NASA CR-66511
(NSL 67-300)

ORBITING EXPERIMENT FOR STUDY OF EXTENDED WEIGHTLESSNESS

Volume V

PROGRAM PLANS

Prepared under Contract No. NAS1-6971 by
NORTHROP SYSTEMS LABORATORIES
Hawthorne, California
for
Langley Research Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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ABSTRACT

This document constitutes a portion of the final report under contract NAS 1-6971, Orbiting Experiment for study of Extended Weightlessness, for the Langley Research Center, National Aeronautics and Space Administration, Hampton, Virginia. The following 6 documents comprise the total report:

NASA CR-66507	Volume I	Summary
NASA CR-66508	Volume II	System Definition
NASA CR-66509	Volume III	Spacecraft Preliminary Design
NASA CR-66510	Volume IV	Laboratory Test Model
NASA CR-66511	Volume V	Program Plans
NASA CR-66512	Volume VI	Orbiting Primate Spacecraft Applications

This report summarizes the results of a definition study of a spacecraft system to support two primates in unattended, weightless, earth-orbital flight for extended periods of time. The experiment is planned as part of the Apollo Applications Program; the spacecraft launched as a LEM substitute on an AAP flight; the primates recovered by Astronaut EVA on a later flight and returned to earth in retrieval canisters within the Command Module. Intensive post-flight examination is planned to ascertain even subtle physiological changes in the primates due to their extended exposure to weightlessness. The study includes definition of mission profile and Apollo Applications Program interfaces, preliminary design of the spacecraft, and planning for subsequent phases of the program.

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LIST OF ABBREVIATIONS

A	Analog
AAP	Apollo Applications Program
ACE	Automatic Checkout Equipment
ACM	Apollo Command Module
ACS	Attitude Control System
A/D	Analog to Digital
AFB	Air Force Base
AGC	Automatic Gain Control
Ag-Zn	Silver-Zinc
APC	Automatic Phase Control
APIC	Apollo Parts Information Center
AM	Airlock Module
ASME	American Society for Mechanical Engineers
ASPR	Armed Services Procurement Regulation
ATM	Apollo Telescope Mount
AVD	Avoidance Component
B	Biological
BCD	Binary Coded Decimal
BLO	Phase Lock Loop Bandwidth of Ground Receiver
BPM	Beats Per Minute
BW	Bandwidth
C	Control (Present)
C&C	Command and Control
CCW	Counter-Clockwise
C/D	Count Down

CDR	Critical Design Review
CEI	Contract End Item
CG	Center of Gravity
CIBA	CIBA Parmaceutical Company
C_L	Centerline
CM	Command Module
Cmds	Commands
C/O	Checkout
CO_2	Carbon Dioxide
CONFAC	Configuration Factor Computer Program
CRB	Configuration Review Board
CSM	Command Service Module
CW	Clockwise
D	Degradation
DAF	Data Acquisition Facilities
DB	Decibel
DCASR	Defense Contract Administrative Service Region Agent
DFO	Director of Flight Operations
DMU	Dual Maneuvering Unit
DOD	Department of Defense
DR	Discrepancy Report
DRD	Document Requirement Description
DRL	Data Requirements List
DRR	Document Request and Release
DSIF	Deep Space Instrumentation Facilities
E	Engineering
E	Event

ECG	Electrocardiogram
ECP	Engineering Change Proposal
ECS	Environmental Control System
ECU	Environmental Control Unit
EDS	Experiment Data System
EKG	Electrocardiogram
EO	Engineering Order
EMI	Electromagnetic Interference
ETR	Eastern Test Range
EVA	Extravehicular Activity
EXC	Exercise Component
FAB	Fabrication
FACI	First Article Configuration Inspection
FARADA	Failure Rate Data Program
FC-75	Minnesota Mining & Manufacturing (Product Designator)
FM	Frequency Modulated
FMEA	Failure Mode, Effect, and Analysis
FMECA	Failure Mode, Effect, and Criticality Analysis
FOV	Field-of-View
FSC	Flight Spacecraft
FTM	Functional Test Model
GAEC	Grumman Aircraft Engineering Corporation
G&C	Guidance and Control
GCPY	Gas Consumed Per Year
Gen.	Generator
GETS	Ground Equipment Test Set

GFE	Government Furnished Equipment
Gnd	Ground
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
h	Unit of Hysteresis
Hg	Mercury
Hz	Hertz
ICD	Interface Control Document
I.D.	Inside Diameter
IDD	Interface Definition Document
IDEP	Interservice Data Exchange Program
ILK	Interlock Task
I/O	Input/Output
IR	Infrared
IU	Instrument Unit
KC	Kilocycles
Kg	Kilogram
KSC	Kennedy Space Center
LEM	Lunar Excursion Module
LES	Launch Escape System
LiOH	Lithium Hydroxide
LM	Lunar Module
LMS	Lunar Mapping System
LMSS	Lunar Mapping and Survey System
LOS	Line-of-Sight
LRC	Langley Research Center

LSS	Life Support System
LTM	Laboratory Test Model
LUT	Launch Umbilical Tower
LV	Launch Vehicle
M	Mission
MAA	Maintenance Assembly Area
MAAS	Manufacturing Assembly and Acceptance Sheet
MC	Control Moment
MCC-H	Mission Control Center - Houston
MCP	Management Control Plan
MDA	Multiple Docking Adapter
MEI	Master End Item
MFOD	Manned Flight Operations Division
MHz	MegaHertz
MLF	Mobile Launch Facility
M&O	Mission and Operations
MOL	Manned Orbiting Laboratory
MRB	Materials Review Board
MS	Multiple Schedule
MSC	Manned Spacecraft Center
MSF	Manned Space Flight
MSFC	Marshall Space Flight Center
MSFN	Manned Space Flight Network
MSOB	Manned Spacecraft Operation Building
M/VM	Mass/Volume Measurement
M/V MD	Mass/Volume Measurement Device

N	Nuisance
NA	Not Applicable
NAA	North American Aviation, Inc.
NAMI	Naval Aerospace Medical Institute
NASCOM	NASA Communications Division
NASCOP	NASA Communications Operating Procedures
NRZC	Non-Return to Zero Change
NSL	Northrop Systems Laboratories
OCP	Operational Checkout Procedures
O.D.	Outside Diameter
OMSF	Office of Manned Spaceflight
OPS	Orbiting Primate Spacecraft
P	Performance (past)
PAM	Pulse Amplitude Modulation
PCM	Pulse Code Modulation
PCU	Pyrotechnic Control Unit
PDR	Preliminary Design Review
PERT	Program Evaluation Review Techniques
PI	Principal Investigation
PIA	Preinstallation Acceptance (test)
PLSS	Portable Life Support System
PM	Phase Modulation
PPM	Parts Per Million
PRINCE	Parts Reliability Information Center
PSC	Primate Spacecraft
PWR	Power
Q	Quick look

QA	Quality Assurance
QC	Quality Control
QM	Qualification Model
QTM	Qualification Test Model
R	Redundant feature
Rad	Irradiation dose unit of measurement
Rad.	Radius
RCS	Reaction Control System
RF	Radio Frequency
RH	Relative Humidity
RMS	Root Mean Square
RTG	Radioisotope Thermoelectric Generator
S	Saftey
SAA	Saturn Apollo Applications
S/AAP	Saturn Apollo Applications Program
S/C	Spacecraft
SCD	Specification Control Drawing
SCN	Specification Change Notice
Seq	Sequence
SGL	Space Ground Link
SIB	Saturn IB
SLA	Spacecraft LEM Adapter
SM	Service Module
SNR	Signal to Noise Ratio
SPS	Service Propulsion System
SRO	Superintendent of Range Operations
STADAN	Space Tracking and Data Acquisition Network

STM	Structural Test Model
TCM	Thermal Control Model
TCS	Thermal Control Subsystem
TE	Time Estimation
TIG	Tungsten Inert Gas
TIM	Timing Task
TLM	Telemeter
TM	Thermal Model
TTM	Thermal Test Model
TWT	Traveling Wave Tube
UCLA	University of California at Los Angeles
USC	University of Southern California
UV	Ultraviolet
VAB	Vertical Assembly Building
VCO	Voltage Controlled Oscillator
VIG	Vigilance Task
VOM	Volt-Ohmmeter
WMS	Waste Management System
WMU	Waste Management Unit
WTR	Western Test Range

INTRODUCTION

This Program Plan (and Appendices A through G) documents the future activity for designing, developing, fabricating, and delivering a Primate Spacecraft for a late 1970 launch.

The guidelines which were established for this plan are as follows:

(1) Primate Spacecraft flight readiness is required by late 1970.

(2) A two phase follow-on program; Phase 2 Design and Phase 3 - Development/Operations will follow the NASA standard procurement procedures.

(3) A Laboratory Test Model Program will be directly coordinated with, but not encompassed within, the Phase 2 Design Program.

(4) One qualification spacecraft, one flight spacecraft, and one backup flight spacecraft will be required.

(5) Detailed definition of the final project concept, including the system design and breadboarding of critical subsystems, as necessary, will be performed in Phase 2.

MASTER PHASING PLAN

The Preliminary Program Plan for the Primate Spacecraft Program is summarized in figure 1. During this two-phase effort, the Phase 2 planning approach will be to define and establish a baseline design for requirements of the spacecraft system, and design, fabricate, checkout and deliver a Laboratory Test Model. This activity will continue into Phase 3. Phase 3 will include design, completion, fabrication, checkout, qualification, and delivery of a Primate Spacecraft to Kennedy Spaceflight Center (KSC) for a late 1970 launch. The estimated time span from Phase 2 go-ahead to spacecraft flight readiness has been established at 29 months.

The Summary Chart shows major milestones of the program with the first Laboratory Test Model Design completion occurring 4 months after the Phase 2 go-ahead date. The Laboratory Test Model is to be completed and delivered 10 months after contract award. During Phase 3, the Preliminary Design Review will be 2 months, and Critical Design Review 4 months, after the Phase 3 go-ahead date. First Article Configuration Inspection will occur 15 months after contract award, and the first flight spacecraft delivery will take place 19 months after award. After a 2 month checkout period at KSC, the spacecraft will be flight ready 21 months from Phase 3 go-ahead date.

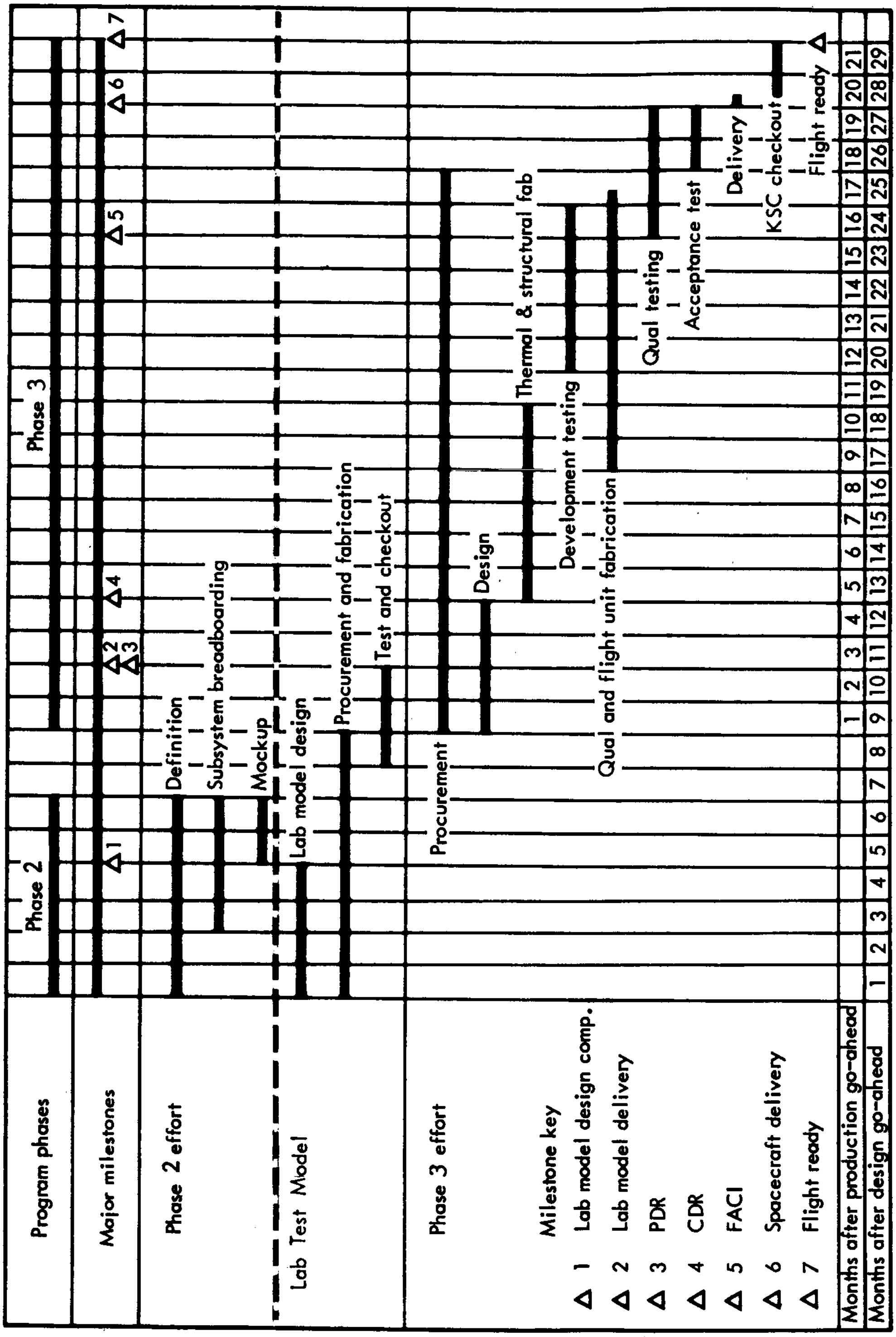

Figure 1.- Primate program summary

Primate Program Master Schedule

The Master Schedule shown in figure 2 depicts a two-phased program relationship covering Phase 2 and Phase 3. The Primate Program, from beginning of Phase 2 through late 1970 spacecraft launch readiness, represents a 29-month no-contingency type schedule and is based on the following assumptions and ground rules:

(1) Five Primate Spacecraft will be delivered. This delivery will include a structural model, a thermal control model, and three flight articles. One flight article will be used for qualification, and one will be used for flight. The third flight article will be maintained for flight backup. The structural model will be refurbished after development use, and will be delivered to KSC for checkout crew training and verification of compatibility with KSC equipment and facilities. The qualification model spacecraft will be refurbished after test and used as a Primate Spacecraft Orbit Simulator.

(2) Production of flight and flight backup Primate Spacecraft will be scheduled on 1-month centers permitting acceptance testing to be conducted on 1-month centers.

(3) The NASA Formal Acceptance will be conducted on each Primate Spacecraft after final integration of subsystems and components has been satisfactorily accomplished. This acceptance will occur at the factory and will culminate in issuance of a DD-250.

(4) As a rule, all parts for the Qualification Model (QM), which subsequently will be maintained as the Primate Spacecraft Orbit Simulator, and all purchased flight hardware will be purchased as prequalified hardware if available. New component and subsystem designs will be qualified by the contractor prior to QM testing.

(5) Qualified parts which undergo minor changes or modifications will be evaluated for extent of requalification required and submitted to NASA for approval.

(6) The design of equipment to be qualification tested shall be approved by NASA prior to beginning of qualification testing.

(7) Ground Support Equipment will be assembled from MIL-STD parts and/or of proven commercial usage where possible, and qualification parts will not be ordered where qualification is not a requisite.

(8) The spacecraft contractor qualification test will be conducted primarily at system level on the completed Primate Spacecraft. After installing components and subsystems into the QM, the system will be functionally checked out. NASA will witness and approve this functional checkout prior to commencement of system qualification testing. After completion of the system qualification program, NASA will issue a Certificate of Completion.

(9) Primate Spacecraft Launch Readiness will be determined from four activities:

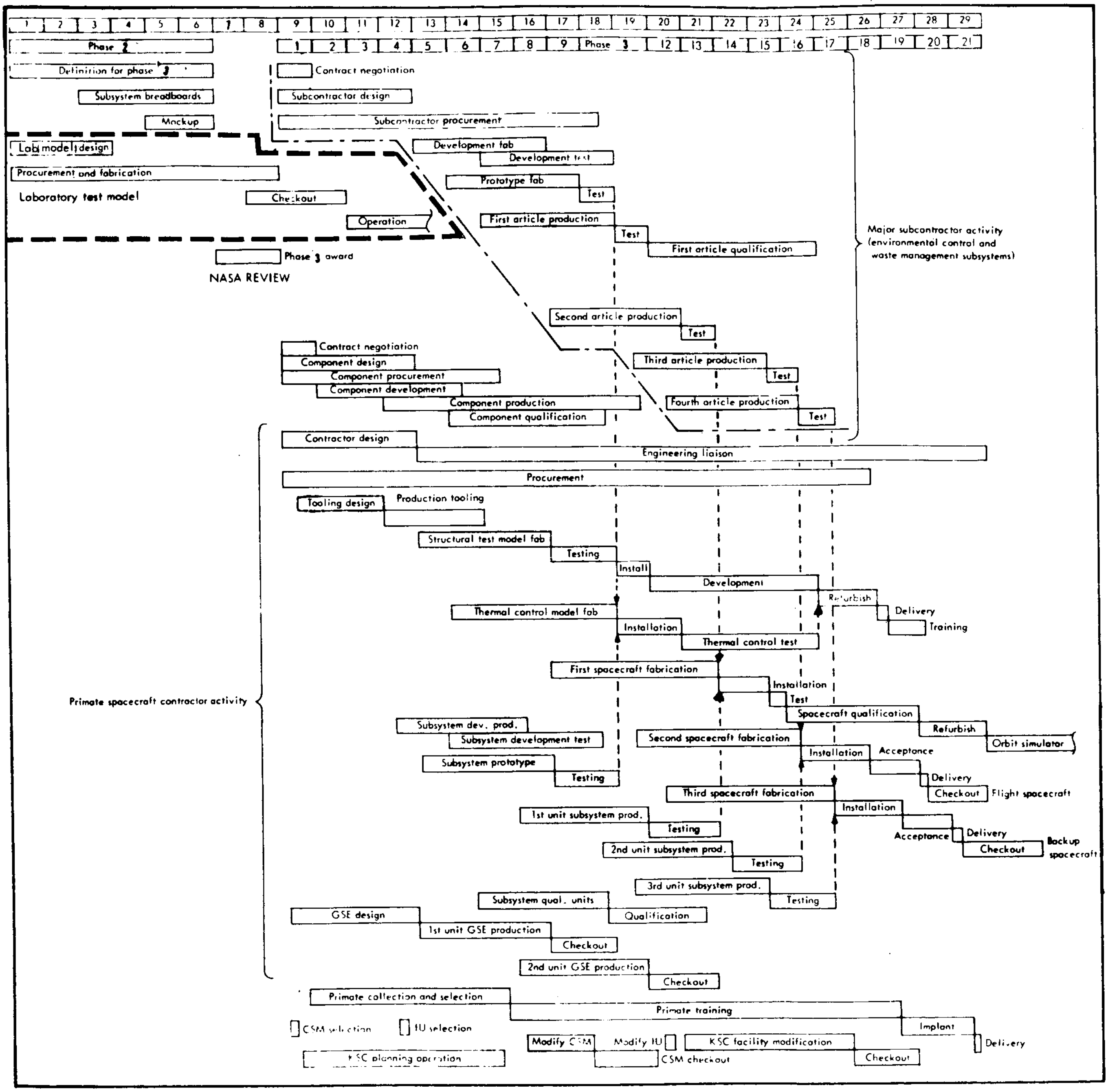

Figure 2. - Primate program master schedule

(a) Test will be that testing activity associated with all nonflight hardware. This will include qualification test on hardware identical to flight but which will not fly.

(b) Checkout will be that testing of flight hardware either at the factory or KSC.

(c) Operations will be that activity conducted at KSC.

(d) Compatibility test will be performed with both the Primate Spacecraft and the Ground Support Equipment to assure that they are compatible and that the GSE can be used to prove that the Primate Spacecraft will function to the specifications to which it was designed.

(10) The first complete Primate Spacecraft structure to be built will be the Structural Model. This model will be used for structural and pressure proof testing. Since this structure is required before all of the production tooling can be provided, some parts may be built by alternate tooling methods. The first Primate Spacecraft to be completely built with production tooling will be the Thermal Control Model.

(11) Only one set of production tooling will be required for the Primate Program Phase 3.

(12) Two sets of Ground Support Equipment (GSE) are planned for the Primate Program. One set will be used for factory acceptance testing and launch site operation. The other set will be used for spacecraft qualification testing and for Primate Spacecraft Orbit Simulator checkout.

(13) Although the conclusion of Phase 2 effort will follow the NASA guidelines for detailed definition of the final project concept, including detail design and the breadboarding of components and subsystems, additional design effort will be required during the Phase 3 period. This design effort will include:

(a) Modification of the Phase 2 mockup drawings to Phase 3 configuration.

(b) Tooling Design

(c) GSE Design

(14) The feasibility of meeting the late 1970 launch date is predicated upon Contractor Milestones being accomplished during Phases 2 and 3. From Phase 2 go-ahead date, the total program time for the first flight ready spacecraft will be 29 calendar months. From Phase 3 go-ahead date, the total program time for the first flight ready spacecraft will be 21 calendar months. A holding period of 2 months for the NASA review is shown between Phase 2 and Phase 3. By eliminating the holding period between Phases 2 and 3, the total program could be reduced to 27 months after the Phase 2 go-ahead date.

(15) The feasibility of meeting the late 1970 launch date is also predicated upon the NASA milestones being accomplished on schedule. Three of the major constraining milestones are listed below:

(a) Tight schedule of the delivery dates for flight hardware requires the contractor to place purchase orders for procurement immediately after Phase D contract award. It is assumed that NASA will approve the advanced releases and early procurement effort which includes the early approval of the Make or Buy List.

(b) Based upon the latest SAA program schedule supplied by NASA, a mission number has not been assigned to the Primate Program. In order to perform the long term planning and achieve the required procurement and launch vehicle modification to support the Primate Program, it is assumed that NASA will assign the mission number and authorize the planning operation early in the program.

(c) The Apollo resources at KSC will be used to support Primate Spacecraft checkout operations to the maximum extent possible without significant impact to the Apollo Programs cost or schedules. It is assumed that the special Primate Spacecraft GSE will be supplied by the contractor and that standard GSE to support the Primate Spacecraft checkout will be supplied by KSC. It is also assumed the KSC will furnish ground station support for recording telemetered data during test operations.

Phase 2. - Phase 2 will consist of two separate but related efforts. These efforts consist of the detailed definition activity and the Laboratory Test Model activity.

The six-month Phase 2 detailed definition effort would consist of the following activities:

(1) Detailed performance analysis of components, subsystems, assemblies, and structure.

(2) Detailed design of components and hardware subassemblies.

(3) Detailed design of spacecraft structure.

(4) Definition of program plans for the subsequent Phase 3 effort.

(5) Breadboarding components and subsystems which have not been previously qualified or will not be a part of the Laboratory Test Model.

(6) The fabrication of a spacecraft mock-up.

The program objective during the 6-month Phase 2 activity will be to define and establish a baseline design and requirements for the Primate Spacecraft Program. This program definition will permit a smooth transition into the Phase 3 activity.

It is anticipated that breadboarding of components and subsystems will commence 2 months after the program go-ahead date and that the mock-up will be constructed during the final 2-month period.

The separate design and fabrication activity of the Laboratory Test Model (LTM) will be initiated concurrently with, and be related to, Phase 2 activity. Delivery of the LTM, however, will be made 10 months after the Phase 2 go-ahead date. Procurement of long lead time items will commence with contract award based on current Phase 1 study design with will permit delivery of Environmental Control and Waste Unit components 8 months after program go-ahead date

The Laboratory Test Model design will be frozen 3 months after start of Phase 2; however, the latest component and subsystem design resulting from Phase 2 design activity will be incorporated into the LTM.

Test and checkout of the LTM will begin before delivery of Environmental Control and Waste Unit components and will continue until delivery of the LTM 10 months after program go-ahead date.

Phase 3. - A 21-calendar-month program has been scheduled for the Phase 3 effort to meet the late 1970 launch requirement. Following the Phase 2 detailed definition activity, an additional 4 months will be required to complete design and generate production drawings. After 8 weeks, a Preliminary Design Review will be conducted, and after 4 months the Critical Design Review will be conducted. This design review will precede the start of production. Tooling design will occur concurrently with spacecraft design followed by the manufacturing and procurement of production tooling. This activity will be accelerated as much as possible to permit the use of hard tooling early in the spacecraft fabrication phase, and is scheduled to be completed 6 months after the Phase 3 go-ahead date. The structural test model will be the first spacecraft structure to be fabricated and is scheduled to be completed at the end of the 8 months. This structure will undergo leak test, pressure proof test and static-dynamic load tests. Following structural test, this spacecraft will be used for the development of subsystem installation and interface checkout. Refurbishment of the structural model spacecraft will begin during the sixteenth month. One month before flight spacecraft delivery, this refurbished structural spacecraft will be shipped to KSC where it will be used for checkout crew training.

The second Primate Spacecraft structure to be fabricated will be the Thermal Control Model and will be completed by the end of the tenth month. Thermal testing will be performed with the Thermal Model and will include both passive and active testing on the temperature control systems. For active testing, the prototype environmental control subsystem will be installed.

The first Primate Spacecraft in Flight Configuration will be subjected to system qualification testing. This unit will be fabrication completed 13 months after Phase D go-ahead date, and after a 10 week installation period, this unit will go through First Article Configuration Inspection. First Article Configuration Inspection will be accomplished prior to spacecraft system qualification. Following the qualification testing, the spacecraft will be refurbished and used as an Orbit Simulator during flight Primate Spacecraft mission operations.

The second and third Flight Configuration units will be the flight and backup spacecraft. Spaced on 1 month centers, fabrication complete will occur from 15-1/2 to 16/1/2 months after Phase 3 contract go-ahead date. Following a 2 month installation effort, checkout and acceptance will be completed prior to KSC delivery.

GSE design will begin early in the Phase 3 activity and will be completed in 4 months. Two sets of GSE will be required for this program. The first set will be available in 10 months, and the second set will be available in 13 months.

Other activities shown in the Primate Program Master Schedule include KSC planning operations, Primate training, Command Module (CM) and Instrument Unit (IU) modification (if required for launch phase communications) and checkout.

PERT program. - The feasibility of having a flight-ready Primate Spacecraft by late 1970 is predicated upon the assumptions and conditions outlined in the Program Plan. To assure NASA that the program milestones will be met on time, the contractor's management must be provided with a planning tool that can be used to control the manpower, money, materials, machinery, and time. The planning tool recommended is a PERT System that is compatible with the NASA PERT and Companion Cost System and will permit management to accomplish the following tasks:

(1) Select the program objectives and plan the strategy for carrying out the objectives.

(2) Determine the requirements to complete the program.

(3) Allocate the resources to complete each job in the program according to the Master Plan and Schedule.

(4) Control the entire process from point of decision or commitment to completion.

(5) Itemize related cost incurred to progress achieved.

Figure 3 is a preliminary PERT Network that illustrates the subsystem events that must be completed for Phase 3 and the activity time in weeks to complete each event. Upon award of Phase 2, the objectives will be reviewed to assure that the network logic and program requirements have not changed. Any changes in the new program objectives will be incoporated into both the network and schedules. Once the networks have been revised, the Phase 3 operational cycles should occur as follows:

(1) Establish the Program Master Milestones predicated on contractual mandatory requirements and related schedule exhibits in the contract statement of work. The critical dates affixed to the milestones will then serve as precise parameters.

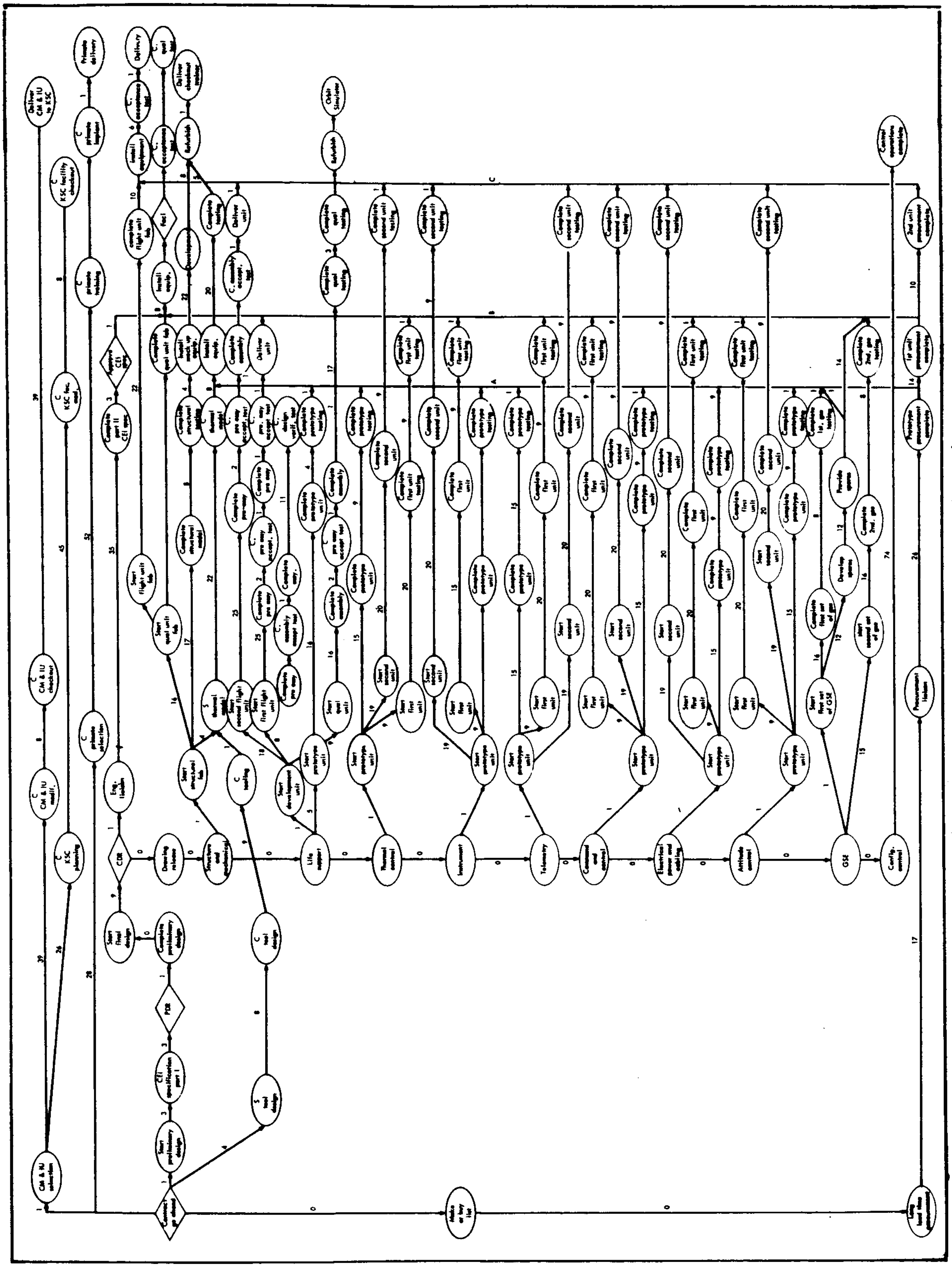

Figure 3. - Primate program PERT network - phase 3

(2) Obtain the current Management Control Plans to identify subtasks (activities) for each organizational area. The activities will be completed in detail and will be organized to encompass planning logic and time estimates, as well as interrelationship of effort by contractor and other outside support.

(3) Transfer Management Control Plans to network planning format. Plot activities in series by program element (i.e., GSE, Prototype, etc.) identify constraints, assign organization responsibility, and denote realistic time estimates.

(4) Determine the "Critical Path" and its flow and relationship to Program Master Milestones by Analytical Technique. Alert management and the organization counterpart of problem areas that jeopardize prime objectives.

(5) Generate corrective action to rectify incompatibilities. Resolve schedule differences by resource exchanges, sequence planning, premium time effort, manloading assignment, multishift operation and adjustment to priority control.

(6) Develop, where necessary, additional temporary subnetworks to simulate and encompass problem areas and maintain some for the duration of Phase 3 to ensure effective management and control. The level of details for these subnetworks should be dictated by the technical nature and magnitude of activity. Monitoring should be accomplished at a level that satisfies timely accomplishment and problem resolution.

(7) Establish a financial visibility through a network of discrete cost centers identified to contract end item (CEI) and traceable through the PERT network. This control should be established and maintained from Phase 3 award through the final financial documentation by an orderly plan which utilizes the NASA approved cost collection system.

PHASE 2 - DESIGN

The major tasks of this phase will be two-fold; a detailed definition of the Primate Spacecraft, and initiation of the design, fabrication and delivery of an Orbiting Primate Spacecraft Laboratory Test Model. During this phase, a zero-g flight test program for waste management subsystem configuration should also be performed.

Definition

The program objective during the 6-month Phase 2 detailed definition effort will be to define and establish a baseline for requirements of the Primate Program to permit a smooth transition from Phase 2 to Phase 3 and will consist of the following activities:

(1) Design

(2) Breadboarding

(3) Mockup

Design. - During the Phase 2 design activity, the engineering approach will be to design the Primate Spacecraft using as much qualified hardware as possible and to simplify the design to assure high reliability. The design effort will afford NASA the opportunity to review and approve baseline requirements which fulfill the criteria and constraints and will include the following:

(1) Operational and maintenance functional flows and analyses

(2) Proposed end item requirements

(3) Systems and Primate utilization analyses

(4) Functional interfaces

(5) Subsystem schematics

(6) Design drawings

(7) Design specifications

(8) Detailed cost

(9) Schedules

Breadboarding. - Phase 2 will include breadboarding of subsystems and components as required to provide reasonable assurance that the technical milestones schedules and resource estimates for the next phase can be met and definitve contracts can be negotiated for Phase 3. Only breadboarding of critical subsystems or components which are not included in the Laboratory Test Model need be considered.

(1) Developmental Electronics

(2) Mass Measurement Device (if not developed under separate development contract).

(3) Behavioral Panel

Mockup. - During Phase 2 an engineering mockup will be fabricated to the latest design configuration. The mockup will be used to confirm arrangements of the subsystems and interfaces with the launch vehicle mounting rack and Command Module. Materials used in the mockup will consist of wood, metal and transparent plastic.

LABORATORY TEST MODEL (LTM)

The primary objective of the Laboratory Test Model (LTM) Program will be to design, fabricate and deliver to NASA, one Laboratory Test Model capable of a 1-year operating lifetime and capable of simulating or duplicating selected functions, subsystems and components of the Orbiting Primate Spacecraft.

<u>Laboratory Test Model design</u>. - Design of the Laboratory Test Model will be related to but not encompassed entirely within the Phase 2 effort. The systems and subsystem design, generated during Phase 2 , forms the basis for design of the Laboratory Test Model; however, the design objectives will be as follows:

(1) Design a Laboratory Test Model which interfaces with the primates in the same manner as the spacecraft flight system interfaces with the primates.

(2) Design the Laboratory Test Model so it can be operated in an air conditioned laboratory.

(3) Design the Laboratory Test Model for a 1-year operational capability.

<u>Procurement and fabrication</u>. - Procurement of long lead time items for Laboratory Test Model will commence with contract award permitting delivery of Environmental Control and Waste Unit components eight months after program go-ahead. During the eight month procurement phase, detailed design and fabrication of Laboratory Test Model structure will take place. Fabrication completion will include integration of the environmental control and waste management components providing delivery 2 months later, or 10 months from the start of Phase 2 .

ZERO-GRAVITY FLIGHT TEST PROGRAM

The prolonged effect of the zero-gravity field on the waste management subsystem cannot be completely determined prior to Primate Spacecraft orbit. A test program should be performed, therefore, that would help ensure that the waste management subsystem will function as designed. Economic factors and the proposed Primate Spacecraft launch schedule preclude the use of actual orbital missions as a means of investigating all of the possible effects; and ground-based methods of simulating zero-gravity produce too-short periods or imperfect simulated zero-gravity. A method has been developed, however, that produces a true zero-gravity field by means of flying specific maneuvers in aircraft. Although the range of zero-gravity time using this method is from seconds to a minute, its use is recommended during Phase 2 for development and preliminary evaluations of the waste management subsystem for the Primate Program.

During this Flight Test Program, a mockup of the life cell complete with circulating air ducts and equipment producing actual air flow patterns could be flown aboard a KC-135 aircraft. Since the zero-gravity state only occurs when the aircraft is on a ballistic trajectory, sufficient time would not be available for the use of live primates to generate the fecal matter. A substitute system could be used to distribute the floating material to determine if the life support system air flow would move the floating material to the bottom of the of the life cell.

PHASE 3 - DEVELOPMENT/OPERATIONS

Phase 3 is that effort required to complete the detailed design and development, fabrication and test of the Primate Spacecraft and related GSE.

During the 21 month Phase 3 period, the contractor's activities would include: design, procurements, tooling, fabrication, development, testing, support and delivery.

Design. - The design effort will consist of completing the detailed design baselined during Phase 2 and will include:

(1) Detail design completion of Phase 3 production drawings

(2) Tooling design

(3) GSE design

Two design reviews are recommended during the Design Phase: A Preliminary Design Review and a Critical Design Review. Preliminary Design Review will approve the following:

(1) End item design criteria

(2) Circuit and logic diagrams

(3) Packaging layouts

(4) Maintainability and interchangeability requirements

(5) Anticipated development cycle

(6) Human engineering and safety requirements

(7) Load analysis

(8) Interface definition

(9) Tooling design

Critical Design Review will approve the following:

(1) Design specifications

(2) Manufacturing drawings

(3) Interface drawings

(4) Parts selection standards

(5) Electrical characteristics

(6) Installation requirements

(7) Detailed load analysis

(8) GSE design

(9) Training requirements

Procurement. - The feasibility of meeting the late 1970 launch date is predicated upon the contractor milestones being accomplished on time. It will be necessary for the contractor to place purchase orders for long lead time items immediately after Phase 3 contract award to meet procurement milestones, because of the tight delivery schedule dates for flight hardware. To accomplish this, it will be necessary for NASA to approve the advance releases and early procurement effort. This includes approval of the Make and Buy Plan as early as possible.

Figure 4 shows the procurements milestone schedule for the Phase 3 Program. To meet these milestones, emphasis will be placed on the specific procurements which will have the greatest impact on program schedule. Raw materials for the structural and thermal control models is an example of critical procurements.

Tooling. - During Phase 2, the Tooling Plan will be developed. The tooling requirements will be determined by the design tolerance requirements rather than production rate. The three major controlling tool requirements are as follows:

(1) The interface joint control with other hardware items such as Primate Spacecraft to rack and Primate Spacecraft to CSM docking adapter.

(2) Dimensional control to achieve required operation requirements such as the fit of hatches, recovery capsule seals and bulkhead seals for minimum leak rate.

(3) Fit requirements to achieve high quality welded joints of thin gage pressure shells.

During Phase 3 detailed tooling should be designed using the Tooling Plan developed during the Phase 2 activity. To obtain a higher degree of product reliability, production tooling should be fabricated from formal designs rather than layout type drawings or sketches.

Since the number of spacecraft to be manufactured is limited, only those tools which are mandatory for producing a qualified and reliable article will be fabricated by the tooling organization. In addition to the hard tooling, simple soft tooling aids will be fabricated as needed. Only one complete set of production tooling will be required.

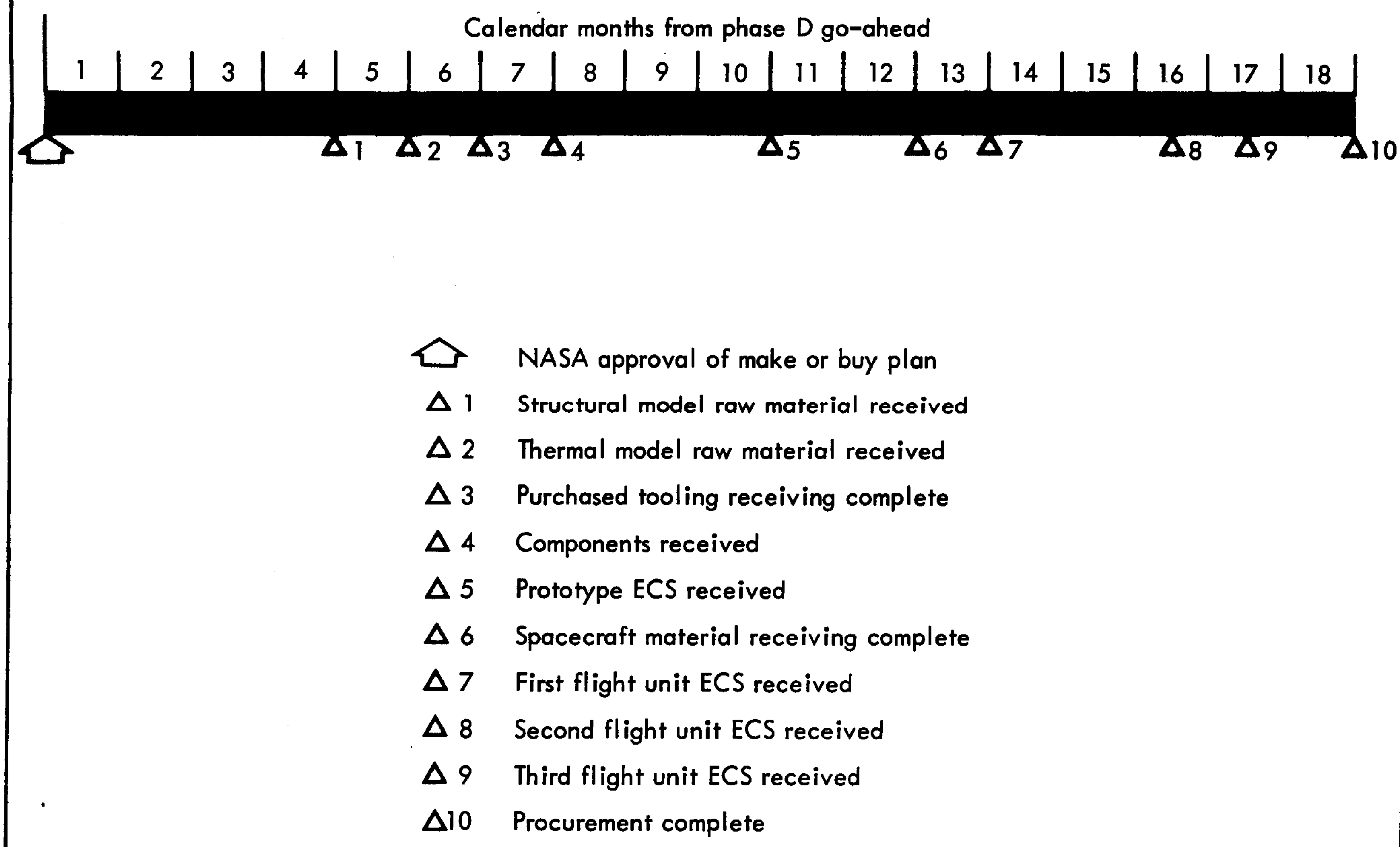

Figure 4.- Procurement milestone schedule

Fabrication. - During Phase 3, the fabrication activity will consist of manufacturing five Primate Spacecraft and two sets of GSE. One spacecraft will be used for structural testing; one for thermal control testing and one for qualification testing. Two flight spacecraft will be provided. One will be provided for flight, and one will be held for flight backup. One set of GSE will be used for factory checkout and one set will be used for checkout at KSC.

Fabrication of the structural test model will begin at the conclusion of the Critical Design Review and is scheduled to be completed by the end of the ninth month from the Phase 3 go-ahead date. The one piece skin and one piece bulkhead design will permit the use of basic aircraft machining and manufacturing processes with major development problem being foreseen. Since this structure will be required for structural testing before all production tooling can be provided, some parts will be built by alternate tooling methods.

The Thermal Control Model will be the first Primate Spacecraft to be completely built using production tooling.

The first flight spacecraft, Serial No. 1, will go through First Article Configuration Inspection (FACI) and will be used to establish the product configuration baseline for the contract end-item spacecraft. This spacecraft will also be used for spacecraft system qualification. The following two flight spacecraft, Serial No. 2 and No. 3 will be subjected to Acceptance Testing.

Development. - During Phase 3, prototype subsystems will be installed, integrated and tested in the structural and thermal control models. The hardware and development objectives are as follows:

(1) Development testing on thermal model. Perform developmental thermal testing on the passive and active temperature control systems. Verify heat transfer characteristics, heat flow and temperature distribution.

(2) Development testing on structural model. Develop techniques for fabrication and assembly, installation and sealing techniques for bulkheads and hatches, determine meteroid, radiation and toxicity hazards.

Testing. - Testing during Phase 3 will consist of component testing, development and evaluation testing, qualification testing and acceptance testing. Testing at the component level will be limited to those components which will be newly designed for the Primate Spacecraft and will have no prior qualification or operational history. Development and evaluation testing will support the derivation of the operational configuration spacecraft; qualification testing will verify that the design and construction satisfies the operational criteria for performance; and acceptance testing will assure that the deliverable hardware meets the quality standards and functional criteria. The hardware and test objectives for Phase 3 are as follows:

(1) Components. For evaluation of functional characteristics and resistance to the environmental stresses.

(2) Structural model. For stress, leak and proof test, subsequently used for development subsystem installation and interface checkout, and verifying compatibility with KSC equipment and facilities.

(3) Thermal model. For thermal control, hot or cold spots, acoustic level, cold and hot soak and thermal vacuum transient test.

(4) Qualification spacecraft. For ambient and vacuum thermal operation, electro-interference test, vibration qualification and operating life qualification. Subsequently refurbished and used for Primate Spacecraft Orbit Simulator.

(5) Flight models. For acceptance testing and flight operations.

Support. - During the Phase 3 Activity a careful evaluation of the support equipment needed through all phases of operations will be made. This will begin with a study of the sequence of events for spacecraft fabrication, test, checkout and prelaunch operations followed by a determination of equipment and manuals necessary to support these events. The actual support equipment evolved through this process will result in a complete set of items which can readily meet system support requirements and will include items shown in table 1.

TABLE 1. - SUPPORT EQUIPMENT

Support category	Purpose
GSE	Handling and transportation equipment, status and monitoring equipment, servicing equipment, and auxiliary equipment.
Logistics	Maintenance, transportation, spares, checkout crew training, and technical documentation.
Simulator and Training Equipment	Checkout crew training, spacecraft, orbit simulator.
Facilities	Contractor, operational.

The Ground Support Equipment (GSE) is a major category in the support area and will be designed to meet specific requirements of the Primate Program. Some of the controlling design rules are listed as follows:

(1) Two sets of GSE are planned for the Primate Program. One set will be used for factory acceptance testing and launch site operation. The other set will be used for spacecraft qualification testing and Primate Spacecraft Orbit Simulator checkout.

(2) GSE will be assembled from MIL-STD parts and/or of proven commercial usage where possible and qualification parts will not be ordered where qualification is not a requisite.

(3) The Apollo resources at KSC will be used to support the Primate Spacecraft checkout operations to the maximum extent possible without significant impact to the Apollo cost or schedules.

(4) Automatic Checkout Equipment (ACE) will not be used for Primate Spacecraft checkout at KSC.

(5) Special Primate Spacecraft GSE will be supplied by the contractor and standard GSE to support the Primate checkout will be supplied by KSC.

(6) KSC will furnish ground station support for recording telemetered experiment data during test operations.

(7) GSE will be designed so loads resulting from prelaunch operations, ground handling, transportation, and fabrication do not determine the design of any primary structure of the spacecraft.

(8) GSE will be designed to handle the spacecraft by its hard points only.

(9) A spreader beam will support the spacecraft during handling operations.

During the various phases of testing and during checkout and handling, one complete set of GSE will be required at the factory for the flight model, backup model, qualification model, thermal control model and structural model of the Primate Spacecraft. This equipment will be available for handling operations during fabrication and will be capable of being used to perform test at the system level and used to isolate malfunctions to the subsystem level. Wherever required, additional equipment will be available for handling, transporting and special component level test.

A second complete set of GSE will also be required at KSC to perform system test when the Primate Spacecraft is located at the Manned Spacecraft Operation Building (MSOB), and when the spacecraft is assembled on the booster vehicle on Pad 34.

A preliminary definition the GSE complement is shown in table 2.

TABLE 2. - PRELIMINARY DEFINITION OF GSE

GSE required	Function
Assembly and test stand	Used for contractor final assembly, equipment installation, and test.
Transportation dolly	Used to transport spacecraft from one test area to another, and used during KSC checkout to provide a base to attach a hard all weather protective cover.
Lifting sling	Used for attachment to spreader beam.
Spreader beam	Attach to spacecraft lifting points.
Portable clean room	Provide a means for environmental and contamination control for the interior of the spacecraft.
Transportation Equipment, consisting of purge or environment sustaining system, protective cover and sensors for environment and shock.	During shipment spacecraft must be protected against and monitored for excessive climatic environments and shock.
Servicing equipment for LO_2, LN_2, GN_2, and water	Checkout of liquid and gas storage equipment.
Inverting fixture	Provide a means for inverting spacecraft for fit check with CSM.
Work platforms	Provide access to spacecraft during fabrication, test, checkout and prelaunch operations.
Environmental control subsystem checkout set	Monitor ECS during test and checkout operations.
Leakage measuring device	Measure spacecraft leakage during acceptance testing.
Alignment fixture	Alignment of spacecraft hard points for rack installation.

TABLE 2. - Concluded

GSE required	Function
Coolant fluid circulating unit	Provide coolant circulation to spacecraft ECS from checkout through lift-off.
System test set	Simulate the battery power; 35 VAC, 1200 cycle power; 115 VAC, 11, 400 cycle power; and regulated 28 volts DC.
Command generator	Generated signals used to modulate the uplink RF carrier.
Data handling equipment	Provide simulated signals of the spacecraft data.
PCM simulator	Provide simulated spacecraft data into decommutator.
Control and monitoring equipment	Provide the controls for switching on the various types of power, and provide for critical malfunction indication, both audible and visual.

Delivery. - The NASA Formal Acceptance will be conducted on each Primate Spacecraft after final integration of the subsystems and components has been satisfactorily accomplished. The objective of the acceptance should be to prove that each spacecraft is built to the drawings and will perform within its design specifications. This acceptance will occur when the DD-250 is issued at the factory.

After acceptance, the Primate Spacecraft will be packed and crated for protection against all hazards of transportation from the contractors facility to NASA at KSC. The Spacecraft will be packed, packaged and marked in accordance with the requirement of MIL-P-7936A. A Government Bill of Lading will be prepared 30 days in advance of shipment as directed by NASA. Primary mode or shipment will be by air transportation at government expense from the contractor's facility to Patrick Air Force Base.

BUDGETARY COST ESTIMATES

A budgetary cost estimating plan has been prepared to aid in forecasting the expected costs for implementing the contracted effort on the Primate Spacecraft Program up to launch of the final experiment.

Basis of Estimate

The budgetary estimates should be based on the accomplishment of the effort as described in the preceding sections of this document and in the program plans presented in Appendices A through G.

Methodology

The labor cost estimates are derived by the preparation of Management Control Plans (MCP's). MCP's are a sequential, narrative, and graphic presentation of the tasks, schedules, and manpower loading for performing the Primate Spacecraft Program which are prepared in accordance with the work Breakdown Structure and MCP format illustrated in the management plan (Appendix A). MCP's, are prepared for, each of the following Contract End Items, Subdivision of Work and Task Area:

Contract End Item

(1) Laboratory Test Model-consisting of:

- Support equipment
- Development hardware
- Spares
- Tooling
- Documentation

(2) Phase "D" Development Hardware-consisting of:

- Structural test model
- Thermal test model
- Qualification test components
- Qualification test subsystems
- Tooling
- Documentation

(3) Flight hardware consisting of:

- Flight model 1 and 2
- Qualification test model
- Simulation article

Trainer

Documentation

(4) Ground support equipment including documentation

Subdivision of Work

(1) Life support subsystem

(2) Thermal control subsystem

(3) Structure to mechanical subsystem

(4) Instrumentation subsystem

(5) Telemetry subsystem

(6) Command to control subsystem

(7) Electrical power to cabling subsystem

(8) Attitude control subsystem

Task Areas

(1) Program management

(2) System engineering

(3) Design

(4) Manufacturing

(5) Test and Operations

(6) Reliability

(7) Quality assurance

The information obtained from MCP's is then transposed to a cost matrix which segregates the labor hours by Contract End Item, by Subdivision of Work, and by Task Area.

The labor categories associated with each task can then be determined to provide a composite labor rate by Task Area and Subdivision of Work. The rates used are in accordance with the rate tables approved for bidding purposes by the Defense Contract Administrative Service Region Agent (DCASR). The rates utilized should be those which will be effective during the mid-point of the program. By applying these labor rates to the items delineated in the cost matrix, complete labor costs can be obtained in accordance with the matrix breakdown described above.

The MCP's also provide anticipated manload requirements for each Task Area. The preparation of MCP's provides all the necessary information for future PERT analysis. The complete program lends itself quite readily to an integrated cost control system to provide an effective and timely management tool.

Detailed Make-or-Buy lists were prepared (illustrated in the manufacturing plan, Appendix G of this document) which delineate all of the materials, purchased parts, and components, along with the quantities required, in support of the deliverable hardware for this program.

The decision for "Make" or "Buy" as shown on the referenced lists resulted from the equipment list review by the Make-or-Buy Board as described in the Manufacturing Plan Appendix G. The Purchasing Department can obtain pricing information from various suppliers for all of the items listed and provided inputs for tentative supplier selection. It should be noted that supplier's pricing should include development and qualification costs as applicable.

Budgetary Cost Summary

Phase 2 - Design

Including:

(1) Spacecraft design

(2) GSE design

(3) Detail program definition

(4) Documentation

(5) Mockup fabrication

Total xxx,xxx

Laboratory test model acquisition

Including:

(1) Development hardware

(2) Ground support equipment

(3) Spares

(4) Tooling

(5) Documentation

Labor	xxx,xxx	
Raw materials	xxx,xxx	
Purchased parts	xxx,xxx	
Total		xxx,xxx

Phase 3 - Development/operations

Including:

(1) Structural test model

(2) Thermal test model

(3) Qualification test components

(4) Qualification test subsystems

(5) Trainer

(6) Ground support equipment

(7) Qualification test article

(8) Flight article #1

(9) Flight article #2

(10) Documentation

Labor	xxx,xxx	
Raw material	xxx,xxx	
Purchasing parts	xxx,xxx	
Subcontract	xxx,xxx	
Total		xxx,xxx

ADVANCE TECHNOLOGY AND DEVELOPMENT

Most of the development effort anticipated in the course of the program has been identified as being within the scope of present state of the art. Two significant areas have been identified, however, which merit special attention during the Phase 2 period. It would be extremely important to have problems in these areas resolved and solutions formulated before the major portion of a Phase 3 effort is initiated. These two areas are:

(1) Waste removal by airflow in zero-gravity

(2) Mass measurement techniques and devices.

Waste Management

The control and storage of wastes from an unrestrained primate in a zero g environment for a period of one year has never been attempted to date. Development of an integrated set of waste management equipment to perform the task required by the Orbiting Primate Spacecraft has been minimal to the present time. The complexities of the waste management problem are inherent in the nature of certain constituent functions of overall waste management; these are:

Collection of waste under zero g conditions
Storage for a one year period
Interaction of waste storage with life cell air flow

The most promising approach to collection of waste is by means of forced air flow. The determination of air flow patterns and movement of waste in the air stream under zero g conditions will require special investigation; the findings will have a significant impact on final equipment design. The effectiveness of graded porosity filters in the zero g collection and storage of waste matter and the mechanization of their application will also require special effort.

This area lends itself to a flight test program utilizing KC-135 aircraft describing parabolic trajectories for portions of their flight profile in order to produce short term zero-gravity conditions. Life Cell mockups with pertinent elements of the waste management equipment would be flown in the aircraft to study the distribution patterns and flow paths of waste matter in the Life Cell in this environment. Such tests would provide significant data for optimizing the Life Cell and waste management design approaches.

Mass Measurement

Measurement of mass under zero gravity conditions presents unique problems. Without the assistance of gravity, measurement of mass must rely on techniques other than weighing. The two most promising techniques employ inertia or volume measuring methods. A device for determination of mass under weightlessness conditions utilizing an inertial-oscillatory technique has been developed by Lockheed Missile and Space Company under Contract NAS 1-5999. The device was designed to determine the mass of a human subject and proved to be satisfactory if the subject was restrained in a chest harness and told to immobilize his head, arms and legs by strong muscular tension. Similar developments have been conducted by the Air Force under Dr. W. E. Thorton of the Aerospace

Medical Division, Brooks AFB, San Antonio. Reports of this activity indicate success with human subjects but poor results with animals--even well restrained dogs.

An approach to mass measurement using volumetric measuring techniques has been explored using as a basis a device developed by Acoustica Associates, Inc. of Los Angeles for measuring liquid volumes. The principle employed measures volume by means of adiabatic compression of a known atmosphere surrounding the subject in an enclosure of known volume. Northrop performed tests using this device in measuring the volumes of two Macaca speciosa monkeys. A problem encountered, which will require additional investigation, was attributed to animal respiration involving body dynamics of the chest cavity as they affect the pressure measurements, and thermal effects as they affect pressure measurement.

