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ATM MISSION OPERATIONS DOCUMENTATION

Augmentation Task No. 40

LMSC-A842330 5 September 1967

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Lockheed

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SUNNYVALE, CALIFORNIA

ATM MISSION OPERATIONS

DOCUMENTATION

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Prepared Under Contract No. NAS8-21003 by

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A Group Division of Lockheed Aircraft Corporation
Sunnyvale, California

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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CONTENTS

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ILLUSTRATIONS

Section 1
SOLAR ATM GROUND SUPPORT PLAN

The purpose of this plan is to define the application of the ground-based solar-monitoring facilities and experiment-support personnel during solar ATM operations. Coordination of these ground-based activities within the constraints established by centralized mission control is discussed along with a description of the type of data available to support real-time decisions and postflight analysis.

A centralized data collection agency will be established at the Huntsville Operations Support Center (HOSC) for limited quick-look data evaluation during the mission. This will also be the repository for all mission data used for postflight analysis and dissemination to the scientific community.

1.1 OPERATIONS SUPPORT

1.1.1 Experiment Analysis Group

The Experiment Analysis Group is composed of scientific and engineering teams for each MSFC experiment. They will make an in-depth determination of experiment success. Each team consists of a Principal Investigator (PI) and his assistant(s), the cognizant experiment scientist, and engineers. They will normally be located at HOSC during mission operations, although it may be convenient for the PI to be located at his home base. The data and voice network will allow him to keep in close contact with the operation.

Experiment performance evaluation and failure analysis will be coordinated by the Experiment Analysis Group through the Experiment Activities Officer (EAO) at MCC-H. He in turn will report directly to the Flight Director on all matters relating to the conduct of experiment activities.

ATM scientific data available at HOSC during the mission will be limited to the digital output of the UV spectroscope counters (Experiment S055) and the astronaut's verbal description of high experiment video display. All other scientific data will be recorded on film and returned with the astronaut at the end of the mission.

Both real-time and stored experiment engineering data will be available at HOSC to be used by the experiment engineers for equipment failure analysis and experiment evaluation.

1.1.2 Solar Observatories

It is currently planned that the Lockheed Solar Observatories at Rye Canyon, California and Oudtshoon, Cape Colony, South Africa will provide full-time support with identical instrumentation for all ATM Mission operations. Together, they will provide 20 hr of continuous solar disc coverage each day.

During the daylight hours of each mission day, the observatories will take time-lapse high-resolution 35mm photographs every 10 sec with an average exposure of 1/25 sec. These photographs will record data in the 6563°A region (center hydrogen alpha), of the entire solar disc. This will be their normal mode of operation. The data from this operation will be used during postflight analysis for a direct comparison with ATM data.

The solar observatories will also make a significant contribution to the ATM mission in the prediction of flares and in the recording of preflare and early flare history. In addition, automated magnetographs at Mount Wilson, California and HAO, Boulder, Colorado, will monitor changes in the magnetic field around solar flares.

It is also proposed to equip weather satellites with solar X-ray sensors to provide continuous coverage of solar flare and associated X-ray activities. These data will be available through the world-wide facilities of the Space Disturbance Forecasting Laboratory (SDFL), ESSA, Boulder, Colorado.

Voice communication between Mission Control and the solar observatories will be established by tying the SDFL into a conference net with MCC-H and HOSC. Currently, all solar observatories are tied into the SDFL by voice, teletype and video circuits for routine coordination of solar data. The SDFL will play a very active role in the ATM mission operations.

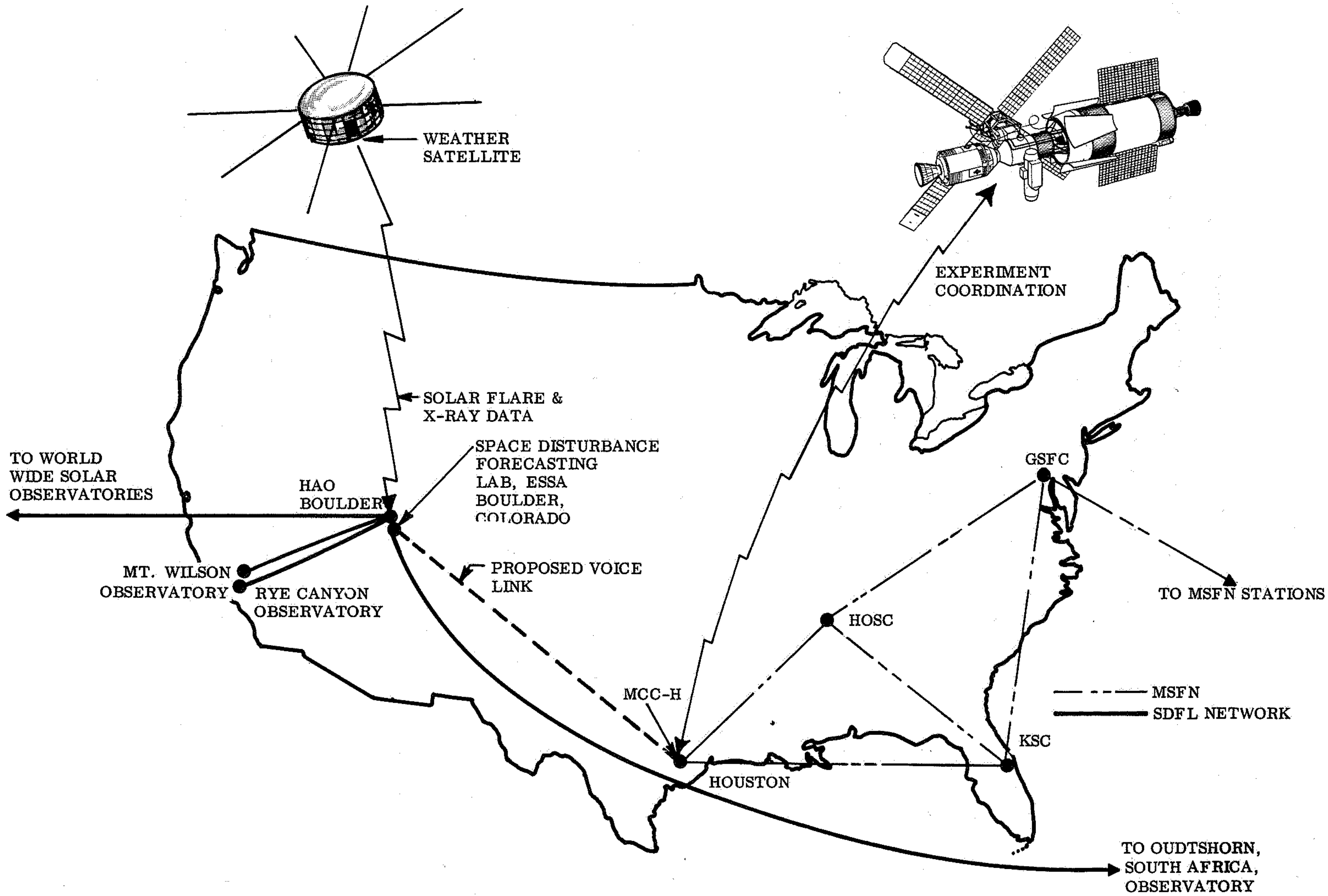

Fig. 1-1 Proposed Network for Coordination of Solar Observatory and ATM Experiment Operation

1.2 SOLAR FLARE PREDICTION

Accurate and timely prediction of solar flare activity requires a considerable element of luck; however, the probability of success may be enhanced with a knowledgeable assessment of the solar-surface phenomena that precede a flare outburst. This section briefly describes typical, but not necessarily conclusive, preflare indicators as outlined by Lockheed Solar Observatory (LSO) Report No. 19038, dated July 1965. This report is based on detailed studies of some 297 flares.

