inches wide X 22 inches long (high). Each panel contains an analog CRT and alphanumeric keyboard for initiating computer sub-routines, commands and data monitoring. The second CRT on each panel can display graphics, video imagery as well as engineering data. This CRT, called a Video Monitor, can be controlled by the single keyboard on that panel segment. A rotary facility Selector Switch is provided with each CRT to enable the operator to monitor, point and command any of the payload facilities and/or instruments.

Instrument Pointing System (IPS) controls reside below each Video Monitor. Four push buttons (arranged in diamond form) provide X-Y translation and two twist knobs are used

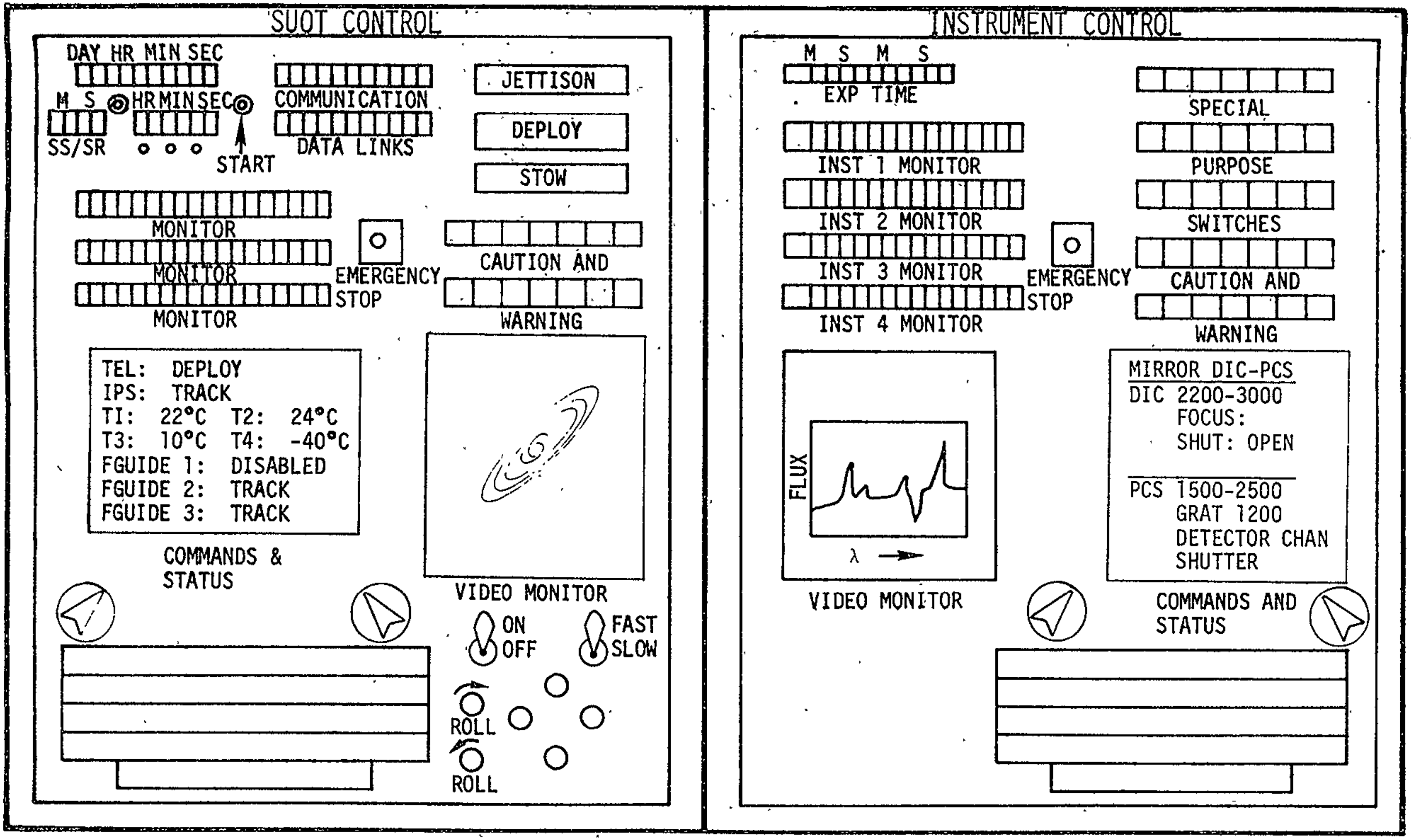


FIG V-1 PRELIMINARY CONCEPT OF THE PAYLOAD SPECIALIST STATION REQUIRED BY THE SUOT FACILITY for roll-right and roll-left. These controls are activated by an on/off toggle and fast/slow rate switch enabling manual input to augment the computer driven fine pointing gimball requirements.

A Universal time clock, stop clock, and event timer are positioned in the upper left corner of the SUOT Control Panel. Status light banks are shown for monitor, communication, and data link, and C&W status are included on the upper portion of this panel. Combination press actuated controls/indicators are shown for Facility Jettison, Deploy, and Stow. Instrument status monitoring indicators, C&W lights, and general purpose switches are included on the upper half of the Instrument Control panel.

While scaling the CRT's to full size, it was determined their display field measured approximately 6 inches square. Further expansion in the side by side configuration would exceed the panel width of 19 inches. Although this size is representative of the Tektronics 4010, it was considered insufficient for high density data fields. The current ERNO spacelab CRT measures 12 inches on the diagonal which approximates an 8 inch square data field face.

Upon further review of the SUOT operational requirements with Ted Gull, he indicated the basic objective was to standardize the C&D sufficiently to permit flexibility in their use for all astronomy type, pallet-only payloads. If multifunction display capability for the payload CRT's is not available, the CCTV monitors could be used to display video signals from the payload.

A single panel at the Mission Station will be available to support payload operations where required. This panel will be R11 or R12 depending on launch monitoring requirements. The Multi-Cathode Ray Tube Display System (MCDS) will then be located on the remaining panel (R11 or R12) <u>not</u> selected for payload controls and displays.

2. Functional Assignment and Skill Mix

To determine the optimum panel layout configuration which would take maximum advantage of both the Mission Station and Payload Station discussions focused on crew utilization, skill mix and the shift requirement. Long term operations at the Payload Station by two crewmen was found to be undesirable due to space limitations. A further examination of crew skill mix and apparent responsibility indicates that the Commander and Pilot will be responsible for the management of the Spacelab subsystems and, at the discretion of the payload sponsor, may support specific payload operations for which they have received sufficient training. The Commander, Pilot, and Mission Specialist will be responsible for Orbiter attitude maneuvers in support of payload operations.

Facility management, including pointing, target acquisition and verification, planning, and malfunction analysis were assigned to the MS. Additionally the Mission Specialist would be responsible for the management of payload programs in the experiment computer. Instrument control and monitoring and data collection were assigned the Payload Specialist.

Current SUOT requirements specify two 12-hour shifts with two crewmen per shift. Presumably this requirement will be compatible with other payloads selected to fly with SUOT. For the purposes of this study the crew complement consisted of one Mission Specialist and one Payload Specialist on each 12-hour shift. The operational requirements of SUOT plus three pallets of related astronomy instrumentation are assumed to provide an adequate workload for two men continuously through almost 6 days of scientific data collection. A second Mission Specialist assures a duplicate crew proficiency during second shift operations.

3. Modified Spacelab CRT and Hybrid Keyboard Layout

With the crew complement defined the detailed panel layouts and AFD location were reanalyzed. Separation of the total SUOT controls and displays into a Facility Control and Instrument Control Panel appears consistent with the division of skills anticipated for the Mission Specialist and Payload Specialist. Placement of the Facility Control panel at R12 will alleviate the "crowding" anticipated by two-man operation at the Payload Station. Panel L11 was selected for the SUOT Instrument Control Unit. This Payload Station panel affords the greatest accessibility and therefore should be assigned the more frequently used controls and displays. L10 is the second preference for crew access and was selected as a near duplicate of the L11 C&D configuration.

The automated concept for facility/instrument control and performance monitoring dictate extensive sue of the multifunctional control and display system by AFD operators. With a payload comprised predominately with pointing type instruments (such as SUOT) video monitors are essential for target identification, acquisition, and in some cases, status. The large 8 inch (+) square CRT which, with keyboard, consumes about 65 percent of the 19 X 22 inch standard panel, make it desirable to include video and data monitoring capability on each CRT. This capability was assumed for each CRT assigned to the three AFD panels - L10, L11, and R12. To enhance operator flexibility while managing multi-pointing instruments, which may require simultaneous or overlapping data acquisition, a selector switch is provided for each Spacelab terminal to permit communication with any of the active instruments and/or facilities. The same logic was applied in providing identical pointing controls with each of the three computer terminals. A full alpha/numeric keyboard with space bar, a single bank of 14 function keys and a 3 X 4 cursor/screen key set complement each CRT. The resulting panel designs used during the first phase of the SUOT simulation are shown in Figures V-2, V-3 and V-4.

Discrete hardwired SUOT instrument controls and indicators are also located on the L11 panel. Space is provided for controls and indicators for other instruments to be flown with SUOT on Panel L10; while L12 is reserved for other TBD dedicated switches and displays required for spacelab instrumentation. A listing of the discrete control/indicators provided on the SUOT Facility and Instrument Panels is shown in the following table:

TABLE V-1 SUOT DISCRETE CONTROLS & INDICATORS

<u>Facility Panel</u>

(a) SUOT mirror positioning (Meter/Stow)
(b) SUOT/IPS mating and separation
(c) Emergency stop (Facility/IPS) power off
(d) SUOT facility jettison
(e) SUOT release/stow

<u>Instrument Panel</u>

(a) Acquisition Camera - Power on/off
(b) Direct Imaging Camera (DIC)
(c) Spectrograph - Power on/off
(d) Spectrograph - High Voltage on/off
(e) Planetary Camera - Power on/off
(f) Planetary Camera - High Voltage on/off
(g) Precisely Calibrated Spectrophotometer (PCS) - Power on/off
(h) PCS - High Voltage on/off
(i) Telescope Fine Pointing and Rate (2 speed)
(j) Telescope Fine Pointing Command Control - on/off

Fig V-2 Facility Control Panel - SUOT

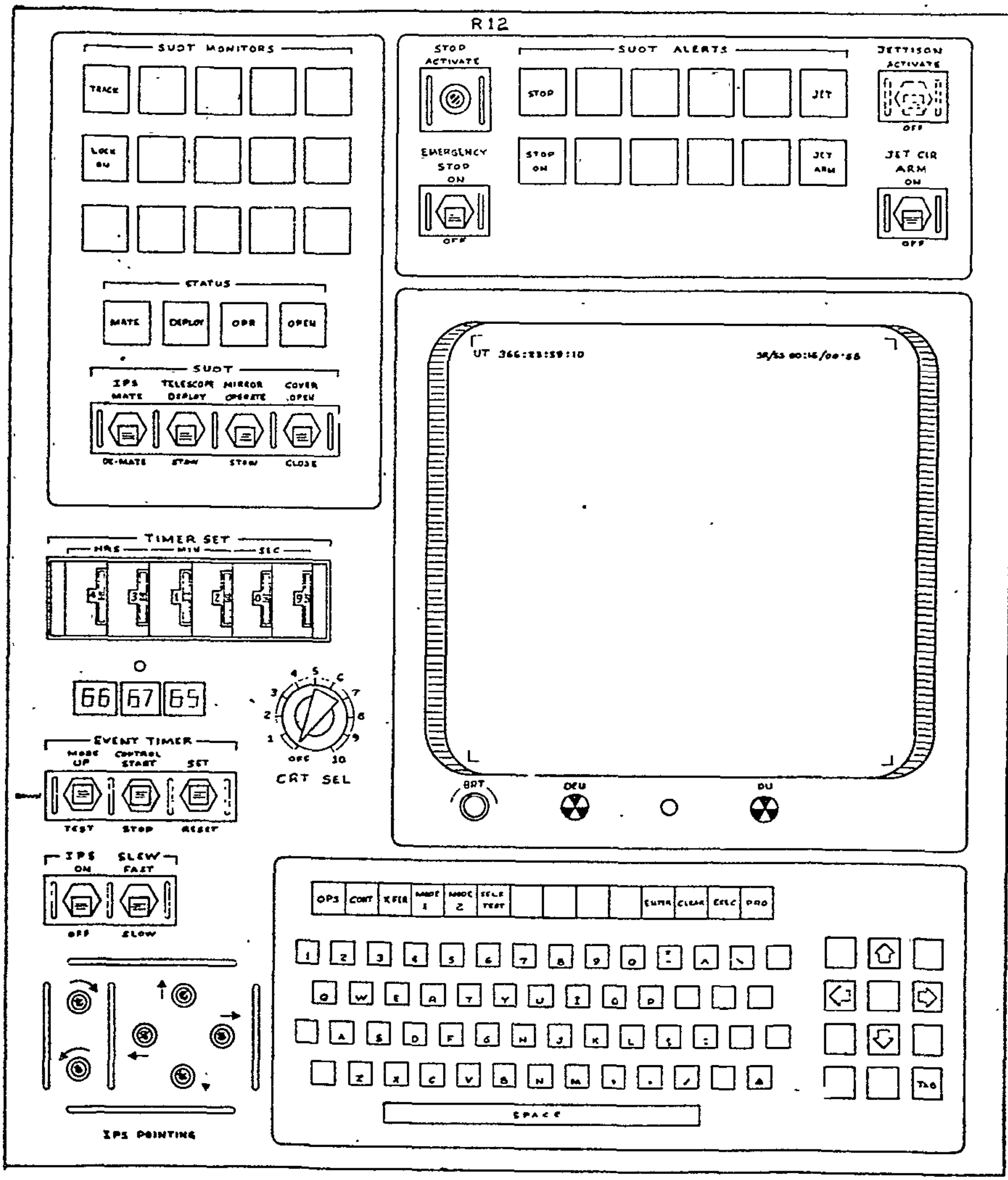


Fig V-3 Instrument Control Panel - SUOT

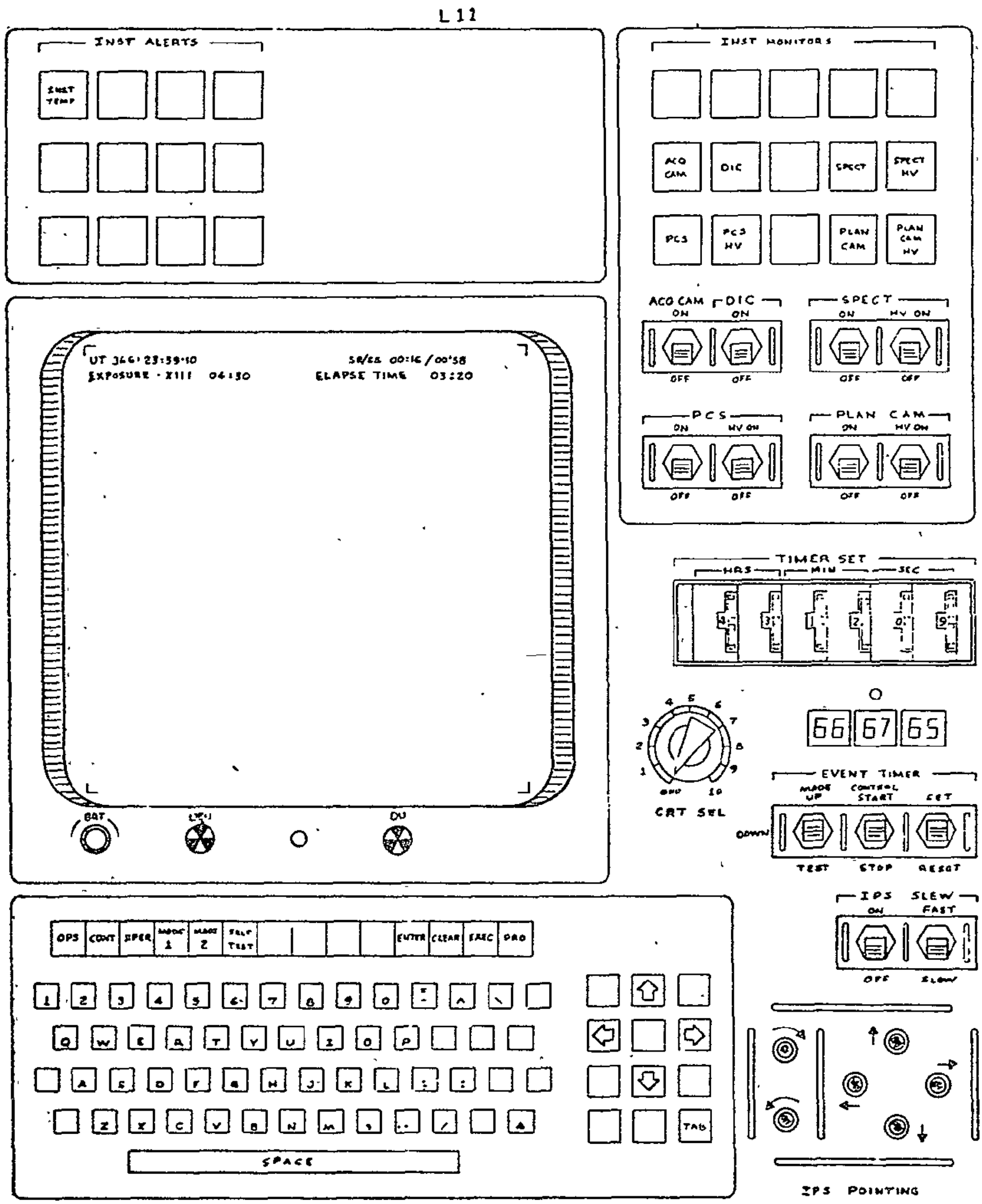
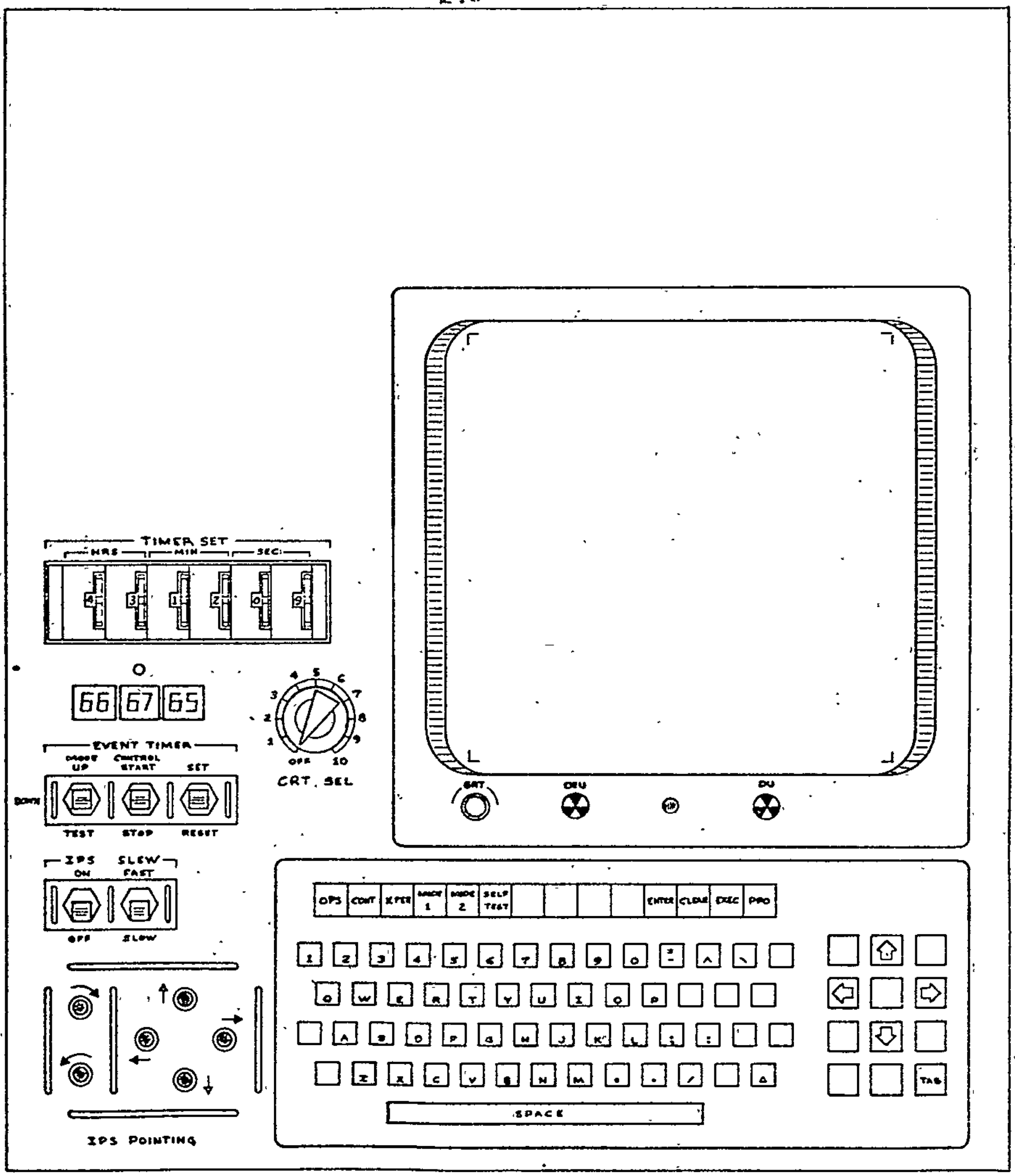


Fig V-4 Other Instruments Control Panel

L10



The first phase of the SUOT simulation confirmed that with two CRT's and keyboards to support payload operations the preferred locations are L11 at the Payload Station and R12 at the Mission Station. This provides ample working space for each crewman. The unknown factor for this configuration is the time required for the Commander (CDR) or Pilot (PLT) to address panel R7 for the control and monitoring of payload supporting systems. Should extended periods of Commander or Pilot attendance at the Mission Station occur during payload operations, then the "crowding" condition avoided at L10 and L11 has been transferred across the AFD.

Lack of R12 panel space for payload dedicated switches and indicators hinders the Mission Specialist's efficiency and requires that he translate to the Payload Station work area or that responsibility for these functions be transferred to the Payload Specialist. Other solutions would be to use the OOS for payload unique C&D which require the Mission Specialist's attention or swap the Mission Specialist's work and Payload Specialist's work sites if the Payload Specialist's responsibilities require fewer dedicated controls and indicators. Based on this design approach (reference Figures V-2 and V-3) unique controls are about equal in number for the two crewmen although frequency of usage would favor the Payload Specialist.

Without video capability on the Spacelab CRT the CCTV monitors must serve the target acquisition and verification function. The operator cannot perform fine pointing adjustments using a fixed controller panel at the Mission Station while simultaneously viewing the CCTV monitor. Even from the Payload Station confusion is possible if the fixed pointing controller's axes are not aligned with the video monitor. In addition, the viewing angles from the PS are not desirable for fine pointing. For this reason, portable pointing control units are recommended.

4. Oversize Spacelab CRT and Keyboard Layout

In March 1976 the advertised dimensions for the Spacelab CRT and keyboard (reference Figure V-5) exceeded the available AFD standard panel height by about 3 inches. Layouts were made assigning the CRT and keyboard to separate panels for evaluation in the mockup.

The Spacelab keyboard was assigned to Panel L10 along with the event timer and controls, and dedicated instrument switches and indicators. This layout is depicted in Figure V-6. The Spacelab CRT, pointing control panel, and facility switches and indicators were assigned to Panel L11 as shown in Figure V-7. A second CRT was located on Panel L12 with other experiment D&C and a 6-inch IPS Emergency Panel (reference Figure V-8).

Fig V-5 Spacelab CRT & Keyboard

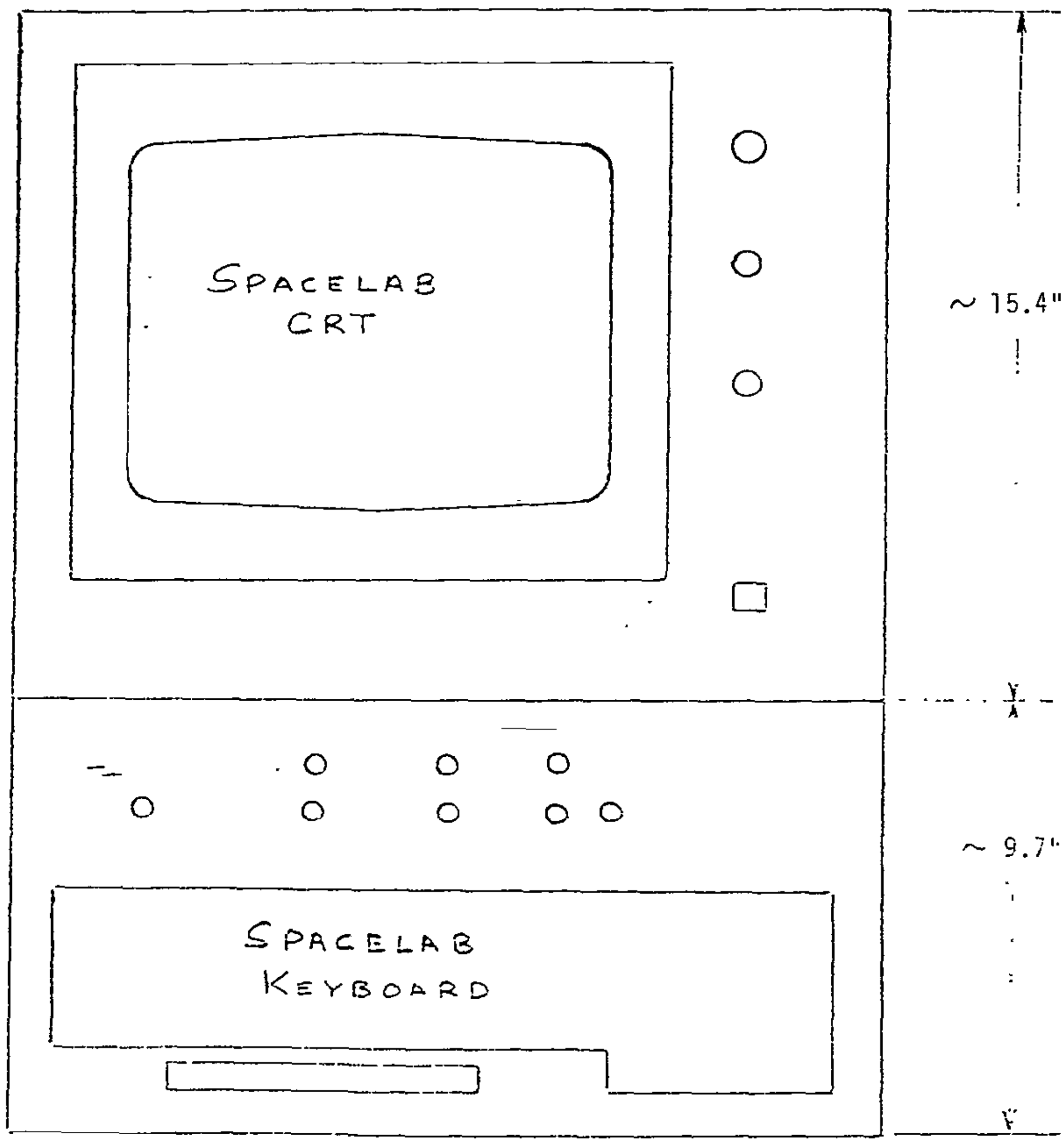


Fig V-6 SUOT Instrument Control Panel

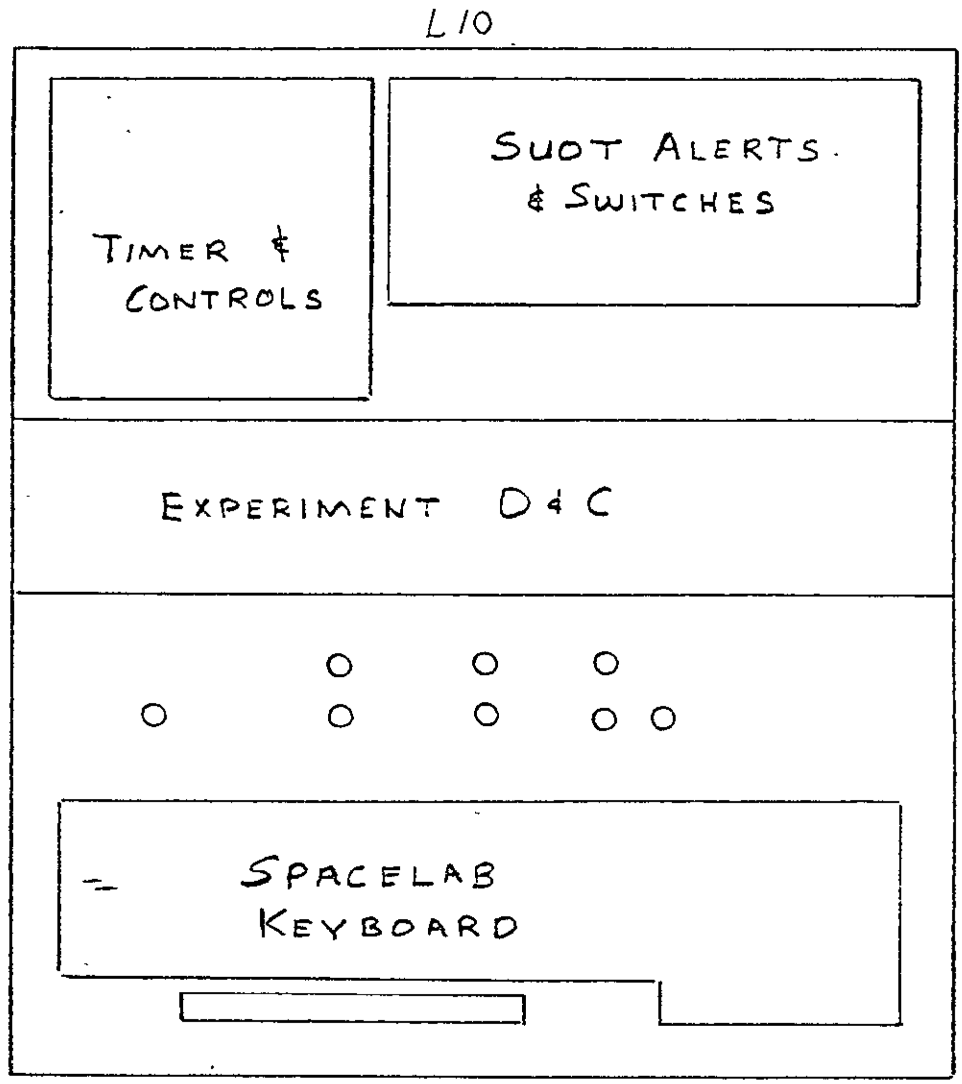


Fig V-7 SUOT Facility Control Panel

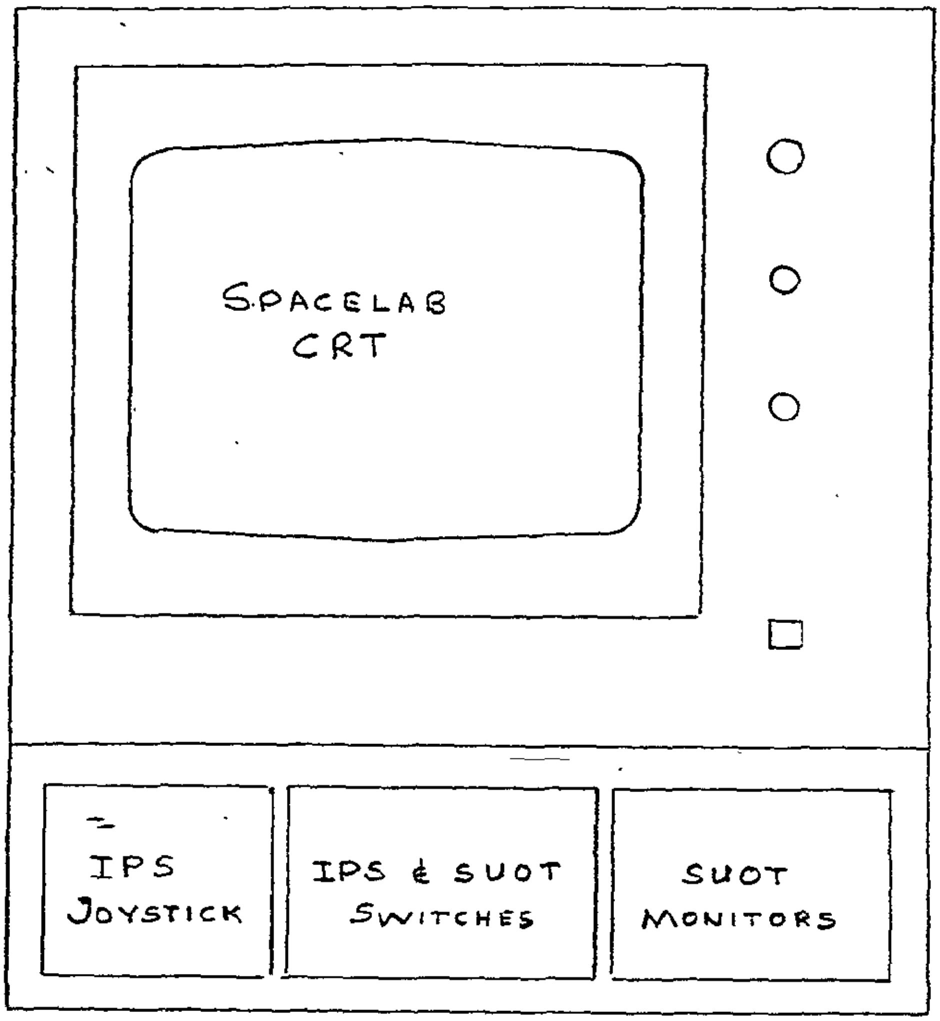
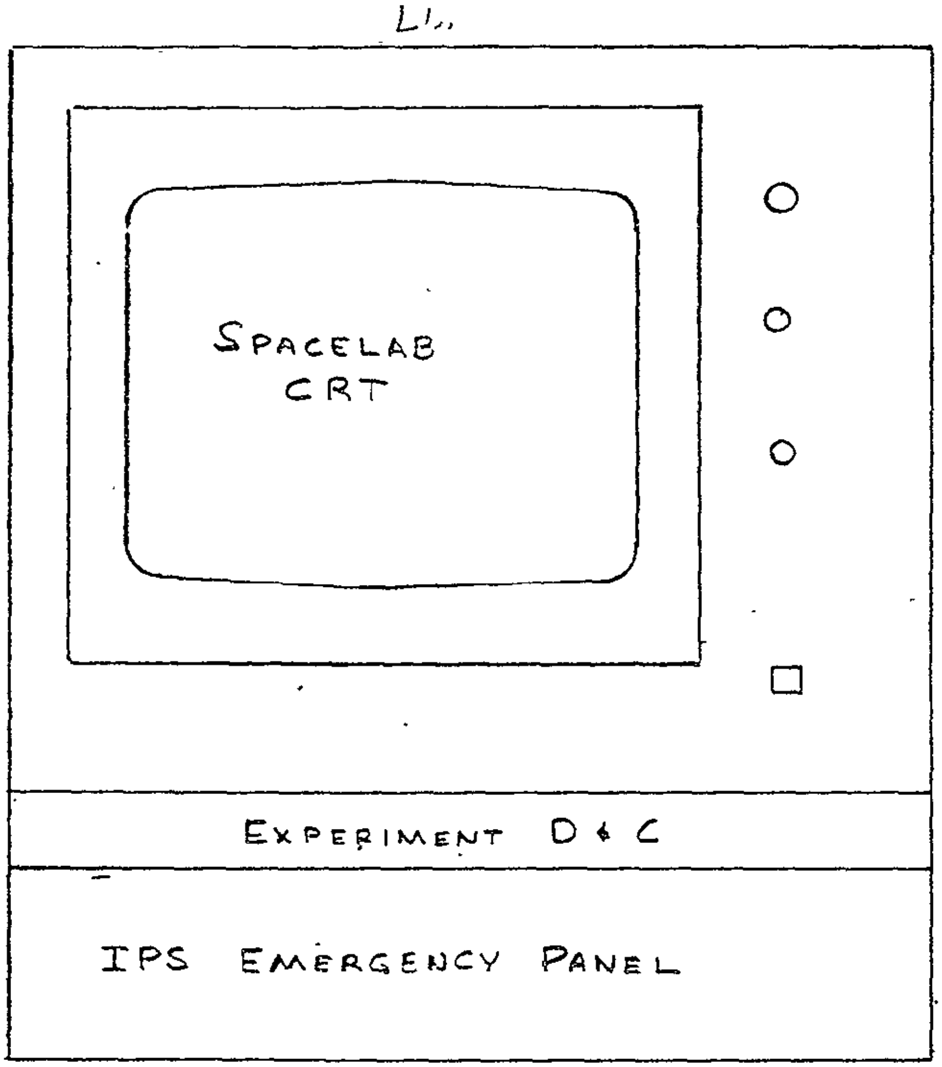


Fig V-8 Associated Control Panel



Separation of the keyboard and CRT created an awkward situation for both the one and two crewmen operation. The operator must continually shift positions for direct CRT viewing, an unacceptable condition with foot restraints. A second crewman must wait his turn behind the attending crewman and then step around to access first the keyboard and second the CRT. Because of the limited access and visual offset of Panel 12, a CRT at this location is useless for primary operations.