Attaining the required accuracy and providing a suitable enclosure in which to perform the measurement, and then correlating volume measurements with mass are the specific items requiring the additional development effort.

The area indicated above, Mass Measurement, is one which will require an early start in basic investigation and design. Most of the various techniques for mass measurement developed to date are limited in their applicability because of dependence upon cooperative subjects. In the orbiting weightlessness experiment conditions are such that a minimum of this cooperation can be expected from the primates. Hence, it will be necessary to augment current efforts. Determination of mass by volumetric measurement shows promise and requires the least subject cooperation.

Development of a volumetric mass measurement technique and device should be initated as early as possible to assure availability for use in the flight spacecraft. The development effort should encompass design and testing to implement one or more of the volumetric mass measurement approaches.

APPENDIX A

MANAGEMENT PLAN

INTRODUCTION

Purpose

The purpose of this Management Plan is to:

(1) Outline the essential management techniques applicable to Phases 2 and 3.

(2) Provide for Management visibility, flexibility, and control.

(3) Establish an efficient organizational philosophy.

Objective

The objective of this plan is to establish a viable and responsive management framework capable of assuring attainment of program performance, schedule, and cost objectives.

ORGANIZATION

The size and scope of the primate program defines the need for an organization specifically tailored to meet the peculiar requirements of each phase, taking into consideration:

(1) Efficient utilization of personnel resources

(2) Maintenance of short communication lines - both internally and with NASA/LRC

(3) Relative position in company organization.

The Phase 1 study team forms the nucleus of a progressively expanding project organization as the program progresses from Phase 2 to Phase 3. During Phase 2, the project will operate at the group level within the company organization. As the program progresses into Phase 3, the expanded project will operate as a section, in order to maintain a balanced position with respect to other concurrent programs. Figures A1, A2, and A3 present the estimated manpower buildup schedules for Phase 2, Laboratory Test Model, and Phase 3 programs respectively.

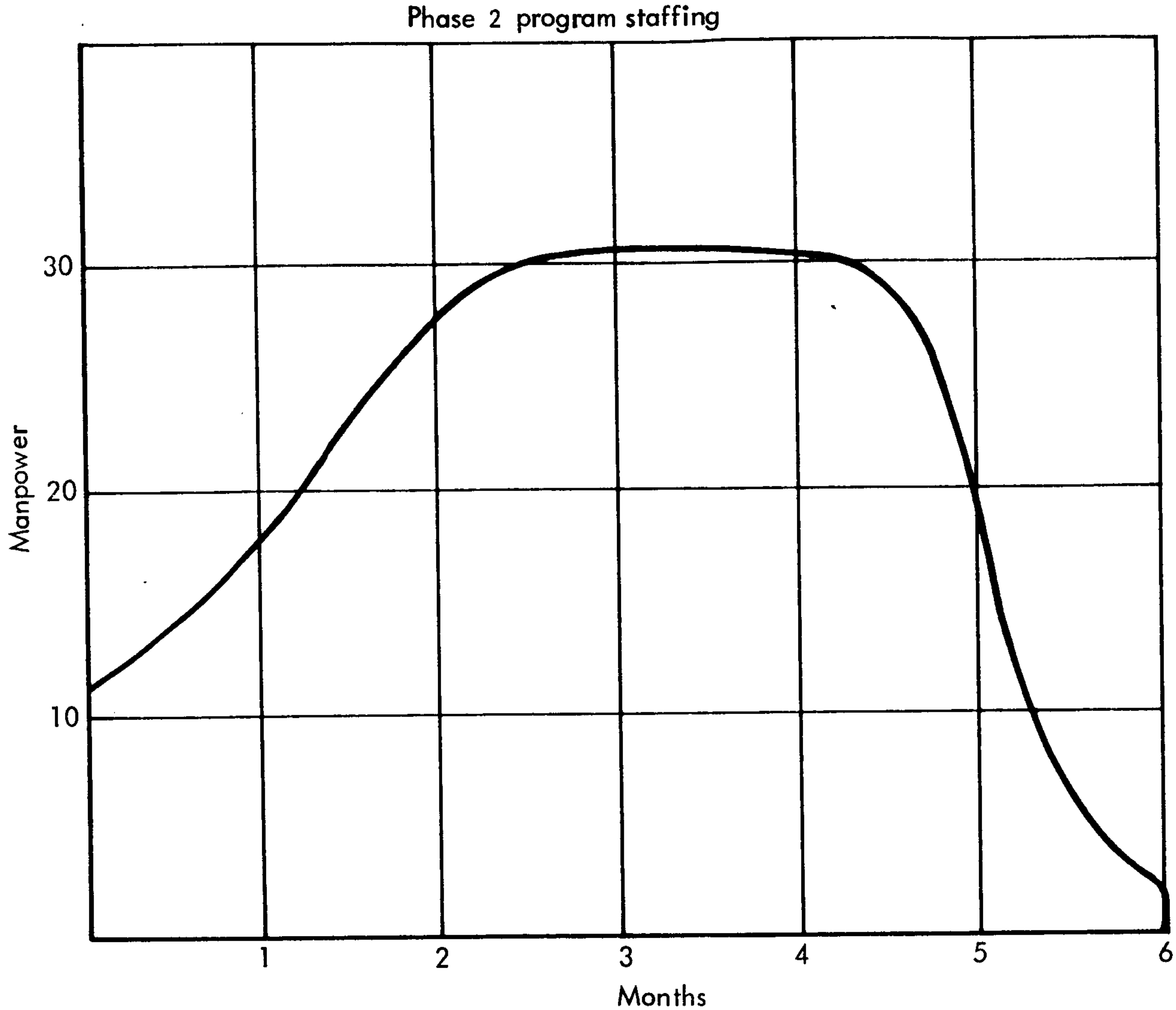

Figure A1.—Estimated manpower build up phase 2 program staffing

The intent is to expand the organization in a timely and orderly manner as dictated by program requirements. Dependence will be placed on the hard-core cadre of cognizant and responsible individuals for the maintenance of technical and management continuity throughout the period of the contract. In this manner, specialized resources are only employed when needed and can be efficiently employed for specific tasks. Resources committed to the program are under the control of the Program Manager for the period of the commitment.

The organization has been arranged to enhance the implementation of control procedures and policies further described in this document. With this organizational structuring, communication lines are shortened between the Program Manager and all elements of the organization and provide for efficient application of resources.

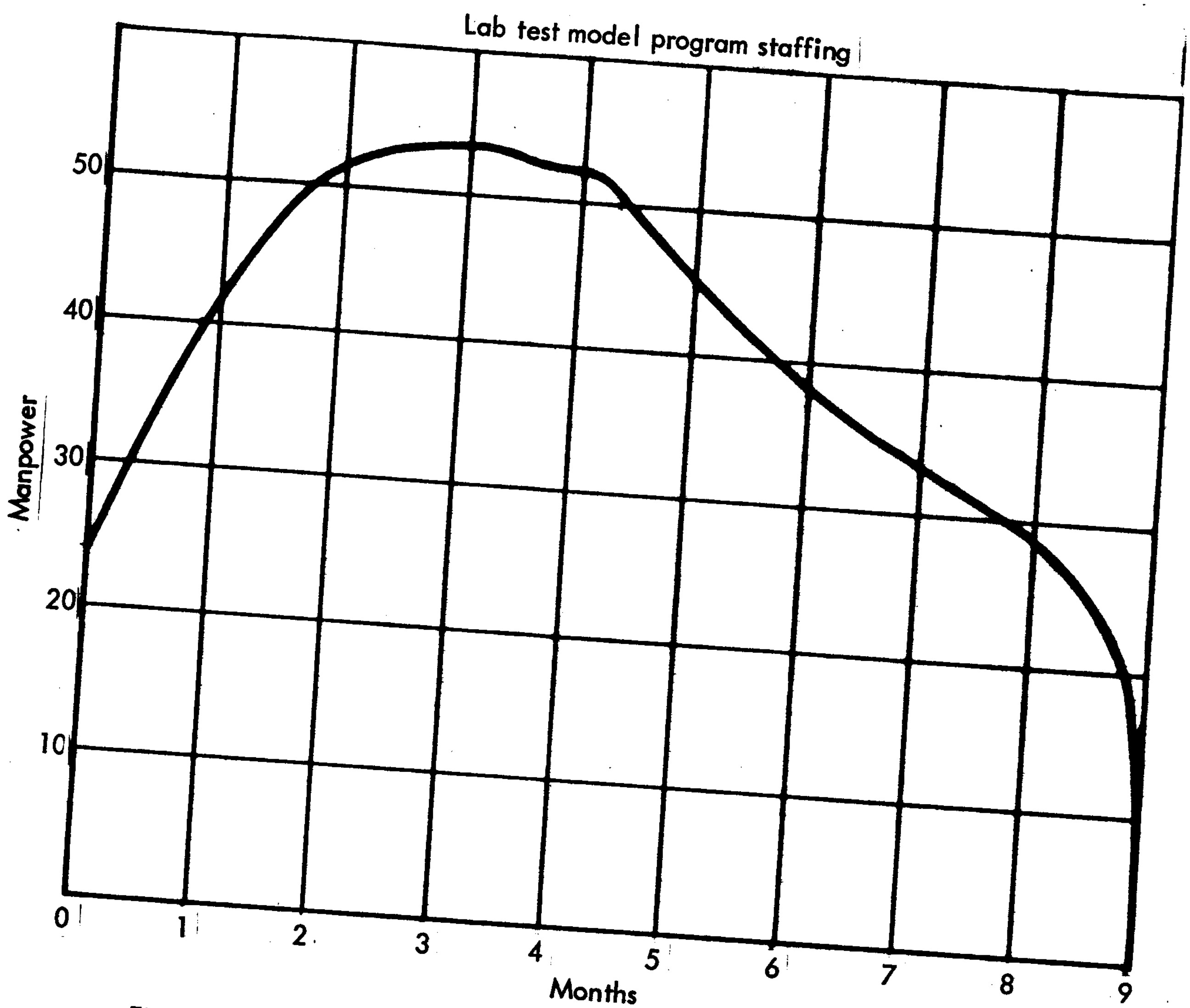

Figure A2.– Estimated manpower build up fab test model program staffing

Figure A4 represents an organization wherein each of the five line groups reports directly to the Program Manager.

Each group plans, schedules, coordinates, controls, and directs its efforts in conjunction with other appropriate areas as required for the accomplishment of the organization's basic authorities and responsibilities. In order to accomplish these tasks, timely and effective communication of facts and other pertinent information through use of documents, reports, and direct personal exchanges is essential.

Implementation of this program is further enhanced by a policy delegating specific authority and responsibility to cognizant engineers within areas of the program organization. The cognizant engineer is a technical specialist in

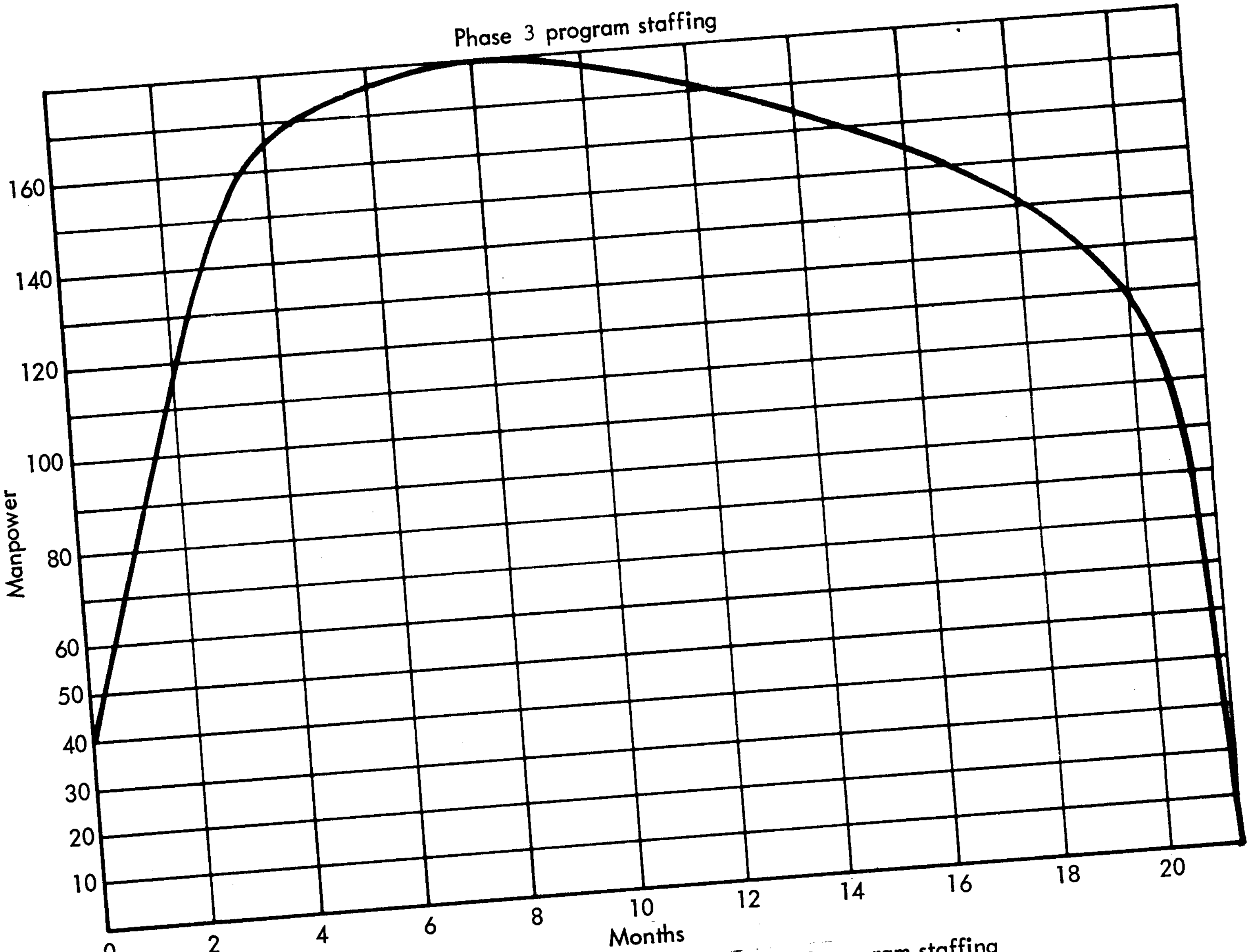

Figure A3. - Estimated manpower build up phase 3 program staffing

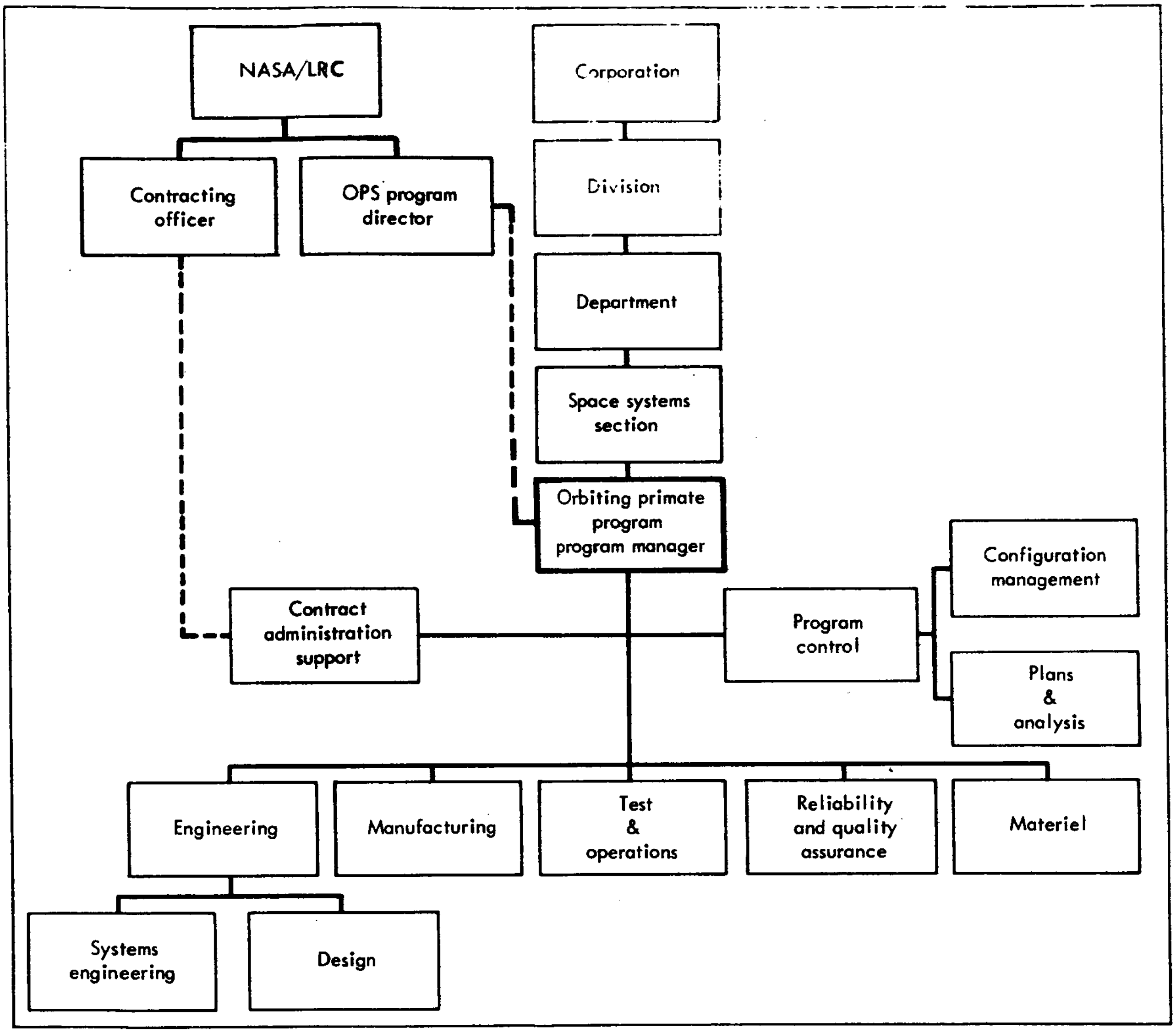

Figure A4.- Organization chart for phase 2

a particular technology. Within the boundaries of delegated responsibility and contract commitments, he is responsible either for the management of a technical task or for the design and development of specific hardware.

The program continuity is maintained in the Phase 3 organization by carrying the cognizant individuals over into the expanded organization. The Phase 3 organization is given in figure A5.

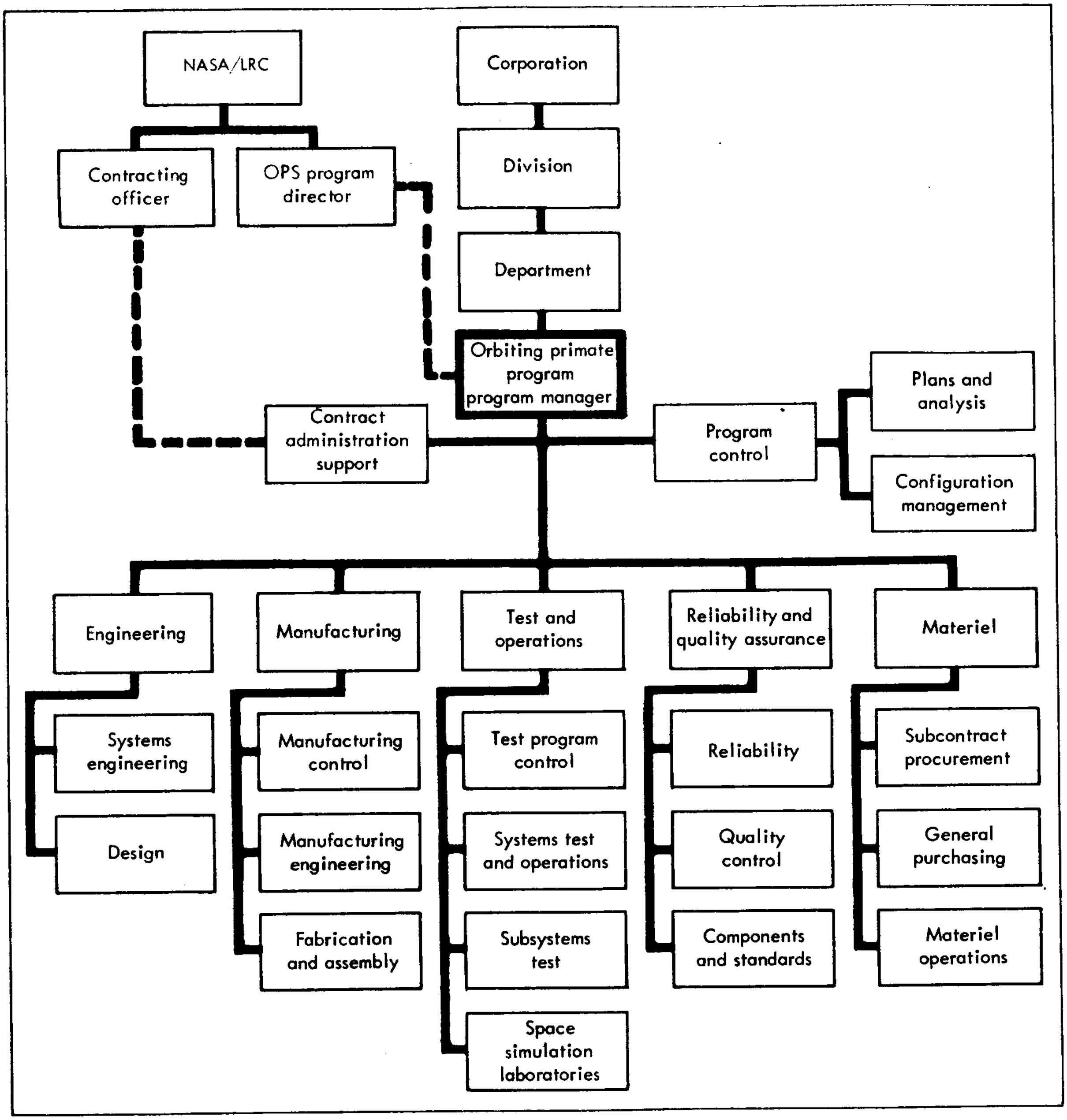

Figure A5. – Organization chart for phase 3

PROGRAM MANAGEMENT FUNCTIONS

Program Manager

The Program Manager is singularly responsible for complete accomplishment of the tasks contractually required. His organization contains all the elements necessary to meet the expected technical, schedule, and cost demands of the program. His authority includes complete control of assigned resources and services. The Program Manager is responsible to, and has ready access to Department level management for the effective conduct of his program within contractual requirements. This includes the responsibility of alerting higher management to any need to increase available program resources. By virtue of the Program Manager's assignment, his authority is exercised through the lead positions in his organization. As shown in figure A4, he serves as the single point of authority between the Orbiting Primate Spacecraft Program and LRC on matters pertaining to technical, schedule, and cost decisions, directions, and management.

Contract Administrator

The project assigned Contract Administrator is responsible for providing service on all contractual matters. In this manner, direct lines of authority and communication between the LRC Contracting Officer and the Northrop Systems Laboratories Contract Administrator will be provided as shown in figures A4 and A5. The Contract Administrator is responsible for:

(1) Assuring contract compliance through periodic meetings with the Program Manager regarding performance, cost and schedule.

(2) Acting as a central point for contract interpretation as to program scope, fiscal funding, legal and regulatory constraints.

(3) Supporting the Program Manager in negotiation and contractual liaison with the LRC Contracting Officer.

(4) Coordinating preparation of formal change proposals.

Program Control

Labor expenditures and Configuration Management within the program are under the centralized administration of the Program Control organization.

<u>Plans and analysis</u>. - The Plans and Analysis organization is charged with the responsibility of maintaining current program status displays for Management Control. These include:

PERT Networks

Schedules

Work Statements

Budgets and Cost

Each organization will be measured for performance within the assigned budget allocated in the Management Control Plans (MCP). It is against these MCP's and the PERT and Integrated Cost System that the Program Manager measures the performance of his organization. To derive maximum utilization of the MCP as the program status baseline, these plans are constructed in accordance with the work breakdown structure. This format provides visibility at the deliverable level and systems level by organizational elements or levels at which responsiblity for control of expenditures of resources is vested.

MANAGEMENT PLANS

Management Control System

The Program Manager, in his direction of the program, will be aided by the Management Control System which is described herein.

This Management Control System is administered by the Program Control organization. It provides the Program Manager with visibility of program, schedule and cost status.

Management documents, order of precedence. - The order of precedence of management documents in the Management Control System is as follows:

(a) Contract

(b) Contract - statement of work

(c) Sales order

(d) Program plan

(e) Management plan

(f) Management control plans

(g) Pert and integrated cost plan

Interrelationship of management documents. - Figure A6 depicts the interrelationship of management documents and functional plans, indicating the flow of data during the preparation phase of these documents. This same interrelationship prevails during the use and maintenance phase of the documents. It should be noted that the Management Control Plans are the focal point of the management documentation.

Management control plans. - Management Control Plans are a sequential, narrative and graphic presentation of the tasks, schedules, and costs for performing the program. There are Management Control Plans for each of the program's organizational elements.

MCP format: The MCP format consists of a one-page presentation, as shown in figure A7 which contains the task descriptions. The MCP format also provides for scheduling the subtasks to be performed by an organizational element for an indicated subdivision of work.

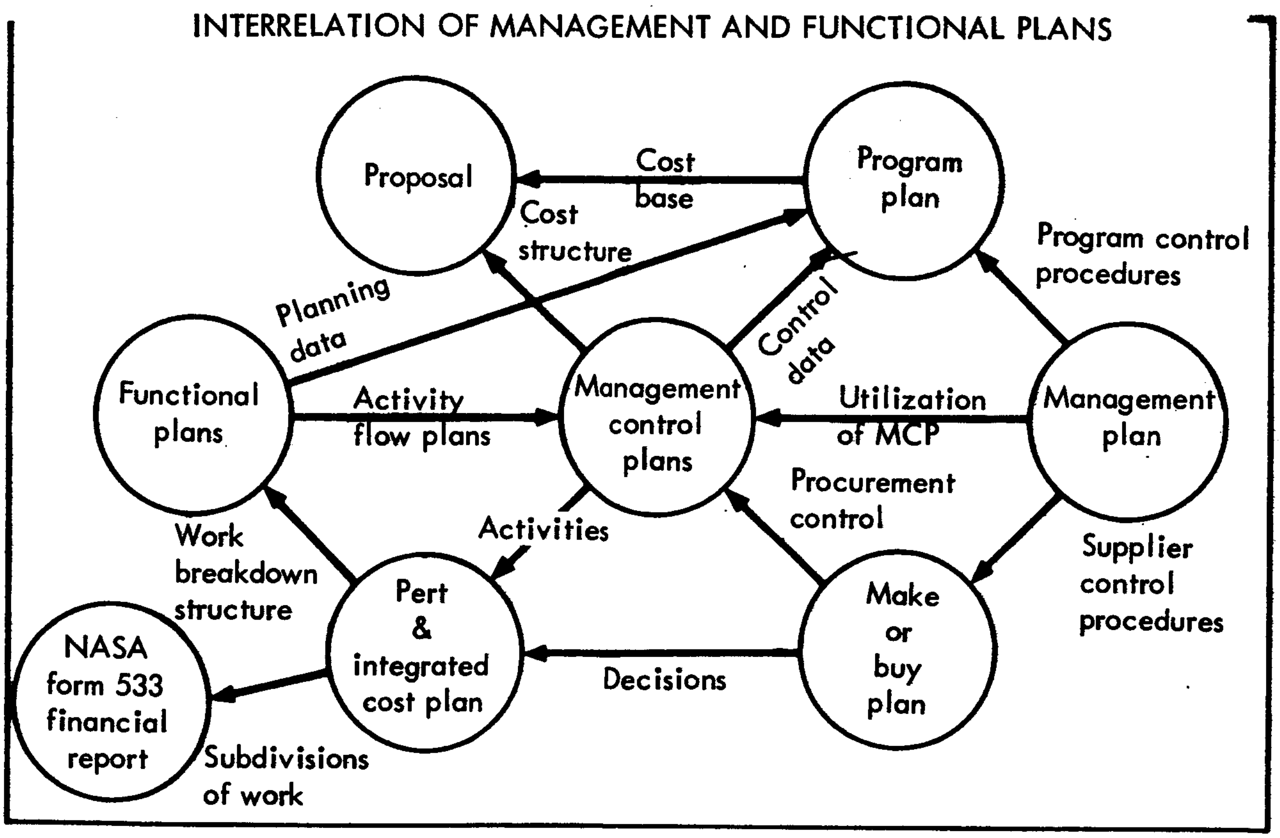

Figure A6.—Interrelation of management and functional plans

Contract end item ____________

Task No.	Task description	Months																		Subtotal	M/M total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		

Figure A7. - Management control plans format

Control in two dimensions: The numbering system for the MCP provides a means for sorting such that the various tasks and subtasks can be segregated either by the Work Breakdown Structure (Contract End Items) or by organization. This two-way sort permits two types of Management Control Plans to be collated and used for management control in two dimensions as follows:

(1) Contract End Item Control - A numerical sort of MCP's by Contract End Items, subdivisions of work, subsystems, and functional tasks provides a sequential listing of tasks and subtasks that is used by cognizant engineers to manage the activities of all organizations in designing, manufacturing, testing, and delivery of equipment for which they have cognizance. A complete numerical sort by Contract End Item is used by the Program Control Area to monitor the activities of all organizations to provide the Program Manager with program status against the CEI MCP as a baseline.

(2) Organization Control - A numerical sort of the MCP's by organization yields a sequential listing of tasks and subtasks to be used by organization chiefs and supervisors as a baseline for control of their day-to-day work assignments and plan for expenditure of their budget resources.

Program control. - Program control, in support of the Program Manager, utilizes the Northrop Systems Laboratories Management Control System described above to provide work, schedule, and cost status and control of the program using the Management Control Plan as a baseline.

Functional plans: Table A1 lists the Functional Plans which detail methodologies utilized by organizations for accomplishing the program. Based on these plans, each organization has derived a listing of discrete tasks or activities that they perform in relation to the end items to be delivered under the Contract. These discrete tasks are listed in the Management Control Plan for each organization and included on the PERT network and Cost Plans that are companion to the MCP's.

TABLE A1. - KEY FUNCTIONAL PLANS AND USING ORGANIZATIONS

Functional Plan	Using organization
Integrated test plan	Test
Qualification test plan	Test
Reliability plan	Reliability
Quality plan	Quality assurance
Support plan	Operations
Facilities plan	Program control

TABLE A1. - (concluded)

Functional Plan	Using organization
Management plan	Program control
Engineering plan	Engineering
Management plan	Program control

Work breakdown structure: Table A2 is a work breakdown structure of the program which is based on the Contract Statement of Work and the deliverable items of the contract. The numbering system applied to the work breakdown structure corresponds to the last six digits of the eight-digit numbers used in the Sales Order System. These last six numbers of the sales order number are also used to number the networks of the PERT system. A detailed description of the numbering system is contained in the PERT and Integrated Cost Plan.

TABLE A2. - MANAGEMENT CONTROL PLANS (MCP'S)

	Contract End Items
100000	Phase 2 Development Hardware and Breadboards
110000	Spacecraft Mockup
120000	Laboratory Test Model
130000	Laboratory Test Model Support Equipment
140000	Spares
150000	Tooling
160000	Phase 2 Documentation
200000	Phase 3 Development Hardware
210000	Structural Test Model
220000	Thermal Test Model
230000	Qualification Test Components
240000	Qualification Test Subsystems
250000	Tooling
300000	Qualification Test Model

TABLE A2. - Continued

Contract End Items	
310000	Flight Model #1
320000	Flight Model #2
330000	Simulation Article
340000	Trainer
350000	Ground Support Equipment
360000	Spares
Subdivision of Work - Laboratory Test Model	
XX1000	Life Support Subsystem
XX1100	Environmental Control Unit
XX1200	Waste Unit
XX1300	Life Cell
XX1400	Feeder
XX1500	Waterer
XX1600	Behavioral Panel
XX1700	Recovery Capsule
XX2000	Thermal Control
XX2100	Water Heat Transfer Unit
XX2200	Insulation
XX2300	Thermal Simulation
XX3000	Structure and Mechanical
XX3100	Supporting Structure
XX3200	Pressure Vessel
XX4000	Instrumentation
XX4100	Television
XX4200	Recorders
XX4300	Activity Counter
XX4400	Biotelemetry Receivers

TABLE A2. - Continued

Subdivision of Work - Laboratory Test Model	
XX4500	Sensors
XX4600	Mass/Volume Measurement Device
XX4700	Support Instruments
XX6000	Command and Control
XX6100	Control Console
XX6200	Program Sequencer
XX6300	Manual Control Unit
XX6400	Display Panel
XX6500	Power Control and Distribution Unit
XX6600	Cabling
XX6700	Behavioral Control Interface Unit
Subdivision of Work for All Contract End Items Other than LTM	
XX1000	Life Support Subsystem
XX1100	Environmental Control Unit
XX1200	Waste Unit
XX1300	Life Cell
XX1400	Feeder
XX1500	Waterer
XX1600	Behavioral Panel
XX1700	Recovery Capsule
XX2000	Thermal Control Subsystem
XX2100	Thermal Transport Loop
XX2200	Passive Thermal Control
XX4000	Instrumentation Subsystem
XX4100	Television
XX4200	Dosimeter
XX4300	Activity Counter
XX4400	Biotelemetry Receivers

TABLE A2. - Continued

Subdivision of Work - Laboratory Test Model	
XX4500	Sensors
XX4600	Mass/Volume Measurement Device
XX4700	Signal Conditioners
XX4800	Data Processer
XX4900	Status Monitors
XX5000	Telemetry Subsystem
XX5100	Transmitters
XX5200	Transponder
XX5300	Antennas
XX5400	Diplexer
XX5500	PCM Encoder
XX5600	Tape Recorders
XX5700	Pre Modulation Processor
XX6000	Command and Control Subsystem
XX6100	Decoder
XX6200	Program Sequencer
XX7000	Electrical Power and Cabling Subsystem
XX7100	Solar Panel
XX7200	Batteries
XX7300	Regulators
XX7400	Inverters
XX7500	Distribution Equipment
XX7600	Protection Equipment
XX7700	Squib Firing Equipment
XX7800	Cabling
XX8000	Attitude Control Subsystem
XX8100	Gyros
XX8200	Sun Sensors
XX8300	Control Unit
XX8400	Cold Gas Equipment

TABLE A2. - Concluded

Task Areas	
XXXX00	Program Management
XXXX10	Systems Engineering
XXXX20	Crew Participation
XXXX30	Design
XXXX40	Manufacturing
XXXX50	Test and Operations
XXXX60	Reliability
XXXX65	Quality Assurance
XXXX80	Support
XXXX90	Training

CONFIGURATION MANAGEMENT

The Configuration Management organization, figure A8, has the responsibility to provide configuration identification, accounting, and control so that all interfaces and requirements are identified, evaluated and documented. The section operates in accordance with the Configuration Management Plan which is in essential compliance with NPC-500-1 as amended by MSC Supplement No. 1 Revision B.

Functional description of Configuration Management is provided as follows:

(1) Provide the program with Configuration Management Policies and Procedures

(2) Provide Program Management design cognizance

(3) Satisfy requirements of NPC-500-1 to the extent specified in the Configuration Management Plan

(4) Define and assure compliance to customer and experimenter technical requirements

(5) Assure design compatibility with system and interface criteria.

The Configuration Control of Configuration Management as shown in figure A6 is described as follows:

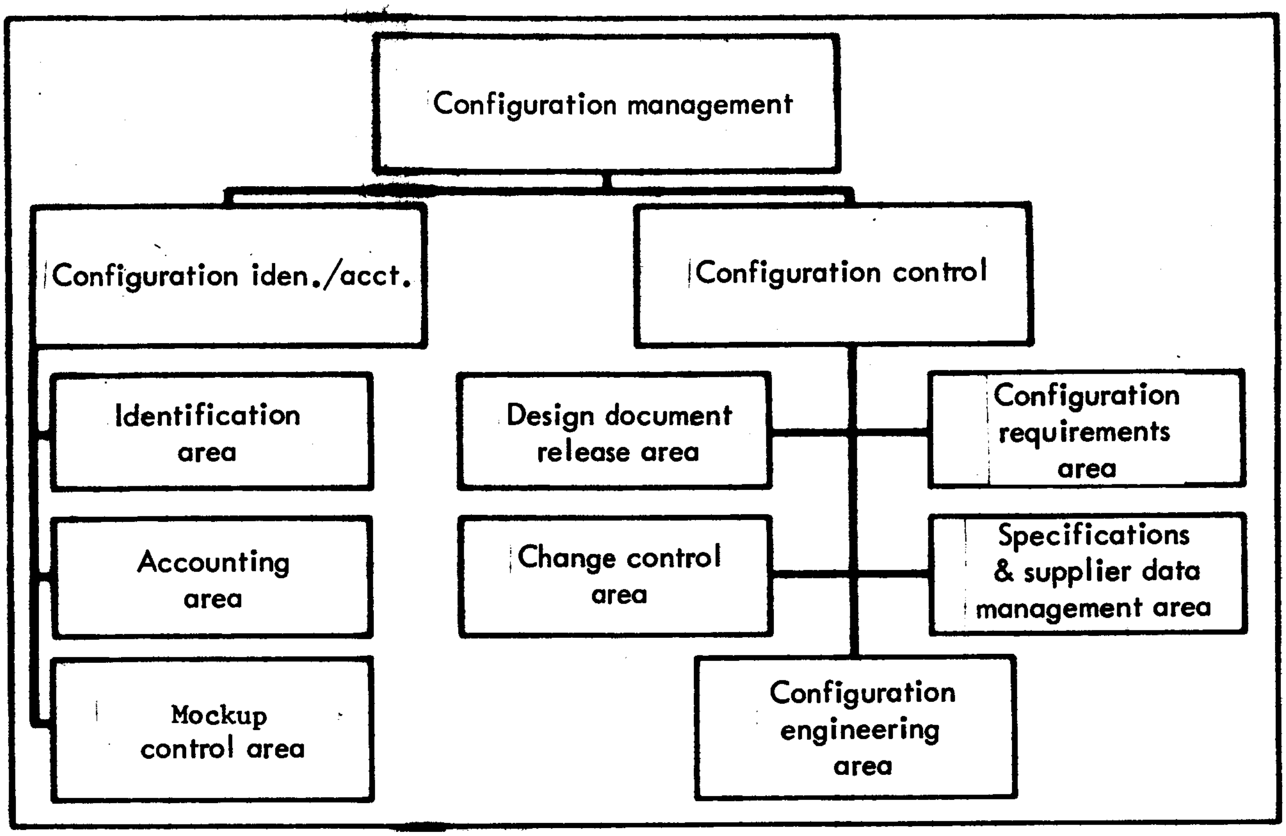

Figure A8. - Configuration management

(1) Functional description

(a) Establish, coordinate, and implement a formal Configuration Review Board (CRB)

(b) Conduct CRB meetings

(c) Provide vehicle engineers

(d) Perform drawing check and release functions

(e) Implement Configuration Management Plan

(f) Organize, coordinate and conduct PDR, CDR, and FACI reviews and inspections

(g) Release and maintain end item specifications, detail specifications, SCD's and ICD's

(h) Prepare and process ECP's and SCN's.

(2) Task Manager - The Organizational head of Configuration Control is the Task Manager for the following functions:

(a) Design drawing control and release

(b) Change control (CRB)

(c) Supplier data management

(d) Configuration engineering

(f) Configuration requirements

(3) Interrelationships - The Configuration Control interfaces with all Program Organizations in addition to the interfaces associated with Personnel and Industrial Relations.

(4) Design drawing control and release area

(a) Functions

Perform drawing check

Release engineering drawings

Format and release specifications, SCD, ICD's

Release operating and test procedures

Maintain vendor data files

(b) Task products

Contract end items

Released engineering drawings

Released specifications and ICD's

Documents

SCD's

Released test procedures

Detail specifications

(5) Change control area (CRB)

(a) Functions

Manufacturing liaison

Engineering liaison

Vendor liaison

Active member of CRB

Determine change compatibility

Change classification

Change effectivity

(b) Task products

ECP's

Released EO's

Specification change notices

Change directives

(6) Supplier data management area

(a) Functions

Provide data requirement inputs to specification controlled purchase orders

Determine if vendor supplied data will meet purchase orders and design objectives

Preparation of all Phase II handbooks

Format, coordinate and prepare for release end item specifications, detail specifications, ICD's, SCD's and IDD's

(b) Task products

Handbooks

E. I. specifications

Detail specifications, ICD's, SCD's, and IDD's

(7) Configuration engineering area

(a) Functions

ECP preparation and evaluation

Change verification

Participate in design reviews and inspections

Assist in preparation of acceptance data package

Provide interface and integration control

Perform vehicle engineer functions

Control and approve test procedures

Provide technical assistance on configuration review

Maintain current design status

(b) Task products

ECP's

SCN's

Acceptance data package

(8) Configuration requirements

(a) Functions

Establish experiment integration schedules

Establish and maintain design guidelines with regard to engineering reports and data, support manuals, progress reports and special reports

Define contractual and derived design requirements

Evaluate interface definition

Negotiate and approve ICD's

Establish and update agreements and decision documents

Define and maintain experiment documentation

Establish and maintain design guidelines

Define contractual design requirements

Identification of interface and interface requirements

(b) Task products

Integration schedules

Design guidelines

ICD's

Agreements and decision documents

(9) Configuration identification and accounting functional description is provided by the following:

(a) Configuration identification

(b) Configuration accounting

(c) Configuration reporting

(d) Payload integration

(f) Direct mock-up activities

(10) The Task Manager is the Chief of Configuration Identification and Accounting for the following functions:

(a) Configuration identification

(b) Configuration accounting

(c) Mockup control

(11) The interrelationships consist of the configuration identification and accounting interfaces with all program organizations in addition to the interfaces associated with personnel and industrial relations.

(12) The configuration identification area is broken down into functions and task product. A description of functions and task products are as follows:

(a) Functions

Prepare and maintain identification lists for drawings, specifications and technical reports

Provide procedures for document identification and part serialization

Maintain data library

Issue monthly identification reports

(b) Task products

Identification and traceability records

Technical data file

Monthly identification reports

(13) The configuration accounting area is broken down into functions and task products. The functions and task products are listed as follows

(a) Functions

Maintain records for drawings, specifications, technical records

Prepare and participate in design reviews to maintain current configuration status

Coordinate and direct activities on mockups to ensure schedule and configuration compliance to contractual requirements

Coordinate field support and retrofit

(b) Task products

Integration of payloads

Mockups

Program Line Functions

The basic authority, responsibility, and task descriptions of each of the groups shown in figure A4 is summarized in the following paragraphs.

Engineering. - Cognizant engineers are assigned the overall responsibility for three prime engineering task groups: system design and analysis, subsystem design, and integration. They are responsible to the program manager for the conduct of their assigned areas from the inception through to the completion of the program. This responsibility extends to directing and evaluating the technical activities of the suppliers. Furthermore, these cognizant engineers act as the principal interface for exchange of technical data with LRC. Their assignment requires complete up-to-date knowledge of the program, from milestones and planning to related management guide, supplied to him through the Program and Contract Administrators. In turn, the cognizant engineers report their activities for inclusion in management displays.

With the engineering groups, cognizant engineers are responsible for all technical aspects of their respective systems. This includes resolving interfaces with other systems and, in general surveillance over the complete development task. Detailed knowledge and understanding of each system is prerequisite to this responsibility. Each cognizant engineer also serves as the direct contact point for counterpart LRC supporting system engineers. In these discussions, each Northrop Systems Laboratories' cognizant engineer has the authority to represent Northrop Systems Laboratories engineering in technical discussions concerning his subsystem or technology. Each cognizant engineer is additionally responsible for keeping the Program Manager abreast of the status and needs of his task performance.

Manufacturing. - The manufacturing organization performs the planning, scheduling, manufacturing, engineering, tooling design, and documentation tasks required to fabricate, assemble, and integrate development models and deliverable end items. Manufacturing activities also includes fabrication of mockups, breadboard electronics, test specimens, and tooling.

Test and operations. - The Operations Test Group Organizations. This group performs the tasks described in the Integrated Test Plan (Appendix D).

The Test and Operations Group is responsible for planning, conducting, and reporting on all tests performed at the factory and the operations conducted at launch site, as required; logistics requirements, acceptance data requirements, and prepare operations manuals as required.

Reliability and quality assurance. - Those groups are responsible for assuring the Program Manager, Northrop management, and LRC that the system is of acceptable quality and reliability; establishing system reliability requirements and directing reliability programs to assure satisfaction of these requirements; and coordinating with customer representatives on all quality matters.

The Reliability and Quality Assurance Groups perform their tasks in accordance with the Reliability Plan, Quality Program Plan, and the Make or Buy Plan.

The Reliability and Quality Assurance Groups have the authority to implement and conduct a Reliability Program as defined in the Reliability Plan and direct the Quality Assurance functions defined in the Quality Assurance Plan.

Materiel. - The Material Organization function is broadly described here since a procurement plan was not developed for this program. The Material Organization utilizes Nortronics' Procurement organization which is staffed with personnel skilled in the areas of negotiation, pricing, and cost analysis, and having a thorough knowledge of ASPR and related Government regulations. In order to minimize procurement lead times, communications are maintained with the key selected or potential suppliers. Work proceeds during the holding period to firm up statements of work, implement any changes that result during these periods, and assess the effect on cost, schedule, and performance. Concurrently, negotiations with the selected long lead high value suppliers concerning such matters as terms and conditions, data submittal, hardware delivery schedules, any filed support requirements, etc., are being finalized. This effort permits implementation of critical procurements within one month after prime contract go-ahead.

Procurement Management plans, schedules, coordinates, controls, and directs the combined efforts of the supplier and the Northrop purchasing with the Program Operations Group. Procurement management extends from the time efforts and the final closeout of the records. This assures that all phases of the supplier's development efforts are compatible with LRC's objectives regarding technical performance, schedule performance, quality, documentation, and cost.

All suppliers are required to maintain effective configuration management and to support Northrop Systems Laboratories in an overall NPC 500-1 Configuration Management Program.

High value/low value/ long lead concepts. - Program procurement personnel apply the concept of High Value/Low Value to all procurement activities; i.e., plan and schedule actions required commensurate with the relative value of the items involved. Thorough cost reduction efforts are applied to High Value items to accomplish the attainment of desired performance and reliability by considering such factors as: depth of competition to be solicited; level of specialized supplier capability needed; potential second-source selection; extent of flow time required; and priority of internal handling.

Target pricing techniques are used in this type of procurement where the purchase authority is routed through an estimating and budgeting function to establish a reasonable target price for the buyer to meet. This target is established by referring to past history records of similar procurements from previous contracts which are maintained in the central purchasing function. Large aberrations from the target price must be approved by the Program Manager prior to placement of the order.

Status reporting. - Each High Value item is scheduled individually for all significant events which must be accomplished to effect on-time delivery of the item. The buyer is responsible for updating the actual performance of delivery schedules. Weekly reviews are held by the Procurement Area on status of all High Value items. At this time, program aberrations are discussed and direction given as to corrective action to be taken.

Program implementation. - To implement the Program procurement in a timely manner, within the first month after prime contract go-ahead, it is necessary for effort to proceed so that a detailed step-by-step program can be negotiated to fit the special situation presented by identified High Value items. It is desired that these purchase orders be issued as formal contracts, avoiding the use of the interim letter-type contracts.

To accomplish the above objectives, the following specific activities are planned and implemented.

Description of the product. - Preparation of specializations and other documents necessary to define the function, performance, envelope, and testing criteria for each of the end items to be procured. These documents are submitted to the suppliers for review and incorporation of changes so that they form the basis for the negotiated orders.

Significant events to be witnessed and approved. - Detail schedules for submittal of supplementary documents, such as test plans, test schedules, and test reports are prepared in sufficient detail to permit specific events and activities to be incorporated in the eventual contract and the controlling PERT Network.

Contractual terms, conditions, and special clauses. - Negotiation of fiscal and legal clauses, such as contract type, incentive features, progress payments, significant milestones, and application of specific management and administrative techniques are submitted to the supplier for negotiation and tentative approval, only subject to variations which may occur due to specific details required by the prime contract.

PROGRAM DOCUMENTATION

Program Control is the central agency for the administration, control and submittal of all contractually required data in accordance with the Documentation Plan and Configuration Management Plan.

General

Program Control shall prepare and submit documentation in response to the contract requirements in accordance with the negotiated Data Requirements List (DRL), figure A9. The negotiated DRL will be the contractual instrument that identifies and adds definition to those Document Requirement Descriptions (DRD'S), figure A10, comprising the total Contractor data submittal requirement. A description of this submittal requirements is listed as follows:

(1) Documents referenced on the DRL and applicable DRD's are the issue in effect on the contract date and form a part of the DRL or DRD to the extent specified therein.

(2) The documentation requirements specified by the DRL shall not be altered as a result of a make or buy decision.

(3) Insofar as practicable, internal documents shall be utilized to meet the requirements specified herein. Internal documents shall not be retyped or printed on more expensive paper prior to submission.

DATA REQUIREMENTS LIST

ATTACHMENT NUMBER: I
EXHIBIT NUMBER: C
CONTRACT/RFP NUMBER:
DRL NUMBER:

PROJECT/SYSTEM: Apollo Applications Project (Definition Phase)

CONTRACTOR:
PREPARATION DATE:
PAGE 1 OF 9 PAGES
REVISION:

1 Line Item No.	2 DRD Number	3 Title	4 OPR	5 Type	6 Inspect/Accept	7 Freq of Subm	8 Initial Submittal	11 Copies A	11 Copies B	9 Remarks
1	MA-500	Plan, Program, Definition Phase		I		9	15*	1 2	40 1	*Due 15 days after contract date
2	MA-501	Plan, Administrative Management		I		9	6*	1 2	25 1	*Due 6 months after contract date
3	MA-502	Plan, Technical Management		I		9	6*	1 2	25 1	*Due 6 months after contract date
4	MA-503	Summary, Program Requirements		II		9	6*	1 2	50 1	*Due 6 months after contract date

10 AS OF DATE; 11 COPIES; A TYPE; B NO.

REMOVE THIS SECTION BEFORE PLACING ON CONTRACT

CONTRACTOR PREPARATION DATE

12 Contr Use %	13 Est/Act	14 Total Cost
15 Est No. Subm/Pgs per Subm		18 Prep. Costs (Admin)
16 Est No. Rev/Pgs per Rev		19 Prep. Costs (Tech)
17 Repro and Deliv. Cost		20 Develop Cost
21 Remarks		

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Figure A9. - Example data requirements list

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DOCUMENT REQUIREMENT DESCRIPTION

1. TITLE

2. NUMBER

3. USE

4 DATE

5 OFFICE OF PRIMARY RESPONSIBILITY

APPROVED (NAME-TITLE)

6 REFERENCES

7. INTERRELATIONSHIP

8. PREPARATION INFORMATION

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Figure A10. -Document requirement description (DRD)

(4) Periodic documentation requirements reviews shall be held to assess the adequacy of Government and Contractor documentation efforts.

(5) Where a conflict exists between the requirements of the DRL and those of other contractually referenced documents, the requirements of the DRL shall apply.

Phase 2 Documentation

The following documents will be prepared during Phase 2 to define the Primate Spacecraft Program:

(1) Technical Studies and Analyses Reports

(2) Design Reference Mission Document

(3) Drawings and Associated Lists

(4) Measurement Requirements Document

(5) Interference Control Plan

(6) Experiment Handbook

(7) Preliminary Mission Experiments Requirements

(8) General Environmental Specification

(9) Spacecraft Specification

(10) GSE Specification

(11) Detail Specifications

(12) CFE Specifications

(13) Interface Definition Documents

(14) Interface Control Documents

(15) Technical Description - Phase 3

(16) Engineering Plan - Phase 3

(17) Program Plan - Phase 3

(18) Management Plan - Phase 3

(19) Management Control Plans - Phase 3

(20) GSE Development & Test Plan - Phase 3

(21) Mission and Crew Operational Support Plan - Phase 3

(22) Training Plan - Phase 3

(23) Integrated Test Plan - Phase 3

(24) Qualification Test Plan - Phase 3

(25) Ground Operation Plan - Phase 3

(26) Support Plan - Phase 3

(27) Flight Operation Plan - Phase 3

(28) Manufacturing Plan - Phase 3

(29) Facilities Plan - Phase 3

(30) Reliability Plan - Phase 3

(31) Quality Assurance Plan - Phase 3

(32) Make or Buy Plan - Phase 3

(33) Configuration Management Plan - Phase 3

(34) Documentation Plan - Phase 3

(35) Pert Network - Phase 3

(36) Monthly Progress Reports

(37) Final Phase 2 Report

(38) Presentation Material

Types of Data

(1) Type I data shall be submitted to the Contracting Officer for approval. Implementation of Type I data shall not proceed prior to approval by the Contracting Officer.

(2) Type II data shall be submitted for information and review.

(3) Type III data shall be retained by the Contractor and submitted to the Contracting Officer only upon request.

Document Identification

All documentation shall be organized into a series of numbered documents and shall reference the assigned contract numbers. All documents delivered, except drawings, shall be clearly marked with the DRL line item number that requires such delivery. Documents that satisfy the requirements of more than one DRL line item shall reflect all applicable line item numbers.

Type I documents shall be clearly marked "Preliminary - NASA approval Pending" or "Approved by NASA," as appropriate.

Sources of information contained in Type I and Type II documents shall be referenced by title, author or publisher, and page or section.

Revisions, Amendments, and Additions

In preparing Type I and Type II documentation that will require periodic revision, the documents shall be initially prepared using a refastening method so that pages may be deleted and/or inserted. When the original document is so prepared, revision shall be accomplished by submitting revised, amended, or additional pages as appropriate. Accompanying these pages will be an instruction page detailing the exact means for effecting the revision or amendment. The provisions of this paragraph do not apply to specifications or drawings, which have an established procedure for the processing of amendments and revisions.

Report Preparation

The preparation and submittal of all contractual reports including NASA/Contractor Management Review Meetings will be coordinated by Program Control. All elements of the report will be obtained from the cognizant organizations and incorporated into the submitted document.

Individuals will be assigned specific responsibilities for each action required to prepare for the monthly meeting and to preface the minutes of the various working meetings. These individual elements will be incorporated into the submittal documents by a program documentation representative. All submittals will be reviewed and approved by the Program Manager or his representative.

Document Maintenance

Document maintenance includes: document storage, release control, and change accountability.

Document storage. - The Technical Data Services Group is the sole custodian of all document originals. The document originals are stored in locked cabinets with limited access by authorized personnel.

Release control. - No document originals, or any part therof, may be withdrawn without submitting to the Release Desk a Document Request and Release Form (DRR) signed by the Program Manager or his designated alternate with a written explanation of why the original is being withdrawn.

A Chargeout Card replaces a withdrawn original and the DRR form is filed for record. The same rule applies to additional copies.

If a request for additional copies is received from Langley Research Center or required by Northrop, an authorized DRR must be submitted to the Release Desk.

Change accountability. - Document change accounting will be accomplished by maintaining a Document Identification Index. This index is the responsibility of Program Control and is prepared for use by Langley Research Center. A section of this index contains Supplier Documents. There is a separate page for each document. The index is updated immediately as each original document is released and a document is reissued or changed. As each document is submitted to Configuration Management for release, reissue, or change, this office will compare the Document Identification Index with the information presented on the Document Request and Release Form.

As previously stated, the Program Control Administrator is the last authority to approve documents prior to release. It is his responsibility to assure consistency with release procedures.

Printing Requirements

The requirements outlined in paragraph 35 of Government Printing and Binding Regulations, Joint Committee on Printing, Congress of the United States, April 1, 1964, concerning contract printing, is waived in accordance with the committee's Authorization No. 21985.

Printing of reports resulting from this study shall be in accordance with the following general specifications:

(1) Method of reproduction - offset.

(2) Finished size - 8 1/2 x 11.

(3) Paper - 60-pound opaque book.

(4) Cover - litho cover stock.

(5) Pages will be printed on one side; blank pages will be avoided when possible.

(6) Oversize pages will be avoided when possible, but if necessary, will be folded to 8 1/2 x 11.

(7) Additional color shall be used only upon prior approval by the Contracting Officer.

(8) Binding shall be the most economical method commensurate with the size of the publication and its intended use.

APPENDIX B
EXPERIMENT PLAN

INTRODUCTION

This plan differs from the other Orbiting Primate Spacecraft plans in that it traces the experiment related tasks through all phases of spacecraft development and overall mission support operations. The gross responsibilities of NASA, the Principal Investigator and Northrop as the spacecraft contractor are presented. In a sense, this plan serves as a preliminary work statement for the experiment related functions. The last section contains the essential data required for NASA form 1346 Experiment Proposal using the standard format for this document;these dataare required to permit evaluation of experiment and compatibility with a manned space mission and also provides preliminary mission operational information.

RESPONSIBILITIES

A clear understanding of the experiment and mission related responsibilities of NASA, the Principal Investigator and Northrop is essential to effective conduct of the Orbiting Experiment for Study of Extended Weightlessness. These responsibilities are herein defined and related to the responsible organization.