Success in flare prediction requires center-hydrogen-alpha high-resolution observations in addition to those in both the blue and red wings (i.e., displaced by 0.5 Å either side of the 6563 Å hydrogen-alpha-centered observations). These observations enable the observer to locate the position where flares can be anticipated in the active centers.

The following tabulation of changes frequently associated with flares reflect timing of both preflare and post-maxima activity, and will be useful in the construction of flare models. These changes are very subtle, requiring the interpretation of experienced and highly qualified solar observers.

Description of Change	Flare Importance <Imp2 (Min)	>Imp2 (Min)	All (Min)
Preflare			
Darkening of absorption feature	-26	-41	-32
Start of earliest preflare brightening	-27	-37	-39
Expansion of absorption feature	-24	-20	-23
Breakup of absorption feature	-1	-4	-8
Transition to emission in absorption feature	-2	-10	-5
Post-Maxima			
Ejection of absorption feature	+3	+6	+4
Additional bright or dark ejecta	+2	-9	+1
Minimum point of visibility for absorption feature	+2	+6	+3
Appearance of absorption in a new location	+15	+25	+17

In addition to the above, indications of solar flare activity may be obtained from a detailed study of solar magnetograms. For example, LSO personnel have found that complex bipolar regions are statistically more than three times as flare-producing as simple bipolar regions. Magnetic complexity appears to be related to the conditions under which regions develop, especially in or near older regions, i.e., those surviving several solar rotations. It is believed that flares can be produced by the interaction of two or more closely spaced bipolar regions.

Flare duration may vary from 15 min to 4 hr depending on the flare importance and intensity. It is expected that the solar ATM mission will be scheduled during a period of maximum solar activity. Based on past experience, there is a high probability of numerous subflares and several major flares occurring during the mission.

1.3 MISSION OPERATIONS

This section briefly describes a typical ATM operation and the activities involved in coordinating unplanned events resulting from ground based observations.

The solar ATM mission has been scheduled for 47 operational periods (one period equal to 15 revolutions). Of these, 37 are defined as experiment periods, 3 are EVA/ATM, and 6 are rest and recreation (R&R) periods.

During the experiment periods, the ATM will operate in the active, patrol, or standby modes with at least one crew member always available for experiment activation. Reaction time in response to an unplanned event, such as photographing a solar flare or prominence, will be almost immediate in the active mode and several minutes in the patrol or standby mode. This assumes precise pointing and mode instructions from Mission Control.

During the R&R periods, the ATM experiments will normally be inactive and the LM/ ATM will be unmanned. Reaction time to activate the system, from receipt of a flare alarm, will be a minimum of 20 min under these conditions.

No experiment activity will be performed during the EVA/ATM periods.

Because of the greater resources available to them, the Solar Observatories, as discussed in Section 3.0, will be in a better position to predict flare outbursts than the astronaut. Upon detection of a flare build up, the solar observatories will immediately notify the EAO through the Experiment Analysis Group at HOSC. The EAO will be informed of the importance of the flare and given preliminary experiment-operating-mode information from HOCS. With his local knowledge of current and scheduled mission activities, the EAO will then make his recommendation to the Flight Director. He in turn may alert the astronauts of an impending out-of-sequence operation.

When positively identified as an important flare build up, the solar observatories will give ATM pointing instructions to the EAO. These are expected to be in terms of a heliocentric latitude and longitude grid system lined up on the astronaut video display. The EAR will establish which experiments are to be activated and the modes of operation to be selected. A Flight Directive will be prepared by the EAO defining the specific astronaut instructions. This will be approved by the Flight Director for onward transmission to the astronaut via the Spacecraft Communicator.

It should be stressed that acquisition of preflare and early flare data is very desirable during the ATM mission. Therefore, it is important that the time between the onset of preflare activity (as detected by the solar observatories) and alerting of the astronaut must be minimal. Preflare buildup will last approximately 40 min for flares greater than Importance 2 and 25 min for those less than Importance 2.

During experiment periods, it should be feasible to coordinate the necessary astronaut instructions in a timely manner so that a large precentage of preflare activity will be recorded. Obtaining preflare data during R&R periods is marginal and will depend on astronaut response to the situation.

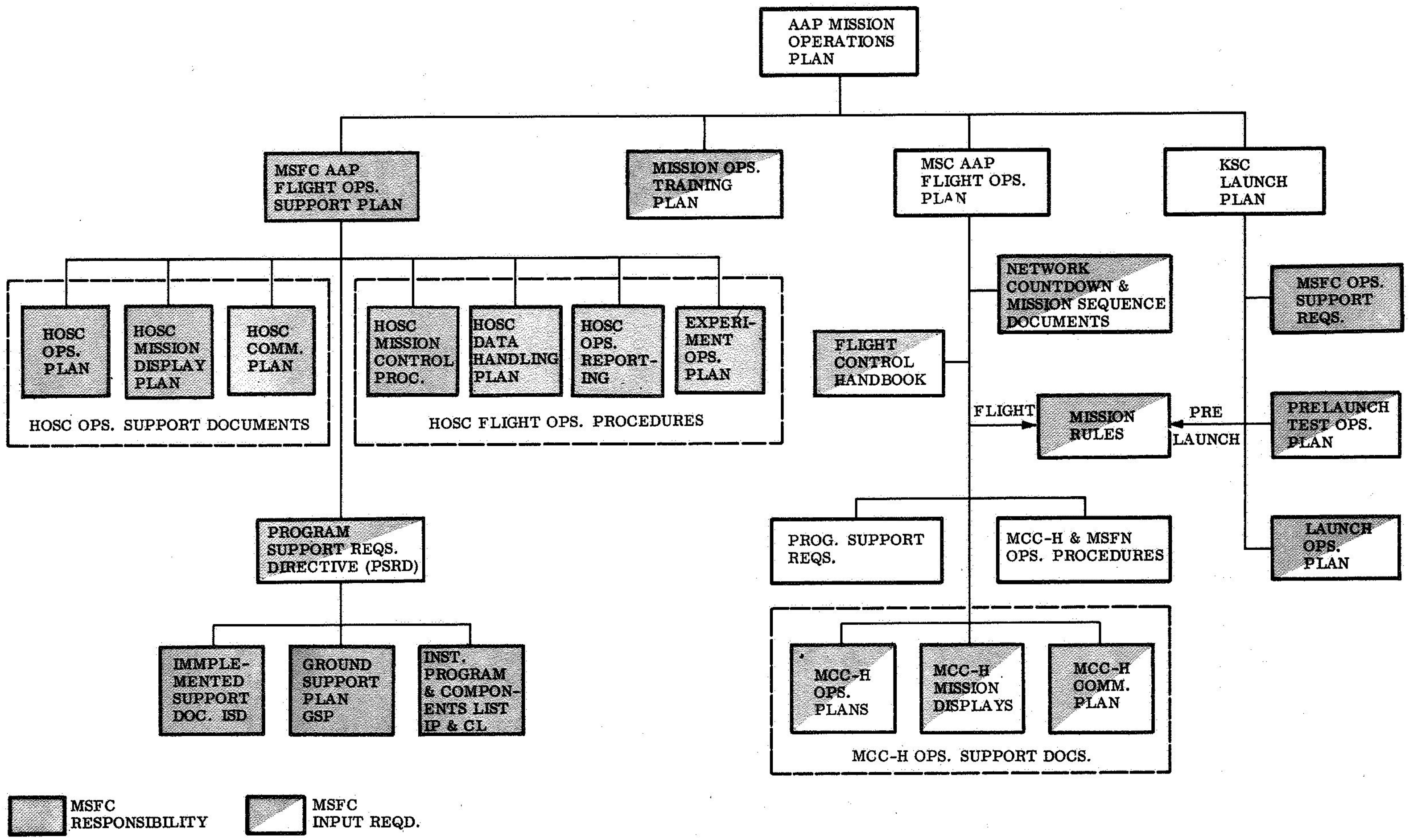

Fig. 2-1 AAP Mission Operations Documents

Section 2

MSFC-AAP MISSION OPERATIONS DOCUMENTATION PLAN

This plan identifies the documentation required to prepare for and support the MSFC role in the AAP mission operations. The MSFC role has been defined as providing major support to MSC to ensure that the responsible hardware mission objectives of MSFC are met. The documentation requirements of MSFC fall into the following categories:

- Program Support Requirements Documents
- Operations Support Documents
- Flight Operations Procedures
- Inputs to MSC responsible documents

Figure 2-1 shows the relationship of MSFC, MSC, and KSC documentation. For the purpose of this plan, only those MSC and KSC documents to which MSFC has an input are shown. Figure 2-2 shows the release schedule for these documents.

2.1 AAP MISSION OPERATIONS PLAN

This plan will be prepared by NASA Headquarters to establish the policy and general requirements for the AAP . It will identify agency support roles and will serve as the top mission-planning document.

2.2 MSC AAP FLIGHT OPERATIONS PLAN

This document defines MSC's flight operations role for the AAP.

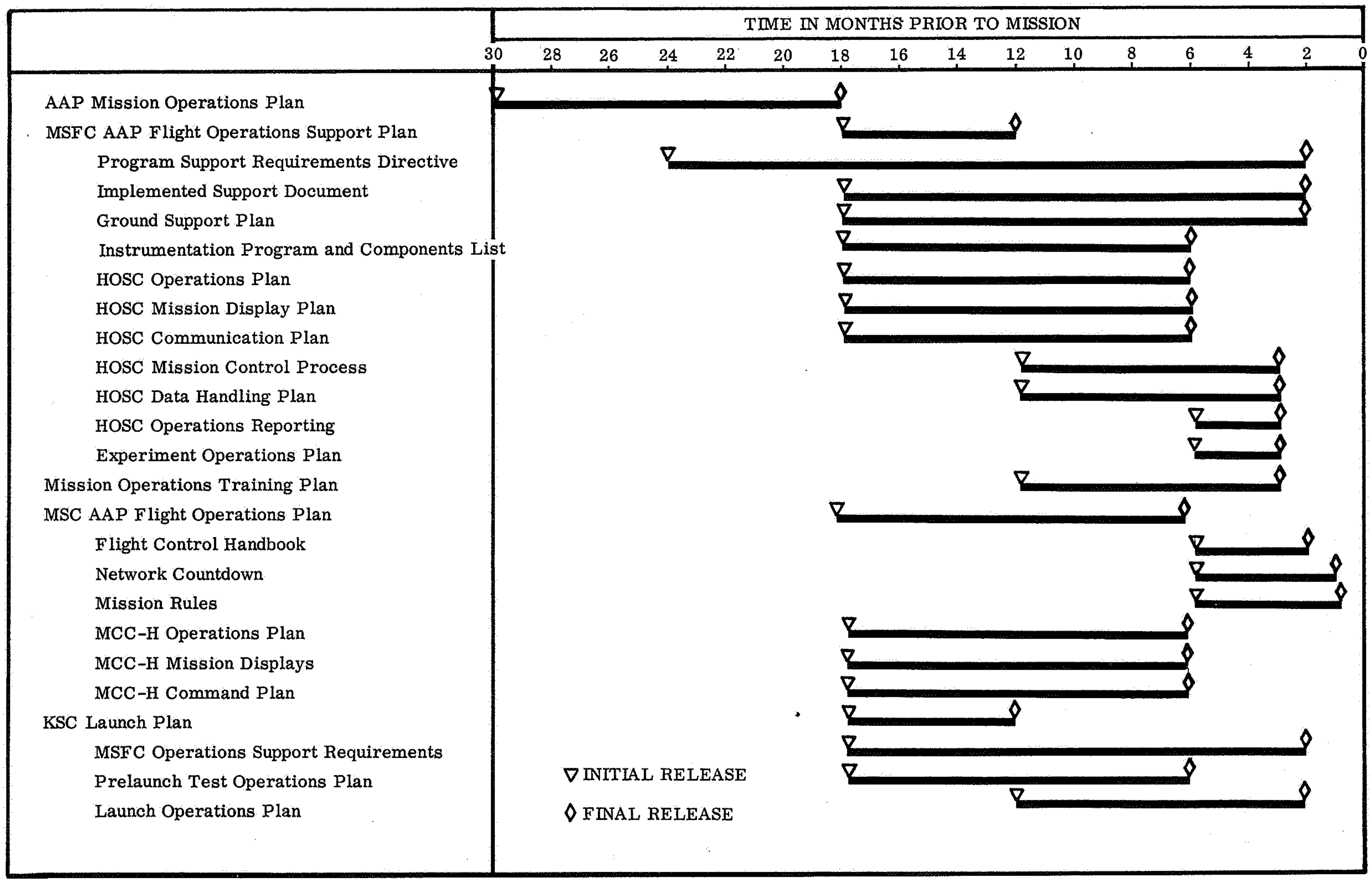

Fig. 2-2 AAP Mission Operations Documentation Release Schedule

2.3 MSFC AAP FLIGHT OPERATIONS PLAN

This plan defines the MSFC flight operations role for the AAP.

2.4 PROGRAM SUPPORT REQUIREMENTS DOCUMENTATION

This section outlines the NASA and DOD resources required to support the Apollo Applications Program.

2.4.1 Program Support Requirements (PSRD)

The program support requirements document is controlled by the NASA/DOD Program Support Requirements Control Group (PSRCG). Program inputs are prepared by the requesting agency (e.g., MSFC) on standardized forms. It is an integrated document containing both general information and specific requirements of the program and mission.

Program Requirements. Program requirements are those needs for basic resources external to a requesting agency's capability and/or responsibility that necessitate long range planning, scheduling, and funding by support agencies in order to meet program objectives.

Mission Requirements. These are the details of programmed needs external to a requesting agency capability and/or responsibility which result in the mobilization of existing resources for a specific mission and its associated tests.

2.4.2 Implemented Support Document (ISD)

The implemented support document is an extract of the PSRD and states, in detail, all of MSFC's implemented mission requirements for support of a specific AAP mission. It also lists the response to these requirements as stated by the implementing agencies. This is an internal MSFC document and is similar in Scope to the NASA Operational Support Requirements Document (OSRD) and Program Support Plan (PSP).

2.4.3 Ground Support Plan (GSP)

This is an internal MSFC document compiled for each mission and defines MSFC developed launch and orbital vehicle ground-network support requirements for engineering evaluation and flight operations objectives, network coverage constraints, and the data flow plan. These requirements are levied officially through the PSRD.

2.4.4 Instrumentation Program and Components List (IP and CL)

This is an internal MSFC document which defines the instrumentation and communication requirements for MSFC developed hardware. It is a control document which defines specific telemetry equipment measurement lists and parameters and channel assignments.