B. INTEGRATED C&D DESIGN APPROACH FOR DEDICATED UV ASTRONOMY PAYLOAD

Prior to the dedicated UV Astronomy Payload simulation, the C&D analysis was concentrated on the Spacelab CRT and keyboard integrated to fit on a standard AFD panel.

1. Integrated Spacelab CRT and Keyboard Layouts

In this configuration three Spacelab CRT and keyboard sets were positioned at Panels L10, L11, and R12. The layout used was similar to that shown in Figure V-5, but with approximately 3 inches subtracted from the CRT's height to allow the CRT and keyboard to be located on the same panel. The key disadvantage is lack of payload unique C&D area immediately adjacent to the primary work sites. With adequate space and wiring interface at the OOS plus portable pointing controllers this configuration may be acceptable.

During the Dedicated UV Astronomy Simulation which employed SUOT, SUSS, and DUST facilities both two and three Spacelab CRT/Keyboard versions were evaluated. The first portion of the simulation was configured with two terminals at L11 and R12. Panels L10 and L12 are shown in Figure V-9 and V-10. Portable pointing controllers (shown in Figure V-II) were stowed beneath the lip of Panels L11 and R12. A digital readout panel identifying RA, Dec, Elevation, and Azimuth for each of the three pointable facilities (reference Figure V-12) was located to the upper left of the available space on A7. A CCTV/Payload Video Control Panel for payload video routing was positioned to the right of the digital panel (reference Figure V-13).

Results of this evaluation indicated that the CCTV Selector/Indicator Panel cannot be realistically considered if the existing Orbiter Payload Video Control Panel has been baselined. The conceptual panel, although easier to use if accepted as an alternate, is redundant to the existing design. Recommendations for the existing Payload Video Control may be reviewed in Section IV-C.

Fig V-9 Payload Unique C & D
(Used During 1st Portion of Dedicated UV Astronomy Sim)

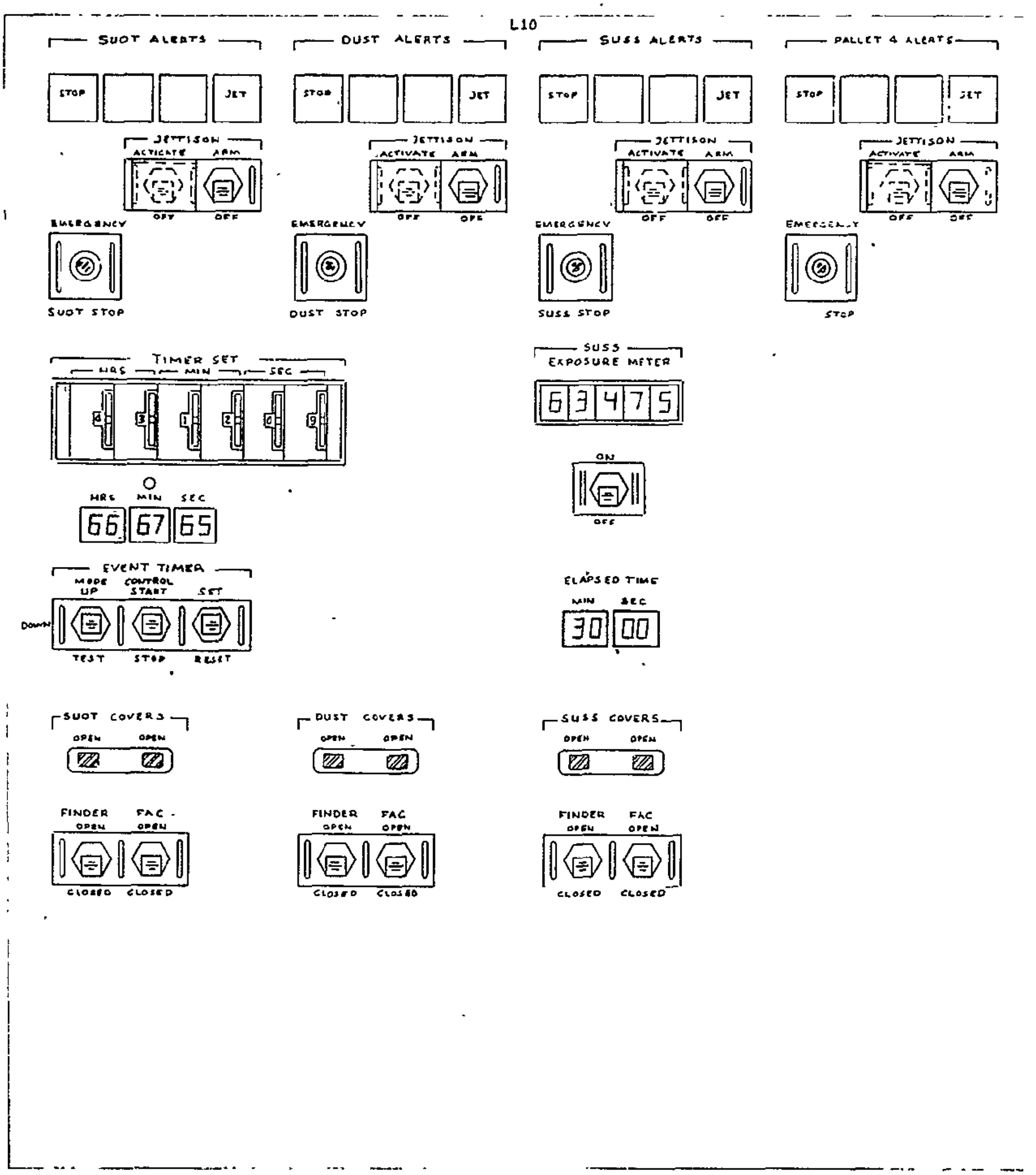


Fig V-10 · Payload Unique C & D
(Used During 1st Portion of Dedicated UV Astronomy Sim)

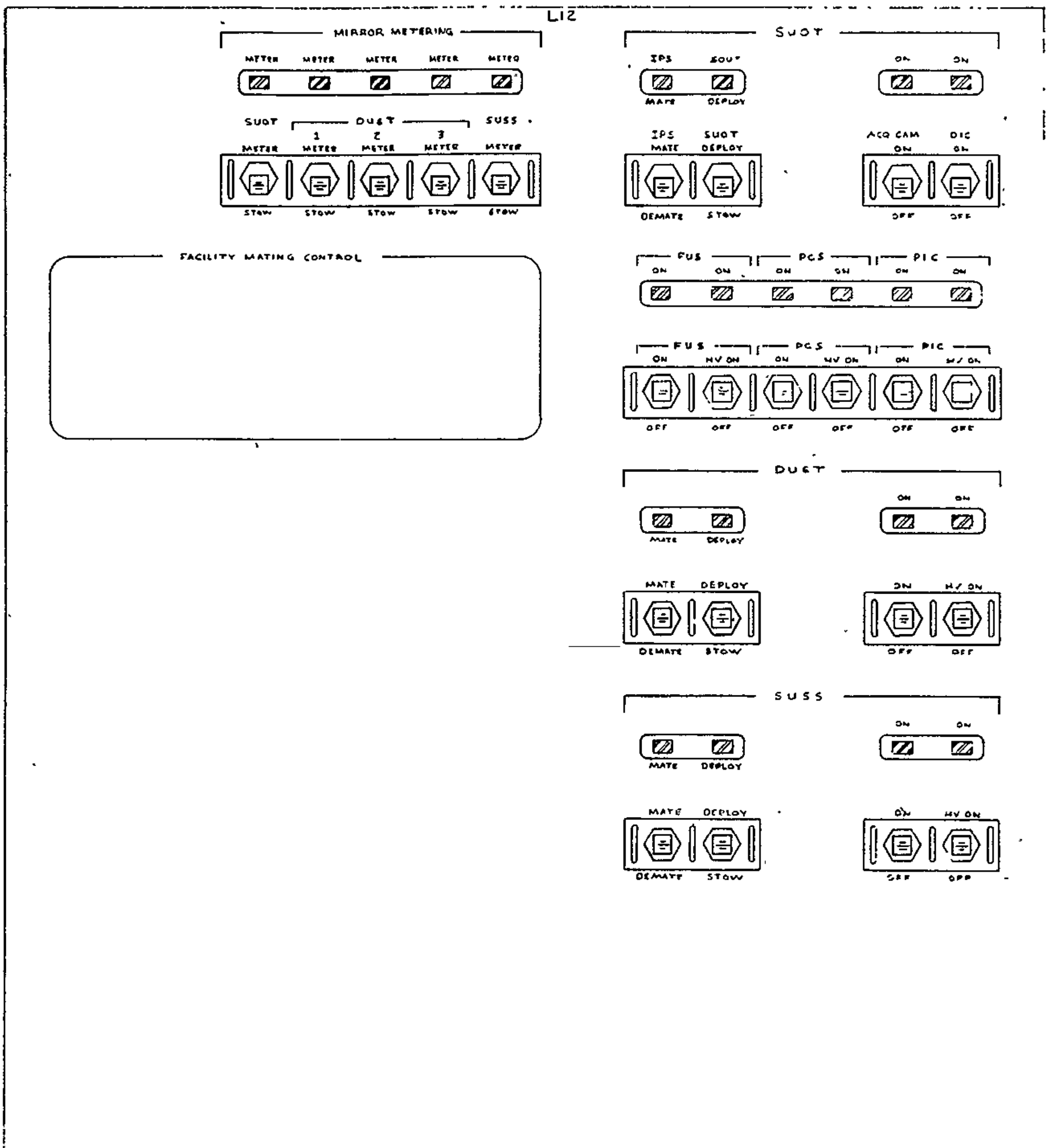


Fig V-11 Portable Pointing Controller

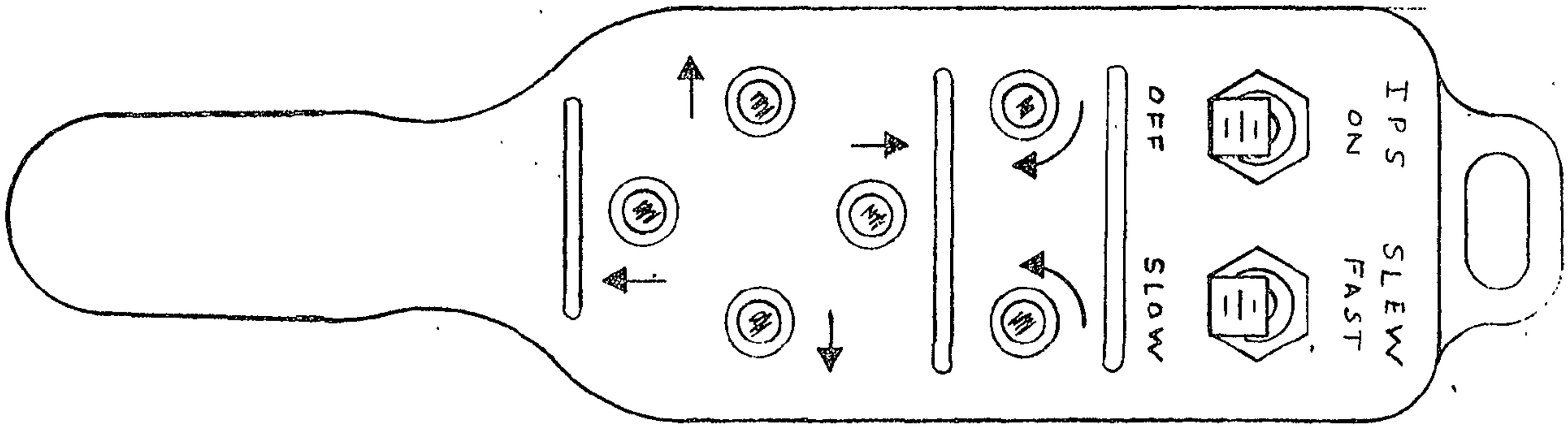


Fig V-12 Instrument Position Display
(Used During 1st Portion of Dedicated UV Astronomy Sim)

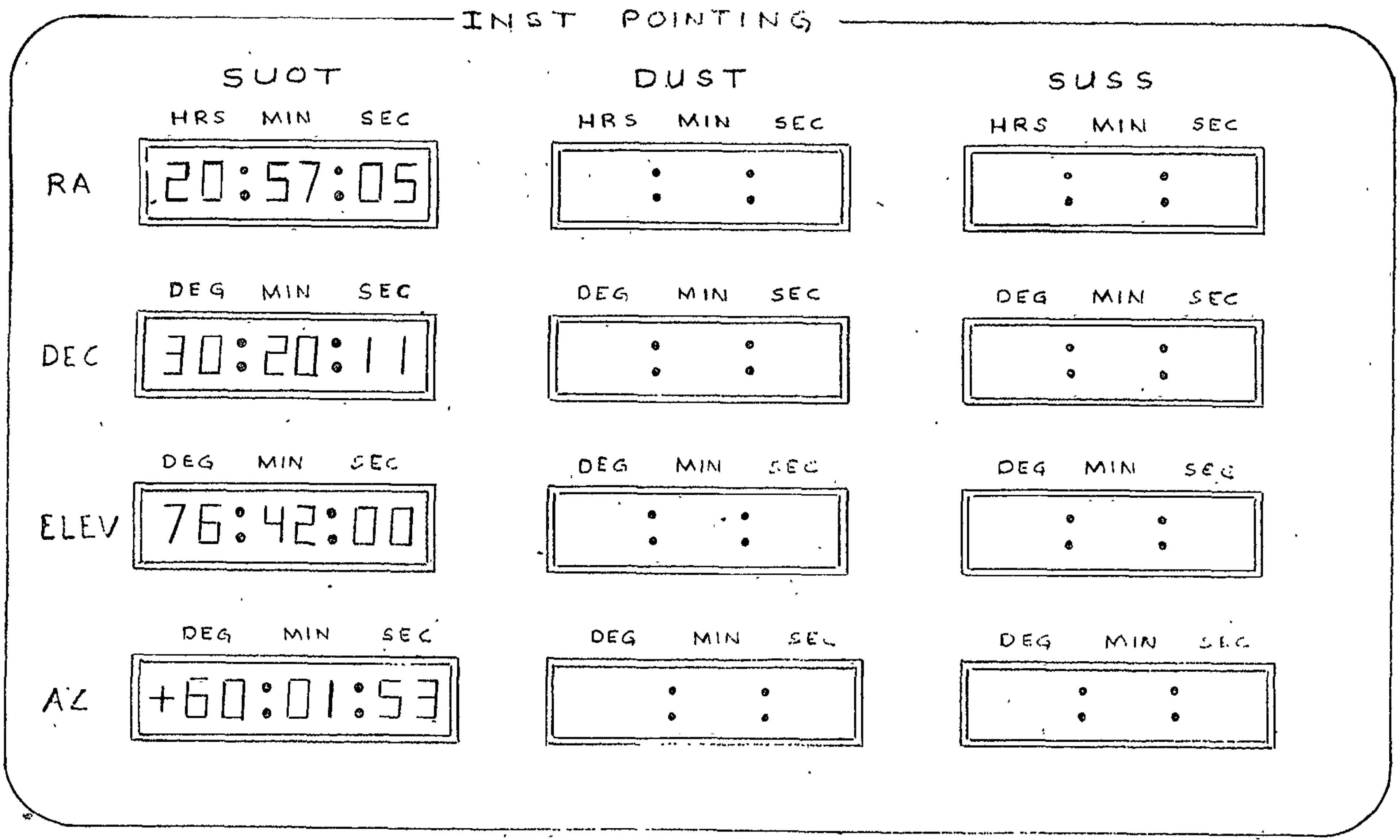
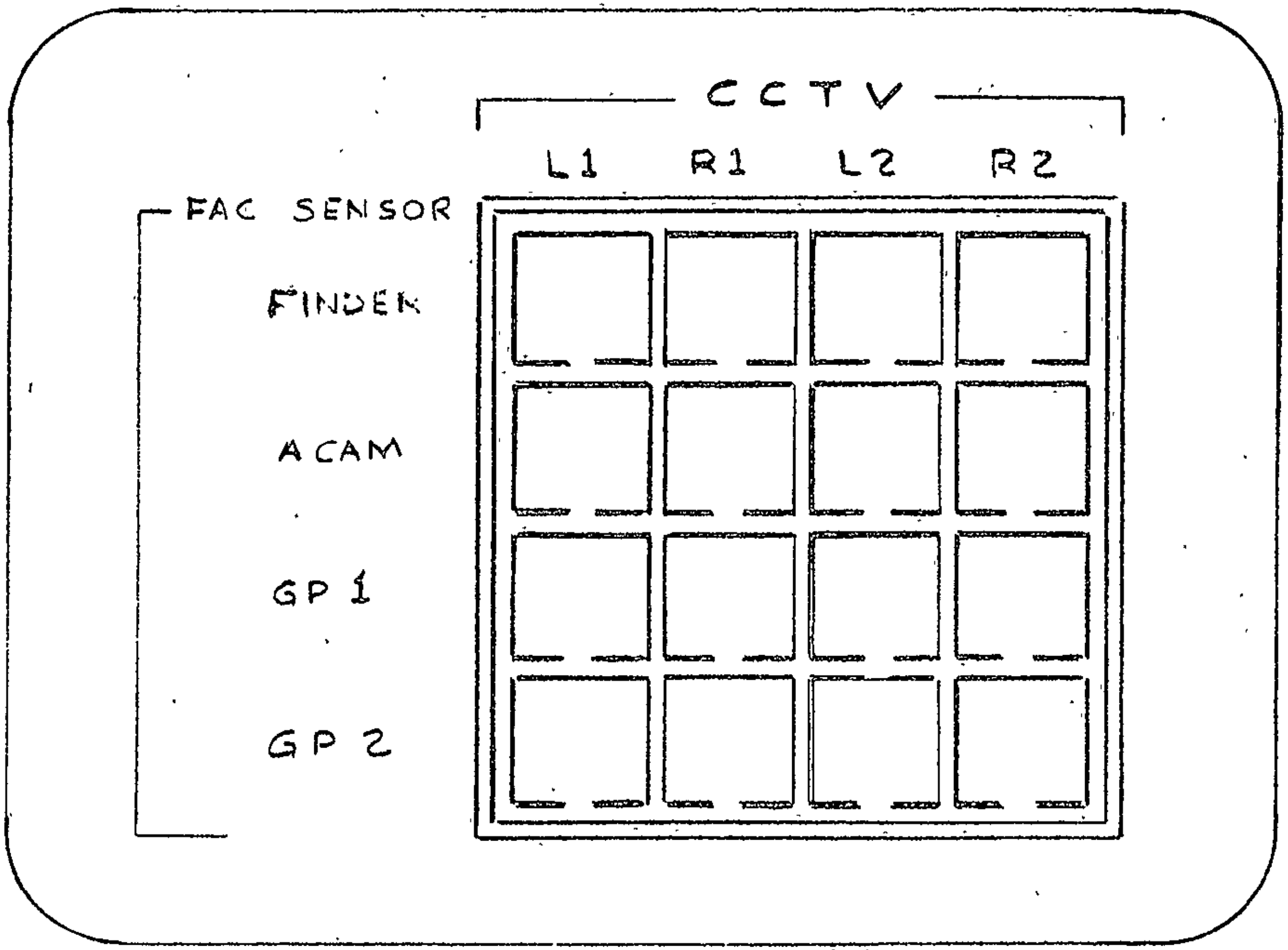


Fig V-13 CCTV/Payload Video Control Panel



The Instrument Pointing Panel is desired as a ready reference to the crew for current positions of all facilities. A7 is visually accessible from both the Mission and Payload Stations.

As in the SUOT simulation the same conclusion was reached regarding the need for payload unique panel area near the Mission Station. The operational evaluation of this four pallet astronomy payload indicated that each crewman should have more autonomy to better manage his assigned instruments. With two payload operators per shift the Mission Specialist was assigned responsibility for overall payload coordination and planning, facility slewing, SUOT facility management (not instruments) and pointing, and DUST management including pointing and instrument data collection (assigned crew functions are shown in Table VI-1). Unique controls and displays for these payload facilities and instruments should be accessible by the crewmen to whom they are assigned. Therefore, with the Mission Specialist attending R12, the SUOT and DUST facility and Finder Telescope Cover Switches, associated power switches, and payload alert indicators should be positioned for easy access. Without additional space at the Mission Station, Panel A6 is the next preferred location. Payload alert indicators would be positioned at A7 for ease in viewing from most positions on the AFD. An Event Timer and control should also be available to the Mission Specialist.

Results of the three Spacelab CRT/Keyboard configuration supported those cited above. For this evaluation the pilot was assigned management of DUST at Station R12, the Mission Specialists were located at A7 and those assigned to DUST were placed on A6 near the pilot. Portable pointing controllers were provided for each crewman at L10, L11, and R12 and each crewman was assigned target acquisition responsibility for his facility. This arrangement proved satisfactory for the simulation period (approximately 1-1/2 hours). Crowding at the Payload Station was somewhat alleviated by the side stance periodically assumed by the Mission Specialist. Head clearance at L10 is marginal.

2. C&D's for Facility Mating, Deployment, and Stow

Dedicated switches and indicators were provided for the evaluations to simulate payload activation proceedings. Should dedicated C&D be required their preferred location would be on Panel A6 for operation by the Mission Specialist during the early and latter portions of the mission. This allows him to use the R12 terminal, view the CCTV monitor, and look through the aft window as required.

C. ATL DESIGN APPROACH

1. Initial Evaluation

- The ATL Experiment C&D's fall into two basic categories, with exception of one experiment.

CAT. I - Experiment C&D's which have deploy, retract, fire and burnout observations, all which are critical operations and which require CCTV Monitors and/or AFT window viewing.

CAT. II - Experiment C&D's which do not require CCTV or window viewing, but for the most part require continuous or periodic monitoring, update, and/or operation.

EXCEPTION-Experiment CS-X is essentially automatic and requires little monitoring or C&D's operation on-orbit.

The experiments are:

CAT. I - PH4 - Molecular Beam
PH7 - Molecular Shield
NG10 - Figure Control
CS5 - Pyrotechnic Technology
TC7 - High Conductance/Heat Pipes
EN3 - Non Metallic Materials

CAT. II - EO4 - Microwave Radiometer
EO1 - Lidar Measurements
NV4 - Auton Nav/Horizon Sensor
SS1 - Precision Attitude Reference

EXCEPTION-CS-X Contamination Monitor

The starting point for the evaluation of the ATL was a set (11) of experiment C & D's provided by Langley and consisting primarily of discrete switches and displays. A preliminary review of the total space required for the proposed experiment C&D indicated that an overcrowding of the most desirable operational locations (i.e., panels L10, L11, A6, and A7) would occur. Therefore it was decided to start by reducing panel space requirements and allocating functions to KB/CRT and software operation.

An initial C&D design layout had CAT. I C&D's at Payload Specialist's station panels L12 and L11 with a Spacelab KB/CRT at L10. This layout made it difficult to coordinate critical operations on panels L11 and L10 and still observe CCTV and/or window viewing. (Operations such as pyro-firings deploy, etc.) Experiment CS-X was located on L12.

Panels A6 and A7 (bottom half) contained experiments EO-4, SS1, EO-1, and NV4 (CAT. II). KB/CRT functions were at R12 of the Mission Station. This separation appeared adequate as the frequency of operation was not great and compatible to A6 and A7 functions. See Figures V-14, 15, 16, and 17.

The ATL experiment functions which could be effectively performed through KB/CRT operation are those which are non analog, non time critical, selection in nature, monitoring of measurements, status keeping, data review/analysis, and discrete operation of auxiliary functions--such as tape recorders, experiment data, processors, etc.

Those experiment functions which were time critical and often analog in nature were deploy, retract, extend, fire, slew, and adjust. These functions were retained as specific panel controls and displays. In addition, basic power on/off and associated operation of vital subsystems such as lasers, star trackers, IRU, etc., were also retained as discrete panel controls due to the required coordination of operation of these items during normal and abnormal operations and their frequency of use.

A summary of the experiment function allocated for KB/CRT operation and the location of the remaining C&D's is given in Table V-2.

2. Table Top Reevaluation

A reevaluation of the first layout was conducted with an additional ground rule.

Separate the experiment operations and locate the C&D such that Crewman one operates primarily at the Payload Station using the KB/CRT and Crewman two operates primarily at the On-Orbit Station and the Mission Station KB/CRT.

FIG V-14 A6 (1ST ATL LAYOUT)

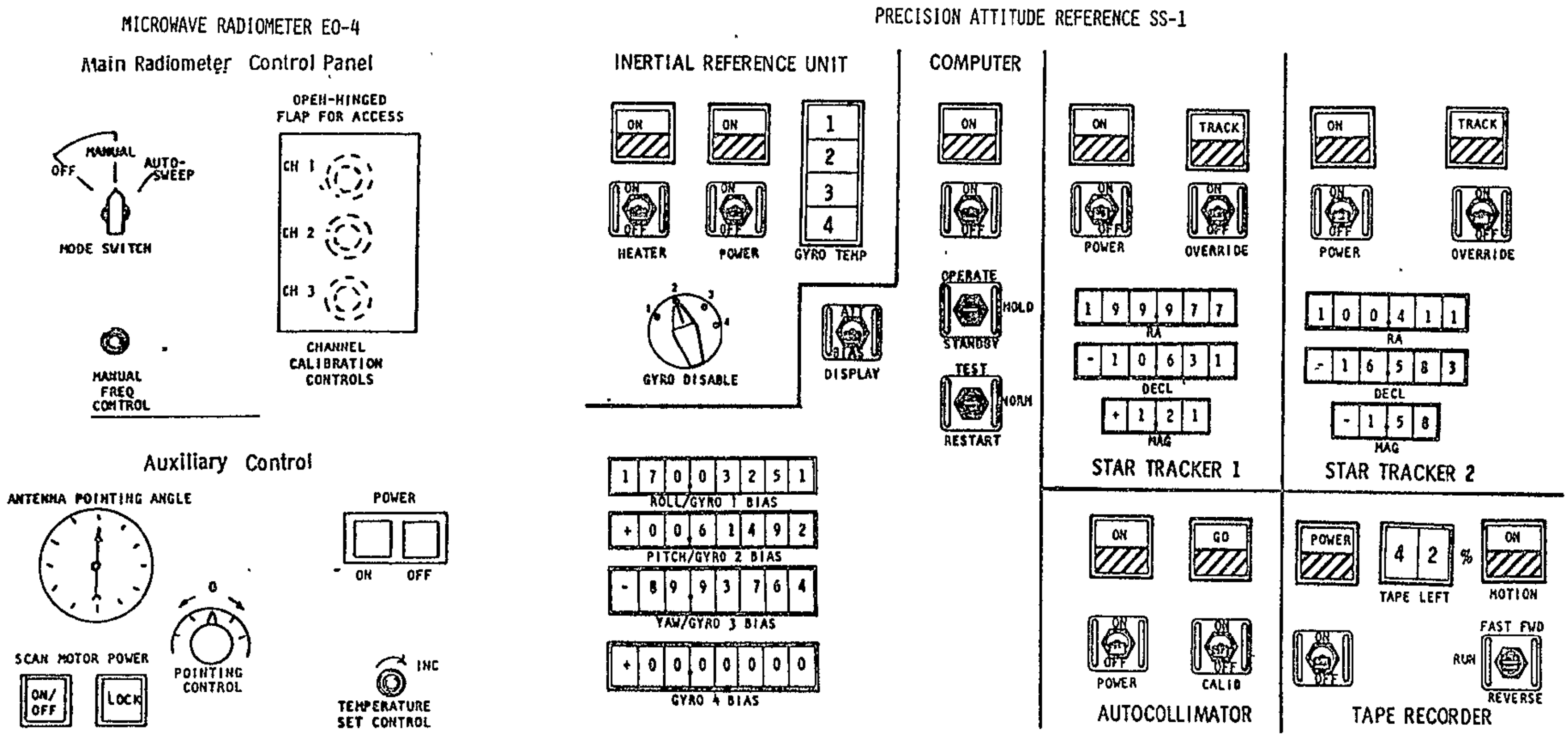
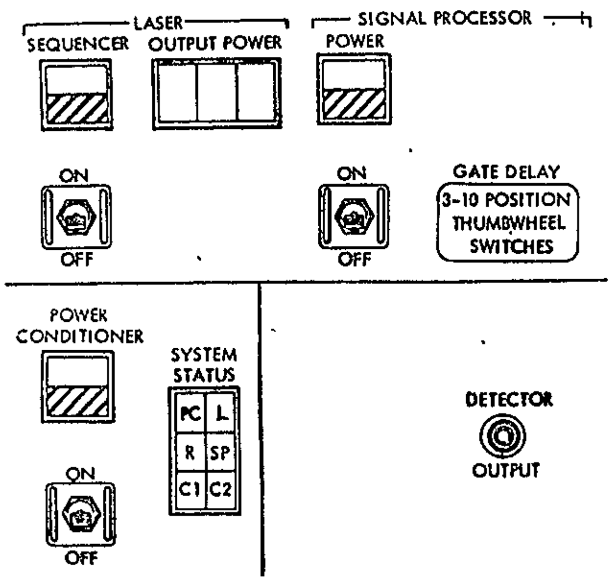


FIG V-15 A7 (1st ATL LAYOUT)

LIDAR MEASUREMENTS EO-1



AUTONOMOUS NAVIGATION-HORIZON SENSOR NV-4

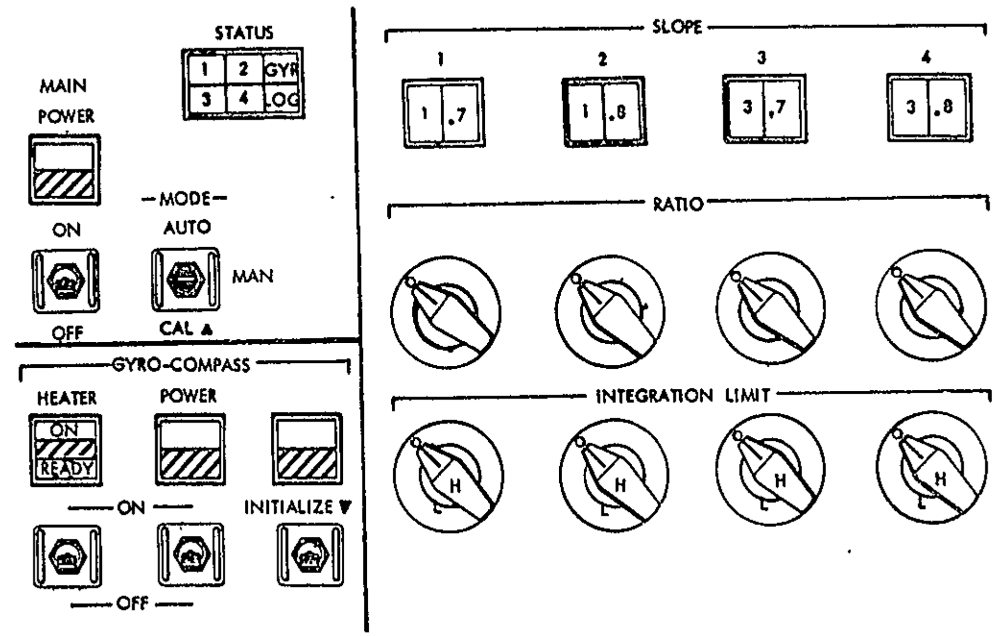


FIG V-16 L11 (1st ATL LAYOUT)

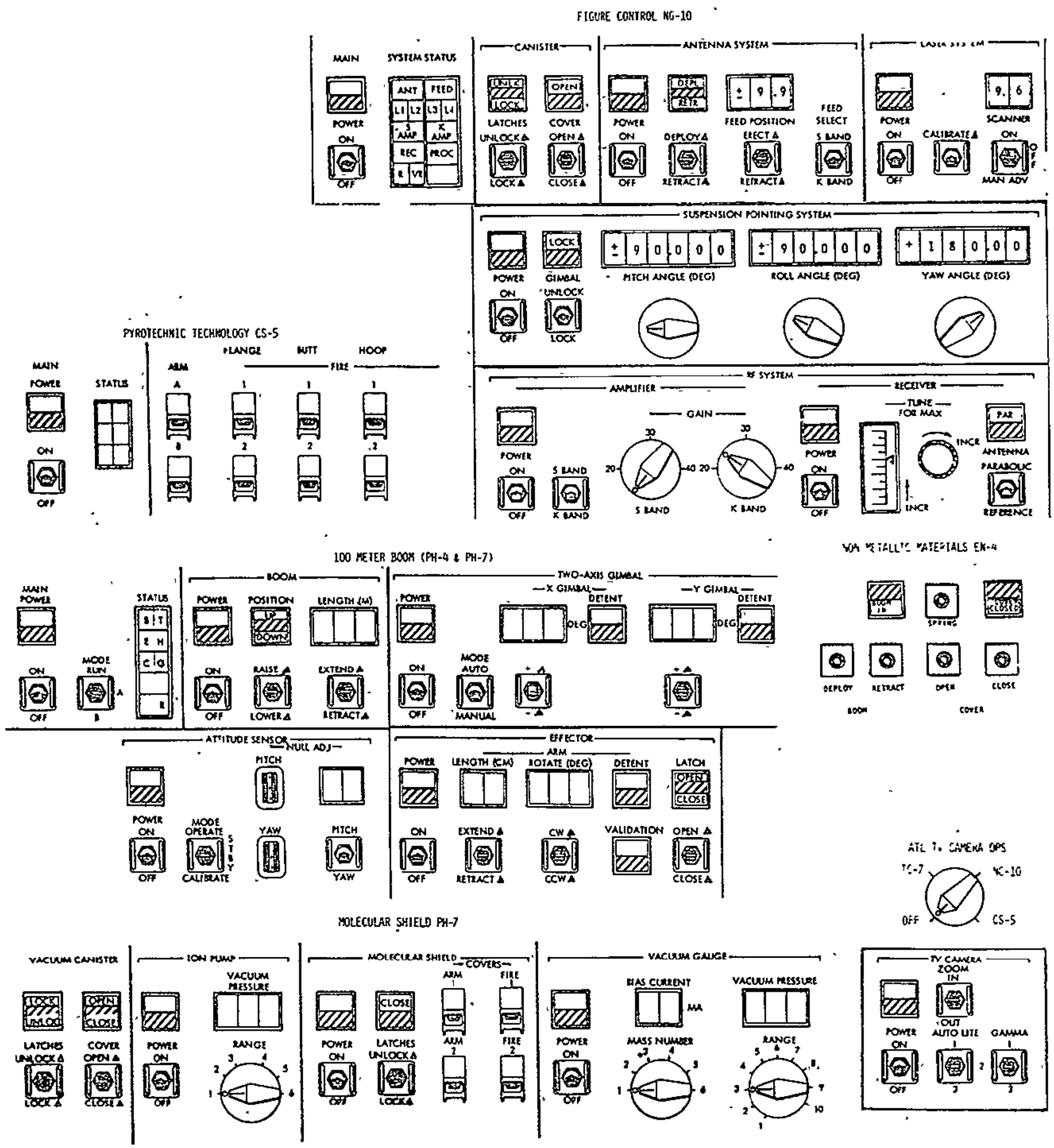
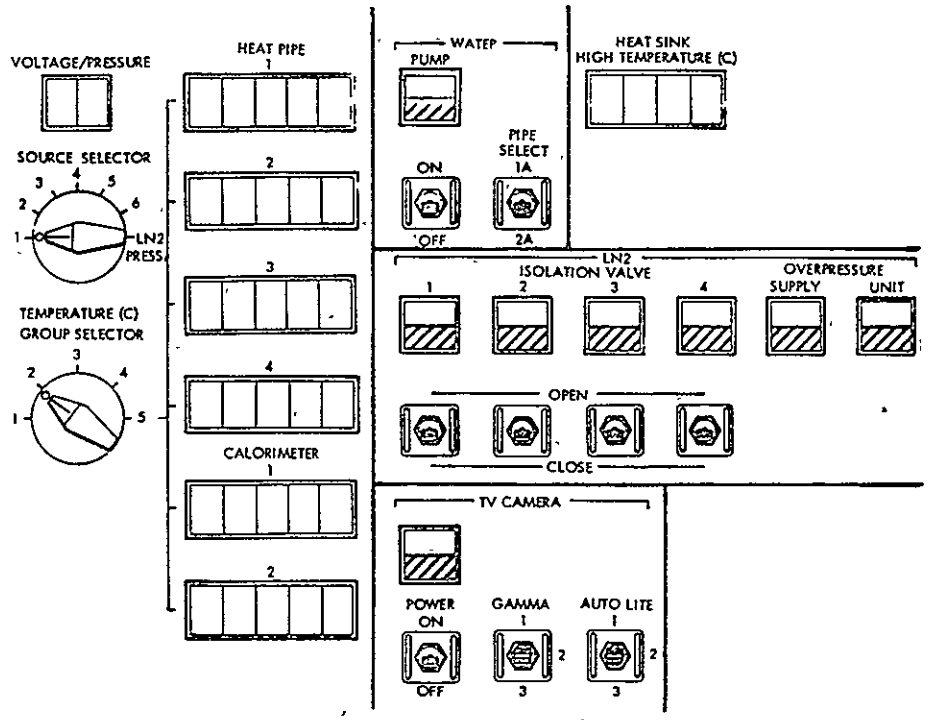
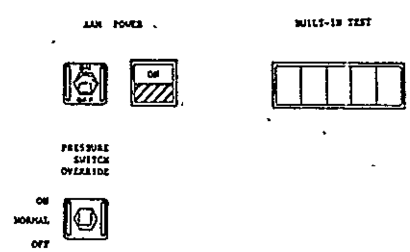


FIG V-17 L12 (1st ATL LAYOUT)

HIGH CONDUCTANCE HEAT PIPES TC-7



CONTAMINATION MONITOR CS-X



MOLECULAR BEAM PH-4

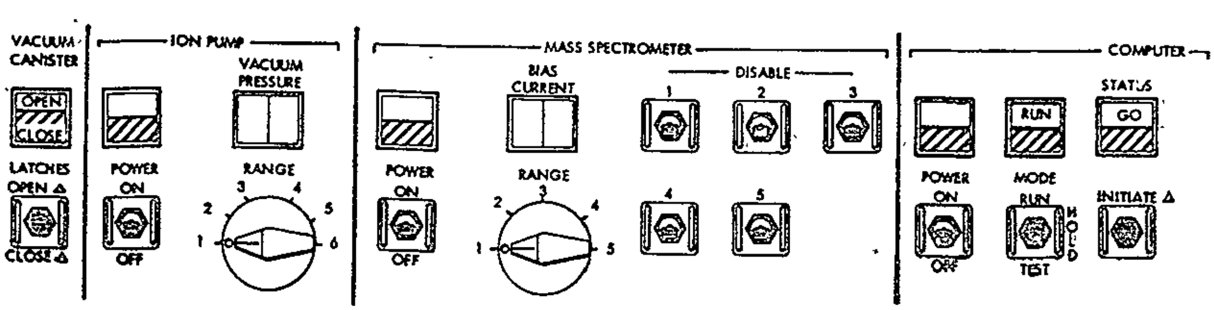


TABLE V-2

ATL PAYLOAD 3 - C & D ORBITER AFT STATION LAYOUT AND KB/CRT ALLOCATION

Exp.	Discrete C & D's - Panel	Spacelab KB/CRT - L10/R12
TC-7	Partial on Panel L12 with TV camera ops separated and shared with CS-5 and HG-10 on L11	Heat Pipe Power 1A, 1B, 1C, 2A, 2B, 2C - ON/OFF Voltage Inc/Dec for 6 above Calorimeter Power ON/OFF for 6 above Tape Recorder Ops
PH-4	Panel L12 (PH-4) NOTE - Shares 100m boom with PH-7	Computer Operations
	Boom C & D on Panel L11 (used for PH-4 and PH-7)	Tape Recorder Ops
PH-7	All on Panel L11 NOTE - Shares 100m boom with PH-4	None
CS-5	Partial on Panel L11 with TV camera ops separated and shared with TC-7 and NG-10 on L11	Movie Camera Operations Tape Recorder Ops
NG-10	Partial on Panel L11 with TV camera ops separated and shared with TC-7 and CS-5 on L11	Data Processor Operations Video Recorder Operations Tape Recorder Operations
CS-X	All on Panel L12	None
EN-3	All on Panel L11	None
EO-4	Panel A7 Lower Half NOTE - Operated parallel to TC-7 on L10	Temperature Monitor Channel Selection 1, 2 & 3 Voltage Selection Voltage Monitor
EO-1	Panel A6 Lower Half	Covers Open & Close Cameras Power & Frame Count Tape Recorder Ops
NV-4	Panel A7 Lower Half NOTE - Operated with SS-1 on A7	Sensor Power-ON/OFF 1, 2, 3, 4 Solar Exposure 1, 2, 3, 4 Tape Recorder Ops
SS-1	All on Panel A6 Lower Half NOTE - Operated with NV-4 on A6	None

The reevaluation was accomplished by using the initial C&D layouts, the timeline data (prepared for this evaluation), and the ATL experiment data package performance/operation and procedural outlines in a table top evaluation of each experiment operation and the associated Control and Displays.