Northrop Responsibilities

Northrop is responsible for the Orbiting Primate Spacecraft (OPS) design and manufacture, the integration of the primate experiment requirements into the OPS design, the provision of mission and crew requirements data for mission planning and the provision of operational support during the OPS mission.

Design and Manufacture. - Northrop's design and manufacture responsibilities for the orbiting primate spacecraft are identified in the following plans:

Management Plan, Appendix A

Engineering Plan, Appendix C

Integrated Test Plan, Appendix D

Reliability Plan, Appendix E

Quality Assurance Plan, Appendix F

Manufacturing Plan, Appendix G

Experiment Integration. - Northrop is responsible for the following experiment integration functions:

(1) Systematically compiling in usable engineering terms the requirements and constraints imposed on the spacecraft design, the mission, and the crew of the CM.

(2) Utilization of Northrop's scientific staff to assist in experiment definition.

(3) Performing on an iterative basis a compatibility analysis of experiment definition.

(4) Preparation and maintenance of an Experiment Handbook containing a comprehensive experiment description which places particular emphasis on integration requirement and constraints imposed on the experiment, the spacecraft design and mission.

(5) Maintaining an experiment integration schedule to provide smooth flow of engineering manufacturing functions to coordinate these functions with the principal investigator and NASA.

(6) Providing for operational support to the principal investigator during integration of the primates into the laboratory test model and the flight spacecraft.

(7) Providing for operational engineering support to the principal investigator during the mission.

(8) Assurance of adequate subsystem support of the experiment.

Mission and Apollo Crew Requirements. - Northrop is responsible for providing mission and crew related functions. In accomplishing this, the following tasks are performed:

(1) Determination of preliminary estimates of mission and Apollo crew requirements for the Orbiting Primate Spacecraft and the preparation and delivery of a Preliminary Mission Experiment Requirements Document. This document includes the following items:

Experiment support requirements

Integrated spacecraft support requirements

Preliminary mission requirements

Crew activity requirements

Operational support requirements

Training requirements

GSE requirements

(2) Performance of a feasibility analysis of data handling and processing requirements of the Orbiting Experiment for Study of Extended Weightlessness and the subsequent preparation and delivery to NASA of a Preliminary Mission Data Requirements Document.

(3) Perform analysis of overall mission operational requirements with the subsequent preparation and delivery to NASA of a Preliminary Mission Operations Plan. This plan shall include the following:

NASA Mission Control requirements from T-6 to recovery, includes prelaunch, launch orbit and recovery operations.

Summary of data recovery procedures

Crew utilization procedures

Principal investigator support procedures

An overall mission profile

(4) Preparation of an Orbiting Primate Spacecraft familiarization manual.

(5) Provide operational support to NASA mission planning and mission control organization.

(6) Provide operational support to NASA for data processing and analysis.

(7) Provide support data for crew training functions.

(8) Assure EMI compatibility of the OPS with Saturn Apollo equipment.

(9) Prepare and deliver to NASA an OPS Flight Performance Reports.

Laboratory Test Model Support. - Northrop is responsible for design, development and operational support of the Laboratory Test Model of the Orbiting Primate Spacecraft. The experiment related tasks are as follows:

(1) Provide operational scheduling for the laboratory test model.

(2) Provide operational procedures for the laboratory test model.

(3) Provide operational support during model operation.

(4) Provide assistance with the analysis and interpretation of test data, particularly in the area of evaluation of performance of life support equipment.

(5) Provide the necessary engineering support data need to analyze performance of the laboratory test model.

(6) Provide inputs to the laboratory test model performance report.

(7) Incorporate changes in the design of the OPS which are indicated as a result of tests with the laboratory test model.

(8) Conduct special engineering test necessary to evaluate the performance and dynamic range of life support equipment.

NASA Responsibilities

The NASA OART is the overall program manager for the Orbiting Experiment for Study of Extended Weightlessness Program. Some of the specific NASA responsibilities are:

(1) Function as the central source of contractual direction for the Orbiting Primate Spacecraft Program.

(2) Provide approval of experiment requirements set forth by the principal investigator.

(3) Provide the overall scheduling for experiment development and delivery, scheduling of OPS development and delivery and the identification of flight schedule.

(4) Procure experiment facilities and equipment which are not a part of the Northrop contracted responsibilities.

(5) Provide overall mission planning.

(6) Conduct design reviews.

(7) Issuance of the mission reference trajectory.

(8) Publish overall mission rules.

(9) Issue final flight plan.

(10) Provide overall direction for the development and operation of the laboratory test model.

Principal Investigator Responsibilities

The principal investigator is responsible for the following:

(1) Definition of the experiment functional requirements.

(2) Assurance that an adequate research program is conducted to minimize the possibility of ambiguous interpretation of the flight data.

(3) Management of the efforts of other members of his team and the coordination of this effort with the program schedule.

(4) Assisting the OPS contractor in the preparation of experiment support requirements.

(5) Assurance that the experiment related implementation will permit the experiment objectives to be met.

(6) Support Northrop in implementing solutions to experiment integration problems.

(7) Assurance that plans are made and implemented to process, analyze, and report on the results of the experiment investigation.

(8) Participation in the operational phase of the mission.

(9) Provision of trained experimental animals for the experimental flight and experimental controls during the mission.

(10) Provide trained test animals for the laboratory test model.

(11) Provide support for operation of the laboratory test model.

(12) Analysis of laboratory test model data, particularly in the area of animal performance.

(13) Provide inputs to the laboratory test model performance report.

EXPERIMENT RELATED TASKS

This section describes the experiment integration tasks to be carried out by Northrop and serves as a statement of work for the various experiment related functions. The schedule for performing these tasks are shown in figure B1 of this document.

EXPERIMENT MISSION ANALYSIS

The objective of this effort is to assist NASA in defining the compatibility of the experiment with the SAA Program mission operations and crew utilization. This procedure continues on an iterative basis throughout the program. As the experiment and associated spacecraft designs are refined, the mission requirements are refined and the details for completing a successful mission are refined.

The more pertinent tasks in this area are defined below:

(1) Define requirements for launch, orbit and recovery mission profiles. Assist NASA with detailed mission analysis.

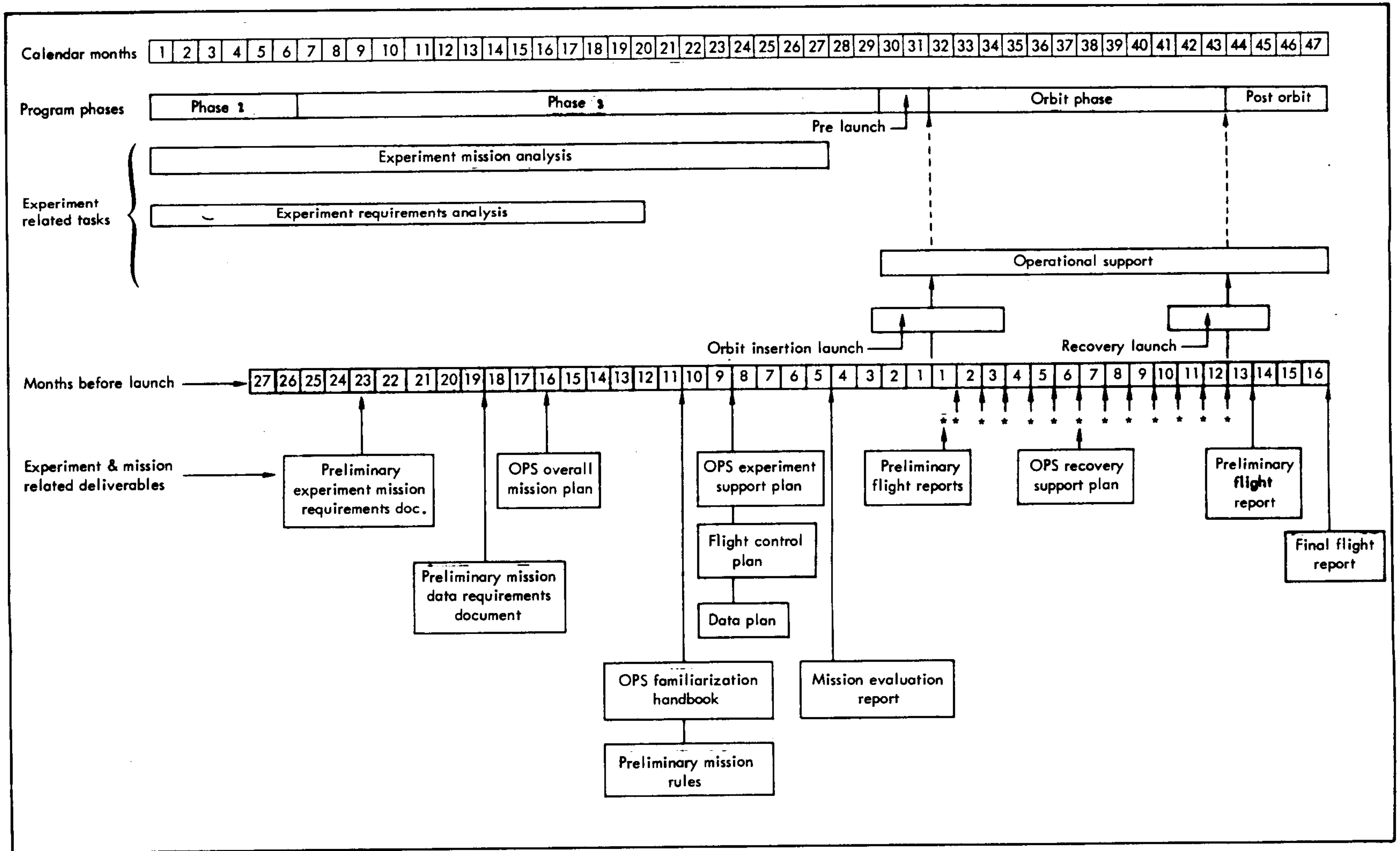

Figure B1.– Schedule of experiment related tasks

(2) Define and analyze the compatibility of the OPS interfaces with the launch and recovery vehicles.

(3) Define the data handling and processing requirements for the mission and their compatibility with the NASA facilities.

(4) Define requirements for crew utilization and analyze the compatibility of these requirements with crew capabilities.

(5) Prepare and deliver the mission related documents defined below:

(a) Preliminary mission experiment requirements document

(b) Preliminary mission data requirements document

(c) Preliminary overall mission operations plan

(d) Orbiting Primate Spacecraft familiarization manual

(e) Orbiting Primate Spacecraft performance reports

(f) Overall mission operations plan

(g) OPS experiment support plan

(h) Mission evaluation report

Experiment Requirements

This paragraph identifies the tasks associated with the definition of primate experiment requirements and the conversion of these requirements to usable engineering terms. This section also identifies the analysis of the OPS design to insure that it satisfies the requirements of the experiment.

These tasks are a continuing iterative process of refinement. As the primate experiment and the spacecraft designs are more clearly defined, the analysis becomes more detailed. The tasks are summarized as follows:

(1) Coordination with the principal investigator to provide a clear and concise definition of the primate experiment requirements.

(2) Incorporate changes in experiment source requirements as they are identified by the principal investigator and approved by NASA.

(3) Review the OPS design and the planned mission to insure that the experiment requirements are met.

(4) As incompatibilities between mission capabilities and experiment requirements are identified clearly, define the incompatibility and negotiate corrective action.

(5) Prepare and publish the Experiment Handbook.

Experiment Animal Integration

The experiment animal integration function is directly related to assuring that the primates and the equipment form an integral functional unit. Although handling, training, and maintenance of the animals are the responsibility of the principal investigator, the OPS contractor has the responsibility for assisting the principal investigator with the actual integration into the laboratory test model and the spacecraft.

The OPS contractor is also responsible for providing appropriate scheduling data and spacecraft information that is associated with the interfaces between the animal and the spacecraft. Specifically, the integration tasks include:

(1) Providing updated schedules for coordination of the principal investigators activities with the OPS contractors activities and the mission planning activities.

(2) Providing and maintaining a definition of the interfaces between the primate and the spacecraft.

(3) Providing technical and facility support to the principal investigator during the actual installation of the primates into the laboratory model and the spacecraft.

Operational Support

This paragraph identifies those tasks that are associated with operational support of the Laboratory Test Model and flight operations. These tasks are listed as follows:

(1) Provide instructions for proper operation of the Laboratory Test Model and assist with the interpretation of test data.

(2) Provide maintenance support for the Laboratory Test Model.

(3) Provide technical support to NASA flight operations and the principal investigator.

(4) Provide technical inputs to the Laboratory Test Model and OPS Mission Reports.

NASA FORM 1346 - EXPERIMENT PROPOSAL

The NASA Experiment Proposal, NASA Form 1346 is illustrated in the following pages. The title page of this experiment plan is shown on the first page of figure B2. The introduction which follows describes the format of NASA Experiment Proposal.

Section I, illustrated on figure B2, Administrative/Biographical, has not been completed as this is rightfully the responsibility of the NASA sponsoring program office.

Section II paragraph 3 of the Experiment Plan has been intentionally left blank to show that this part of the form will be completed by the NASA sponsoring program office.

Section V has also been left blank for the reason given above. Information concerning Northrop for inclusion in this section has been presented under the Budgetary Planning paragraph of this document and in Appendix A above.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

EXPERIMENT PROPOSAL

FOR

MANNED SPACE FLIGHT

TITLE ____

(Confine to total of 30 letters, numerals, spaces, punctuation marks, etc.)

____

EXPERIMENT NUMBER

PRINCIPAL INVESTIGATOR ____________________________________

(Signature) *(Date)*

PRINCIPAL ADMINISTRATOR ___________________________________

(Signature) *(Date)*

NASA FORM 1346 JAN 67 REPLACES NASA FORMS 1138, 1138A, B, AND C, WHICH ARE OBSOLETE.

Figure B2.—NASA form 1346

THIS DOCUMENT PROVIDES THE FORMAT TO BE FOLLOWED BY THE INVESTIGATOR OR PROPOSING INSTITUTION, WITH SUPPORT AS REQUIRED FROM THE NASA SPONSORING PROGRAM OFFICE, WHEN SUBMITTING PROPOSED EXPERIMENTS FOR MANNED SPACE FLIGHT TO NASA FOR REVIEW AND ACCEPTANCE. INFORMATION REQUESTED SHOULD BE COMPLETED AS ACCURATELY AND WITH AS MUCH DETAIL AS POSSIBLE, SINCE THIS DOCUMENT WILL PROVIDE THE PRIMARY DATA FOR AN EVALUATION OF EXPERIMENT MERIT AND DETERMINATION OF EXPERIMENT COMPATIBILITY TO A MANNED SPACE MISSION. ALSO, THE TECHNICAL ENGINEERING, AND OPERATIONAL INFORMATION (SECTIONS II, III, AND IV) CONTAINED IN THIS PROPOSAL, WHEN UPDATED, WILL CONSTITUTE THE EXPERIMENT DESCRIPTIVE INFORMATION PORTION OF THE EXPERIMENT IMPLEMENTATION PLAN, TO BE PREPARED BY A NASA CENTER BEFORE FINAL APPROVAL OF THE EXPERIMENT CAN BE AUTHORIZED.

FOR MONITORING PURPOSES, PLEASE NUMBER THE PAGES OF YOUR PROPOSAL PROGRESSIVELY FROM THE FIRST TO THE LAST AS FOLLOWS: PAGE 1 OF N PAGES, PAGE 2 OF N PAGES . . ., PAGE N OF N PAGES.

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Figure B2.—NASA form 1346 (continued)

SECTION I - ADMINISTRATIVE /BIOGRAPHICAL

1. APPLICANT INSTITUTION

Name of Applicant Institution

Type of Institution
☐ Government
☐ University
☐ Non-Profit
☐ Industrial
☐ Other

Address

Telephone

Name of Principal Administrator Responsible for Experiment

Title

2. PRINCIPAL INVESTIGATOR

Name of Principal Investigator

Title

Mailing Address

Telephone

Biographical Sketch:
Brief summary of education, experience and professional qualifications.

3. OTHER INVESTIGATORS

NAMES	MAILING ADDRESSES	TITLES OR POSITIONS

NASA FORM 1346 Jan 67

1

Figure B2.—NASA form 1346 (continued)

SECTION I - ADMINISTRATIVE/BIOGRAPHICAL (Cont'd.)

4. RESEARCH SUPPORT

List all other funded and proposed research support of the principal investigator. Include support for this proje[ct] received from own organization. Amounts shown should reflect total funds awarded over the entire grant period[s] indicated in the final column.

a. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION SUPPORT

GRANT/CONTRACT NUMBER	TITLE OF PROJECT	APPROXIMATE PERCENT TIME/ EFFORT ON PROJECT	TOTAL AMOUNT ($)	TOTAL PERIOD OF SUPPORT WITH DATES

b. ALL OTHER RESEARCH SUPPORT

SOURCE AND GRANT/ CONTRACT NUMBER (If designated)	TITLE OF PROJECT	APPROXIMATE PERCENT TIME/ EFFORT ON PROJECT	TOTAL AMOUNT ($)	TOTAL PERIOD OF SUPPORT WITH DATES

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2

Figure B2.—NASA form 1346 (continued) (sheet 3 of 4)

SECTION I - ADMINISTRATIVE/BIOGRAPHICAL (Cont'd)

5. PRINCIPAL INVESTIGATOR'S ROLE IN RELATION TO THIS EXPERIMENT
(Include percent of time to be spent on this project)

6. RESPONSIBILITIES OF OTHER KEY PERSONNEL
(Include percent of time to be spent on this project)

NASA FORM 1346 Jan 67 3

Figure B2. - NASA form 1346 (continued)

SECTION II - TECHNICAL INFORMATION

1. OBJECTIVES

The purpose of this experiment is to study the effects of extended weightlessness on two or more unattended primates in earth orbit for periods up to one year in order to provide guidance in the continuing research program to validate long duration manned flight. Specifically, the scientific objectives are to:

a. Provide physiological and psychological data for extended flight spacecraft design validation,

b. Delineate weightlessness effects on vestibular function,

c. Provide scaling factors for long term life support requirements in weightlessness, oxygen, water, food, contaminant control, and temperature, and,

d. Provide long term life support component experience.

This experiment is capable of being carried into orbit during proposed Saturn Apollo Applications flights. This spacecraft can be carried as a LEM companion or LEM substitute. The experiment package, as an independent spacecraft, will be separated from the launch vehicle, self-maintained from six months to one year and at the end of the test, the primates will be recovered by astronaut rendezvous and returned to earth in the Apollo Command Module. The primate subjects will be unrestrained during the entire duration of the flight and will be instrumented using implanted sensors and transmitters to provide required physiological data. Video monitoring will supplement the instrumentation.

These studies will, in part, complement the manned inflight observations and are expected to render additional information which could not be gained by manned flight. Clinical disorders due to zero g may be observed in the cardiovascular system by alterations of bone density, and other physiological changes. Post-flight histopathology studies would be performed on the animals. In order to enhance the value of the data collected, ground-based investigations would be carried on prior to and during flight.

NASA FORM 1346 Jan 67

Figure B2 NASA form 1346 (continued)

SECTION II - TECHNICAL INFORMATION

2. SIGNIFICANCE

Manned space flights of limited duration have, to date, indicated the possibility of some rather basic and fundamental physiological changes occurring. The data available, however, are limited and are not sufficient to be conclusive.

Ground based studies of the effects of gravity and parabolic aircraft zero g flights have indicated possible physiological effects. Various physiological changes have been predicted in the event men are exposed to extended weightlessness. The only possible manner by which these effects can be studied is by means of orbital flights.

One of the long range goals of the nation's space programs is manned flights to or close by some of the nearby planets. Before such long flights can be undertaken it is necessary that all possible detrimental effects of weightlessness be evaluated and understood.

3. DISCIPLINARY RELATIONSHIP

(To be supplied by NASA or the Principal Investigator.)

4. EXPERIMENT APPROACH

a. Experiment Concept

The orbiting experiment for study of extended weightlessness is a biological experiment utilizing primates (Macaca mulatta) in an unrestrained weightless condition for one year. The physiological, pathological and biological effects of extended weightlessness will be studied. A spacecraft specifically designed to support two animals for one year in an orbit will be designed. The spacecraft will be launched by a Saturn Apollo Application mission. A second mission will be utilized in conjunction with astronauts to recover the animals and return them to earth for pathological studies.

NASA FORM 1346 Jan 67

Figure B2 NASA form 1346 (continued)

Design Phase: The next step involves a Phase 2 definition contract to detail the design of the spacecraft and to detail requirements for mission and crew functions. In addition, a Laboratory Test Model would be developed. The objectives of the Laboratory Test Model is to determine the design adequacy of specific portions of equipment proposed for use in the Orbiting Primate Spacecraft. Additional objectives include providing signaling factors for oxygen, food, water and contamination control which can be used in the final design of the spacecraft. A third objective is to provide a realistic training behavioral environment for the laboratory test analysis.

Development/Operations: The next step would be to perform a Phase 3 portion of the program which involves the final design and development of the spacecraft.

Orbital Flight Procedures: Animals are to be installed in the spacecraft and launched using a manned Apollo launch vehicle. The spacecraft would remain in an approximate 250 nautical mile orbit for one year. During this period MSFN stations would be utilized to receive data from the spacecraft and to send the necessary commands for spacecraft control. At the end of the one year period, a second manned Apollo launch vehicle would be utilized to rendezvous with the spacecraft and recover the animals. At rendezvous the animals would be installed in recovery capsules; the astronaut in an EVA procedure would remove the recovery capsule containing the animals from the spacecraft and return them to the Command Module. The Command Module would then be used to return the animals to earth for pathological studies.

c. <u>Measurements</u>

The measurement and range values expected are listed in Section III paragraph 7, Data Measurements Requirements.

NASA FORM 1346 Jan 67

Figure B2 NASA form 1346 (continued)

d. Data Analysis and Interpretation

Each time the OPS orbits within range of the ground receiving station spacecraft and animal status data is transmitted first. These data are recorded on magnetic tape and analyzed. The data will indicate if the spacecraft is capable of continuing transmission -- if not, corrective commands are sent to the spacecraft -- if so, primary and spacecraft engineering data is transmitted and recorded on magnetic tape. Real time TV data is also transmitted for observation.

The primary data will be analyzed and presented in such a manner that a quick review of the primates well being may be made before the spacecraft's next time over station. This will permit modification of the life support equipment through corrective commands. Provision will be made at the control center to analyze engineering data in order to further determine the spacecraft condition.

All data received from the spacecraft shall be recorded on magnetic tape and converted to digital computer format for analyses. The computer will be programmed to provide preformance parameters convenient for quick interpretation of the primates physiological and psychological health and of the spacecraft subsystems preformance evaluation.

e. Obstacles and Uncertainties

The areas of uncertainty are the manner of mass volume measurement, water storage, waste management, primate behavior in adverse conditions, nutrition and implanted telemetry. These obstacles and uncertainties shall be resolved during the period preceding and concurrent with the Laboratory Test Model such that the proper techniques, materials and hardware may be incorporated into the OPS.

NASA FORM 1346 Jan 67

Figure B2 NASA form 1346 (continued)

SECTION II - TECHNICAL INFORMATION

During the orbit, the animals would be instrumented to determine physiological and behavioral effects of extended weightlessness. This instrumentation includes measurements of the animal's temperature, his heart rate and respiration rate. The animal's consumption of food, water and oxygen will be measured in conjunction with his mass to determine metabolic changes. The animals will be trained to perform specific tasks to receive food and water. The responses to these tasks will be instrumented to determine the effects of weightlessness on his behavioral characteristics. In addition, television will be utilized to supplement the above instrumentation. After one year the animals would be recovered from orbit using astronauts and an SAA flight. Upon return to earth, pathological studies would be conducted to further determine the effects of weightlessness. During the period when the orbit experiment is being conducted, controlled animals in a similar environment here on earth will be instrumented for comparison of the weightlessness effects to those occurring in a 1 g environment.

b. <u>Experiment Approach</u>

Present Status: To date the basic experiment concepts have been worked out to determine the types of physiological, pathological and biological data required. The basis support requirements for maintaining the animals alive in orbit for one year have been established and preliminary experiments have been conducted with animals in a closed envirøment for extended periods. Study contracts have been let and completed to study the feasibility of developing and launching a spacecraft to meet these requirements. These studies have identified the basic systems approach to the spacecraft design, have identified the design approach to subsystems, and have identified the requirements for SAA missions and crew activities. These studies have shown that the experiment and spacecraft designs are pratical, that the program can be ready for launch in 1970 and that support requirements are compatable with SAA mission capabilities.

NASA FORM 1346 Jan 67

Figure B2 NASA form 1346 (continued)

f. Astronaut Significance

The significance of utilizing an astronaut in this experiment is primarily concerned with the recovery of the animals. The reliability and success of the experiment is greatly improved if an astronaut is utilized to remove the animals from the spacecraft and return them to earth in the command module. In addition, a considerable savings in equipment is accomplished if the spacecraft and recovery capsules are not required to perform de-orbit and re-entry maneuvers. Other activities which the astronaut may perform include assistance with the insertion of the spacecraft and initial observations of spacecraft performance. The astronaut could be utilized to deploy solar panels and activate subsystems should the automatic functions fail to perform properly.

5. BASELINE OR CONTROL DATA

There are two controls in this experiment. The first is supplied by the flight primates. During training and preparation a vast amount of data can be collected on each primate thus yielding firm baseline data. Preflight and postflight histopathological studies may be compared by means of biopsies. Flight data may be compared with the baseline data and with the postflight data. In this manner each primate serves as its own control.

During the flight two or more primates will be installed in a closed system identical to the spacecraft and maintained as experiment controls. The two sets of primates would experience identical environments except for the gravity difference thus making it possible to distinguish those effects due to weightlessness as opposed to the effects of isolation, diet, etc.

NASA FORM 1346 Jan 67

Figure B2 NASA form 1346 (continued)

SECTION III - ENGINEERING INFORMATION

1. EQUIPMENT DESCRIPTION

The Orbiting Primate Spacecraft serves as the carrier for extended weightlessness experiment. It is designed to be compatible with the Apollo system and SAA program although it can be adapted to alternate systems and launch vehicles.

REQUIREMENTS

The requirements influencing the configuration of the spacecraft are detailed in MEI Specification CP10000, and are summarized as follows:

(1) An orbiting vehicle accommodating two unrestrained primates for the purpose of studying the effects of extended weightlessness in orbit for 6 months to 1 year.

(2) Provide compatibility between the spacecraft and the Apollo system, specifically implementing the SAA missions.

(3) Provide self sufficiency for a mission period of 6 months to 1 year with the latter being the design goal.

(4) Provide for recovery of the primates from orbit by EVA as part of an Apollo SAA mission noting that the primates and container are to be stowed in the CM for return to earth.

(5) Provide for acquisition of primate behavioral and physiological data throughout the mission.

(6) Provide radiation and meteoroid protection.

(7) Consider adaptation of the spacecraft as part of a rotating system for application of artificial gravity forces.

NASA FORM 1346 Jan 67

Figure B2 NASA form 1346 (continued)

(8) Provide a 14.7 ± 2 psi internal atmospheric pressure during orbital operations; the atmosphere should be 21 % oxygen and the remainder nitrogen.

DESCRIPTION

The Orbiting Primate Spacecraft, described herein, represents an assembly of interrelated subsystems, mechanically, thermally, electrically, and functionally integrated into a cohesive unit suitable for use in the SAA program as a LEM companion or as a substitute on manned or unmanned vehicles with a self sustaining capability from 6 months to 1 year. Figures III.1-1 and III.1-2 show the configurations for both the stowed and in-orbit modes.

External Configuration

The external gross appearance of the spacecraft is that of a right circular cylindrical upper element joined to an octagonal lower section. The cylinder contains the pressurized volume and is of welded construction. The sides and top of the cylinder form one removable unit which is flange mounted at a sealed joint to the bulkhead forming the bottom of the cylindrical section of the spacecraft. The lower section is unpressurized and contains most of the subsystem equipment. The flat panels forming the sides of the octagonal structure serve as bases and heat sinks for electronic equipment mounted to the interior surfaces. A 20 inch by 20 inch sealable door is provided as access to the pressurized area for insertion of the primate or performance of maintenance.

Attachments to the basic external structural stringers are in the form of meteoroid protective shielding and thermal insulation. The latter is behind and attached to the meteoroid shielding panels and is removable as part of these assemblies.

A radiator which is part of the thermal control subsystem is mounted to the external vertical stringer and covers an area of the cylindrical section approximately eleven inches in width extending

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Figure B2 NASA form 1346 (continued)

Section III - Engineering information (continued)

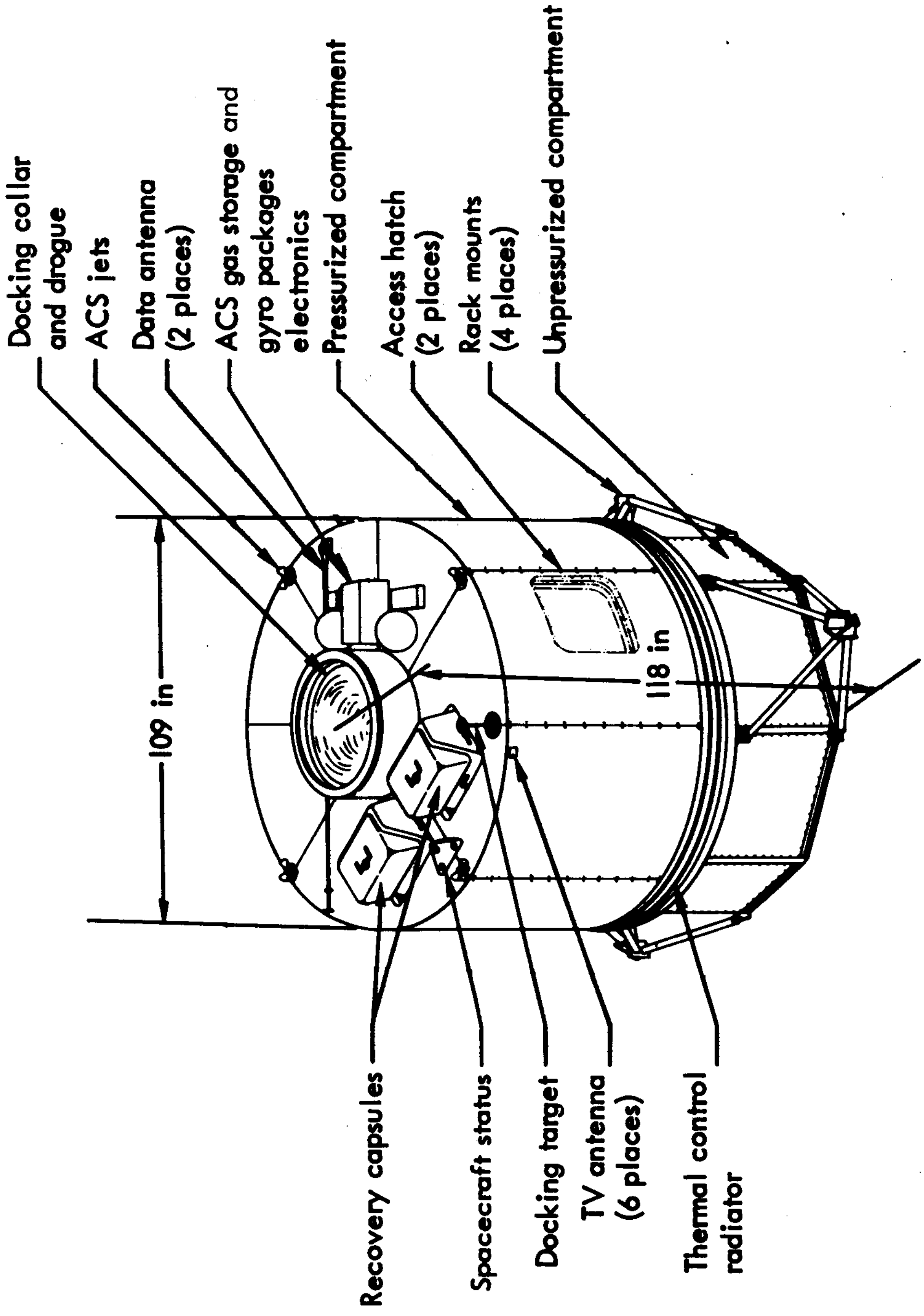

Figure III.1-1. - Spacecraft assembly - external configuration - stowed mode

Figure B2.-NASA form 1346 (continued)

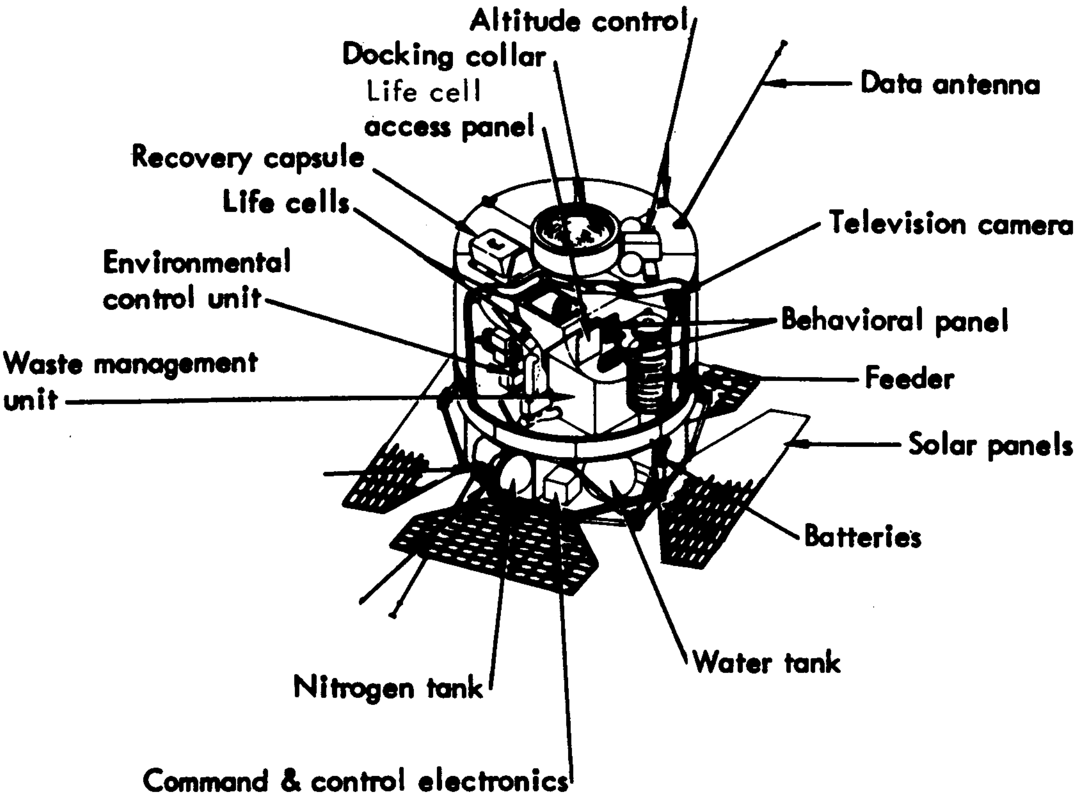

Figure III.1-2. Spacecraft assembly - orbital mode internal configuration

Figure B2.– NASA form 1346 (continued)

completely around the circumference; the radiator supplements the meteoroid shielding and insulation in this region.

Four tubular truss assemblies are used to attach the spacecraft to the ATM, LMSS or other appropriate structures in the SLA area of the Apollo Launch Vehicle. Separation at these attach points is accomplished pyrotechnically following docking of the spacecraft and CM after launch. The docking is accomplished through use of the docking collar located on the upper bulkhead of the spacecraft. The collar contains the LEM type drogue which engages with the CM probe during docking.

The upper bulkhead also mounts the primate recovery capsule which is situated as shown to facilitate removal during EVA operations. In its shown location it can be reached by the astronaut standing in the CM hatch opening. The upper bulkhead and adjoining area of the cylindrical section of the spacecraft also provide mounting for the attitude control subsystem; tankage, valves, plumbing, and thrusters as well as the gyro module and electronic subassembly. The thrusters are arranged in four clusters of three units each. In addition a visual docking aid for use during the docking maneuver is located on the upper bulkhead as is the spacecraft status monitoring panel which is positioned so as to be visible from the CM window.

Antennas also located on the top section of the spacecraft consist of five flush mounted TV antennas, four of which are mounted 90° apart around the periphery and one of which is mounted on the top bulkhead. A communications antenna, boom mounted and deployable is also located on the upper bulkhead. It is so positioned in the deployed position as to avoid interference with the CM during docking. Two more antennas are mounted at the bottom end of the spacecraft, one for TV and the other for communications. The octagonal shaped end of the spacecraft mounts the four paddles which form the solar array. As noted in Figure III.1-1, in the stowed condition they are folded over against the bottom spacecraft surface; their shape conforms with the octagonal outline of the bulkhead to facilitate stowage. Figure III.1-2 shows the array in the deployed condition with the active area facing away from the spacecraft. Two more antennas are mounted at the end of the spacecraft. One is an

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Figure B2 NASA form 1346 (continued)

additional TV antenna centrally located on the bottom surface and the other is a communication antenna similar to the one mounted at the opposite end.

Internal Configuration

As indicated in Figure III.1-2 there are two major internal areas of the spacecraft: the pressurized volume within the cylindrical section and the unpressurized section below it in which most of the support subsystems are installed.

Pressurized Area

The pressurized portion of the spacecraft contains two life cells to accomodate one primate each. The life cells are mounted to the bottom bulkhead of the pressure vessel. The two life cells are located side by side with approximately one inch of space between to permit: installation of the structural tension members through that space; separation between the life cell social windows precluding other than minimum physical contract between primates. The major external equipment attachments to the life cells are: television cameras, waste management assemblies at the bottom, the feeders, waterers and mass measurement devices. The recovery capsules open into the top of the life cells but are mounted externally on the upper bulkhead with a sealed transition provided to the life cell. Environmental control equipment is also mounted within the pressurized section and consists of: air filters, condensers, evaporation, primary and secondary fans, and catalytic burner.

Unpressurized Area

The lower octagonal section of the spacecraft is unpressurized and contains most of the electronic subsystems elements as well as the expendables other than food which is stored in the feeder.

The environmental control equipment located in this area consist mainly of: nitrogen and oxygen cryogenic storage tanks, heat exchanger between primary and secondary thermal loops, coolant pump, accumulator,

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Figure B2 NASA form 1346 (continued)

control module, gas analyzer, and lithium hydroxide. The latter unit location is also dictated by its need for a thermal input which can be obtained through the surface of the spacecraft which faces the sun. The lower end of the lithium hydroxide container forms part of the bottom solar oriented surface of the spececraft and is centrally located there.

The environmental control expendables as well as water tankage is distributed to optimize the weight and balance during the period of consumption.

The electronic equipment is installed on: the bottom surface, the removable side panels, the central structure column formed by the lithium hydroxide container, the bottom of the lower bulkhead of the pressure vessel.

The various equipments are segregated functionally where feasible with consideration given to thermal characteristics, access and maintainability. Thus, the heat dissipating elements of the power subsystem operating continuously are mounted on the flat panels forming the outside of the octagonal section. These serve as heat sinks radiating to space. Equipment which would tend to become cold is mounted to the warmer surfaces. The panels upon which equipment is mounted are designed to swing out and be removable to improve accessibility and maintainability.

REQUIRED EQUIPMENT AND STATUS

Table III.1-1 lists the required equipment and shows the state of equipment definition in terms of whether it is conceptual, design, bread-board, prototype or flight hardware.

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Figure B2 NASA form 1346 (continued)

SECTION III - ENGINEERING INFORMATION

TABLE III.1-1

Equipment	Definition
Laboratory Test Model	
ECS	Conceptual and Design
Life Cells	Design
Waste Unit	Conceptual
Feeder	Design
Waterer	
Tank, valve	Commercial
metering mouthpiece	Design
M/VMD	Commercial
Recovery Capsule	Conceptual
Behavioral Panel	Design
Thermal Control	Conceptual
Structure and Mechanical	Conceptual
Instrumentation	Commercial
Command and Control	Commercial
Electrical Power	Laboratory Supply
Orbiting Primate Spacecraft	
ECS	Design
Life Cells	Design
Waste Unit	Design
Feeder	Design
Waterer	Design
M/VMD	Conceptual

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Figure B2 NASA form 1346 (continued)

TABLE III.1-1 (contd.)

Equipment	Definition
Recovery Capsule	Design
Behavioral Panel	Design
Thermal Control	Conceptual
Structure and Mechanical	Design
Instrumentation	Conceptual
Telementry	Conceptual
Command and Control	Conceptual
Electrical Power	Design
Attitude Control	Design
Recovery Capsule	Design
ECS	Design
Ground Support Equipment	
LTM	
LTM Support Console	Conceptual
Computer Interface Unit	Conceptual
Oscilloscope	Commercial
VOM	Commercial

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Figure B2 NASA form 1346 (continued)

SECTION III - ENGINEERING INFORMATION

TABLE III.1-1 (concluded)

Equipment	Definition
Orbiting Primate Spacecraft	
Apollo Ground Station	Existing
Computer Interface Unit	Conceptual
Computer	Commercial
LTM	Design
Laboratory	Existing
Launch	
Facilities (Cape Kennedy)	Existing
SIB or SV Booster	Existing

2. ENVELOPE

Figures III.2-1 and III.2-2 show the basic dimensions of the Orbiting Primate Spacecraft. The OPS is compatible with both the LMSS and ATM racks as mounting interfaces in the SLA area.

3. WEIGHT AND SIZE

Table III.3-1 gives the weight, volume, dimensions and shape of the Orbiting Primate Spacecraft, the recovery capsules and the recovery capsules external ECS.

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Figure B2 NASA form 1346 (continued)

SECTION III - ENGINEERING INFORMATION

TABLE III.3-1

Equipment	Weight	Volume ft³		Dimensions inches		Shape	
		Stored	Operation	Stored	Operation	Stored	Operation
Orbiting Primate Spacecraft	5380 lb.	689.	672.	109.OD x 118.	Fig.III. 2-1 Fig.III. 2-2	Fig.III. 2-1 Fig.III. 2-2	Fig.III. 2-1 Fig.III. 2-2
Recovery Capsule		42.	42.	21-8 x 17.5 x 19.	21-8 x 17.5 x 19.	Fig.III. 1-2	Fig.III. 1-2
Recovery Capsule External ECS	33. lb	1.78	1.32	20. x 16. x 9.5	20. x 9.5 x 6.+ 10. x 9.5 x 6.	Fig.III. 1-2	Fig.III. 1-2

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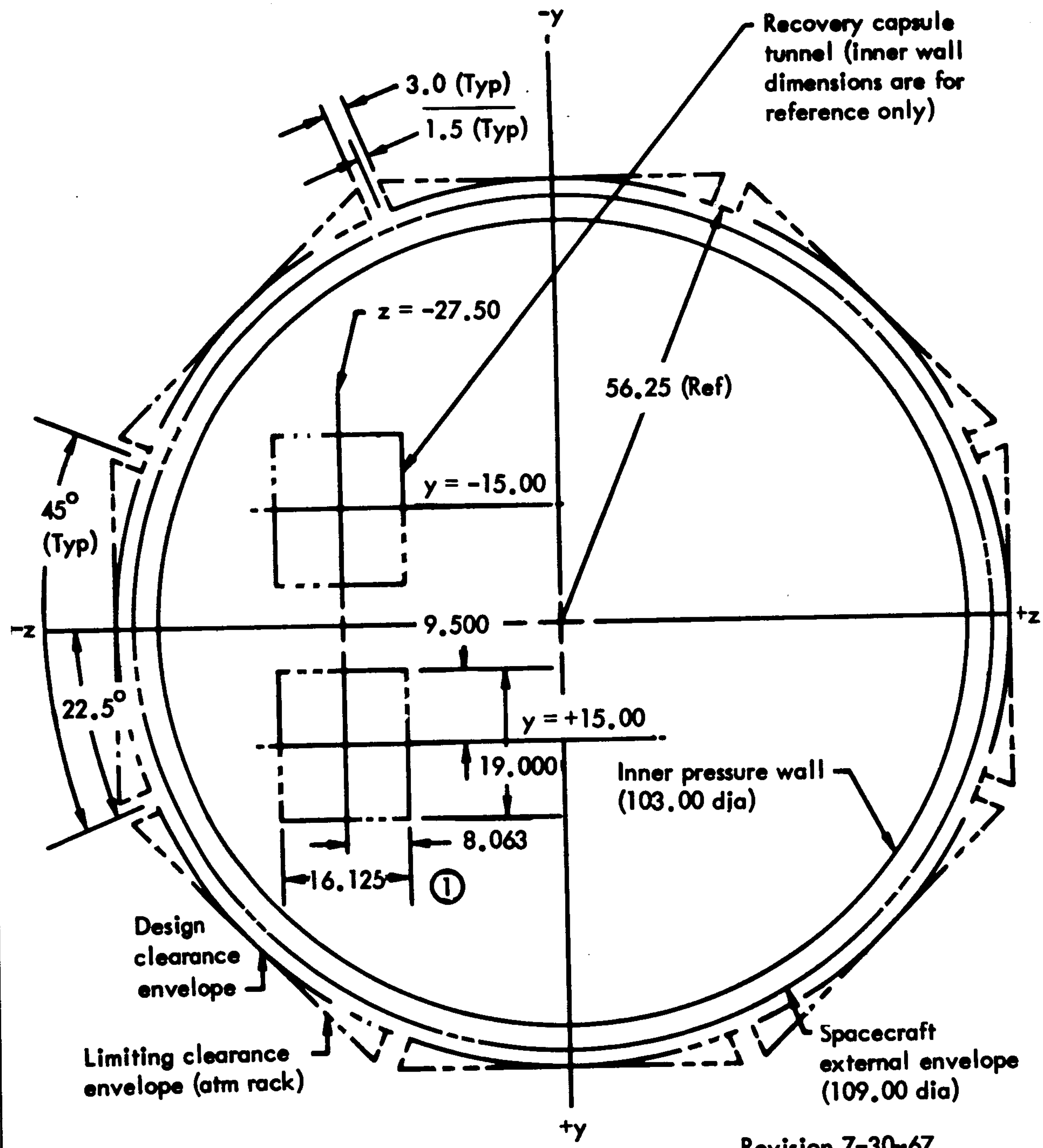
Figure B2 NASA form 1346 (continued)

Section III - Engineering information (continued)



Revision 7-30-67

① 16.125 was 19.25
19.000 was 16.50
8.063 was 9.625
9.500 was 8.25

ATM rack details per MSFC dwg: SK30-3812
DTD 2-15-67 (NAS 8-20073

Figure III.2-1. Basic dimensions of orbiting primate spacecraft

Figure B2.-NASA form 1346 (continued)

Section III - Engineering information (continued)

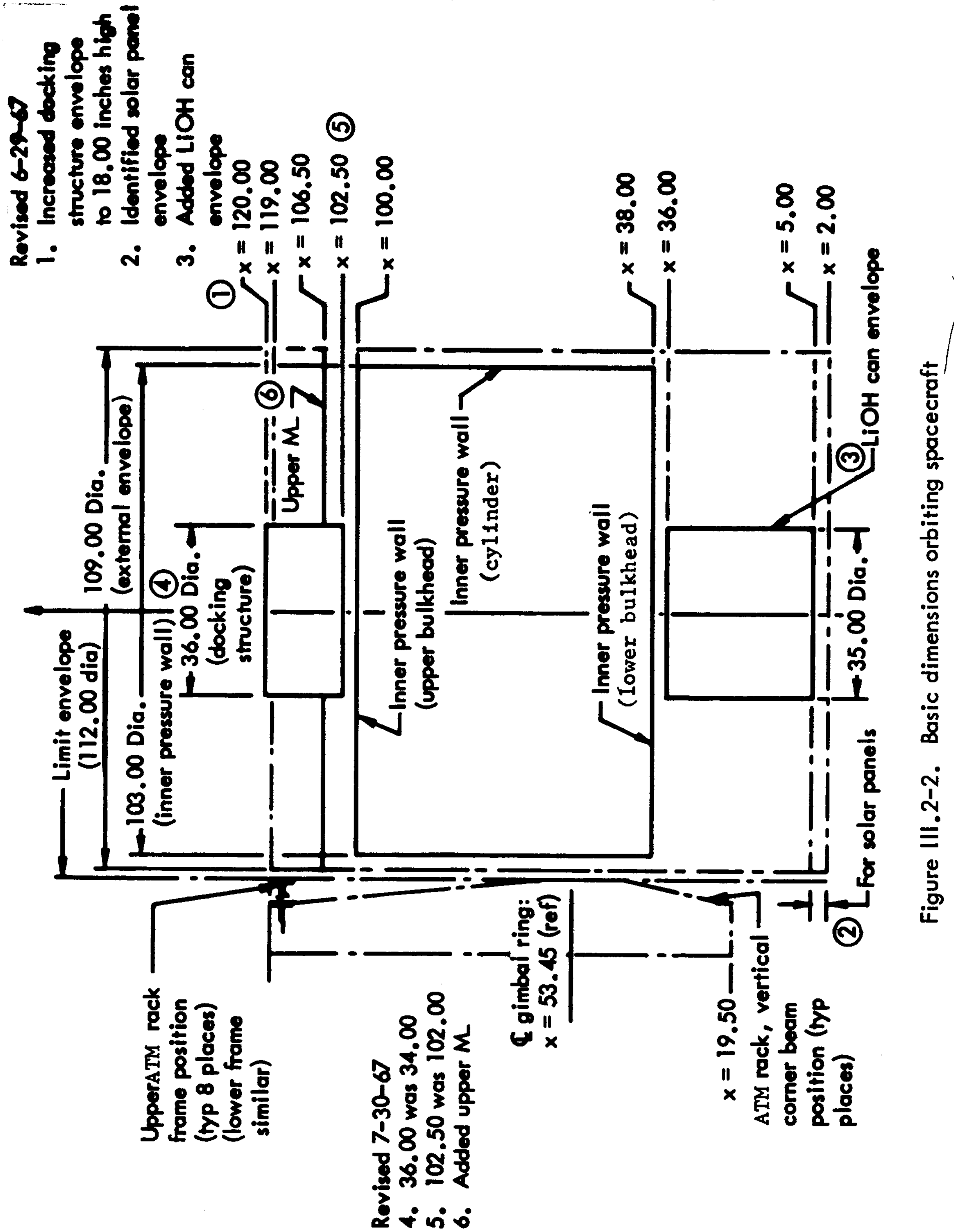


Figure III.2-2. Basic dimensions orbiting spacecraft

Figure B2.—NASA form 1346 (continued)

5. SPACECRAFT INTERFACE REQUIREMENTS

The OPS shall be equipped with appropriate attach points for handling during assembly in the MSOB. The spacecraft shall have access parts to permit the installation of primates and the replacement of perishable and useable stores while the spacecraft is installed on the launch vehicle.

The Orbiting Primate Spacecraft shall be carried between the SIVB booster and the Apollo Command Module in the SLA area as a LEM companion or LEM substitute. Figures III.5-1 and III.5-2 show the OPS mounted on either the LMSS rack as a LEM substitute or on the ATM rack as a LEM companion or substitute.

The OPS shall be disconnected from either of the racks by the firing of pyrotechnic attachments. Separation shall be accomplished by a combination of short springs and small thrusters.

The OPS shall have provisions for both hard and soft docking with the CM. The spacecraft and its docking mechanism shall be capable of taking the loads coupled through the docking collar during maneuvering and thrusting.

The recovery capsule dimensions and weight shall be compatible with storage within the Command Module and with the handling capabilities of a space suited astronaut moving it from the spacecraft to its storage position through the CM hatch. Mechanical manipulations required by the astronaut shall not cause his metabolic load to exceed 2,000 BTU per hour with a maximum of 4,800 BTU for the entire recovery task.

In general, it is desirable that the primate spacecraft use its own checkout equipment wherever practical. However, it will be necessary to establish checkout and monitoring interfaces with ACE and OCS during the latter portions of the countdown.

The Vertical Assembly Building (VAB) consists of two principal areas, the Low Bay and the High Bay. The Low Bay is used for inspection and a limited amount of premating checkout of the S-II and S-IVB stages. Low Bay checkout will consist primarily of tests which cannot be performed after mating or would require disassembly should a malfunction occur. Receiving inspection of the Instrument Unit (IU) is also performed in the Low Bay. The High Bay area is used for assembly and checkout of the vehicles. The assembly process consists of sequentially stacking the stages

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Figure B2 NASA form 1346 (continued)

Section III - Engineering information (continued)

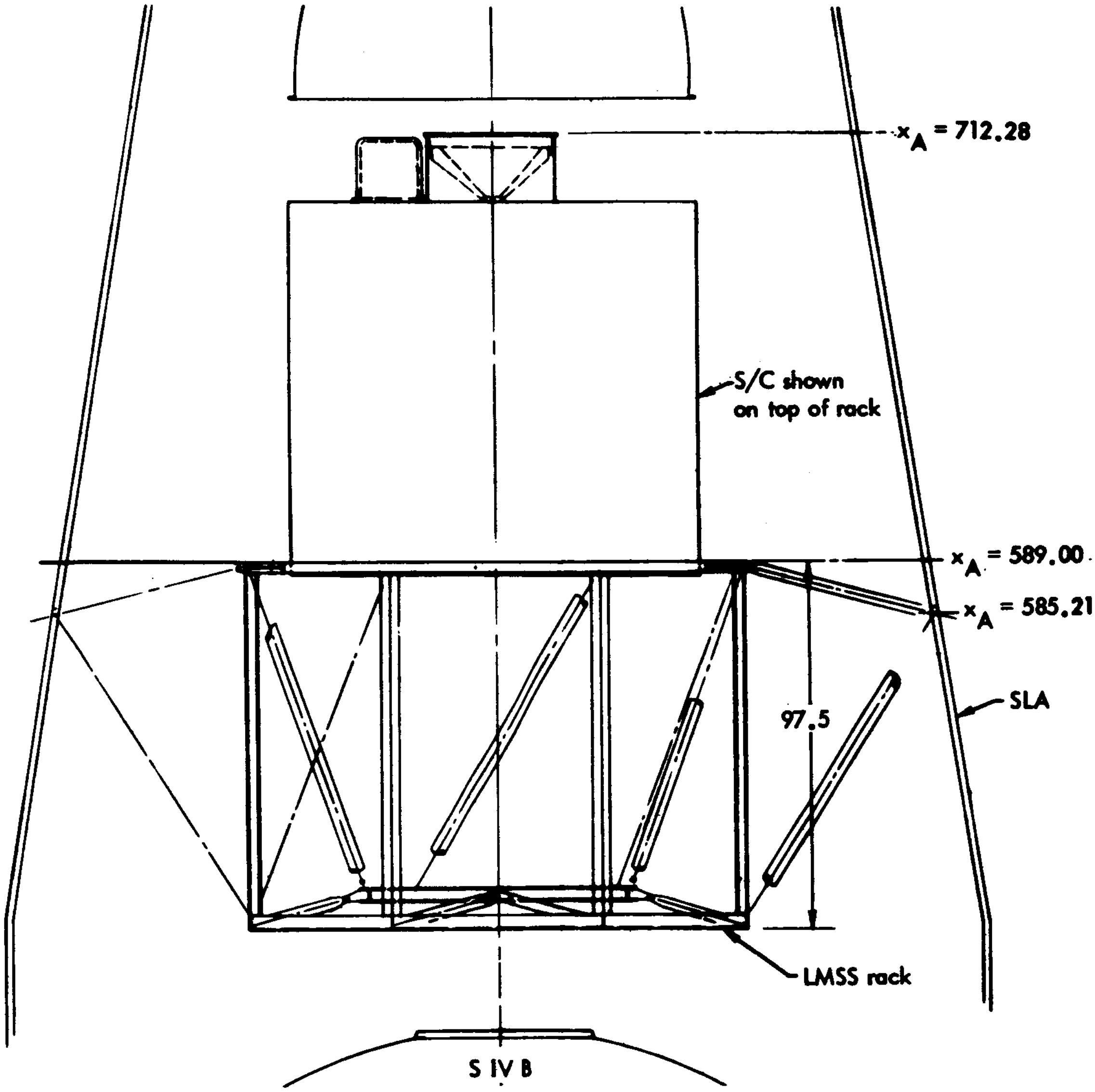

Figure III.5-1. Orbiting spacecraft installed on LMSS

Figure B2.–NASA form 1346 (continued)

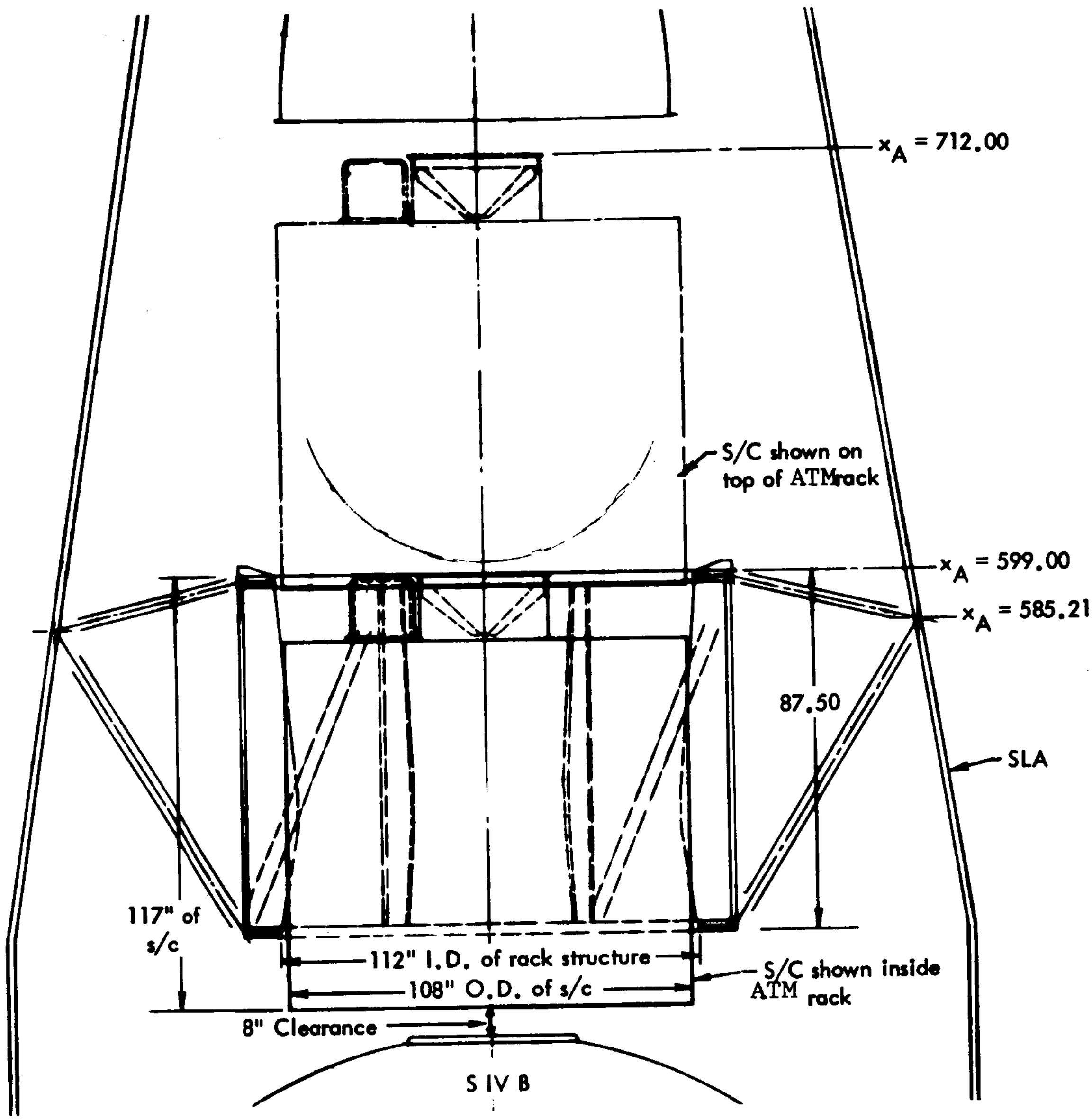

Figure III.5-2. Orbiting primate spacecraft installed on ATM rack

Figure B2.—NASA form 1346 (continued)

and IU on a Mobile Launch Facility (MLF). First, the GSE in the MLF is connected to the GSE in the Launch Control Center (LCC) and checked out. Ground Equipment Test Set (GETS) checks are conducted to verify that the Electronic Support Equipment (ESE) is ready to process the launch vehicle. Next the vehicle will be assembled on the MLF. Once assembly is completed an integrated checkout of the launch vehicle is accomplished. This checkout is performed using the primate spacecraft and the special ACE equipment associated with the later phases, Figure III.5-3 is a block diagram of these interfaces.