2.5 OPERATIONS SUPPORT DOCUMENTATION

This section outlines the documentation prepared by MSFC describing in detail the MSFC support areas both at HOSC and MCC-H. In general, these documents will be revised for each mission to define the specific functions for that mission.

2.5.1 Huntsville Operations Support Center (HOSC) Operations Plan

The purpose of this document is to identify the support functions performed by the HOSC for specific AAP missions. Detailed support activities for the following operational phases will be described on the following page.

- Vehicle prelaunch checkout
- Launch operations
- Flight operations

HOSC support areas are identified and their role in the overall mission are described. These areas include the following:

- Main conference room
- Information control room
- Teleconference room
- Staff room
- Operations support room
- Data reduction equipment area
- Communication rooms

It should be noted here that the operations support room is currently configured to support booster operations. Additional consoles and data processing equipment will be added to monitor MSFC responsible equipment and experiments during the mission.

HOSC Mission support personnel are identified and the responsiblities for the detailed tasks are described. Their relationships with MCC-H and KSC operational personnel are also identified. HOSC personnel are grouped in the following categories:

- HOSC operations manager
- Flight evaluation team consisting of an engineering and experiment analysis group
- Console support engineers
- Data handling and program support groups
- MSFC laboratory personnel
- Principle investigators

2.5.2 HOSC Mission Display Plan

The purpose of this document is to identify HOSC data displays and data processing requirements for specific AAP missions. Real time data will be received and processed at HOSC during all mission phases. This document will identify specific data sources, types, and edit modes.

Data-recording devices, printers, and engineering console display requirements are described. Telemetry formats and limit sensing requirements are established, and video display systems requirements are described.

2.5.3 HOSC Communications Plan

This document identifies all communication services required by the HOSC for AAP missions. It will be used as the control document for configuration and operation of HOSC communications. Circuit requirements internal to HOSC and MSFC and external to other centers such as KSC and MCC-H are identified. A detailed description of all nets and operational modes will be provided.

2.5.4 Mission Control Center – Houston (MCC-H) Operations Plan

The purpose of this document is to identify those MSFC related functions performed at the MCC-H for specific AAP missions. The document will have a format similar to that of the HOSC operations Plan and will identify the support areas where MSFC personnel will be located. These areas include the vehicle systems staff support room and the experiment room.

The specific equipment and display requirements for monitoring the performance of MSFC-developed flight hardware (e.g. ATM, OWS) and experiments will be identified. The MCC-H located MSFC personnel are identified and their responsibility for the detailed tasks is described. Relationships with other flight operations personnel at MCC-H and HOSC are also detailed.

2.5.5 MCC-H Mission Display Plan (MSFC Requirements)

This document provides the MSFC input to the MCC-H Data Plan. It will describe data processing and display requirements for MSFC developed flight hardware support at MCC-H. Unique displays for monitoring scientific data from MSFC experiments will be identified.

2.5.6 MCC-H Communication Plan (MSFC Requirements)

This document provides the MSFC communications requirements to the MCC-H Communications Plan. It identifies communications requirements internal to the MCC-H and external to other centers for coordination of mission operations activities related to MSFC developed equipment. Communication requirements to other mission support facilities, such as the solar observaties, are identified. Communication-net requirements at all MSFC operated consoles will be identified.

2.6 FLIGHT OPERATIONS PROCEDURES

This section outlines the procedural type documents required for the conduct of the AAP missions. It is recognized that centralized mission control will be performed by MCC-H and that operational procedures will relate to the MCC-H activities. It is the intent of this section to define those procedures which describe the HOSC operations and provide MSFC inputs to MSC responsible procedures.

2.6.1 HOSC Mission Control Procedure

This document establishes the role of the HOSC and defines responsibility for the HOSC operations manager and his flight operations support team during the AAP missions. The mission support tasks defined are primarily to monitor, evaluate, and provide resolution of problems relating to MSFC developed hardware.

In addition to standard operational procedures, this document will contain procedures for the isolation and correction of faults.

2.6.2 HOSC Data Handling Procedure

This document describes MSFC responsibilities for data collection, distribution, and analysis during AAP mission operations.

2.6.3 HOSC Operational Reporting Procedure

This procedure establishes the network discipline required to ensure complete MSFC support during mission operations. It will identify the mission control and support nets and responsibilities for their use.

2.6.4 Experimenters Operation Plans

A series of plans will be developed, in conjunction with the PI's, to define the operational sequences required for the experiment phases of the mission. An example will be a plan which defines the coordination between the Solar Observatory ground observers and the ATM operations. These plans will be integrated into the overall mission sequence document.

2.7 OPERATIONS COUNTDOWN AND MISSION SEQUENCE DOCUMENTS

MSFC will provide inputs to the MCC-H and MSFN Countdown and Mission Sequence Documents. This will establish the phasing of the HOSC activities in relation to the overall mission task.

2.8 MISSION OPERATIONS TRAINING PLAN

Training and mission simulation concepts will be established in this document. MCC-H, HOSC, and MSFN participation in the premission training exercises will be defined and special simulation equipment will be identified. Area training for flight controllers and experimenters, together with overall mission simulation training for all mission control and support personnel and flight crews, will be established. MSFC will provide the HOSC training requirements for this plan.

2.9 MISSION RULES

The purpose of mission rules is to outline preplanned actions to assist making real-time decisions during the prelaunch and flight period. The mission rules contain experiment completion priorities and rulings on specific conditions and malfunctions. Preplanned mission rules provide flight controllers alternate paths for accomplishing experiment objectives when contingencies occur.

MSFC will establish mission rules for MSFC responsible equipment and experiments.

2.10 FLIGHT CONTROL OPERATIONS HANDBOOK

This is a compilation of all pertinent AAP mission data and flight control standard operating procedures for use by mission control and support personnel as a handy reference source. Information with respect to the mission description and profile, control criteria, vehicle and experiment configuration, data acquisition and processing, vehicle commands, and operational software will be included.

2.11 KSC LAUNCH PLAN

This document defines KSC's activities during the prelaunch checkout and subsequent launch of AAP boosters and payloads.

2.11.1 MSFC Operational Support Requirements at KSC

This MSFC prepared document will establish MSFC operational support requirements at KSC during the prelaunch checkout and launch of MSFC developed AAP payloads. Support roles, facilities, equipment, data handling, and communication equipment will be defined.

2.11.2 Prelaunch Test Operations Plan

The detailed operational prelaunch checkout of MSFC developed AAP payloads and experiments will be defined by MSFC. Integration and launch-readiness tests with the booster will be detailed.

2.11.3 Launch Operations Plan

MSFC will provide an input to the KSC launch operations plan defining the operation and response of MSFC developed hardware during the launch countdown.

Section 3

POINTING CONTROL SYSTEM MISSION OPERATIONS

3.1 MISSION OPERATIONS - ATM/PCS

3.1.1 Definition

Mission Operations as used here refers to the carrier and ground activity to perform ATM pointing control functions during the AAP-3 (A-3) and AAP-4 (A-4) portion of the Cluster A mission. The operations described are concerned only with verification/ calibration, activation, and alignment up to the point where the ATM becomes ready for experiment operation. Both onboard display systems and telemetry requirements are identified.

3.1.2 Introduction

The ATM Pointing Control Subsystem (PCS) is designed for inertial experiment pointing and attitude control. It consists of two parts – the coarse control subsystem and the fine pointing control subsystem. The coarse control subsystem is capable of orbital plane acquisition, automatic hold, and manual operation based on a control moment gyro (CMG), coarse sun sensor, and star tracker configuration. The CMG operates within a deadband built into the reaction control system to provide stabilization, with respect to a sun reference, throughout those mission phases required to meet the ATM objectives.