The evaluation resulted in a rearrangement of the C&D panels and some minor changes in the allocation of C&D functions to the CRT and Keyboard.

These new C&D panel layouts were then used as a basis for the final review of the KB/CRT assignments.

a. Timeline Preparation

Prior to this reevaluation an overall mission/flight timeline was developed to identify the interaction based on mission objectives and orbital parameters. (See Figure V-18 for flight timeline.)

In addition, in order to appreciate the density of crew/experiment activities and operations and to determine specific crew function, a 4-hour detailed timeline segment was developed. (See Figure V-19 for detailed 4-hour timeline.)

Based on this timeline data, the responsibilities for experiment operations were divided as equally as practical between two payload operators upon which a reevaluation of C&D locations was made.

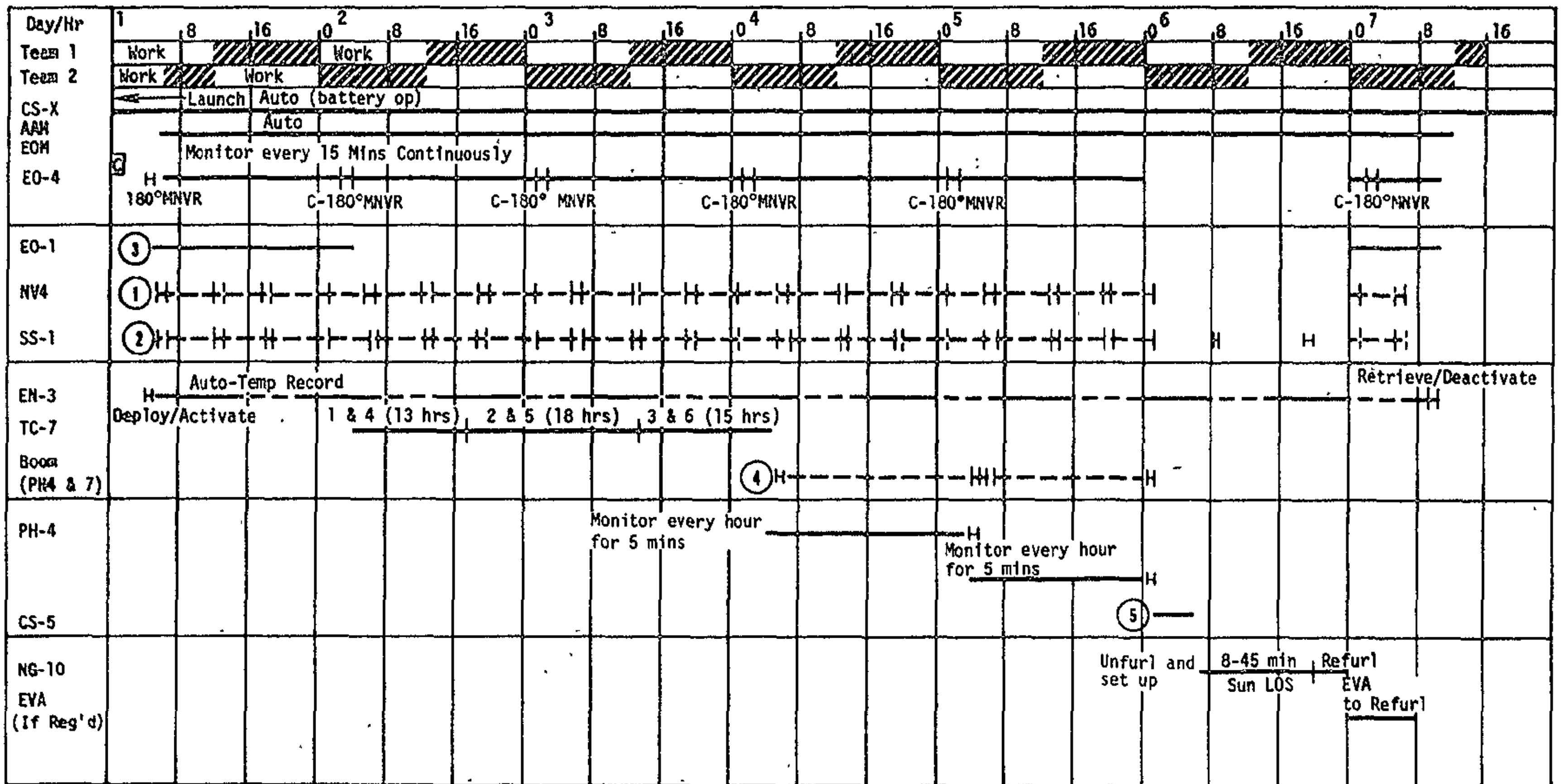
b. C&D Layout

The two basic categories/grouping of ATL experiments were unchanged following the new evaluation, although there was an interchange of C&D's between the Payload Station and On-Orbit Stations. The majority of CAT. I experiment C&D's were moved to A6 and A7 and the majority of CAT. II experiment C&D went to L10 and L12 with the Spacelab KB/CRT relocated at L11. (See Figures V-20, 21, and 22 for second ATL C&D layout.

The prime reasons for the relocations were:

1. Improved viewing of deploy and retrieve operations, out of the Orbiter aft windows and of the CCTV's.

FIG V-18 ATL - FLIGHT TIMELINE - PALLET PAYLOAD 3



C -Calibrate over land mass (20 Mins)
-180° Roll to Invert Orbiter

1 4° SCAN at Horizon accomplished by Orbiter attitude maneuvers (MNVRS)

2 Inertial Reference Unit (45 Mins) Align (4 per day)

3 Continuous laser firing with Orbiter Inverted for as long as inverted attitude is maintained

4 Orbiter attitude stabilized for cone pointing within 1° deg of flight vector

5 Requires 1 crewman

FIG V-19 ATL - DETAIL 4 HOUR TIMELINE

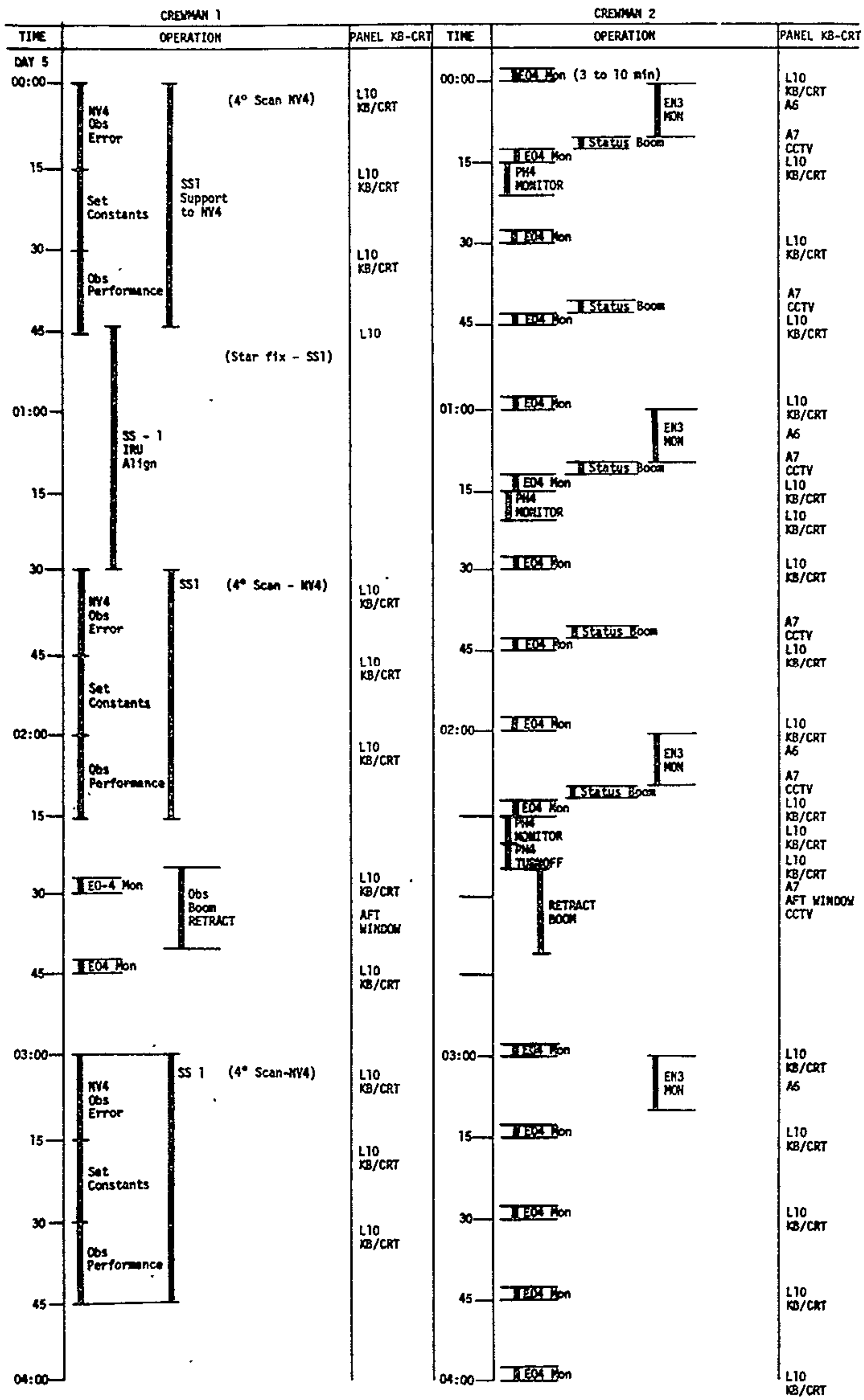
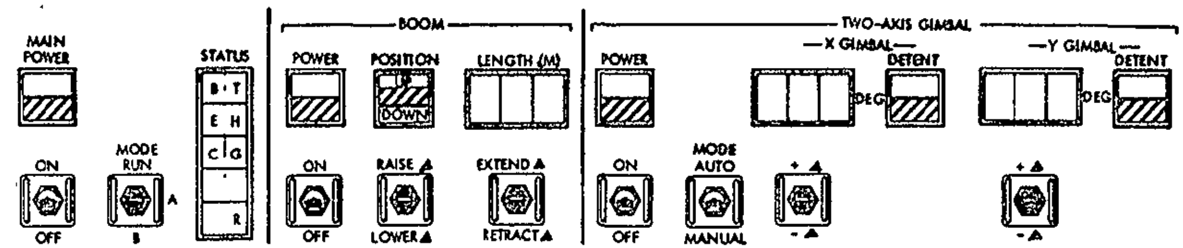
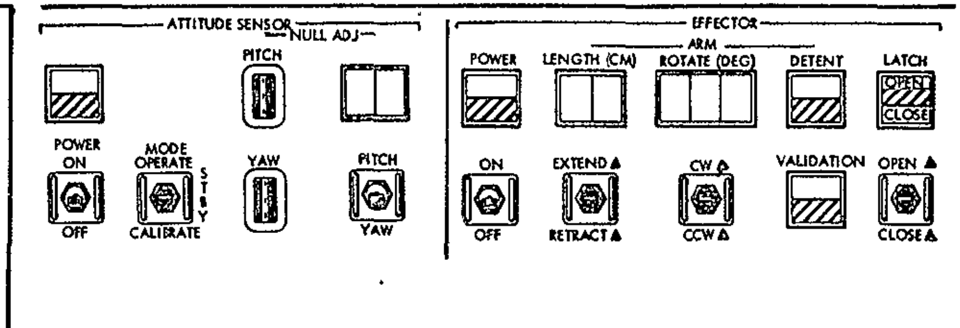


FIG V-20 A7 (ATL)

100 METER BOOM (PH4 & PH7)





PYROTECHNIC/EXPLOSIVE TECHNOLOGY CS-5

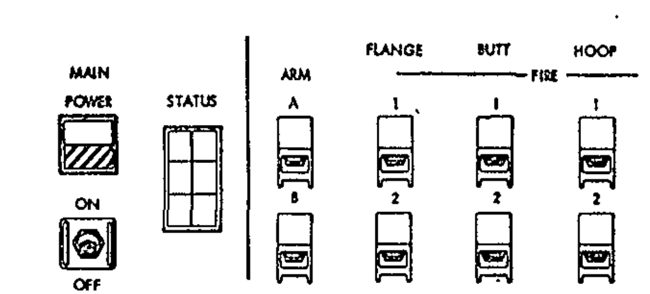


FIGURE CONTROL NG-10

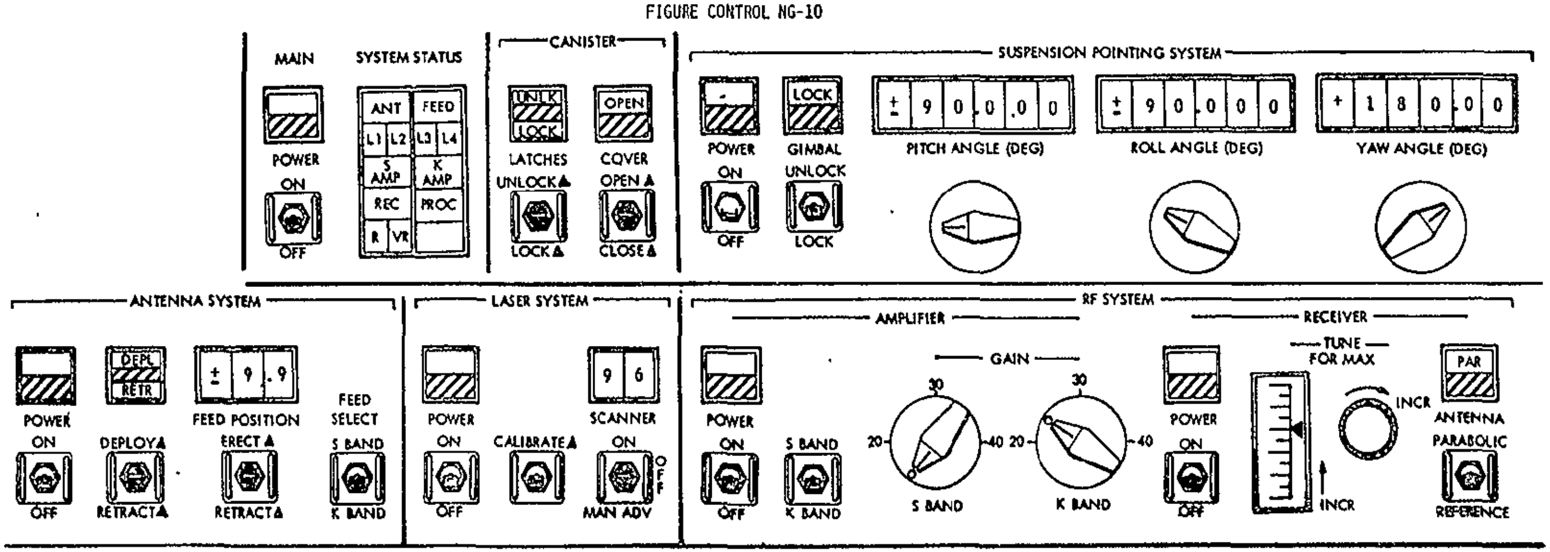


FIG V-21 A6 (ATL)

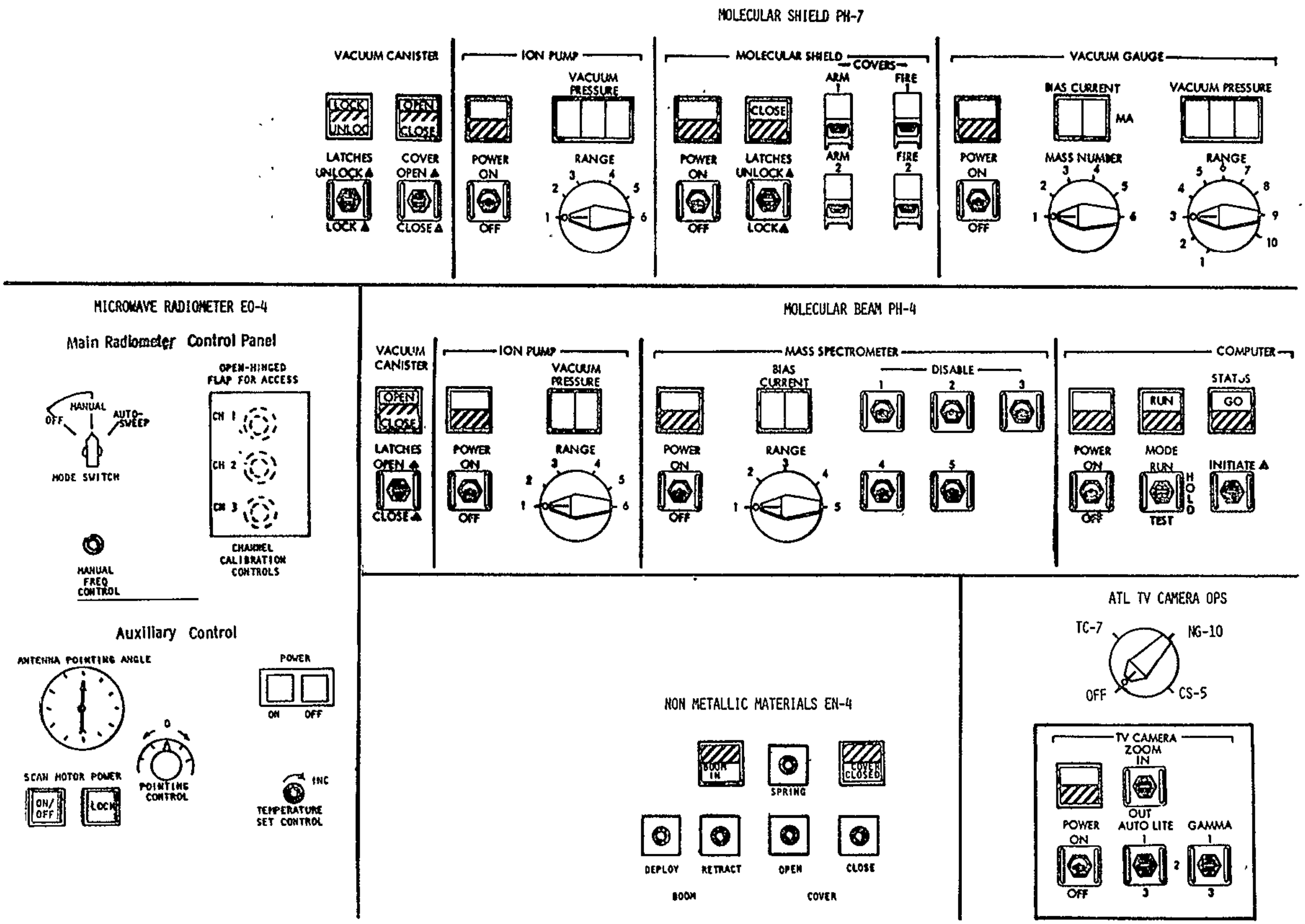


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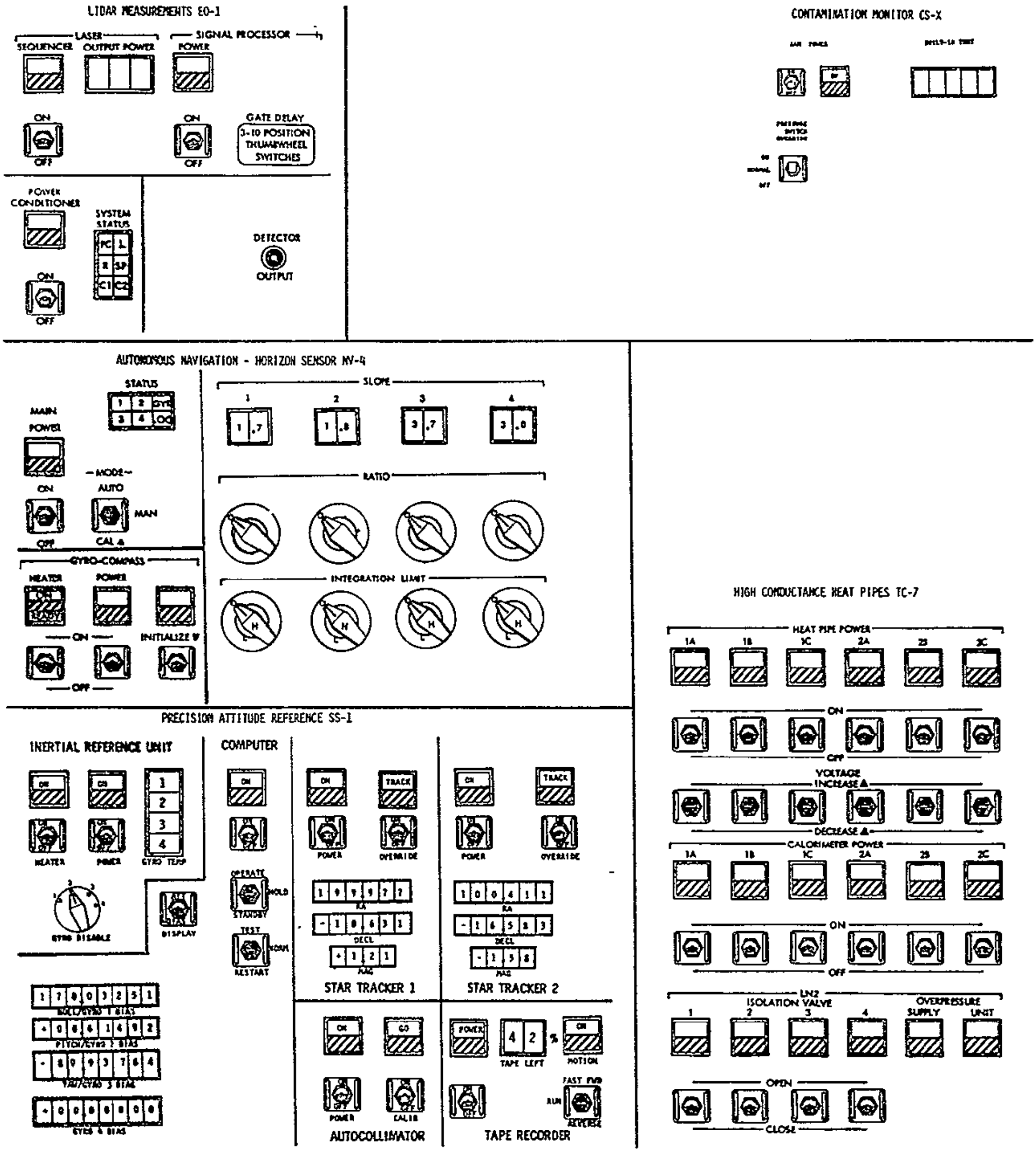
FIG V-22 L10 (ATL)



2. To locate experiment C&D operated by Crew two as close as possible to his "primary" work area at the Mission Statin. The On-Orbit station panels were looked upon as common operating areas for Crewman one and two. The C&D's Crewman one was likely to use was located on A7 closer to the Payload Station. These C&D arrangements minimized crew interference.

NOTE: The majority of ATL experiments contain a main power switch located in the proximity of the associated experiment controls and displays, however, the display indicators which might identify the requirement to kill power due to abnormal operation were not identifiable from the material available for this evaluation. There appears to be a considerable amount of experiment operations which might create the need to kill power, such as the inadvertent driving of a boom extension motor due to a short. Therefore, it would be highly desirable to have a centralized set of Main Power kill switches and alert indicators which would be lighted by an abnormal or malfunctioned state.

c. KB/CRT Operations Assignment

The initial selectin of the C&D's for KB/CRT function assignment was reviewed to identify additional candidates for KB/CRT.

The overall objective in the assignment of C&D panel functions to CRT and Keyboard functions was the optimization of the use of the CRT and Keyboard. This in turn hopefully enhances the operation, but also creates some integration and potential operational interference. To minimize interference and enhance operations the CRT and Keyboard must be used consistently for similar functions and such functions should not require frequent switching back and forth. The discrete C&D Panel, CRT, and Keyboard functions should compliment each other.

It is felt that as the techniques of KB/CRT utilization progress the criteria for separation of functions will become more fixed and consequently more acceptable. Such standard functions as status and monitoring will become highly automatic and will result in the display of a greater amount of data than from fixed hardware displays.

It should be remembered that the approach taken for the study of the ATL started with a concept of all displays and controls being hardware panels. Therefore, the design of the panels and the selection of the functions were based on implementing the functions, by existing hardware devices and not by software or a combination of software and hardware. So, it is highly likely that, if one started with the premise that a combination of software and hardware would be used, even the entire operational concepts of some of the experiments might be different and that some different functions would be identified. Thus, it should be remembered that an experiment level, "design-of-operation" may be necessary before a final set of C&D hardware functions and software functions are selected.

- The KB/CRT operations assignment review was based on a set of criteria which became longer during the evaluation. A summary list of the prime criteria used is as follows:

Assignment to KB/CRT Operations

- Displays for Status Monitoring
- Control of Peripheral Equipment
  - Data Recording
  - Video Recording
- Control of Data Processors and Micro Computer Operations
- Data Evaluation and Analysis

Retention for Panel Controls and Displays

- Discrete Controls Frequently Used
- Main Power ON-OFF Switches
- High Voltage Power Switches
- Analog - Slewing Operations
- Analog - Gain/Sensitivity Controls
- Rotational-Hand Controller Operations
- Deploy, Retrieve, Jettison Functions

3. Results of Final KB/CRT Review

The following list of controls and displays resulted from the table top review of the second set of C&D panels (see Table V-3).

TABLE V-3

ATL - PAYLOAD 3 - C & D
ORBITER AFT STATION LAYOUT AND KB/CRT ASSIGNMENT

Exp.	Discrete C & D's - Panel	Spacelab KB/CRT - L11/R12
SS-1	L10 Inertial Ref. Unit Star Tracker 1 Star Tracker 2	Computer Autocollimator Tape Recorder
NV-4	A6 Main Power ON-OFF Gyro Compass Slope Ratio Integration Limit	Sensor Power Solar Exposure Tape Recorder Status Ind Mode Switch
CS-X	L10 AAM Power Pressure Switch Override Built-in Test	None
EN-3	A6 Boom Deploy - Retract Cover Open - Close Spring	None
EO-4	A6 Mode Switch Manuel Freq. Ad. Channel Calib Controls Aut Pointing Angle Ind Pointing Control Scan Motor Power Power ON-OFF Temp Set Control	Brightness Temp. K Ind Channel Selector Voltage or Temp. (K) Ind Voltage or Temp. Selector
EO-1	L10 Power Cond ON-OFF System Status Laser Cont/Ind Detector Output	Covers Cameras Tape Recorders Signal Processor Cont/Ind
NG-10	L10 Main Power - ON-OFF Antenna System Suspension Pointing System A6 TV Camera Operation	Tape Recorder Data Processor Video Recorder System Status Ind Canister Latches and Cover Laser System

TABLE V-3 Continued

Exp.	Discrete C & D's - Panel	Spacelab KB/CRT - L11/R12
CS-5	A7 Main Power ON-OFF Status Indicators Pyro Arm and Fire Switches A6 TV Camera Operation	Tape Recorder Camera Controls
TC-7	L10 Heat Pipe Power (6) Voltage Calorimeter Power LN2 Operation A6 TV Camera Operation	Tape Recorder Voltage Pressure Indicator Source Selector Switch Temp Group Selector Heat Pipe and Calorimeter Indicator Water Control Heat Sink High Temp.
PH-4	A6 Vacuum Canister Latches Ion Pump Mass Spectrometer Computer Power ON-OFF Mode Switch Initiate Switch	Computer Operations Thumbwheel Switches
PH-7	A6 Vacuum Canister Latches and Cover Ion Pump Moleculor Shield Vacuum Gauge	None
100 Meter Boom	A7 Main Power ON-OFF Mode Status Ind. Boom Operate Two Axis Gimbal Attitude Sensor Effector	Tape Recorder

VI. CREW UTILIZATION

A. MISSION SPECIALIST ASSIGNMENT AND FUNCTION

In February 1976 Task 1 personnel were asked to review the Mission Specialists role and assignment with the various Payload Development Centers. In March the writer and Al Holt travelled to MSFC, GSFC, and LaRC and discussed the Mission Specialist's functions. The Mission Specialist's functions were later discussed with ARC personnel and the results of the initial disucssions presented at the STS/Payload Operations Steering Group Meeting (August 12, 1976). At that meeting each center was asked to review their understanding of the Mission Specialist's functions by center or payload project and return any comments. Since that meeting, considerable effort has been expended at JSC in the definition of a new set of crew function definitions. This activity should more effectively accomplish the Mission Specialist crew function objective of this study including the desired NASA-wide review and coordination. Thus, no additional work will be done in this study towards this objective.

B. CREW FUNCTIONS

The simulations conducted under the auspices of Task 1 provided a means to further evaluate crew functions for pallet only astronomy missions. The results of these simulations are detailed in Section IV. With a 3 facility payload employing telescopes of the UV classification like SUOT, DUST, and SUSS, it was apparent that the CDR and PLT could usefully support payload operations. The level of their support is dependent on their training, the number of CRT's and keyboards available at the AFD (by which the astronomy facilities and instruments are managed), the CDR and PLT Orbiter system workload, and the amount of support required for Orbiter and Spacelab system's management.

By involving the Commander and Pilot in payload operations ranging from assistance to operation and management of an instrument; a greater flexibility in payload scheduling, malfunction analyses, and crew utilization can be achieved. In particular the Mission Specialist would have more time to coordinate and plan overall payload operations. Both the Mission Specialist and Payload Specialist would have more time to devote to target selection and data analysis.

C. TIMELINE ANALYSIS BASED ON CRT/KEYBOARD AND CREW AVAILABILITY

An analysis was conducted using four different CRT/keyboard configurations for the Detailed UV Astronomy Payload. An operational sequence was selected which required the preparation for an Orbiter attitude maneuver, the maneuver, facility slewing, instrument initial setup and target acquisition, final setup and data taking. The three astronomy facilities used for the analysis were SUOT, SUSS, and DUST. Instrument exposures required were as follows:

SUSS	-	50 minutes
SUOT DIC	-	30 minutes concurrent with SUSS
SUOT PCS	-	6 minutes concurrent with SUSS, but following DIC
DUST	-	30 minutes followed by 6 minutes both concurrent with SUSS

1. Timelines

Timelines were generated for each of the following CRT/keyboard configurations:

1 CRT and 1 keyboard
1 CRT and 2 keyboards
2 CRT's and 2 keyboards
3 CRT's and 3 keyboards

These follow in Figures VI-1 through VI-4. The two and three CRT/keyboard configurations and their event sequences were used for the payload operations segment of the dedicated UV astronomy simulation. Additional details of this simulation may be reviewed in Appendix A.