Upon completion of VAB assembly and checkout, the MLF is disconnected from the LCC and the MLF/space vehicle combination is transported to the launch pad. After connection of the MLF to the pad has been completed, the vehicle will undergo another series of checks. Once the operability of the vehicle has been verified, countdown and launch will be initiated. The terminal phase of the countdown sequence, after T-186 seconds, is fully automatic.

After T = 0 and the vehicle has escaped the launch pad, all hard wire interfaces cease to exist. The only command and control available is that of RF links. On-board data is collected, processed and transmitted to the ground station utilizing the telemetry and communication links. A gross example is illustrated in Figure III.5-4.

Docking with the CM may be required twice during the mission. First when the S/C is maneuvered from the SLA by the CSM and released in orbit, the second is for the purpose of retrieving the primates. Two parallel wired connectors containing 48 wires each (total of 96 wires) are available across the docking interface for possible use where required.

The following types of electrical interfaces are with the CM:

a. To supply power to on-board experiment equipment and to monitor, control and to record events during the checkout and orbit insertion of the primate spacecraft.

b. To supply power to on-board experiment equipment, to monitor control and record events during checkout of the primate spacecraft just after docking during the recovery mission.

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Figure B2 NASA form 1346 (continued)

Section III - Engineering information (continued)

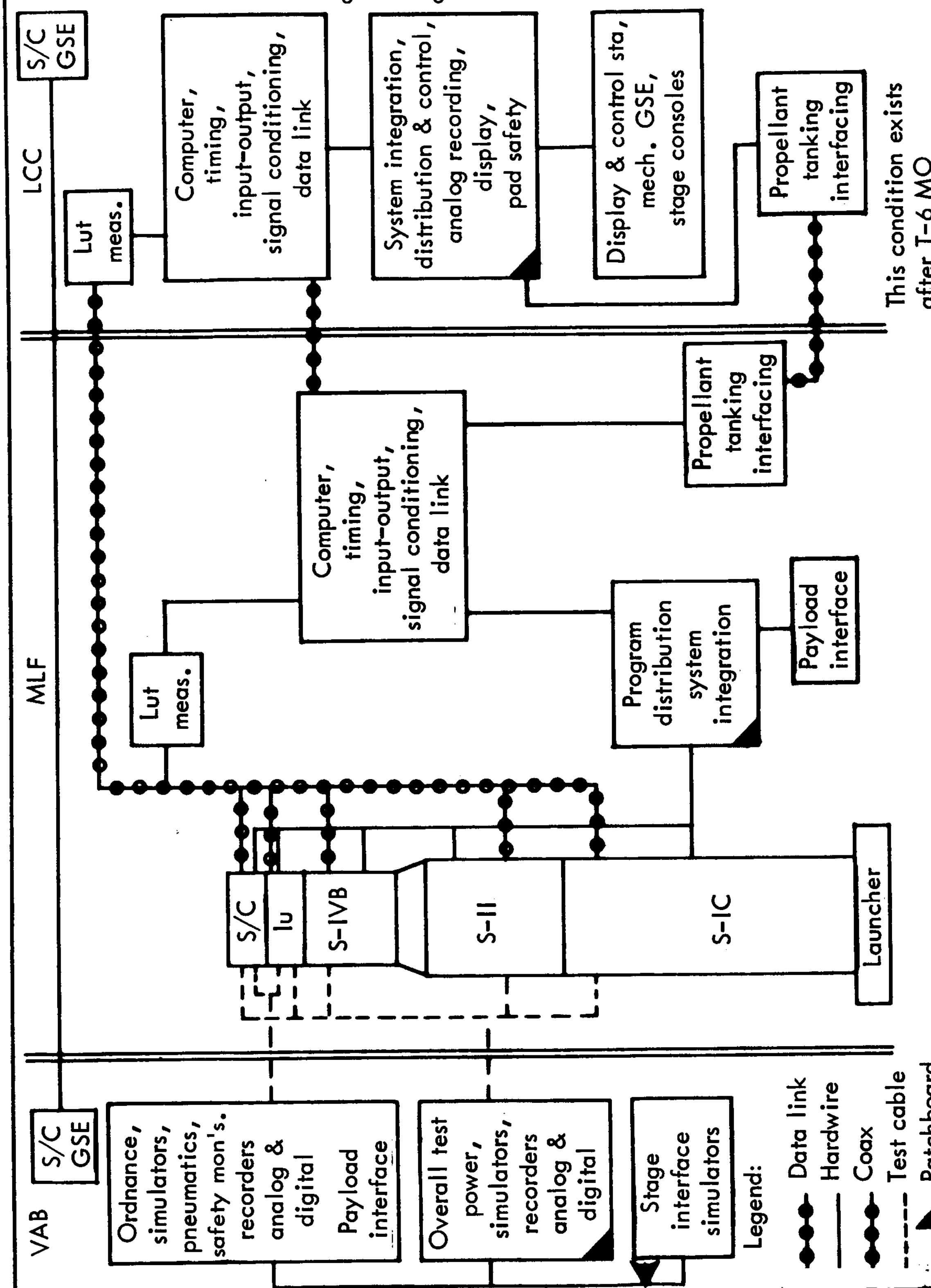

Figure III.5-3. Vertical assembly building interfaces (elec)

Figure B2.— NASA form 1346 (continued)

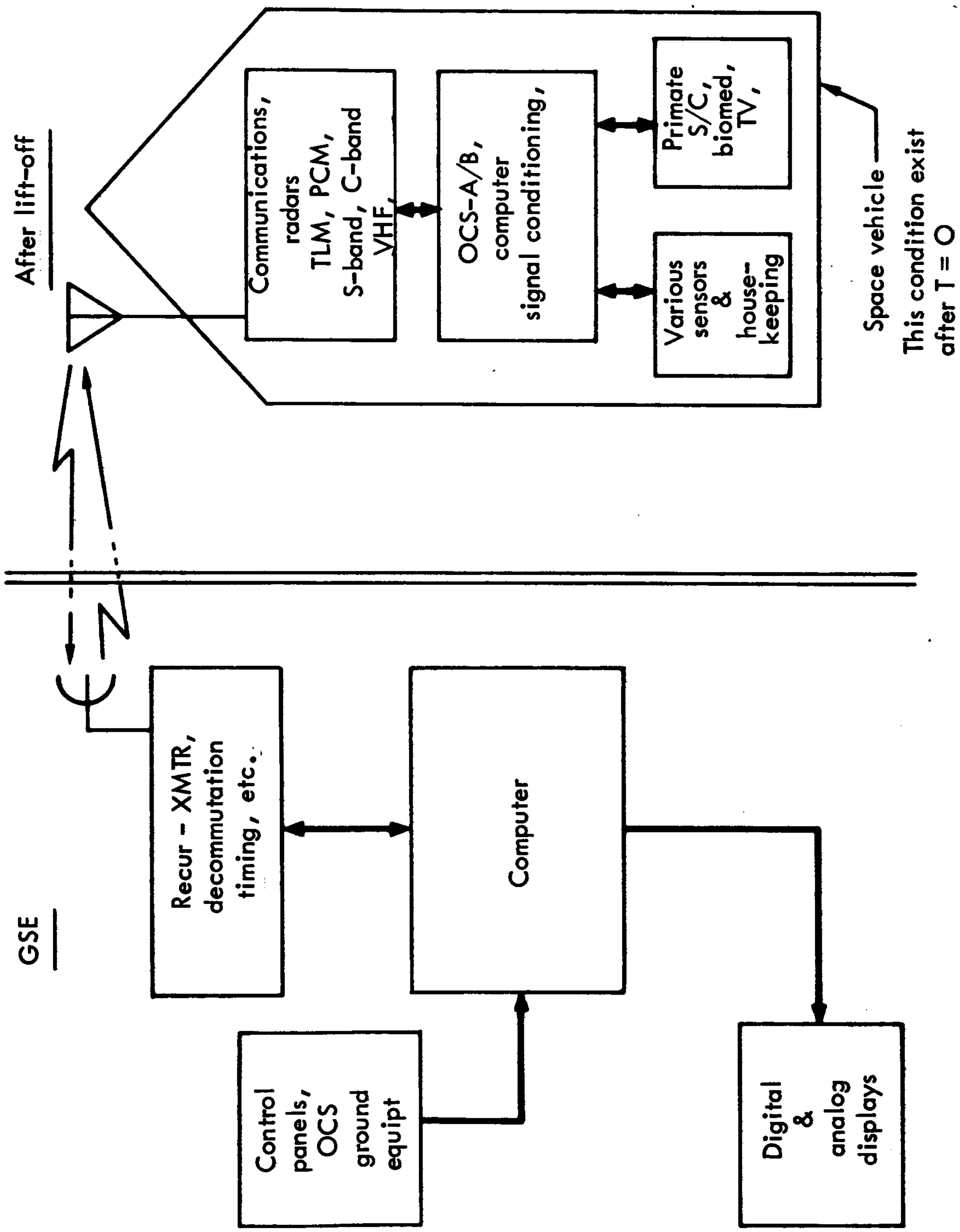

Figure III. 5-4 - Lift-off and pre-orbit interfaces

Figure B2. - NASA form 1346 (continued)

c. To provide power to the recovery capsules, monitoring control and recording events during the re-entry phase of the recovery mission.

EVA techniques will be employed in retrieving the primates.

a. Separation of the recovery capsule from the S/C is performed by the astronaut.

b. Command from the CM and EVA is required to deploy and retract the EVA handrails or other booms that may be deployed.

6. ENVIRONMENT CONSTRAINTS

The three assemblies, Orbiting Primate Spacecraft, recovery capsule and the recovery capsule external environmental control unit, shall operate satisfactorily in the environments referenced below in Table III.6-1.

TABLE III.6-1

Constraint	Prelaunch	Launch	Post Launch
Thermal			
Storage	Table III.6-2.1	not applicable	not applicable
Operational	Table III.6-2.1	Table III.6-2.1	Table III.6-2.2
Atmospheric Pressure	Table III.6-2.3	Table III.6-2.3- to Table III.6-2.4	Table III.6-2.4- to Table III.6-2.3
Relative Humidity	Table III.6-2.5	Table III.6-2.5- to not applicable	not applicable to Table III.6-2.5

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Figure B2 NASA form 1346 (continued)

SECTION III - ENGINEERING INFORMATION

TABLE III.6-1 (contd)

Constraint	Prelaunch	Launch	Post Launch
Atmospheric Composition	Table III.6-2.7	Table III.6-2.7- to not applicable	not applicable - to Table III.6-2.8
Contaminants	Table III.6-2.9	Table III.6-2.9- to not applicable	not applicable
Acceleration			
Storage		not applicable	not applicable
Operational		Table III.6-2. 10	Table III.6-2.11 Table III.6-2.12
Vibration			
Storage	Table III.6-2. 13	not applicable	not applicable
Operational	Table III.6-2. 13	Table III.6-2. 14	Table III.6.2.15
Noise	Table III.6-2. 18	Table III.6-2. 16	Table III.6-2.17
Radiation Tolerance	Table III.6-2. 19	Table III.6-2. 19 to Table III. 6-2.20	Table III.6-2.20 Table III.6-2.21
EMI	Table III.6-2. 22	Table III.6-2. 22	Table III.6-2.22

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Figure B2 NASA form 1346 (continued)

SECTION III - ENGINEERING INFORMATION

TABLE III.6-2

Constraint	Value
1. Thermal	-20°F to + 145°
2. Thermal	50° F increasing to 110° F max
3. Pressure	2.4 psia to 17.0 psia
4. Pressure	10^{-13} mm Hg
5. Relative Humidity	0 to 100% relative humidity, including conditions wherein condensation takes place (water or frost) for at least 30 days
6. Air movement rate	Per Cape Kennedy wind data for the height intervals of 10 to 400 feet
7. Atmospheric Composition	Sea level normal
8. Atmospheric Composition	100% O_2 at 5 psia
9. Contaminants	Rain - Up to 0.6 in./hr for 12 hours and 2.5 in./hr maximum Sand and Dust - As encountered in desert and ocean beach areas, equivalent to 140-mesh silica flour (particle density - 0.25 grams/ ft^3 at a particle velocity = 500 ft/min) Fungus - As experienced in a Florida climate. Materials will not be used which will support or be damaged by fungi.

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Figure B2 NASA form 1346 (continued)

SECTION III - ENGINEERING INFORMATION

TABLE III.6-2 (Contd)

Constraint	Value
	Salt Spray - Salt atmosphere as encountered in coastal areas, the effect of which is simulated by exposure to a 5% NaCl solution (by weight) for 48 hours Ozone - 18 months exposure, including 72 hours at 0.5 PPM, 3 months at 0.25 PPM, and the remainder at 0.05 PPM Meteroid - The meteriod environment that shall be used for the Primate Spacecraft design is as follows: Flux, Mass: Log N = -1.34 log m + log S - 10.423 Where N = number of impacts per square foot per day m = mass in grams S = seasonal viriation Log = Log Base 10 Density: 0.5 gm/cc, all particle sizes Average Geocentric Velocity: 30 km/sec, all particle sizes The flux-mass relationship stated above is shown graphically in Figure III.6-1
10. Acceleration	Axial launch accelerations for both booster stages are shown in Figure III. 6-2. Lateral acceleration during the launch period does not exceed $\pm$ 0.8 g.

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Figure B2 NASA form 1346 (continued)

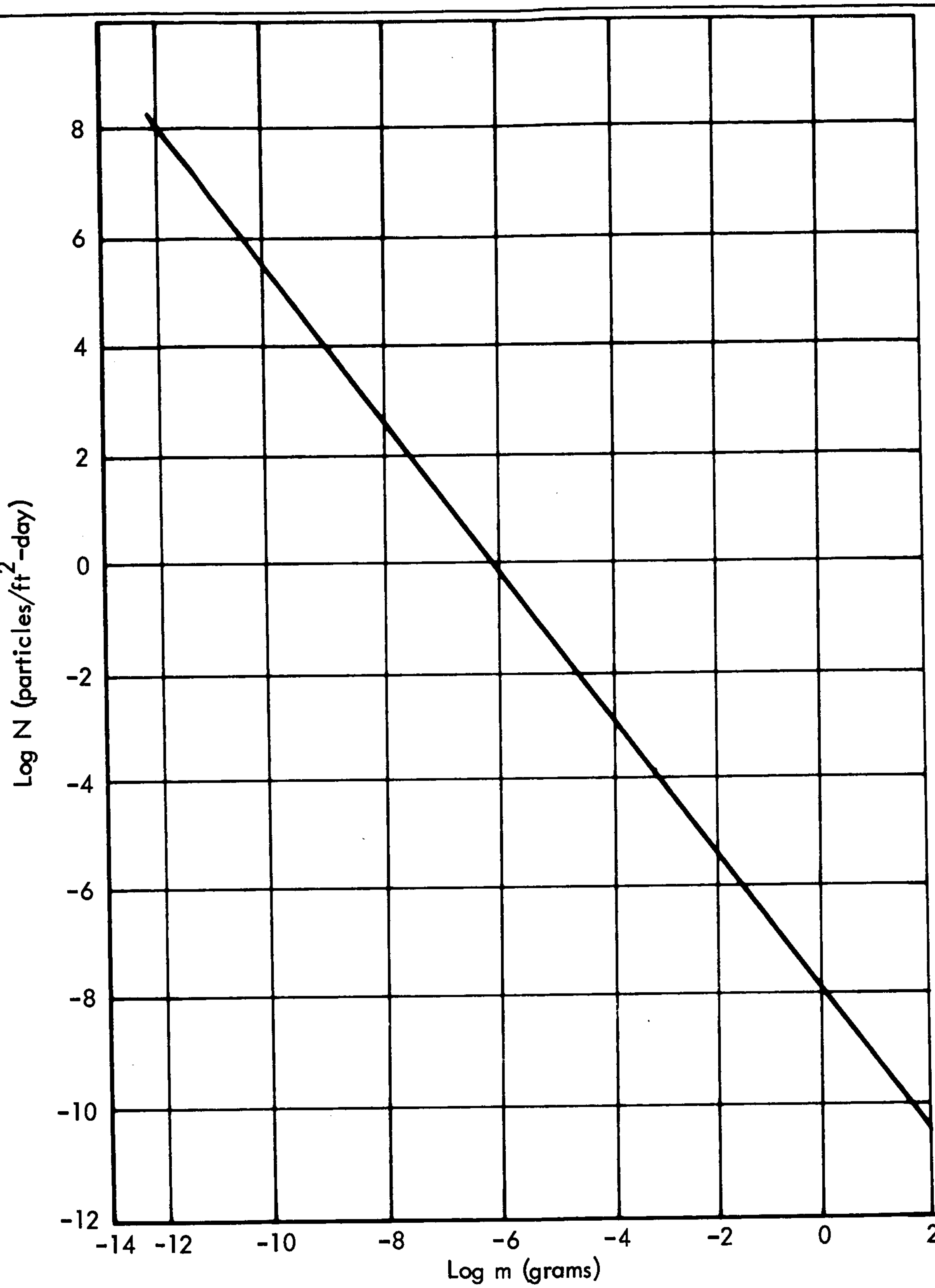

Figure III.6-1. Near earth and cislunar primary meteoroid environment (S = 1)

Figure B2.– NASA form 1346 (continued)

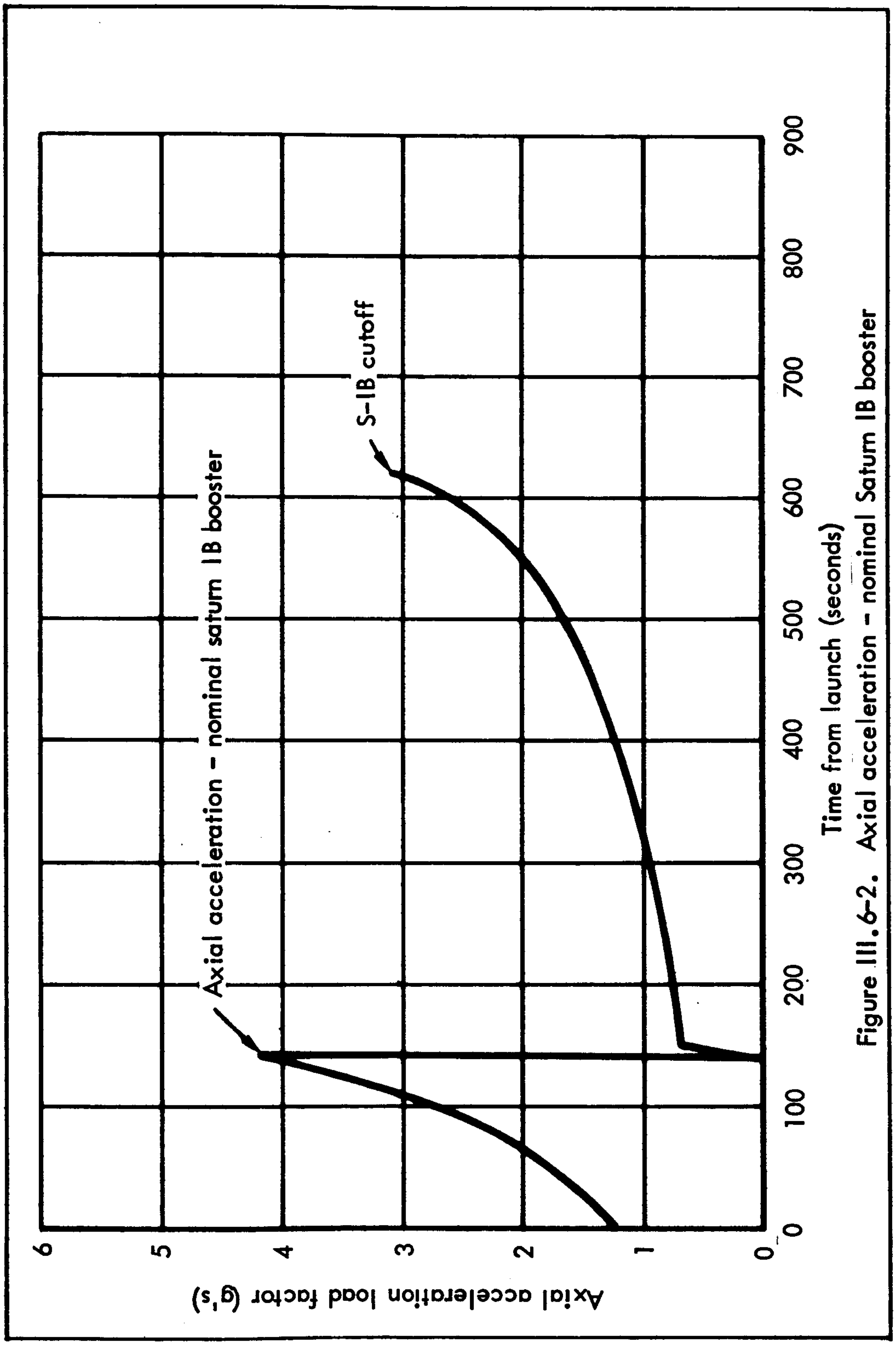

Figure III.6-2. Axial acceleration - nominal Saturn IB booster

Figure B2. - NASA form 1364 (continued)

TABLE III.6-2 (Contd)

Constraint	Value
11. Acceleration	0.001 g any axis with 0.01 g transients
12. Acceleration	The axial CM decelaration values versus entry time are shown in figure III.6-3
13. Vibration	Sinusoidal, 500 CPS ± 6.0 g maximum
14. Vibration	Launch vibrations for the Primate Spacecraft are shown in figure III.6-4
15. Vibration	The design vibration levels for the CM are presented in figure III.6-5
16. Noise	Intense broad-band random acoustic noise levels will exist within the SLA due to the Saturn IB engine noise at liftoff and during the transonic and max-q portions of flight due to aerodynamic turbulence along the SLA surface. A time history of the overall level is shown in figure III.6-6. Transonic and max-q levels are attenuated from the vibration effects due to the reduced pressure and acoustic radiation impedance in the SLA at altitude. The octave band acoustic noise spectrum at liftoff is shown in figure III.6-7. Attenuated noise levels internal to the Primate Spacecraft are shown in figure III.6-8.

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Figure B2 NASA form 1346 (continued)

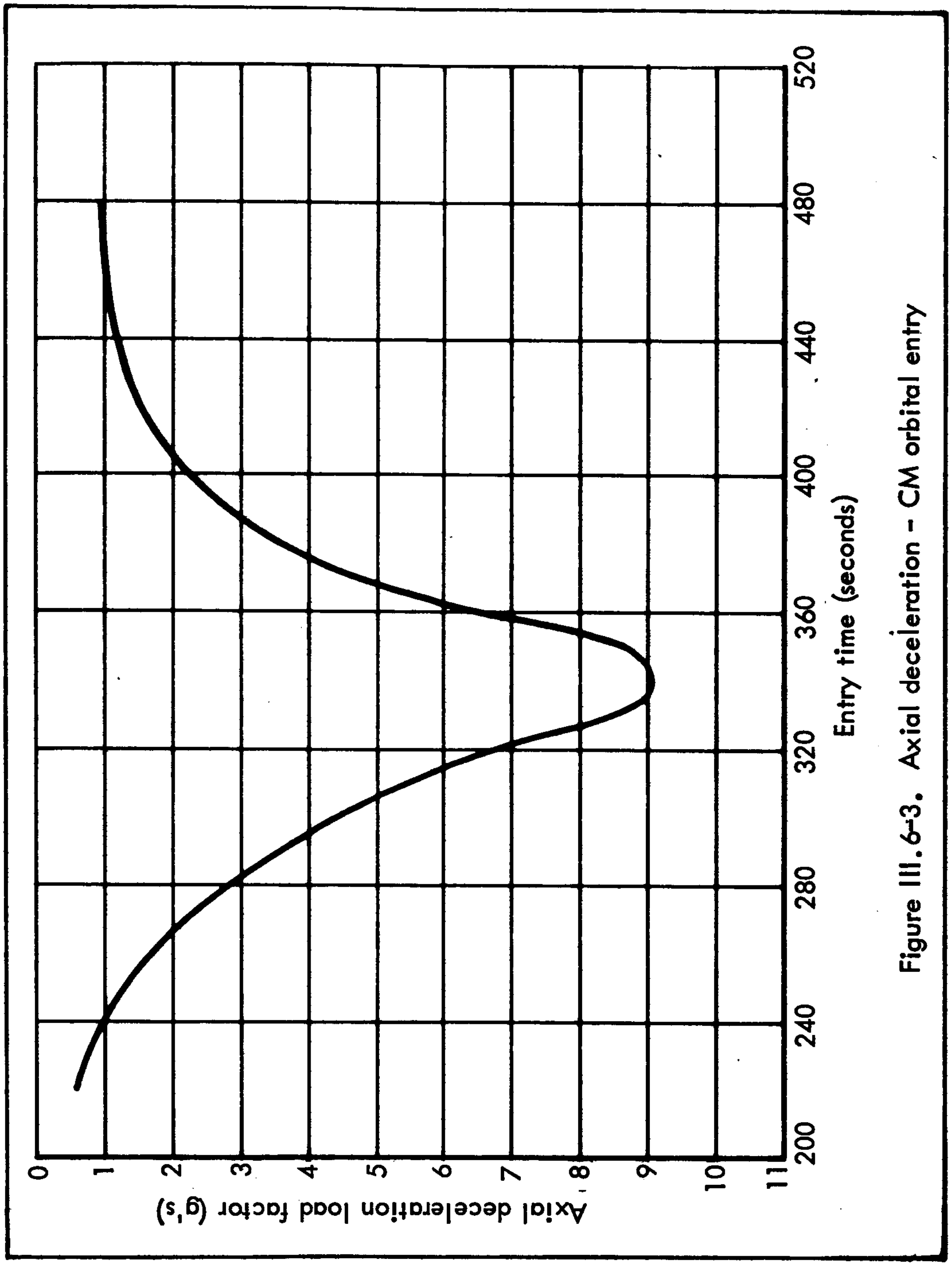

Figure B2. - NASA for 1346

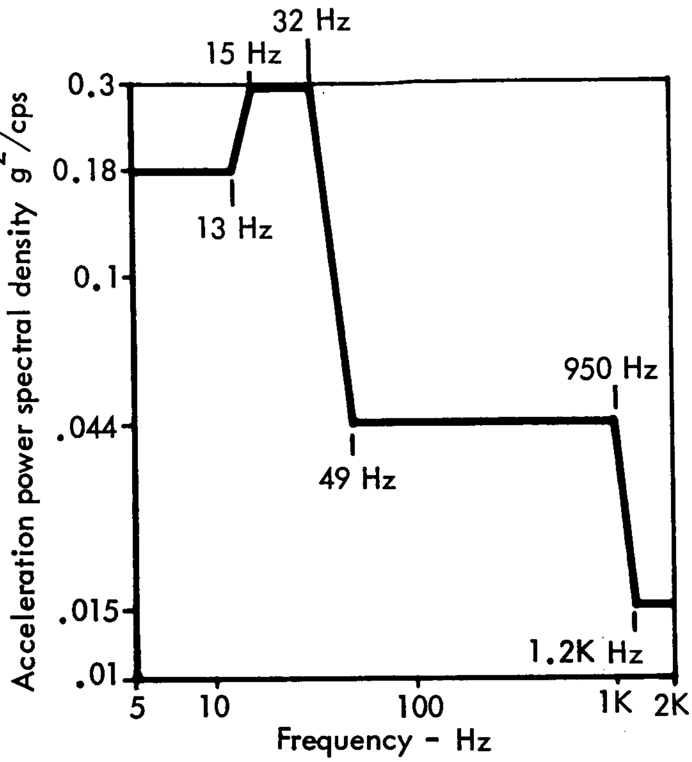

Figure III.6-4. LEM internal equipment vibration levels (per GAEC spec. LED-520)

Figure B2. - NASA form 1346 (continued)

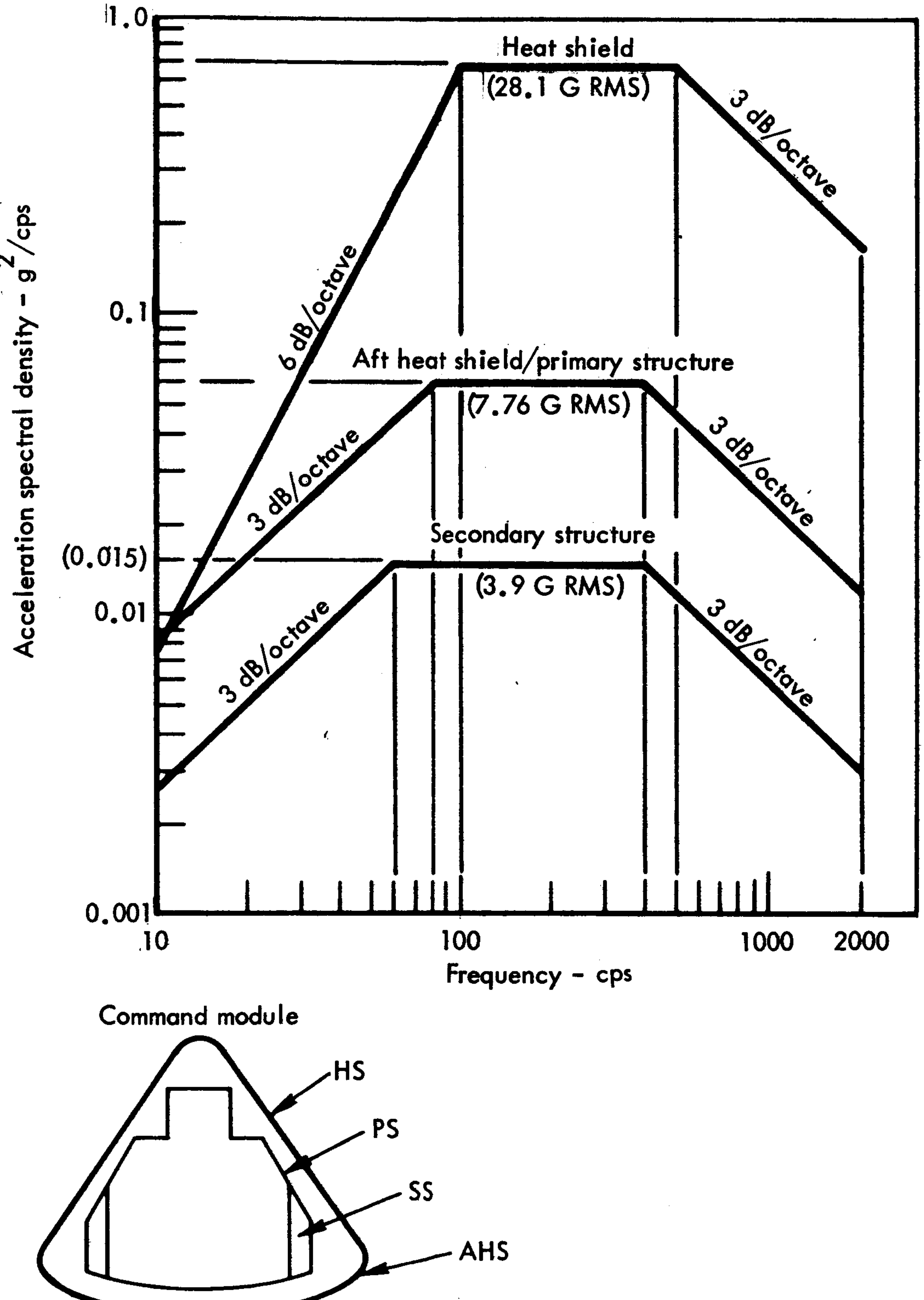

Figure III.6-5. - Vibration CM - atmospheric flight

Figure B2. - NASA form 1346 (continued)

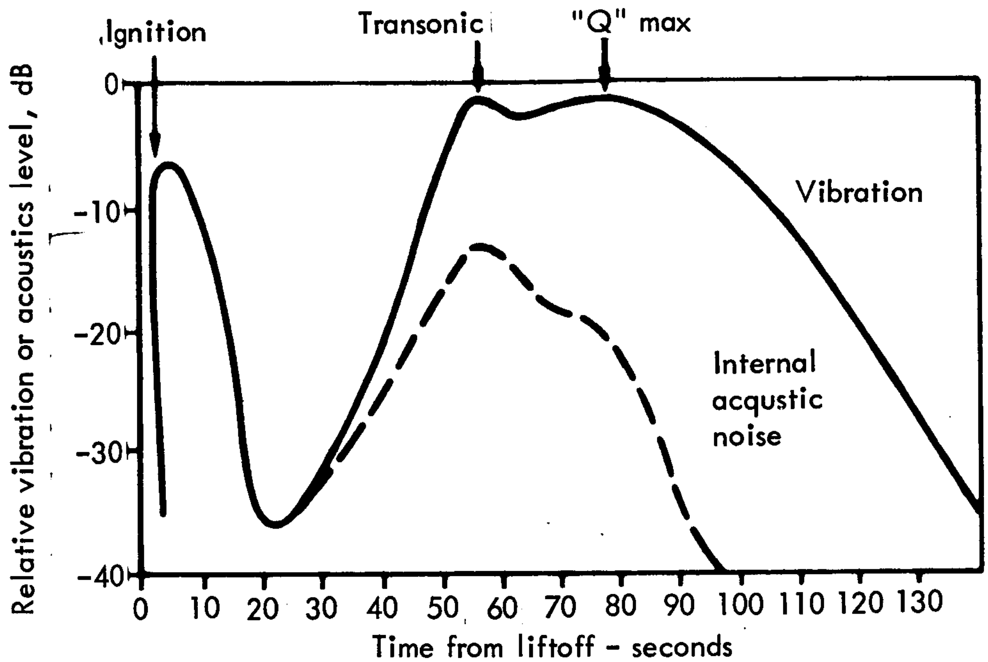

Figure III.6-6. Relative overall acoustic and vibration levels during launch phase

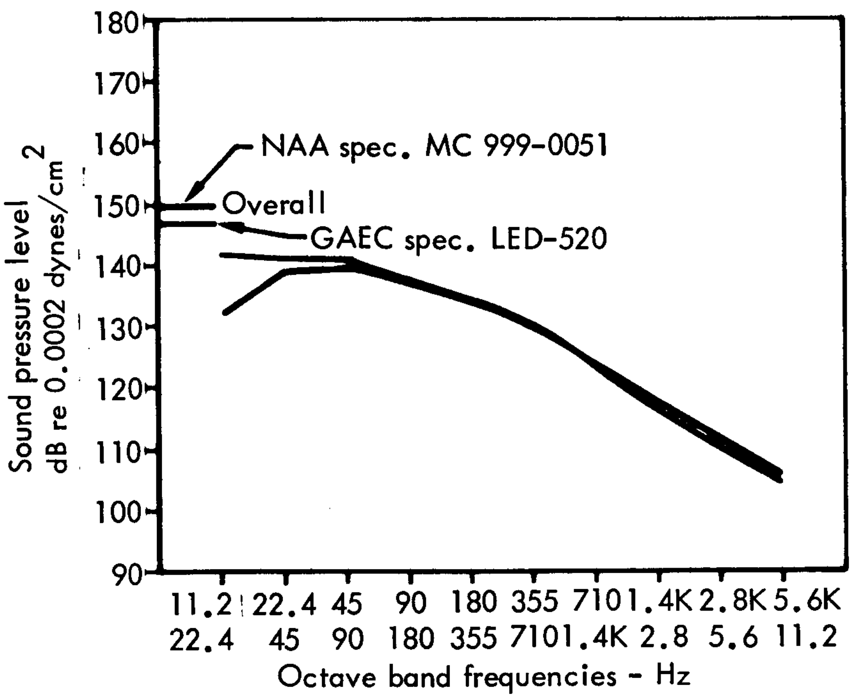

Figure III.6-7. - Launch acoustic spectrum internal to SLA

Figure B2. - NASA form 1346 (continued)

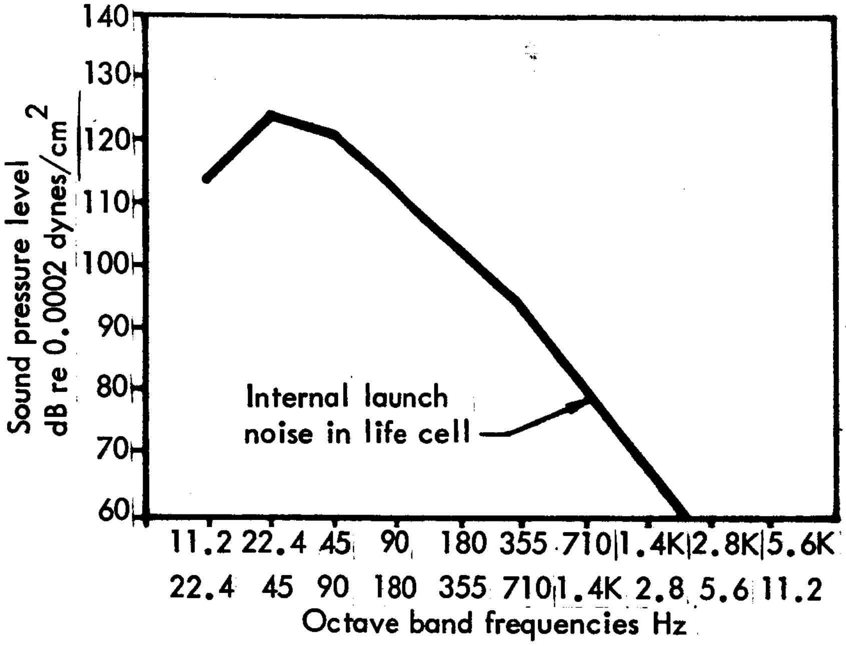

Figure III.6-8. Launch acoustic noise in life cell

Figure B2. - NASA form 1346 (continued)

SECTION III - ENGINEERING INFORMATION

TABLE III.6-2 (Contd)

Constraint	Value
17. Noise	The design acoustic levels for the CM interior are presented on figure III. 6-9 when uniformly reduced by 10 db.
18. Noise	0 to 150 db broadband
19. Radiation	Sunshine - Solar radiation = 360 BTU/ft^2/hour for 6 hours/day for 2 weeks
20. Radiation	Space Sink 0°R Direct Solar Radiation 442 BTU/ft^2/hr Earth Emission 73 BTU/ft^2/hr Earth Reflection 168 BTU/ft^2/hr
21. Radiation	Based on a 250 n. mi., 28.5° inclination circular orbit the following particle intensities apply: Proton $I_p = 2.63 \times 10^6$ protons/cm^2/day E = 40Mev Electron $I_e = 7.9 \times 10^9$ electrons/cm^2/day E = 0.5 Mev. Proton and electron energy spectra for a 250 n. mi. 28.50 inclination circular orbit were analyzed in particle penetration computer programs yielding unit dose in tissue as a function of aluminum thickness. The dose was normalized to particle/cm^2 -sec with energy greater than 40 Mev for protons and 0.5 Mev for electrons.

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Figure B2 NASA form 1346 (continued)

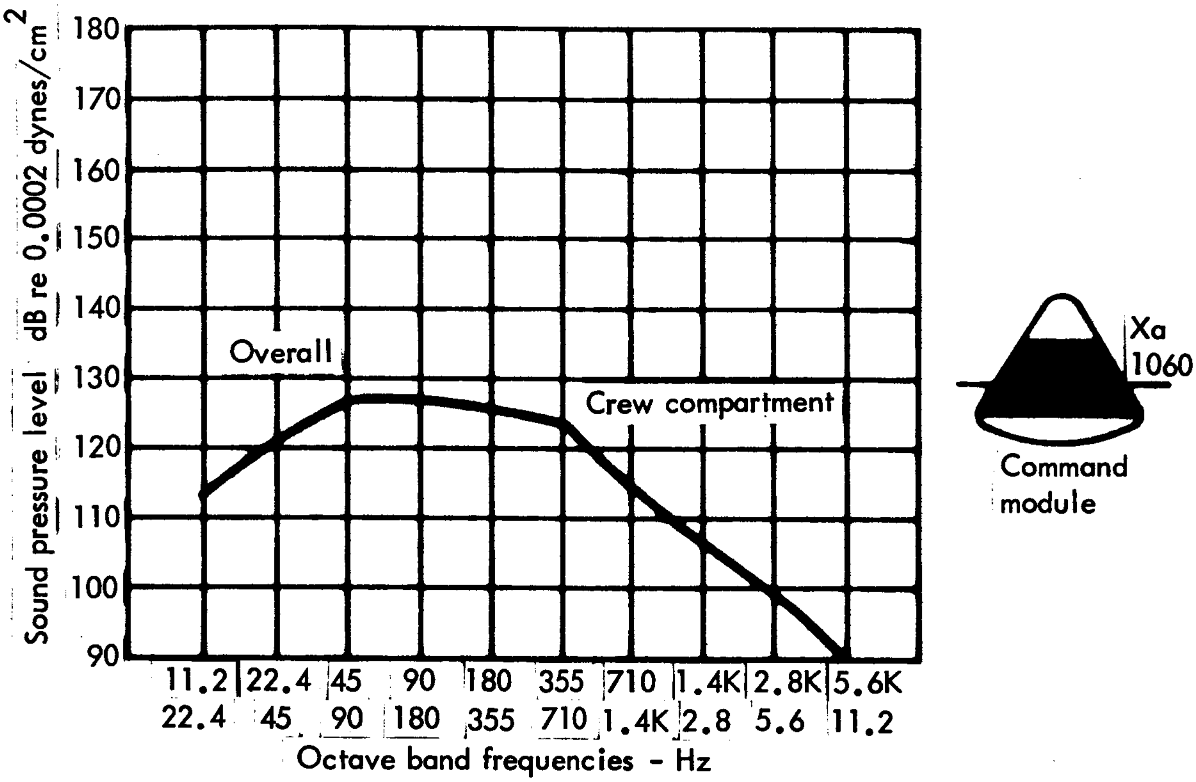

Figure III.6-9.- Acoustics CM - atmospheric flight - crew compartment

Figure B2. - NASA for 1346 (continued)

TABLE III.6-2 (Concluded)

Constraint	Value
21. Radiation (Contd)	Assuming these spectra to be typical for the 250 n. mi. orbit, the above intensities can be combined to develop Figure III.6-10, a plot of dose versus aluminum thickness for a one-year period.
22. EMI	Per MIL-STD-826, MIL-E-6051D, MIL-B-5087.

7. DATA MEASUREMENTS REQUIREMENTS

The data required during the experiment and the measurement characteristics are listed in Table III.7-1.

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Figure B2 NASA form 1346 (continued)

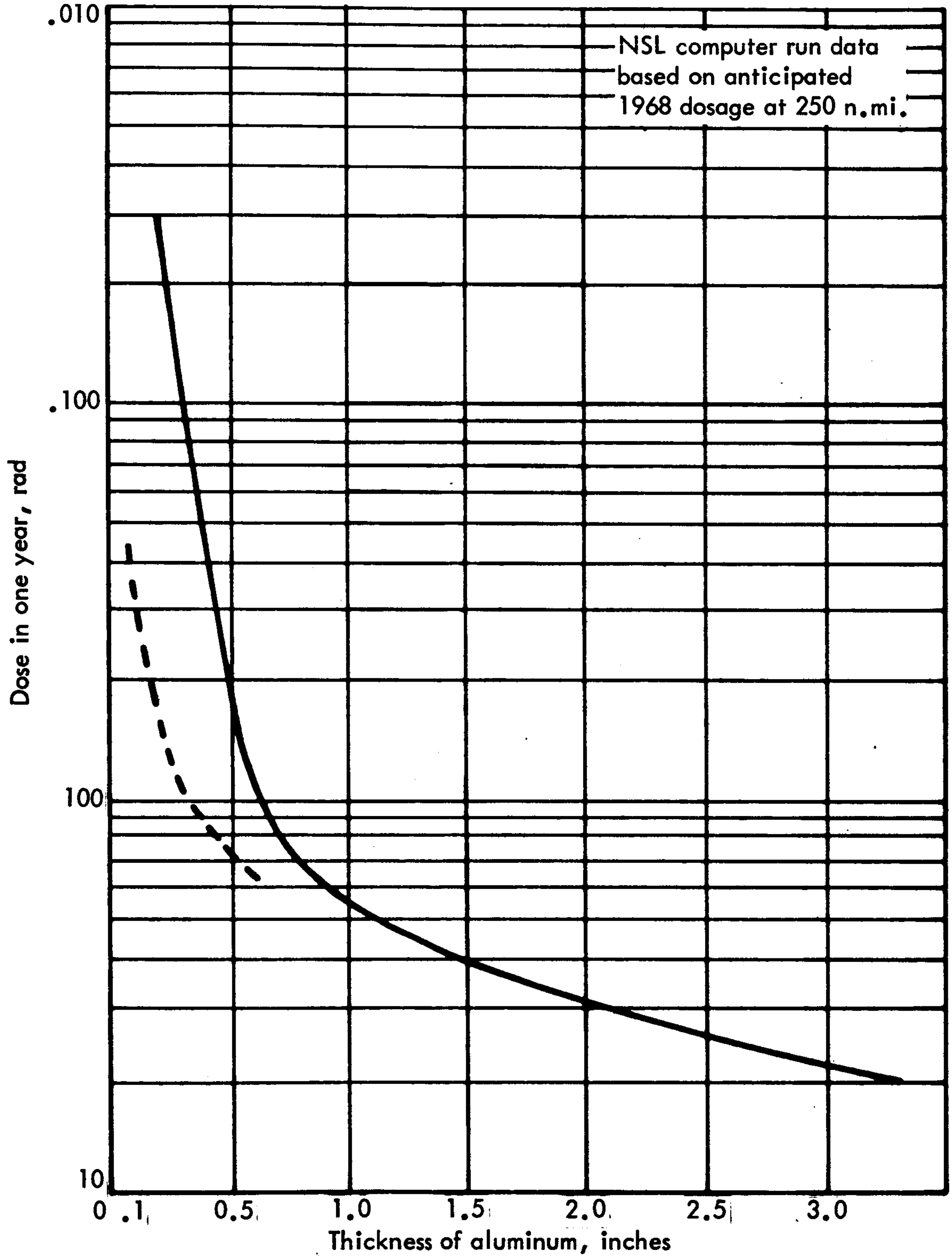

Figure III.6-10. Estimated dose versus Al thickness for 1 year 250 n.mi., 28.5° circular orbit

Figure B2. - NASA form 1346 (continued)

TABLE III.7-1 EXPERIMENT DATA REQUIREMENTS
ORBIT PHASE

LEGEND

Type:	A - Analog
	E - Event
	D - Digital
Use:	P - Performance (Past)
	C - Control (Present)
	D - Diagnosis (Future)
Origin:	B - Biological
	E - Engineering
	M - Mission
Accuracy:	Refers to accuracy from pickup to receipt on the ground.
Observations:	Refers to the number of times that the function must be monitored each specified time interval.
Sampled Period:	Refers to the period of time that the function must be measured during each observation.
Min-Max Frequency:	Refers to minimum and maximum frequency components of the signal. For events this refers to the minimum and maximum number of events per specified time period.
PI Review Schedule:	Recommended interval for review of data by Principal Investigator and staff.
Rating:	Q - Refers to quick look data transmitted in real time as the S/C comes within range.
	1 - Refers to that primary information of a time dependent nature that must be accumulated to preclude significant experiment continuity degradation.
	2 - Refers to that secondary information that may be gathered at times of opportunity. Intermittent loss of this data will not significantly affect experiment continuity.