The fine pointing control is provided to isolate the telescope package from the disturbing torques of the Cluster. Utilizing a fine sun sensor package and gyro package to provide the necessary stabilization, the system is capable of acquisition, offset pointing, automatic attitude hold operation, and manual operation. The basic line-of-sight reference for fine pointing will be provided by the fine sun sensors. However, all observations and offset pointing decisions made by the astronaut will use the experiment boresight or Hα telescope display.

3.1.3 Ground Rules and Assumptions

The operational sequences delineated have assumed the following conditions:

- One-man operation in the LM/ATM.
- Activities considered with the verification/calibration, activation, and alignment are those required for a typical orbit-day operation.
- LM/ATM is hard-docked to the MDA with the CMG's spun up to speed in the inertial attitude.
- LM/ATM crew member is on station and ready to go.
- During periods of occultation from the sun, a programmed maneuver will position the carrier for CMG dumping by the gravity gradient method. Upon reentering the sunlight, a programmed reverse maneuver will position the carrier for sun and Canopus reacquisition.

3.2 PROCEDURE REQUIREMENTS

This section defines the combined ground and astronaut activities for the ATM pointing control function. The first part describes the basic operational requirements for the PCS. The second part presents the step-by-step sequence for each operational phase, it indicates the display and control utilization for initiating and confirming action for both pilot and ground support.

3.2.1 General Operations Requirements and Concepts

3.2.1.1 Pointing Control Subsystem

Pointing Accuracies. The PCS will be designed to meet the following requirements:

Carrier Gross Pointing	Pitch and Yaw	$< \pm 20$ deg
	Roll	$< \pm 1$ deg

Carrier Coarse Pointing	Pitch and Yaw	$< \pm 0.1$ deg
ATM Fine Pointing	Roll	± 7.5 arc-min
	Pitch and Yaw	± 2.5 arc-sec
Pointing Stability Drift Area	± 2.5 sec/15 min period (Pitch and Yaw)	
	± 7.5 arc-min/15 min period (Roll)	
Jitter Rate	± 1 arc-sec/sec (Pitch and Yaw)	
Pointing Offset	Repositioning capability from any point to any other point within a ± 21 arc-min square nominally centered on the solar disc. The time to accomplish the maneuver, including setting up time at the new point, shall not exceed one minute.	
Roll Orientation	± 95 deg from zero-roll orientation	

Data and Communications. Voice communication will be established between the prime ATM/LM crew member and the MCC-H. A centralized control mode will be established via the MSFN for coordination of ATM pointing and experiment activities. A PCM telemetry system will transmit real-time ATM/PCS data via the MSFN data link. Engineering data, such as power, thermal, pressures, attitude control, sun-presence signal, star tracker presence and lock-on signals, will back up and augment the on-board displays for ground confirmation of orbital events and determination of ATM pointing criteria.

Experiment data will be recorded for later playback over one ground station.

Controls and Displays. The control and Display panel in the LM ascent stage will serve as the experiment work station. The panel will be used by the astronaut to control and monitor the experiments, the PCS, and power system.

The PCS controls are used for system activation, vehicle pointing, and station keeping by sun acquisition and manual pointing. The manual pointing mode utilizes a hand control unit with visual reference provided by vidicon and digital displays.

Experiment pointing will utilize the PCS manual mode when offset pointing from the sun's center is required. The offset coordinates will be displayed so that areas of interest may be noted for repeated investigations. The video displays will be switched to the appropriate TV camera for each experiment.

Operation Constraints. Sun acquisition and carrier stabilization are a prerequisite to experiment performance. Some mild constraints in astronaut motion will be required to reduce the rms amplitude of the carrier deviation from its mean attitude.

3.2.1.2 Pilot

The pilot will select the control mode for the PCS as determined by the mission phase. He will operate the manual transmitters for ATM attitude control, and spar-pointing controls for offset pointing determination. He will monitor the onboard displays and controls for correct system operation and experiment-related activities and will maintain voice communication with the MSFN ground station to correlate performance data.

3.2.1.3 Ground Support

The ground support will accomplish the following:

- Verify PCS operation by analysis of telemetry parameters and correlate results with astronaut
- Determine carrier maneuver requirements as a backup to the programmed maneuvers required for gravity gradient stabilization

The ground support will use voice and T/M data from either real-time or recorded sources. When activity occurs out of ground station contact, the recorded data will be used. The monitoring of the data is the same for both real-time or recorded data since the function of the ground support is basically to supplement pilot operation and is not required to perform the experiment in real time.

3.2.2 Sequence Definition

The purpose of this subsection is to correlate, in detail, the ATM/PCS activity and the control and verification of its operation. Each step in the operation is defined and the controls, displays, and telemetry measurements (where known) are identified. (see attachment pages 3-8 through 3-15).

3.3 MEASUREMENT REQUIREMENTS

This section defines the measurements and information about each measurement, required to ensure successful flight operations of the ATM/PCS.

3.3.1 Flight Operations Data

This subsection defines the data required to support operations and their utilization.

3.3.1.1 Telemetry Data

A complete listing of ATM measurements is presented in MSFC document 50M12711 "Instrumentation Program and Components List ATM Rack" (ATM No. 11). Described below are those real-time telemetry measurements considered essential to verify correct system performance during PCS operations.

- Temperature measurements C001-702 through C062-707 monitor thermal conditions of critical components such as the CMG bearings, battery power modules, and solar panels. C097-701 through C115-701 monitor structural temperatures of the spar, shroud, and heat shield. C116-702 through C148-701 monitor experiment package and rate gyro temperatures.
- Verification of CMG spin up can be obtained by monitoring T001-702 through T006-702 CMG bearing vibration and T001-702 through T001-702 CMG wheel speed.

- ATM attitude maneuvers can be monitored by G023-702 through G028-702 No. 1, 2, and 3-CMG X & Z gimbal angles.
- Fine pointing coordinates can be obtained by monitoring G033-701 and G034-701 fine sun-sensor offset yaw and pitch coordinates.
- Flight mode and configuration can be monitored by K014-702 through K022-702.
- Star tracker operations can be verified by K023-702 star tracker presence, K126-702 and K126-702 star tracker mode and shutter position, K165-702 star tracker drive mode, M181-702 through M184-702 pitch and yaw errors and gimbal operation.
- The coarse and fine sun sensor operation can be verified by K024-701 acquire sun sensor presence and K025-701 fine sun sensor.
- Power system performance can be monitored by M001-702 through M018-702 No. 1 – No. 18 battery voltage. M019-702 through M064-707 monitors bus voltage and charging current. M065-702 through M112-702 monitor voltage and current in Power Modules No. 1 – No. 24.

3.4 GROUND DISPLAY DATA

One of the main constraints to centralized mission operations for the ATM PCS is the limited data-transmission capability within the MSFN. Presently, five standard telephone circuits plus two teletype circuits are available from MCC-H to each of the MSFN ground stations. From MSFC to MCC, the same circuits are available, plus a 40.8 kbit/sec wideband data link. Three of the telephone circuits will ordinarily be utilized by voice, biomedical data, and critical CSM status.

Two circuits could be utilized for ATM PCS data; however, a method of data compression or sampling must be devised at the ground station since the volume of data would overload the transmission capability (24 kbits/sec) of the system.