2. Conditions and Constraints

The crew responsibilities for payload operations are largely dependent on the number os Spacelab computer terminals (CRT and keyboard) available at the Aft Flight Deck. Utilization of crewmembers for this analysis are shown in Table VI-1. Other conditions and constraints assumed for this analysis were as follows:

a. For the three CRT and keyboard configuration the Pilot and/or Commander would be sufficiently trained to manage DUST operations and the Pilot or Commander would be available when DUST operations were scheduled.

b. Slewing of the three facilities could be done concurrently.

c. The payload video (CCTV) system would permit target acquisition for the three facilities concurrently. This requires serial routing of the facility sensors. SUOT's Finder Telescope and PCS Slit image require simultaneous display.

d. Locations of the Spacelab CRT's and keyboards for the four configurations are:

(1) 1 CRT/keyboard - Panel L11
(2) 1 CRT/2 keyboards - Panel L11, second keyboard on L10
(3) 2 CRT's/2 keyboards - Panels L10 and L11
(4) 3 CRT's/3 keyboards - Panels L10, L11, and R12

e. Facility slewing constraints are:

(1) When SUOT DIC operating - no slewing of DUST or SUSS

(2) When SUOT PIC operating - no slewing of DUST or SUSS

(3) When SUOT PCS operating - slewing of DUST and SUSS okay

FIG VI-1 STELLAR UV ASTRONOMY COMBINED SEQUENCE - 1 CRT/KYBD

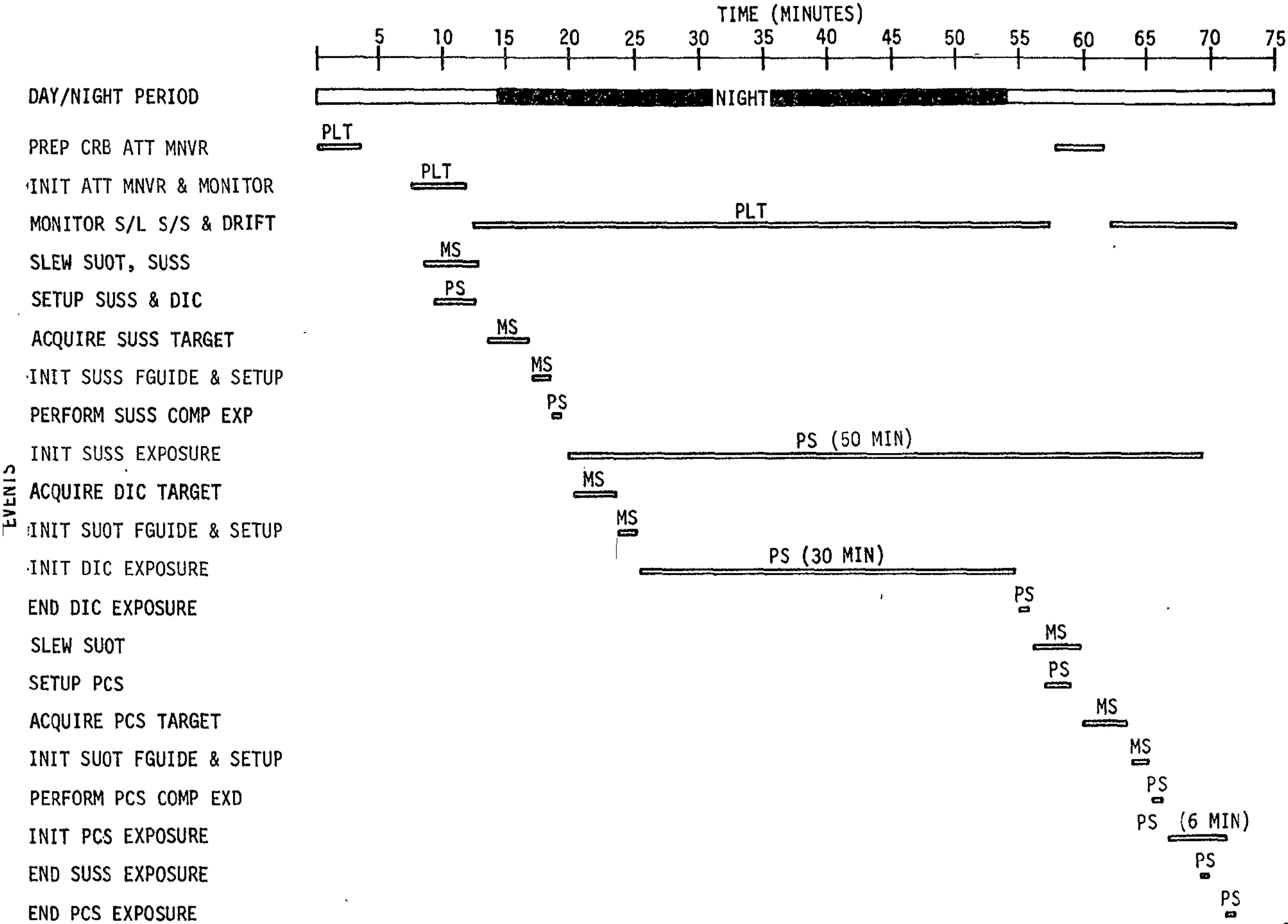


FIG VI-2 STELLAR UV ASTRONOMY COMBINED SEQUENCE - 1 CRT/2 KYBD'S

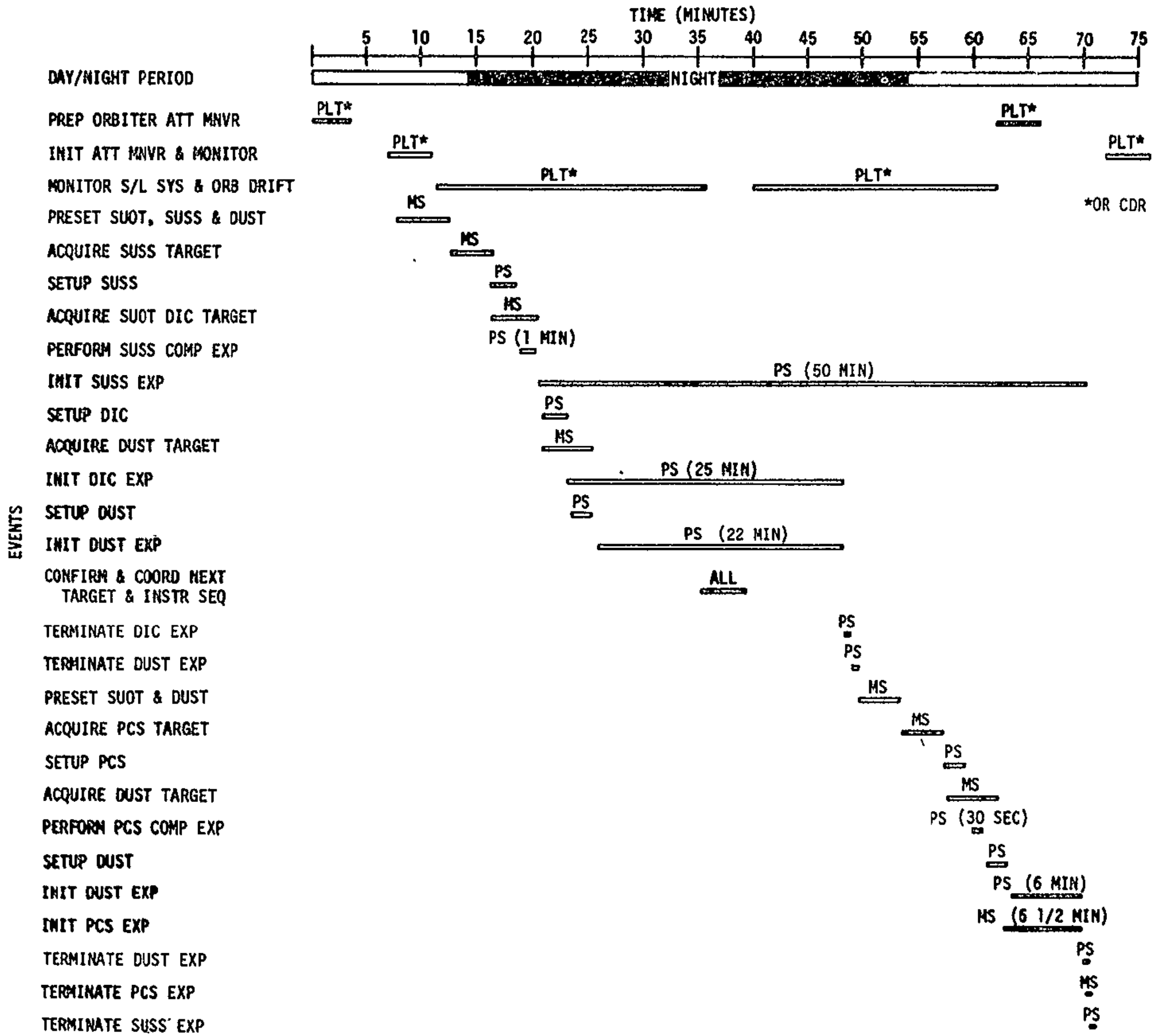


FIG VI-3 STELLAR UV ASTRONOMY COMBINED SEQUENCE - 2 CRT/KYBD'S

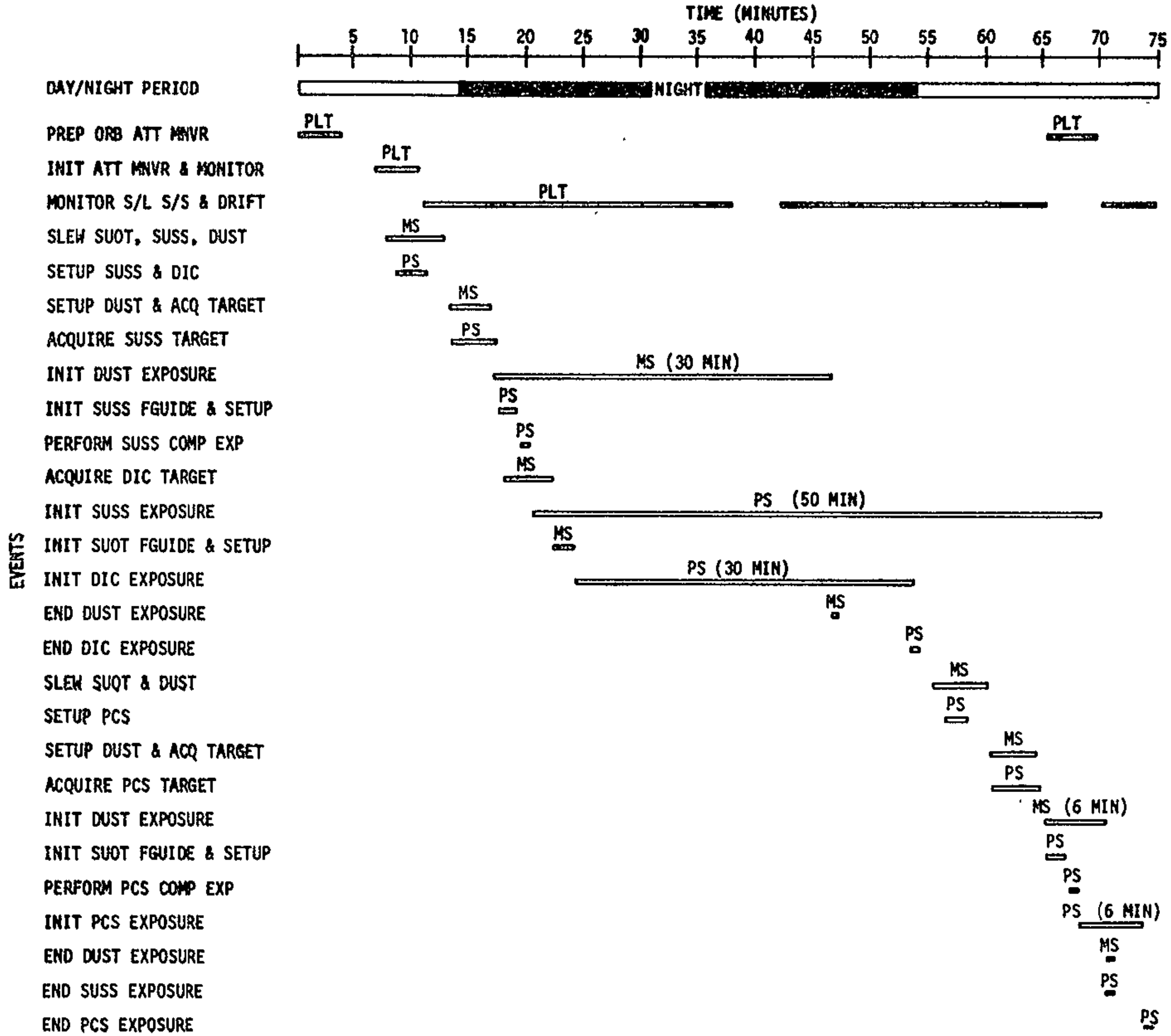


FIG VI-4 STELLAR UV ASTRONOMY COMBINED SEQUENCE - 3 CRT/KYBD'S

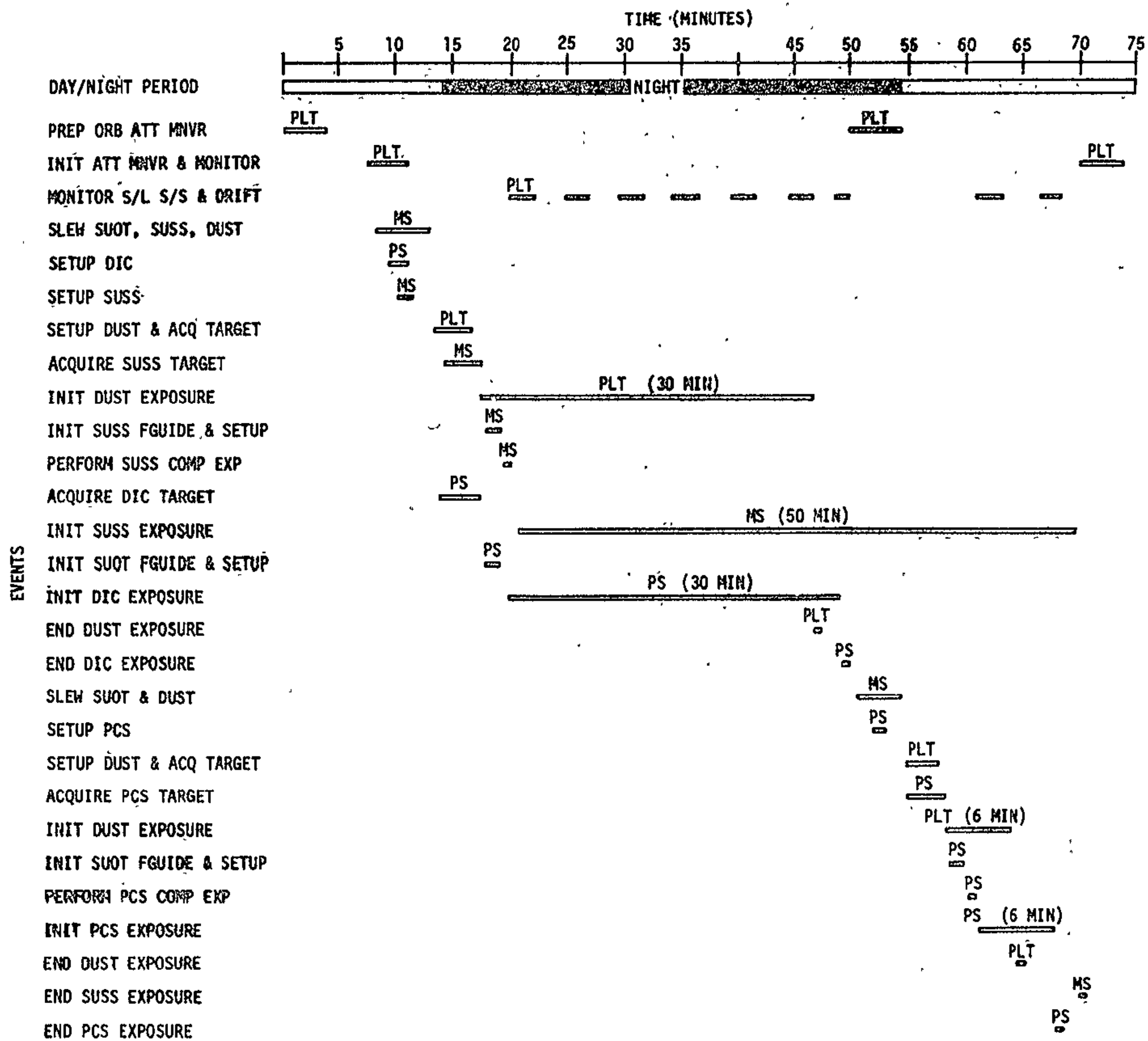


TABLE VI-1 CREW UTILIZATION FOR DEDICATED UV ASTRONOMY SEQUENCE

CONTROL & DISPLAY CONFIGURATION	CREW	ORB ATT MNVRS	PAYLOAD FUNCTIONS: FACILITY (COARSE) SLEWING	OVERALL COORD	SUOT FACILITY MGT	SUOT DIC TARGET ACQ*	SUOT DIC MGT	SUOT PCS TARGET ACQ*	SUOT PCS MGT	SUSS TARGET ACQ*	SUSS MGT	DUST TARGET ACQ*	DUST MGT
1 CRT & 1 KYBD	CDR/PLT	X											
	MS		X	X	X	X		X		X		X	
	PS						X		X		X		X
1 CRT & 2 KYBD's	CDR/PLT	X											
	MS		X	X	X	X		X	1	X		X	
	PS						X		2		X		X
2 CRT'S & 2 KYBD's	CDR/PLT	X											
	MS		X	X	X	3						X	X
	PS					4	X	X	X	X	X		
3 CRT'S & 3 KYBD'S	CDR/PLT	X										X	X
	MS		5	X	X					X	X		
	PS					X	X	X	X				

NOTES:

1. When concurrent with DUST & SUSS exposures.
2. All other cases.
3. When concurrent with or overlapping DUST & SUSS exposures.
4. All other cases.
5. Concurrent slewing of 3 facilities; slewing by facility/instrument manager may be preferable in all other cases with cognizance of MS.

*Target acquisition includes 2 degrees of fine pointing for SUOT and refers to the simple fine pointing for SUSS and DUST.

(4) When SUOT FUS operating - slewing of DUST and SUSS okay

(5) When DUST operating - slewing of SUOT and SUSS should be minimized

(6) When SUSS operating - slewing of SUOT and SUSS okay

3. Results and Conclusions

Results of this paper analysis were verified dur tion. The configuration of one CRT with one or two keyboards does not permit efficient usage of the three facilities and data collection is sacrificed. Although the one CRT/two keyboard configuration permits computer commands required for concurrent operation of the three facilities, statusing of these facilities and the SUOT instruments is difficult with a single CRT. Should a payload contingency arise which may require correcting or monitoring via the experiment terminal, the CRT would be monopolized for this purpose. The three CRT/keyboard configuration with the Commander or Pilot managing DUST allows the Mission Specialist more time to plan and coordinate overall activities. It is further apparent that when contingencies arise he would be better able to react with a lesser penalty to scientific data collection than would be expected with the other configuratior

For the first portion of this analysis all instrument exposure periods were fixed for each of the CRT/keyboard configurations. These are shown in Table VI-2. Times are not included for the one CRT/two keyboard configuration combined facility operating sequence because this configuration is not acceptable for reasons cited above. Data collection for one CRT/one keyboard mode would require the SUOT instrument and DUST to be operated alternately. The table reflects the mission time consumed for each CRT/keyboard configuration. These figures indicate a 4-minute savings on the timeline by adding the third CRT/keyboard. However, because data exposure periods were predefined (constant) the mission time is the only measurable variable reflecting the three CRT/keyboard advantage.

For this reason a second analysis was conducted to determine the maximum data collection time in a fixed mission period for each of the CRT/keyboard configurations. The mission time selected was 71 minutes. The DIC and initial DUST exposure periods of 30 minutes wereheld constant based on known operating requirements of the instruments and 50 minutes was targeted for SUSS if attainable within the 71 minute timeline. Slewing, target acquisition, and instrument setup times were equated by instrument for each configuration. The resulting deltas were then derived from the maximum permissible operating times remaining for the second DUST and PCS exposures.

TABLE VI-2 MISSION TIME REQUIRED FOR FIXED EXPOSURE PERIODS

FACILITY/ INSTRUMENTS \ C & D CONFIG.	1 CRT 1 KYBD	2 CRT'S 2 KYBD'S	3 CRT'S 3 KYBD'S
SUSS	50'	50'	50'
SUOT DIC	30'	30'	30'
SUOT PCS	6'	6'	6'
DUST - 1st EXP	---	30'	30'
DUST - 2nd EXP	---	6'	6'
TOTAL INSTR DATA	86'	122'	122'
MISSION TIME	73'	75'	71'

TABLE VI-3 INSTRUMENT EXPOSURE FOR FIXED MISSION PERIOD

C & D CONFIG.	1 CRT 1 KYBD	2 CRT'S 2 KYBD'S	3 CRT'S 3 KYBD'S
SUSS	50'	50'	50'
SUOT DIC	30'	30'	30'
SUOT PCS	5'	3'	9'
DUST - 1st EXP	---	30'	30'
DUST - 2nd EXP	---	5'	12'
TOTAL INSTR DATA	85'	118' *	131' *
MISSION TIME	71'	71'	71'

*Can be substantially increased if slewing constraints are relaxed and targets of opportunity exposures are maximized.

Table VI-3 depicts the results of the fixed mission period analysis. Exposure time is increased approximately 33 minutes or 39 percent by adding a one CRT and keyboard and 46 minutes or 54 percent by the addition of two terminals. If the facility slewing constraints are relaxed and targets of opportunity are maximized, the exposure time could increase to 75-100 percent for the two CRT/keyboard combinations.

VII. RECOMMENDATIONS FOR FUTURE STUDIES AND SIMULATIONS

A. FUTURE STUDIES

1. What redundant control and monitoring is required for safety and reliability reasons? How would this redundancy affect C&D designs?

2. Will avionics interfaces require changes in the location of C&D including the portable pointing controller?

3. Based on the SUOT/SUSS/DUST payload, how many wires are required for C&D at the On-Orbit Station? Are these wires available? Is any cooling required?

4. Is there a significant cost and reliability difference associated with utilizing smaller switches and indicators for payload operations than the standard Orbiter type switches?

5. How often will Orbiter attitude hold or free drift mode have to be reinitialized and how do the reinitializations affect payload operations?

6. Can star fields be stored in the Spacelab experiment computer and overlayed over payload video on the CCTV's? What additional interfaces would be required?

7. To what extent does the use of an interactive computer language, such as FORTH, optimize payload operations?

B. FUTURE SIMULATIONS

1. Select payloads involving different payload support elements such as an Interim Upper Stage (IUS), Multimodular Spacecraft (MMS), and a Spacelab module and pallet.

2. Select payloads such as the Shuttle Infrared Telescope Facility which are complex, potentially require substantial crew interactions, and/or require unique support equipment such as a cryogen supply system.

3. Simulate flight periods of 1-1/2 orbits or more with realistic data downlink and voice communication periods included.

4. Utilize working event timers and GMT clock in the Orbiter aft crew station.

5. Utilize Commander and Pilot couch mockups which are more representative of the latest design for Orbiter 102.

6. Utilize Orbiter restraint devices such as suction cups for the feet to help determine optimum location and use of C&D.

7. For the Advanced Technology Laboratory payload, determine if a second Spacelab CRT and keyboard is required, highly desirable, or desirable for payload operations. Could additional experiments be added if a second CRT and keyboard are available?

TASK 1 FINAL REPORT

APPENDIX A

DEDICATED UV ASTRONOMY SIMULATION DATA

APPENDIX A - DEDICATED UV ASTRONOMY SIMULATION

A. PAYLOAD CONFIGURATION

Payload consisted of three stellar astronomy facilities -

SUOT - Spacelab UV Optical Telescope
DUST - Deep Sky UV Survey Telescope
SUSS - Shuttle UV Stellar Spectrograph

1. SUOT

    a. SUOT occupied Pallets 4 and 5.

    b. This facility contains 4 instruments which are:

        DIC - Direct Imaging Camera
        PCS - Precisely Calibrated Spectrophotometer
        FUS - Far UV Spectrograph
        PIC - Planetary Imaging Camera

    c. A Finder Telescope mounted external to the facility and an Acquisition Camera mounted internally are used for target acquisition, verification and fine pointing.

    d. SUOT utilizes the IPS for pointing.

2. DUST

    a. DUST occupied Pallet 3.

    b. DUST contains one instrument which is the facility itself.

    c. The facility has no active mirrors and all pointing is accomplished by the platform gimbats.

    d. A Finder Telescope is used for target acquisition, verification and alignment.

3. SUSS

    a. Occupied Pallet 2.

    b. Contains one instrument which is the facility itself.

    c. Utilizes Finder Telescope for target acquisition, verification and alignment.

3. 101 CDR and PLT couches used; ejection tracks were removed.

4. Payload Operating Control and Display layouts were developed for AFD Panels L10, L11, L12, R12 and available portions of A6 and A7.

5. Audio junction units installed and used with earpiece, mike and cord - 3 at AFD & 1 each at CDR and PLT forward cockpit positions.

6. Amplifier, speaker and mike positioned external to Orbiter Mockup.

7. A fluorescent light was installed above both the Mission and Payload Stations.

8. Proceedings were tape recorded.

D. OPERATIONS

1. Crew complement - PLT, MS & PS

2. Simulated events were:

   a. CCTV activation and operation with P/L cameras (incl. P/L lighting).

   b. SUOT, DUST & SUSS C/O, mirror metering, mating, deployment and restatus.

   c. Attitude maneuvering, CCTV P/L video input setup, facility slewing, target acquisition and combined instrument data collection (event time approx. 75 min).

3. Operations were simulated for both a 2 and 3 CRT/keyboard configuration.

   a. 1st run - CRT/kybds at L11 and R12

   b. 2nd run - CRT/kybds at L10, L11 and R12

4. Detailed procedures used for all events in 2 above, except attitude maneuvering.

5. Event sequence used as a guide for the assignment and timing of activities.

E. PERSONNEL

1. Dr. Karl Henize/JSC - MS

2. Dr. Ted Gull/LEC - PS

3. Dave Peterson/JSC - PLT - 1st run

B. SIMULATION OBJECTIVES

1. Evaluate the Mission and Payload Stations for:

   a. The more efficient assignment of displays and controls

   b. The more efficient utilization by the Mission and Payload Specialist in performing both sequential and concurrent activities.

2. Evaluate displays and controls for:

   a. Design (including size)

   b. Frequency of usage

   c. Location with respect to other functionally related displays and controls

   d. Location for convenient access with respect to the assigned crewman's location during various mission phases

   e. Redundancy with potential keyboard commanded and CRT generated functions

3. Evaluate the overall flight deck layout for the optimum number, utilization and location of crewmen during Spacelab activation and operational sequences.

4. Evaluate preliminary procedures for selected Spacelab systems and payload operational sequences for:

   a. Assignment of tasks relative to current crew skill and speciality groundrules

   b. Tasks which may more efficiently be conducted by 1 vs. 2 or more crewmen

   c. Preferred crew location and panel selection

   d. Gross time for completion

C. FACILITIES AND PROVISIONS

1. Simulation was conducted in Building 9A Orbiter Mockup on May 17 & 18.

2. 102 drawings were used to simulate forward and aft flight deck control and display configurations.

4. Bill Carmean/MCC - Test Conductor - 1st run
   PLT - 2nd run

5. Al Holt/JSC - Test Monitor - 1st run
   Test Conductor - 2nd run

6. John Smialek/MCC - Test Monitor

F. CONTROL AND DISPLAY CONFIGURATIONS

1. Figure A-1 illustrates the Spacelab CRT and keyboard configuration at Panels L11 and R12 for the 1st simulation run and at Panels L10, L11 and R12 for the 2nd simulation run.

2. Figures A-2 and A-3 depict Panels L10 and L12 respectively, used for the 1st simulation run.

3. Figure A-4 depicts the subpanel configuration at Panel A7 which was used for the 1st simulation run.

4. Figure A-5 and A-6 represent the subpanels used on Panels A6 and A7 respectively for 2nd simulation run.

5. Figure A-7 shows layout for Panel 12 used for the 2nd simulation run.

G. TIMELINE

Timelines were developed for both the 2 and 3 CRT/keyboard configurations and these, along with the event sequence, were used as a guide for crew assignments and gross time allotment during the simulation. Figure VI-3 in Section VI contains the 2 CRT/keyboard timeline. For this configuration on the Pilot performed attitude maneuvers, monitored Orbiter drift and managed the Spacelab subsystems. He was not directly involved with payload operations. The MS slewed the facilities, coordinated overall payload operations, managed the SUOT facility (not instruments), acquired DUST targets and managed the instrument, and acquired targets for the SUOT DIC instrument when performed concurrently with SUSS and DUST operations. Other SUOT instrument and SUSS management functions were performed by the PS. (These assignments may be reviewed in Table VI-1, Section VI of this report.)

Time for accomplishment of the major events were grossly maintained during the simulation and resulted in about a 10% reduction of the estimates expressed in Figures VI-3 (Section VI).

The timeline for the 3 CRT/keyboard configuration was shown in Figure VI-4. (Crew assignments during the simulation are identified in Table VI-1.) For this configuration the PLT assumed responsibility for DUST management including target acquisition in addition to his Orbiter attitude maneuvering and Spacelab subsystems management duties. It was assumed the CDR had equal payload proficiency and would have performed these functions had these events been scheduled for a second shift. As in the 2 CRT/keyboard

Fig A-1 Spacelab CRT & Keyboard

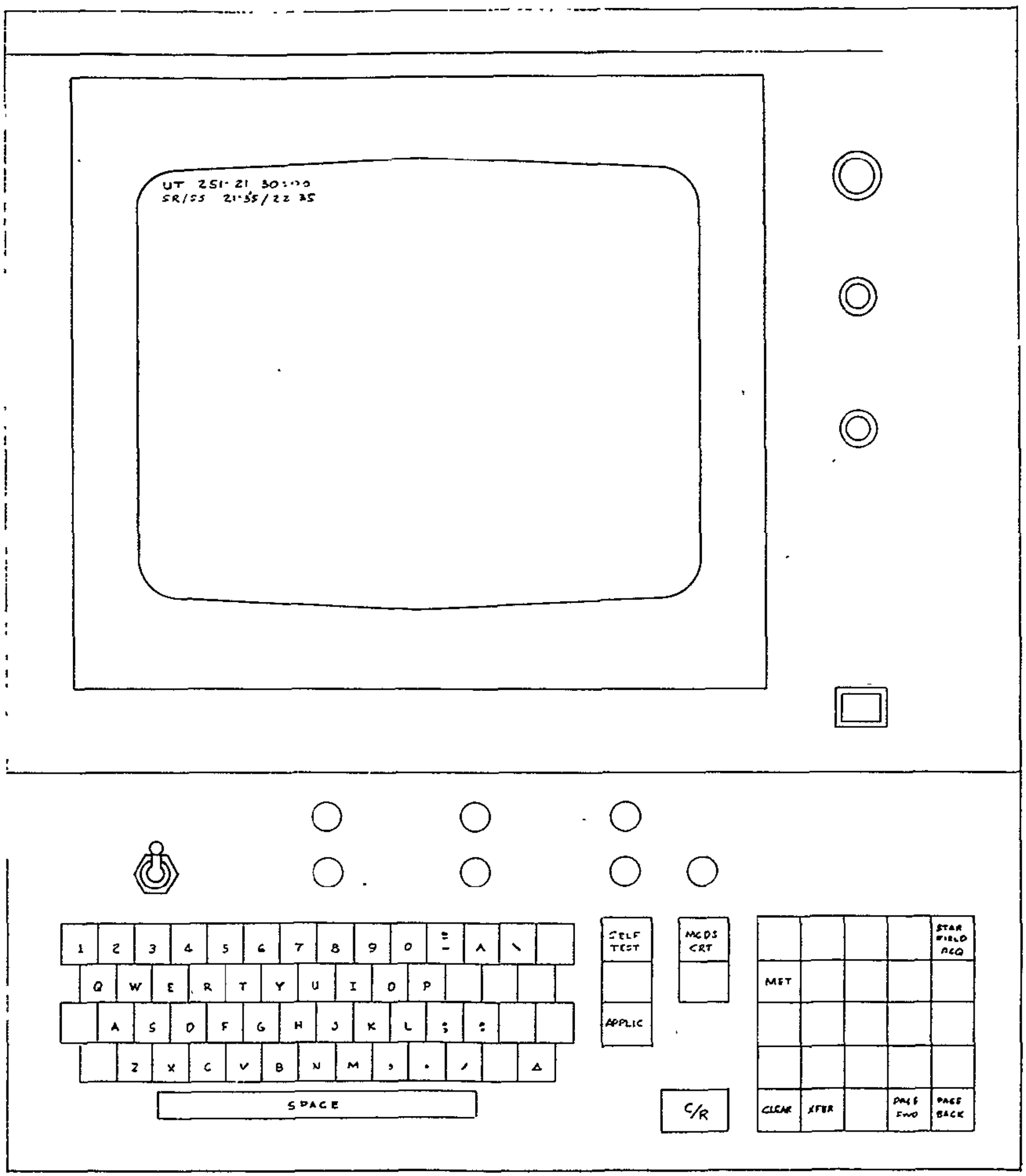


Fig A-2 Payload Unique C & D
(Used During 1st Portion of Dedicated UV Astronomy Sim)

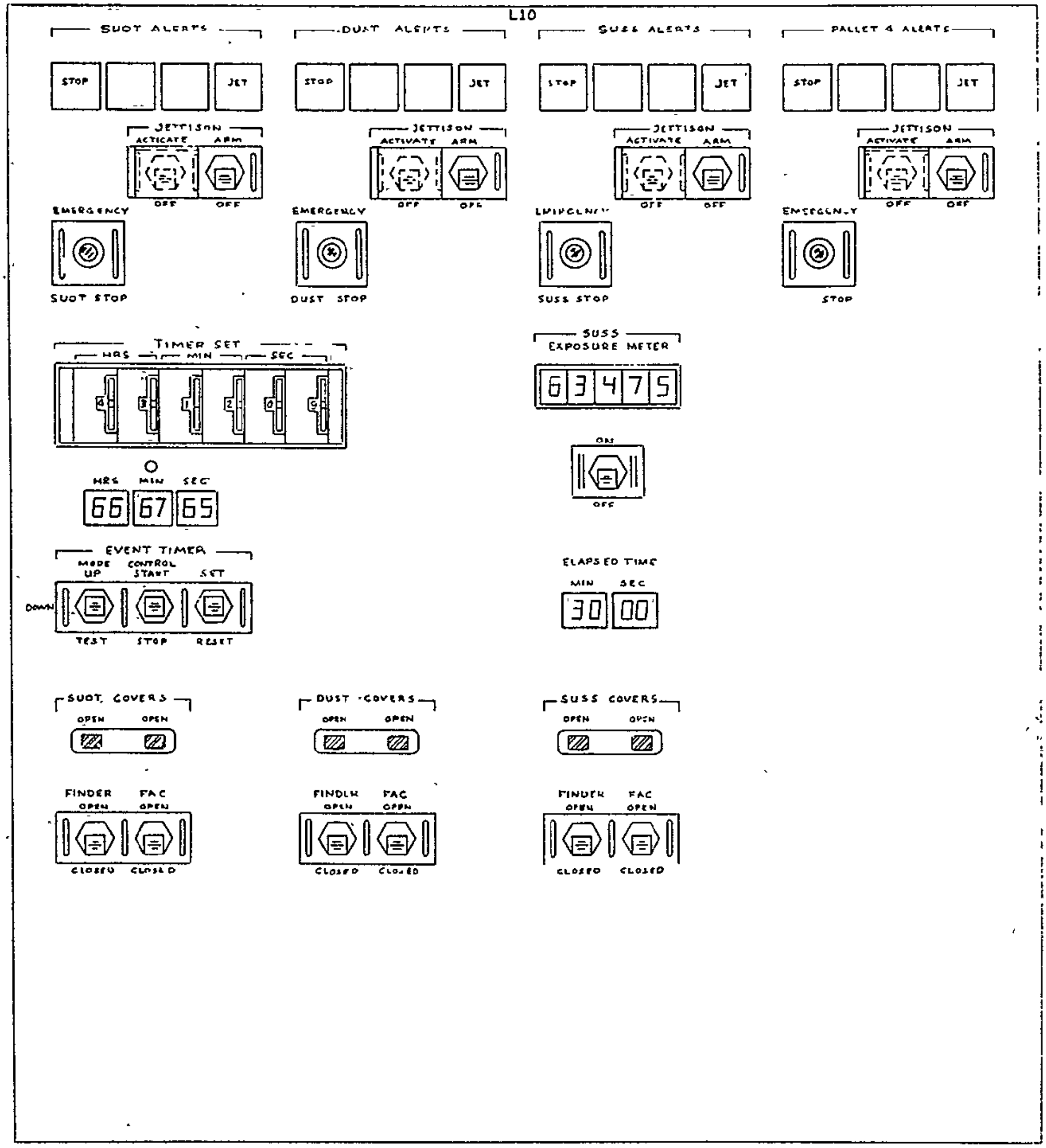


Fig A-3 Payload Unique C & D
(Used During 1st Portion of Dedicated UV Astronomy Sim)