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Figure B2 NASA form 1346 (continued)

TABLE III.7.1 (Continued)

Sub-area	No.	Name	Type A	Type E	Type D	Use P	Use C	Use D	Origin B	Origin E	Origin M	Parameter range	Accuracy	Observa-tions	Sampled Period	Min-max Frequency	PI review schedule	Rating	Remarks
Life support	D1	O_2 Quantity	X			X		X		X		0-140 liters	±2%	4/day	1 sec	dc	2/week	1	Determine use and leak by PI
	D2	N_2 Quantity	X			X		X		X		0-47 liters	±2%	4/day	1 sec	dc	2/week	1	
Environmental control unit	D3	O_2 Pressure	X			X		X		X		0-50 psia	±1psia	4/day	1 sec	dc	2/week	2	
	D4	N_2 Pressure	X			X		X		X		0-50 psia	±1psia	4/day	1 sec	dc	2/week	2	
	D5	Life cell pressure	X			X	X	X	X			12.7-16.7psia	±0.2psia	4/day	5 min	0-0.12 cph	1/day	1	Verify maintenance of living conditions required by PI
	D6	pO_2	X			X	X	X	X			140-180 mmH_g	±1%	4/day	5 min	0-0.12 cph	1/day	1	
	D7	pCO_2	X			X		X	X			0-5 mmH_g	±1%	4/day	5 min	0-0.12 cph	1/day	1	Verify evacuation at mission end
	D8	pN_2	X			X	X	X	X			580-620 mmH_g	±1%	4/day	5 min	0-0.12 cph	1/day	1	
	D9	Humidity	X			X		X	X			45-75% 35-80%	±5% ±5%	1/hr	1 sec	0-0.12 cph	1/day	1	Not to exceed 2 days
	D10	Spare																	
	D11	LC air temperature	X			X	X	X	X			70-90°F	±0.2°F	1/5min	6 sec	0-1° F/min	1/day	1	
	D13	Contam cont fan pressure change	X			X	X	X		X		0-3 in H_2O	±2%	1/day	1 sec	dc	1/week	2	Verify proper flow through contam cont bed
	D14	Main fan pressure change	X			X	X	X	X			0-2 in H_2O	±2%	4/day	1 sec	dc	2/week	2	Verify proper circulation through life cell
	D15	Temp before main fan	X			X	X	X		X		75-100°F	±0.2°F	1/day	5 sec	0-1° F/min	1/week	1	
	D16	Condenser temp (gas)	X			X		X		X		40-60° F	±2°F	1/day	5 sec	0-1° F/min	1/week	2	
	D17	Spare																	
	D18	Pump pressure change	X			X	X	X		X		0-10 psia	±2%	1/day	1 sec	dc	1/week	2	
	D20	Contam cont fan 1 curr		X		X		X		X		on-off		1/week	1 sec	dc	1/week	2	
	D21	Contam cont fan 2 curr		X		X		X		X		on-off		1/week	1 sec	dc	1/week	2	Determine which fan is selected and that it is actually operative
	D22	Contam cont fan 3		X		X		X		X		on-off		1/week	1 sec	dc	1/week	2	
	D23	Main fan 1 current		X		X		X		X		on-off		1/week	1 sec	dc	1/week	2	Determine which fan is selected that it is actually operative
	D24	Main fan 2 current		X		X		X		X		on-off		1/week	1 sec	dc	1/week	2	
	D25	Main fan 3 current		X		X		X		X		on-off		1/week	1 sec	dc	1/week	2	
	D29	O_2 flow rate	X			X		X	X			0-1b/day	±2%	1/5 min	2 sec	0-0.1 cph	2/week	1	Metabolic use and leak rates
	D30	N_2 flow rate	X			X		X	X			0-1 lb/day	±2%	1/5 min	2 sec	0-0.1 cph	2/week	1	
	D31	Spare																	
	D32	Spare																	
	D33	Spare																	
	D34	H/E outlet gas temp	X			X		X		X		50-75°F	±2°F	1/day	5 sec	0-1°F/min	1/week	2	Equipment and metabolic heat loads
	D35	Condenser freon temp	X			X	X	X		X		35-55°F	±2°F	1/day	5 sec	10 cph	1/week	2	Verify performance

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Figure B2 NASA form 1346 (continued)

TABLE III.7.1 (Continued)

Sub-area	No.	Name	Type A	Type E	Type D	Use F	Use C	Use D	Origin B	Origin Z	Origin M	Parameter range	Accuracy	Observations	Sampled period	Min-max frequency	PI review schedule	Rating	Remarks
Life cell	D36	Wall charge a on		X		X		X	X			yes-no		1/5 min	as occurs	dc	1/week	1	Monitor wall charge
	D37	Wall charge b on		X		X		X	X			yes-no		1/5 min	as occurs	dc	1/week	1	
	D38	Wall position a	X			X		X	X			0-110°	±5°	1/5 min	2 min	90°/min	1/week	1	Monitor wall position
	D39	Wall position b	X			X		X	X			0-110°	±5°	1/5 min	2 min	90°/min	1/week	1	
	D40	Spare																	
	D188	Exercisor force a	X			X		X	X			1/8 - 5 lb	±5%	as occurs	30 sec	0.16-0.33/hr	2/week	1	Primate health
	D189	Exercisor force b	X			X		X	X			1/8 - 5 lb	±5%	as occurs	30 sec	0.16-0.33/hr	2/week	1	
	D190	Exercisor time a			X	X		X	X			0 to 30 sec	±1%	as occurs	30 sec	0.16-0.33/hr	2/week	1	
	D191	Exercisor time b			X	X		X	X			0 to 30 sec	±1%	as occurs	30 sec	0.16-0.33/hr	2/week	1	
Feeder	D41	Food delivered a		X		X		X	X			yes-no		when occur	once	dc	1/day	1	Required by PI verify food delivery
	D42	Time food delivered a			X	X		X	X			see D68	±0.01sec	when occur	once	0.008-0.5/sec	1/day	1	Required by PI behavioral response
	D43	Ram mtr current a	X			X		X		X		0 to 1.0 amp	±5%	1/day	once	dc	1/week	2	Ram friction
	D44	Capstan mtr current a	X			X		X		X		0 to 1.0 amp	±5%	1/day	once	dc	1/week	2	Food tube tension
	D45	Drum torque mtr time a			X	X		X		X		see D63		1/day	2 sec	0.008-0.5/sec	1/week	2	Verify proper movement, tension and operation of transport mechanism
	D46	Reel takeup mtr time a			X	X		X		X		see D63		1/day	2 sec	0.008-0.5/sec	1/week	2	
	D47	Pulloff drum mtr time a			X	X		X		X		see D63		1/day	2 sec	0.008-0.5/sec	1/week	2	
	D48	Food delivered b		X		X		X	X			yes-no		when occurs	once	dc	1/day	1	Required by PI verify food delivery
	D49	Time food delivered b			X	X		X	X			see D85	±0.01sec	when occurs	once	0.008-0.5/sec	1/day	1	Required by PI behavioral response
	D50	Ram mtr current b	X			X		X		X		0to 1.0 amp	±5%	1/day	once	dc	1/week	2	Ram friction
	D51	Capstan mtr current	X			X		X		X		0to 1.0 amp	±5%	1/day	once	dc	1/week	2	Food tube tension
	D52	Drum torque mtr time b			X	X		X		X		See D80		1/day	2 sec	0.008-0.5/sec	1/week	2	Verify proper movement, tension and operation of transport mechanism
	D53	Reel takeup mtr time b			X	X		X		X		See D80		1/day	2 sec	0.008-0.5/sec	1/week	2	
	D54	Pulloff drum mtr time b			X	X		X		X		See D80		1/day	2 sec	0.008-0.5/sec	1/week	2	
Waterer	D55	Storage pressure a	X			X	X	X		X		40-60	±5 psia	1/day	once	dc	1/week	2	Verify storage conditions
	D56	Water delivered a		X		X		X	X			Yes-no		as occurs	1 sec	0.01-10/sec	1/day	1	Verify delivery of water
	D57	Delivery time a			X	X		X	X			See D68	±0.01 sec	as occurs	once	0.01-10/sec	1/day	1	Required by P. I. behavioral response
	D58	Water volume a	X		X			X	X			0-152 liters	±5 liters	1/day	once	dc	2/week	1	Use rate
	D59	Storage pressure b	X			X	X	X		X		40-60 psia	±5 psia	1/day	once	dc	1/week	2	Verify storage conditions
	D60	Water delivered b		X		X		X	X			Yes-no		as occurs	1 sec	0.01-10/sec	1/day	1	Verify delivery of water

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Figure B2 NASA form 1346 (continued)

TABLE III.7.1 (Continued)

Sub-area	No.	Name	Type A	Type E	Type D	Use P	Use C	Use D	Origin B	Origin E	Origin M	Parameter range	Accuracy	Observations	Sampled period	Min-max frequency	P I review schedule	Rating	Remarks
Waterer (cont)	D61	Delivery time b				X		X	X			See D85	±0.01 sec	as occurs	once	0.01-10/sec	1/day	1	Required by P. I. behavioral response
	D62	Water volume b	X			X		X	X			0-152 liters	±5 liters	1/day	once	dc	2/week	1	Use rate
Behavioral panel	D63	Food prox time a			X	X	X	X	X			See D68	±0.01 sec	as occurs	once	0.01-10 sec	1/day	1	Behavioral response, ref. time for D45-D47
	D64	Water prox time a			X	X	X	X	X			See D68	±0.01 sec	as occurs	once	0.01-10 sec	1/day	1	Behavioral response, ref. time for D57
	D65	Spare																	
	D216	Vig handle a			X	X	X	X	X			See D68	±0.01 sec	as occurs	once	0.02-10/sec	1/day	1	Behavioral response (D216, D66, D217, D67)
	D66	Tim handle a			X	X	X	X	X			See D68	±0.01 sec	as occurs	once	0.02-10/sec	1/day	1	
	D217	Vig handle b			X	X	X	X	X			See D35	±0.01 sec	as occurs	once	0.02-10/sec	1/day	1	
	D67	Ilk handle a			X	X	X	X	X			See D68	±0.01 sec	as occurs	once	0.01-10/sec	1/day	1	
	D68	Blue stimulus A			X	X	X	X	X			on-off	±0.1 sec	as occurs	once	0.05-0.5/sec	1/day	1	Behavioral response, ref. time for D71, D72, D42, D57, D63-D67, D192, D193, D188, D189, D190, D191 (D68, D69, D218, D70, D219)
	D69	Yellow stimulus A			X	X	X	X	X			on-off	±0.1 sec	as occurs	once	0.02-10/sec	1/day	1	
	D218	Green stimulus A			X	X	X	X	X			on-off	±0.1 sec	as occurs	once	0.02-10/sec	1/day	1	
	D70	Red stimulus A			X	X	X	X	X			on-off	±0.1 sec	as occurs	once	0.01-10/sec	1/day	1	
	D219	Green stimulus B			X	X	X	X	X			on-off	±0.1 sec	as occurs	once	0.02-10/sec	1/day	1	
	D71	Reward lights A			X	X	X	X	X			see D68	±0.01 sec	as occurs	once	0.01-10/sec	1/day	1	Reward available indicators secondary reinforcement
	D72	Deliver reward A			X	X	X	X	X			see D68	±0.01 sec	as occurs	once	0.01-0.5/sec	1/day	1	Activate proximity trigger switches
	D73	Spare																	
	D74	Spare																	
	D75	Panel activated A		X		X	X	X	X			yes-no		1/hr	once	DC	1/day	2	State of panel to avoid inadvertent deprivation
	D76	TIM task time A			X	X	X	X	X			0.1-60 sec	±0.01 sec	1/day	once	0.01-10/sec	1/week	2	Panel status task requirements to be reviewed prior to commanding change (D76, D79)
	D77	Spare																	
	D78	Spare																	
	D79	ILK ratio A			X	X	X	X	X			0-100 responses		1/day	once		1/week	2	
	D220	VIG ref tone A			X	X	X	X	X			2 sec	±0.1 sec	as occurs	2/sec	6/sec	1/day	1	
	D221	VIG ref tone B			X	X	X	X	X			2 sec	±0.1 sec	as occurs	2/sec	6/sec	1/day	1	
	D80	Food prox time B			X	X	X	X	X			see D85	±0.01 sec	as occurs	once	0.01-10/sec	1/day	1	Ref time for D52-D54
	D81	Water prox time B			X	X	X	X	X			see D85	±0.01 sec	as occurs	once	0.01-10/sec	1/day	1	Ref time for D61
	D82	Spare																	
	D83	TIM handle B			X	X	X	X	X			see D85	±0.01 sec	as occurs	once	0.02-10/sec	1/day	1	
	D84	ILK handle B			X	X	X	X	X			see D85	±0.01 sec	as occurs	once	0.01-10/sec	1/day	1	
	D85	Blue stimulus B			X	X	X	X	X			on-off	- - -	as occurs	once	0.05-0.5/sec	1/day	1	Ref time for D49, D61, D80-D84, D88

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Figure B2 NASA form 1346 (continued)

TABLE III.7.1 (Continued)

Sub-area	No.	Name	Type A	Type E	Type D	Use P	Use C	Use D	Origin B	Origin E	Origin M	Parameter range	Accuracy	Observa-tions	Sampled period	Min-max frequency	P I review schedule	Rating	Remarks
Behav-ioral panel (cont)	D86	Yellow stimulus B			X	X	X	X	X			on-off	- - -	as occurs	once	0.02-10/sec	1/day	1	Ref time for D49, D61, D80-D84, D88
	D87	Red stimulus B			X	X	X	X	X			on-off	- - -	as occurs	once	0.01-10/sec	1/day	1	
	D88	Reward lights B			X	X	X	X	X			see D85	±0.01 sec	as occurs	once	0.01-10/sec	1/day	1	
	D89	Deliver reward B			X	X	X	X	X			see D85	±0.01 sec	as occurs	once	0.01-0.5/sec	1/day	1	
	D90	Spare																	
	D91	Spare																	
	D92	Panel activated B		X		X	X	X	X			yes-no	- - -	1/hr	once	dc	1/day	2	
	D93	TIM task time B			X	X	X	X	X			0.1-60 sec	- - -	1/day	once	0.01-10/sec	1/week	2	
	D94	Spare																	
	D95	Spare																	
	D96	ILK ratio B			X	X	X	X	X			0-100 responses	±0.1 sec	as occurs	once	- - -	1/week	2	
	D222	VIG test tone A			X	X	X	X	X			2 sec	±0.1 sec	as occurs	2 sec	8/sec	1/day	1	Reference onset to onset of D69 and D86
	D223	VIG test tone B			X	X	X	X	X			2 sec	±0.1 sec	as occurs	2 sec	8/sec	1/day	1	
Recovery capsule	D97	RC door open A		X		X	X	X	X			yes-no	- - -	as occurs	as occurs	dc	as occurs	1	Assure that primate can and does enter capsule and that it is subsequently sealed and habitable
	D98	RC door sealed A		X		X	X	X	X			yes-no	- - -	as occurs	as occurs	dc	as occurs	1	
	D99	RCECU A working		X		X		X	X			yes-no	- - -	as occurs	as occurs	dc	as occurs	1	
	D100	RC lights on A		X		X		X	X			yes-no	- - -	as occurs	as occurs	dc	as occurs	1	Information must go to astronaut
	D101	RC door open B		X		X	X	X	X			yes-no	- - -	as occurs	as occurs	dc	as occurs	1	
	D102	RC door sealed B		X		X	X	X	X			yes-no	- - -	as occurs	as occurs	dc	as occurs	1	Reference time for sampled period is receipt of command to start recover
	D103	RCECU B working		X		X		X	X			yes-no	- - -	as occurs	as occurs	dc	as occurs	1	
	D104	RC lights on B		X		X		X	X			yes-no	- - -	as occurs	as occurs	dc	as occurs	1	
Mass/volume measure-ment device	D105	M/V door open A		X		X	X	X	X			yes-no	- - -	1/day	20 sec	dc	1/week	2	Verify operation of device and consequent validity of measurement without primate followed by measurement with primate in device.
	D106	M/V door closed A		X		X	X	X	X			yes-no	- - -	1/day	20 sec	dc	1/week	2	
	D107	M/V measurement A	X			X		X	X			4-8 Kg	±1%	4/day	1 min	0-10/sec	as occurs	1	Verify operation of device and consequent validity of measurement without primate followed by measurement with primate in device.
	D108	M/V door open B		X		X	X	X	X			yes-no	- - -	1/day	20 sec	dc	1/week	2	
	D109	M/V door closed B		X		X	X	X	X			yes-no	- - -	1/day	20 sec	dc	1/week	2	
	D110	M/V measurement B	X			X		X	X			4-8 Ks	±1%	4/day	1 min	0-10/sec	as occurs	1	Ref time for sampled period is command to start M/V routine.

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Figure B2 NASA form 1346 (continued)

TABLE III.7.1 (Continued)

Sub-area	No.	Name	Type A	Type E	Type D	Use P	Use C	Use D	Origin B	Origin E	Origin M	Parameter range	Accuracy	Observa-tions	Sampled period	Min-max frequency	P I review schedule	Rating	Remarks
Thermal control	D111	Radiator temp	X			X		X		X		-200-450°F	±5°F	4/day	1 sec	0.67 cph	1/week	1	Evaluate performance
	D112	By pass temp	X			X	X	X		X		60-80°F	±1°F	4/day	1 sec	0.67-0.05cph	1/week	1	
	D113	Spare																	
	D114	Spare																	
	D12	FC-75 pressure	X			X		X		X		0-10 psia	±2%	1/day	1 sec	0-15 cpm	1/week	2	Evaluate leakage
	D19	FC-75 quantity	X			X	X	X		X		0-1 liter	±2%	1/day	1 sec	dc	1/week	2	Detect leak or meteoroid puncture
	D26	Pump 1 current		X		X		X		X		on-off	- - -	1/week	1 sec	dc	1/week	2	Determine which pump is selected and that it is actually operative
	D27	Pump 2 current		X		X		X		X		on-off	- - -	1/week	1 sec	dc	1/week	2	
	D28	Pump 3 current		X		X		X		X		on-off	- - -	1/week	1 sec	dc	1/week	2	
Structure and mechanical	D115	Attachment A release		X		X		X			X	yes-no	- - -	when occurs	once	dc	when occurs	1	Verify S/C separation
	D116	Attachment B release		X		X		X			X	yes-no	- - -	when occurs	once	dc	when occurs	1	
	D117	Attachment C release		X		X		X			X	yes-no	- - -	when occurs	once	dc	when occurs	1	
	D118	Attachment D release		X		X		X			X	yes-no	- - -	when occurs	once	dc	when occurs	1	
	D119	Solar panel A deployed		X		X		X		X		yes-no	- - -	when occurs	once	dc	when occurs	1	Verify solar panel deployment
	D120	Solar panel B deployed		X		X		X		X		yes-no	- - -	when occurs	once	dc	when occurs	1	
	D121	Separation		X		X		X			X	yes-no	- - -	when occurs	once	dc	when occurs	1	
	D224	Solar panel C deployed		X		X		X		X		yes-no	- - -	when occurs	once	dc	when occurs	1	Verify solar panel deployment
	D225	Solar panel D deployed		X		X		X		X		yes-no	- - -	when occurs	once	dc	when occurs	1	
Instru-mentation	D122	EKG waveform A	X			X		X	X			-11 to +11MV	±2%	1/4 hr	5 min	0.1-100 Hz	1/day	1	
	D123	Temperature A	X			X		X	X			95-105°F	±0.2°F	12/hr	once	dc	1/day	1	Required by P.I.
	D124	Respiratory rate A			X	X		X	X			20-60 bpm	±1breath	12/hr	once	20-60bpm	1/day	1	Primate Health
	D125	Activity A			X	X		X	X			4 quadrants	- - -	1/min	once	10,000 to 40,000 per day	1/day	1	
	D126	Primate voice A	X		X	X		X	X			20-20,000 Hz	- - -	as occurs	contin-uous	20-20,000Hz	1/day	1	Voice Key
	D127	EKG waveform B	X			X		X	X			-10 to +10 MV	±2%	1/4 hr	5 min	0.0-100 Hz	1/day	1	
	D128	Temperature B	X			X		X	X			95-105°F	±0.2°F	12/hr	once	dc	1/day	1	
	D129	Respiratory rate B			X	X		X	X			20-60 bpm	±1breath	12/hr	once	20-60 bpm	1/day	1	
	D130	Activity B			X	X		X	X			4 quadrants	- - -	1/min	once	10,000 to 40,000 per day	1/day	1	

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Figure B2 NASA form 1346 (continued)

TABLE III.7.1 (Continued)

Sub-area	No.	Name	Type A	Type E	Type D	Use P	Use C	Use D	Origin B	Origin E	Origin M	Parameter range	Accuracy	Observa-tions	Sampled period	Min-max frequency	P I review schedule	Rating	Remarks
Instru-mentation (cont)	D131	Primate voice B	X			X		X	X			20-20,000 Hz	- - -	as occurs	contin-uous	20-20,000Hz	1/day	1	Voice Key
	D132	Accumulated radiation			X	X		X	X			0-10 rads	±5%	1/day	24 hrs	- - -	1/week	1	Require [illegible] P.I.
	D133	TV A	X			X		X	X			10 frames @ 250 lines	5 levels of gray	1 min/day hr 1 min/midnite 1 min/lite out	1 min	40 Hz to 500 KHz	RTOS	1	RTOS (real time over station) Required by P.I. primate condition and behavior
	D134	TV A	X			X		X	X			10 frames @ 250 lines	5 levels of gray	1 min/lite on 30 sec/RTOS	1 min		RTOS	1	
	D135	High light current		X		X		X	X			yes-no	- - -	4/day	once	1 cpd	2/week	1	Assure proper photo period
	D136	Low light current		X		X		X	X			yes-no	- - -	4/day	once	1 cpd	2/week	1	
Telemetry	D137	PCM data switch 1 position			X	X		X		X		1 or 2	- - -	1/day	once	dc	2/week	2	Determine switch position
	D138	PCM data switch 2 position			X	X		X		X		1 or 2	- - -	1/day	once	dc	2/week	2	
	D139	TV amplifier 1 temp	X			X		X		X		+40 to +260°F	±10%	1/day	once	dc	2/week	2	TV TWT amplifiers base-plate temp. when TV on
	D140	TV amplifier 2 temp	X			X		X		X		+40 to +260°F	±10%	1/day	once	dc	2/week	2	
	D141	Data transmitter 1 temp	X			X		X		X		+40 to +260°F	±10%	1/day	once	dc	2/week	2	Data transmitters base plate temp. when on
	D142	Data transmitter 2 temp	X			X		X		X		+40 to +260°F	±10%	1/day	once	dc	2/week	2	
	D143	PCM base temp 1	X			X		X		X		+40 to +120°F	±5%	1/day	once	dc	2/week	2	PCM units base plate temp. when on
	D144	PCM base temp 2	X			X		X		X		+40 to +120°F	±5%	1/day	once	dc	2/week	2	
	D145	Data trans selec-tion SW			X	X	X	X		X		1 or 2	- - -	1/day	once	dc	2/week	2	Switch position
	D146	TV trans selection SW			X	X	X	X		X		1 or 2	- - -	1/day	once	dc	2/week	2	Switch position
	D147	Calibration source input	X			X	X	X		X		28 ± 0.3VDC	±1%	1/day	once	dc	2/week	2	Source input voltage
	D148	PCM unit selection SW			X	X		X		X		1 or 2	- - -	1/day	once	dc	2/week	2	Switch position
	D149	TV switch position			X	X		X		X		1 or 2	- - -	1/day	once	dc	2/week	2	Switch position
Command and control	D150	Command REC AGC 1	X			X	X	X		X		-10 to +10MV	±10%	1/day	once	0 to 1000Hz	2/week	Q	AGC voltage
	D151	Command REC AGC 2	X			X	X	X		X		-10 to +10MV	±10%	1/day	once	0 to 1000Hz	2/week	Q	
	D152	Command REC 1 temp	X			X		X		X		+40 to +120°F	±10%	1/day	once	dc	2/week	2	Command receiver base plate temp when on
	D153	Command REC 2 temp	X			X		X		X		+40 to +120°F	±10%	1/day	once	dc	2/week	2	
	D154	Command decoder temp	X			X		X		X		+40 to +120°F	±10%	1/day	once	dc	2/week	2	Decoder base plate temp
	D155	Programmer temp	X			X		X		X		+40 to +120°F	±10%	1/day	once	dc	2/week	2	Programmer base plate temp
	D156	Central timing temp	X			X		X		X		+40 to +120°F	±10%	1/day	once	dc	2/week	2	Central timing system temp
	D192	Master clock freq			X	X	X	X		X		1 MEG Hz	±0.1%	1/day	once	1.0 ± 0.001 MHZ	2/week	Q	

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Figure B2 NASA form 1346 (continued)

TABLE III.7.1 (Continued)

Sub-area	No.	Name	Type A	Type E	Type D	Use P	Use C	Use D	Origin B	Origin E	Origin M	Parameter range	Accuracy	Observa-tions	Sampled period	Min-max frequency	P I review schedule	Rating	Remarks
Electrical power and cabling	D157	Spare																	
	D158	Spare																	
	D159	Panel 1 current	X			X		X		X		0 to 8 amp	±5%	1/hr	once	2/3 cph	1/week	Q	Efficiency sun orientation in sun or occult
	D160	Panel 2 current	X			X		X		X		0 to 8 amp	±5%	1/hr	once	2/3 cph	1/week	Q	
	D161	Main bus unreg volt	X			X		X		X		24-32 vdc	±5%	1/5 min	once	dc	1/week	Q	Primary power
	D162	Main bus unreg current	X			X		X		X		0-37 amp	±5%	1/5 min	once	dc	1/week	Q	
	D163	115 VAC voltage rectivied	X			X		X		X		105-125 vdc	±5%	1/hr	once	dc	1/week	1	Inverter condition
	D164	Spare																	
	D165	Spare																	
	D166	Panel 1 temp	X			X		X		X		-150 to +140°F	±5%	1/week	once	2/3 cph	1/week	2	Panel condition
	D167	Spare																	
	D168	Spare																	
	D169	Spare																	
	D193	Panel 3 current	X			X		X		X		0 to 8 amp	±5%	1/hr	once	2/3 cph	1/week	Q	Efficiency Sun orientation In sun or occult
	D194	Panel 4 current	X			X		X		X		0 to 8 amp	±5%	1/hr	once	2/3 cph	1/week	Q	
	D170	Secondary batt 1 temp	X			X		X		X		0 to +200°F	±5%	1/hr	once	dc	1/week	1	Battery temperature
	D171	Secondary batt 2 temp	X			X		X		X		0 to +200°F	±5%	1/hr	once	dc	1/week	1	
	D195	Secondary batt 3 temp	X			X		X		X		0 to +200°F	±5%	1/hr	once	dc	1/week	1	
	D196	Secondary batt 4 temp	X			X		X		X		0 to +200°F	±5%	1/hr	once	dc	1/week	1	
	D197	Secondary batt 1 volt	X			X		X		X		21 to 35 vdc	±5%	1/hr	once	dc	1/week	Q	Battery voltage
	D198	Secondary batt 2 volt	X			X		X		X		21 to 35 vdc	±5%	1/hr	once	dc	1/week	Q	
	D199	Secondary batt 3 volt	X			X		X		X		21 to 35 vdc	±5%	1/hr	once	dc	1/week	Q	
	D200	Secondary batt 4 volt	X			X		X		X		21 to 35 vdc	±5%	1/hr	once	dc	1/week	Q	
	D201	Panel 5 current	X			X		X		X		0 to 8 amp	±5%	1/hr	once	2/3 cph	1/week	Q	
	D202	Battery select switch			X	X		X		X		1 or 2	- - -	1/day	once	dc	2/week	2	
	D203	Primary batt 1 volt	X			X		X		X		21 to 35 vdc	±5%	1/day	once	dc	1/week	2	Primary battery condition
	D204	Primary batt 2 volt	X			X		X		X		21 to 35 vdc	±5%	1/day	once	dc	1/week	2	
	D205	Batt charger 1 current	X			X		X		X		0 to 10 amp	±5%	1/hr	once	dc	1/week	Q	Charger condition when charging

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Figure B2 NASA form 1346 (continued)

TABLE III.7.1 (Concluded)

Sub-system	No.	Name	Type A	Type E	Type D	Use F	Use C	Use D	Origin B	Origin E	Origin N	Parameter range	Accuracy	Observations	Sampled period	Min-max frequency	P I review schedule	Rating	Remarks
Electrical power and cabling (cont)	D206	Batt charger 2 current	X			X		X		X		0 to 10 amp	±5%	1/hr	once	dc	1/week	Q	Charger condition when charging
	D207	Batt charger 3 current	X			X		X		X		0 to 10 amp	±5%	1/hr	once	dc	1/week	Q	
	D208	Batt charger 4 current	X			X		X		X		0 to 10 amp	±5%	1/hr	once	dc	1/week	Q	
	D209	400 Hz invert temp	X			X		X		X		+40 to +400°F	±5%	1/day	once	dc	1/week	2	
	D210	2400Hz invert temp	X			X		X		X		+40 to +200°F	±5%	1/day	once	dc	1/week	2	Inverter condition when on
	D211	1600Hz invert temp	X			X		X		X		+40 to +200°F	±5%	1/day	once	dc	1/week	2	
	D212	1600Hz invert volt	X			X		X		X		24 to 32 VAC	±5%	4/day	once	1440-1760Hz	1/week	1	Attitude control gyros input
	D213	ESS REG BUS volt	X			X		X		X		27 to 29 vdc	±1%	1/hr	once	dc	1/week	Q	
	D214	2400Hz invert volt	X			X		X		X		35 VAC	±5%	5/day	once	2260-2660Hz	1/week	1	3 phase
	D215	Main regulator temp	X			X		X		X		+40 to +170°F	±5%	1/day	once	dc	1/week	2	
Attitude control	D172	Sun sensor pair 1	X			X	X	X		X		0.0-1.0 vdc	±1%	1/2 hr	1 min	0.67 cph	2/week	1	State of S/C and sensors
	D173	Sun sensor pair 2	X			X	X	X		X		0.0-1.0 vdc	±1%	1/2 hr	1 min	0.67 cph	2/week	1	
	D174	Sun sensor pair 3	X			X	X	X		X		0.0-1.0 vdc	±1%	1/2 hr	1 min	0.67 cph	2/week	1	Monitor D172-D175, D176-D184 at the same time
	D175	Sun sensor pair 4	X			X	X	X		X		0.0-1.0 vdc	±1%	1/2 hr	1 min	0.67 cph	2/week	1	
	D176	Pitch rate gyro out	X			X	X	X		X		0-5 deg/sec	±0.25°/sec	1/2 hr	1 min	0-5/sec	2/week	1	Flight control evaluation
	D177	Yaw rate gyro out	X			X	X	X		X		0-5 deg/sec	±0.25°/sec	1/2 hr	1 min	0-5/sec	2/week	1	
	D178	Roll accelerometer	X			X	X	X	X			0-0.003G	±0.0001G	1/2 hr	1 min	0-5/sec	2/week	1	Required by P.I.
	D179	A/P command X	X			X	X	X		X		-10 to +10vdc	±0.1 vdc	1/2 hr	1 min	0-5/sec	2/week	1	Flight control evaluation
	D180	A/P plant out X	X			X	X	X		X		-10 to +10 vdc	±0.1 vdc	1/2 hr	1 min	0-5/sec	2/week	1	
	D181	A/P command Y	X			X	X	X		X		-10 to +10 vdc	±0.1 vdc	1/2 hr	1 min	0-5/sec	2/week	1	
	D182	A/P plant out Y	X			X	X	X		X		-10 to +10 vdc	±0.1 vdc	1/2 hr	1 min	0-5/sec	2/week	1	
	D183	A/P command Z	X			X	X	X		X		-10 to +10 vdc	±0.1 vdc	1/2 hr	1 min	0-5/sec	2/week	1	
	D184	A/P plant out Z	X			X	X	X		X		-10 to ±10 vdc	±0.1 vdc	1/2 hr	1 min	0-5/sec	2/week	1	
	D185	Gyro temp	X			X	X	X		X		65-75°F	±2°F	1/day	once	dc	2/week	2	Gyro performance
	D186	Fuel pressure A	X			X		X		X		0-6000 psia	±100psia	1/day	once	dc	1/week	1	Fuel quantity
	D187	Fuel pressure B	X			X		X		X		0-6000 psia	±100psia	1/day	once	dc	1/week	2	

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Figure B2 NASA form 1346 (continued)

1. SPACECRAFT ORIENTATION REQUIREMENTS

This section identifies the mission requirements which are imposed on the Primate Experiment by the launch vehicle, the launch complex, the Apollo system MSFN and the Air Force Eastern Test Range. It is intended that one Saturn launch vehicle system will place the Primate Spacecraft into orbit, and that a second Saturn launch vehicle system will be used to retrieve the primates. While it is assumed that the Saturn/Apollo vehicle that will place the experiment in orbit is manned, an unmanned experiment insertion into orbit is also entirely feasible. This could be accomplished on any of several Saturn Apollo Application missions that are scheduled to be flown without a CSM.

For purposes of identifying mission requirements, it is assumed that the launch vehicle systems will be identical Saturn IB boosters and Apollo Spacecraft. A Saturn V could be similarly used for either or both of the booster requirements, but this vehicle will, in all probability, not be used for earth orbital missions during the time period of this experiment.

The mission operational requirements are best identified by dividing the mission into five phases, as follows:

a. Launch Preparation
b. Prelaunch
c. Launch
d. Orbit
e. Recovery

Each of these mission phases listed above is examined in detail in the paragraphs below.

a. The launch preparation phase of the mission begins approximately 51 days before launch and continues through installation of the primates into their spacecraft installed in the Apollo launch vehicle on Pad 34 or 37b at Cape Kennedy. Actual assembly and installation of the spacecraft into the Apollo is accomplished during the preflight period while the Apollo and Primate Spacecraft are both in the Manned Spacecraft Operations Building (MSOB). The launch preparation phase ends at spacecraft close-out after primate installation. Table IV.1-1 shows the sequence

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Figure B2 NASA form 1346 (continued)

of events for the launch preparation phase that applies in particular to the experiment during the MSOB operations and later while on the pad.

TABLE IV.1-1

Event	Time Before Lift Off
Launch preparation start	51 days
Spacecraft installed on rack	31 days
Spacecraft and Apollo installed on LV	20 days
Preliminary spacecraft system checks	7 to 2 days
Install animals in spacecraft, close out spacecraft, and start monitoring primate status	2 days

The actual installation of the Primate Spacecraft is accomplished in the MSOB. The entire operation in the MSOB is custom-tailored to each individual CSM-SLA combination because each CSM will carry a different scientific payload complement. In the case of the Primate Spacecraft, the MSOB sequence takes into account the complete installation as well as the mechanical and electrical checkout.

b. The prelaunch phase of the mission begins 2 days before launch with installation of the primates into the spacecraft and ends at launch vehicle (LV) lift off.

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Figure B2 NASA form 1346 (continued)

SECTION IV - OPERATIONAL REQUIREMENTS

Table IV.1-2 shows the sequence of events for this phase:

TABLE IV.1-2

Event	Time Before Lift Off
Start monitoring primate status	2 days
Final spacecraft system checks	2 days to 2 hours
LV countdown starts	10 hours
Spacecraft put on internal power	2 hours
Monitor primate activity	2 hours to 0

c. The launch portion of the mission begins at Saturn IB booster liftoff and ends at the end of the separation sequence of the Primate Spacecraft from the Apollo CSM.

The basic Saturn IB mission involves placing an Apollo CSM into a low earth orbit. Using just Saturn IB propulsion, this can be accomplished in one of four ways, as follows:

1. The CSM and Primate Spacecraft are injected directly into the earth orbit (250 n mi) using the S-IB stage to 35 n mi and a single burn SIVB stage to the orbital altitude.

2. The CSM and Primate Spacecraft are first placed at 100 n mi by the S-IB stage burning to approximately 35 n mi altitude where the SIVB stage takes over and in one burn, passes throughout the 100 n mi point. The SIVB stage continues to burn while at 100 n mi to provide an orbital velocity that is sufficient to provide a 250 n mi apogee altitude after a Hohmann transfer. The SIVB stage is then shut down and the coasting transfer is conducted. At apogee, the SIVC is fired a second time and the orbit is circularized.

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Figure B2 NASA form 1346 (continued)

3. After the SIB stage fires to approximately 35 n mi, the SIVB stage places itself, the CSM and the Primate Spacecraft into a 100 n mi circular parking orbit. After a short coast period used for system checkout, the SIVB fires a second time to raise perigee velocity to a value that will result in a 250 n mi apogee altitude. The SIVB is then shut down and a Hohmann transfer coast maneuver is performed to the final orbital altitude. At the 250 n mi apogee altitude, the SIVB fires a third time to circularize the orbit.

4. The fourth method uses the SCM to remove the spacecraft from the SLA after the SIVB stage places its payload into a 100 n mi parking orbit. The SM main propulsion engine then provides the thrust required to execute a Hohmann transfer maneuver from 100 to 250 n mi altitude. The sequence of major events listed below reflects this method of spacecraft orbital insertion.

Table IV. 1-3 below shows Saturn IB payload capability based on the four insertion modes previously described. The weights listed are based on:

(1) Final circular orbital altitude is 250 n mi.

(2) Launch is due East from KSC.

(3) Orbital inclination is 28.5°.

(4) The manned insertion modes assume that a CSM and SLA and an ATM rack are carried in addition to the Primate Spacecraft.

(5) The unmanned insertion modes assume that only 4000 lbs of shroud and payload adapter are carried in addition to the Primate Spacecraft.

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Figure B2 NASA form 1346 (continued)

TABLE IV. 1-3

Insertion Mode	Manned Launch Vehicle Payload - Lbs	Unmanned Launch Vehicle Payload - Lbs
Direct Ascent	-200*	25,000
SIVB-2 Burn Ascent	7395	32,595
SIVB-3 Burn** Parking Orbit and Ascent	5952	31,152
CSM-2 Burn** Parking Orbit and Ascent	8883	Not Applicable

* Saturn IB is only capable of placing 29,000 lbs directly to 250 n mi which is 200 lbs less than the combined weight of the CSM, SLA and ATM rack alone.

** The SIVB state of Saturn IB has, at present, a one burn only capability.

Following is the sequence of major events that make up the launch booster phase:

Saturn S-IB ignition and liftoff

Saturn S-IB burnout and separation

Launch escape system (LES) jettison

S-IVB ignition

S-IVB burnout at 100 n mi earth parking orbit altitude.

After the SIVB stage places itself, the CSM and the Primate Spacecraft into the parking orbit, the CSM separates itself and the spacecraft and

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Figure B2 NASA form 1346 (continued)

performs an orbital altitude change. This maneuver consists of (1) one CSM main engine thrusting period to change orbital velocity from a value that would just sustain a 100 n mi altitude to one that would result in a 250 n mi apogee altitude; (2) a coast period from 100 to 250 n mi altitude (one-half orbital revolution); (3) and a second CSM burn that would increase apogee altitude velocity to a value that would result in a 250 n mi circular altitude. After a short checkout, the CSM crew would then release the spacecraft.

The release sequence of events for the Primate Spacecraft is as follows:

1. Apollo crew determines from on board and ground tracking data that the proper earth parking orbit has been achieved.

2. CSM releases from SLA, rotates and docks with LEM ascent stage or LEM substitute.

3. CSM, LEM, or LEM substitute and spacecraft separate from S-IVB.

4. Astronauts perform status check on spacecraft.

5. CSM performs Hohmann transfer maneuver from 100 to 250 n mi altitude.

6. CSM releases spacecraft to orbit on its own for upwards of one year.

At the time of final spacecraft separation from the CSM, the experiment must be capable of operation independent of the launch vehicle that placed it in orbit.

d. The orbital phase of the mission starts at the point where the Primate Spacecraft is physically released from the CSM and continues to the point in the mission (approximately 1 year later) where an astronaut from a second Apollo vehicle retrieves the primates. Spacecraft sun orientation and communication establishment with ground stations constitute the major events.

e. The recover and reentry phase of the mission actually starts with count-down of the Apollo launch vehicle that will return the primates to earth. For purposes of establishing requirements and constraints that affect the spacecraft design, however, the mission profile is assumed to start in this phase with the docking

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Figure B2 NASA form 1346 (continued)

and EVA required to bring the live primates on board the Apollo CM. The primates, enclosed in individually sealed recovery capsules, will then be stored aboard the CM, after which a standard Apollo reentry maneuver will be conducted. The recovery and reentry phase is complete at the time of CM touchdown in the WTR recovery area.

Following is the sequence of events for this phase of the mission, assuming that the CSM has arrived in a position to start the docking maneuver:

1. The CSM docks with the Primate Spacecraft after a spacecraft status check is received and evaluated.

2. The Astronauts activate EVA aids (handrails, etc.) and suit up in preparation for decompression of the CM interior.

3. A single astronaut performs EVA and arrives at the recovery capsule locations at the outer skin of the Primate Spacecraft.

4. Astronaut activates the manual capsule releases, removes the capsules from the spacecraft, and returns to the hatch of the CM.

5. The second astronaut brings the capsules inside of the CM and stores them in the CM storage areas.

6. The CM hatch is then closed, the CM repressurized and a standard reentry procedure is started.

7. The Primate Spacecraft is jettisoned.

8. Retro-maneuver is completed and the SM is jettisoned.

9. Aerodynamic reentry is conducted.

10. Drogue and main chutes are deployed.

11. Splashdown in CM recovery area is conducted.

One portion of the second, or recovery, Apollo mission of extreme importance to the primate retrieval is the earth launch of this booster/CSM and the associated launch window. For low earth orbits in a fixed plane, a launch window on the amount of propellant that can be expended in the actual rendezvous maneuver will normally be on the order of 10-20 minutes.

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Figure B2 NASA form 1346 (continued)

A minimum of 15% of the allowable CSM payload will be carried as rendezvous and docking propellant, with additional propellant being required as the launch window is expanded.

Measurements shall be taken during the launch phase to assure that the Orbiting Primate Spacecraft has been properly inserted into orbit. Further data shall be taken to precisely establish the spacecraft's orbit to insure its location at mission termination or in the event an emergency recovery is required.

The spacecraft shall be orientated with its roll axis pointing toward the sun with the rates about all axes such that the acceleration level of 0.001 is never exceeded except for transients of 0.01 G.

Telemetered data shall be obtained as the OPS passes within range of the ground station. Quick look data shall be obtained and examined first to determine whether transmission should continue. If it should, primary data and TV shall be recovered followed by secondary data, if time permits. Commands may be given the OPS at this time, if required.

2. ASTRONAUT TRAINING

The participation of the astronauts in this experiment is minimal and is concentrated in the recovery phase. The training required by the astronauts consists of familiarization with the OPS, its mission and hardware, and underwater practice for the EVA.

3. ASTRONAUT PARTICIPATION PLAN

The astronauts shall be required to participate in the experiment during the late launch phase and during the recovery phase of the mission. The launch phase involves docking operations and orbit transfer and release operations. The recovery phase involves rendezvous, EVA and separation functions.

A preliminary analyses of the astronauts tasks during EVA is included in the Mission and Experiment requirements digest, Northrop Document NSL 67-301. This analyses indicates that all EVA functions can be completed well within the capabilities of a suited astronaut in zero g.

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Figure B2 NASA form 1346 (continued)

4. PRELAUNCH SUPPORT

a. Shipping and handling procedures.

The Primate Spacecraft, GSE and spare parts will be packed and crated for protection against hazards of transportation from the Northrop facility to the NASA Kennedy Space Center. Primate system equipment will be packed, packaged and marked in accordance with the requirement of MIL-P-7936A. Shipment will not be made until prior clearnace is received from the NASA. All shipments will be made on Government Bill of Lading, as directed by the NASA, 30 days in advance of date of shipment. Primary mode of shipment will be by air transportation from Los Angeles International Airport to Patrick Air Force Base at government expense. Northrop personnel will accompany the shipment and direct the movement of the spacecraft during the truck transportation from Northrop to Los Angeles International Airport and from Patrick Air Force Base to the NASA Kennedy Space Center. When government air transportation is not available, the Primate Spacecraft, in its shipping container, will be transported by commercial air freight, in accordance with NASA's instructions.

Shipment and storage of the Primate Spacecraft will be accomplished as an assembled system. It will be protected against climatic environments by a plastic sheath, incorporating a filtered breathing port containing a dessicant cartridge. Protection will be afforded against rain, sunshine, humidity, sand, dust, and salt atmosphere. All Primate Spacecraft structure and equipment will be constructed, wherever possible, of materials which will afford protection against ozone and age deterioration within the maximum storage condition expected for this program. The Primate Spacecraft, including subsystems, but less batteries and consumables, will be lowered into the shipping container and attached by means of the spacecraft/rack attach points and additional points at each end. Isolation devices will be installed to limit transmission of shocks to the spacecraft. The container will rest on integral slides and will be capable of being moved by slings or fork lifts. A sketch of the shipping container is shown in Figure IV.4-1. Transportation will be under direct Northrop supervision and continual serveillance, subject to preferred handling conditions, to assure elimination of potentially hazardous dynamic environments. Air transportation will be in a pressurized, air conditioned cabin. This criteria is specified since cargo handlers will be required to accompany the equipment. Since this criteria is specified, temperature and altitude differential extremes during air shipment are not significant factors.

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Figure B2 NASA form 1346 (continued)

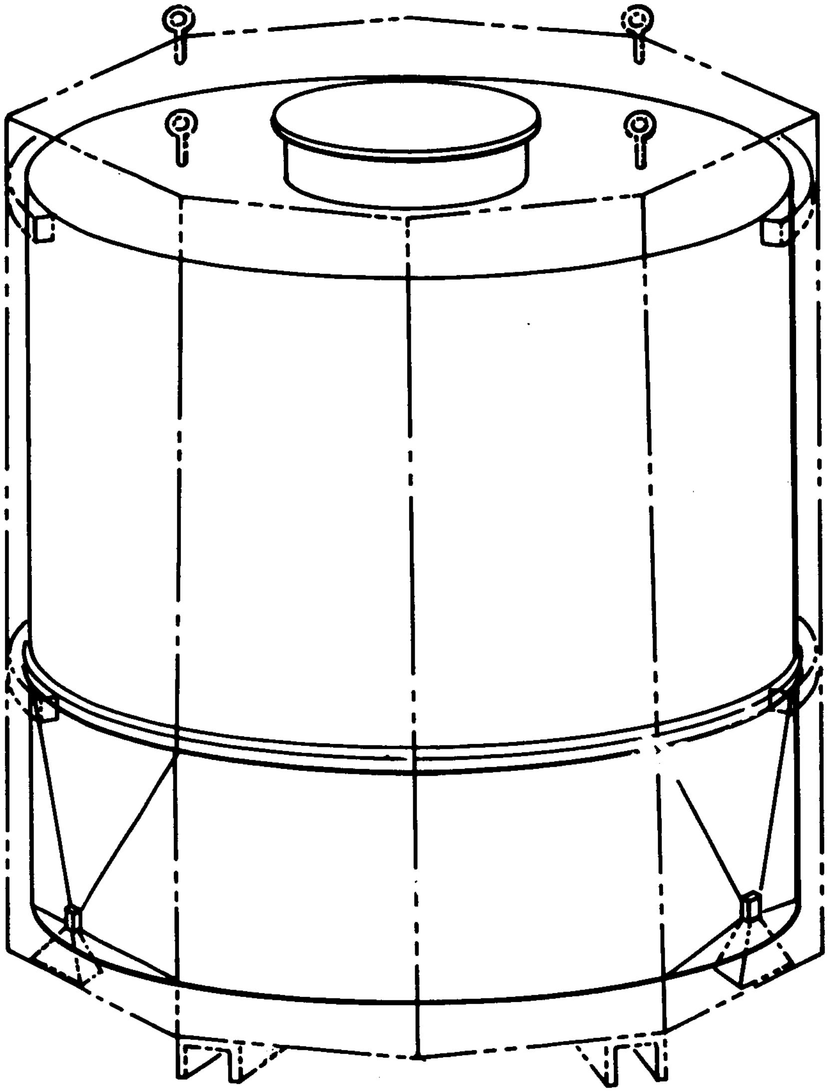

Figure IV.4-1. - Primate spacecraft shipping container

Figure B2. - NASA form 1346 (Continued)

Items considered fragile will be instrumented for recording shock loads during handling and transit. Analysis of this data at point of delivery will identify when and where shock occurred and if the shock loads exceeded the allowable limitation for that particular item.

GSE, components and spare parts will be packaged to protect the equipment against the natural environmental extremes which may be encountered in a non-operating condition during transportation, ground handling and storage.

b. Installation and checkout procedures

The prelaunch checkout starts when the Primate Spacecraft is delivered to Kennedy Space Center and is completed at the end of the launch vehicle count down with space vehicle lift off from the launch pad. This prelaunch checkout will have as its objective, the assurance that the Primate Spacecraft is ready for launch and is functionally capable of meeting its mission requirements.

Prelaunch checkout operations fall into three categories: (1) receipt, inspection and checkout of ground support equipment; (2) receipt, inspection, installation and checkout of the Primate Spacecraft; and (3) support of the Apollo Applications and Checkout (I & C) Contractor.

Subsequent to the completion of Acceptance Testing at the Northrop Hawthorne facility, the Primate Spacecraft will be packaged and shipped to KSC. At KSC, the Primate Spacecraft will be delivered to the Maintenance Assembly Area (MAA) in the Manned Spacecraft Operations (MSOB) Building, where it will be unpacked, inventoried, and visually inspected for transportation damage. See Figure IV.4-2 for on-site flow diagram.

At the MAA, the Primate Spacecraft will be mounted on an assembly dolly, the GSE will be connected, and launch site checkout will be accomplished. The checkout will consist of compatibility, functional, and EMI tests. These tests will verify that the Primate Spacecraft fulfills the requirements for mating with the SLA rack structure. The Primate Spacecraft checkout in the MAA will be the responsibility of Northrop.

After completion of the checkout, the Primate Spacecraft will be moved by Northrop and installed on the SLA rack structure by the I & C Contractor. Fasteners, separation mechanisms, and adapter connections will be mated, and interconnections with the rack accomplished. Functional and operational testing will be accomplished in accordance with the Apollo Integrated

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Figure B2 NASA form 1346 (continued)

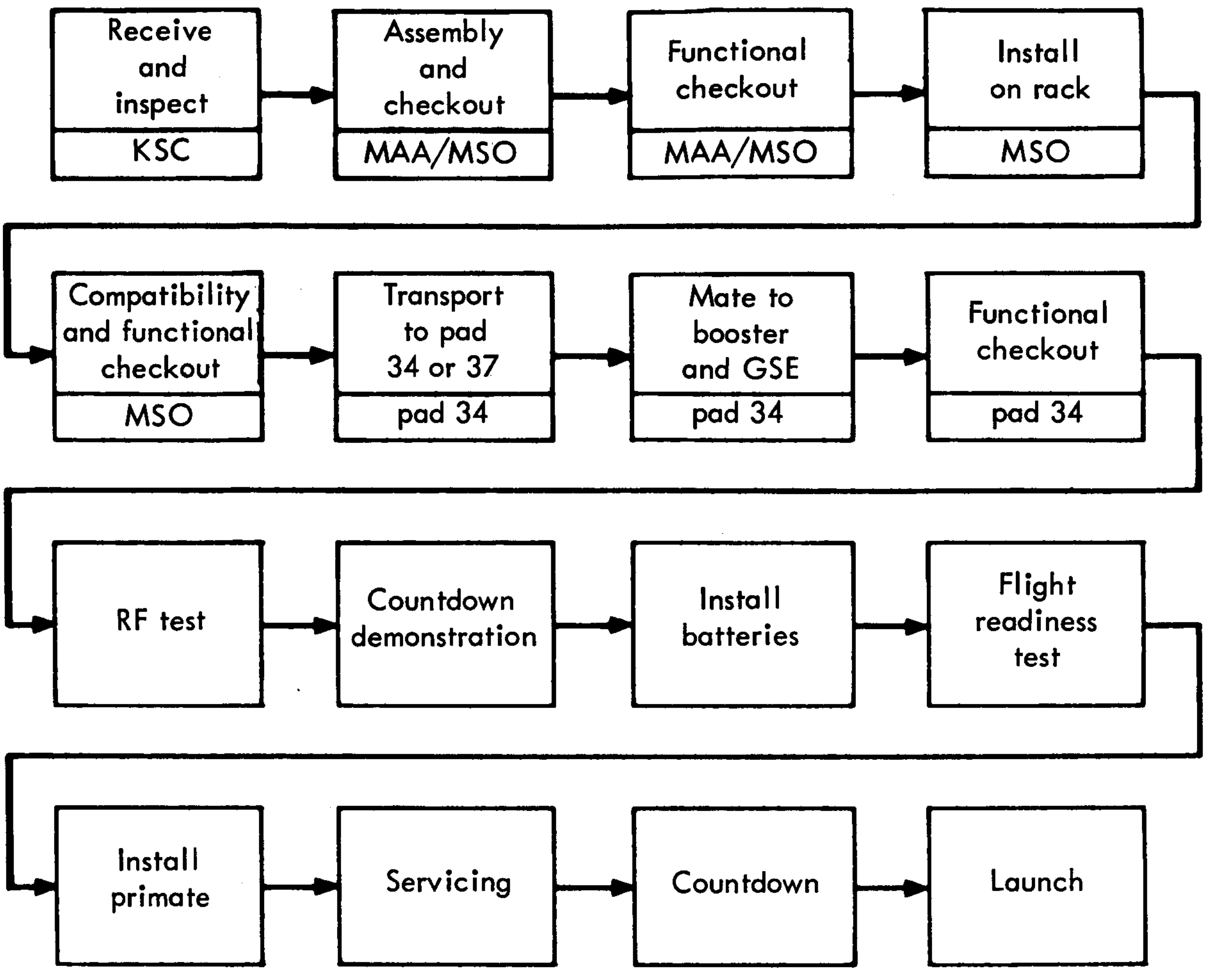

Figure IV.4-2. On-site flow diagram for KSC

Figure B2.– NASA form 1346 (continued)

Checkout and Countdown Procedures Manual. Northrop will support, technically and physically, the I & C Contractor in Primate Spacecraft testing and preparations through integration, checkout and countdown operations.

Subsequent to completion of GSE acceptance testing at Northrop-Hawthorne, the equipment will be packaged and shipped to KSC. The equipment will be uncrated, inventoried and inspected for transportation damage in the Maintenance Assembly Area. Only one set of equipment will be shipped to KSC and will be moved from one location to another, as required.

At KSC, the Primate Spacecraft will be delivered to the Maintenance Assembly Area where it will be uncrated, inventoried and visually inspected for transportation damage.

The Primate Spacecraft will be placed on a dolly in the MAA and mated with the GSE. Spacecraft to GSE cabling will be given continuity checks and connected. Operating tests will then be made to assure that no power or signal mismatch exists between the two.

Functional checks of each subsystem, i.e., life support, thermal control, instrumentation, telemetry, power and stabilization and control will be accomplished against the GSE to determine that they are functioning properly. After it is determined that all independent loops are operating satisfactorily, an integrated primate system test will be accomplished. The GSE will be used to monitor the responses to system stimuli.

This sequence of test operations will validate the Primate Spacecraft for installation on and integration with the SLA rack. The Primate Spacecraft subsystems and interface operations will include:

1. Cabling and Interconnect Equipment - To determine continuity and validate Primate Spacecraft, rack and CSM interconnections.

2. Power Subsystem - To determine that the solar cell-battery pack output is within tolerance, that intra Primate Spacecraft mechanisims are operating and that the Primate Spacecraft/GSE ground power switchover mechanism is operating.

3. Data Subsystem - To determine that all planned sensored data is being acquired; that events and experiments data links are functioning; that transmitter output is within tolerances as to frequency, power, data, rate, and data format.

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Figure B2 NASA form 1346 (continued)

4. Thermal Control Subsystem - To determine that indicators denoting pressurant, water, and coolant are at proper operating levels. In prelaunch checkout and operations of the Primate Spacecraft, GSE cooling equipment is used in lieu of the Primate Spacecraft Thermal Control Subsystem. This prevents depletion of batter power and the venting of expendables in the vicinity of the spacecraft.

5. Pressure Shell Subsystem - The Primate Spacecraft will be fabricated so that the pressure shell cover can be separated from the pressure shell base. During the checkout operations at KSC, the pressure shell cover will be removed from the spacecraft, giving access to the spacecraft equipment. Upon completion of the subsystem checkouts, the pressure shell cover will be replaced and bolted to the base. A leakage test will then be performed to verify that the spacecraft leakage rate does not exceed the CEI specification.

For uprated Saturn I launch vehicles, the CSM Primate Spacecraft, rack and SLA will be moved from the MSOB directly to the launch pad assigned to a primate mission where launch vehicle mating will be accomplished starting at approximately T-20 days. Additional integrated functional checkout operations will be accomplished after mating the CSM/Primate Spacecraft/SLA with the launch vehicle.

Functional checkout will be accomplished early in the terminal countdown. Batteries will be installed in the spacecraft at the latest possible time (approximately T-3 days) in the countdown to preserve battery life. Final checkout will then be performed. Completion of installation of the primates will be accomplished through access panels in the SLA at T-2 days. At T-6 hours, when the service structure will be removed from the space vehicle and the Primate Spacecraft GSE disconnected, monitoring of the Primate Spacecraft system on a go-no go basis will be accomplished by the Instrumentation Unit data link.

Upon arrival at KSC, the GSE will be inventoried, inspected, assembled and installed in the Primate Spacecraft maintenance assembly area in the MSO. Only one set of GSE will be delivered to KSC and will be moved from location to location as required. After installation and connection, the GSE will be verified by the self-check features built into the equipment. For parts of the GSE which do not lend themselves to self-check methods, proper operation will be verified by use of simulators and other test equipment similar to that employed in factory checkout. Cabling and harnessing

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Figure B2 NASA form 1346 (continued)

will be evaluated by continuity checks. Checkout of GSE which interfaces with other Contractor or Government organization equipment or facilities will be coordinated with personnel of the appropriate organizations to effect an integrated checkout effort. The completed installation will be operated and tested by the use of dummy test loads to verify proper functional operation, compatibility, and competency of operating personnel.

The following launch test criteria will be established to cover the checkout and testing of the Primate Spacecraft at KSC to certify its operational readiness for each flight.

1. Test records of each equipment, subsystem, system, and experiment covering all test phases are used in the final determination of flight readiness. From these data, equipment operating trends are determined.

2. Tests are accomplished in accordance with NASA approved Operational Checkout Procedures (OCP). An OCP is prepared for each test.

3. On-site tests use the same procedures as in-plant tests on systems, subsystems, equipment, and experiments wherein the test content is the same.

4. The total checkout and testing operations on the spacecraft, and its associated equipment, accomplish all compatibility, functional, performance, and EMI tests necessary to assure flight readiness of the primate system.

5. Equipment design, test procedures, and GSE design and deployment reflect the following:

   a. Only controlled limited access to the spacecraft will be permitted once preflight checkout has commenced.

   b. Electrical and mechanical connections once made in the spacecraft are not disconnected for the purpose of checkout.

6. Malfunctions determined in on-site and prelaunch testing are isolated to the replaceable module or component level. Field repairs will not be accomplished on any Primate Spacecraft articles. "Black box" replacements will be used as corrective measures for malfunctions. In cases of replacement, testing will be recycled to the appropriate level dictated by the replacement made.

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Figure B2 NASA form 1346 (continued)

7. Test time on a component will not exceed its design life minus its flight life. Operating logs will be maintained on all items having a limited shelf/flight life.

8. Test and checkout equipment will be calibrated in accordance with written approved procedures and records maintained to assure consistency in test data and a high confidence level in test results.

9. Only approved and acceptance tested GSE will be utilized in accomplishing testing and checkout of the Primate Spacecraft system.

c. Facilities

As mentioned under (b) above, the facilities required are those of the Maintenance Assembly Area in the Manned Spacecraft Operations Building and Pad 34 of the Kennedy Space Center. In addition to these facilities for checkout and integration of the OPS, office space and desks shall be required by the Northrop personnel assigned to KSC for this operation.

d. Test Equipment

Special and commercial test equipment required during the checkout and integration of the OPS shall be supplied by Northrop and shipped air freight to KSC at government expense.

e. Services

The MAA and Pad 34 are equipped with sufficient services to permit complete checkout and integration of the OPS.

5. FLIGHT OPERATIONAL REQUIREMENTS

During the initial launch, insertion and orbit phases, several ground stations shall be required both for tracking of and receipt of data from the OPS. Tracking data is required by the experiment only to assure proper orbit and to permit positive location for the recovery mission. Experiment data must be closely monitored during the initial phases of the flight to assure proper equipment operation while recovery is still possible.

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Figure B2 NASA form 1346 (continued)

SECTION IV - OPERATIONAL REQUIREMENTS

The OPS Attitude Control Subsystem shall be activated after the OPS is released into orbit and the CM has cleared the area. The subsystem shall be de-energized when the CM again nears the OPS on the recovery mission.

The real time communications required with the CM, the data communications required from the OPS, as well as the commands to be sent to the OPS, are depicted in chart IV.5-1. Table IV.5-1 is a list of the commands required during the mission to assure success of the experiment.

6. RECOVERY REQUIREMENTS

The entire recovery phase is aimed at recovering two primates from the OPS. Each primate is to be encouraged into a recovery capsule. This capsule is supplied with life support facilities capable of maintaining the primate for 24 hours. The capsule is sealed and then disconnected from the OPS by an Astronaut and installed within the CM for subsequent return to earth. The recovery capsule is specified by Northrop drawing 148-11700.

Special equipment required for the recovery mission include a recovery capsule tether, tools for disconnecting the capsule and special attachments to secure the capsule within the CM.

7. DATA SUPPORT REQUIREMENTS

Pre-flight control data shall be gathered by the Principal Investigator at his laboratory on the primates that are being trained for the mission. When the primates are moved to the KSC, no special requirements exist for data gathering until the primate is installed in the OPS. Prior to this time, medical examination of the primate is sufficient along with cursory checks of the implanted telemetry.