In addition, priority should be assigned to the PCS data. Primary data will be transmitted on the telephone circuits at one sample per second and secondary data on the teletype lines at 100 wpm. Primary data are assigned as follows:

- C004-702 through C011-702, C036-701, C119-701, C120-701, C139-701, and C140-701 temperatures
- T001-702 through T003-702-gyro speed, and E001-702 through E006-702 CMG bearing vibration (these data will be compressed so that the peak vibration measurement is transmitted.)
- G023-702 through G023-702 CMG gimbal angles
- G033-701 and G034 fine sun sensor coordinates
- K014-702 through K022-702 flight mode configuration
- K023-702, K126-702, M228-702, M229-702, K127-202, and K165-702 star tracker operations
- M181-702 through M184-702 star tracker error voltages
- M024-701, K025-701, and M198-701 through M201-702 sun sensor operation
- M123-701 and M124-701 power system status

The remainder of the temperature, voltage,and current readings may be transmitted over the teletype lines as secondary data. Both primary and secondary data will be displayed in the form of a teletype printout.

FOLDOUT FRAME 1

FOLDOUT FRAME 2

TASK/EQUIPMENT ANALYSIS	Experimenter: MSFC	Experiment Number:	Experiment Title: ATM-PCS	Designa[tion] 709

FUNC.	NO.	CREW TASK/EVENT	ASTRONAUT ACTIVITY (%)	EQUIP-MENT INTERFACE	VISUAL FEEDBACK	DISPLAY	CONTROL	NOTES
ACTIVATION AND ALIGNMENT	1	Verify Switch Position	B-100	A8				
		Monitor Selector Switch			Switch in off position. No digital read-out.	M6	S8	
		Gyro Selector Switches			Vertical switch position. No digital read-out		S5, 6, 7	
	2	Verify Flag Status	B-100	A8	Flags show grey	DS10, 11 12		
		Star Present Flag			Flag shows grey	DS7		
		Acquisition Sensor Flag			Flag shows grey	DS8		
		Fine Sensor Flag			Flag shows grey	DS9		
	3	Verify Switch Position	B-100	A9				
		Configuration Mode Sub Mode			Switches in neutral position		S1, S2 S3, 4, 5 S6-S11	
		Computer Selector Switches Test Switch Insert Read/Erase Inhibit Switch			"A", 0, 0, 0. Locked in "OFF" Switch pos neutral		S16 S17 S18 S19	
	4	Verify Flag Status	B-100	A9				
		Configuration Mode Sub Mode Computer Confirm Ground Command System			Flags show configuration Flag shows inhibit	DS1-2 DS3-6 DS7-12 DS13-14 DS15		

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tor Code Number:

A600A8, 9, 10, 11

T/M MEASUREMENT NO.	T/M MEASUREMENT NAME
K004-702	Roll Lock
K005-702	Yaw Lock
K006-702	Pitch Lock
K023-702	Star Tracker Presence
K024-701	Acq. Sun Sensor Presence
K025-701	Fine Sun Sensor Presence
K019-702 through K022-702 through	Flight Configuration No. 1 – 4
K014-702 through K017-702	Flight Mode

FOLDOUT FRAME 1

FOLDOUT FRAME 2

TASK/EQUIPMENT ANALYSIS	Experimenter: MSFC	Experiment Number:	Experiment Title: ATM-PCS	Designa 709

FUNC.	NO.	CREW TASK/EVENT	ASTRONAUT ACTIVITY (%)	EQUIP-MENT INTERFACE	VISUAL FEEDBACK	DISPLAY	CONTROL	NOTES
ACTIVATION AND ALIGNMENT	5	Verify Switch Position Camera Selector Switches Camera Power Switches Monitor Power Switches TV Zoom Switches Sync. Gen. Switch	B-100	A10	 Switch pos at ATM locked in Off Sw pos neu Sw pos neu Neu. pos		 S3, S4 S5-9 S10-S11 S12-S13 S14	
	6	Verify Switches Positions Switch ? External Door Switch	B-100	A11	 In Off pos Lock in closed pos		 S1	
	7	Verify Flag Status	B-100	A11	Flag shows "C"	DS1		
	8	Verify Switch Positions Power Monitoring	B-100	709A600A1	Sw pos		S1-S8	
	9	Verify Flag Status & Meters	B-100	709A600A1	Flags & analog meters	M1-M2 DS1-DS6		
	10	Select Flight Configuration	B-100	A9	Configuration flag shows	DS1 or 2	S-1, or 2	Flight configuration to be consistent with mission requi ments.
	11	Alert Astronauts that ATM is Ready for Acquisition Mode.	A-100	7 ?				This alert is given by Astronaut A in the CSM following gross positioning of the Cluster by RCS.
	12	(Deploy Solar Arrays)	B-100	709A600A1	Flag shows extended-locked	DS8	S10	The Solar Array must supply a sufficient amount of pow the beginning of this mission to meet the total power loa requirement. Solar panels will provide power when poi within a few degrees of the sun.
	13	Select ATM System Power "ON" Code Insert Coded-Signal into Computer Verify Signal Configuration Select Computer "read"	B-100	A9	Sw pos Flag shows confirm	 DS13, 14	S12-15 S17 S18	This follows the gross positioning of the Cluster/ATM. The Cluster is in a coarse inertial hold until ATM point control subsystem is fully activated.

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FOLDOUT FRAME 3

tor Code Number:
A600A8, 9, 10, 11

	T/M MEASUREMENT NO.	T/M MEASUREMENT NAME
	NA	Camera Cont Unit No. 1 2 3 5
	NA	TV Camera No. 1 2 3 5
e-		
	M060-704 through M064-707	Cur. Solar Array Short Ckt Panel No. 3 and No. 5
er at d ited	M021-702 M022-702	Voltage, Solar Bus No. 1 Voltage, Solar Bus No. 2
ng		

TASK/EQUIPMENT ANALYSIS	Experimenter: MSFC	Experiment Number:	Experiment Title: ATM-PCS	Designa[tion] 709A

FUNC.	NO.	CREW TASK/EVENT	ASTRONAUT ACTIVITY (%)	EQUIP-MENT INTERFACE	VISUAL FEEDBACK	DISPLAY	CONTROL	NOTES
ACTIVATION AND ALIGNMENT	14	Verify Power Status of Power Modules 1 Through 24	B-100	709A600A1	Readings on analog meters within tolerance	709A600A1 M1, M2	709A600A1 S1, S2	The Selector Switch allows for individual power module capability and is on a time-shared basis between batter[y] Temperature, voltage and current are monitored in thi[s]
	15	Select TEST Mode	B-100	A9	Flag shows "Test"	DS6	S5	This mode must be used to verify ATM subsystem oper[ation] prior to entering experiment pointing mode.
	16	Select Roll, Pitch and Yaw Switches	B-100	A9	Sw Pos		S5-S7	
	17	Select Spar Gimbal Operation Code Insert Coded Signal into Computer Verify Signal Configuration	B-100	A9	Sw Pos Flag shows confirm	 DS13-14	S12-S15 S17	
		Select Computer "Read"			Digital Disp. Change		S18	
	18	Verify Spar Gimbals Operation	B-100	A8	Digital Readout			
	19	Verify Sun Sensor Operation Acquisition Sensor	B-100	 A8	 Flag shows "sunpresent"	 DS8		
		Fine Sensor		A8	Flag shows "sunpresent"	DS9		
	20	Select Hand Control Switch	B-100	A8	Flag shows submode	DS9	S8	
		Operate Hand Controller (Verify Hand Controller Operation)			Flag shows different face for each of four quadrants	DS14	H1	
	21	Verify External Door Operation Select Switch to Open Select Switch to Closed	B-100	A11	Flag shows "O" & "C"	DS1	S2	
	22	Verify Operation of Hα TV System Select ATM Hα "On" camera select Switch Select Power "On" to Hα "Camera" Select Power "On" to No. 1 Monitor	B-100	A10	CRT Image Sw Pos Sw Pos Sw Pos Raster	M1	 S3 S6 S10	