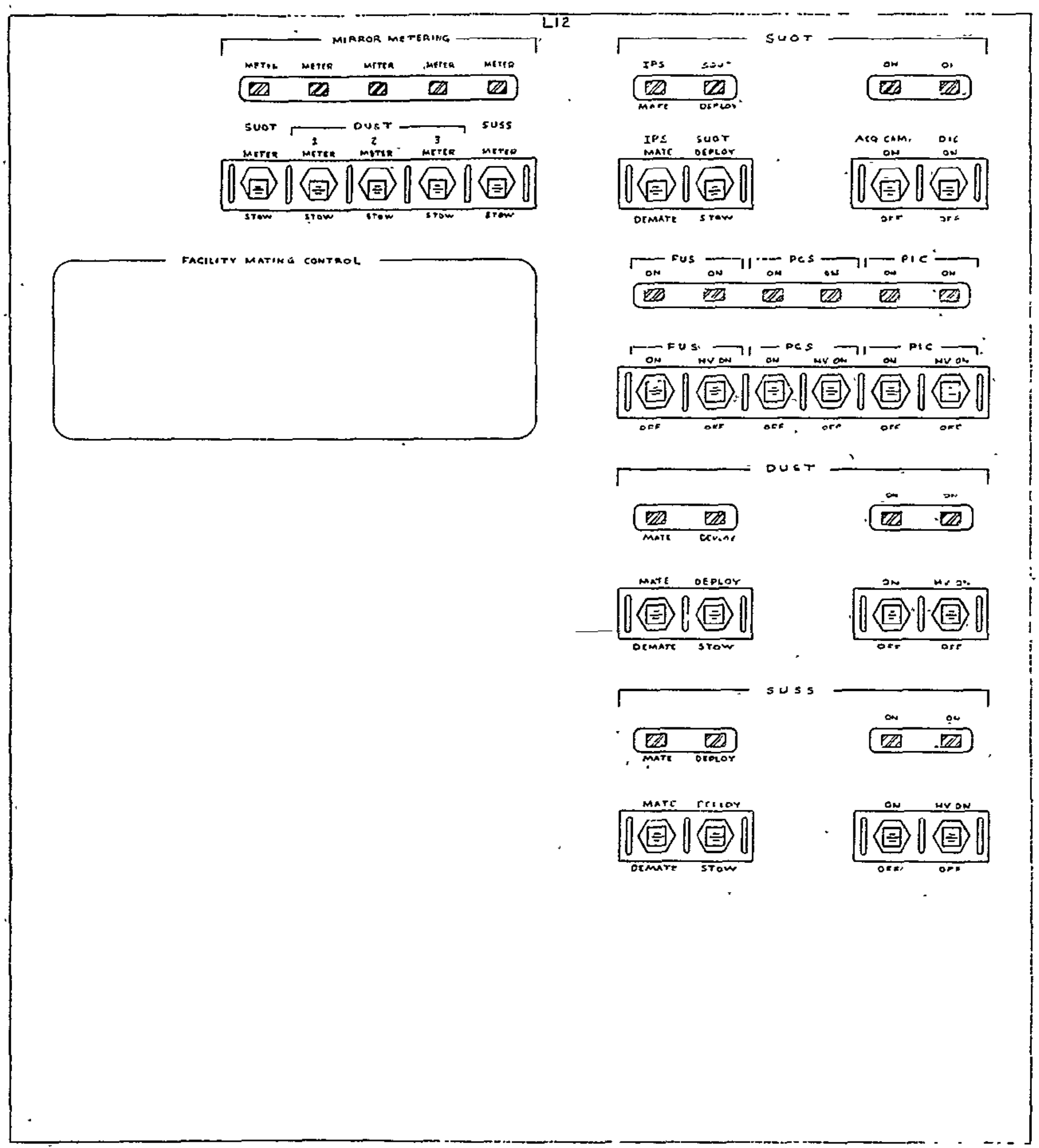


Fig A-4 Instrument Position Display
(Used During 1st Portion or Dedicated UV Astronomy Sim)

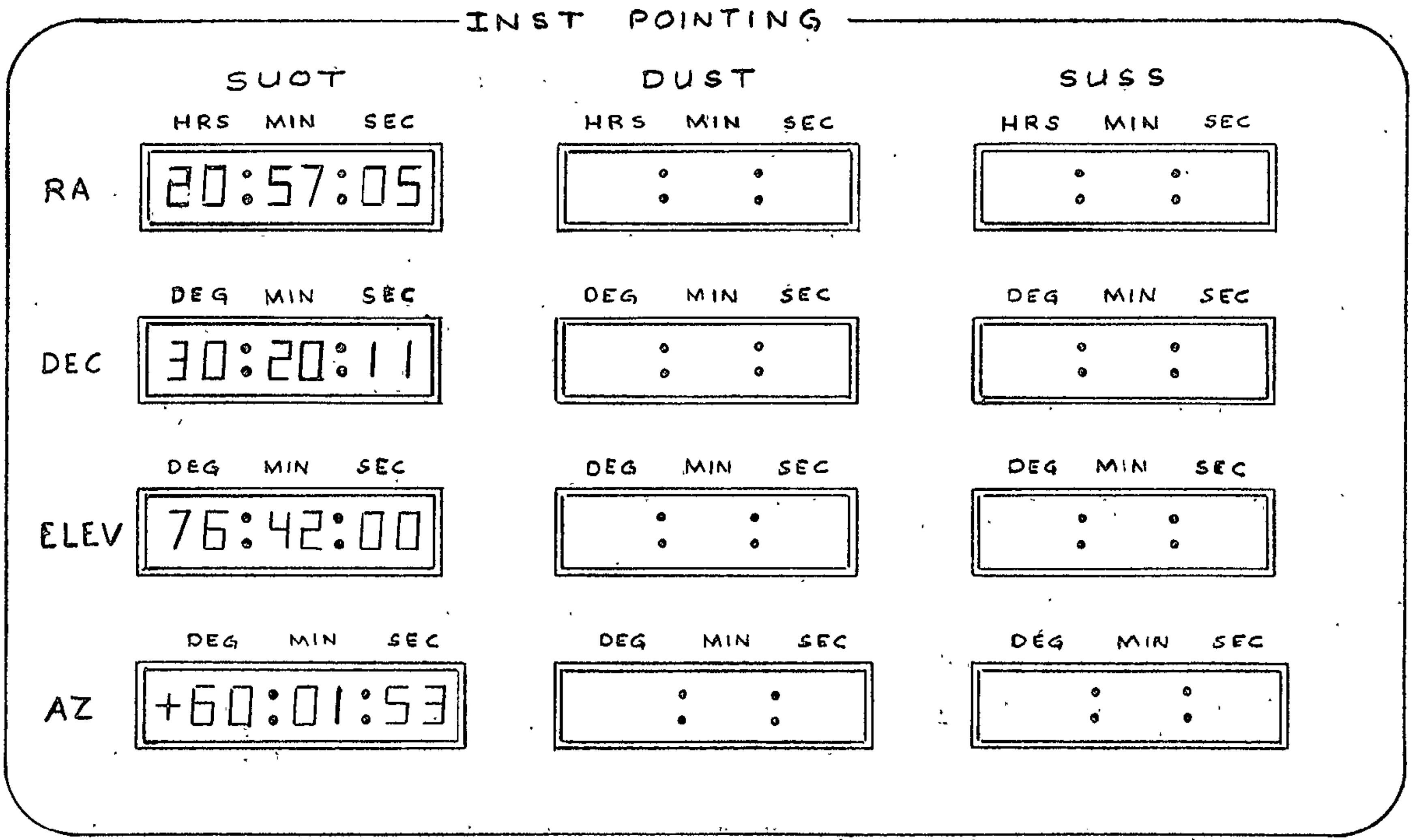


Fig A-5 Payload Unique C & D At Panel A-6
(2nd Portion of Dedicated UV Astronomy Sim)

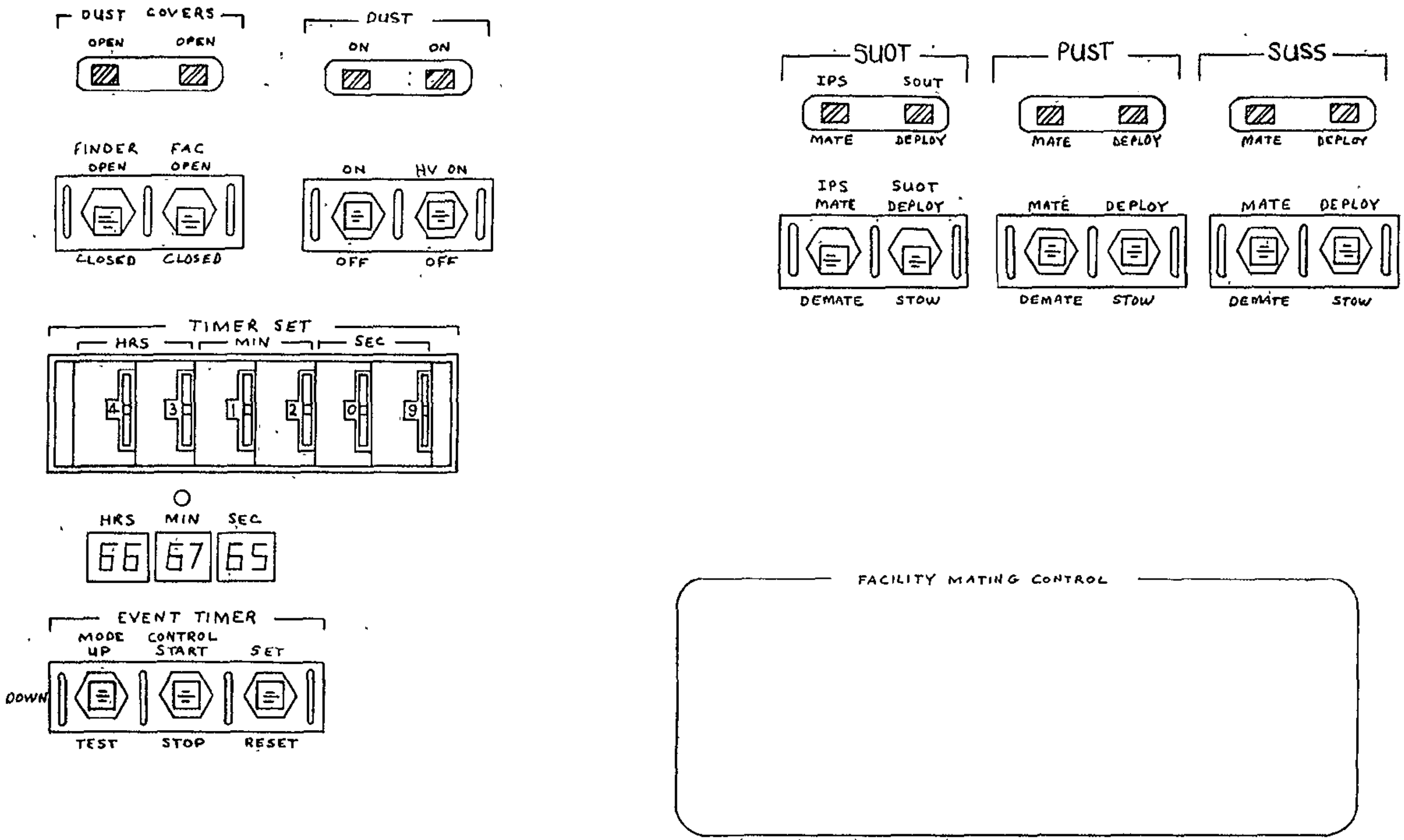
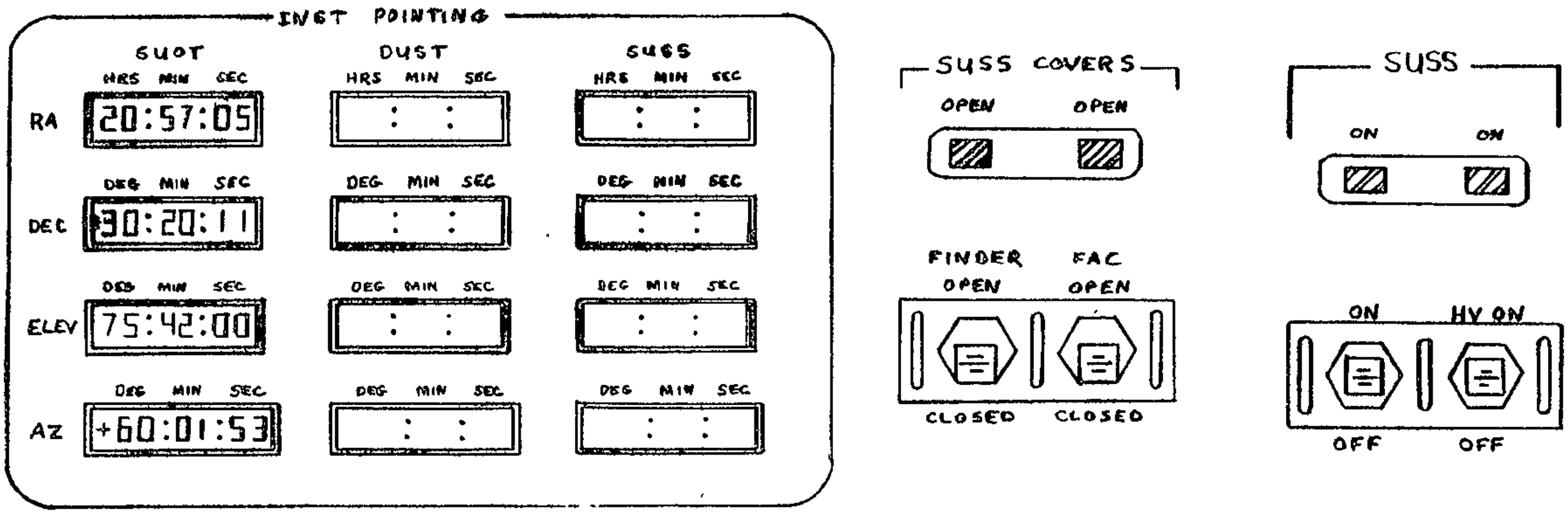


Fig A 6 Payload Unique C&D At Panel A-7
(2nd Portion of Dedicated UV Astronomy Sim)



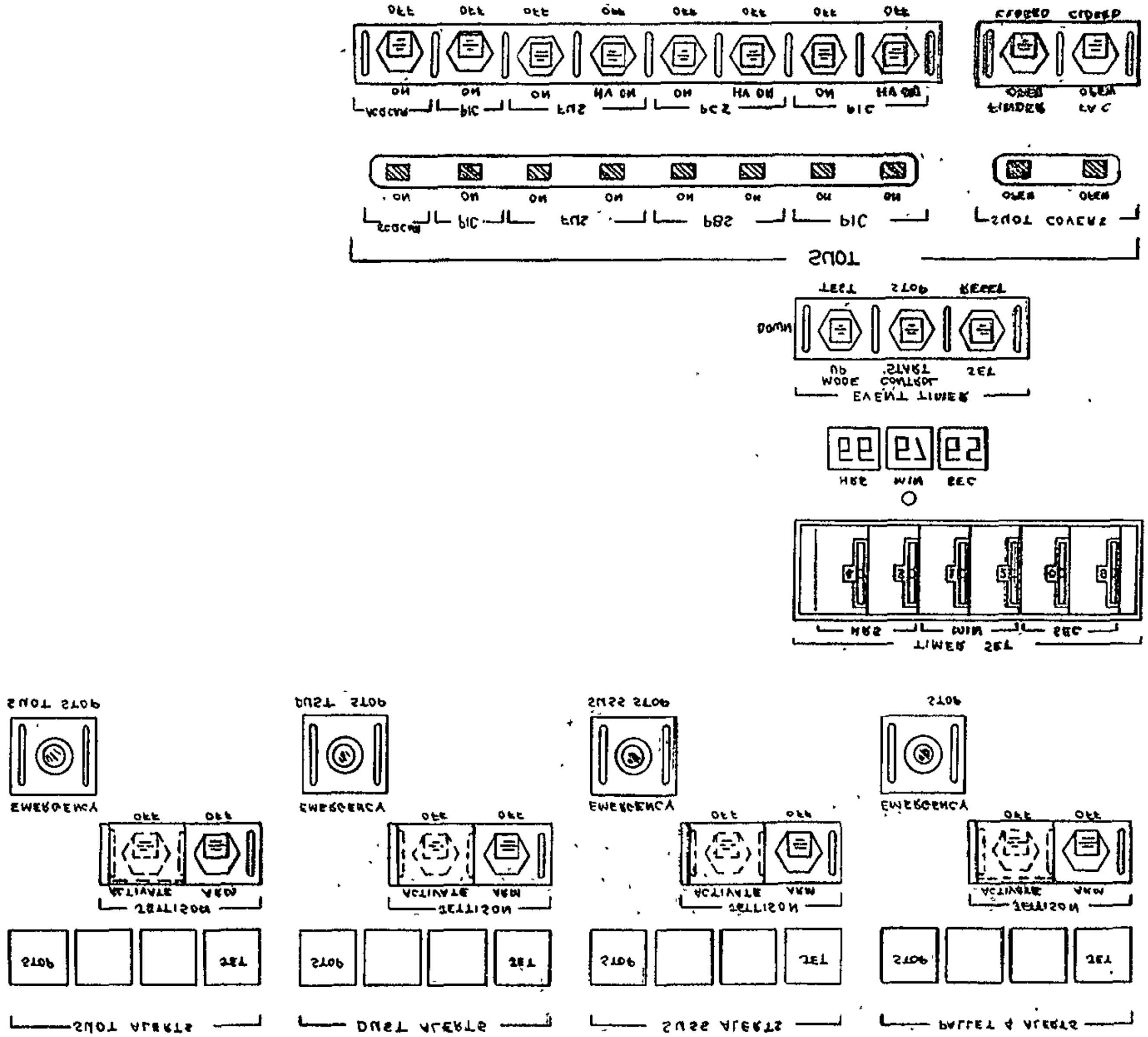


Fig A-1 Payload Unique C & D
(2nd Portion of Dedicated UV Astronomy Sim)

configurations, crew performance of simulated events required approximately 10% less time than had been previously estimated on Figure VI-4.

H. EVENT SEQUENCE

The event sequence used for the Dedicated UV Astronomy 2 CRT/keyboard operation is shown in Table A-1. Major events are identified in the left column followed by Mission Elapsed Time (MET) and the crew assigned functions. MET is not included for the activation phase because it was not considered critical for the purposes of this simulation. Panel numbers at the AFD are provided for each crew function.

For the 3 CRT/keyboard evaluation the event sequence on the timeline (Figure VI-4) was utilized to guide the proceedings.

I. PROCEDURES

Detailed procedures were prepared and used by each of the three "crewmen" for the events simulated. These procedures follow in Tables A-2 thru A-12 at the end of Appendix A and cover the following events:

TABLE A-2 - SUOT C/O & DEPLOYMENT OPS
TABLE A-3 - DUST & SUSS C/O & DEPLOYMENT OPS
TABLE A-4 - CCTV & PAYLOAD BAY LIGHTING ACTIVATION
TABLE A-5 - CCTV & PAYLOAD BAY LIGHTING DEACTIVATION
TABLE A-6 - THREE FACILITY PRESET & SETUP OPS
TABLE A-7 - CCTV SPLIT SCREEN OPS FOR PAYLOAD INPUTS
TABLE A-8 - DUST OPERATION
TABLE A-9 - SUSS OPERATION
TABLE A-10 - SUOT DIC OPERATION
TABLE A-11 - DUST & SUOT PRESET & SETUP OPS
TABLE A-12 - SUOT PCS OPERATION

The crew assignments reflected in these procedures apply to the 2 CRT/ kybd. configuration. For the evaluation involving a third CRT and keyboard, crew assignment and station (panel) were modified for the facility preset and instrument operations. These procedures are included in the following tables (A-13 thru A-18). The procedures and their table assignment are:

TABLE A-1 DEDICATED UV ASTRONOMY PAYLOAD EVENT SEQUENCE

EVENTS	MET	CDR/PLT		MS		PS	
		CDR		MS2		PS2	
SUOT PRE-DEPLOY				LOAD SUOT FILES	R12	LOAD DIC PCS	
C/O & METERING				METER MIRROR	L12	POWER UP INSTR	L12
		ACT CCTV & P/L LITES	A7	STATUS FACILITY	R12	STATUS INSTR.	L11
						LOAD FUS DIC STATUS	
						POWER DOWN	L12
SUOT/IPS MATING		OPERATE CCTV	A7	MATE SUOT/IPS	R11	MONITOR MATING	AFD
				STATUS FACILITY	R12		
SUOT DEPLOYMENT		OP CCTV & MONITOR	AFD	DEPLOY SUOT	R12	MONITOR DEPLOYMENT	AFD
& STATUS		DEPLOYMENT					
		MNVR ORB FOR BIAS		STATUS FACILITY	R12	POWER UP INSTR	L12
						STATUS INSTR	L11
				UNLOAD FILES	R12	POWER DOWN INSTR	L12
DUST & SUSS PRE-				LOAD DUST FILES	R12	LOAD SUSS FILES	L11
DEPLOY C/O &				POWER UP INSTR	L12	POWER UP INSTR	L12
METERING				METER MIRRORS	L12	METER MIRROR	L12
		ADJ CAMERAS & LITES	A7	STATUS DUST	R12	STATUS SUSS	L11
						POWER DOWN INSTR	L12
DUST/PTG SYS MATING		OPERATE CCTV	A7	MATE DUST/PTG SYS	R11	MONITOR MATING	AFD
				STATUS DUST	R12	POWER UP DUST	L12
DUST DEPLOYMENT		OP CCTV & MONITOR	AFD	DEPLOY DUST	R12	MONITOR DEPLOYMENT	AFD
& STATUS		DEPLOYMENT					
				STATUS DUST	R12		
						POWER DOWN DUST	L12
SUSS/PTG SYS MATING		OPERATE CCTV	A7	MATE SUSS/PTG SYS	R11	MONITOR MATING	AFD
						POWER UP SUSS	L12
						STATUS SUSS	L11
SUSS DEPLOYMENT		OP CCTV & MONITOR	AFD	DEPLOY SUSS	R12	MONITOR DEPLOYMENT	AFD
& STATUS		DEPLOYMENT				STATUS SUSS	L11
	0700	DEACT CCTV & LITES	A7	UNLOAD FILES	R12	POWER DOWN SUSS	L12
HANDOVER							

TABLE A-1 DEDICATED UV ASTRONOMY PAYLOAD EVENT SEQUENCE

EVENTS	MET	CDR/PLT		MS		PS	
		PLT		MS1		PS1	
ATT MNVR PREP	-6100	PREP ORB ATT MNVR	C2	ACT. CCTV P/L CONTROL	A7		
ORBITER ATT MNVR	-6107	INIT & MONITOR MNVR	F7	LOAD FILES	R12	LOAD DIC	
FACILITY SLEWING & INSTR. SETUP	-6108			SLEW SUOT, DUST, SUSS		MONITOR SLEWING	A6
						SETUP/STATUS SUSS & DIC	L11
				SETUP/STATUS DUST		ROUTE FINDER SIGNAL	L11/ A6
DUST & SUSS TARGET ACQUISITION	-6113			ROUTE FINDER SIGNAL	R12/ A6	OPEN FIND & SHUTTER	L11
				OPEN FIND & SHUTTER		INIT COARSE GUIDE	L11
		MONITOR S/L SUB-SYSTEMS & ORBITER DRIFT		INIT COARSE GUIDE	R12	VERIFY FIELD, RA/DEC	A3/ A6
				VERIFY FIELD & CENTER	A/3 R12	OPEN SUSS COVER	L11/ L10
				UPDATE VECTOR	R12	SETUP GP/VERIFY STARS	L11/ A3
				OPEN DUST COVER		CENTER FINDER IMAGE	L10/ A3
DUST EXPOSURE START	-6117	MONITOR S/L SUB-SYSTEMS & ORBITER DRIFT		INIT DUST EXP		INIT FINE GUIDANCE	L11
DIC TARGET ACQUIS.	-6118			ROUTE SUOT FIND SIG	R12/ A6	UPDATE VECTOR	
				OPEN FIND & SHUTTER	R12	SETUP FINAL CONFIG.	
SUSS COMP EXPOSURE	-6119			INIT COARSE GUIDE	R12	PERFORM COMP EXP	
SUSS EXPOSURE START	-6121			VERIFY FIELD & CENTER	A3/ A6	INIT SUSS EXP	
						MONITOR SUSS STATUS	
				OPEN SUOT CODER	R12		
				ACT ACAM & ROUTE SIG.	R12/ A6		
				ALIGN STAR FIELD	A3		
				SETUP GP/VERIFY STARS	R12/ A3		

TABLE A-1 DEDICATED UV ASTRONOMY PAYLOAD EVENT SEQUENCE

EVENTS	MET	CDR/PLT	MS		PS	
		PLT	MS1		PS1	
			INIT FINE GUIDANCE	R12		L11
			UPDATE VECTOR			
			SETUP FINAL CONFIG			
DIC EXPOSURE START	-6124		INIT DIC EXP			
			STATUS SUOT		MONITOR DIC STATUS	
			MONITOR DUST STATUS			
		COORD TARGET SEQ	REVIEW NEXT DUST TARGET DATA		REVIEW NEXT (PCS) TARGET DATA	
DIC & DUST EXP END	-6154		END DUST EXP		END DIC EXP	
SUOT & DUST SLEWING	-6155	MONITOR S/L SUBSYSTEMS & ORBITER DRIFT	LOAD SUOT PCS	R12		
			SLEW SUOT & DUST		MONITOR SLEWING	A6
					SETUP/STATUS PCS	L11
DUST & PCS TARGET ACQUISITION	-6201		SETUP/STATUS DUST		ROUTE FINDER SIGNAL	L11/ A6
			ROUTE FINDER SIGNAL	R12/ A6	OPEN FIND & SHUTTER	L11
			OPEN FIND & SHUTTER	R12	INIT COARSE GUIDE	L11
			INIT COARSE GUIDANCE	R12	VERIFY FIELD, RA, DEC	A3/ A6
			VERIFY FIELD & CENTER	A3	OPEN SUOT COVER	L11
					ACT ACAM & RT.SIG.	L11/ A6
			UPDATE VECTOR	R12	SETUP GP/VERIFY STARS	L11/ A3
			OPEN DUST COVER		ROUTE PRESLIT IMAGE	L11
DUST EXPOSURE START	-6205		INIT DUST EXP		CENTER IMAGE ON SLIT	A3
					INIT FINE GUIDANCE	L11
			CHECK SUSS STATUS		UPDATE VECTOR	
ATT MNVR PREP	-6206	PREP ORB ATT MNVR C2	MONITOR DUST STATUS		SETUP FINAL CONFIG.	
PCS COMP EXPOSURE	-6207				PERFORM COMP EXP	
			REVIEW NEXT TARGET DATA			
PCS EXPOSURE START	-6208				INIT PCS EXP	
					CHECK SUSS STATUS	
DUST & SUSS EXP END	-6211		END DUST EXP		END SUSS EXP	
PCS EXP END	-6214				END PCS EXP	

TABLE A-13	-	THREE FACILITY PRESET & SETUP OPS
TABLE A-14	-	SUSS OPERATION
TABLE A-15	-	DUST OPERATION
TABLE A-16	-	SUOT DIC OPERATION
TABLE A-17	-	DUST & SUOT PRESET & SETUP OPS
TABLE A-18	-	SUOT PCS OPERATION

For both the 2 and 3 CRT/kybd evaluation the single DUST OPERATION procedure was utilized for both the 30 minute and the 6 minute exposure periods.

J. RESULTS AND RECOMMENDATIONS

All results, recommendations and conclusions derived from the Dedicated UV Astronomy Payload Simulation are identified in Section IV of this report.

TABLE A-2 SUOT C/O & DEPLOYMENT OPERATIONS

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Sign ON Experiment Computer/SUOT Application and Wait for Confirmation	R12	x		
MS	Type LOAD SUOT DIC PCS & Depress C/R key and await acknowledgement	R12	x		
MS	Switch SUOT MIRROR to METER and confirm metering by Indicator	L12		x	Meters Mirror
MS	Type SUOT STATUS & Depress C/R Key and Await Response	R12	x		
MS	Review SUOT status for acceptable parameters	R12		x	
PS	Sign ON Experiment Computer/SUOT Application and await confirmation	L11	x		
PS	Switch DIC Power ON and confirm by Indicator	L12		x	
PS	Type DIC STATUS & Depress C/R Key	L11	x		
PS	Review DIC Status for acceptable predeployment parameters	L11		x	
PS	Type DIC PWR STANDBY & C/R	L11	x		
PS	Confirm voltage at 14500 on DIC Status			x	
PS	Switch PCS Power ON and confirm by Indic.	L12		x	
MS	Type LOAD FUS PIC & C/R & await acknowledgement	R12	x		
PS	Type PCS STATUS & Depress C/R	L11	x		
PS	Review PCS Status for acceptable parameters	L11		x	
PS	Switch DIC & PCS Power OFF	L12		x	
PS	Switch FUS Power ON and confirm by Indicator	L12		x	
PS	Type FUS STATUS & C/R	L11	x		
PS	Review FUS Status for acceptable parameters	L11		x	
PS	Switch PIC Power ON and confirm by Indicator	L12		x	
PS	Depress PAGE FORWARD key & type PIC STATUS & C/R	L11	x		
PS	Review PIC Status for Acceptable parameters	L11		x	
PS	Advise MS when Instr. Statusing complete	L11		x	
PS	Switch FUS and PIC Power OFF	L12		x	SUOT & Instrument programs remain loaded thru IPS mating & deployment

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Enter OPS 23 PRO on MCDS Keyboard	R11	x		Calls SUOT/IPS MATE CONTROL SEQ
MS	Enter ITEM 23 EXEC & acknowledge OR Enter Discrete Commands shown below	R11	x		Dedicated switches are also provided for SUOT mating on Panel L12
MS	Enter ITEM 1 EXEC & Acknowledge	R11	x		Enables Pallet 4 Latch Control Mechanis
MS	Enter ITEM 2 EXEC & Acknowledge	R11	x		Sets SUOT Bay Latching in XLATE POS
MS	Enter ITEM 3 EXEC & Acknowledge	R11	x		SUOT/IPS Winch Motor to STANDBY
MS	Enter ITEM 4 EXEC & Acknowledge	R11	x		Cable Drive to ENGAGE
MS	Enter ITEM 5 EXEC & Acknowledge	R11	x		Mating Latches to RECEIVE
MS	Enter ITEM 6 EXEC & Acknowledge	R11	x		Winch Motor - DRIVE
MS	Enter ITEM 7 EXEC & Acknowledge	R11	x		SUOT/IPS Latches-LOCK
MS	Enter ITEM 8 EXEC & Acknowledge	R11	x		Cable Drive - RELEASE
MS	Enter ITEM 9 EXEC & Acknowledge	R11	x		Winch Motor OFF
MS	Enter ITEM 10 EXEC & Acknowledge	R11	x		P/L Bay Restraint Latch RELEASE
MS/ PS	Monitor Mating Sequence on CCTV	A3		x	
MS	Type SUOT STATUS & C/R and recheck facility parameters	R12	x		
MS	Type PRESET Z0 & Depress C/R & Await Response	R12	x		Elevates SUOT to 90^{o} Position
CDR & PS	Confirm SUOT Elevation thru Aft windows, by CCTV2 and by Elevation and Azimuth Indicators	A3/ A7		x	
MS	Confirm Final SUOT Position at 90^{o} Elevation, 0^{o} Azimuth	A7		x	
MS	Recheck SUOT Status	R12	x		
PS	Repeat Instr. Power Up and Parameter Status	L11	x		
MS	Type UNLOAD SUOT ALL & C/R & await confirmation	R12	x		
MS/ PS	Sign OFF SUOT Application & await acknowledgement	R12/ L11	x		

Date 5-11-76

TABLE A-3 DUST & SUSS C/O & DEPLOYMENT OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Sign ON DUST & SUSS Applications & await confirmation	R12	x		
MS	Type LOAD DUST SUSS & C/R & await acknowledgement	R12	x		
MS	Switch DUST Power ON & confirm by Indicator	L12		x	
MS	Switch SUSS Power ON & confirm by Indicator	L12		x	
MS	Switch DUST MIRROR 1 to METER & confirm by Indicator	L12		x	
MS	Switch DUST MIRROR 2 to METER & confirm by Indicator	L12		x	
MS	Switch DUST MIRROR 3 to METER & confirm by indicator	L12		x	
MS	Switch SUSS MIRROR to METER & confirm by indicator	L12		x	
PS	Sign ON SUSS Application & await confirmation	L11	x		
MS	Type DUST STATUS & C/R	R12	x		
MS	Review DUST Status for acceptable parameters	R12		x	
PS	Type SUSS STATUS & C/R	L12	x		
PS	Review SUSS Status for acceptable parameters	L12		x	
PS	Switch DUST & SUSS Power OFF	L12		x	
MS	Clear MCDS Screen	R11	x		
MS	Enter OPS 24 PRO on MCDS Keyboard	R11	x		Calls DUST/Ptg Sys Mate Control Seq.
MS	Enter ITEM 24 EXEC & await acknowledgement	R11	x		Dedicated switches also provided for DUST Mating on Panel L12
MS/PS	Monitor Mating on CCTV	A3		x	
PS	Switch DUST Power ON & confirm by Indicators	L12		x	
MS	Type DUST STATUS & C/R and recheck parameters	R12	x		
MS	Type PRESET Z0 & C/R & await response	R12	x		Elevates DUST to 0 position
CDR/PS	Confirm DUST Deployment thru Aft windows, by CCTV and by Elevation & Azimuth Indicators	A3/A7		x	
MS	Confirm Final DUST Position at 90^{o} Elevation & 0^{o} Azimuth.	A7		x	

TABLE A-3 DUST & SUSS C/O & DEPLOYMENT OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Recheck DUST Status	R12	x		
PS	Switch DUST Power OFF	L12		x	
MS	Sign OFF DUST Application	R12	x		
MS	Clear MCDS Screen	R11	x		
MS	Enter OPS 25 PRO on MCDS Keyboard	R11	x		Calls SUSS/Ptg Sys Mate Control Seq.
MS	Enter ITEM 25 EXEC & acknowledge	R11	x		Dedicated switches also provide for SUSS Mating on Panel L12
MS/ PS	Monitor Mating on CCTV	A3		x	
PS	Switch SUSS Power ON & confirm by Indicators	L12		x	
PS	Type SUSS STATUS & C/R & recheck status parameters	L11	x		
MS	Type PRESET Z0 & C/R & await response	R12	x		Deploys SUSS & Elevates to 0 position
CDR	Confirm SUSS Deployment thru Aft windows, by CCTV and by Elevation & Azimuth Indicators	A3/ A6		x	
MS	Confirm final SUSS Position at 90^{0} Elevation and 0^{0} Azimuth	A6		x	
PS	Recheck SUSS Status	L11	x		
PS	Switch SUSS Power OFF	L12		x	
PS	Sign OFF SUSS Application	L11	x		
MS	Type UNLOAD DUST SUSS & C/R & await response	R12	x		
MS	Sign OFF SUSS Application	R12	x		

TABLE A-4 CCTV & PAYLOAD BAY LIGHTING ACTIVATION

Date 5-12-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
	AFT BAY CAMERA & FLOOD LIGHT ACTIVATION				
CDR/ PLT	Switch Control Unit - MN A	A7		x	Enables CCTV System
	Switch AFT Bay Camera Power - ON	A7		x	
	Select Video Output - MON 1 Depress	A7		x	MON 1 Lights
	Select Video Input - AFT Bay Depress	A7		x	AFT Bay Lights
	Switch Camera Command - Test ON	A7		x	
	Observe & Verify Camera Operation Pattern	A7		x	
	Switch Camera Command - Test OFF	A7		x	
	Switch AFT Floods (Left & Right) - ON	A7		x	
	Switch MID Floods (Left & Right) - ON	A7		x	
	STANDARD CAMERA COMMAND SEQUENCE				
	Adjust Camera Command - IRIS to OPEN	A7		x	
	Observe Image Facility Image - MON 1	A7		x	
	Facility may not be in field of view	A7		x	
	SLEW CAMERA COMMANDS:	A7		x	
	Pan to Facility Image - Left or Right	A7		x	
	Tilt to Facility Image - Up or Down	A7		x	
	Adjust Camera Commands to Optimum Image:	A7		x	
	IRIS - OPEN/CLOSE - As Required	A7		x	
	FOCUS - FAR-NEAR - As Required	A7		x	
	ZOOM - IN/OUT - As Required	A7		x	
	Observe Subject Lighting and Change Flood Combinations, AFT/MID/FWD, LEFT/RIGHT	A7		x	
	Reconfigure Camera Commands for Optimum Image	A7		x	