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 EXPERIMENT COMMAND REQUIREMENTS

Subarea	No.	Name	Critical	Mission phase				Remarks
				PL	L	O	R	
Life Support	C1	Main fan index		X		X		Switch to next main fan
	C2	Contam. cont fan/index		X		X		Switch to next contaminant cont. fan
	C3	Spare						
	C4	Freon pump index		X		X		Switch to next freon pump
	C5	LC Evacuate	X				X	Depressurize life cell - astronaut source
	C6	Recharge freon				X		Recharge freon loop
Life Cell	C7	LC purge	X			X		High leak rate
	C8	Wall A extend		X		X		Move wall (may be astronaut source) (C8–C11)
	C9	Wall A retract		X		X		
	C10	Wall B extend		X	X			
	C11	Wall B retract		X		X		
	C12	Release wall A				X		Disconnect drive from wall
	C13	Photoperiod continuous				X		Change photo period (C13–C14)
	C14	Photoperiod normal				X		

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 (Continued

Subarea	No.	Name	Critical	Mission phase				Remarks
				PL	L	O	R	
Life Cell (continued)	C15	Release wall B				X		Disconnect drive from wall
	C16	Spare						
	C17	Spare						
	C18	Wall charge A		X		X	X	Turn wall charge to on or off (toggled) (may be astronaut source)
	C19	Wall charge B		X		X	X	
Feeder	C20	Spare						
	C21	Spare						
	C22	Spare						
	C23	Spare						
	C24	Food override A				X		Eliminate behavioral task requirement for reward
	C25	Food override B				X		
Waterer	C26	Spare						
	C27	Spare						
	C28	Water override A				X		Eliminate behavioral task requirement for reward
	C29	Spare						

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 (Continued)

Subarea	No.	Name	Critical	Mission phase PL	L	O	R	Remarks
Waterer (continued)	C30	Spare						
	C31	Water override B				X		Eliminate behavioral task requirement for reward
Behavioral Panel	C32	Activate BPA		X		X	X	Control status of BP (may be astronaut source)
	C33	Deactivate BPA	X	X		X	X	
	C34	Tim interval inc. A		X		X		Required by PI change work task
	C35	Tim interval dec. A		X		X		
	C36	Spare						
	C37	Spare						
	C38	Spare						
	C39	Spare						
	C40	ILK response inc. A		X		X		Required by PI Change work task
	C41	ILK response dec. A		X		X		
	C42	Activate BPB		X		X	X	Control status of BP (may be astronaut source)
	C43	Deactivate BPB	X	X		X	X	

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 (Continued)

Subarea	No.	Name	Critical	Mission phase PL	L	O	R	Remarks
Behavioral Panel (continued)	C44	Tim interval inc. B		X		X		Required by PI Change work task
	C45	Tim interval dec. B		X		X		
	C46	Spare						
	C47	Spare						
	C48	Spare						
	C49	Spare						
	C50	ILK response inc. B		X		X		Required by PI Change work task
	C51	ILK response dec. B		X		X		
	C96	Exc. force A inc.		X		X		Control exerciser force and extension into life cell
	C97	Exc. force A dec.		X		X		
	C98	Exc. force B inc.		X		X		
	C99	Exc. force B dec.		X		X		
	C100	Retract exc.				X	X	

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 (Continued)

Subarea	No.	Name	Critical	Mission phase PL	L	O	R	Remarks
Behavioral panel (continued)	C101	Vig. time A inc.		X		X		Change behavioral task
	C102	Vig. time A dec.		X		X		
	C103	Vig. time B inc.		X		X		
	C104	Vig. time B dec.		X		X		
Recovery Capsule	C52	Load primate A	X				X	Start sequence
	C53	Evacuate RC A	X			X		Dry cadavar
	C54	Load primate B	X				X	Start sequence
	C55	Evacuate RC B	X			X		Dry cadavar
	C56	Incr door open A					X	Provide close control of closing door (may be astronaut source)
	C57	Incr door open B					X	
	C58	Incr door close A					X	
	C59	Incr door close B					X	
Mass/volume measurement device	C60	M/VM task on A		X		X		Makes M/VM task part of behavioral task
	C61	M/VM task on B		X		X		
	C62	M/VM task off A		X		X		Eliminates M/VM task from schedule also, opens door
	C63	M/VM task off B		X		X		

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 (Continued)

Subarea	No.	Name	Critical	Mission phase				Remarks
				PL	L	O	R	
Thermal control	C64	Radiator index				X		Switch to alternate radiator
Structure and mechan-ical	C65	Insertion seq. backup	X		X			Backup automatic func-tions (may be astronaut source)
	C105	Deploy antennas			X			Deploy all antennas
	C106	Deploy solar panels			X			Deploy all solar panels
Instrumen-tation	C66	TV A on		X		X	X	Turn TV on upon request when over ground station (may be astronaut source)
	C67	TV A off		X		X	X	
	C68	TV B on		X		X	X	
	C69	TV B off		X		X	X	
	C70	Index TV window A		X		X	X	Provide clean viewpoint in case of fouling (may be astronaut source)
	C71	Index TV window B		X		X	X	
	C72	Startle noise		X		X		Test primate response
	C107	TV A turret change		X		X	X	Change from wide angle to narrow angle lens
	C108	TV B turret change		X		X	X	

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 (Continued)

Subarea	No.	Name	Critical	Mission phase				Remarks
				PL	L	O	R	
Instrumentation (continued)	C109	TV secondary recorder		X		X		Command secondary TV recorder
	C110	Calibration		X		X		Calibrate PCM and FM/FM subsystems
Telemetry	C73	TV recorder playback		X		X		Retrieve information on request
	C74	Data recorder playback		X		X		
	C75	Rendezvous beacon on		X		X	X	Location of S/C (may be astronaut source
	C76	Rendezvous beacon on		X		X	X	
	C77	MSFN on				X	X	Turn transmitters on
	C78	Spare						
	C79	Trans. off		X		X	X	Turn transmitters off
	C111	Data trans. 2 on		X		X		Switch to alternate transmitter
	C112	TV trans. 2 on		X		X		
	C113	Step TV antenna		X		X	X	Switch antennas
Command and control	C80	Real time data		X		X	X	Real time transmit data
	C81	Real time TV		X		X	X	Real time transmit TV

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 (Continued)

Subarea	No.	Name	Critical	Mission phase PL	L	O	R	Remarks
Electrical power and cabling	C82	Turn tel on		X		X	X	Control power consumption as required
	C83	Turn tel off		X		X	X	
	C84	Turn A/C on	X	X		X	X	Interlock with docking (may be astronuat source)
	C85	Turn A/C off	X	X		X	X	
	C86	Solar panel disconnect	X			X	X	Kill S/C after mission
	C87	Solar panel connect	X			X	X	
	C114	Battery select sw		X		X		Switch from primary battery
	C115	Charge reg. 1 sw		X		X		Disconnect charge regulator
	C116	Charge reg. 2 sw		X		X		
	C117	Charge reg. 3 sw		X		X		
	C118	Charge reg. 4 sw		X		X		
	C119	Invert tran. override 1		X		X		Disconnect inverter-override automatic switching
	C120	Invert tran. override 2		X		X		
	C121	Invert tran. override 3		X		X		
	C122	Reg. tran. override		X		X		Override automatic switching

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 (Continued)

Subarea	No.	Name	Critical	Mission phase				Remarks
				PL	L	O	R	
Electrical power and cabling (continued)	C123	Noness. load disconnect		X		X		Disconnect nonessential load
Attitude control	C88	Torque gyro x plus		X		X	X	Emergency torquing of gyro to control attitude (C88–C125)
	C89	Torque gyro x minus		X		X	X	
	C90	Torque gyro y plus		X		X	X	
	C91	Torque gyro y minus		X		X	X	
	C124	Torque gyro z plus		X		X	X	
	C125	Torque gyro z minus		X		X	X	
	C29	Spare						
	C93	Spare						
	C94	Spare						
	C95	Spare						

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Figure B2 NASA form 1346 (continued)

TABLE IV.5-1 (Concluded)

Subarea	No.	Name	Critical	Mission phase PL	L	O	R	Remarks
Attitude control (continued)	C126	Pos. roll jet on				X		Direct jet control to control S/C attitude
	C127	Neg. roll jet on				X		
	C128	Pos. pitch jet on				X		
	C129	Neg. pitch jet on				X		
	C130	Pos. yaw jet on				X		
	C131	Neg. yaw jet on				X		
	C132	Roll gyro cage	X	X		X		Provide a torquing capability for drift compensation
	C133	Roll gyro uncage		X		X		
	C134	Pitch gyro cage	X	X		X		
	C135	Pitch gyro uncage		X		X		
	C136	Yaw gyro cage	X	X		X		
	C137	Yaw gyro uncage		X		X		

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Figure B2 NASA form 1346 (continued)

SECTION V - RESOURCE REQUIREMENTS

1. FUNDING REQUIREMENTS

a. Summarize total experiment cost by major category of expenditure as outlined below:

ITEM	AMOUNT
DIRECT LABOR (Separate by Labor Category; Rate per hour or man-month; Personnel involved, what they will do, etc.)	$
MANUFACTURING BURDEN (Overhead) RATE (%) (Flight experiments normally will be supported by contracts rather than grants.)	
MATERIALS (Total) (Bill of Material, including estimated cost of each major item.)	
SUBCONTRACTS (List those over $25,000) (Specify the vendor if possible, and the basis for estimated cost. Include baseline study contracts.)	
SPECIAL EQUIPMENT (Total) (List of lab equipment, purposed uses, and estimated costs.)	
TRAVEL (Estimated number of individual trips, destinations, and costs.)	
ANY OTHER ITEMS (Total) (Explain in detail similar to the above.)	
TOTAL COSTS	$
General and Administrative Rate ( )	$
TOTAL ESTIMATED COST	$

b. Funding Obligation Plan. Provide the preliminary funding requirements of the experiment by quarter as indicated on the attached sheet (Quarterly Funding Requirements). Funding should be broken into the general areas indicated on the following page and should identify the source of funding for each area.

Figure B2.—NASA form 1346 (continued)

SECTION V - RESOURCE REQUIREMENTS (Cont'd)
2. PRELIMINARY DEVELOPMENT SCHEDULE

MAJOR MILESTONES	PLANNED DEVELOPMENT SCHEDULE											
	FY ______				FY ______				FY ______			
	QUARTERS				QUARTERS				QUARTERS			
	1	2	3	4	1	2	3	4	1	2	3	4
EIP COMPLETE												
MSFEB Action												
Hardware Contract												
ICD Complete												
Design Complete												
DEP Complete												
Prototype Delivered												
Qualification Testing Complete												
Flight Units Fabricated												
Delivery of Flight Hardware												

Figure B2.—NASA form 1346 (continued)

SECTION V - RESOURCE REQUIREMENTS (Cont'd)
C. Quarterly Funding Requirements (Dollars in Thousands)

ITEMS	FUNDING SOURCE	FY ____				FY ____				FY ____				FY ____				TOTALS
		QUARTERS				QUARTERS				QUARTERS				QUARTERS				
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
Definition, Breadboard, Design, Development, Fabrication, Test (mock-ups, prototypes, and support equipment)																		
Fabrication, Test and Delivery (Flight units and spares)																		
Supporting Studies and Other Implementation Efforts																		
Data Analysis and Publication																		
YEARLY TOTALS																		
																GRAND TOTAL		

Figure B2.—NASA form 1346 (continued)

SECTION V - RESOURCE REQUIREMENTS (Cont'd)

3. MANPOWER

Provide a brief summary of manpower requirements both in-house and contract.

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4. FACILITIES

Provide a brief listing of facilities and major lab equipment requirements. Specifically identify new facility requirements. Whenever possible, indicate the schedule of usage for each item.

Figure B2.-NASA form 1346 (concluded)

APPENDIX C
ENGINEERING PLAN

INTRODUCTION

This plan defines the engineering effort to be accomplished during the Design Definition and Laboratory Demonstration phase and to some extent the Phase 3 Development phase of the Extended Weightlessness Program. The scope of the effort described will reflect the tasks to be accomplished within the major engineering organizational subdivisions. Other technical and engineering related activity is described in other plans and documents as noted below:

Management Plan, Appendix A
Experiments Plan, Appendix B
Integrated Test Plan, Appendix D
Reliability Plan, Appendix E
Quality Assurance Plan, Appendix F
Manufacturing Plan, Appendix G

Purpose

The Engineering Plan is intended to present an overview of the methodology, organization tasks and schedule as presently conceived for accomplishing: (1) Phase 2 design of the Orbiting Primate Spacecraft System, (2) design, fabrication and test of a Laboratory Demonstration Model of the Orbiting Primate Spacecraft, (3) the development effort of Phase 3. The plan will serve to delineate the responsibilities, functional interfaces, flow of information and detailed effort of the System Engineering and Design areas of the Engineering Organization.

Two major products will result from the engineering effort described in the plan. One will be principally concerned with the detailed preliminary design of the Orbiting Primate Spacecraft and its associated ground support and training equipment as reflected in the list of anticipated major engineering documentation contained in table C1. The other will be a Laboratory Demonstration Model of the Orbiting Primate Spacecraft with the requisite documentation to permit its fabrication and test during this next program phase. This model will reflect the detailed definition of the spacecraft which will be developing concurrently. Only those subsystems and elements which can meaningfully be operated and demonstrated in the laboratory will be included however; principal areas of attention in this connection will be Life Support and Waste Management. The documentation to support this effort will stress: the detailed design drawings; fabrication and assembly instructions, checkout, test and data analysis. The Phase 3 effort will result in the actual implementation of the flight hardware and will reflect the Phase 2. definition and laboratory test results. A detailed description of hardware deliverable areas for the Laboratory Demonstration Phase and Phase 3 is continued in Appendix G of this Volume V.

TABLE C1. - ENGINEERING DOCUMENTATION

1. Engineering Drawings	15. EMI Control and Test Plan
2. System Specifications	16. Qualification Test Plan
3. Subsystem Specifications	17. Reliability Plan
4. Equipment Specifications	18. Support Plan
5. Loads Analysis Report	19. Ground Operation Plan
6. Dynamic Analysis Report	20. Mission Operation Plan
7. Stress Analysis Report	21. Integrated Test Plan
8. Electrical Load Analysis Report	22. Engineering Plan
9. Thermal Control Heat Balance and Temperature Analysis	23. New Technology Report
10. ECS and Thermal Control Performance Analysis	24. Training Manual
	25. Familiarization Manual
11. Life Support and Waste Management Performance Analysis	26. GSE Development and Test Plan
12. ACS Performance Analysis	27. Interface Control Documents - Spacecraft to Apollo
13. Measurement Requirements	28. Mission and Operations Plan
14. Antenna Development Report	

Methods

Accepted and proven engineering methodology and procedures will be the means of implementing the next phase of the Orbiting Primate program. The block diagram of figure C1 illustrates the general approach to be taken in accomplishing the major tasks of Phase 2. Figure C2 reflects the Phase 3 activity.

The proposed approach for Phase 2 recognizes several significant aspects of the activity which are considered of particular importance. These are:

(1) Utilization of Phase 1 study results.

(2) Early differentiation between the Spacecraft and Laboratory Demonstration Model requirements.

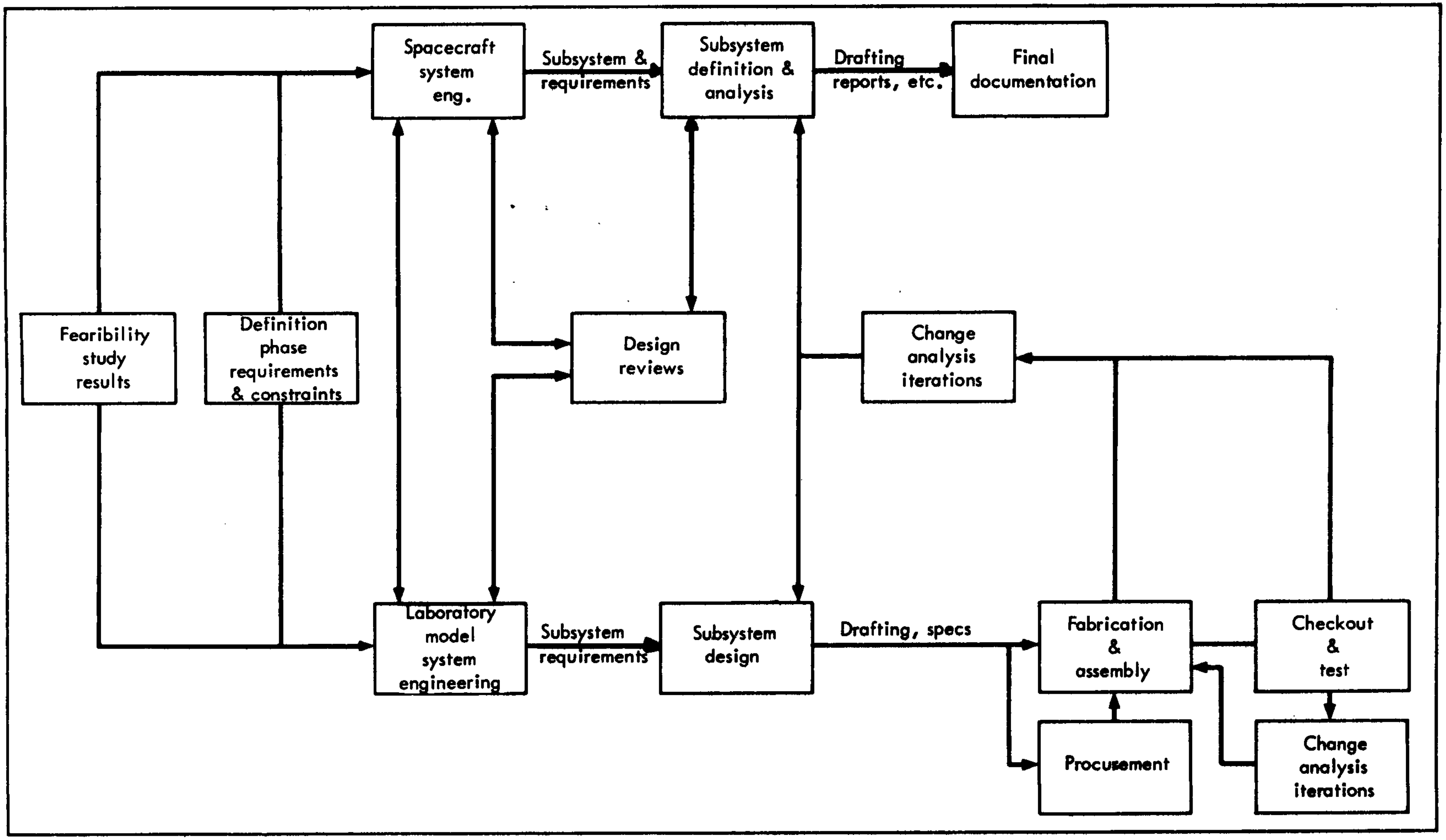


Figure C1. - Engineering methodology block diagram - phase 2

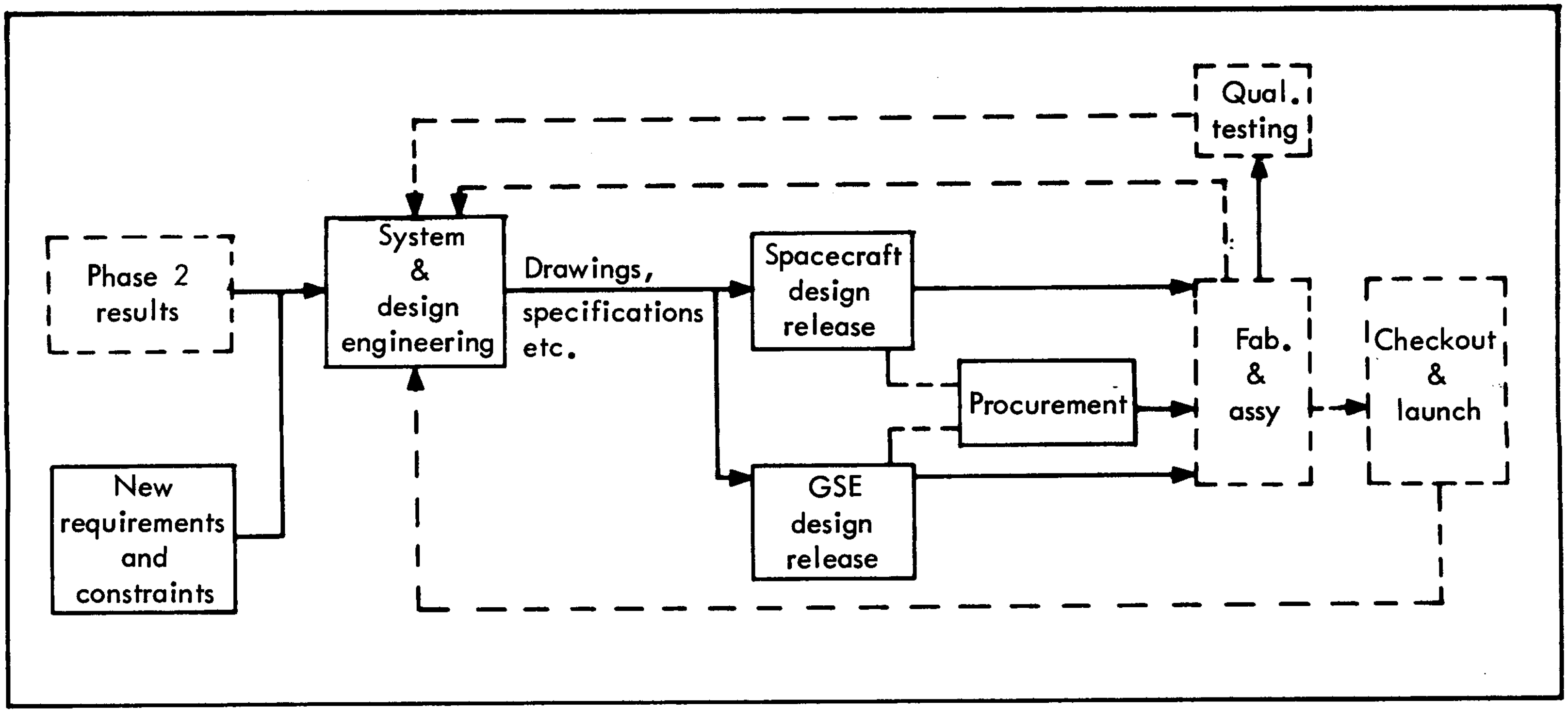


Figure C2. - Engineering methodology block diagram - phase 3

(3) Continuing interchange between the Spacecraft definition effort and the Laboratory model design, fabrication and test activities.

The determination of applicability of the Phase 1 study results in view of any revised requirements and constraints generated for the spacecraft program phase will be performed at an early stage of the engineering activity. This will include consideration of both spacecraft definition and laboratory demonstration model design. Similarly, additional differentiation between the spacecraft and the laboratory model will be required to set the initial guidelines for the design of the latter. Since both the spacecraft definition effort and that related to the laboratory demonstration model are concurrent, particular attention will be required to assure that the proper degree of commonality between the two is achieved. Feedback from fabrication, assembly and test of the laboratory demonstration model will also be used advantageously to optimize the spacecraft design definition.

The Phase 3 effort will utilize the results of the Phase 2 activity as a starting point and will proceed in the detailing, refinement, optimization of design to permit fabrication, assembly, and qualification of the spacecraft.

RESPONSIBILITY

The primary responsibility for performing the engineering tasks described in this plan for the Phase 2 effort rests in the organization defined in figure C3. The Phase 3 proposed organization is indicated in Appendix A Management Plan and will implement the engineering tasks for that phase.

The head of engineering as indicated in figure C3 reports directly to the Program Manager at the same level of communication as other technical, administrative and supporting organizations.

The System Engineering organization will perform the initial evaluation of the Phase 1 results relative to applicability to the subsequent effort. This evaluation in conjunction with review of new requirements and constraints will serve as the point of departure for establishing system and subsystem requirements, and defining the system configurations for both the Spacecraft and Laboratory Demonstration Model. The system integration function and the correlation of design mechanization with requirements will be also a responsibility of the System Engineering organization.

The Design Engineering organization will be responsible for the mechanization of the requirements and within the constraints specified by System Engineering. The parallel design effort required in implementing the spacecraft and laboratory model requirements will largely be conducted by this organization and will include the preparation of drawings, specifications, design criteria forming part of the design and integration of the spacecraft and laboratory demonstration model.

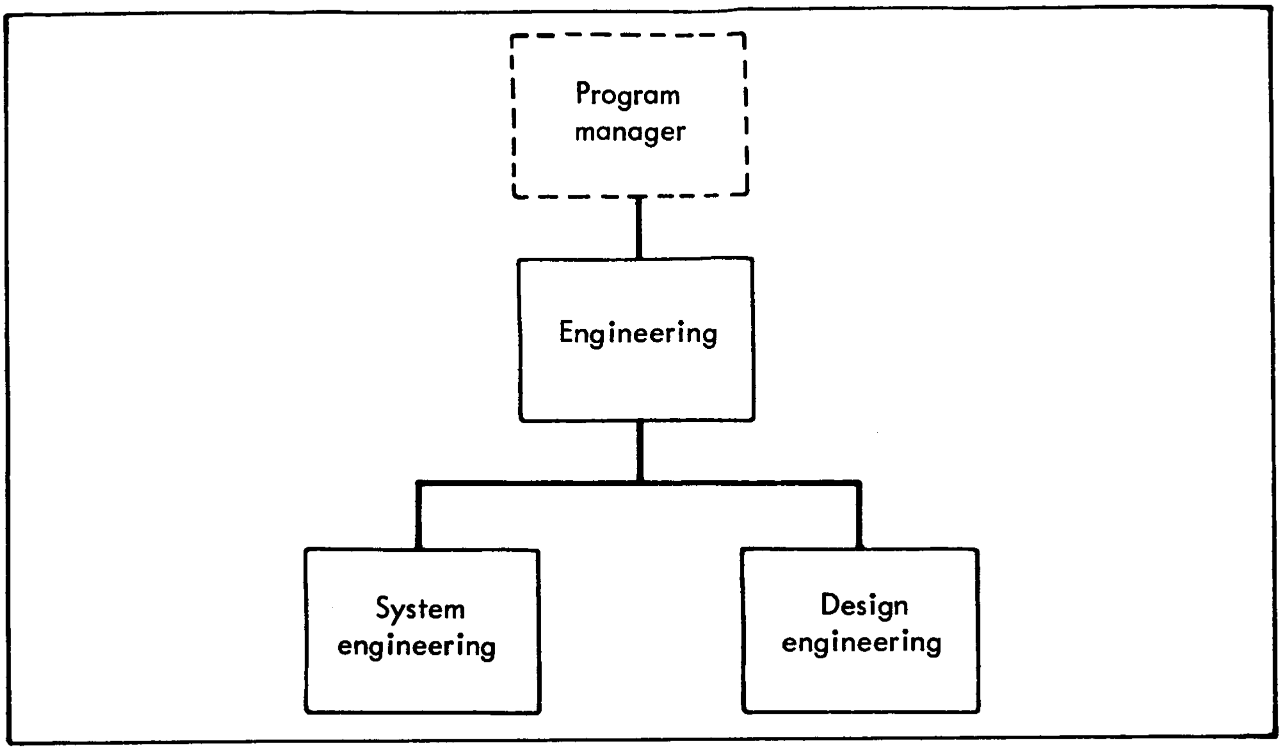


Figure C3. - Engineering organizations

The Engineering organization proposed for the Phase 3 effort will perform essentially the same functions as those described above for Phase 2 except that the final level of hardware implementation will now have been reached. Consequently, the major effort will be directed toward amplifying the Phase 2 design, providing the more extensive detailing, documentation and test support required for this stage of development. The emphasis within the engineering design organization will be on "cradle-to-grave" cognizance by individual engineers on a subsystem basis; these "cognizant engineers" will be responsible for the development, checkout and delivery of the various spacecraft subsystems and will be authorized the necessary resources to accomplish this within the supporting structure of the engineering organization.

Interfaces

In the process of implementing either the Phase 2 or Phase 3 portions of the Primate Program, the Engineering organization is required to interface directly or indirectly with almost every element of the overall program organization. The proper flow and coordination of requirements and the essential interchange of technical data is accomplished through these interfaces. Figure C4 graphically summarizes the more significant of these interfaces and identifies the information flow required. The channels of communication are established to bring to bear all the necessary resources and skills required for the expeditious performance of the engineering tasks, The Phase D interfaces will essentially parallel those depicted in figure C4 except that the augmented task will necessitate an increase in their number. Additionally, the volume of information flow across certain interfaces will of necessity increase, i.e., between engineering and manufacturing; between engineering and Test/Operation, etc.

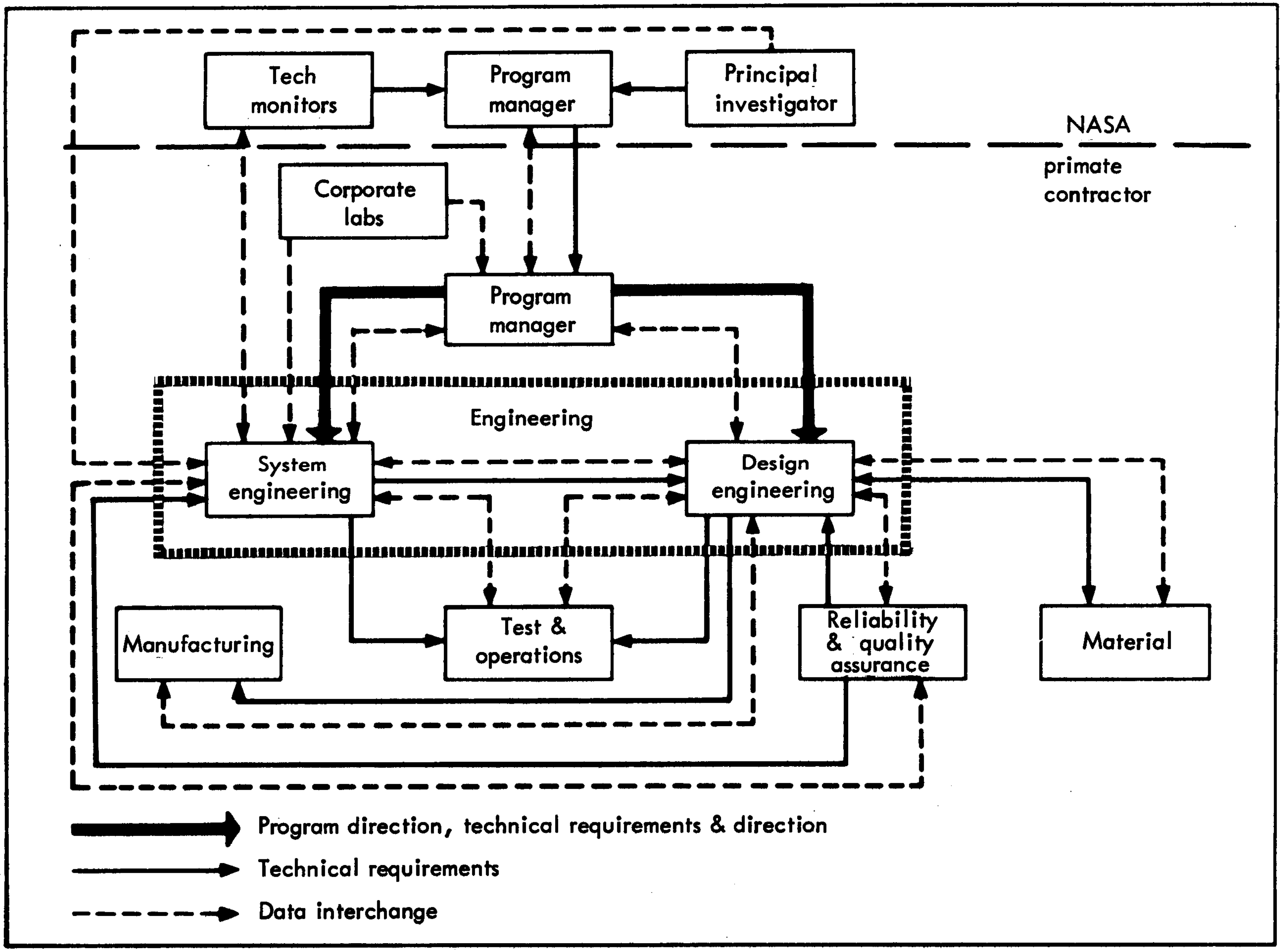


Figure C4. - Engineering interfaces - phase 3

TASK DETAILS

The details of major tasks which the engineering organization will perform in the course of Phase 2 are discussed below. The applicability of these task descriptions to the Phase 3 effort is direct in those cases where they relate to the spacecraft and its GSE. The major difference as pointed out earlier will be that many more additional tasks will be required during Phase 3 to accommodate the needs of that stage of development. These additional tasks will mainly involve the refinement of detail design and its documentation to facilitate fabrication, assembly, test, checkout and launch of the spacecraft with a parallel effort being required to provide suitable GSE.

The tasks are described with reference to the organizational element which will perform it and hence in this respect the discussion supplements the one relating to responsibilities delineated earlier.

System Engineering Tasks

The system engineering tasks serve: to set the overall approach and configuration for the spacecraft system and laboratory model; to assure design compatibilities; to assure compliance with mission requirements. These tasks are as follows:

(1) Task 1 - Review existing requirements and constraints for currency and applicability.

(2) Task 2 - Analyze new requirements and constraints.

(3) Task 3 - Determine overall spacecraft system configuration.

(4) Task 4 - Determine overall Laboratory Demonstration Model configuration.

(5) Task 5 - Define subsystem design requirements and constraints for spacecraft system and Laboratory Demonstration Model.

(6) Task 6 - Define system interfaces for spacecraft.

(7) Task 7 - Define system interfaces for Laboratory Test Demonstration Model.

(8) Task 8 - Define GSE requirements and utilization for spacecraft system.

(9) Task 9 - Define laboratory support equipment for demonstration model.

(10) Task 10 - Perform overall integration function for spacecraft system

(11) Task 11 - Perform integration and liaison for spacecraft mockup activity.

(12) Task 12 - Define system test requirements

(13) Task 13 - Prepare all necessary drawings, specifications, reports to document the tasks performed.

(14) Task 14 - Perform mission and operations analysis.

Design Engineering Tasks

The design engineering tasks, using the system engineering inputs as points of departure, establish the detailed design of the spacecraft subsystems, ground support equipment and Laboratory Demonstration Model; these tasks are as follows:

(1) Task 1 - Analysis of existing data derived during previous program phase to determine applicability.

(2) Task 2 - Define spacecraft subsystem and GSE mechanization based on requirements and constraints delineated by System Engineering.

(3) Task 3 - Define Laboratory Demonstration Model and support equipment based on requirements and constraints delineated by Systems Engineering.

(4) Task 4 - Define spacecraft mockup and breadboard mechanizations.

(5) Task 5 - Establish subsystem test requirements.

(6) Task 6 - Provide necessary liaison support during fabrication, assembly and test.

(7) Task 7 - Prepare necessary drawings, specifications, and reports to document the detail design effort.

SCHEDULE

The schedule for the accomplishment of engineering tasks is shown in figure C5. The engineering task schedule is shown in the context of both the Phase 2 and 3 efforts and is referenced to major program milestones to better indicate the interactions and chronological interrelations which exist amongst the various program stages.

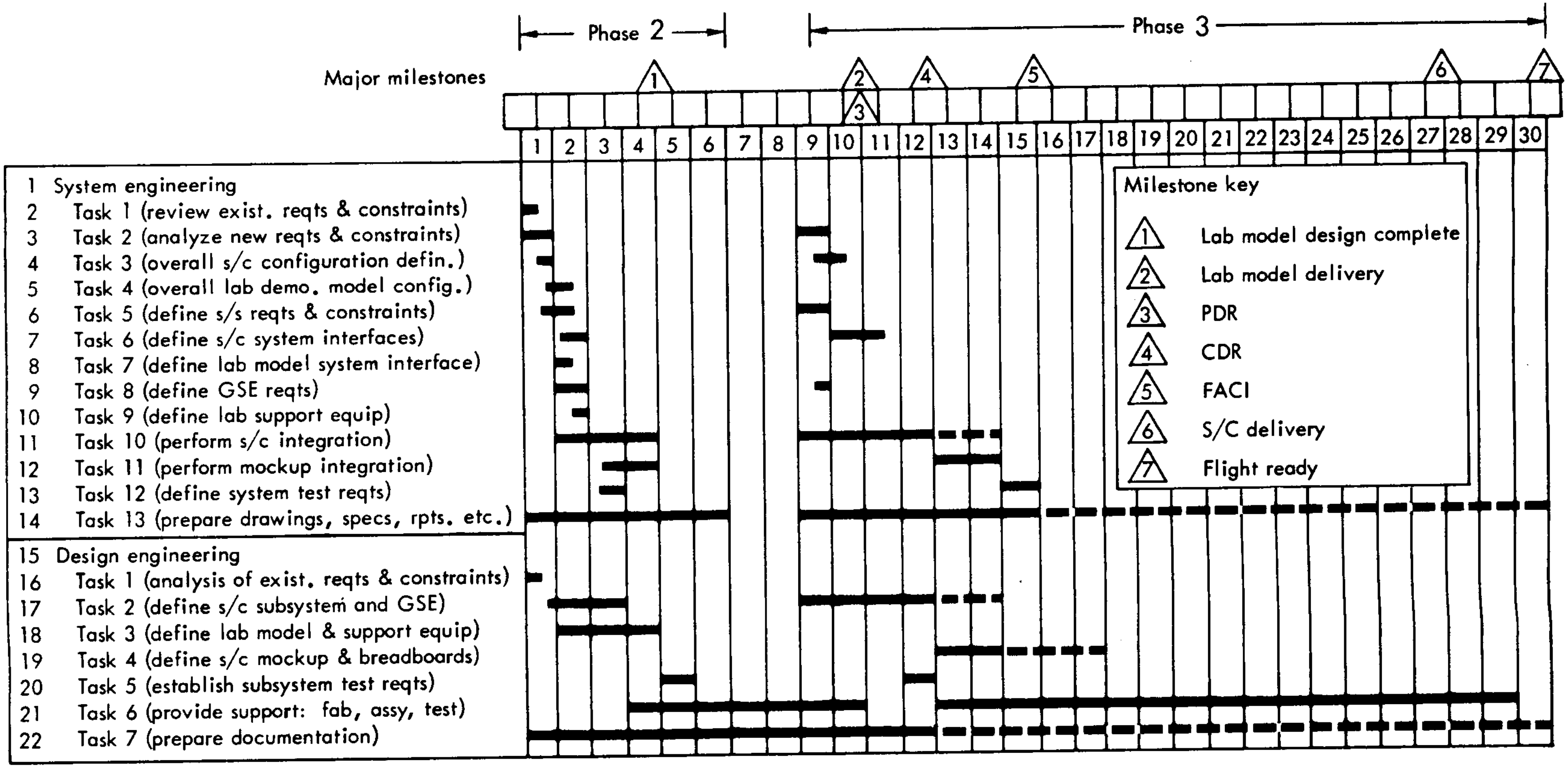


Figure C5. - Engineering task schedule

SUMMARY AND CONCLUSIONS

The Engineering Plan has defined the approaches, organization and schedule for accomplishing the tasks delineated for both the Phase 2 and 3 efforts. The Phase 2 activity has reflected the software nature of the Spacecraft System definition and the more hardware oriented needs of the Laboratory Demonstration Model. The Phase 3 activity is paced to the Spacecraft development involving final design, fabrication, assembly and test. The results of Phase 2 are considered largely applicable to the subsequent phase and as such the latter is considered an extension or continuation of the Phase 2 effort. The major risk problems such as Life Support and Waste Management will largely be resolved during the Phase 2 effort so that the following program phase can be viewed with a high degree of optimism. New equipment development will be minimized through the use of available hardware and techniques with prior history or comparable usage wherever possible; these have been identified as constituting the majority of the spacecraft equipment.

GSE is recognized as a significant area during all phases of the program and as such receives early and continuing attention to assure suitability of function and interface comptability with both the spacecraft and launch facilities.

The overall program aspect taken from an engineering view reflects a significant time constraint which can be accommodated with proper scheduling and phasing of the various program stages.

APPENDIX D
INTEGRATED TEST PLAN

INTRODUCTION

Purpose

The purpose of this plan is to define the requirements for the various types of testing pertinent to the experimental, development, and operational phase of the Orbiting Experiment for the Study of Extended Weightlessness (Primate Spacecraft) program, and to describe the rationale, schedule, criteria and ground rules for conducting the test program. This plan also presents the interrelationships among the test programs, and establishes Northrop's comprehension of the scope and detail requirements of the program, and the physical and technical capabilities to conduct the program.

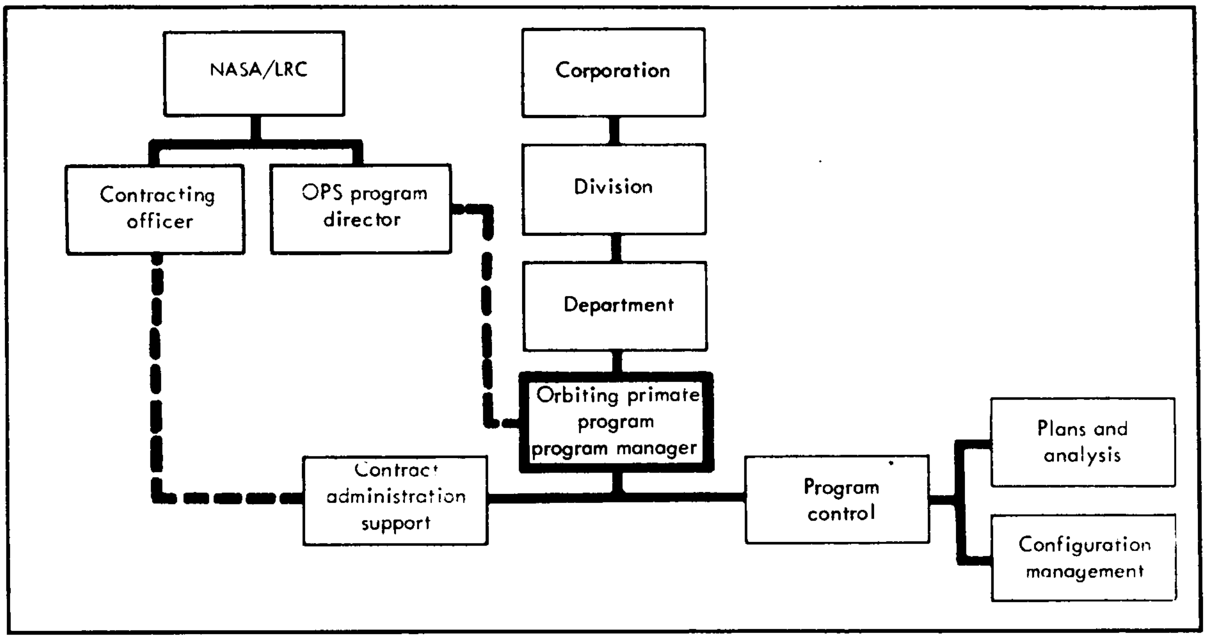
Scope

The Integrated Test Plan encompasses the technical operations of test and support activities which supplement the design, production, quality and field usage of the Primate Spacecraft. It integrates and describes the Laboratory Model Test Program at the Naval Aerospace Medical Institute (NAMI), the contractor's in-plant test program (evaluation, acceptance, and qualification), and the field support activities. It also presents the organizational relationship for this activity and establishes the pertinent schedule of operations.

Organizational Relationships

The conduct of test and field support functions is the responsibility of the Test and Operations element of the Orbiting Primate Spacecraft Program organization. The relationship of Test and Operations with other elements of the program organization is shown in figure D1.

Test and Operations responsibilities include the preparation of test and checkout procedures, selection of test equipment and facilities, design of special test fixtures, performance of tests, and preparation of test reports. These tasks require interface with other program elements and Northrop organizations to assure effective performance and controls. Interface with both Mission and Experiments and with Engineering is required to establish test requirements, assure that the procedures adequately encompass the requirements, and confirm that the test reports have established adequate verification of the design criteria. Interface with Reliability and Quality Assurance includes reliability review of procedures to assure that applicable objectives are achieved, monitoring and inspection of test activities, and review of test reports for accuracy and reliability evaluation. Manufacturing Operations interface is required for the manufacture and procurement of test articles and the fabrication of test fixtures.



Figue D1. - Internal organization

The majority of components selected for use on the Primate Spacecraft Program are purchased items. In all cases, such components are purchased on the basis of having been previously qualified to Apollo criteria, or will have been so qualified by the supplier prior to operational use in the Primate Spacecraft. Purchased items undergo pre-installation acceptance testing at the supplier's facility, and are witnessed by the Northrop Quality Control Group. The NASA personnel may witness such testing at their discretion. Pre-installation acceptance testing by the supplier promotes efficiency in the conduct of tests and minimizes turn around time for substitution of defective components.

LABORATORY MODEL TEST PROGRAM

Objective

The objective of the Laboratory Model Test Program is the orderly and timely acquisition of essential engineering and biological data in support of the long range operational objectives of the Orbiting Experiment for Study of Extended Weightlessness. This initial objective will be achieved as a consequence of the design and construction of a suitable laboratory model, and the operation of the model in conjunction with two primate specimens (Macaca mulatta) for a period of twelve months. Specific data requirements to achieve the objective include:

(1) Operating characteristics of equipment employing basic life support design concepts contemplated for the operational vehicle.

(2) Scaling factors for animal metabolic rates and contamination constituents introduced by the animal and its waste products.

(3) Basic Behavioral response data associated with animal training functions.

Program Responsibilities

The Laboratory Test Model Phase will encompass the detail design of the model, manufacture of one model system and sufficient spare parts to assure continuity of operation, final checkout and acceptance at the contractor facility by the NASA Langley Research Center, delivery to the Naval Aerospace Medical Institute, Pensacola, Florida, final installation and checkout, and testing and evaluation for a twelve month period. Design and manufacturing responsibility rests with the contractor, subject to the design and performance constraints imposed by the NASA, and defined by the approved Master End Item Detail Specification, Orbiting Primate Spacecraft Laboratory Test Model. The twelve month test program will be a joint effort of the NASA Langley Research Center and/or the Naval Aerospace Medical Institute (the Principal Investigator) and the contractor. The Principal Investigator will be responsible for the primate and its behavioral and biological aspects, and the contractor will be responsible for engineering data, performance, operation, and maintenance of the model. The "Program Flow Plan," figure D2 identifies the progression of events associated with the Laboratory Model Test Program.

Model Description

The application of a Laboratory Model Test Program is to substantiate the capability of the operational spacecraft system to meet its objectives. The primate spacecraft system objectives are to provide the means for studying the effect of prolonged weightlessness and to obtain scaling factors for the design of life support equipment in future spacecraft extended missions. The laboratory model, operating under an earth gravity environment, cannot directly achieve the primary objective of the orbiting experiment. However, it will provide supplemental data to assure the integrity of the operational primate spacecraft and to demonstrate compatibility of the primate with the system. The equipment constituting the laboratory model thus will be operated for a twelve month test period providing the life support for two implanted primates (GFE). The test system will be operated within a laboratory ambient environment with control equipment maintaining the primate environment within the specified criteria.

The following paragraphs describe the elements of the Laboratory Test Model and the extent to which they simulate the operational spacecraft.

Life support. - The environmental control and waste management equipment will be constructed in prototype configuration for use during the laboratory model test program. The configuration will not only reflect the functional design characteristics but will also present an interface with the primate identical to the operational spacecraft. The construction of this subsystem will provide the necessary mechanization to demonstrate the effectiveness of of the design and verify that its control elements are indeed compatible with the primate for an extended time period. The performance of the equipment will be continuously monitored by recording ambient conditions within the primate cage as well as the critical operating elements within the basic environmental control system. Thus, deviations from the intended environment may be rapidly detected and minor maintenance or repair requirements can be handled without significant interruptions to the overall test program.

The Primate Life Cell will be constructed to provide an identical configuration with the operational version. The feeder and waterer mechanisms will be prototype versions similar in mechanization to the operation version to the degree necessary to demonstrate the equipment design integrity. Elements of the feeder equipment which interface with the primate will be identical to the operational version to assure effective training of the primate. Dynamic functions of the cage and feeder subsystem will be cycled in a normal manner to demonstrate reliability of the system design as well as its functional operability. Lighting and activity panel configuration will simulate the spacecraft configuration, and cyclic activities will be simulated continuously

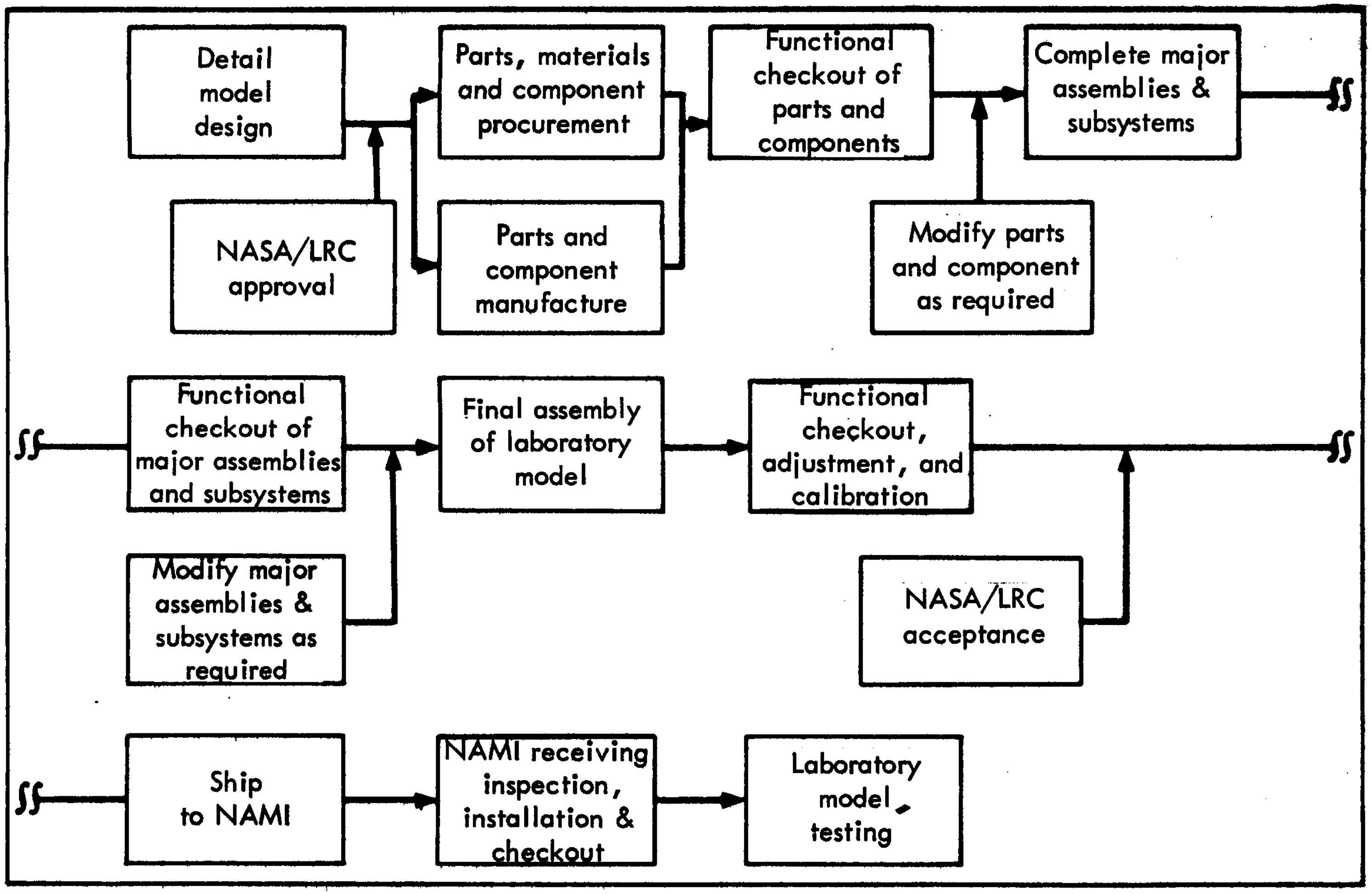


Figure D2.- Program flow plan

during the test period. A mass measurement device of conventional (one "g") type will be provided to monitor primate weight during the test period. The Recovery Capsule will be simulated only to the extent of interior configuration and decor.

Thermal control subsystem. - The passive element of the thermal control subsystem is operated on the basis of radiant heat in a vacuum environment. Since the Laboratory Model Test Program will be conducted under laboratory ambient conditions, operational simulation of passive control will not be provided.

The active elements, which include and control the fluid (freon) transport loop, will not be duplicated, but its characteristics will be simulated by a plant chilled water supply system.

Structure and mechanical subsystem. - The structure and mechanical subsystem will be constructed in sufficient detail to provide structural support and operational integrity of other subsystems in the simulation of the primate interface environment. This subsystem will not be exposed to environments other than laboratory ambient and need only be compatible with its interface hardware during the laboratory test period. Thus, the structure and mechanical subsystem will not constitute a critical phase of the Laboratory Model Program. All necessary developmental and demonstration tests for the subsystem will be performed during the subsequent acquisition phase of the operational spacecraft system program.

Instrumentation subsystem. - The instrumentation subsystem for the Laboratory Model includes commercial television cameras, housekeeping transducers, physiological data pickups, signal conditioning equipment, and activity counter. These elements are requisite to the effective operation of the laboratory model and, to a lesser degree, demonstration of their own functional and reliability characteristics. The selected instrumentation subsystem components will be comprised of a combination of prototype and operational equipment. Performance data of key functions will be monitored by continuous recordings, and television outputs will be received by both video tape and conventional receiver.

Telemetry subsystem. - The telemetry subsystem is comprised of qualified, conventional components which obviate the need for demonstration of operability or reliability. Data transmission from the Laboratory Model will be by hard line. The spacecraft telemetry subsystem will not be employed in the Laboratory Test Model.

Command and control subsystem. - The spacecraft command subsystem consists of the command decoder, programmer/sequencer, and status multiplexer. Its purpose is to decode commands received from the telemetry subsystem and provide timing and control signals. In the Laboratory Test Model, however, telemetry requirements have been deleted and the Behavioral Panel will be controlled by GFE programming and monitoring equipment. Remaining limited sequencing operations will be provided by manually actuated switches and timers thus eliminating the need for provision of either an operational or simulated command and control subsystem.

Electrical power subsystem. - Sufficient operational data exist to obviate the necessity for additional demonstration of the practicality and reliability of solar cell panels and batteries in conjunction with the laboratory test model. Power requirements will be simulated by the use of laboratory power supplies supplemented by emergency battery power, and power usage data will be continuously recorded during the test program.

Attitude control subsystem. - Due to gravitational and installation restraints, the use of an attitude control system in the laboratory test model is not feasible. Consequently, the attitude control system selected for the operational spacecraft will not be installed in the system.

Test support equipment. - Test equipment required to support the Laboratory Model Test Program consists of the data acquisition system for monitoring, recording, and analyzing the biological, behavioral, environmental, and engineering information. Biological and behavioral data outputs will be provided as 0-5 V analog signals to GFE data acquisition system existing at NAMI. The data will then be scanned, digitized, and processed by Univac 418 Computer for storage and analysis. The environmental and engineering data will be processed by contractor furnished equipment to yield primarily strip chart format information. The capability will exist however, for selective data channels to be monitored and processed by the NAMI Computer facility. Strip chart recordings will be provided by multipoint recording potentiometers for temperature and humidity, and a multichannel oscillograph for pressure, current, voltage and function measurements. A digital counter will be provided for periodically monitoring atmosphere flow-meter outputs, and an indicating potentiometer will permit periodic monitoring of the oxygen sensor output. Additional indicating devices include pressure gages, flow indicators, and portable ammeters and voltmeters.

Test Operations Requirements

The Laboratory Model Test Program will be conducted at the Naval Aerospace Medical Institute at Pensacola Florida. It will be conducted as a contractor supported effort for a twelve month period under the cognizance of the NASA/LRC and/or the NAMI Principal Investigator. This section describes the organizational approach and operational requirements requisite to the conclusion of an effective program.

Organization relationship. - The Laboratory Model Test Program will be conducted under the cognizance of the NASA/LRC and/or the NAMI Principal

Investigator, who will be supported by the contractor organization under the cognizance of the contractor test director. The functional relationship is identified in figure D3. The test director will assure the orderly progress of activity in accordance with the test procedure; provide for necessary maintenance or repair of the model; implement modifications as

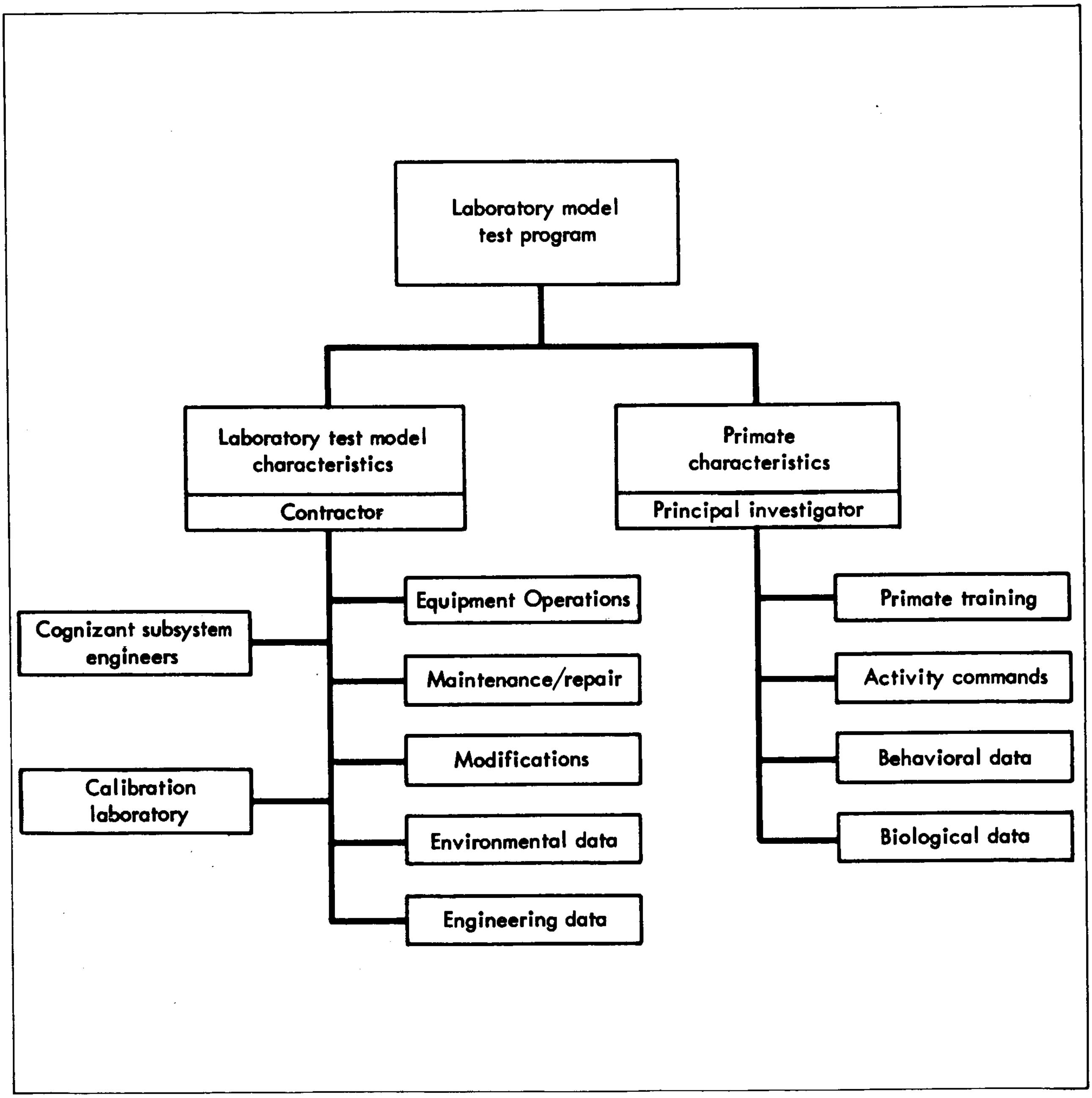


Figure D3.- Functional relationship

required by evaluation of equipment performance or to support deviations in the primate interface requirements as may be established by the Principal Investigator; and assure the effective operation and calibration of test instrumentation. The test director will arrange for the contractor non-resident cognizant engineers to trouble shoot and advise on the subsystems should any major performance discrepancy arise; resident personnel will resolve minor discrepancies to assure continuity of the program.