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tor Code Number:

.600A8, 9, 10, 11

	T/M MEASUREMENT NO.	T/M MEASUREMENT NAME
s	M001-702	Voltage Power Mod
ies.	through	Battery No. 1 - 18
s way.	M018-72	
	M019-702	Voltage Load Bus No. 1
ation	M020-702	No. 2
	K004-702	Roll Lock
	K005-702	Yaw Lock
	K006 702	Pitch Lock
	G023-702 through G028-702	X and Z Gimbal Angles No. 1, 2 and 3 CMGs
	K025-701	Fine Sun Sensor Presence
	K016-702	Flt Mode C inertial Hold and Maneuver
	NA	TV Display Monitor
	NA	TV Camera No. 1
		No. 2
		No. 5
	NA	Video Switch

FOLDOUT FRAME 1

FOLDOUT FRAME 2

TASK/EQUIPMENT ANALYSIS	Experimenter: MSFC	Experiment Number:	Experiment Title: ATM-PCS	Des 7

FUNC.	NO.	CREW TASK/EVENT	ASTRONAUT ACTIVITY (%)	EQUIP-MENT INTERFACE	VISUAL FEEDBACK	DISPLAY	CONTROL	NOTES
ACTIVATION AND ALIGNMENT	22	(Continued)						
		Select Crosshairs for "On" and Adjust Intensity			Image change	M1	R3	
		Adjust Brightness			Image change	M1	R4	
		Adjust Vertical & Horizontal Crosshairs			Hairs shift	M1	R1, R2	
		Select Power "Off" to No. 1 Monitor			Sw Pos	M1	S10	
		Select Power "Off" to Camera			Sw Pos		S6	
	23	Repeat Step 22 for No. 2 Monitor	B-100	A10		M2		
	24	Verify Operation of Test & Confirmation Circuits by Selecting to "Test"	B-100	A9	Flags show "Confirm"	DS14	S16	
	25	Inform Ground Control of ATM Status	C-100	7xx?				Vehicle communications system is used. (It is assu ATM is "GO" at this point.)
	26	Receive Permission From Ground Control to Proceed with ATM Subsystem Activation	C-100	7xx?				
	27	Activate CMG Subsystem	B-100	A9				This step must be undertaken regardless of a vehicle with or without CMG's spinning. The Cluster gross will enable the solar arrays to provide power to batt prior to CMG spin-up. The CMG's will be brought u full speed while caged in a zero momentum position.
		Select Stop-Start/Standby Code			Flag shows S-S	DS6	S5	
		Insert Coded Signal Into Computer & Verify Signal Confirmation.			Sw Pos	DS13-14	S12–S15	
		Select Computer "read"			Digital Display Change		S18	
	28	Verify that CMG's are in Acceleration	B-100	A8				As gross solar orientation has been accomplished, t period will not involve further manual orientation.
		Select to read speed for each of 3 axes			Analog meter reading	M6	S4	
	29	Perform Housekeeping tasks and Monitor CMG's, undertake experiment visual activation checks.	B-100 C-100					While CMG's are spinning up the astronauts require of vigilance in performing CMG monitor activities. drain due to CMG run-up will preclude experiments operational checks.

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FOLDOUT FRAME 3

ignator Code Number: 09A600A8, 9, 10, 11		
	T/M MEASUREMENT NO.	T/M MEASUREMENT NAME
	NA	TV Display Monitor
ned that		
launch pointing eries to		
is spin-up	E001-702 through E006-72	Vibration No. 1 and 2 Bearings No. 1, 2. and 3 Gyros
	T001-702 through T002-702	Gyro Wheel Speed No. 1, 2, and 3
a minimum Power		

FOLDOUT FRAME 1

FOLDOUT FRAME 2

TASK/EQUIPMENT ANALYSIS		Experimenter: MSFC			Experiment Number:		Experiment Title: ATM-PCS		Designat[ion] 709A[...]
FUNC.	NO.	CREW TASK/EVENT	ASTRONAUT ACTIVITY (%)	EQUIP-MENT INTERFACE	VISUAL FEEDBACK	DISPLAY	CONTROL	NOTES	
ACTIVATION AND ALIGNMENT	30	(Verify that CMG's have attained maximum operational speed.)	B-100	A8	Flag shows	DS13			
	31	Alert Crew Members that Fine Pointing Maneuvers are starting	C-100	7xx?				Crew Movement must be reduced to a minimum. Crew M[...] will secure "seat" harness etc.	
	32	Select Monitor/Acquisition Mode Verify Mode Undertaken		A9	Flag shows Mode M&A	DS3	S3	Flag will only show mode letter after spar/rack lock has activated.	
	33	Select External Door Switch to "Open"	B-100	A11	Sw Pos		S2		
	34	Verify the Door is "Open"	B-100	A11					
	35	Activate Hα Telescope Select ATM Hα Camera Select Power "On" to "Camera" Select Power "On" to No. 1 Monitor	B-100	A10	Sw Pos Sw Pos Sw Pos Sw Pos	M1	S3 S3 S6 S10		
		Adjust Crosshairs Intensity			Raster Image Change	M1	R3	This thumbwheel switch should also control intensity	
		Adjust Brightness & Contrast			Image Change	M1	R4, R5		
		Adjust Vertical & Horizontal Crosshairs Shift			Hairs Shift	M1	R1, R2		
	36	Select Hand Control Submode	B-100	A9	Flag shows mode entered		S8		
	37	Select Roll Ref Switch	B-100	A8	Sw Pos		S5		
	38	Astronaut Rolls Cluster by Operating Hand Controller	B-100	A8	Digital read-out	M3	H1	This operation makes use of visible star patterns, or LM[...] CSM inertial displays. Canopus must come within the fr[...] of the star tracker gimbals (± 70° in roll)	
	39	Reset Hand Control Submode Switch	B-100	A9	Flag shows reset	DS9	S8		
	40	Select Star Tracker Switch	B-100	A9	Flag shows Mode	DS7	S6		

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FOLDOUT FRAME 3

tor Code Number:
500A8, 9, 10, 11

	T/M MEASUREMENT NO.	T/M MEASUREMENT NAME
	T001-702 through T002-702	Gyro Wheel Speed No. 1, 2, and 3
lembers		
been	G023-702 through G028-702	No. 1, 2, and 3 Gyros X and Z Gimbal Angles
	K015-702	Flight Mode B, Monitor and Acquire
	K041-701	Hα No. 3 Telescope Aperture
	K040-701	Hα No. 3 Telescope Mode Manual or Automatic
	K016-702	Flight Mode C, Inertial Hold and Maneuver
or eedom	G023-702 G028-702	X and Z Gimbal Angles

FOLDOUT FRAME 1

FOLDOUT FRAME 2

TASK/EQUIPMENT ANALYSIS	Experimenter: MSFC	Experiment Number:	Experiment Title: ATM-PCS	Designa 709A6