TABLE A-4 CCTV & PAYLOAD BAY LIGHTING ACTIVATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
	FWD BAY CAMERA & FLOOD LIGHT ACTIVATION				
CDR/ PLT	Switch FWD Bay Camera Power - ON	A7		x	MON 2 Lights MON 1 Image & FWD CAM
	Select Video Output - MON 2 Depress (Observe MON 1 Light Goes Out)	A7		x	Remain as initially set up
	Select Video Input - FWD Bay Depress (Observe AFT Bay Light Goes Out)	A7		x	FWD Bay - Lights MON 2 is now slaved to FWD Camera - No changes to MON 1 & AFT Camera
	Switch Camera Command - TEST ON	A7		x	
	Observe & Verify Camera Operation Pattern	A7		x	
	Switch Camera Command - Test OFF	A7		x	
	Switch FWD Floods (Left & Right) - ON	A7		x	
	Procede to: "Standard Camera Command Sequence" (Page 1, last half)				

TABLE A-5 CCTV & PAYLOAD BAY LIGHTING DEACTIVATION

Date 5-12-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
CDR/ PLT	Switc Camera PWR to OFF	A7		x	
"	Switc	A7		x	
"	Switc RT/LEFT Floods OFF	A7		x	Where Applicable

TABLE A-6 THREE FACILITY PRESET & SETUP OPS

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Sign on to Facility Applications by typing S/SUOT DUST SUSS & C/R & await confirmation	R12	x		
MS	Type LOAD SUOT DIC DUST SUSS & C/R & await acknowledgement	R12	x		
MS	Confirm Orbiter attitude MNVR has been initiated and rates are nominal (with CDR/PLT)	R12		x	
MS	Check Current Elevation & Azimuth of facilities	A6		x	
PS	Sign on to SUOT DIC SUSS & C/R & confirm	L11	x		
MS	Advise crew on pending facility slewing command	R12		x	
MS	Type PRESET ALL & C/R & await confirmation	R12	x		
MS/PLT	Monitor Facility Elevation/Azimuth Indicators & view facilities	A6		x	
PS	Type SUSS SET1 & C/R & review status parameters	L11	x		Star List parameters are programmed. SUSS status printed out.
PS	Type DIC SET1 & C/R & review status parameters	L11	x		Star List parameters are programmed. DIC status printed out.
MS	Confirm Final Elevation, Azimuth and RA, DEC for each facility	A6		x	

TABLE A-7 . CCTV-SPLIT SCREEN OPERATION FOR PAYLOAD INPUTS

CREW	TASK	PANEL	AUTO	MAN	REMARKS
ANY	(CCTV - with 4 Video Inputs from Payloads)				
	[Assumes CCTV Control Setup Complete]				Completed during CCTV Activation & P/L Lighting Setup.
	Monitor 1				
ANY	SELECT - MUX1-L	A7		X	(Video out) To Monitor
ANY	SELECT - PL2	A7		X	Finder Tel. Sensor
ANY	SELECT - MUX1-R	A7		X	(Video Out) to Monitor
ANY	SELECT - PL3	A7		X	Finder Tel Sensor
ANY	SELECT - MON1	A7		X	CCTV Monitor 1
ANY	SELECT - MUX1	A7		X	(Video Input from previous MUX1-L & R)
ANY	Observe PL2 & PL3 images on Monitor 1	A3		X	
	Monitor 2				
ANY	SELECT - MUX 2-L	A7		X	(Video Out) to monitor
ANY	SELECT - PL1	A7		X	GP1 Sensor
ANY	SELECT - MUX2-R	A7		X	(Video Out) to Monitor
ANY	SELECT - PL4	A7			
ANY	SELECT - MON2	A7		X	CCTV Monitor 2
ANY	SELECT - MUX2	A7		X	(Video Input from previous MUX2-L & R)
ANY	Observe PL1 and PL4 Images on Monitor 2	A3			

TABLE A-8 DUST OPERATION

Date 5-6-76

CONDITIONS:

1) ASSIGNED TO MS AT R12
2) MISSION REVOLUTION NO. 34 (EXP INIT)
3) 2 EXPOSURES
   1st - MIN 30 MINUTES, START S/S + 5 MIN
   2nd - MIN 6 MINUTES, START S/R + 10 MIN
4) ORB ATT - XPOP; MODE - FREE DRIFT
5) TARGET RA & DEC
   1st - 12 HR, 10 MIN/0°
   2nd - 15 HR, 30 MIN/$4^{\circ}20'$
6) CONCURRENT WITH SUSS - BOTH EXPOSURES
   CW SUOT DIC - 1st EXP
   CW SUOT PCS - 2nd EXP

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Recheck instrument exposure sequence, starfield identifiers and exposure times	R12		X	
MS	Sign off SUSS Application by typing S/SUSS OFF & C/R	R12	X		Still signed on to DUST & SUOT
MS	Type DUST SET & C/R and review status parameters	R12	X		Star list parameters are programmed DUST is configured, frame advanced & status printed out.
MS	Type FIND TV1L & C/R & await acknowledgement	R12	X		Powers Finder & routes video signal & guide starfield to left side of CCTV1 screen
MS	Type ØFCOV & C/R & await acknowledgement or	R12	X		Opens Finder Telescope Cover
PS	Switch DUST Finder Cover to OPEN	L10		X	

TABLE A-8 DUST OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type OFSHUT & C/R & await acknowledgement	R12	X		Opens Finder Dark Slide Shutter
MS	Type CGUIDE & C/R & await acknowledgement	R12	X		Coarse Guidance initiated. Update of error signal from finder sent to pointing system
MS	Examine Field (CCTV1L), confirm coarse guide operative, verify field, and check RA and DEC	A3, A7		X	
MS	Remove Pointing Control Paddle from Storage Location	R12		X	Located Below Lip of R12 Panel
MS	Set Pointing Control Slew Rate and turn Power Switch ON	R12		X	
MS	Align Target Starfield with Guide Star Pattern on CCTV1 & check RA, DEC Readout	R12. A3&A7		X	
MS	Switch Pointing Controller Power OFF and stow Paddle Control	R12		X	
MS	Type OBJ & C/R and await acknowledgement	R12	X		Updates DUST vector and corrects pointing error program
MS	Type ØDCOV & C/R and await acknowledgement	R12	X		Opens DUST Facility Cover
	or				
PS	Switch DUST Facility Cover to OPEN	L10		X	
MS	Recheck DUST status for correct parameters	R12		X	
MS	Type STAR & C/R & await response - then after DUST EXP TIME: Type Desired Time in MM:SS	R12	X		Reference Chart for exposure time for target, REV and UT
MS	Reference UT, SR & SS Readout on CRT and when ready depress C/R twice	R12	X		Initiates DUST exposure
	At end of DUST EXPOSURE Computer Prints Out - Time= __:__ If more exposure time desired type: INCRE If not type: END	R12	X		

TABLE A-8 DUST OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type END & C/R & await acknowledgement	R12	X		Closes Finder & DUST Shutter & reduces power; will close Finder and DUST Covers if openend by keyboard
PS	If Finder Cover Opened by switch then - Switch DUST Finder Cover to CLOSE	L10		X	
PS	If DUST Cover opened by switch then - Switch Dust Facility Cover to CLOSE	L10		X	

TABLE A-9 SUSS OPERATION

CONDITIONS:

1) Assigned to PS at L11
2) Mission Revolution No. 34 (EXP. INIT)
3) 1 Exposure - 50 min, start within S/S + 7 min
4) ORB ATT - XPOP; MODE - Free Drift
5) Target RA & DEC
   18 hr, 20 min, 00 sec/ -02° 18' 00"
6) During this exposure -
   2 DUST EXP - 30'min & 6' min
   1 DIC EXP - 30' min
   1 PCS EXP - 6' min

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Recheck Instrument exposure sequence, starfield identifiers and exposure times	L11		x	
PS	Check application routing by depressing APPLIC key	L11	x		
PS	Type FIND TV2L & C/R & await acknowledgement	L11	x		Powers Finder & routes video signal & guide starfield to left side of CCTV2 screen.
PS	Type ØFCOV & C/R & await acknowledgement	L11	x		
	OR				Opens Finder Telescope Cover
PS	Switch SUSS Finder Cover to OPEN	L10		x	
PS	Type ØFSHUT & C/R & await acknowledgement	L11	x		Opens Finder Dark Slide Shutter
PS	Type CGUIDE & C/R & await acknowledgement	L11	x		Coarse Guidance initiated, update of error signal from finder sent to pointing system.
PS	Examine and verify field, confirm coarse guide operative; check RA and DEC	A3/ A7		x	
PS	Type ØSCOV & C/R & await acknowledgement	L11	x		
	OR				Opens Facility Cover
PS	Switch SUSS Facility Cover to OPEN	L10		x	

TABLE A-9 SUSS OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Type GP SETUP & C/R & await acknowledgement	L11	x		Computer sets position of GP to pre-selected guide star from P List.
PS	Type GP TV2R & C/R & verify star acquisition	L11	x		GP video signal routed to right side of CCTV2 Monitor
PS	TYPE Ø EXPM & C/R & await acknowledgement OR	L11	x		Activates Photon Counter which monitors white light flux thru slit viewer
PS	Switch SUSS Exposure Meter ON	L10		x	
PS	Remove Pointing Controller from storage location	L11		x	Located below lip of panel
PS	Set Pointing Control Slew Rate and Switch Power ON	L11		x	
PS	Monitor Photon Counter and Finder Image & center target field with Pointing Controller	L10/ A3		x	Counter reading should increase
PS	Check RA & DEC reading	A7		x	
PS	Stow Pointing Controller	L11		x	
PS	Type FGUIDE & C/R & await acknowledgement	L11	x		Initiates Fine Guidance
PS	Type OBJ & C/R & await acknowledge	L11	x		Updates SUSS vector and corrects pointing error program
PS	Switch Pointing Controller Power OFF	L11		x	
PS	Type SETUP2 & C/R & review status	L11	x		New freq. spectrum is programmed, frame advanced & status printed out.
PS	Type COMP & C/R & await response - then after COMPTIME: Type time desired & enter C/R twice.	L11	x		Initiates comparison exposure. Hold next command execution until comparison is completed.
PS	Type STAR & C/R & await response - then type desired exposure terminating value after EXP METER: ___ or EXP TIME: MM:SS	L11	x		If EXP METER is selected, enter total Photon Count desired; the meter will be reset to 0 (from previous value) when exposure is initiated whether meter or time is selected.

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Reference UT, SR & SS Readout on CRT and when ready depress C/R twice	L11	x		Initiates SUSS exposure
	At end of SUSS Exposure Computer prints out: END OF SUSS EXPOSURE TIME = MM:SS and METER = _ _ _ _ _ if more exposure desired type: INCRE if not type END		x		
PS	Type END & C/R & await acknowledgement [Computer prints status incl. DUST & Finder Cover Closed or Open]	L11	x		Closes Finder & SUSS Shutter, reduces power & frame advanced; will close finder & SUSS covers if opened by keyboard; will turn off exposure meter if activated by keyboard.
PS	If Finder Cover Opened by Switch then - Switch SUSS Finder Cover to CLOSE	L10		x	
PS	If SUSS Cover Opened by Switch then - Switch SUSS Facility Cover to CLOSE	L10		x	
PS	If Exposure Meter Opened by Switch - then switch SUSS EXP METER to OFF	L10		x	Meter powered down and reading zeroed.

TABLE A-10 SUOT DIC OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type FIND TV1L & C/R & await acknowledgement	R12	x		Powers Finder & routes video signal & guide starfield to left side of CCTV
MS	Type ØFCOV & C/R & await acknowledgement	R12	x		
	OR				Opens Finder Telescope Cover
PS	Switch SUOT Finder Cover to OPEN	L10		x	
MS	Type ØFSHUT & C/R & await acknowledgement	R12	x		Opens Finder Dark Slide Shutter
MS	Type CGUIDE & C/R & acknowledge	R12	x		Initiates Coarse Guidance & sends Updated Error Signal to IPS
MS	Examine field & confirm coarse guidance operative	A3		x	CCTV1
MS	Remove Pointing Controller from Storage Location	R12		x	Located below lip of panel
MS	Set Pointing Control Rate to SLOW	R12		x	
MS	Switch Pointing Control Power to ON	R12		x	
MS	Correct Pointing with Controller	R12/ A3		x	CCTV1
MS	Temporarily Stow Pointing Controller	R12		x	
MS	Type ØSCOV & C/R & await acknowledgement	R12	x		
	OR				Opens SUOT Facility Cover
PS	Switch SUOT Facility Cover to OPEN	L10		x	
MS	Type ACAM TV1R & C/R	R12	x		Sets up Acquis. Camera and routes video signal to CCTV1 right side
MS	Type ØACAM & C/R & acknowledge	R12	x		Opens Acquis. Camera Shutter
MS	Remove Pointing Controller from storage and center P star with controller	R12/ A3		x	
MS	Stow Pointing Controller	R12		x	
MS	Type GP SETUP & C/R & await acknowledgement	R12	x		Computer sets position of GP1 and GP2 to preselected guide stars for P List selection
MS	Type GP1 TV2L & C/R & confirm Star	R12/ A3	x		GP1 video to left side of CCTV2 Finder & SAO Image
MS	Type GP2 TV2R & C/R & confirm Star	R12/ A3	x		GP2 Video to right side of CCTV2

TABLE A-10 SUOT DIC OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type FGUIDE & C/R & acknowledge	R12	x		Initiates Fine Guidance
MS	Type OBJ & C/R & acknowledge	R12	x		Updates SUOT vector and corrects pointing error program
MS	Switch Pointing Controller Power OFF	R12		x	
PS	Type DIC SET2 & C/R & Review DIC Status Parameters	L11	x		Moves mirror and prints out status
PS	Type STAR & C/R and wait for response then: After Exposure Time: Type MM:SS & C/R	L11	x		Frame advanced Event time appears below UT at 00:00
PS	When ready (ref Display UT) depress C/R C/R	L11	x		Time countup begins on display, shutte opens and exposure begins
PS	Monitor DIC Status	L11		x	
MS	Type SUOT STATUS & C/R and monitor it	R12	x		Status printed out
PS	Depress Page Forward key	L11	x		
PS	Type P LIST & C/R & obtain next target data	L11			
PS	Depress Page Forward key	L11	x		
PS	Type P & C/R & await response	L11	x		
PS	After WHICH OBJ? Type M81-5 & C/R & await targetting information	L11	x		Data for PCS
PS	Confirm Primary Target with MS	L11		x	
	At end of DIC Exposure Computer Prints Out: END OF DIC EXPOSURE TIME= _ _:_ _, CAL WEDGE = __	L11	x		
PS	Type END & C/R & await acknowledgement	L11	x		Closes Finder & DIC Shutter, reduces power & advances frame; will close Finder & SUOT covers if opened by keyboard.
PS	If Finder Cover opened by Switch then - Switch SUOT Finder to CLOSE	L10		x	
PS	If SUOT Cover opened by Switch then - Switch SUOT Facility Cover to CLOSE	L10		x	

Date 5-13-76

TABLE A-11 DUST & SUOT PRESET & SETUP OPS

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type LOAD SUOT PCS & C/R & await acknowledgement	R12	x		
PS	Sign on to SUOT PCS & C/R & confirm	L11	x		
MS	Advise crew on pending facility slewing command	R12		x	
MS	Type PRESET SUOT DUST & C/R & await confirmation	R12	x		
MS/PLT	Monitor Facility Elevation/Azimuth Indicators & view facilities	A7		x	
PS	Type PCS SET1 & C/R & review status parameters	L11	x		Star List parameters are programmed. PCS status printed out.
MS	Confirm final Elevation, Azimuth & RA, DEC for two facilities	A7		x	

TABLE A-12 SUOT PCS OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Type FIND TV2L & C/R & await acknowledgement	L11	x		Powers Finder & routes video signal & guide starfield to left side of CCTV2 screen.
PS	Type ØFCOV & C/R & await acknowledgement	L11	x		Opens Finder Telescope Cover
	OR				
PS	Switch SUOT Finder Cover to OPEN	L10		x	
PS	Type ØFSHUT & C/R & await acknowledgement	L11	x		Opens Finder Dark Slide Shutter
PS	Type CGUIDE & C/R & await acknowledgement	L11	x		Initiates Coarse Guidance
PS	Examine Starfield (CCTV2), confirm coarse guidance operative, verify field & check RA & DEC	A3/ A7		x	
PS	Remove Pointing Controller from storage location	L11		x	Located below lip of panel
PS	Set Pointing Control Slew Rate to FAST & turn power switch ON	L11		x	
PS	Correct pointing with Controller	L11/ A3		x	
PS	Temporarily Stow Pointing Controller	L11		x	
PS	Type ØSCOV & C/R & await acknowledgement	L11	x		Opens SUOT Facility Cover
	OR				
PS	Switch SUOT Facility Cover to OPEN	L10		x	
PS	Type ACAM TV2R & C/R & await acknowledgement	L11	x		Sets up Acquisition Camera & routes video signal to right side of CCTV2 screen
PS	Remove Pointing Controller from storage and center field	L11/ A3		x	
PS	Temporarily stow Pointing Controller	L11		x	
PS	Type GP SETUP & C/R & acknowledge	L11	x		Computer sets position of GP1 and GP2 to preselected guide stars from P List selection
PS	Type GP1 TV1R & C/R and confirm star	L11/ A3	x		GP1 video signal routed to right side of CCTV1 screen
PS	Type GP2 TV1R & C/R & confirm star	L11/ A3	x		GP2 video signal routed to right side of CCTV1 screen replacing GP1 image

TABLE A-12 SUOT PCS OPERATION

Date 5-13-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Type SMIR TV1R & C/R	L11/ A3	x		Used for PCS to examine image from Preslit Viewer (replaces GP2 image on right side of CCTV1 screen)
PS	Remove Pointing Controller from Storage Location	L11		x	
PS	Using CCTV1 and pointing control center image through slit. MS or PS monitor thru exposure.	A3/ L11		x	Star image is moved to fall thru slit
PS	Stow Pointing Controller	L11		x	
PS	Type FGUIDE & C/R & acknowledge	L11	x		Initiates Fine Guidance
PS	Type OBJ & C/R & acknowledge	L11	x		Updates SUOT vector and corrects pointing error program
PS	Switch Pointing Control Power OFF	L11		x	
PS	Type SET2 & C/R & await response	L11	x		Adjusts optics
PS	Type COMP & C/R & wait for response - then after COMPTIME: Type time desired & depress C/R twice	L11	x		Comparison time - calls up timer Required for PCS. Hold next command until comp is completed.
PS	Type STAR & C/R & wait for response - then after PCS EXP TIME: Type MM:SS	L11	x		Event time field appears below UT on display
PS	When ready (ref Display UT) depress C/R C/R	L11	x		Time countup begins on display, shutters open & exposure begins
PS	Page Forward for PCS End Message	R12		x	
	At end of PCS Exposure Computer Prints: END OF PCS EXPOSURE EXP TIME = MM:SS If more exposure time desired type INCRE If not type END	L11	x		
PS	Type END & C/R & await acknowledgement	L11	x		Closes Finder & PCS Viewer & reduces power; will close finder & SUOT covers if opened by keyboard.
PS	If finder cover opened by switch then - switch SUOT Finder Cover to CLOSE	L10		x	
PS	If SUOT Cover opened by switch then - switch SUOT Facility Cover to CLOSE	L10		x	

TABLE A-13 THREE FACILITY PRESET & SETUP OPS

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Sign on to Facility Applications by typing S/SUOT DUST SUSS & C/R & await confirmation.	L10	x		
MS	Type LOAD SUOT DIC DUST SUSS & C/R & await acknowledgement	L10	x		
MS	Confirm Orbiter attitude MNVR has been initiated and rates are nominal (with CDR/PLT)	L10		x	
MS	Check Current Elevation & Azimuth of facilities	A7		x	
PS	Sign on to SUOT DIC SUSS & C/R & confirm	L11	x		
MS	Advise crew on pending facility slewing command	L10		x	
MS	Type PRESET ALL & C/R & await confirmation	L10	x		
MS/ PS	Monitor Facility Elevation/Azimuth Indicators & view facilities	A7		x	
MS	Type SUSS SET1 & C/R & review status parameters	L10	x		Star List parameters are programmed. SUSS status printed out.
PS	Type DIC SET1 & C/R & review status parameters	L11	x		Star List parameters are programmed. DIC status printed out.
MS	Confirm Final Elevation, Azimuth and RA, DEC for each facility	A7		x	

TABLE A-14 SUSS OPERATION

CONDITIONS:

1) Assigned to MS at L10
2) Mission Revolution No. 34 (EXP. INIT)
3) 1 Exposure - 50 min, start within S/S + 7 min
4) ORB ATT - XPOP; MODE - Free Drift
5) Target RA & DEC
   18 hr, 20 min, 00 sec/ -02^{o} 18' 00"
6) During this exposure -
   2 DUST EXP - 30'min & 6'min
   1 DIC EXP - 30' min
   1 PCS EXP - 6' min

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Recheck Instrument exposure sequence, starfield identifiers and exposure times	L10		x	
MS	Check application routing by depressing APPLIC key	L10	x		
MS	Type FIND TV1R & C/R & await acknowledgement	L10	x		Powers Finder & routes video signal & guide starfield to left side of CCTV2 screen.
MS	Type ØFCOV & C/R & await acknowledgement	L10	x		Opens Finder Telescope Cover
	OR				
MS	Switch SUSS Finder Cover to OPEN	A7		x	
MS	Type ØFSHUT & C/R & await acknowledgement	L10	x		Opens Finder Dark Slide Shutter
MS	Type CGUIDE & C/R & await acknowledgement	L10	x		Coarse Guidance initiated, update of error signal from finder sent to pointing system.
MS	Examine and verify field, confirm coarse guide operative; check RA and DEC	A7		x	

111

TABLE A-14 SUSS OPERATION

Date 5/17/76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type ØSCOV & C/R & await acknowledgement	L10	x		Opens Facility Cover
	OR				
MS	Switch SUSS Facility Cover to OPEN	A7		x	
MS	Type GPSETUP & C/R & await acknowledgement	L10	x		Computer sets position of GP to preselected guide star from P List.
MS	Type GP TV1R & C/R & verify star acquisition	L10	x		GP video signal routed to right side of CCTV2 Monitor
MS	Type Ø EXPM & C/R & await acknowledgement	L10	x		Activates Photon Counter which monitors white light flux thru slit viewer
MS	Remove Pointing Controller from storage location	L10		x	Located below lip of panel
MS	Set Pointing Control Slew Rate and Switch Power ON	L10		x	
MS	Monitor Photon Counter and Finder Image & center target field with Pointing Controller	L10/ A3		x	Counter reading should increase
MS	Check RA & DEC reading	A7		x	
MS	Stow Pointing Controller	L10		x	
MS	Type FGUIDE & C/R & await acknowledgement	L10	x		Initiates Fine Guidance
MS	Type OBJ & C/R & await acknowledgement	L10	x		Updates SUSS vector and corrects pointing error program
MS	Switch Pointing Controller Power OFF	L10		x	
MS	Type SETUP2 & C/R & review status	L10	x		New freq. spectrum is programmed, frame advanced & status printed out.
MS	Type COMP & C/R & await response - then after COMPTIME: Type time desired & enter C/R twice.	L10	x		Initiates comparison exposure. Hold next command execution until comparison is completed.

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type STAR & C/R & await response - then type desired exposure terminating value after EXP METER: _ _ _ _ or EXP TIME: MM:SS	L10	x		If EXP METER is selected, enter total Photon Count desired; the meter will be reset to 0 (from previous value) when exposure is initiated whether meter or time is selected.
PS	Reference UT, SR & SS Readout on CRT and when ready depress C/R twice	L10	x		Initiates SUSS exposure
	At end of SUSS Exposure Computer prints out: END OF SUSS EXPOSURE TIME = MM:SS and METER = _ _ _ _ _ if more exposure desired type: INCRE if not type END		x		
PS	Type END & C/R & await acknowledgement Computer prints status incl. DUST & Finder Cover Closed or Open	L10	x		Closes Finder & SUSS Shutter, reduces power & frame advance; will close finder & SUSS covers if opened by keyboard; will turn off exposure meter if activated by keyboard.
PS	If Finder Cover Opened by Switch then - Switch SUSS Finder Cover to CLOSE	A7		x	
PS	If SUSS Cover Opened by Switch then - Switch SUSS Facility Cover to CLOSE	A7		x	

TABLE A-15 DUST OPERATION

CONDITIONS:

1) ASSIGNED TO PLT AT R12
2) MISSION REVOLUTION NO. 34 (EXP INIT)
3) 2 EXPOSURES
   1st - MIN 30 MINUTES, START S/S + 5 MIN
   2nd - MIN 6 MINUTES, START S/R + 10 MIN
4) ORB ATT - XPOP: MODE - FREE DRIFT
5) TARGET RA & DEC
   1st - 12 HR, 10 MIN/0^{o}
   2nd - 15 HR, 30 MIN/4^{o} 20'
6) CONCURRENT WITH SUSS - BOTH EXPOSURES
   CW SUOT DIC - 1st EXP
   CW SUOT PCS - 2nd EXP

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PLT	Recheck instrument exposure sequence, starfield identifiers and exposure times	R12		x	
PLT	Sign on DUST Application by typing S/DUST ON & C/R	R12	x		
PLT	Type DUST SET & C/R and review status parameters	R12	x		Star list parameters are programmed DUST is configured, frame advanced & status printed out
PLT	Type FIND TV1L & C/R & await acknowledgement	R12	x		Powers Finder & routes video signal & guide starfield to left side of CCTV1 screen
PLT	Type ØFCOV & C/R & await acknowledgement	R12	x		
	OR				Opens Finder Telescope Cover
PLT	Switch DUST Finder Cover to OPEN	A6		x	
PLT	Type OFSHUT & C/R & await acknowledgement	R12	x		Opens Finder Dark Slide Shutter
PLT	Type CGUIDE & C/R & await acknowledgement	R12	x		Coarse Guidance initiated. Update of error signal from finder sent to pointing system

TABLE A-15 DUST OPERATION

Date 5/17/76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PLT	Examine Field (CCTV1L), confirm coarse guide operative, verify field, and check RA and DEC	A3/ A7		x	
PLT	Remove Pointing Control Paddle from Storage Location	R12		x	Located Below Lip of R12 Panel
PLT	Set Pointing Control Slew Rate and turn Power Switch ON	R12		x	
PLT	Align Target Starfield with Guide Star Pattern on CCTV1 & check RA, DEC Readout	R12/ A3&A7		x	
PLT	Switch Pointing Controller Power OFF and stow Paddle Control	R12		x	
PLT	Type OBJ & C/R and await acknowledgement	R12	x		Updates DUST vector and corrects pointing error program
PLT	Type ØDCOV & C/R and await acknowledgement	R12	x		
	OR				Opens DUST Facility Cover
PLT	Switch DUST Facility Cover to OPEN	A6		x	
PLT	Recheck DUST status for correct parameters	R12		x	
PLT	Type STAR & C/R & await response - then after DUST EXP TIME: Type Desired Time in MM:SS	R12	x		Reference Chart for exposure time for target, REV and LUT
PLT	Reference LUT, SR & SS Readout on CRT and when ready depress C/R twice	R12	x		Initiates DUST exposure.
PLT	At end of DUST EXPOSURE Computer Prints Out - Time = __:__ If more exposure time desired type: INCRE If not type: END	R12	x		
PLT	Type END & C/R & await acknowledgement	R12	x		Closes Finder & DUST Shutter & reduces power; will close Finder and DUST Covers if opened by keyboard
PLT	If Finder Cover Opened by switch then - Switch DUST Finder Cover to CLOSE	A6		x	
PLT	If DUST Cover opened by switch then - Switch DUST Facility Cover to CLOSE	A6			

TABLE A-16 SUOT DIC OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Type FIND TV2L & C/R & await acknowledgement	L11	x		Powers Finder & routes video signal & guide starfield to left side of CCTV
PS	Type ØFCOV & C/R & await acknowledgement	L11	x		Opens Finder Telescope Cover
	OR				
PS	Switch SUOT Finder Cover to OPEN	L12		x	
PS	Type ØFSHUT & C/R & await acknowledgement	R12	x		Opens Finder Dark Slide Shutter
PS	Type CGUIDE & C/R & acknowledge	R12	x		Initiates Coarse Guidance & sends Updated Error Signal to IPS
PS	Examine field & confirm coarse guidance operative	A3		x	CCTV1
PS	Remove Pointing Controller from Storage Location	L11		x	Located below lip of panel
PS	Set Pointing Control Rate to SLOW	L11		x	
PS	Switch Pointing Control Power to ON	L11		x	
PS	Correct Pointing with Controller	L11/ A3		x	CCTV2
PS	Temporarily Stow Pointing Controller	L11		x	
PS	Type ØSCOV & C/R & await acknowledgement	L11	x		Opens SUOT Facility Cover
	OR	L11			
PS	Switch SUOT Facility Cover to OPEN	L12		x	
PS	Type ACAM TV2R & C/R	L11	x		Sets up Acquis. Camera and routes video signal to CCTV1 right side
PS	Type ØACAM & C/R & acknowledge	L11	x		Opens Acquis. Camera Shutter
PS	Remove Pointing Controller from storage and center P star with controller	L11/ A3		x	
PS	Stow Pointing Controller	L11		x	
PS	Type GP SETUP & C/R & await acknowledgement	L11	x		Computer sets position of GP1 and GP2 to preselected guide stars for P List selection
PS	Type GP1 TV2L & C/R & confirm Star	L11 A3	x		GP1 video to left side of CCTV2 Finder & SAO Image
PS	Type GP2 TV2L & C/R & confirm Star	L11 A3	x		GP2 Video to right side of CCTV2

TABLE A-16 SUOT DIC OPERATION

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Type FGUIDE & C/R & acknowledge	L11	x		Initiates Fine Guidance
PS	Type OBJ & C/R & acknowledge	L11	x		Updates SUOT vector and corrects pointing error program
PS	Switch Pointing Controller Power OFF	L11		x	
PS	Type DIC SET2 & C/R & Review DIC Status Parameters	L11	x		Moves mirror and prints out status
PS	Type STAR & C/R and wait for response then: After Exposure Time: Type MM:SS & C/R	L11	x		Frame advanced Event time appears below UT at 00:00
PS	When ready (ref Display UT) depress C/R C/R	L11	x		Time countup begins on display, shutte opens and exposure begins
PS	Monitor DIC Status	L11		x	
MS	Type SUOT STATUS & C/R and monitor it	L10	x		Status printed out
PS	Depress Page Forward key	L11	x		
PS	Type P LIST & C/R & obtain next target data	L11			
PS	Depress Page Forward key	L11	x		
PS	Type P & C/R & await response	L11	x		
PS	After WHICH OBJ? Type M81-5 & C/R & await targetting information	L11	x		Data for PCS
PS	Confirm Primary Target with MS	L11		x	
	At end of DIC Exposure Computer Prints Out: END OF DIC EXPOSURE TIME= _ _:_ _, CAL WEDGE = __	L11	x		
PS	Type END & C/R & await acknowledgement	L11	x		Closes Finder & DIC Shutter, reduces power & advances frame; will close Finder & SUOT covers if opened by keyboard.
PS	If Finder Cover opened by Switch then - Switch SUOT Finder to CLOSE	L12		x	
PS	If SUOT Cover opened by Switch then - Switch SUOT Facility Cover to CLOSE	L12		x	

TABLE A-17 DUST & SUOT PRESET & SETUP OPS

Date 5-17-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Load PCS & C/R	L11	x		
PS	Sign on to SUOT PCS & C/R & confirm	L11	x		
MS	Advise crew on pending facility slewing command	L10		x	
MS	Type PRESET SUOT DUST & C/R & await confirmation	L10	x		
MS/ PLT	Monitor Facility Elevation/Azimuth Indicators & view facilities	A7		x	
PS	Type PCS SET1 & C/R & review status parameters	L11	x		Star List parameters are programmed. PCS status printed out.
MS	Confirm final Elevation, Azimuth & RA, DEC for two facilities	A7		x	

TABLE A-18 SUOT PCS OPERATION

Data 5-17-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Type FIND TV2L & C/R & await acknowledgement	L11	x		Powers Finder & routes video signal & guide starfield to left side of CCTV2 screen.
PS	Type ØFCOV & C/R & await acknowledgement	L11	x		Opens Finder Telescope Cover
	OR				
PS	Switch SUOT Finder Cover to OPEN	L12		x	
PS	Type ØFSHUT & C/R & await acknowledgement	L11	x		Opens Finder Dark Slide Shutter
PS	Type CGUIDE & C/R & await acknowledgement	L11	x		Initiates Coarse Guidance
PS	Examine Starfield (CCTV2), confirm coarse guidance operative, verify field & check RA & DEC	A3/ A7		x	
PS	Remove Pointing Controller from storage location	L11		x	Located below lip of panel
PS	Set Pointing Control Slew Rate to FAST & turn power switch ON	L11		x	
PS	Correct pointing with Controller	L11/ A3		x	
PS	Temporarily Stow Pointing Controller	L11		x	
PS	Type ØSCOV & C/R & await acknowledgement	L11	x		Opens SUOT Facility Cover
	OR				
PS	Switch SUOT Facility Cover to OPEN	L12		x	
PS	Type ACAM TV2R & C/R & await acknowledgement	L11	x		Sets up Acquisition Camera & routes video signal to right side of CCTV2 screen
PS	Remove Pointing Controller from storage and center field	L11/ A3		x	
PS	Temporarily stow Pointing Controller	L11		x	
PS	Type GP SETUP & C/R & acknowledge	L11	x		Computer sets position of GP1 and GP2 to preselected guide stars from P List selection
PS	Type GP1 TV1R & C/R and confirm star	L11/ A3	x		GP1 video signal routed to right side of CCTV1 screen
PS	Type GP2 TV1R & C/R & confirm star	L11/ A3	x		GP2 video signal routed to right side of CCTV1 screen replacing GP1 image

TABLE A-18 SUOT PCS OPERATION

ate 5-17-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Type SMIR TV1R & C/R	L11/ A3	x		Used for PCS to examine image from Preslit Viewer (replaced GP2 image on right side of CCTV1 screen)
PS	Remove Pointing Controller from Storage Location	L11		x	
PS	Using CCTV1 and pointing control center image through slit. MS or PS monitor thru exposure.	A3/ L11		x	Star image is moved to fall thru slit
PS	Type FGUIDE & C/R & acknowledge	L11	x		Initiates Fine Guidance
PS	Switch Pointing Controller OFF and stow	L11		x	
PS	Type OBJ & C/R & acknowledge	L11	x		Updates SUOT vector and corrects pointing error program
PS	Type SET2 & C/R & await response	L11	x		Adjusts optics
PS	Type COMP & C/R & wait for response - then after COMPTIME: Type time desired & depress C/R twice	L11	x		Comparison time - calls up timer Required for PCS. Hold next command until comp is completed.
PS	Type STAR & C/R & wait for response - then after PCS EXP TIME: Type MM:SS	L11	x		Event time field appears below UT on display
PS	When ready (ref Display UT) depress C/R C/R	L11	x		Time countup begins on display shutters open & exposure begins
PS	Page Forward for PCS End Message	L11		x	
	At end of PCS Exposure Computer Prints: END OF PCS EXPOSURE EXP TIME = MM:SS If more exposure time desired type INCRE If not type END	L11	x		
PS	Type END & C/R & await acknowledgement	L11	x		Closes Finder & PCS Viewer & reduces power; will close finder & SUOT Covers if opened by keyboard
PS	If finder cover opened by switch then - switch SUOT Finder Cover to CLOSE	L12		x	
PS	If SUOT Cover opened by switch then - switch SUOT Facility Cover to CLOSE	L12		x	

TASK 1 FINAL REPORT

APPENDIX B

SUOT SIMULATION DATA

APPENDIX B - SUOT SIMULATION

A. PAYLOAD CONFIGURATION

Payload consisted of only the Spacelab UV Optical Telescope Facility (SUOT) which occupies 2 pallets. This facility employs the IPS for pointing. Target acquisition is accomplished by slewing the IPS gimbals until the desired starfield is acquired by a Finder Telescope mounted on the outside of the SUOT facility. Fine pointing is accomplished by motion of the primary mirror while viewing the target image seen thru the facility's Acquisition camera.

Two star trackers are mounted on the SUOT and maintain the correct tracking profile for the telescope. Their images will be checked after target alignment is accomplished.

SUOT contains four instruments -

DIC - Direct Imaging Camera
PCS - Precisely Calibrated Spectrophotometer
FUS - Far UV Spectrograph
PIC - Planetary Imaging Camera

B. SIMULATION OBJECTIVES

1. Evaluate the Mission and Payload Stations for:

   a. The more efficient assignment of displays and controls.

   b. The more efficient utilization by the Mission and Payload Specialist in performing both sequential and concurrent activities.