Instrumentation and checkout. - The Laboratory Test Model and associated instrumentation and support equipment will be received at the NAMI facility, installed, and functionally checked by contractor personnel. The facility utilities will be verified to assure the adequacy of power, chilled water supply, and facility temperature control. The instrumentation will receive calibration checks and will then be integrated with the laboratory model. Gas storage supplies will be weighed and recorded and verification of initial operability will be performed. The primate will be inserted in the Life Cell by the Principal Investigator and the laboratory model sealed in accordance with its normal operating conditions. Food and water storage supplies will be verified as adequate for the projected test duration. Instrumentation will be started and monitoring of equipment and primate functions will be initiated.

Test Description. -

Life support: Measurements will be made of system air velocities in the various elements of the system ducting network to verify proper flow rate and distribution of the gas mixture. Gas flow will also be monitored in the lines down stream of the gas supply regulators to verify make-up gas usage. The gas storage bottles will be mounted on beam balance scales to monitor long term mass transfer to the Life Cell. In addition, the gas storage bottles will be monitored for pressure and temperature as a cross-check on gas usage. Air temperature and humidity will be continuously monitored in the Life Cell and ducting to permit engineering evaluation of the operating characteristics of the life support air conditioning system. Air pressure will be monitored in the Life Cell for absolute pressure determination and across each fan in terms of pressure differential for evaluation of fan performance. The waste storage unit will incorporate a bank of thermocouples for monitoring the temperature profile in the waste bed. The ducting downstream of the waste unit will be monitored for gas flow rate and humidity to determine if clogging of the waste unit occurs and to determine wet and dry cycles of the waste matter. Air samples will be periodically extracted from the system and transported to a chemical laboratory for analysis of the gas constituents. Lithium Hydroxide bed core samples will be extracted periodically and submitted to laboratory chemical analysis to evaluate the composition and condition of the hydroxide bed. Drinking water use rate and food pellet consumption will be monitored to determine the primate consumption rate; this data will be provided in dual outputs to permit recording concurrently by the facility computer network and laboratory instrument recorders.

Instrumentation: Television monitoring of the primate's activity and cage characteristics within the field of view, will be recorded by video tape. Primate audio outputs will be concurrently recorded by video tape during its cycle of operation and will be continuously monitored by a conventional speaker within the laboratory. Biotelemetry data transmission from the primate implants will be received by on-board antenna, processed by commercial type signal conditioners, and transmitted by hard line to GFE facility equipment. Provision will exist for parallel recording by contractor furnished analog equipment. Activity monitor outputs will be dually monitored by the facility computer network and the laboratory event recorder.

Electrical power: The total power consumption of the laboratory model system will be monitored and recorded continuously. Individual power demand rates of the various system components will be periodically sampled at jack points by the use of portable laboratory meters. Provision will exist for continuous recording of selected components as required for more detailed analysis, evaluation, or trouble shooting.

Measurement requirements. - Table D1 defines the individual parameters to be measured during the program and establishes their method of sampling, period of sampling, and recording techniques.

TABLE D1. - LTM MEASUREMENTS REQUIREMENTS ANALYSIS

Parameter	Range	Sensor type	Location	Qty	Time basis (Sample)	Acquisition method	Channels required
Temperature	60-120°F	Thermo-couple	Waste Unit (20 ea)	40	1/Hr.	Printout Recorder	40
	50-120°F	Thermo-couple	LiOH Bed	10	1/Hr.	Printout Recorder	10
		Thermo-couple	LiOH Bed Gas Inlet	1	1/Hr.	Printout Recorder	1
		Thermo-couple	LiOH Bed Gas Outlet	1	1/Hr.	Printout Recorder	1
		Thermo-couple	Heat Ex-changer Gas Inlet	1	1/Hr.	Printout Recorder	1
		Thermo-couple	Condenser Gas Outlet	1	1/Hr.	Printout Recorder	1

TABLE D1. - Continued

Parameter	Range	Sensor type	Location	Qty	Time basis (sample)	Acquisition method	Channels required
		Thermo-couple	Heat Exch. Gas Outlet	1	1/Hr.	Printout Recorder	1
		Thermo-couple	Condenser Coolant Outlet	1	1/Hr.	Printout Recorder	1
		Thermo-couple	Heat Exch. Coolent Outlet	1	1/Hr.	Printout Recorder	1
		Thermo-couple	Condenser Coolant Inlet	1	1/Hr.	Printout Recorder	1
		Thermo-couple	Life Cell (Wet and Dry)	4	1/Hr.	Printout Recorder	4
		Thermo-couple	WU Outlet (Wet and Dry)	2	1/Hr.	Printout Recorder	2
		Thermo-couple	Feeder Vacuum Cleaner	2	1/Hr.	Printout Recorder	
		Thermo-couple	Gas Regen-erator	1	1/Hr.	Printout Recorder	1
		Thermo-couple	Main Fan Outlet	1	1/Hr.	Printout Recorder	1
		Thermo-couple	Main Gas Regen. Outlet	1	1/Hr.	Printout Recorder	1
Gas Flow Rate		Rotary Meter	LiOH Bed Input	1	1/Hr.	Digital Counter	1
		Rotary Meter	H/E Inlet	1	1/Hr.	Digital Counter	Share
		Rotary Meter	Waste Unit	2	1/Hr.	Digital Counter	Share

TABLE D1. - Continued

Parameter	Range	Sensor type	Location	Qty	Time basis (sample)	Acquisition method	Channels required
		Rotary Meter	Condenser Inlet	1	1/Hr.	Digital Counter	Share
		Rotary Meter	Feeder Vacuum Cleaner	2	1/Hr.	Digital Counter	Share
		Rotary Meter	Main Circulation	1	1/Hr.	Digital Counter	Share
Pressure O_2		Electrolyte	Life Cell Inlet Plenum	1	1/Hr.		1
		Perkin/ Elmer	Life Cell Inlet	1	1/Hr.		1
Pressure N_2		Perkin/ Elmer	Life Cell Inlet Plenum	Share	1/Hr.		Share
Pressure CO_2		Perkin/ Elmer	Life Cell Inlet Plenum	Share	1/Hr.		Share
Water Content		Perkin/ Elmer	Life Cell	Share	1/Hr.		Share
Vacuum		Ion gage	Perkin/ Elmer Vacuum Source	1	Continuous	Visual Monitor and Alarm	1
Pressure		Strain Gage Transducer	Across Main Fans	1	1/Hr.	Oscillograph	1
		Strain Gage Transducer	Across Contam. Fans	1	1/Hr.	Oscillosgraph	1
		Strain Gage Transducer	H/E Coolent in to out	1	1/Hr.	Oscillosgraph	1

TABLE D1. - Continued

Parameter	Range	Sensor type	Location	Qty	Time basis (sample)	Acquisition method	Channels required
Video		Camera	Life Cell	2	As Req'd	Video Tape/ Monitor	1
Sound		Micro-phone	Life Cell	2	As Req'd	Loudspeaker/ Recorder	
Animal Temp		Antenna	Primate Implant	2	As Req'd	Meter/ Recorder	2
Animal Position		AGC	Primate Implant	2	Con-tinu-ous	Recorder	2
Valve Position		Switch	Gas Flow Control Valve	7	Con-tinu-ous	Event Recorder	1
Door Position		Poten-tiom-eter	Life Cell Door	2	Con-tinu-ous	Meter	2
Door Position		Poten-tiom-eter	M/V MD	2	Con-tinu-ous	Meter	2
Function		Photo-cell	Feeder Star Wheel	2	Con-tinu-ous	Event/ Time Totalizer	2
		Switch	Waterer Plunger	2	Con-tinu-ous	Event/ Time Totalizer	2
	On-Off	Switch	TE Handle	2	Con-tinu-ous	Event/ Time Totalizer	2
	On-Off	Switch	ILK Handle	2	Con-tinu-ous	Event/ Time Totalizer	2
	On-Off	Switch	Exercise	2	Con-tinu-ous	Event/ Time Totalizer	2

TABLE D1. - Concluded

Parameter	Range	Sensor type	Location	Qty	Time basis (sample)	Acquisition method	Channels required
	On-Off	Lamp	Blue Stimulus	2	Con-tinu-ous	Event/ Time Totalizer	2
	On-Off	Lamp	Yellow Stimulus	2	Con-tinu-ous	Event/ Time Totalizer	2
	On-Off	Lamp	Red Stimulus	2	Con-tinu-ous	Event/ Time Totalizer	
	On-Off	Lamp	Reward Light	2	Con-tinu-ous	Events Recorder	2
Weight	4-8 Kg	Load Cell	M/V MD	2	As Req'd	Digital Volt-meter	1
	0-25	Load Cell	O_2 and N_2	2	As Req'd	Digital Volt-meter	Share

Documentation

The Laboratory Model Test Program will be controlled and recorded on the basis of documentation tailored to the needs of the program. The use of formal documentation assures the orderly progress of the essential sequence of tasks and the comprehensive recording of significant data for the analysis and evaluation of system performance. Test documentation is categorized as procedures and reports.

Test Procedures. - The Laboratory Model Test Procedure will be prepared by the contractor prior to delivery of the test model. The test procedure will identify the test model to the level at which measurements will be made. It will also specify the measurements and the method and frequency for making the measurements. Measurement requirements tables will be included to organize and simplify the logging of data. The test procedure will be prepared for the NASA/LRC review and approval three weeks prior to delivery of the Laboratory Model. Revisions to the test procedure during the actual test operations may become necessary due to the experimental nature of some aspects of the program; any procedural revisions will require the approval of the NASA/LRC.

Test Reporting. - Timely reporting of the progress, status and performance of the system tests is essential for the rapid dissemination of pertinent information. Such information permits suitable response to actual or potential problems and enables effective decisions to be made with respect to equipment design and primate capabilities. Three forms of reports will be employed during the program. These are the flash report, the preliminary test summary report, and the final test report.

The flash report is an informal document in memorandum form. It is used to identify equipment malfunctions or unusual occurrences which should be brought to the attention of the equipment designers or the Principal Investigator. Its normal release schedule is within twenty-four hours of the occurrence of the event to be reported.

A preliminary test summary report will be prepared at the end of the first and second month of testing. These reports will describe the status of the test program and provide preliminary information regarding the primate's condition and engineering analysis of the equipment performance. At the conclusion of the third and final month of testing, a final test report will be prepared, which summarizes the results of the test program and incorporates an analysis and evaluation of the system operating characteristics. The final test report will identify significant data trends and provide the means for establishing design functional or configuration modifications essential to the success of an operational version primate spacecraft.

IN-PLANT INTEGRATED TEST PROGRAM

Objective

This section describes the requirements and method of testing for supporting the derivation of the operational configuration spacecraft (development and evaluation tests); verifying that the design and construction satisfies the operational criteria for performance (qualification tests); assuring that deliverable hardware meets the quality standards and functional criteria (acceptance test); and providing the means for factory level trouble shooting, failure analysis, and reliability evaluation after delivery of flight hardware system simulator. Figure D4 presents the test sequence flow diagram for the integrated in-plant test program.

Program Responsibilities

The in-plant integrated test program encompasses the developmental, evaluation, acceptance, and qualification tests, which are performed to assure the effective development, production, and performance of the operational Primate Spacecraft. The responsibility for accomplishing these tests is assigned to the Test and Operations organization through the program manager. Figure D5 describes the organization relationships for implementing the in-plant test program.

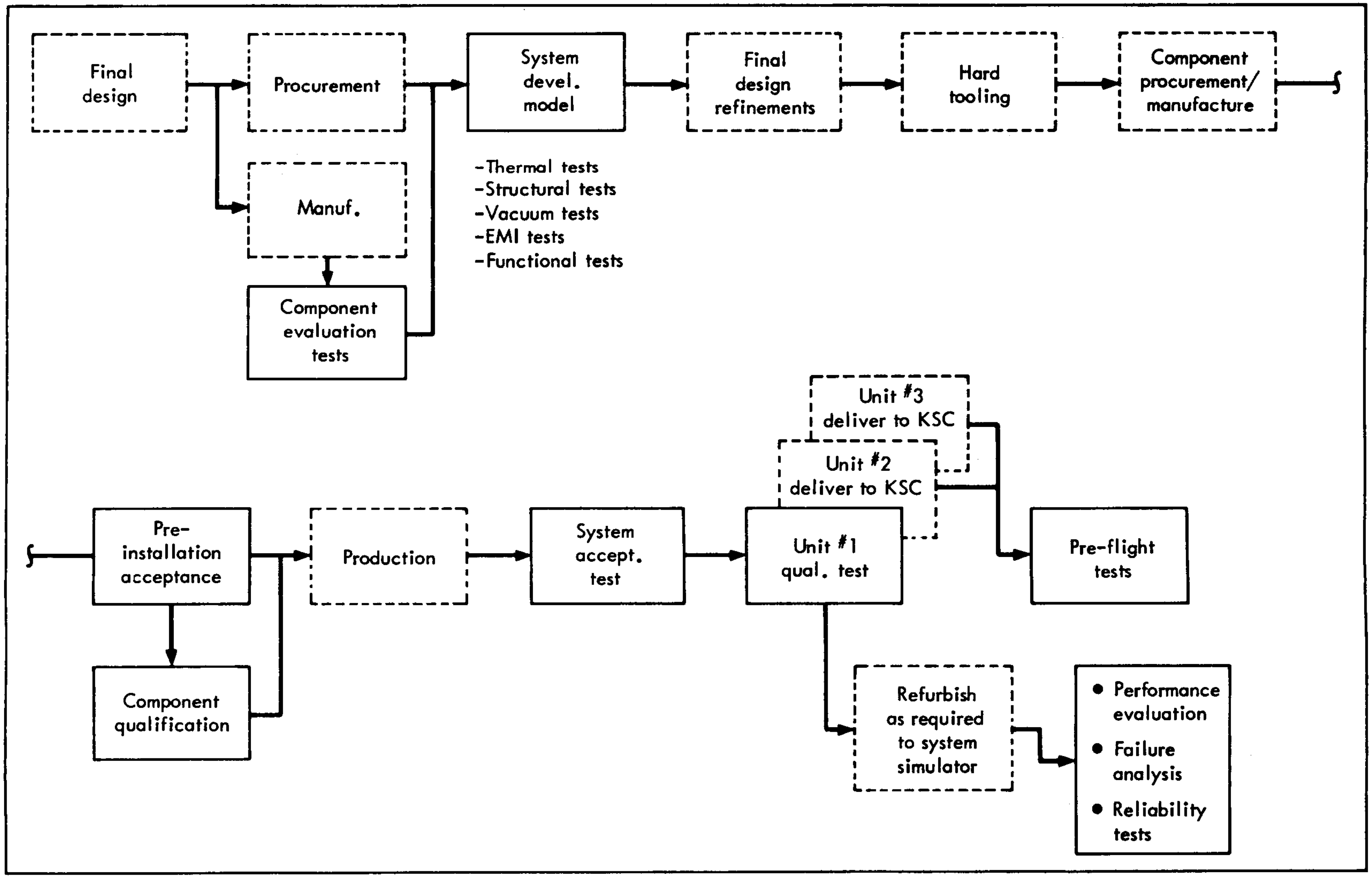


Figure D4.– In-plant test program flow plan

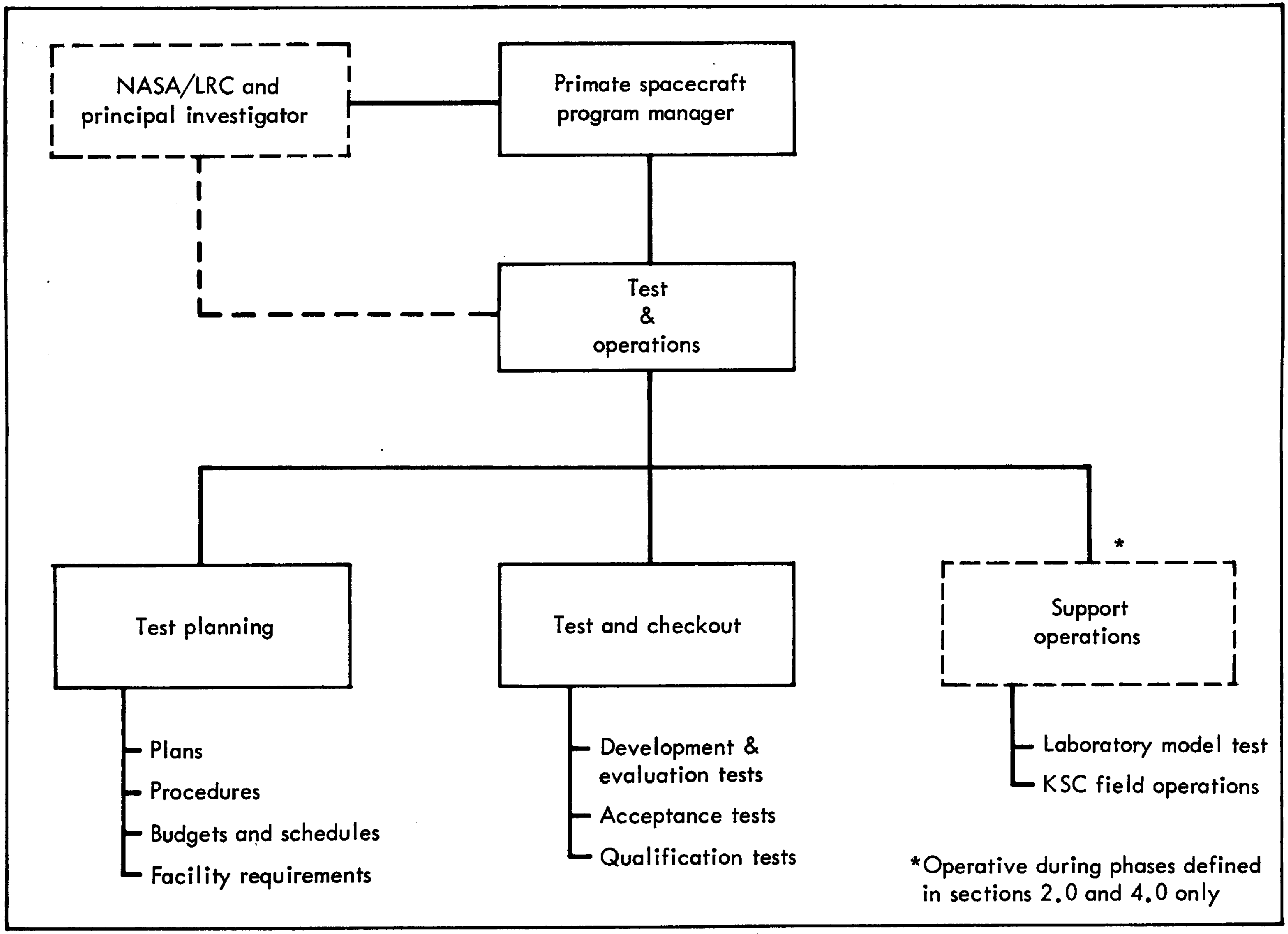


Figure D5.- Functional organization chart

Test and Operations will plan, organize and control the test program in accordance with the overall program requirements for tasks and schedule. The Test and Operations Supervisor will effect a direct and informal communications link with the cognizant counterpart personnel at the NASA/LRC and with the Principal Investigator as required with respect to status, progress, and performance of the test program. Formal communications will be maintained through the program manager.

Development, acceptance, and qualification testing of purchased components will be performed by the component supplier under the cognizance of Test and Operations, while on-site monitoring of suppliers' efforts will be satisfied by Quality Assurance. Plans and procedures prepared by suppliers will be reviewed by Test and Operations for consistency with Northrop and the NASA/LRC requirements. The NASA/LRC will retain the option to review and approve supplier plans and procedures.

Evaluation Test Plan

Each element of the Primate Spacecraft System must be evaluated for performance with respect to its application. Where confidence has been established in the performance of a part or component due to prior qualification, justifiable similarity of application, or rigorous analysis, further demonstration by test is unnecessary. However, newly designed, developed, or applied equipment requires physical demonstration and evaluation of suitability. In some cases, modeling techniques may be satisfactory; in other cases, environmental and functional testing of the actual equipment is employed. Whenever evaluation tests are conducted, performance data is provided the responsible design engineer immediately upon its availability and validation for accuracy, to assure that any necessary design changes can be initiated without serious impact on the program schedule.

Component tests. - Developmental evaluation tests at the component level will be limited to those components which are newly designed for this program and have no prior qualification or opertional history. Such tests will include evaluation of functional characteristics and of resistance to the anticipated environmental stresses.

Life support equipment: Development test requirements exist for various components within the Environmental Control and Waste Management Subsystems, as well as for the integrated subsystems. These subsystems will be developed on a subcontract basis by (subcontractor) and the development test program related to this equipment is separately defined in the (Subcontractor)Program Plan. The test program requirements will be consistent with the Northrop Procurement Specification for the equipment.

The feeder and waterer devices consist of mechanisms of conventional design, and parts and materials which have extensive prior qualification and/or operational histories. The purpose for conducting the tests is to verify the operation as integrated assemblies, and establish confidence in the functional characteristics, repeatability and durability for an extended operating period.

Initial tests of the feeder will verify the operations and actuations of individual critical parts, and refine essential adjustments. Subsequent testing will verify the operation of the assembly following shock, vibration, and acceleration environments, and during exposure to cyclic temperature and humidity, and possible fungus or bacterial growth.

Testing of the waterer will establish reliable operation and leakage rate of the water ejection mechanism, durability of the primate mouthpiece, and performance of the storage container. Testing will be performed at an accelerated cycle rate to demonstrate the long term operability of the assembly.

A prototype of the Recovery Capsule will be constructed in accordance with the preliminary design configuration. It will be evaluated for compatibility with the primate and modified as required to optimize its configuration. The preliminary design closure method will be incorporated to evaluate its compatibility with the primate and to assure that the primate cannot forcibly open it or cause an impediment in the proper closing. The recovery capsule will be evaluated for retrieval method to verify that EVA techniques can be performed in accordance with the design concepts. The capsule door sealing method will be tested to assure satisfactory performance in effecting a leak-proof seal for the capsule during the EVA recovery phase. The test will be conducted by incorporating the device in the capsule and door assembly and operating the assembly within an evacuated space chamber to evaluate its performance.

A prototype of the extractor device will be evaluated to determine the feasibility of employing such techniques. The devices will be tested with the primate cage, recovery capsule, and primate as an integrated subsystem and functional characteristics of the devices will be monitored during its operation to determine its compatibility as a system element.

The mass/volume measurement device will be developed to achieve periodic measurement of the primate mass under a zero g environment during the development phase of the Primate Spacecraft Program. The equipment in its various potential configurations will be subjected to functional tests under 1 g and simulated zero g (horizontal freedom) environment of shock, vibration, and acceleration to verify its resistance to these transient, but non-operating conditions. Climatic conditions, as exposure to the surface material may permit, will not be included in developments tests due to the selective application of climatically resistant materials. Functional media in the instrumentation portion will be subjected to the applicable climatic environment, to the extent that exposure is possible. Under these conditions, accelerated life testing techniques will be employed to verify the adequacy of the equipment design and material selection.

Thermal control equipment: The temperature controller will be constructed in prototype configuration and subjected to functional and environmental tests as required to demonstrate its satisfactory functional performance and environmental resistance. Environmental testing will include shock, vibration, acceleration, temperature extremes, and exposure to space vacuum.

A prototype of the space radiator device will be subjected to thermal vacuum tests in the Northrop space chamber to verify its performance capabilities at maximum and minimum thermal extremes. It will be tested in conjunction with the thermal control subsystem (prototype) to properly simulate the conditions required for spacecraft thermal control.

Structural and mechanical equipment: General functional and structural resistance tests of the structural and mechanical equipment will be performed in conjunction with the structural test phase of the system development model.

Additional specific functional tests will be performed on active devices such as hinges, actuators, and brackets. Functional mechanical devices located external to the pressure shell will be required to demonstrate performance under a thermal vacuum environment. Equipment located within the pressure shell will be subjected to temperature, humidity, and simulated salt contaminant atmosphere. Functional checks will be performed subsequent to the imposition of dynamic environments.

Instrumentation equipment: The majority of components comprising the instrumentation subsystem will be selected on the basis of prior qualification. Those components which currently require additional development include the TV recorder, elements of the signal conditioning equipment (receivers, selection box, demodulator) and the mass spectrographic gas analyzer. It is anticipated that the gas analyzer supplier will complete development and qualification of the unit prior to its required application with a contingency provision of the use of alternative gas analysis techniques. The remaining components requiring development will be subjected to functional and environmental tests to assure compatibility with operational requirements.

Telemetry equipment: All components within the telemetry subsystem have been selected on the basis of prior qualification and require no additional development testing. The antenna will require selective calibration for the application and calibration checks and measurements will be made.

Command and control equipment: The program sequencer and decoder will be designed to be specifically applicable to the Primate spacecraft requirements. Subsequent to breadboard functional checks, these components will be constructed in prototype configuration and subjected to final functional tests and environmental exposure. The equipment will be required to demonstrate operability subsequent to dynamic environment and concurrent with the induced climatic environment within the Primate spacecraft.

Electrical power and cabling equipment: All parts and components selected for use in the electrical power and cabling subsystem have been qualified for prior programs and will require no further development tests. However, subsystem and system level electrical checkout and interface compatibility tests will be performed to verify the system and equipment operability with relation to interfacing equipment.

Attitude control equipment: The attitude control system components include three gyroscopes,sun sensors, a nitrogen supply system, plumbing complex, solenoid jet valves, and logic circuitry for system sequencing and operation. The subsystem will employ qualified components in all cases except the logic and control circuitry. Development and evaluation testing will be required of the circuitry and the integrated subsystem to assure proper operational characteristics.

Breadboard circuitry will be constructed to supplement analytical design of circuit operation. A prototype (or brassboard) configuration will then be built to verify operation during and resistance to environmental stresses such as temperature, vacuum, shock and vibration. The subsystem will be subjected to a pneumatic test sequence (pressure drop, regulation, filtration proof pressure, leakage, and storage capacity) coupled with the dynamic effects of vibration. Subsystem operating characteristics (acquisition, stability and control), will be verified by use of a rate table and simulated sun.

System development model.- A system development test model program will be initiated during the final design period to establish an empirical evaluation of the primate spacecraft system performance. The system development model program will require the construction of two system level models for complementary and concurrent testing of different aspects of the system operational requirements. One system model will be employed as a structural test model and will subsequently be used for functional checkout. The second model will be used as a thermal test model for evaluation tests in the thermal vacuum space chamber Specific advantages of the use of such models include:

(1) Confirmation of design functional characteristics

(2) Confirmation of resistance to environmental stresses

(3) Availability of operating hardware to check out design modifications

(4) Verification of mechanical and electrical interfaces

(5) Checkout of ground support equipment

(6) Detection of potential reliability problems

(7) Accumulation of operating experience

(8) Checkout of hard tooling for operational models

(9) Refinement of acceptance checkout techniques

(10) Development of efficient prelaunch maintainability techniques

(11) Availability of a training medium

(12) Provide demonstrable confidence in initiating the qualification test program.

Figure D6 describes the System Development Model flow plan.

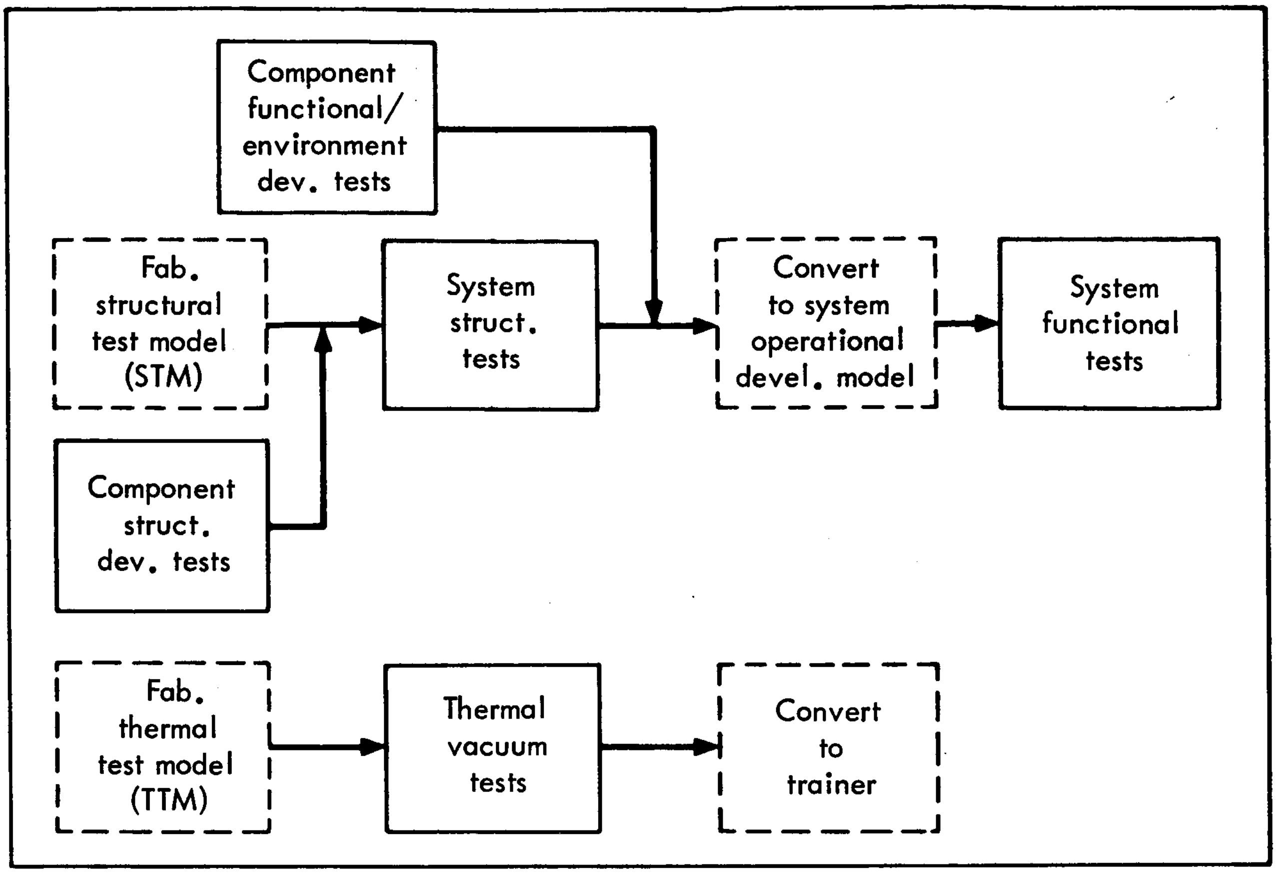


Figure D6.- System development model flow plan

Structural test model, structural static tests: The System Development Models will include a structural test model (STM) to verify the design characteristics under static structural tests. The basic structure and pressure shell will be subjected to internal pressure and pure stresses. The nominal design pressure for the spacecraft pressure shell is 14.7 $\pm$ 2 psia. The ultimate design characteristics, based on a safety factor of two, is 33.4 psia. Since only one structure will be built for developmental purposes, and future tests will be required of the structure, the specimen will not be tested to the ultimate strength limit of 33.4. However, a 10 percent reduction to a pressure of 30 psia will be employed in verifying the structural characteristics of the spacecraft design, while minimizing the possible effects of permanent deformation in the region of the ultimate design limit. Future operational vehicles, designed to the same basic conditions, will be tested to the proof pressure level of 23.4 psia.

The ultimate pressure test will be conducted by using ordinary air as a pressurizing medium. The spacecraft will be installed in the Northrop Fragmentation Test Cell to assure safety of personnel and test equipment in the event of destruction of the specimen during the test. During the test, the test specimen will be instrumented by the application of strain gauges to areas of anticipated high stress levels. Structural stress will be monitored continuously during the gradual pressure rise as well as the pressure holding period of 15 minutes. The test data will subsequently be analyzed to evaluate the structural characteristics of the pressure shell. Structural tests of the pressurized structure will be conducted by applying static loads at the tie points of the basic structure equal to an equivalent loading of the spacecraft when subjected to a 3.7 g actual acceleration load. Significant areas of possible high stress concentrations will be strain gauged and the material stress monitored and recorded continuously during the test to permit evaluation of the structural characteristics of the structural members.

Structural test model, structural dynamic tests: The structural test model will again be employed to evaluate the design with respect to structural dynamic resistance. Dynamic requirements in the structural design include resistance to vibration, shock and transient acceleration peaks. The structural dynamic tests of the test model will be limited to vibration testing. The vibration condition is the one which imposes the most complexity in the design analysis and the vibration test can be designed to include much of the shock and acceleration requirements. The test model will be subjected to a sinuosidal sweep of up to 6 g to identify resonant frequencies of the structure within that range and to determine the effect of the various vibration frequencies upon the basic structure. The structure will be monitored at various points to determine the amplification factors of the vibration inputs through the structural system. In addition, the 6 g level of vibration will encompass the basic design criteria for shock level and acceleration. Prototype subsystems, which are available at the time of the test, will be included in the test model. Those subsystems and components, which are not available, will be simulated by the attachment of simulated component and subsystem masses to produce the proper resonant characteristics of the total system.

Thermal test model: The system development model will include a thermal test model (TTM) for purposes of evaluating the thermal balance of the system and the design characteristics of the thermal control subsystem. Thermal centers will be incorporated within the spacecraft to simulate the heat output conditions for both equipment and the primates. The system will include the thermal control subsystem and the radiant panels of prototype version. The test model will be installed in the Northrop 12 foot diameter Space Simulation Chamber and will incorporate heating panels to simulate the solar input on the surface facing the sun. The chamber walls are provided with nitrogen flooded shroads for simulating the black space sink environment. The test model temperature will be continuously monitored at various points for determining the heat balance characteristics. The heat input to the system will also be monitored to verify the performance characteristics under a varying heat load condition.

Functional test model: The structural test model will be refurbished after use to establish a functional test system. Initial testing of the refurbished system will include a checkout for compatibility of all electrical and mechanical interfaces. Initial mating tests of subsystems will be performed; electrical continuity will be checked; and ground support equipment will be connected to verify compatibility and functional characteristics. All instruments will be calibrated, and signal stability and continuity will be verified. As production jigs, fixtures and other hard tooling are developed, they will be checked against the model for fit and function. The system will be evaluated for susceptibility to, as well as generation of, electromagnetic interference.

Acceptance Test Plan

Each item of deliverable hardware will be subjected to acceptance testing to verify operational integrity of the equipment. Testing will be performed at both the component/assembly level and at the system level; these levels are identified as pre-installation acceptance and acceptance tests, respectively.

Pre-installation acceptance tests. - Pre-installation acceptance (PIA) testing is a functional check of a part, component, or subassembly, manufactured "in-house," by a subcontractor or vendor, or furnished as GFE. Its purpose is to verify that the article is of proper fit, form, and function prior to incorporation in the next level of assembly. Components procured from suppliers will receive PIA tests by the supplier in accordance with Northrop approved procedures and subject to witnessing by the Northrop Quality Control Group. Testing performed at the supplier's facility will obviate the need for duplication of specialized test equipment and facilitate corrective action or replacement if defective components should be encountered. Components and assemblies manufactured by Northrop will receive PIA tests prior to each successive significant level of assembly. In all cases, the NASA representatives maintain the option to witness PIA testing at their discretion.

Limited environmental exposure will be provided to verify the quality of production and satisfy critical functional verifications. Components will be subjected to low level sinusoidal vibration sweeps to assist in the detection of stray parts or particles, loose parts or fasterners, and defective electrical joints (solder) and terminals. Components which normally operate in vacuum or at temperature extremes will be functionally checked under the applicable environment to verify proper operation. Pressure vessels and plumbing assemblies will be subjected to proof pressures, and sealed components will be leak tested.

Acceptance tests. - Acceptance testing provides for the complete electrical, mechanical, and visual checkout of the primate spacecraft as well as GSE and other deliverable hardware. Acceptance testing of spacecraft equipment will include selective application of vibration and thermal-vacuum environments to assure the integrity of equipment installation and compatibility with the space environment. Acceptance testing will be performed at the Northrop facility by the Test and Operations unit. Testing will be performed in accordance with the NASA approved test procedures, and the results documented by data sheets. Testing will be witnessed and verified by Northrop quality control representatives and by the NASA representative or his designate. Final acceptance will be satisfied by completion of Form DD-250, which establishes conformance with the required testing, inspection, and preparation of the hardware prior to shipment.

The following test requirements apply to the Acceptance Test Program:

Article	Quantity	Test
Laboratory Test Model	1	Functional
Qualification Model	1	Functional/Environ.
Flight Model	2	Functional/Environ.
Ground Support Equipment	2	Functional/Environ.

Laboratory test model: Acceptance testing of the Laboratory Test Model will consist of functional check-out and operational compatibility with its interface equipment. The LTM will be visually inspected to verify conformance with production requirements and freedom from obvious mechanical defects. The LTM will then be mated with its applicable support equipment, which consists primarily of recording and signal conditioning equipment and will be subjected to an operational sequence. Upon completion of the functional check-out, the LTM will receive acceptance approval in accordance with Form DD-250 and will subsequently be prepared for shipment to the NAMI facility at Pensacola, Florida.

Qualification model: All equipment scheduled for qualification testing will be subjected to the acceptance test procedure designated for flight hardware. At the component and major assembly levels, testing designated as pre-installation acceptance will satisfy the requirements of acceptance. A formal system level acceptance test will be performed on the qualification system model and will consist of functional, compatibility, and limited environmental tests. The qualification model will be subjected to a low level sinusoidal vibration sweep over the range of 5 to 2,000 Hz at a level of 1 g RMS. The vibration testing will be performed with the system in an operational mode; electrical outputs will be monitored continuously during vibration and the system will be physically observed for unusual deformation or indication of loose or separated parts. A thermal vacuum acceptance test will be performed in which the spacecraft will be subjected to a vacuum of 1×10^{-5} torr (or greater) and the system will be exposed to a radiant panel wherein the temperature is cycled over the range of -100°F to +200°F for eight hours. Functional checkout of the spacecraft will be performed in conjunction with operational Ground Support Equipment to verify both the functional characteristics and interface compatibility. Formal acceptance of the qualification model, as evidenced by Form DD-250, will not be established at this point to facilitate satisfactory completion of the qualification test program, should subsequent equipment modifications become necessary.

Flight models: Each flight model will be subjected to the acceptance test procedure as previously described for the qualification model. Upon completion of the acceptance test, each flight article will be formally accepted at the Northrop facility in accordance with Form DD-250 and prepared for shipment to the facility designated by the NASA/LRC.

Ground support equipment: Acceptance testing of the Group Support Equipment will consist of a functional (electrical and mechanical) checkout and an interface operability checkout with the Primate Spacecraft system. Low level vibration testing will be performed to verify mechanical integrity; however, simulation of thermal vacuum environment will not apply to Ground Support

Equipment. Form DD-250 acceptance will be performed at the Northrop facility. Subsequently, one set of Ground Support Equipment will be shipped to the NASA/LRC designated facility and the other set will be retained at the Northrop facility for use in further acceptance testing and qualification testing.

Qualification Test Plan

Qualification objectives. - The Qualification Program will be conducted in the most economical manner consistent with a thorough and rigorous establishment of confidence in the equipment meeting its design requirements and performing its function for its use cycle.

Qualification tests of the Primate Spacecraft will demonstrate the ability of the equipment to function in accordance with its design criteria while subjected to an environmental spectrum which simulates its normal operating environment. Conventionally, this is accomplished by subjecting the equipment to sequential, singly applied environments at design limit conditions (design limit test), and a second set of equipment to one operational cycle and one subsequent mission cycle at normal mission conditions (endurance test). These tests include both natural and induced environments which simulate, as closely as required, the anticipated environments during the operational cycles in level, range, and sequence. As a practical consideration, however, such test requirements will apply only to those articles for which a less costly qualification cannot be established.

Many elements of the Primate Spacecraft are identical or similar to previously qualified equipment, or can be shown by analysis to be able to withstand the environmental conditions. Where this can be established, independent tests of the article may be deleted. Where multiple cycle testing is completely redundant for adequate demonstration, it may be reduced; where the application, intensity or duration of any environment within the basic Apollo criteria is not directly applicable to the Primate Spacecraft, it may be modified or deleted. Thus, valid justification will be shown to exist to reduce the complexity, cost and time of the qualification program without compromising the rigor as a basic program objective.

Administration. - The responsibility for determination of the qualification status of equipment, subject to the NASA approval, rests with the Reliability function. This responsibility is supported by the efforts of Design Engineering for establishing performance criteria, and by Test and Operations for conducting the qualification test program and evaluating test methods of vendor qualification programs.

All equipment manufactured by Northrop will be qualified by Northrop. The Test and Operations Section is responsible for preparing the qualification test procedures, conducting the test, and preparing test reports to assure that the test article has been effectively excercised through its functional and environmental requirements to establish its qualification status. This condition can only be established by effective interface with other responsible organizations. Design Engineering provides the performance criteria which are incorporated in the test procedures, and in conjunction with Reliability, establishes which environmental tests may justifiably be waived. Such waivers will be subject to the NASA approval. Quality Control monitors the testing process to assure conformance to procedures, accurate transcription of data, and calibration of instrumentation. Test reports are reviewed by Design Engineering to determine the equipment performance, by Reliability to support the reliability analysis and establish the equipment qualification status, and by Quality Control to verify the accuracy of the test results. The test report is submitted to Program Operations which maintains the document interface with NASA. Manufacturing Operations interface establishes the manufacture and procurement of test articles and the fabrication of test fixtures.

Qualification basis.-

Test article criteria: Each test article subjected to the qualification procedure will be of flight hardware configuration. It will be manufactured with production tooling in accordance with the flight article production methods. In accordance with the policy of maximizing hardware utilization, refurbishing or replacement of time dependent and "one-shot" devices will be permitted where it is consistent with proper demonstration of performance. Refurbished equipment will be subjected to rigorous inspection and approval by the NASA prior to reuse.

Prior to initiation of any formal qualification test functions, each test article must have satisfactorily completed its acceptance test. Acceptance test criteria include functional performance of each test article in accordance with end item factory checkout procedures. Acceptance test requirements for the qualification model are identical in all respects to the acceptance test requirements for flight hardware. Qualification of the Primate Spacecraft is deemed complete upon acceptance and approval of the final qualification report by the NASA. Submittal of the report is preceded by conformance to all criteria which are essential to the demonstration of qualification. Additional qualification criteria include preparation of test procedures and reports, maintenance of the Qualification Status List, and completion of the Qualification Readiness Review.

Qualification readiness review: Before equipment is committed to a formal qualification test program, it must be demonstrated that there is reasonable assurance that the equipment can complete the qualification program. This assurance is obtained from several sources including design verification testing, status of the design effort, and the analysis of failures which have occurred, as described in the Reliability Plan Appendix.

At least ten days prior to the scheduled date for committing equipment to a qualification test, information is provided for the NASA to formally review and evaluate the contributing factors to determine the state-of-readiness for qualification. The required information is submitted as a part of the Qualification Status Report and consists of the following:

(1) Design Verification Tests

A description of the testing procedures.

A physical and technical description of the test article (specimen) equipment, facilities, and setup.

The variable data and data analyses of the conditions imposed, the test article's reaction to those conditions and the resulting performance of the test article.

A correlation of test results to Failure Mode and Effects Analyses.

(2) Design Status/Configuration - This includes a presentation of the current design including all changes and the logic for the change, and a correlation between the characteristics of this "final" design and the design verification test article.

(3) Failure Reporting and Analysis - There shall be available a listing of all failures that have occurred during the developement of the equipment and the resulting corrective actions. An analysis of the effects of the failure and corrective action upon the confidence associated with completing qualification is also included.

The result of this review is a decision to proceed with qualification or direction as to what must be done before qualification can commence.

Requalification provisions: Requalification of a test article shall be required when: (1) The test article fails to conform to the performance specification when subjected to environmental conditions; (2) The imposed condition has been shown to be no longer representative of anticipated conditions, or, (3) The test article is no longer considered representative of the deliverable flight article.

(1) Test Article Malfunction - Continuous monitoring of the test article and its recorded data provides a timely indication of nonconformance to the specification requirements. Should failure of an article be determined during a test inspection, testing of the individual article is discontinued pending resolution of the problem area. A Failure and Correction Taken (FACT) report is prepared describing the nature of the failure and surrounding conditions existing at the time. The NASA shall be notified of the failure by TWX within twenty-four hours of its occurrence.

An initial investigation is conducted to verify that the malfunction was, in fact, traceable to the test article and not to the simulation, monitoring or measuring equipment, or human or procedural error. The environmental simulation conditions are reviewed to assure that the imposed environment was not in excess of the specific criteria. When it has been confirmed that the malfunction was due to an inherent characteristic of the test article, a study of the failure mode is performed by the responsible design and reliability personnel to investigate the cause of the failure and determine the nature of the characteristic design or fabrication weakness. Failure analysis testing is conducted as required to investigate the failure or verify the cause and solution. When a malfunction is attributed to test equipment, procedural or human error, the cause will be eliminated and testing continued. However, the NASA approval shall be required before qualification testing may be resumed.

(2) Revision of Environmental Criteria - As a consequence of a continual upgrading and re-evaluation of the anticipated environmental spectrum, it may become necessary to revise the environmental criteria during or subsequent to its imposition. If an environmental condition has been downgraded subsequent to successful completion of a test phase, the test article is considered acceptable and no additional testing is required. However, should the environmental condition be increased in severity, retesting is required. Evaluation of the test article is made to determine if it can be resubjected to the environment. However, consideration is given to degradation of the equipment subsequent to the first environment and a new or refurbished test article may be employed, if required. A revision of the environmental criteria requires review of the test procedures to assure compatibility with the design requirements.

(3) Test Article Changes - Should any design change, material or part revision, or manufacturing process change and affect the congruency of a test article to the flight hardware, retesting is required to the latest configurtion. A review of the test article and the environmental conditions is made to determine if any of the previous test remains valid. Any phase of testing which is deemed valid does not require repetition.

Test article. - Qualification testing of the Primate Spacecraft is performed in two significant stages. The first stage consists of tests of components or assemblies of components, and the second consists of test performed on the integrated spacecraft system. Figure D7 depicts the equipment-test relationship.

Components manufactured by Northrop will be qualified at the Northrop facility in accordance with NASA approved qualification test procedures. Two sets of each such component will be manufactured for component qualification tests. One set will be subjected to design limit tests; the second set will be subjected to endurance tests. Selected components will be refurbished and subsequently employed in the post-qualification test program. Equipment at the component and part level procured from suppliers will be selected on the basis of prior qualification, or the supplier's ability to qualify the equipment prior to delivery to Northrop. Test and Operations will act in a supporting function by reviewing test procedures and methods to assure compatibility with the rigorous standards applied to Northrop qualification test methods.

One Primate Spacecraft system will be constructed for qualification testing at the Northrop facility. The system will be subjected to the endurance test sequence to demonstrate compatibility with the mission requirements, and subsequently refurbished for use as the System Simulator Model.

The ground support equipment does not include any mission essential equipment and consequently, will not be subjected to environmental qualification test. Functional acceptance testing coupled with a vigorous design review encompassing its applicable environmental resistance criteria, will satisfy the requirement for confidence in GSE operability.

Environments and duty cycles. - The environments and duty cycles applicable to the Orbiting Experiment for Study of Extended Weightlessness mission are

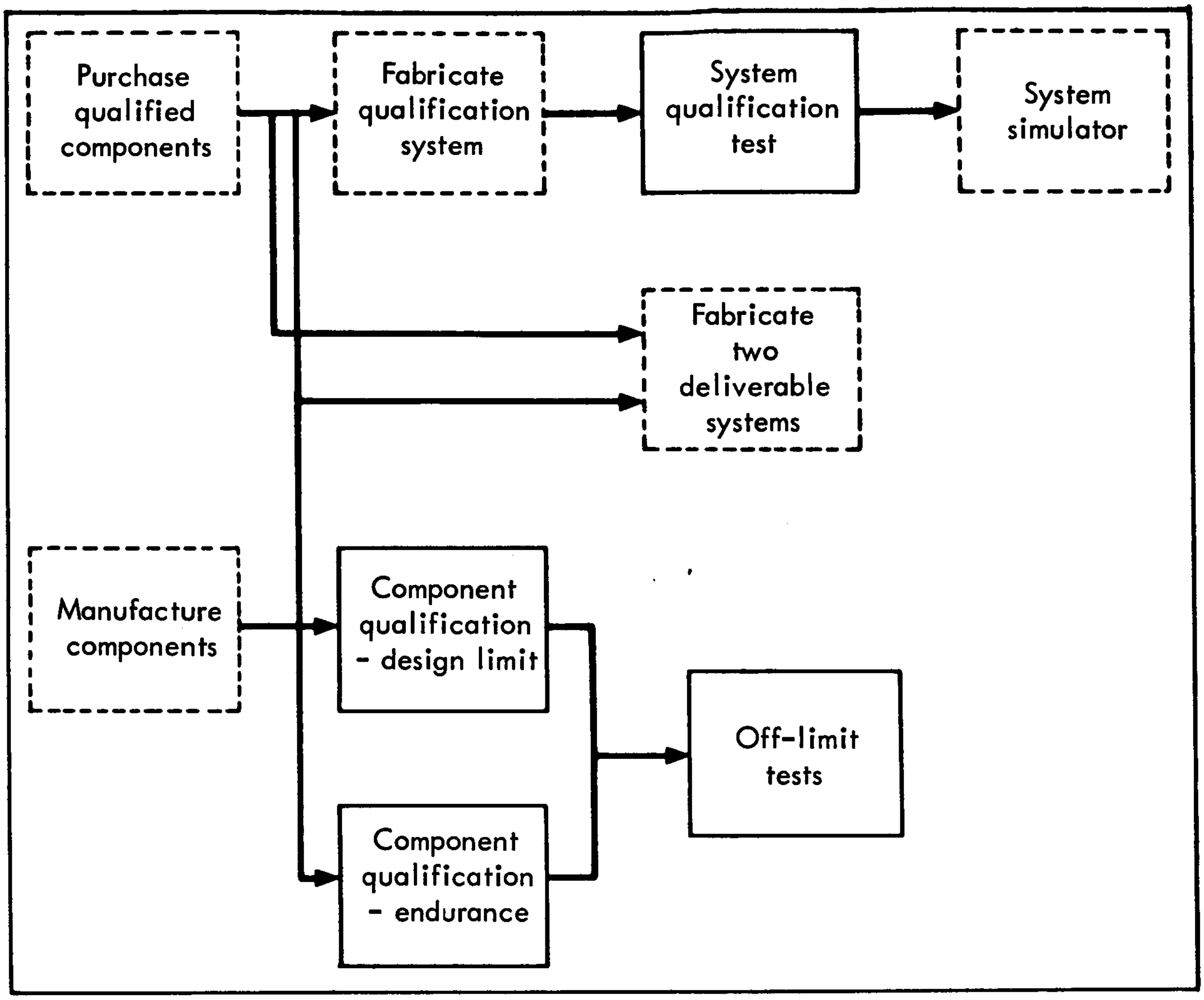


Figure D7. Qualification test flow plan

identified in the master end-item specification (CP-20000). This section presents the selection of those environments as applicable to the Primate Spacecraft, and the extent to which the duty cycle must be simulated.

Environments: Consideration has been given to each of the following environments, and justification for the application, reduction, or elimination of the environment is established.

(1) Transportation, Handling and Storage - During shipment and storage, the Primate Spacecraft will be protected against the climatic environments of rain, sunshine, humidity, sand, dust, and salt atmosphere. All materials will be non-nutrient and, thus, resistant to fungus attack (food and water will be handled separately). Selection of materials also affords protection against ozone or age deterioration within the maximum storage condition of 18

months. The Primate Spacecraft will be transported within a structural package employing shock isolating mounts. Transportation will be under direct Northrop supervision and continual inspection, subject to preferred handling conditions, to assure elimination of potentially hazardous dynamic environments. Air transportation will be pressurized, air conditioned cabin; thus, temperature and altitude differential extremes are not a significant factor. The foregoing conditions eliminate the necessity of testing the Primate Spacecraft to the transportation and storage environments.

(2) Ascent Phase - Dynamic environments occurring during the ascent phase include vibration, acoustic noise and acceleration. The acceleration effects on structural elements can be objectively disposed by conventional analytical methods during the equipment design, thus, eliminating the need for test. The acoustic noise level projected for the Primate Spacecraft is not considered a destructive environment on the basis of extensive prior investigations and test data achieved on missile systems and components at levels up to 172 db. However, each component will be analyzed to determine its ability to withstand the acoustic environment. Conversion of acoustic noise to vibration within the structure is well below the vibrational design level. Vibration testing, however, is a valid consideration. Sinusoidal and complex wave form tests will be provided at both the component and system levels. Vibration tests will be performed at the Northrop facility with the exception of system level complex wave tests. It is projected that this test will be accomplished at the NASA/MSC environmental test facility.

Climatic environments are not considered detrimental during the ascent phase, and test demonstration is not required. By virtue of its short duration, the ascent phase does not induce detrimental effects due to temperature, humidity, salt atmosphere, sand or dust. Thermal inertia due to spacecraft mass provides a satisfactory degree of temperature stability, and the use of a low voltage DC electrical system precludes the possibility of arcing during flight through the rarefied atmosphere region. Higher voltage circuit associated with the tape recorder will be enclosed within a pressurized hermetically sealed container and, thus, does not require an altitude test for electrical arcing. All other electronic equipment will be adequately vented to preclude significant pressure differential during ascent.

(3) Orbital Phase - Equipment external to the pressure shell will be subjected to a thermal-vacuum environment within a controlled temperature range imposed by the thermal control subsystem (TCS). The TCS components will be required to demonstrate functional capability for control to specification limits within the alternating extremes of solar radiation and black space sink. Resistance to the environment shall be demonstrated by a continuous fourteen day system vacuum test at 1×10^{-5} torr or greater, with radiant exposure cycles to the extreme conditions of solar radiation (440 Btu/hr. - ft^2) and cold black space. Freedom from susceptibility to, as well as generation of, EMI are operational criteria during this phase, and will be demonstrated by test.

Life cell installed equipment will be required to function under the normal life cell atmosphere. Effects of corrosive contaminants (perspiration) and trace gases will be determined and evaluated with respect to operational reliability.

(4) Recovery Phase - Equipment pertinent to the recovery phase of the Primate Spacecraft program will be restricted to the Recovery Capsule which includes the capsule structure, sealing door, release latches, and a simplified version of the life support system. The EVA portion of the recovery phase includes verification of the capsule seal integrity and accomplishment of the sealing and capsule uncoupling functions. These tests are primarily for functional characteristics and to demonstrate the ability of the capsule to retain its pressurized condition in a vacuum environment. Operation of the life support unit must be verified subsequent to an extended dormant period since the life support unit may be inoperative for a twelve month period prior to its reactivation. Dynamic environments imposed on the capsule occur as a result of the re-entry and recovery phases of the Apollo Command Module. These phases include deceleration, and vibration during re-entry and shock occurring as a result of parachute deployment and landing impact. The capsule equipment must not only maintain its integrity of operation during and subsequent to these dynamic conditions but also must demonstrate that its instrumentation in the Command Module will not permit freedom of motion (breaking free of its instrumentation), which would imply a physical hazard to the astronauts and possible damage to Command Module equipment. Consequently, testing of the capsule will include thermal vacuum environment, operation within a temperature range to +90°F (Command Module re-entry environment), acceleration to 7 g, vibration, and shock.

Duty cycle: Design limit testing consisting of sequentially applied environments at the design limit of operation and endurance tests, which will include sequential and combined environments with simulated operational life times, will be performed to the degree that they may be reasonably simulated. Endurance tests at the system level will also be performed in accordance with the total mission cycle sequence to the extent warranted by the system operating time and the mission environments. Where different degrees of imposed environmental intensity are required, simulation of the more extreme environment will be considered satisfactory as proof of resistance at all mission phases of that type of environment.

Tables D2 and D3 describe the sequence of environments and conditions of operability to be imposed to satisfy the qualification test program sequence.

Post qualification tests. - The objectives of post-qualification testing are to determine failure modes and actual design margins. This provides greater confidence in the accuracy of performance expectations and greater capability for evaluating the nature and severity of in-flight anomalies.