FUNC.	NO.	CREW TASK/EVENT	ASTRONAUT ACTIVITY (%)	EQUIPMENT INTERFACE	VISUAL FEEDBACK	DISPLAY	CONTROL	NOTES
ACTIVATION AND ALIGNMENT	40	(Continued)						
		Select Search Submode Code Insert Coded Signal Into Computer	B-100	A9	Sw Pos		S12-S15 S17	
		Verify Signal Confirmation			Flag shows confirm	DS13-14		
		Select Computer "read"			Digital Disp. Change		S18	
	41	Select Outer Star Tracker Switch Pos.	B-100	A8	Sw Pos		S6	
	42	Select Inner Star Tracker Switch Pos.	B-100	A8	Sw Pos		S7	
	43	Select Hand Control Submode Switch	B-100	A9	Flag shows mode	DS9	S8	
	44	Slew Tracker by Operating the Hand Controller	B-100	A8	Digital Readout	M4	H1	
	45	Verify Star Presence	B-100	A8	Flag shows Canopus acquisition	DS7		
	46	Reset Hand Control Submode Switch	B-100	A9	Flag shows Reset	DS9	S8	
	47	Select Track Submode Code Insert coded signal into computer	B-100	A9	Sw Pos		S12-S15 S17	
		Verify signal confirmation			Flag shows confirm	DS13-14		
		Select Computer "read"					S18	
	48	Verify Star Tracker Locked on Canopus	B-100	A8	Flag shows lock-on	DS7		
	49	Select Ground Command System Enable Switch	B-100	A9	Flag shows ENA	DS15	S19	
	50	Select Orbital Plane Update Submode	B-100	A9	Flag shows	DS8	S7	Cluster is automatically oriented to angle (?) received f Ground Communication system.
	51	(Verify Completion of Orbital Alignment mode)	B-100	A8?				
		ATM-PCS is ready to enter the Experiment Pointing Mode						

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or Code Number:
JA8, 9, 10, 11

	T/M MEASUREMENT NO.	T/M MEASUREMENT NAME
	K165-702	Star Tracker Direction Mode
	K170-702	Hand Control Gain
	K023-702	Star Tracker Presence
	K165-702	
	M181-702	Voltage Yaw Error Star Tracker
	M182-702	Voltage Pitch Error Star Tracker
rom	G023-702 through G028-702	X and Z Gimbal Angles No. 1, 2, and 3 CMG

FOLDOUT FRAME 1

FOLDOUT FRAME 2

TASK/EQUIPMENT ANALYSIS	Experimenter: HARVARD COLLEGE OBSERVATORY	Experiment Number: S055	Experiment Title: SPECTROHELIOMETER, SPECTROMETER & Hα TELESCOPE/CAMERA	Designa 709A

FUNC.	NO.	CREW TASK/EVENT	ASTRONAUT ACTIVITY (%)	EQUIP-MENT INTERFACE	VISUAL FEEDBACK	DISPLAY	CONTROL	NOTES
Activation - Hα Telescope Camera	1	Confirm ATM Spar is Sun-Centered within ± 15 arc min.	B-100	709A600A10	Sun centered on CRT	709A600A10 M1		
	2	Verify Inhibit Override is Off	B-100	A5	Locked in "Off"	DS2	S4	
	3	Verify Aperture Closed	B-100	A5	Locked in "Closed"	DS1	S3	
	4	Verify Hα Power Off	B-100	A5	Locked "Off"		S2	
	5	Verify all High Voltage Switches are "Off"	B-100	A5	Locked "Off"		S16-S25	
	6	Verify SW and LW Power Switches are "Off"	B-100	A5	Locked "Off"		S14-S15	Switches S16 through S23 will be controlled "Off" by S14. Switches S24 through S25 will be controlled "Off" by S15.
	7	Open Telescope Aperture	B-100	A5	Flag shows "Open"	DS1	S3	Before proceeding with subsequent events, time should b allowed for equipment outgassing.
	8	Activate Manual Pointing Switch	B-100	A5	Locked in HCO		S28	Time-shared with HAO.
	9	Turn on Hα Power	B-100	A5	Locked "On"		S2	
	10	Astronaut voice report of event No. 9	B-100	709A600A				Tape recorded using Vehicle Recording & Comm Sys
	11	Reconfirm that ATM Spar is Sun-centered	B-100					
	12	Activate Hα Camera	B-100	709A600A10				
		Camera Power			Locked in Up Position		709A600A10 S5	
		Camera Select			Points to "HARVARD Hα"		709A600A10 S4	
		Monitor Power			Locked "On"	709A600A10 M2	709A600A10 S11	
	13	Monitor Hα display	B-100	709A600A10	Desired event shown	709A600A10		30 minute field of view. Accurate to within about 1 minu considering misalignment.

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FOLDOUT FRAME 3

tor Code Number:
600A5

T/M MEASUREMENT NO.	T/M MEASUREMENT NAME
G033-701	Fine Sun Sensor Offset Yaw and Pitch
G034-701	Coordinates
M164-701	Voltage, Fine Sun Sensor
M165-701	Yaw and Pitch DC Amplifier

e

M164-701	
M165-701	
NA	TV Camera No. 1 ATM Hα (Vidicon)

te,

FOLDOUT FRAME /

FOLDOUT FRAME 2

TASK/EQUIPMENT ANALYSIS	Experimenter: HARVARD COLLEGE OBSERVATORY	Experiment Number: S055	Experiment Title: SPECTROHELIOMETER, SPECTROMETER & Hα TELESCOPE/CAMERA	Designa 709A

FUNC.	NO.	CREW TASK/EVENT	ASTRONAUT ACTIVITY (%)	EQUIP-MENT INTERFACE	VISUAL FEEDBACK	DISPLAY	CONTROL	NOTES
Activation - Hα Telescope Camera	14	Actuate Hα TV zoom and set to smallest field of view	B-100	709A600A10		709A600A10 M2	709A600A10 S13	
	15	Position Hα to sun center or target of investigation	B-100	A5		M3-1 & M3-2	S26 & S27	Switches S26 and S27 are used to produce 0 reading on D Alignment Null Meter M3
	16	Astronaut voice report of events Nos. 11-15	B-100	709A600A				Tape recorded using Vehicle Recording & Comm. Sys.
	17	Monitor Filter Temperature	B-100	A5	Switch points to HCO Hα		S32	
					Null meter should read 0	M4-1	S30	Moving S30 up increases temperature. Moving S30 down decreases temperature. Time must be allowed for temperature stabilization.
	18	Select FAST Camera Mode	B-100	A5	Locked "Fast"		S5	
	19	Monitor Rate of film usage	B-100	A5		M1		
	20	Deactivate Fast Camera Mode	B-100	A5	Locked "Off"		S5	
	21	Astronaut voice report of film usage rate	B-100	709A600A				Recorded using Vehicle Recording and Communications S
	22	Select SLOW Camera Mode	B-100	A5	Locked in "Slow"		S5	
	23	Monitor Rate of film usage	B-100	A5		M1		
	24	Deactivate Slow Camera Mode	B-100	A5	Locked "Off"		S5	
	25	Astronaut voice report of film usage rate and number of frames remaining	B-100	709A600A				Recorded using Vehicle Recording and Communications S This completes the Hα Camera Activation.

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FOLDOUT FRAME 3

tor Code Number:
600A5

	T/M MEASUREMENT NO.	T/M MEASUREMENT NAME
ual	G033-701	Fine Sun Sensor Offset Yaw and Pitch Coordinates
	G034-701	
	M155-702 M156-702 M157-702	Voltage Hand Control O/P Roll, Yaw and Pitch
	G029-701	Pos, ATM Hα Camera Film
	G030-701	Pos, LW Hα No. 1 Tlse Camera
	G031-701	Pos, LW Hα No. 1 Tlse Camera
ys.		
	G029-701 G030-701 G031-701	
ys.		