2. Evaluate displays and controls for:

   a. Design (including size)

   b. Frequency of usage

   c. Location with respect to other functional related displays and controls

   d. Location for convenient access with respect to the assigned crewman's location during various mission phases

   e. Redundancy with potential keyboard commanded and CRT generated functions

3. Evaluate the overall flight deck layout for the optimum number, utilization and location of crewmen during Spacelab activation and operational sequences.

4. Evaluate preliminary procedures for selected Spacelab systems and payload operational sequences for:

   a. Assignment of tasks relative to current crew skill and speciality groundrules

   b. Tasks which may more efficiently be conducted by 1 vs. 2 or more crewmen

   c. Preferred crew location and panel selection

   d. Gross time for completion

C. FACILITIES AND PROVISIONS

1. Simulation was conducted in Building 9A Orbiter Mockup on April 8 & 9.

2. 102 drawings used to simulate Orbiter's cockpit and applicable AFD display and control panels; Orbiter provide AFD C & D's were 1/2 scale.

3. Payload operating control and display drawings were developed for:

   - SUOT instrument panel including CRT & keyboard
   - SUOT facility panel including CRT & keyboard
   - Other payload panel including CRT & keyboard
   - ERNO CRT and keyboard (2 CRTS & 1 keyboard each on separate panel)
   - Reduced ERNO CRT and keyboard (integrated and used on 2 panels)

4. CDR and PLT's couches and ejection tracks removed and replaced with standard chairs.

5. Audio junction units installed and used with earpiece, mike and cord - 3 at AFD and 1 each at CDR and PLT forward cockpit positions.

6. Amplifier, speaker and mike positioned external to orbiter mockup.

7. GPC and Spacelab computer keyboard entries and computer responses were simulated on paper for each interaction.

8. A fluorescent light was installed above both the Mission and Payload Stations.

9. Proceedings were tape-recorded.

D. OPERATIONS

1. Summary Flight Plan prepared for first 24 hours of mission

    a. Assumed 0415 GMT Launch

    b. Crew complement - CDR, PLT, MS1, MS2, PS1 & PS2

    c. 2 shifts of 12 hours each - PLT, MS1 & PS1 first sleep period from 0230 to 0830 GMT

    d. Spacelab subsystem activation including power up, SUOT C/O, mating and deployment initiated at 0840 GMT and continued incrementally until approx 1100 GMT

    e. First SUOT instrument exposure started at 1628 GMT

    f. 3 exposure sequences conducted

2. Detailed event sequence prepared and used as guide for the assignment and timing of activities

3. Detailed procedures prepared for following operations:

    a. Spacelab preload power up

    b. CCTV activation and payload lighting

    c. SUOT/IPS mating, C/O and deployment

    d. SUOT facility and instrument statusing

    e. Orbiter attitude maneuvering

    f. IPS pointing, SUOT instrument setup and exposure for DIC and PCS

E. PERSONNEL

1. Dr. Karl Henize/JSC served as Mission Specialist

2. Dr. Ted Gull/LEC Astronomer served as Payload Specialist

3. Bill Carmean/MMC - Test Conducted

4. Al Holt/JSC - Test Monitor

5. Frank Hitz/MMC - CDR/PLT

6. Bill Anderson/JSC - Flight Planner/Ground Communicator

7. John Smialek/MMC Denver - Test Monitor

F. CONTROL AND DISPLAY CONFIGURATIONS

Three C & D configurations were evaluated during the SUOT simulation. The first utilized a modified Spacelab CRT and hybrid keyboard at Panel L11, L10 and R12. The second layout incorporated 2 oversized Spacelab CRT's, one at L12 and one at L11; and a single keyboard at L10, and the third configuration employed two reduced ERNO CRT's and keyboards (compatible with standard panel height of 22 inches) located at Panels L10 and L11. This configuration was also evaluated with the CRT/keyboard at Panels L11 and R12. With the larger Spacelab terminals unique payload controls and indicators were moved to Panel L12 for the third phase of this simulation. These panel layouts may be reviewed in Section V, Figures V-2 thru V-8.

A portable pointing controller was conceived to facilitate telescope pointing while using CCTV monitors. This device is shown in Fig. V-11 (Section V).

G. CRT DISPLAYS

Facsimiles were prepared for each simulated Orbiter and Spacelab transaction requiring operator input and computer feedback on the CRT. These were typed on a paper overlay affixed to the C & D location for each CRT located at the AFD for evaluation during the SUOT simulation. Computer responses to each operator command could be seen by turning to the next "CRT" page. Figure B-1 depicts 4 commands and the simulated computer response used for the PS at station R12 while performing the second DIC exposure sequence. Command entries are preceded by asterisks and the computer responses are indented. Instrument (DIC) exposure time remaining is shown in minutes and seconds on the second line in the upper right corner of the CRT page. A facsimile of the CRT image used for the MS at L11 during the SUOT preparation for DIC and PCS exposure is shown on Figure B-2.

Orbiter CRT displays were prepared for the Spacelab Preload Power Sequence, SUOT/IPS mating and latch control, and Orbiter attitude maneuver preparation. Pages extracted from these three sequences are shown in Figures B-3, 4 and 5. The Orbiter MCDS does not have an alpha numeric keyboard and requires coded entry using the function keys. Operational sequences are predefined and the operator enables each task listed. Confirmation of the action is printed out at the base of the screen. Interceding activities, requiring the operator to call another operation, are also printed out at the base of the screen following command advisories.

Fig. B-1- Simulated Spacelab CRT Display for SUOT DIC Exposure Sequence

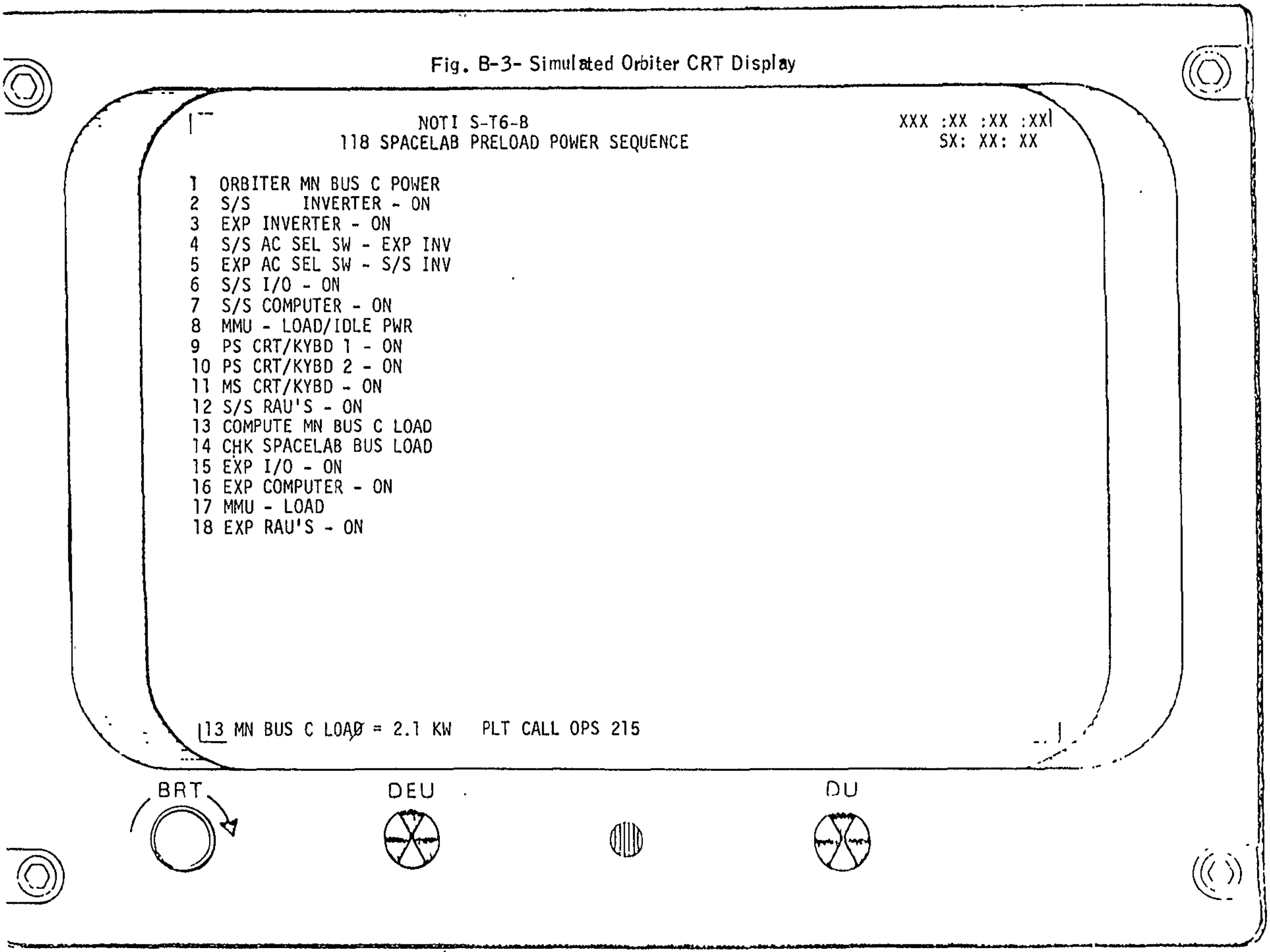
```
ROUTE: EXP COMP    APPLIC: PL SUOT                PG 1                    XXX:XX:XX:XX
                                                                                34:51
*DIC SETUP
     TRANSACTION COMPLETED/STATUS IS:
     PWR:       ON
     FOCUS:     34192
     VOLTAGE:   29000
     TEMP:      -39.7 °C
     FILTER 1:  2200 A°
     FILTER 2:  OPEN
     SHUTTER:   CLOSED
*DIC SETUP
     MIRROR POSITIONED/STATUS IS:
     PWR:       ON
     VOLTAGE    29002
     FOCUS:     29652
     TEMP:      -39.4 °C
     FILTER 1:  2200A°
     FILTER 2:  OPEN
     SHUTTER:   OPEN
*STAR  EXP TIME:  *35M
     TIME SET - WHEN READY DEPRESS C/R TWICE
     SHUTTER OPEN/EXPOSURE IN PROCESS
*SUOT STATUS
     IPS:               GUIDE
     FINDER:            GUIDE
     COVER:             OPEN
     SECONDARY:         GUIDE
     INST. BAY POWER:   ON
     MIRROR:            DIC
     ROTATOR:           47.3°
     GP1:   X=73.126
            Y=29.658
            F=256
            SHUTTER: OPEN
     GP2:   X=189.570
            Y=59.323
            F=512
            SHUTTER: OPEN
```

Fig. B-2- Simulated Spacelab CRT Display for SUOT DIC and PCS Exposure Preperation

```
ROUTE: EXP COMP    APPLIC: PL SUOT                PG 1                          XXX;XX.XX;XX

*  PRESET
      SUOT REPOSITIONED AT __.__° ELV, ±___.__° ROLL, ±___.__° TILT
      SAO TRANSMITTED
* FINDER VIDEO1 Ø FSHUT
      POWER ON/SIGNAL TO CCTV1/FINDER SHUTTER OPEN
*CGUIDE
      COARSE GUIDANCE ENABLED   ERROR SIGNAL UPDATED IN IPS
*Ø SCOVER ACAMERA VIDEO2
      SUOT COVER OPEN/ACQ CAM PWR ON/SIGNAL TO CCTV2
*GP SETUP
      GP 1 & 2 POSITIONED/SHUTTERS OPEN
*GP1 VIDEO2
      SIGNAL TO CCTV2
*GP2 VIDEO1
      SIGNAL TO CCTV1
*PCS SMIR VIDEO2
      PRE SLIT VIEWER SIGNAL TO CCTV2
*FGUIDE
      FINE GUIDANCE ENABLED
*OBJ
      SUOT VECTOR ENTERED/POINTING ERROR UPDATED
*
```

Fig. B-3- Simulated Orbiter CRT Display



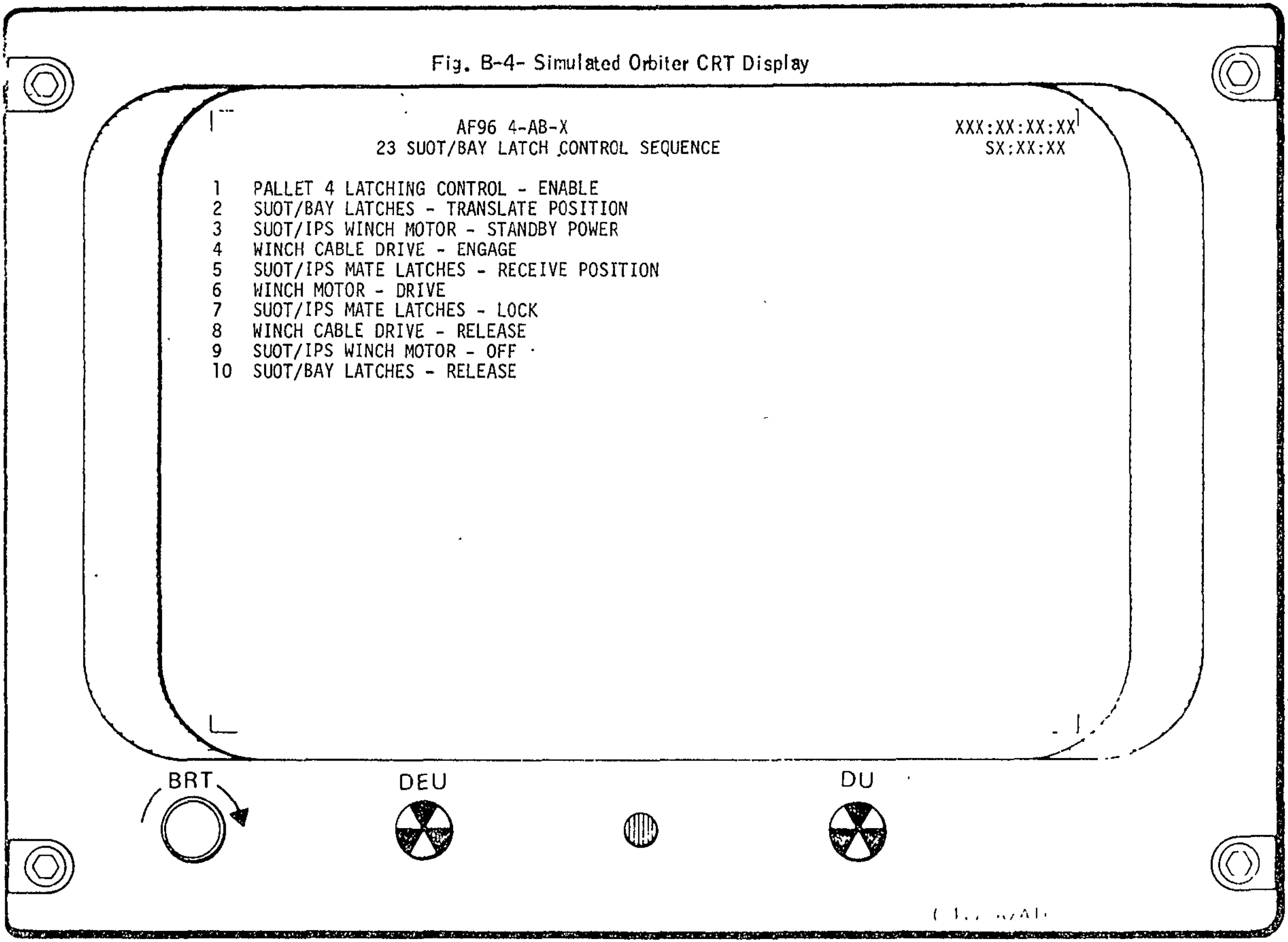
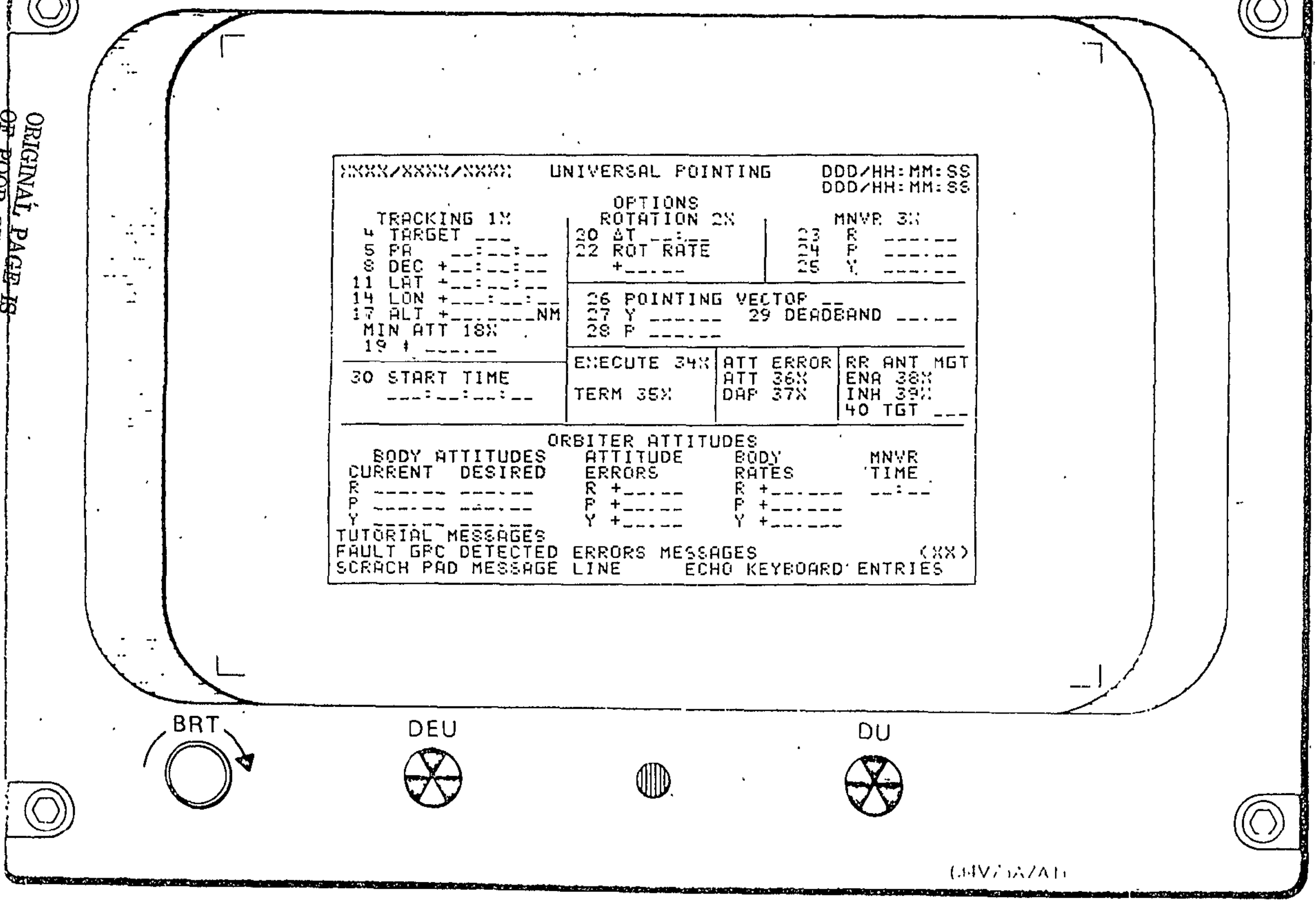


Fig. B-4- Simulated Orbiter CRT Display

Fig. B-5- Simulated Orbiter CRT Display



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Orbiter and Spacelab CRT panel locations utilized for the various payload activation and SUOT operational sequences are shown on the SUOT Event Sequence (Table B-1) in the next section of this appendix.

H. SUMMARY FLIGHT PLAN AND EVENT SEQUENCE

A summary flight plan segment was prepared for the SUOT simulation. This flight plan, shown in Figure B-6, identifies the gross activities performed by each crewman for payload activation and through the SUOT instrument exposure periods.

The detailed SUOT Event Sequence is shown in Table B-1. GMT is included for key events. The crew designations are changed following handover. AFD panel numbers are indicated for each crew event.

I. PROCEDURES

Detailed procedures were prepared and used for each event simulated. These procedures follow in Tables B-2 through B-10 and cover the following events:

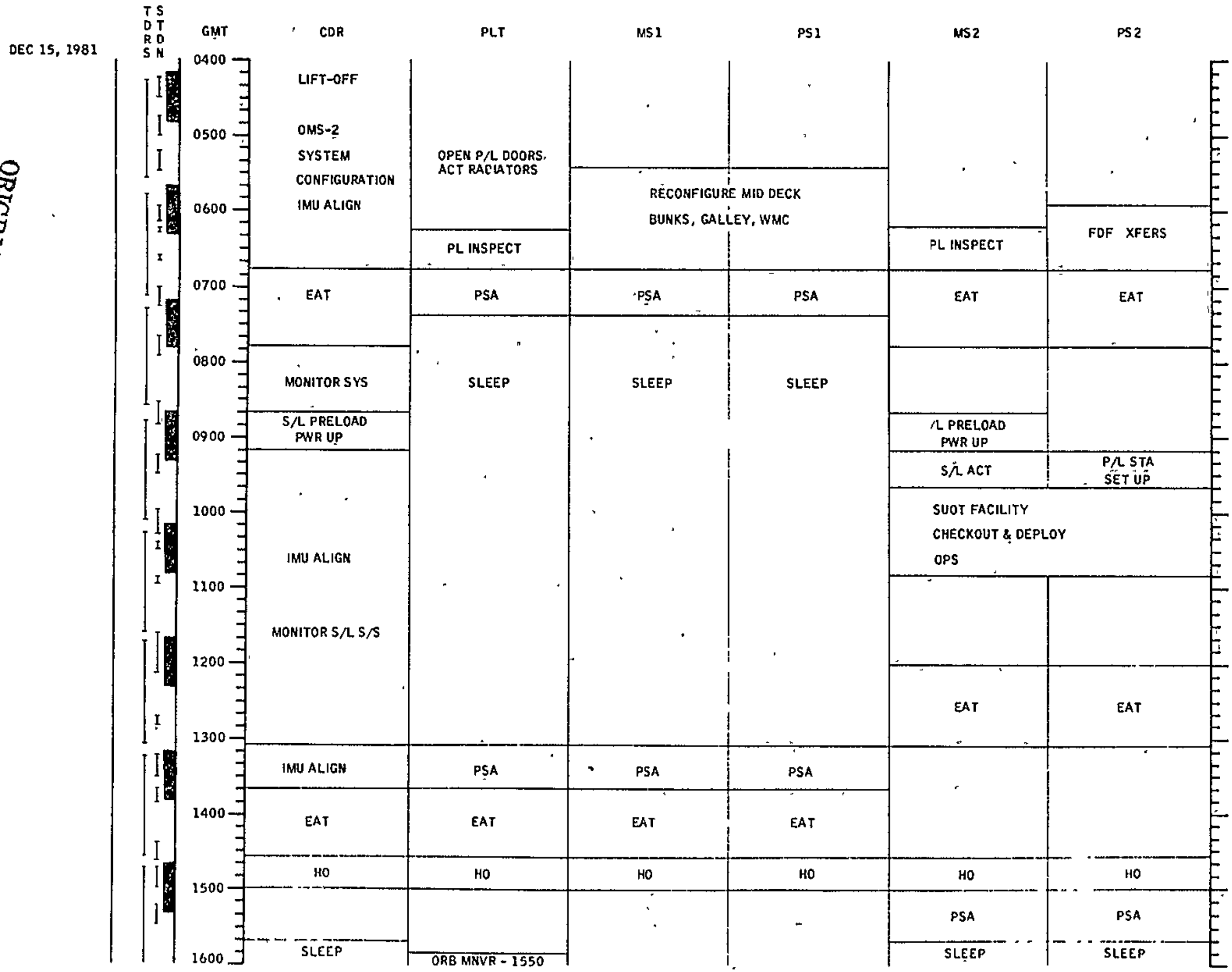
TABLE B-2	SPACELAB PRELOAD POWER
TABLE B-3	CCTV ACTIVATION AND PAYLOAD LIGHTING
TABLE B-4	SUOT C/O AND DEPLOYMENT OPERATIONS
TABLE B-5	UNIVERSAL POINTING - ORBITER MNVR 3
TABLE B-6	CCTV DEDICATED TO PAYLOAD CAMERAS
TABLE B-7	CCTV DOWNLINK
TABLE B-8	SUOT/DIC LOAD AND INITIAL EXPOSURE SEQUENCE
TABLE B-9	SECOND DIC EXPOSURE SEQUENCE
TABLE B-10	DIC/PCS EXPOSURE SEQUENCE

The CCTV Downlink procedure (Table B-7) was not performed during the SUOT simulation.

J. RESULTS AND RECOMMENDATIONS

All results, recommendations and conclusions derived from the SUOT Simulation are identified in Section IV of this report.

FIGURE B-6. SUOT SIMULATION-SUMMARY FLIGHT PLAN



STDN / Time	CDR	PLT	MS1	PS1	MS2	PS2
1600		ORB MNVR	PREP FAC SUOT	PREP INSTR		
			IPS TRK ALIGN	DATA TAKE		
1700			PREP NEXT TGT			
	SLEEP	ORB MNVR 1720			SLEEP	SLEEP
			TGT ACQ	DATA TAKE 1741		
1800		ENTER ORB ATT		1816		
		ORB MNVR 1816	PREP NEXT TGT	182 8		
		ENTER ORB ATT		DATA TAKE		
1900			PREP NEXT TGT	1908		
2000						
2100						
2200						

TABLE B-1 SUOT EVENT SEQUENCE

EVENTS	GMT	CDR/PLT	MS1/MS2	PS1/PS2
		CDR	MS2	PS2
S/L S/S POWER UP	08:40- 08:50	S/L PRELOAD F7		
SUOT PREDEPLOY C/O SUOT MIRROR METER	09:40- 09:46		CRT SEL. SW. R12 LOAD SUOT DIC PCS METER MIRROR SUOT STATUS LOAD FUS PIC PWR OFF PCS/FWS UNLOAD INSTR	CRT SEL. SW. L11 DIC STATUS PCS STATUS FUS STATUS PIC STATUS
SUOT/IPS MATING SUOT DEPLOYMENT	10:15-	ACT. CCTV & LITES A7 MONITOR DEPLOY A AFD DEACT CCTV & LITES A7	SUOT/IPS MATE R11 SUOT UNLATCH R11 DEPLOY SUOT R12	MONITOR DEPLOY AFD
SUOT POST DEPLOY C/O	10:40-		SUOT STATUS R12 P LIST INFO TARGET DATA PWR OFF PCS/FUS UNLOAD SUOT/INSTR	LOAD ALL INSTR L11 DIC STATUS PCS STATUS FUS STATUS PIC STATUS
HO		PLT	MS1	PS1
TARGET INPUT ORB ATT MNVR	15:20- 15:50-	ENTER TARG DATA C2 MONITOR MNVR F7	ACT CCTV1/2 A7 LOAD SUOT DIC L11 SET TIMER FINDER VIDEO ZENITH	DIC STATUS R12 DIC PWR STDBY SET TIMER

TABLE B-1 SUOT EVENT SEQUENCE

EVENTS	GMT	CDR/PLT		MS1/MS2		PS1/PS2	
		PLT		MS1		PS1	
TARGET ACQUISITION	16:10-			OPEN FINDER	L11		
				COARSE GUIDE	A3		
				ALIGN STAR/SAO	L11/A3		
				Ø SUOT COVER			
				ACQ CAMERA			
				CENTER STAR			
				GP SETUP			
				FINE GUIDE	L11	DIC SETUP	R12
DIC PREP				VECTOR UPDATE		DIC HI VOLT	
						DIC STATUS	
DIC EXPOSURE	16:28-			P LIST INFO		EXP START	
	16:31:20-			TARGET DATA		EXP END	
TARGET INPUT	17:15-	ENTER TARG DATA	C2	ENTER IPS DATA	L11	DIC SETUP	R12
ORB ATT MNVR	17:20-	MONITOR MNVR	F7	SET TIMER		SET TIMER	
				FINDER VIDEO			
TARGET ACQUISITION	17:31-			OPEN FINDER			
				COARSE GUIDE	A3		
				ALIGN STAR/SAO	L11/A3		
				Ø SUOT COVER			
				ACQ CAMERA			
				GP SETUP			
				FINE GUIDE	L11	DIC SETUP	R12
				VECTOR UPDATE	L11		
DIC EXP START	17:41-					EXP START	
						DIC STATUS	
						SUOT STATUS	
						P LIST INFO	
						TARGET DATA	
NEXT TARGET INPUT	18:10-	ENTER TARG DATA	C2			LOAD PCS	
						PCS STATUS	
DIC EXP END/ ORB ATT MNVR	18:16-	MONITOR MNVR	F7			EXP END	
ORB ATT MNVR	18:16:10-	MONITOR MNVR	F7	RESET TIMER	L11	RESET TIMER	R12
				ENTER IPS DATA	L11	PCS/DIC SETUP	

TABLE B-1 SUOT EVENT SEQUENCE

EVENTS	GMT	CDR/PLT	MS1/MS2	PS1/PS2
		PLT	MS1	PS1
TARGET ACQUISITION	18:21:30-		FINDER VIDEO/OPEN A3	
			COARSE GUIDE L11/A3	
			Ø SUOT COVER	
			ACQ CAMERA	
			GP SETUP	
			PCS SLIT VIDEO	
			FINE GUIDE L11	PCS SETUP R12
			VECTOR UPDATE L11	COMPARISON
DIC/PCS EXP START	18:28-			DIC/PCS EXP START
				SUOT STATUS
	18:38-			PCS EXP END
				PCS INCRE
	18:38:19			PCS EXPEND
	18:48:19-			PCS SETUP
				COMPARISON
PCS EXP START	18:53-			PCS EXP START
				PCS/DIC STATUS
DIC EXP END	18:58-			DIC EXP END
				P LIST INFO
		ENTER TARGET DATA		TARGET DATA
PCS EXP END	19:08-			PCS EXP END

TABLE B-2 SPACELAB PRELOAD POWER

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
CDR	Enter DISPLAY 118 PRO on Keyboard	C2/F7	x		Calls up menu for preload power sequence on CRT 2
CDR	Enter SPEC 1 PRO on Keyboard	C2/F7	x		Computer reads bus C load to S/L
CDR	Acknowledge MN Bus C load	F7		x	Message at bottom of screen
CDR	Enter ITEM 2 EXEC & Acknowledge	C2/F7	x		Activates S/S inverter
CDR	Enter ITEM 3 EXEC & Acknowledge	C2/F7	x		Activates EXP inverter
CDR	Enter ITEM 4 EXEC & Acknowledge	C2/F7	x		Turns S/S SEL SW to EXP INV.
CDR	Enter ITEM 5 EXEC & Acknowledge	C2/F7	x		Turns EXP SEZ SW to S /S inv.
CDR	Enter ITEM 6 EXEC & Acknowledge	C2/F7	x		Activates S/S I/O
CDR	Enter ITEM 7 EXEC & Acknowledge	C2/F7	x		Activates S/S Computer
CDR	Enter ITEM 8 EXEC & Acknowledge	C2/F7	x		Loads MMU/IDLE Power
CDR	Enter ITEM 9 EXEC & Acknowledge	C2/F7	x		ACT PS CRT/KYBD 1
CDR	Enter ITEM 10 EXEC & Acknowledge	C2/F7	x		ACT PS CRT/KYBD 2
CDR	Enter ITEM 11 EXEC & Acknowledge	C2/F7	x		ACT MS CRT/KYBD
CDR	Enter ITEM 12 EXEC & Acknowledge	C2/F7	x		ACT S/S RAU's
CDR	Enter SPEC 13 PRO	C2/F7	x		Computes Bus C Load to S/L
CDR	Acknowledge S/L Load > 2.0 kw	F7		x	
CDR	Enter DISPLAY 215 PRO on Keyboard	C2/F7	x		Calls S/L Power Reconfig C/L on CRT 3
CDR	Switch PRI FC3 - ON	R1		x	
CDR	Switch PRI MNC - OFF	R1		x	
CDR	Switch MN Bus Tie C - ON	R1		x	
CDR	Switch MN Bus Tie A - ON	R1		x	

TABLE B-2 SPACELAB PRELOAD POWER

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
CDR	Enter SPEC 14 PRO & Ack. Load Note: If Load $>$ 2.0 kw proceed to next step; if $<$ 2.0 kw proceed to 118 load sequence Item 15, then repeat bus load check	C2/F7	x		Compute S/L Bus Load Load must be $>$ 2.0 kw Before FC3 Dedication
CDR	CHK FC3 VOLT/CURRENT	F9		x	24-32 VDC at ~75 Amps
CDR	Switch FC/MN Bus C - OFF	R1		x	Isolates MN Bus C from S/L & Dedicates FC3
CDR	Enter ITEM 15 EXEC	C2/F7	x		ACT EXP I/O
CDR	Enter ITEM 16 EXEC	C2/F7	x		ACT EXP Computer
CDR	Enter ITEM 17 EXEC	C2/F7	x		Loads MMU
CDR	Enter ITEM 18 EXEC	C2/F7	x		ACT EXP RAU's

TABLE B-3 CCTV ACTIVATION & P/L LIGHTING

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
CDR/ PLT	SWITCH CONTROL UNIT - MN A	A7		x	ENABLES CCTV SYSTEM
	SWITCHFWD BAY CAMERA POWER - ON	A7		x	
	SELECT VIDEO OUTPUT - MON 1 DEPRESS	A7		x	MON 1 LIGHTS
	SELECT VIDEO INPUT - FWD BAY DEPRESS	A7		x	FWD BAY LIGHTS
	SWITCH CAMERA COMMAND - TEST ON	A7		x	
	OBSERVE & VERIFY CAMERA OPERATION PATTERN	A7		x	
	SWITCH CAMERA COMMAND - TEST OFF.	A7		x	
	SWITCH AFT STBD FLOOD - ON	A7		x	
	SWITCH MID PORT FLOOD - ON	A7		x	
	STANDARD CAMERA COMMAND SEQUENCE				
	ADJUST CAMERA COMMAND - IRIS TO OPEN	A7		x	
	OBSERVE IMAGE (SUOT) FACILITY IMAGE - MON 1	A7		x	
	FACILITY MAY NOT BE IN FIELD OF VIEW	A7		x	
	SLEW CAMERA COMMANDS:	A7		x	
	PAN TO (SUOT) IMAGE - LEFT OR RIGHT	A7		x	
	TILT TO (SUOT) IMAGE - UP OR DOWN	A7		x	
	ADJUST CAMERA COMMANDS TO OPTIMUM IMAGE:	A7		x	
	IRIS - OPEN/CLOSE - AS REQUIRED	A7		x	
	FOCUS - FAR-NEAR - AS REQUIRED	A7		x	
	ZOOM - IN/OUT - AS REQUIRED	A7		x	
	OBSERVE SUBJECT LIGHTING AND CHANGE FLOOD COMBINATIONS, MID/AFT, STBD/PORT,	A7		x	
	RECONFIGURE FWD BAY CAMERA COMMANDS FOR OPTIMUM IMAGE	A7		x	

TABLE B-3 CCTV ACTIVATION & P/L LIGHTING

Date 4-5-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
	CONTINUE CCTV ACTIVATION - IF TWO PAYLOAD BAY CAMERA DESIRED				
CDR/PLT	SWITCH AFT BAY CAMERA POWER - ON	A7		x	MON 2 LIGHTS
	SELECT VIDEO OUTPUT - MON 2 DEPRESS (OBSERVE MON 1 LIGHT GOES OUT)	A7		x	MON 1 IMAGE & FWD CAM REMAIN AS INITIALLY SET UP
	SELECT VIDEO INPUT - AFT BAY DEPRESS	A7		x	AFT BAY - LIGHTS
	(OBSERVE FWD BAY LIGHT GOES OUT)				MON 2 IS NOW SLAVED TO AFT CAMERA - NO CHANGES TO MON 1 & FWD CAMERA
	SWITCH CAMERA COMMAND - TEST ON	A7		x	
	OBSERVE & VERIFY CAMERA OPERATION PATTERN	A7		x	
	SWITCH CAMERA COMMAND - TEST OFF	A7		x	
	PROCEDE TO: "STANDARD CAMERA COMMAND SEQUENCE" (Page 1, Last half)				

TABLE B-4 SUOT C/O & DEPLOYMENT OPERATIONS

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Turn CRT Selector Switch to 3	R12		x	Routes CRT/KYBD to SUOT/IPS
MS	Sign ON Experiment Computer/SUOT Application and Wait for Confirmation	R12	x		
MS	Type LOADFILE SUOT DIC PCS & Depress C/R key and await acknowledgement	R12	x		
MS	Switch SHOT MIRROR to OPERATE and confirm metering by OPR Indicator	R12		x	Meters Mirror
MS	Type SUOT STATUS & Depress C/R Key and Await Response	R12	x		
MS	Review SUOT status for acceptable parameters	R12		x	
PS	Turn CRT Selector Switch to 8	L11		x	Routes CRT/KYBD to SUOT Instr.
PS	Sign ON Experiment Computer/SUOT Application and wait for confirmation	L11	x		
PS	Type DIC STATUS & Depress C/R Key	L11	x		
PS	Review DIC Status for acceptable predeployment parameters	L11		x	
PS	Type DIC PWR STANDBY & C/R	L11	x		
PS	Confirm voltage at 14500 on DIC Status			x	
MS	Switch PCS Power ON and confirm by Indic.	R12		x	
MS	Type LOADFILE FUS PIC & C/R & await acknowledgement	R12	x		
PS	Type PCS STATUS & Depress C/R	L11	x		
PS	Review PCS Status for acceptable parameters	L11		x	
MS	Switch Spectrograph (FUS) Power ON and confirm by Indicator	L11		x	
PS	Type FUS STATUS & C/R	L11	x		
PS	Review FUS Status for acceptable parameters	L11		x	
PS	Depress PAGE FORWARD key & type PIC STATUS & C/R	L11	x		
PS	Review PIC Status for Acceptable parameters	L11		x	
PS	Advise MS when Instr. Statusing complete	L11		x	
MS	Switch PCS and FUS Power OFF	R12		x	
MS	Type UNLOADFILE DIC PCS FUS PIC & C/R	R12	x		SUOT program remains loaded thru IPS mating & deployment

TABLE B-4 SUOT C/O & DEPLOYMENT OPERATIONS

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Enter OPS 23 PRO on MCDS Keyboard	R11	x		Calls SUOT/Bay Latch Control Seq.
MS	Enter ITEM 1 EXEC & Acknowledge	R11	x		Enables Pallet 4 Latch Control Mechanis
MS	Enter ITEM 2 EXEC & Acknowledge	R11	x		Sets SUOT Bay Latching in XLATE POS
MS	Enter ITEM 3 EXEC & Acknowledge	R11	x		SUOT/IPS Winch Motor to STANDBY
MS	Enter ITEM 4 EXEC & Acknowledge	R11	x		Cable Drive to ENGAGE
MS	Enter ITEM 5 EXEC & Acknowledge	R11	x		Mating Latches to RECEIVE
MS	Enter ITEM 6 EXEC & Acknowledge	R11	x		Winch Motor - DRIVE
MS	Enter ITEM 7 EXEC & Acknowledge	R11	x		SUOT/IPS Latches-LOCK
MS	Enter ITEM 8 EXEC & Acknowledge	R11	x		Cable Drive - RELEASE
MS	Enter ITEM 9 EXEC & Acknowledge	R11	x		Winch Motor OFF
MS	Enter ITEM 10 EXEC & Acknowledge	R11	x		P/L Bay Restraint Latch RELEASE
CDR/PLT	Reference CCTV Activation & Payload Lighting Procedure	A7		x	
MS	Check Application Routing	R12		x	
MS	Type PRESET Z0 & Depress C/R & Await Response	R12	x		Elevates SUOT to 0 Position
CDR & PS	Confirm SUOT Elevation thru Aft windows and by CCTV2	A3		x	
MS	Type ZENITH & C/R & Await Response	R12	x		Checks SUOT position & prints out 90° ELV, 0° ROLL, 0° TILT
CDR	Switch Aft Bay Camera Pwr to OFF	A7		x	
CDR	Switch VCU Power to OFF	A7		x	
CDR	Switch Aft Starboard Flood OFF	A7		x	
CDR	Switch Aft Port Flood OFF	A7		x	
MS	Depress CLEAR key	R12	x		Clears Screen
MS	Check Application Routing	R12		x	Previously Signed on to SUOT
MS	Type SUOT STATUS & Depress C/R	R12	x		

TABLE B-4 SUOT C/O DEPLOYMENT OPERATIONS

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Await Response & review status	R12		x	
PS	Check Application Routing	L11		x	
PS	Type LOADFILE DIC PCS FUS PIC & C/R & Await Response	L11	x		
MS	Switch PCS & FUS Power ON				
PS	Type DIC STATUS & C/R & Await Response	L11	x		
PS	Review Status	L11		x	
PS	Type DIC PWR STANDBY & C/R & Await Response	L11	x		
PS	Review DIC Status	L11		x	
PS	Type PCS STATUS & C/R & Await Response	L11	x		MS can call up PLIST, ident, & enter next target ID & advise CDR
PS	Review PCS Status	L11		x	
PS	Type FUS STATUS & C/R & await response	L11	x		
PS	Review FUS status	L11		x	
PS	Page forward on CRT	L11		x	
PS	Type PIC STATUS & C/R & Await response	L11	x		
PS	Review PIC Status	L11		x	
PS	Advise MS on completion of Instr. Status	L11		x	
MS	Switch PCS & FUS Power OFF	R12		x	
MS	Page Forward on CRT	R12		x	
MS	Type P List & C/R and obtain 1st target data for SUOT	R12	x		
MS	Depress Backpage key & Type Z & C/R & Await Response	R12			
MS	After WHICH OBJ? Type HD149886 & C/R Await Response	R12	x		
MS	Review targeting data	R12		x	
MS	Provide Orb. attitude vectors & acquistion time to CDR	R12		x	
MS	Type UNLOADFILE SUOT DIC PCS FUS PIC & C/R & Await Confirmation	R12	x		After PS has completed Instr. Status

TABLE B-5 UNIVERSAL POINTING - ORBITER MNVR 3

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PLT	Enter OPS, 200, PRO on keyboard	C2	X		Any FWD or AFT KB & CRT calls up Universal Pointing Processor (S/W) in GPC
	Acknowledge Universal Pointing Display	F7		X	Display appears on CRT, with current attitudes given.
PLT	Enter ITEM, 3, EXEC	C2	X		Selects MNVR 3 mode, which maneuvers the orbit to a new set of R, P & Y
PLT	Enter ITEM, 23, ___.__, ___.__, ___.__, ENTER	C2	X		Enters Roll - Item 23 Pitch - Item 24 Yaw - Item 25 of attitude desired
PLT	Acknowledge R, P & Y at "MNVR 3X" and "Body Attitudes Desired" displayed	F7		X	
PLT	Acknowledge "ATTITUDE ERRORS" displayed	F7		X	The difference between current & desired attitude
PLT	Acknowledge "MNVR TIME" displayed	F7		X	The computed maneuver time to get to new attitude - (assume 1/2^{o}/Sec Rate)
PLT	Enter ITEM, 26, 08, ENTER	C2	X		Selects appropriate Pointing Vector
PLT	Acknowledge "POINTING VECTOR" Displayed	F7		X	
PLT	Enter ITEM, 36, EXEC	C2	X		Selects attitude error computation mode for errors to count down to zero
	Note: Next step will execute maneuver				The next entries are critical
PLT	Enter ITEM, 30, ___, __, __, __, ENTER OR	C2	X		Enters the time the maneuver is to be executed, in advance. GMT or MET the S/W will initiate the maneuver as specified time enters the command to execute the maneuver on depression of the "EXEC" key on the keyboard. The maneuver will start immediately after depression of "EXEC".
PLT	Enter (WITH CAUTION) ITEM, 34, EXEC	C2	X		

Date 4-1-76

TABLE B-6 CCTV DEDICATED TO P/L CAMERA(S)

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	SELECT VIDEO OUTPUT - MON 2 DEPRESS (OBSERVE MON 1 or MON 2 LIGHT GOES OUT)	A7		x	MON2 LIGHTS (Previous monitor & Camera Remain as Initially Setup)
	SELECT VIDEO INPUT - PL3 DEPRESS (OBSERVE PREVIOUSLY SELECT VIDEO INPUT - LIGHT GOES OUT)	A7		x	PL3-LIGHTS-MON 2 NOW SLAVED TO PAYLOAD CAMERA
	CHECK BAY CCTV CAMERAS OFF	A7			IF NOT REQUIRED

TABLE B-7 CCTV DOWNLINK

Date 4-7-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
	(Assume Cameras & Monitors Setup) and Comm. Equip. Activated				Refer to CCTV Activation
CDR/PLT	Verify/Select TV Down Link-Enable	A7		x	Allows ground to see CCTV-without it ground has no TV
	Verify/Select (1) SBAND FM-DATA SOURCE-TV	A1		x	SBAND Configured to Downlink TV
	or				
	(2) KUBAND-HIGH DATA RATE-TV/OPS	A1		x	KUBAND configured to Downlink TV
	Select Video Output-Downlink Depress	A7		x	
	Select-Video Input - Desired:	A7		x	Routes Source TV
	FWD BAY - DEPRESS AS DESIRED	A7		x	Signal to Downlink
	AFT BAY - DEPRESS AS DESIRED	A7		x	
	PL3 - DEPRESS AS DESIRED	A7		x	
	ETC - DEPRESS AS DESIRED	A7		x	

TABLE B-8 SUOT/DIC LOAD & INITIAL EXPOSURE SEQUENCE

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PLT	Ref Std Procedure for Orbiter Attitude Maneuver Preparation	F7/C2			
MS	Ref Std Procedure for CCTV Monitor Activation	A7		x	
MS	Check PL Application for Exp Computer	L11		x	
MS	Type LOADFILE SUOT DIC & depress C/R key & wait for acknowledgement	L11	x		Loads programs & tells computer instrument usage
MS	Type SUOT STATUS & depress C/R key	L11	x		Requests printout of SUOT status (PS requests DIC status concurrently)
MS	Review SUOT Status - Guide Probe Coordinates and focus settings should agree with preload settings	L11		x	
PS	Type DIC STATUS & depress C/R key	R12	x		(Concurrent with MS SUCT Status Req.)
PS	Review DIC Status	R12		x	
PLT	Advise of Maneuver Initiation & Confirm "Mnvr Time" Countdown; Confirm R, P, Y Attitude Errors Converging to Zero	F7	x		At 0 the mnvr is completed (initiate mnvr concurrent with DIC status)
PS	Type DIC PWR STANDBY & depress C/R key & wait for acknowledgement	R12			Powers DIC to 1/2 full power - 14,500 volts
PLT	Notify MS & PS upon Maneuver Completion	F7			Time is 15:53:00; Att hold initiated with 0.5° deadband (automatic)
PS	Set Event Timer at 23:00 for DIC Exp at 16:28	R12		x	
MS	Set Event Timer for Countdown to Star Field Acquisition (Acq. at 16:10:00) - set to 05:00	L11		x	
MS	Type FINDER VIDEO1 & C/R & await response & check image on CCTV1	L11/ A3	x		Powers Finder Telescope & routes video signal to CCTV1
MS	Type ZENITH & C/R & confirm SUOT Position Vectors	L11	x		Checks SUOT position & prints out 90° ELV, 0° ROLL, 0° TILT & calls up SAO star pattern for 3° sq. FOV & displays on CCTV1
MS	Confirm SAO pattern on CCTV1	A3		x	
MS	Monitor Event Timer and at 00:15 (by 16:12) Type Ø FSHUT & C/R & await acknowledgement	L11	x	x	Opens Finder Dark Slide - Time is 16:12

TABLE B-8 SUOT/DIC LOAD & INITIAL EXPOSURE SEQUENCE

Date 4-6-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type CGUIDE & C/R & await response	L11	x		Coarse guidance initiated. Update of error signal generated by 10 brightest stars is fed to IPS.
MS	Examine field, confirm coarse guidance operative	A3		x	CCTV1
MS	Set Pointing Control Slew Rate to FAST & turn Power Switch to ON	L11		x	
MS	Search for Z Star with Pointing Controls	L11/ A3		x	
MS	Align Star Pattern with SAO Pattern	L11/ A3		x	
MS	Type Ø SCOVER & C/R & await acknowledgement	L11	x		Opens SUOT Facility Cover
MS	Type ACAMERA VIDEO2 & C/R & check acknowledgement	L11	x		Sets up Acquisition Camera & sends signal for display on CCTV2
MS	Type Ø ACAMERA & C/R & check acknowledgement	L11	x		Opens Acquisition Camera Shutter
MS	Confirm Z Star and Center with Pointing Control	L11/ A3		x	CCTV2 (PS may setup DIC & Status concurrently)
MS	Type GP SETUP & Depress C/R Key & check acknowledgement	L11	x		Computer sets position of GP1 & 2 to preselected guide stars from Z Star List
MS	Type GP1 VIDEO2 & C/R; Confirm Star Acquisition	L11/ A3			Video from GP1 is routed to CCTV2 replacing A Camera & SAO image
MS	Type GP2 VIDEO1 & C/R; Confirm Star Acquisition	L11/ A3	x		Video from GP2 is routed to CCTV1 replacing Finder & SAO image
MS	Type FGUIDE & C/R & acknowledge	L11	x		Initiates fine guidance
MS	Type OBS & C/R & await confirmation	L11	x		Updates SUOT vector and corrects pointing error program
MS	Switch Pointing Control OFF	L11		x	
PS	Type DIC SETUP & C/R	R12	x		Sets up instrument bay for DIC and prints out status
PS	Review DIC Status parameters per setup	R12		x	
PS	Type DIC HI VOLT & C/R	R12	x		Voltage brought up in prescribed levels

TABLE B-8 SUOT/DIC LOAD & INITIAL EXPOSURE SEQUENCE

Date 4-6-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Type DIC STATUS & C/R	R12	x		Status printed out
PS	Review status for proper settings, voltage, temp.	R12		x	(May be done concurrently with GP1 VIDEO above)
PS	Type STAR & C/R & await response	R12	x		Computer sets up and advances FIC frame
PS	After EXP TIME: Type 200S & C/R	R12	x		Exposure time for DIC is entered below UT
PS	When ready depress C/R twice (at 16:28:00)	R12	x		Opens DIC Shutter, Initiates exposure & displays countdown
PS	Monitor Instrument Status	R12		x	
MS	Depress Page Forward Key	L11	x		(MS Sequence concurrent with DIC prep)
MS	Type P LIST & C/R for next target data	L11	x		Prints out Star Target I.D., instr, revolution, coord, max exp time
MS	Depress Page Forward Key	L11	x		
MS	Type P & C/R & await response	L11	x		
MS	After WHICH OBJ? Type NGC1499 & C/R & await response	L11	x		From P List computer selects & prints Epoch, RA, Dec, Phi, G.P., coord, preferred Orb vectors
MS	Review Target data & provide Orbiter Vectors to PLT for next maneuver	L11		x	
MS	Page Backward to pg 1 for SUOT Status	L11	x		
	At end of DIC Exposure computer prints: END OF DIC EXPOSURE TIME = 200 SEC, CAL WEDGE = 3 IF MORE EXP TIME DESIRED TYPE INCRE IF NOT TYPE END	R12	x		Comp. closes DIC shutter
PS	Type END & C/R and wait for acknowledgement	R12	x		Closes Finder Shutter, SUOT cover GP1 & 2 Shutters & Advances DIC Frame

TABLE B-9 SECOND DIC EXPOSURE SEQUENCE

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PLT	Ref Std Procedure for Orbiter Att. Maneuver Preparation	F7/C2	x		
MS	Type PRESET & Depress C/R Key & await response	L11	x		Stores command for computer to maneuver IPS - preset time & rates & to G.P. coord.; calls up SAO pattern for CCTV2 display
PLT	Advise of attitude maneuver initiation & confirm "Mnvr Time" Count Down; confirm R, P, Y attitude error convergence to 0.	F7		x	Mnvr will be complete when R, P, Y read 0
MS	Confirm SAO star pattern on CCTV1	A3		x	
PS	Type DIC SETUP & C/R & review DIC status parameters	R12	x		DIC parameters from star list are programmed & status is printed out
PLT	Notify MS & PS upon maneuver completion	F7		x	Time is 17:22:00; Att. Hold initiated
MS	Set Event Timer for Count Down to Star Field Acquisition (Reg at 17:31:00) - Set to 08:00	L11		x	
PS	Set Event Timer at 18:00 for DIC Exp at 17:41	R12		x	
MS	Type FINDER VIDEO1 & C/R & await response & check image on CCTV1	L11	x		Powers Finder and routes video signal to CCTV1
MS	Monitor EVENT TIMER and at 00:15 type ØFSHUT & C/R & acknowledge	L11	x		Opens Finder Shutter - Time is 17:31:00
MS	Type CGUIDE & C/R & acknowledge	L11	x		Initiates Course Guidance & sends Updated Error Signal to IPS
MS	Examine field & confirm course guidance operative	A3		x	CCTV1
MS	Set Pointing Control Rate to SLOW	L11		x	
MS	Switch Pointing Control Power to ON	L11		x	
MS	Correct Pointing with Controller	L11/ A3		x	CCTV1
MS	Type Ø SCOVER & C/R & await acknowledgement	L11	x		Opens SUOT Facility Cover
MS	Type ACAMERA VIDEO2 & C/R	L11	x		Sets up Acquis. Camera and routes video signal to CCTV2
MS	Type Ø ACAMERA & C/R & acknowledge; center P Star with controller	L11/ A3	x		Opens Acquis. Camera Shutter

TABLE B-9 SECOND DIC EXPOSURE SEQUENCE

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type GP SETUP & C/R & await acknowledgement	L11	x		Computer sets position of GP1 and GP2 to preselected guide stars for P List selection
MS	Type GP1 VIDEO2 & C/R & Confirm Star	L11/A3	x		GP1 video to CCTV1 replacing Finder & SAO Image
MS	Type GP2 VIDEO1 & C/R & Confirm Star	L11/A3	x		GP2 Video to CCTV2 replacing Acq. Camera Image
MS	Type FGUIDE & C/R & acknowledge	L11	x		Initiates Fine Guidance
MS	Type OBJ & C/R & acknowledge	L11	x		Updates SUOT vector and corrects pointing error program
MS	Switch Pointing Controller Power OFF	L11		x	
PS	Type DIC SETUP & C/R Review DIC Status Parameters	R12	x		Moves mirror and prints out status
PS	Type STAR & C/R and wait for response then: After Exposure Time: type 35M & C/R	R12	x		Frame advanced Event time appears below UT at 00:00
PS	When ready (ref Display UT) depress C/R C/R (at 17:41:00)	R12	x		Time countup begins on display, shutter opens and exposure begins
PS	Monitor DIC Status	R12		x	
PS	Type SUOT STATUS & C/R and monitor it	R12	x		Status printed out
MS	Work with other stellar astronomy facilities and monitor Subsys during this period				
PS	Depress Page Forward key	R12	x		
PS	Type P LIST & C/R & obtain next target data	R12			
PS	Depress Page Forward key	R12	x		
PS	Type P & C/R & await response	R12	x		
PS	After WHICH OBJ? Type M81-5 & C/R & await targetting information	R12	x		Data for DIC/PCS
PS	Provide Orbiter Vectors to PLT	R12		x	
PLT	Ref Std Procedure for Orb. Att Mnvr Preparation	F7/C2			At 18:10

TABLE B-9 SECOND DIC EXPOSURE SEQUENCE

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Type LOADFILE PCS & C/R	R12	x		
PS	Type PCS STATUS & C/R	R12	x		
PS	Review PCS Status Parameters	R12		x	
	Computer Prints: END OF DIC EXPOSURE TIME = 35 MIN, CAL WEDGE = 6	R12	x		Closes DIC Shutter
PS	Type END & C/R	R12	x		Close Finder Shutter, SUOT Cover, GP 1 & 2 Shutters & Adv DIC Frame

TABLE B-10 DIC/PCS EXPOSURE SEQUENCE

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PLT	Advise MS/PS of Orb. Att Mnvr initiation & monitor "Mnvr Time" countdown & R, P, Y	F7	x		
MS	Reset Event Timer at 05:00 for Countdown to Star Field Acquisition	L11		x	Acquire at 18:21:30
PS	Reset Event Timer at 11:30 for DIC/PCS Exposure Start	R12		x	Start Exp at 18:28
MS	Type PRESET & C/R & await response; confirm SAO pattern on CCTV1	L11	x		Stores command for computer to initiate IPS maneuver; calls up SAO pattern to CCTV1
PS	Type PCS DIC SETUP & C/R and review status parameters	R12	x		Instr. Star List parameters are programmed & status printed out
PLT	Notify MS/PS upon maneuver completion	F7		x	Time is 18:20:05
MS	Monitor Event Timer and at 00:15 type FINDER VIDEO1 Ø FSHUT & C/R & await acknowledgement	L11	x		Powers Finder, video signal to CCTV1, shutter opened
MS	Type CGUIDE & C/R & acknowledge	L11	x		Course guidance initiated. Update of error signal from Finder sent to IPS
MS	Set Pointing Control Slew Rate to FAST & turn power switch ON	L11		x	
MS	Correct pointing with Controller	L11/ A3		x	
MS	Type Ø SCOVER ACAMERA VIDEO2 & C/R & await acknowledgement; center stay by controller	L11/ A3	x		Opens SUOT Cover, Opens Acquisition Camera Shutter and routes video signal to CCTV2
MS	Type GP SETUP & C/R & acknowledge	L11	x		Computer sets position of GP1 and GP2 to preselected guide stars from P List selection
MS	Type GP1 VIDEO2 & C/R and confirm star	L11/ A3	x		GP1 video signal routed to CCTV2
MS	Type GP2 VIDEO1 & C/R & confirm star	L11/ A3	x		GP2 video signal routed to CCTV1
MS	Type PCS SMIR VIDEO2 & C/R	L11/ A3	x		Used for PCS to examine image from Preslit Viewer
MS	Using CCTV2 and pointing control center image through slit. MS or PS monitor thru exposure.	A3/ L11		x	Star image is moved to fall thru slit

TABLE B-10 DIC/PCS EXPOSURE SEQUENCE

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
MS	Type FGUIDE & C/R & acknowledge	L11	x		Initiates Fine Guidance
MS	Type OBJ & C/R & acknowledge	L11	x		Updates SUOT vector and corrects pointing error program
MS	Switch Pointing Control Power OFF	L11		x	
PS	Type PCS SETUP & C/R & await response	R12	x		Adjusts optics for simultaneous use
PS	Type COMP & C/R & wait for response - then after COMPTIME: Type 10S & C/R	R12	x		Comparison time - calls up timer Required for PCS only. Hold next command until comp is completed.
PS	Type STAR & C/R & wait for response - then after DIC EXP TIME: Type 30M PCS EXP TIME: Type 10M	R12	x		For DIC & PCS type times for each. Event time field appears below UT on display (2 for 2 instr).
PS	When ready (ref Display UT) depress C/R C/R (at 18:28)	R12	x		Time countup begins on display, shutters open & exposure begins
PS	Page Forward for PCS End Message	R12		x	
	At end of PCS Exposure Computer prints - Time = 10 min If more exposure time desired type: INCRE	R12	x		
PS	Type INCRE & C/R & wait for rreponse then after - INCREMENTAL TIME: Type 10M C/R	R12	x		Time to be doubled
PS	After response depress C/R twice	R12	x		Time countup starts, shutter opens and 2nd exposure begins
PS	After computer prints time complete for PCS (10 min) - type END PCS & C/R	R12	x		Closes PCS Shutter
PS	Type PCS SETUP & C/R & review status parameters	R12	x		Star List parameters are programmed on status is printed out. New wave spectrum set.
PS	Type COMP & C/R & await response - then after COMPTIME: type 30S	R12	x		
PS	Type STAR & C/R & wait for response - computer prints PCS EXP TIME: 15 MIN DIC EXP TIME: 5 MIN REMAIN	R12	x		Event timer resets to 00:00
PS	When ready (ref Display UT) depress C/R C/R	R12	x		Time counting begins on display, shutter opens & exposure begins

TABLE B-10 DIC/PCS EXPOSURE SEQUENCE

Date 4-6-76

CREW	TASK	PANEL	MODE AUTO	MODE MAN	REMARKS
PS	Monitor PCS & DIC Status	R12	x	x	
PS	Page Backward for SUOT Status (if req'd)	R12		x	
	At end of DIC Exposure Computer prints out - Time = 30 MIN, CAL WEDGE = 5 If more exposure time desired type INCRE If not type END DIC	R12	x		Computer closes shutter on DIC
PS	Type END DIC & C/R	R12	x		DIC Film Advanced; PCS still operative
PS	Page Forward	R12		x	
PS	Type P LIST & C/R & obtain target & Instr. data for next exposure	R12	x		
PS	Page Forward	R12		x	
PS	Type P & C/R & await response	R12	x		For target I.D. entry
PS	After WHICH OBJECT? Type NGC7027 & C/R & await response; provide Orbiter Vector to PL7	R12	x		
	At end of PCS exposure computer prints: END OF PCS EXPOSURE TIME = 15 MIN IF MORE EXP TIME DESIRED TYPE INCRE IF NOT TYPE END	R12	x		Computer closes shutter on PCS
PS	Type END & C/R	R12	x		Closes Finder Shutter, SUOT Cover, G.P. Shutters

TASK 1 FINAL REPORT

APPENDIX C

PERSONNEL CONTACTED

APPENDIX C - PERSONNEL CONTACTED

Each of the major NASA payload development centers were visited during the course of this study. This appendix identifies the personnel contacted at each center, their phone number and program or function where known.

ARC

Bob Jackson	X5918	Planetary Mission Office
Tom Harmont		SIRTF Study Manager
Charles Swift	X6330	SIRTF
Lou Young	X6546	SIRTF
Ramsey Malugin	X5902	SIRTF
Jim Murphy	X6520	OFT/SIRTF
Skip Nunamaker	X5890	Advanced Mission Office
Dr. Richard D. Johnson	X5117	BESS Study Manager
Dr. John Tremor		BESS
Bill Berry		BESS

GSFC

Fred S. Flatow	X5268	Earth Viewing Applications Lab
Samuel J. Osler	X6619	Astronomy/Spacelab Payloads Office
David Leckrone, Ph.D.	X4904	SUOT Project Scientist
Werner Neupert, Ph.D.	X5523	Solar Astronomy Scientist
Art White	X4345	Dedicated Solar Sortie Mission
Dave Grimes		AMPS Project
Roger Mattson	X5915	
Don Miller	X4481	MMS Project
Don Burrowbridge	X4584	MMS Project
Bill Hoggard	X5515	MMS Project

JPL

Phil Barnett

LaRC

Chas. Llewellyn	X3666	Advanced Technology Laboratory
Bill Goslee	X3666	Advanced Technology Laboratory

MSFC

Harry Watters	X4430	Onboard Payload Functional Reqs.
Roy Lester		1st. Spacelab Mission

TASK 1 FINAL REPORT

APPENDIX D

REFERENCE DATA

A. PAYLOAD DOCUMENT - GENERAL

1) Space Shuttle System - Payload Accommodations, Vol. XIV JSC 07700

2) Spacelab Payload Accommodation Handbook

3) Integrated Control Display Station for Teleoperator and Experiments 7-30-75 MMC/MSFC

4) Summarized NASA Payload Descriptions - Sortie Payloads Level A Data - 7-75 MSFC

5) Payload Descriptions - Vol. II Book 1 Level B Data - July '75 MSFC

6) Payload Descriptions - Vol. II Book 2 - Level B Data - July '75 MSFC

7) Space Shuttle Payload Accommodations on the Aft Flight Deck - JSC-09343 1-20-75

8) Space Shuttle System Payload Accommodations Vol. XI - Crew Operations JSC-07700

9) IUS/TUG Payload Rqmts. Compatibility Study - Final Report Vol. II - MDAC - May '75

10) Summarized NASA Payload Descriptions - Automated Payloads Level A Data - 7-75 MSFC

11) Payload Descriptions Vol. I Automated Payloads Level B Data - 7-75 MSFC

12) Space Shuttle Baseline Evaluation of Capabilities for OFT 8-22-75

13) OFT Payload Planning Excerpts 8-25-75

14) OFT Payload Planning, Supplemental Data - 9-2-75 Excerpts

15) Payload Operation/Crew Function Workshop - R. F. Hergert, NASA TMX-58146

16) Integrated C/D Station for Teleoperator and Experiments, MCR - 75-450, Final Report, Nov. 1975, MMC/MSFC

17) Payload Interfaces Team Documentation, Aft Flt Deck Payload Accommodations, Orbiter 102, Feb. '75 PDR-JSC 09321

18) Safety Policy and Requirements for Payloads Using the Nat'l STS, Draft Prep by: Payload Safety Steering Group, NASA Hdqtrs, Code MQ - Revision Sept. '75, Memo Cover - NS2/75-M158 fr Raines

19) Integrated C/D Station for Teleoperator & Exp. Final Presentation Handout, Dec. '75, MMC

20) IUS Strawman - Phase I Rough Draft - 12/5/75 - Vande Zande

21) Interim Report of Astronomy Spacelab Payloads Study - July '75 - GSFC
- Executive Volume
- Solar Physics Vol. I
- UV & Optical Astron. Vol. 2
- Hi energy Astro Physics Vol. 3
- Mission Analysis Vol. 4
- Engineering Vol. 5

22) RMS - requirements/Definition Doc. - JSC 10633 Rev. A., Dec. 15, 1975

23) JSC-07700 Vol. XIV Rev. D, Payload Accommodations Nov. 26, 1975

24) RMS Handouts by R. B. Davidson, 12-4-75, for BESS Meeting at JSC

25) End Item Description of Multifunction Display System and Test Set for Spacelab CVT - 10-23-73 MSFC

26) Payload Specialist Station Study - Study Plan - Dec. '75, MMC

27) Integrated Control/Display Station for Teleoperator and Experiments - Final Presentation - Dec '75 MMC

28) Payload Specialist Station Study - Orientation Meeting - Dec '75 MMC

29) Payload Specialist Station Study - Monthly Status Report - Feb., 15, 1976- MMC

30) Payload Specialist Station Study - Design Review No. 2, Mar., 16, 1976 - MMC

31) Study for Application of a Sounding Rocket Experiment to Spacelab Shuttle Mission - Arthur D. Code, P. I. (Univ. of Wisconsin) Aug '75, Final Report for GSFC

B. PAYLOAD DOCUMENT - UNIQUE

ADVANCED TECHNOLOGY LAB (ATL)

1) NASA Tech. Memorandum - NASA TMX 2813 - Study of Shuttle Compatible Advanced Technology Laboratory (ATL) Sept. '73

2) ATL Experiment Systems Definition NAS1 14116 - Task I - Experiment Design, March 1976 - SD 76-SA-0017 RI

3) ATL Experiment Definition Packages - 11 each for Payload No. 3 (Pallet Only)

ATMOSPHERIC MAGNETOSPHERIC PLASMAS IN SPACE (AMPS)

1) Man-Eqpt Interactive Experiments on Shuttle/Amps Spacelab - Data Handling, D & Cs revised for selected sample experiments; prelim study by Rice and JSC, May '75

2) Atmospheric Science Facility - Strawman - 12/17/75 - Phase I Rough Draft (also have rough draft of this 12/5/75)

3) JSC-10683 Atmospheric Science Facility - Pallet Only Mode (Feasibility Study) Interim Technical Report, Vol I for Exp Sys Div, JSC Nov. 1975

4) JSC-10683 Atmos. Science Facility - Pallet Only Mode (Feasibility Study) Interim Technical Report, Vol. 2 for Exp. Sys Div, JSC, Nov '75

BIOMEDICAL EXP. SCIENTIFIC SATELLITE (BESS)

1) Second Program Review, Dec 8, 1975 GE, BESS

DEDICATED SOLAR SORTIE MISSION

1) Solar Physics Engineering & Operationsl Interface Study - F75-11 - Astronomy Spacelab Payloads - Final Report 7-30-75 - Ball Bros.

2) Ref. General List Item 2

3) Mid-term Review, Solar Astronomy Payloads Instrument Interface Study - Phase II Data and Control Processing Analysis - 2-6-75 Ball Bros.

4) Data and Control Requirements for a Dedicated Solar Physics Spacelab Mission - Ball Bros.

Payload Documentation - Unique (cont'd)
Page 2

DEEP SKY UV SURVEY TELESCOPE (DUST)

1) Typed Notes from Henize - 5-2-73

2) Proposal from Univ. Texas, Dept. of Astron., Deep Sky Survey in Ultraviolet Wavelengths from Space Shuttle 59000-793

JOINT SPACELAB MISSION - NASA/ESA

1) Joint NASA/ESRO Spacelab Payload Computer and Display Requirements - May, 1974, Prepared by Roy Lester MSFC

2) JSC Memo - JSC Review of First Spacelab Mission Planning Constraints Draft; From: Payloads Coordination Office, Jack Heberlig

3) Draft - Crew Operations Assumptions for Payload Flt. Timeline Development

4) Notes from R. Lester on Flt. 8

5) Spacelab Verification Flight Test Requirements, June 2, 1975 MSFC

MARINER JUPITER ORBITER (MJO 81)

1) 760-122 Final Report, STS Planetary Mission Operations Concepts Study, Apr. 15, 1975 JPL

MULTI-MISSION MODULAR SPACECRAFT (MMS)

1) General Description, GSFC's Multi-Mission Modular Spacecraft, STS Dec '75, Prepared by George Laski

2) Modular Low Cost Spcft - May '75 CTPD - Geo. Laski & Viewgraphs

3) Crew Training for the FSS (Memo) dated 12-18-75; by Don Miller and Report 8-28-75

4) Low Cost Modular Spcft Description X-700-75-140; GSFC - May '75

5) Payload Strawman Timeline for TDS 12-4-75, Comvell, Van Horn

Payload Documentation - Unique (cont'd)
Page 3

SHUTTLE INFRARED TELESCOPE FACILITY (SIRTF)

1) SIRTF Configuration, Hughes Aircraft

2) A Large Cooled Infrared Telescope Facility for Spacelab; Presented to AAS at Denver in Aug. '75 by S. G. McCarthy-Hughes, Lon Young & Fred Wittleborn - ARC

SPACELAB MISSION SIMULATION (SMS II)

1) STS, Spacelab Mission Conducting Medical Discipline Experiments - Lon DeLuca, Kerwin, et. al; Dec. 75

2) Basic Life Sciences Payload Procedures, CTPD, Aug. 16, 1974

3) SMS II Facilities Requirements Document - July 7, 1975 DE-SMS-II-016

4) SMS II Development Plan - Sept. 24, 1975 - DE-SMS-II-017

5) SMS II Interface Control Document - Dec. '75 DE-SMS-II-045

6) SMS II Data Management Plan - Dec. 5, 1975 - DE-SMS-II-040

7) SMS II Experiments and Operations Rqmts - Nov '75 - DE-SMS-II-018

8) SMS II Final Life Sciences Checklist - Jan 23, 1976 and Update per Jan 23, 1976

9) SMS II Crew Activity Plan - Final, Rev. A-Jan 22, 1976 JSC 10509

SOLAR OUT-OF-ECLIPTIC MISSION (OOE)

1) ESS/SS689 Solar Out-Of-Ecliptic Study Mid-term Presentation Brochure Jan '76 BAC

2) 662-13 Joint NASA/ESA OOE Mission Utilizing the NASA STS, Jan 7, 1976 - JPL

3) 27059-6006-RU-00 Solar OOE Mission - Spcft Definition - Mid-term Present - TRW

4) Alternate Trajectory Modes for a Jupiter Swingby OOE Mission, Jan '76, MMC

Payload Documentation - Unique (cont'd)
Page 4

SPACE TELESCOPE

1) Interface Rqmts Document - LST Support Systems Module (SSM) Phase B Def Study - DR-CM-02 Nov '75

2) Minutes of the Space Telescope/Orbiter Interface Discussion - Dec 9, 1975 JSC

3) Space Telescope Phase B Study Approach - LEC for JSC

4) Space Telescope Mission, Technical Report - MSFC, Jan '76-SE-012-018-2H

SPACELAB UV OPTICAL TELESCOPE FACILITY (SUOT)

1) Memo (form) TE-75-07-02 Henize, 7-11-75 Oper. Concepts Contained in Interim Report of the Facility Def. Team for SUOT

2) Memo to: Henize from - Gull, Subj: C & Ds for Payloads on Shuttle

3) SUOT Final Report Extract - starting with VI Operational Concepts, from K. Henize - Revision to D above

4) Feasibility Study of the SUOT, Oct '75 Final Rept. - Ball Bros. F75-19

5) Ref General List Item 21

6) Semi-Final Draft of SUOT Final Report - 12-5-75 (Memo Cover from K. Henize to SUOT FDT)