Post-qualification testing consists of off-limit functions and environments (severity and duration in excess of design limit requirements) imposed on the subsystems and components subsequent to successful completion of the qualification test phase. The results of off-limit tests do not affect the qualification status of the equipment but are intended to demonstrate safety features and level of reliability. Selection of the post-qualification criteria is made on the basis of the failure mode analysis studies and is tailored to those functions or environments which are considered most deleterious to the successful operation of the test article. Thus, it is not required that a complete requalification to higher levels be conducted, but rather a selective application of functions and environments, designed to stress the test article in its most susceptible mode.

TABLE D2. - PERFORMANCE DEMONSTRATION CRITERIA
COMPONENT QUALIFICATION

COMPONENT IDENTIFICATION		ENVIRONMENT							
DESCRIPTION	NUMBER	SHOCK	VIBRATION	TEMP.-HUMIDITY	THERMAL-VACUUM	CORROSIVE CONTAMINANT	ELECTROMAGNETIC INTERFERENCE	NORTHROP QUALIFIED	SUPPLIER QUALIFIED
Life Support Subsystem	148-11000.0	X	X	X		X	X	X	
Environmental Control Unit	148-11100.0	X	X	X		X	X		X
Waste Unit	148-11200.0	X	X	X		X			X
Life Cell Structure	148-11300.1,.2	X	X	X		X		X	
Camera Shield Mechanism	148-11300.3	X	X	X		X		X	
Mechanisms, drives, etc.	148-11300.4-.6	X	X	X		X	X		X
Feeder Unit	148-11400.0	X	X	X		X	X	X	
Waterer Unit	148-11500.0	X	X	X		X		X	
Behavioral Panel	148-11600.0	X	X	X		X	X	X	
Recovery Capsule	148-11700.0	X	X	X	X	X		X	
Recovery Capsule ECS	148-11700.2,.4	X	X	X		X			X
Thermal Control Subsystem	148-12000	X	X	X	X	X	X	X	
Thermal Transport Loop	148-12100.1	X	X	X	X	X	X		X
Passive Thermal Control	148-12200		X		X				X
Structure and Mech. Subs.	148-13000	X	X		X	X		X	
Instrumentation Subs.	148-14000	X	X	X	X	X	X	X	

TABLE D2. - Continued

Component identification		Environment							
Description	Number	Shock	Vibration	Temp - humidity	Thermal-vacuum	Corrosive contaminant	Electromagnetic interference	Northrop qualified	Supplier qualified
Television	148-14100.1	X	X	X		X	X		X
Dosimeter	148-14200.1	X	X	X		X	X		X
Activity Counter	148-14300.1	X	X	X		X	X	X	
Antennas	148-14400.1	X	X					X	
Receivers	148-14400.2	X	X		X		X		X
Filters	148-14400.3	X	X		X		X	X	
Demodulators	148-14400.4	X	X		X		X	X	
Microphones	148-14500.1	X	X	X		X	X		X
Transducers	148-14500.2-.4	X	X	X		X	X	X	X
Mass/Volume Measurement	148-14600.1	X	X	X		X	X	X	
Signal Conditioners	148-14700.1	X	X		X		X	X	
Data Processor	148-14800.1	X	X		X		X	X	
Status Multiplexer	148-14900.1	X	X		X		X	X	
<u>Telemetry Subsystem</u>	148-15000	X	X		X		X	X	
Transmitters	148-15100.1,.2	X	X		X		X		X
Transponder	148-15200.1	X	X		X		X	X	
Antennas	148-15300.4,.5	X	X				X	X	
Diplexer	148-15400.1	X	X		X		X	X	
PCM Encoder	148-15500.1	X	X		X		X		X
TV Tape Recorder	148-15600.1	X	X		X		X		X
Digital Tape Recorder	148-15600.2	X	X		X		X		X
Switching Circuits	148-15600.4	X	X		X		X	X	
Buffer Core Storage	148-15600.3	X	X		X		X		X
Premodulation Processer	148-15700	X	X		X		X		X
Command/Control Decoder	148-16100	X	X		X		X	X	

TABLE D2. - Concluded

Component identification		Environment							
Description	Number	Shock	Vibration	Temp - humidity	Thermal-vacuum	Corrosive contaminant	Electromagnetic interference	Northrop qualified	Supplier qualified
Programmer/Sequencer	148-16200	X	X		X		X	X	
Solar Panel Assemblies	148-17100.1,.2	X	X		X				X
Batteries	148-17200.1-.3	X	X		X				X
Regulators	148-17300.1,.2	X	X		X		X	X	
Inverters	148-17400.1-.3	X	X		X		X		X
Power Distribution Unit	148-17500.1	X	X		X		X	X	
Fuse Box	148-17600.1	X	X		X		X	X	
Pyrotechnic Control Unit	148-17700.1	X	X		X		X	X	
Cabling and Harnessing	148-17800.1	X	X	X	X	X	X	X	
Gyro Package	148-18100.1	X	X		X			X	
Sun Sensors	148-18100.1	X	X		X				X
Control Unit Package	148-18300.1,.2	X	X		X		X	X	
Cold Gas Assembly	148-18400	X	X		X		X	X	

TABLE D3. - PRIMATE SPACECRAFT SYSTEM QUALIFICATION TEST SEQUENCE

Sequence	Test	Description
1	Weight and C.G. determination	
2	Functional	Operational checkout with GSE

TABLE D3. - Concluded

Sequence	Test	Description
3	Vibration	Resonant frequency survey 5-2000 Hz at 1 g maximum in each of three mutually perpendicular axes; random vibration per spectrum of figure D8, 150 seconds in 3 mutually perpendicular axes.
4	Electromagnetic interference	Operational checkout for generation of and susceptibility to radiated and conducted EMI.
5	Leak rate	Measurement of gas leakage rate conducted in vacuum chamber
6	Thermal-vacuum	Fourteen days simulated operation in thermal-vacuum chamber (employing external laboratory power supply); vacuum - 1×10^{-5} torr, temperature panels cycles per normal mission thermal radiation exposure.
7	Attitude control dynamics	Simulated operation on rate table
8	Functional	Final operational checkout with GSE

Spacecraft System Simulator Testing

Purpose. - The purpose of providing a system simulator is to enable the operation of a ground based test of a duplicate system concurrent with the original system operation. Such testing and operation will enable an effective investigation of flight system anomalies by providing an equivalent system by equivalent mission operating time. The system simulator will establish an available basis for investigating the effects of command on the spacecraft prior to committing novel commands to the orbital operation. It will also establish the expected conditions within the spacecraft should certain portions of the operating equipment or telemetry malfunction and interfere with clarity of operational information. An additional advantage is the more extensive investigation of the operational system reliability.

Description. - The spacecraft system simulator will be derived from the qualification test model as an economy measure to eliminate the need for

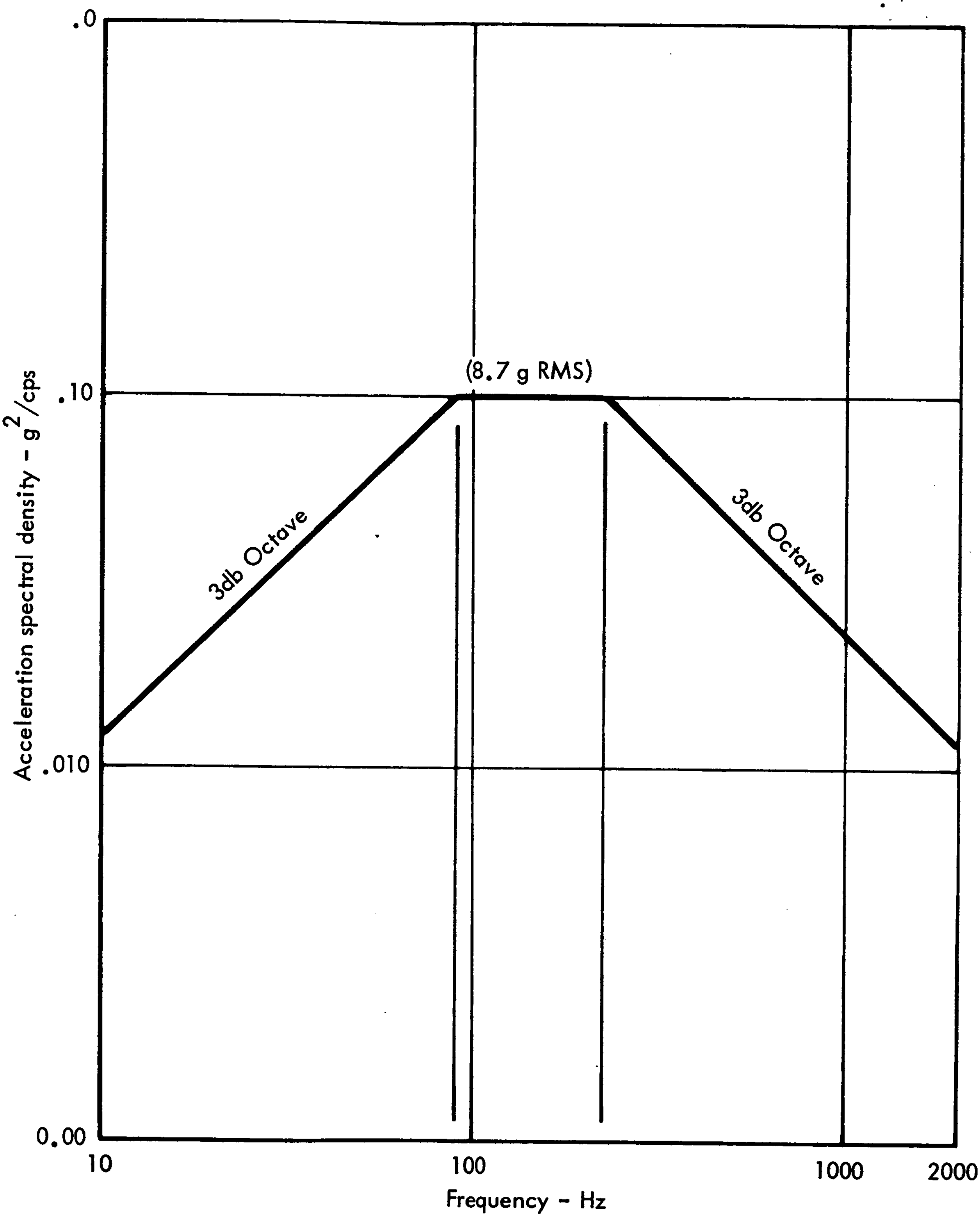


Figure D8.- Random vibration spectrum

construction of an additional system. Following the conclusion of the qualification test program, the qualification model will be refurbished to an effectively new flight type spacecraft to satisfy the operational criteria of a system simulator.

Operation. - The spacecraft system simulator will be operated at the Northrop facility throughout the duration of flight operation. It will include all operational equipment including two implanted primates with the primary difference being a restrained physical condition and 1 g environment. Operational modes for the orbital spacecraft will be duplicated as will all command reports and retreival of acquired data. Record data derived from the simulator operation will be compared with that data acquired from the orbital spacecraft for evaluation of the effectiveness of simulator operation. Projected changes in programmed commands will be implemented in the simulator version prior to orbital commands to verify the appropriate effects of such changes.

Documentation Requirements

Test procedures. - Detailed test procedures are prepared for each level of assembly of equipment subjected to acceptance and qualification tests. Test procedures for any given article will be completed and submitted to the NASA for review at least two weeks prior to the start of the test. The test procedures are employed in the conduct of all phases of acceptance and qualification testing as a directive in the detailed mechanics of performing test functions. Each test procedure will conform to the following requirements:

(1) Each article subjected to testing is completely identified as to part name, number, system involved and application.

(2) Each article tested is fully identified in terms of its functional requirements relative to the system performance.

(3) Each article of test equipment, including simulation equipment, measuring equipment and fixtures is identified as to make, model, type, and accuracy, including minimum calibration cycle requirements.

Test reports. -

Acceptance test: During performance of the acceptance test, the test data documented on the test procedure data sheets will be verified by the Northrop quality control inspector and the NASA quality control representative or his designee. Completion of the test data sheets affirming conformance to all specified requirements will satisfy the requirement for acceptance test reporting.

Qualification test: Subsequent to completion of the Qualification Test Program, a final report will be prepared and submitted to the NASA/LRC for approval. The report will be submitted within thirty days of completion of the test program and will include the following pertinent information:

(1) The variable data of the conditions imposed, the test article's reaction to those conditions, and the resulting performance of the test article.

(2) Appropriate analysis and evaluations of the above data.

(3) A physical and technical description of the test equipment used including size, identification, capabilities, limitations, tolerances, and the results of any special tests performed to evaluate the equipment.

(4) A complete description of the test specimens to include nomenclature, serial or lot number, technical description, and results of acceptance tests and inspections.

(5) specific functions to be performed by the test operator are described in detail, including setup of test equipment, method of installing the test article, attachment of instrumentation, configuration requirements within the simulation equipment, method of performing the test, method of data acquisition and final removal and/or disassembly of the system.

(6) Requirements for inspecting or measuring the test article and manipulation of controls or adjustments on the test article or test equipment are described in detail.

(7) A detailed description is proveded for the control of environmental simulation, operation of the equipment, adjustments of the instrumentation, and precautions to be observed to prevent damage to the test article or test equipment.

(8) Criteria for the acceptance or rejection of the test article as a consequence of the test results is identified to permit effective evaluation of the test results.

(9) Data sheets are incorporated in the test procedures for the immediate logging of observable characteristics pertaining to the test criteria and results.

(10) Disposition of the test article is identified to provide a control mechanism for handling test articles subsequent to qualification testing.

(11) A documentation (including photographs and drawings) of the test set-up, showing sensor or instrumentation location, test facility and equipment utilization, and test article positions or orientations.

(12) A detailed, step by step description of the procedures and actions used during the conduct of the test and a description of all malfunctions, failures, aborted runs, etc., and the corrective action taken.

Qualification status list. - Northrop will prepare and maintain a qualification status list showing the planned and completed qualification status of each part, component, subassembly, and higher level of assembly. The basis for any omission of qualification tests will be shown. Where qualification is based on similarity, reference is made to the pertinent test reports or data. The qualification status list and changes thereto will be submitted for approval at monthly intervals in accordance with the Reliability Plan.

Test Equipment Requirements

Facility requirements. - Test operations for the development, acceptance and qualification of Primate Spacecraft equipment will be accomplished primarily within Northrop's Hawthorne, California, facility. Additional testing will be performed by suppliers of equipment at their own facility, consistent with the philosophy of procuring qualified components and parts to the maximum extent practical. In addition, it is anticipated that the NASA/MSC facility (Houston, Texas) will be available to support system-level vibration tests.

Simulation equipment. - The major articles of environmental simulation equipment to be employed in the integrated test program at the Northrop facility, are identified in table D4.

Instrumentation and calibration. - The selection of instrumentation for the control and measurement of test parameters is made on the basis of range, accuracy and precision. The instrument ranges will be suitable for monitoring the limiting conditions applicable to each test, including the maximum allowable tolerance. The accuracy of each instrument is within one-fifth the tolerance of the variable to be measured or controlled. The performance of the instrument is such that the anticipated environments do not distort its accuracy beyond the limitations stated above.

Laboratory instrumentation and tools, such as oscilloscopes, ammeters, voltmeters, signal generators, digital counters, recorders (tape, pen, optical), etc., are drawn from the extensive inventory of Northrop equipment located in the Engineering Test Crib (Northrop-Hawthorne Environmental Test Laboratory) and the NSL Electronics Development Laboratory. Calibration and repair of instruments are accomplished at the Northrop-Hawthorne Standards and Calibration Laboratory.

TABLE D4. - SIMULATION EQUIPMENT

Environment	Description	Location	Ownership
Thermal-Vacuum	12 ft. Diameter x 15 ft. Long Chamber, 1 x 10^{-8} Torr 5 ft. Diameter Chamber, 1 x 10^{-8} Torr 3 ft. Diameter Chamber, 1 x 10^{-8} Torr	Northrop High Bay, Space Simulation Laboratory	Northrop

TABLE D4. - Concluded

Environment	Description	Location	Ownership
Vibration	Ling, A-249, 30,000 lb. Shaker, Sine & Complex	Northrop-Hawthorne Plant 2	USAF
Electro-magnetic Interference	Screen Room, 20 ft. x 20 ft. x 8 ft. High	Northrop let Electronics Development Laboratory	Northrop
Oxygen-Humidity	3 ft. Diameter Spherical Chamber with Control and Monitoring Console	Northrop-Ventura Environmental Laboratory, Newbury Park, California	Northrop
Shock	Hyge, 40,000 Force-Pound, 100 G/MS 1/2 Sine or Sawtooth	Northrop-Hawthorne, Quality Analysis Environmental Laboratory	Northrop

OPERATIONS AND TEST ACTIVITIES

Prelaunch Checkout

Purpose. - The prelaunch checkout starts when the primate spacecraft is delivered to Kennedy Spaceflight Center and is completed at the end of the launch vehicle countdown with space vehicle liftoff from the launch pad. This prelaunch checkout will have as its objective assuring the NASA that the Primate Spacecraft is ready for launch and is functionally capable of meeting its mission requirements.

Prelaunch checkout operations fall into three categories: (1) receipt, inspection and checkout of ground support equipment; (2) receipt, inspection, installation and checkout of the Primate Spacecraft; and (3) support of the Apollo Applications and Checkout (I & C) Contractor.

Primate spacecraft checkout. - Subsequent to the completion of Acceptance Testing at the Northrop-Hawthorne facility, the Primate spacecraft will be packaged and shipped to KSC. At KSC the Primate Spacecraft will be delivered to the Maintenance Assembly Area (MAA) in the Manned Spacecraft Operations

(MSO) building where it will be unpacked, inventoried, and visually inspected for transportation damage. See figure D9 for on-site flow diagram.

At the MAA, the Primate Spacecraft will be mounted on an assembly dolly, the GSE will be connected, and launch site checkout will be accomplished. The checkout will consist of compatibility, functional, and EMI tests. These tests will verify that the Primate Spacecraft fulfills the requirements for mating with the SLA rack structure. The Primate Spacecraft checkout in the MAA will be the responsibility of Northrop. Reference figure D10.

After completion of the checkout, the Primate Spacecraft will be moved by Northrop and installed on the SLA rack structure by the I & C Contractor. Fasteners, separation mechanisms, and adapter connections will be mated, and interconnections with the rack accomplished. Functional and operational

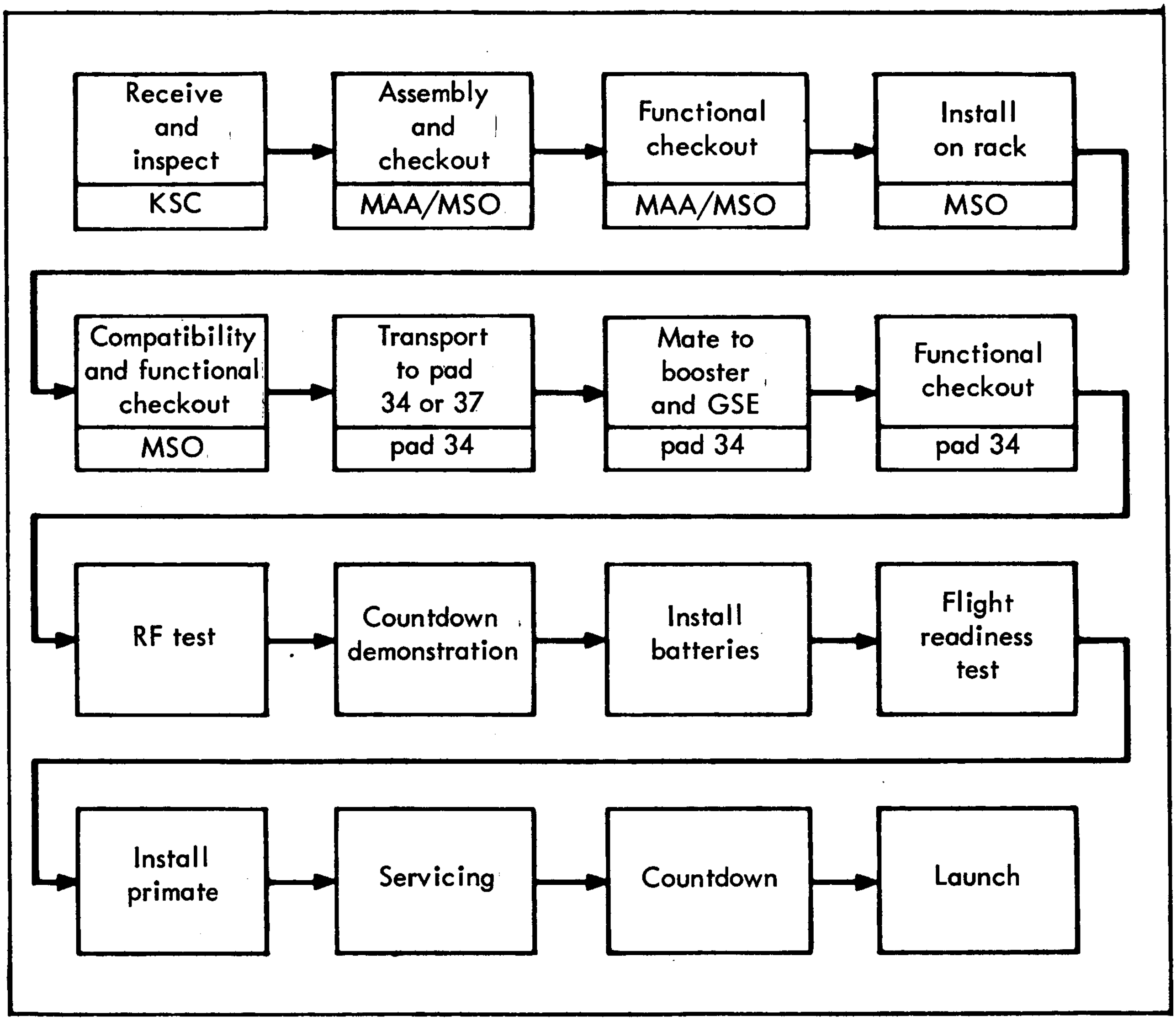


Figure D9.- On-site flow diagram for KSC

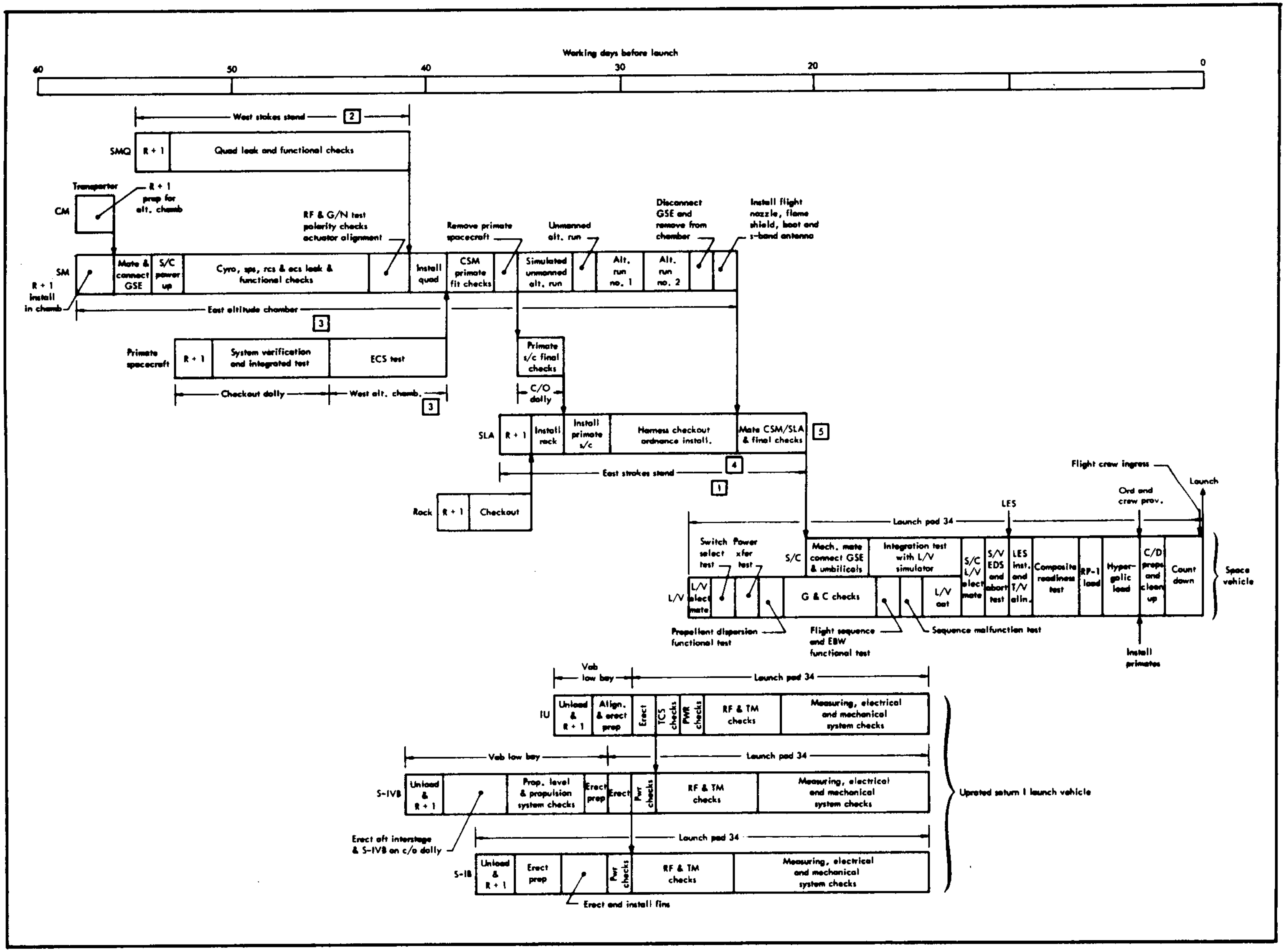


Figure D10. Pre-launch operations

testing will be accomplished in accordance with the Apollo Integrated Checkout and Countdown Procedures Manual. Northrop will support technically and physically, the I & C Contractor in Primate spacecraft testing and preparations through integration, checkout and countdown operations.

Ground support equipment (GSE) checkout. - Subsequent to completion of GSE Acceptance Testing at Northrop-Hawthorne the equipment will be packaged and shipped to KSC. The equipment will be uncrated, inventoried and inspected for transportation damage in the Maintenance Assembly Area. Only one set of equipment will be shipped to KSC, and will be moved from one location to another as required.

Procedures. -

Initial receipt and inspection: At KSC the Primate spacecraft will be delivered to the Maintenance Assembly Area where it will be uncrated, inventoried and visually inspected for transportation damage.

Compatibility testing: The Primate spacecraft will be placed on a dolly in the MAA and mated with the GSE. Spacecraft to GSE cabling will be given continuity checks and connected. Operating tests will then be made to assure that no power or signal mismatch exists between the two.

Functional tests: Functional checks of each subsystem, i.e., Life Support, thermal control, instrumentation, telemetry, power and stabilization and control, will be accomplished against the GSE to determine that they are functioning properly. After it is determined that all independent loops are operating satisfactorily, an integrated primate system test will be accomplished. The GSE will be used to monitor the responses to system stimuli.

This sequence of test operations will validate the Primate spacecraft for installation on and integration with the SLA rack. The Primate spacecraft subsystems and interface operations will include:

(1) Cabling and interconnect equipment - To determine continuity and validate Primate spacecraft, rack and CSM interconnections.

(2) Power subsystem - To determine that the solar cell-battery pack output is within tolerance, that intra Primate spacecraft mechanisms are operating and that the Primate spacecraft/GSE ground power switchover mechanism is operating.

(3) Data subsystem - To determine that all planned sensored data is being acquired; that events and experiments data links are functioning; that transmitter output is within tolerances as to frequency, power, data, rate, and data format.

(4) Thermal control subsystem - To determine that indicators denoting pressurant, water, and coolant are at proper operating levels. In prelaunch checkout and operations of the Primate spacecraft, GSE cooling equipment is used in lieu of the Primate Spacecraft Thermal Control Subsystem. This

prevents depletion of battery power and the venting of expendables in the vicinity of the spacecraft.

(5) Pressure shell subsystem - The Primate spacecraft will be fabricated so that the pressure shell cover can be separated from the pressure shell base. During the checkout operations at KSC, the pressure shell cover will be removed from the spacecraft giving access to the spacecraft equipment. Upon completion of the subsystem checkouts, the pressure shell cover will be replaced and bolted to the base. A leakage test will then be performed to verify that the spacecraft leakage rate does not exceed the CEI specification.

Uprated Saturn I Booster/Primate Spacecraft integration and pad checkout: For uprated Saturn I launch vehicles, the primate spacecraft, rack and SLA will be moved from the MSO directly to the launch pad assigned to a primate mission where launch vehicle mating will be accomplished starting at approximately T-25 days. Additional integrated functional checkout operations will be accomplished after mating the CSM with the SLA.

Functional checkout will be accomplished early in the terminal countdown. Batteries will be installed in the spacecraft at the latest possible time (approximately T-3 days) in the countdown to preserve battery life. Final checkout will then be performed. Completion of installation of the primates will be accomplished through access panels in the SLA at T-2 days. At T-6 hours, when the service structure will be removed from the space vehicle and the primate spacecraft GSE disconnected, monitoring of the primate spacecraft system on a go-no-go basis will be accomplished by the instrumentation unit data link.

Ground support equipment: Upon arrival at KSC the GSE will be inventoried, inspected, assembled and installed in the primate spacecraft maintenance assembly area in the MSO. Only one set of GSE will be delivered to KSC and will be moved from location to location as required. After installation and connection, the GSE will be verified by the self-check features built into the equipment. For parts of the GSE which do not lend themselves to self-check methods, proper operation will be verified by use of simulators and other test equipment similar to that employed in factory checkout. Cabling and harnessing will be evaluated by continuity checks. Checkout of GSE which interfaces with other Contractor or Government organization equipment or facilities will be coordinated with personnel of the appropriate organizations to effect an integrated checkout effort. The completed installation will be operated and tested by the use of dummy test loads to verify proper functional operation, compatibility, and competency of operating personnel.

Criteria. - The following launch test criteria will be established to cover the checkout and testing of the primate spacecraft at KSC to certify its operational readiness for each flight.

(1) Test records of each equipment, subsystem, system, and experiment covering all test phases are used in the final determination of flight readiness. From these data, equipment operating trends are determined.

(2) Tests are accomplished in accordance with NASA approved Operational Checkout Procedures (OCP). An OCP is prepared for each test.

(3) On-site tests use the same procedures as in-plant tests on systems, subsystems, equipment, and experiments wherein the test content is the same.

(4) The total checkout and testing operations on the spacecraft and its associated equipment accomplish all compatibility, functional, performance, and EMI tests necessary to assure flight readiness of the primate system.

(5) Equipment design, test procedures, and GSE design and deployment reflect the following:

Only controlled limited access to the spacecraft will be permitted once preflight checkout has commenced.

Electrical and mechanical connections once made in the spacecraft are not disconnected for the purpose of checkout.

(6) Malfunctions determined in on-site and prelaunch testing are isolated to the replaceable module or component level. Field repairs will not be accomplished on any primate spacecraft articles. "Black box" replacements will be used as corrective measures for malfunctions. In cases of replacement, testing will be recycled to the appropriate level dictated by the replacement made.

(7) Test time on a component will not exceed its design life minus its flight life. Operating logs will be maintained on all items having a limited shelf/flight life.

(8) Test and checkout equipment will be calibrated in accordance with written approved procedures and records maintained to assure consistency in test data and a high confidence level in test results.

(9) Only approved and acceptance tested GSE will be utilized in accomplishing testing and checkout of the primate spacecraft system.

Support Plan

Purpose. - This document defines the functions of logistics, spares, transportation, packaging, maintenance, and support documentation for the Primate Spacecraft Program. The support philosophy reflected in this plan is based on the criteria of a cost effective flight program. Since flight operations invoke major program cost to the government, it is vital that no launch be delayed because of unavailability of spare parts or inadequate work procedures or documentation. It is equally important that the spares be selective and their level and range be planned carefully within the objectives of low cost and availability.

Scope. - The scope of this Support Plan is to provide support of the Primate Spacecraft Program by proper timing and interface of the planning and provisioning elements listed below:

(1) Spare parts supply

(2) Provisions for storage and control of spare parts

(3) Diversion of spare parts and facilities from other programs and other sources, with the NASA approval.

(4) Establishment of controls to insure compatibility of spare parts with end items configuration.

(5) Responsibilities, procedures, and implementation of transportation.

(6) Establishment and development of maintenance concepts, plans and procedures, including requirements for calibration and calibration equipment.

(7) Establishment of requirements, preparation of technical content and control of support manuals.

Fulfillment of these identified support objectives provide economies which contribute to an efficient low cost flight program and allow for Primate Spacecraft utilization with minimum interference to other parts of the Apollo program.

Support manuals. - During Phase 3 support documents will be prepared and submitted in accordance with the requirements of the operational spacecraft phase contract. The necessary documentation to support the Primate Spacecraft Program is listed in table D5.

TABLE D5. - DOCUMENTATION SUPPORT

Support Task	Responsible Organization	Supporting Groups
Familiarization Manual	Engineering	Mission and Experiments
System Handbook	Engineering	
Training Manual	Mission and Experiments	Engineering
Primate Handling Handbook	Mission and Experiments	Program Scientist
Systems Manual	Mission and Experiments	Engineering
Operational Checkout Procedures - KSC	Test and Operations	Engineering, Mission and Experiments
Operational Checkout Procedures - Northrop	Test and Operations	Engineering, Mission and Experiments

TABLE D5. - Concluded

Support Task	Responsible Organization	Supporting Groups
Contractor Facility Test Procedures	Test and Operations	Engineering
GSE Operation and Service Instructions	Test and Operations	Engineering, Mission and Experiments
Returned Parts	Test and Operations	Engineering, Quality Control, Configuration Management
KSC Operations	Test and Operations	Engineering, Mission and Experiments, Manufacturing Operations
Commodities and Consumables	Manufacturing Operations	
Production Control	Manufacturing Operations	
Stock Records & Control	Manufacturing Operations	
Transportation	Manufacturing Operations	Quality Control
Repair & Modifications	Manufacturing Operations	Quality Control
Maintenance	Manufacturing Operations	Quality Control
Stock Balance & Control	Manufacturing Operations	
GFE & GFP Control	Manufacturing Operations	
Packaging	Manufacturing Operations	Quality Control

Test support documentation: The test support documents listed in table 5 will be used by the contractor both in-plant and at KSC during test and checkout of the Primate Spacecraft and GSF and will contain the following essential information.

Test support documentation, Test objectives: The test objectives will include the reasons for performing any given test to assure accomplishment of the test aims. The stated objectives will include consideration of out-of-tolerance conditions and corrective actions to be taken.

Test support documentation, Test support requirements: This section will define the requirements for test instrumentation, ambient environment control, power requirements, and accessory equipment or dummy input/output loads which must be provided. This section will also identify necessary reference material in the form of drawings, handbooks or manuals.

Test support documentation, Safety instructions: This section will define the safe operating limits for all equipment such as temperature, pressure, current, etc. Special attention will be given to conditions which may be hazardous to operating personnel, such as high voltage and high pressure.

Test support documentation, Test setup: Test setup provisions will be defined, such as mounting arrangements, equipment configuration, required cabling and proper connective engagements, instrumentation attachment and specified test points. Initial positions of all operating controls will be specified.

Test support documentation, Pretest preparation: A check list will be provided to assure that all required preparations will be made prior to energizing the system and commencing the test. This check list will be in sufficient detail to assure that all conditions which can be anticipated prior to test are thoroughly covered. Safety precautions will again be emphasized for the benefit of personnel and equipment.

Test support documentation, Detailed test instructions: Proper sequence of energizing equipment will be defined. Step-by-step instructions will be given for the manipulation of controls during test and the measurements of response indications that must be observed.

Test support documentation, Emergency shutdown instructions: These instructions will cover emergency conditions which might occur and the proper method for dealing with each condition. The criterion will be to effect system shutdown in as rapid a manner as possible consistent with the objective of avoiding or minimizing damage.

Test support documentation, Post test requirements: Following testing, the requirements for proper system shutdown will be defined. These requirements will detail the proper sequence for all control manipulations and the indicators to monitor.

Test support documentation, Test data sheets: Detailed data sheets will be provided for each phase of testing. These completed data sheets will assure that every required operation had been performed and that all required observations had been noted and recorded.

GSE operation and service instructions: GSE operation and service instructions will be prepared for major items of electrical, electronic and mechanical GSE. These instruction manuals will be used by Northrop personnel both for checkout and operation of the GSE with the Primate Spacecraft. A list of major items will be prepared and the function of each will be defined. The GSE interface with the Primate Spacecraft will also be described. Each instruction manual will include drawings, photographs, schematics, part list, etc. Complete details for operation, checkout, maintenance and service, trouble analysis, and calibration will be included.

Familiarization manual: This document will be prepared for familiarization of personnel concerned with Primate Spacecraft operations at KSC and Langley. This manual will encompass a description of the detailed Primate Spacecraft operations during the test, prelaunch, flight and primate recovery mission phases.

Training manual: This document will be prepared for the guidance of personnel concerned with Primate Spacecraft operations at KSC and Langley. It will detail the operations during test, prelaunch, flight and primate recovery mission phases. The first issue will be submitted six months after Phase D contract go-ahead and will be up-dated as required. This manual will contain the following information:

(1) System description - flight equipment
(2) System description - ground support equipment
(3) Operational profile - test and prelaunch phase
(4) Operations profile - flight operations phase
(5) Data analysis
(6) Command and control
(7) Procedures and criteria for final launch verification testing

This training manual will be prepared in accordance with the format and style established for the Apollo program.

Packaging and transportation: The Primate Spacecraft, GSE and spare parts will be packed and crated for protection against hazards of transportation from the Northrop facility to the NASA Kennedy Space Center. Primate system equipment will be packed, packaged and marked in accordance with the requirement of MIL-P-7936A. Shipment will not be made until prior clearance is received from the NASA. All shipments will be made on Government Bill of Landing as directed by the NASA 30 days in advance of date of shipment. Primary mode of shipment will be by air transportation from Los Angeles International Airport and from Patrick Air Force Base to the NASA Kennedy Space Center. When government air transportation is not available, the Primate Spacecraft, in its shipping container, will be transported by commercial air freight in accordance with NASA's instructions.

Packaging and transportation, Primate spacecraft shipment: Shipment and storage of the Primate Spacecraft will be accomplished as an assembled system. It will be protected against climatic environments by a plastic sheath, incorporating a filtered breathing port containing a desiccant cartridge. Protection will be afforded against rain, sunshine, humidity, sand, dust, and salt atmosphere. All Primate Spacecraft structure and equipment will be constructed, wherever possible, of materials designed to afford protection against ozone or age deterioration within the maximum storage condition expected for this program. The Primate Spacecraft including subsystems, but less batteries and consumables, will be lowered into the shipping container and attached by means of the spacecraft/rack attach points and additional points at each end. Isolation devices will be installed to limit transmission of shocks to the spacecraft. The container will rest on integral slides and will be capable of being moved by slings or fork lifts. A sketch of the shipping container is shown in figure D11. Transportation will be under direct Northrop supervision and continual surveillance, subject to preferred handling conditions, to assure elimination of potentially hazardous dynamic environments. Air transportation will be in a pressurized, air conditioned cabin. This criteria is specified since cargo handlers will be required to accompany the equipment. Since this criteria is specified, temperature and altitude differential extremes during air shipment are not significant factors.

Packaging and transportation, Fragile equipment shipment: Items considered fragile will be instrumented for recording shock loads during handling and transit. Analysis of this data at point of delivery will identify when and where shock occurred and if the shock loads exceeded the allowable limitations for that particular item.

Packaging and transportation, GSE and spare part shipment: GSE, components and spare parts will be packaged to protect the equipment against the natural environmental extremes which may be encountered in a non-operating condition during transportation, ground handling and storage. The equipment will be capable of meeting the operating requirements of the applicable performance specification after exposure, while protected by its normal packaging, to the following environments.

(1) Temperature (air)

Air transportation	-45 to +140°F for 8 hours
Ground transportation	-20 to +145°F for 2 weeks
Storage	+25 to +105°F for 18 months

(2) Pressure

Air transportation	Minimum of 3.47 psia for 8 hours (35,000 ft altitude).
Ground transportation and storage	Minimum of 11.78 psia for 18 months (6,000 ft altitude).

(3) Humidity	0 to 100 percent relative humidity, including conditions wherein condensation takes place in the form of water or frost for at least 30 days.
(4) Sunshine	Solar radiation of 360 Btu per square foot per hour for 6 hours per day for 2 weeks.

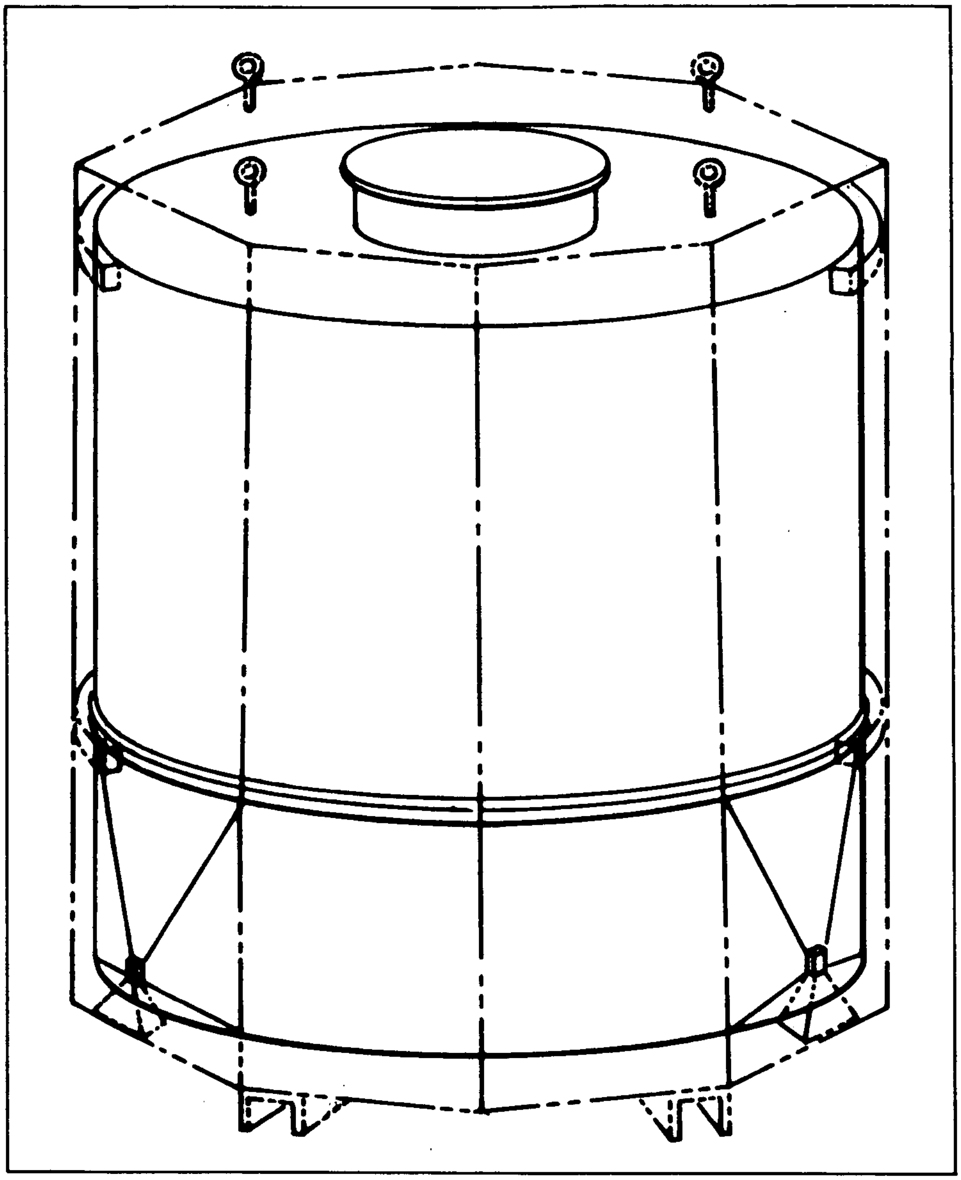


Figure D11. - Primate spacecraft shipping container

(5) Rain	Up to 0.6 inch per hour for 12 hours, 2.5 inch per hour for 1 hour.
(6) Sand and dust	As encountered in desert and ocean beach areas, equivalent to 140 mesh Silica flour with particle velocity up 500 feet per minute and a particle density of 0.25 gram per cubic foot.
(7) Fungus	As experienced in Florida climate. Materials will not be used which will support or be damaged by fungi.
(8) Salt Spray	Salt atmosphere as encountered in coastal areas, the effect of which is simulated by exposure to a 5-percent salt solution by weight for 48 hours.
(9) Ozone	18 months exposure, including 72 hours at 0.5 PPM, 3 months at 0.25 PPM, and the remainder of 0.05 PPM concentration.
(10) Ground winds	These ground wind criteria consist of a description of Cape Kennedy wind data for the height intervals of 10 to 400 feet.
(11) Hail	Hailstones accumulating to a maximum depth of 2.0 inches on horizontal surfaces in 15 minutes having an average diameter of 0.31 inches, a density of 50 lb/ft^3, and a hardness of 3 on Moh's scale. Impact velocity shall be based on a fall rate of 100 ft/sec maximum, with a wind speed of 33 ft/sec maximum.
(12) Lightning	The following condition applies to the Primate Spacecraft only while it is installed within the SM vehicle at Cape Kennedy, Florida: A lightning current surge which reaches a crest value of 100,000 amperes at 10 microseconds and drops to 50,000 amperes at 20 microseconds.

Storage and handling criteria: The environment that the Primate Spacecraft will experience during the fabrication, delivery, storage and installation phase will be controlled so as not to impose additional design requirements over those required for prelaunch, launch and flight conditions.

GSE maintenance and spares. - Test, Checkout and Operations personnel will perform the maintenance on the GSE. Scheduled maintenance, checkout, and calibration that may be required will be documented and submitted to the NASA for approval. Unscheduled maintenance will be accomplished as required by removing and replacing with spares, the malfunctioned items. Since one set only of GSE will be delivered, spares will be readily available to prevent delays in spacecraft checkout.

Spacecraft checkout and spares. - Spacecraft checkout at KSC will be performed by the Checkout and Operations personnel and during this phase no maintenance will be scheduled. Spares for the spacecraft at KSC will be minimal with emphasis placed on having a well qualified spacecraft prior to delivery to KSC.

Training Plan

Purpose. - The purpose of the Training Plan is to assure that a complete and comprehensive program of technical briefings related to the Primate spacecraft, its subsystems and primates, are provided for NASA, intercontractor and intracontractor personnel.

Scope. - This Training Plan describes the requirements and typical schedules for the training program. Briefing outlines and briefing descriptions will be prepared during Phase D to cover all levels of training required for flight crews, flight division personnel, other personnel, intercontractor and intracontractor personnel.

Summary - Northrop will provide, as the required training on the systems and subsystems incorporated into the Primate spacecraft, a series of technical briefings. These briefings will be prepared and presented to three levels of detail: orientation level, familiarization level, and mechanization level. Apollo system information beyond the Primate spacecraft will not be covered.

Training organization. - Northrop shall establish a Training Group that shall be responsible for maintaining direct interface with engineering, assembly, test, installation, checkout, and maintenance personnel. Associated with this Training Group will be a Training Coordinator.

Training coordination. - The Northrop training coordinator will provide liaison between Northrop and the NASA assigned project training coordinator to ensure compatibility of briefings, briefing locations and schedules for customer and intercontractor personnel. Northrop shall look to the NASA training coordinator to notify the cognizant organizations of the briefings, contents, locations, dates and available briefing spaces. The cognizant organizations shall schedule their personnel to be trained with the NASA training coordinator. In the event of conflicts, the NASA training coordinator will resolve the conflicts with the Northrop training coordinator.

Training task. -

Requirements: Northrop will determine the overall training requirements and prepare the detailed training plan. The detailed training plan will be issued six months after Phase D contract go-ahead with subsequent changes accomplished by page and line.

Training manuals: Training manuals and study guides will be prepared to support training classes and to provide sources of information for NASA/Contractor personnel.

Lesson plans: Lesson plans, visual aids, etc. will be prepared to support orientation courses, familiarization courses and mechanization courses. Mechanization courses will be designed for flight crew and certain KSC personnel training.

Instruction: Northrop will provide a familiarization and primate recovery course for the flight crew, orientation and familiarization courses for flight operations personnel, and courses for contractor personnel as required.

Technical briefings. - Northrop will prepare the briefings specified in figure D12 to support specific mission objectives and specific mission hardware.

Briefing classifications. - Briefings will be developed to three levels of detail to provide for the training of the various personnel types requiring Primate spacecraft knowledge.

Orientation briefing level: This briefing level will provide a broad semitechnical treatment of the Primate spacecraft and support equipment including descriptions of the spacecraft, displays and controls, and GSE.

Familiarization briefing level: This briefing level will provide a technical description of the Primate spacecraft systems and related GSE, including a description of hardware capabilities and a functional diagram analysis of each mode of operation.

Mechanization briefing level: This briefing level will provide a detailed technical description of the Primate spacecraft mechanical and electrical/electronic systems, including analysis for all modes of operation, test point locations and trouble shooting.

Briefing programs. -

Flight crew briefings: Northrop will conduct technical briefings for primary and backup flight crew personnel for both the flight and recovery missions. Briefings shall be specifically tailored to each mission, i.e., flight mission will cover spacecraft operation and separation, and recovery mission will cover removal and handling of primates.

NASA briefings: Northrop will conduct technical briefings for NASA personnel responsible for planning and monitoring the Primate Program. Identical briefings will be scheduled at Langley and KSC to familiarize and fulfill the needs of engineering and technical personnel. (See figure D12.)

Intercontractor briefings: Northrop will provide technical briefings in areas of system interfaces for selected intercontractor personnel in accordance with NASA instructions.

Intracontractor briefings: Primate spacecraft technical briefings will not be provided for Northrop personnel; however, personnel will be given on-the-job training. A program of evaluation and certification, with NASA agreement, will be conducted to ensure that competent personnel are assigned throughout the program.

Training materials. - The extent and content of the training material will be established by agreement between NASA and Northrop and will be limited to briefing study guides, instructor briefing plans, lesson plans and training equipment handbooks.

Briefing schedules. - Figure D13 displays a typical implementation schedule. The specific schedules will be established by agreement between NASA and Northrop training coordinators. These schedules will not require Northrop to conduct more than two briefings simultaneously, nor will more than one electrical course or more than one mechanical course be conducted simultaneously.

Orbital and Recovery Plan

The primary objective of this experiment is to study the effects of prolonged weightlessness on two unrestrained primates while in unattended earth orbit. Prerequisite to attainment of the primary objective is the live recovery of specimens subjected to extended weightlessness for post flight patho-physiological studies. This plan presents the method for accomplishing this objective.

Mission phases. - The definition of and the time period for the various phases covered by this plan are listed below.

Prelaunch: This phase covers the period from T-2 days from launch up to liftoff. It begins with the installation of the primates into the spacecraft.

Launch: This phase covers the period from liftoff to orbital altitude and the checkout and insertion of the Primate Spacecraft into orbit.

Orbit: This phase covers the period from release into orbit until the recovery vehicle rendezvous with the Primate Spacecraft.

Recovery: The recovery phase starts with the countdown of the recovery vehicle and includes retrieval of the primates and the CM reentry.

Post recovery: This phase covers the period from splashdown until the primates are returned to the Principal Investigator.

Briefing	Content
Program orientation	Primate spacecraft mission description Primate spacecraft system description Primate spacecraft support description
Life support	Purpose of the subsystem Description of the subsystem and primate interface Description of how the subsystem operates Description of how the subssystem is operated
Data management power & distribution	Subsystem description and purpose Description of how the subsystem operates Description of how the subsystem is operated
Structure and thermal control	Subsystem description and purpose Description of how the subsystem operates Description of how the subsystem is operated
GSE electrical	Purpose and description of equipment Description of how the equipment operates Description of how the equipment is operated
GSE mechanical	Purpose and description of equipment Description of how the equipment operates Description of how the equipment is operated
Primate spacecraft handling	Description of Primate Spacecraft handling requirements Description of handling equipment Description of how the equipment operates Description of how the equipment is operated

Figure D12. Primate spacecraft technical briefing

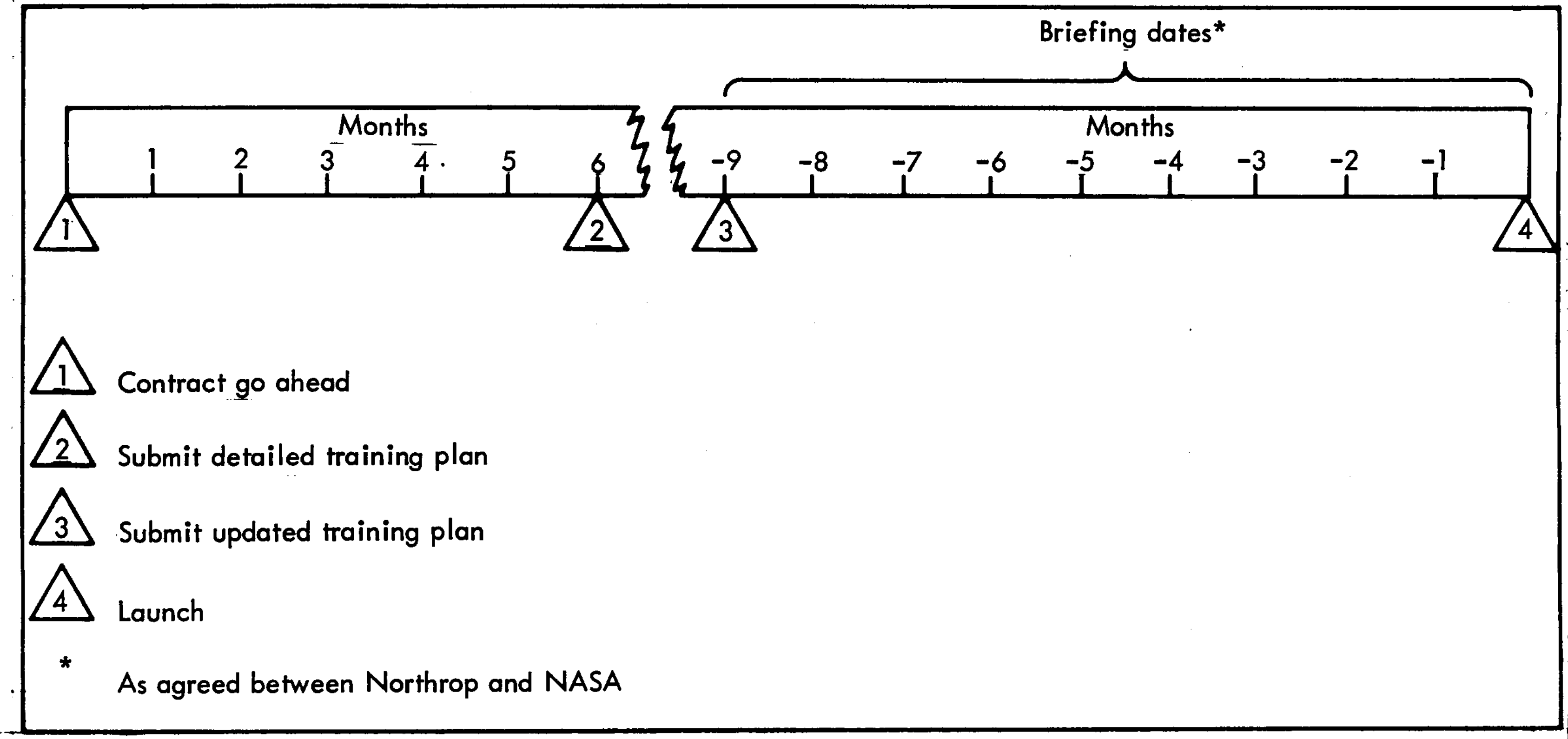


Figure D13. Training schedule

Prelaunch operation. - After final checkout of the Primate Spacecraft has been performed, installation of the primates will be accomplished through access panels in the SLA at T-2 days (figure D14). A removable platform within the SLA will be required to permit access to the top of the Primate Spacecraft, which must be removed before the service tower is closed out at T-6.5 hours. Prior to service tower closeout, GSE will be used to check out the Primate Spacecraft. After the GSE is disconnected and the service tower removed, monitoring of the Primate Spacecraft system on a go-no-go basis will be accomplished by the IU data link.

Topping of the cryogenic tank will be required after service tower removal. This will be accomplished through umbilical pipes from the IU to the Primate Spacecraft.

At T-2 hours the Primate Spacecraft will be switched to internal power and the number of data points reduced to 15.

(1) Primate Number 1 Temperature
(2) Primate Number 1 Heart Beat
(3) Primate Number 1 Respiratory Rate
(4) Primate Number 2 Temperature
(5) Primate Number 2 Heart Beat
(6) Primate Number 2 Respiratory Rate
(7) Oxygen Cryogenic Temperature
(8) Nitrogen Cryogenic Temperature
(9) Oxygen Cryogenic Pressure
(10) Nitrogen Cryogenic Pressure
(11) Calibration - 5 volts
(12) Nitrogen Gas Pressure
(13) Spacecraft Voltage
(14) Spacecraft Current
(15) Spare

Flight crew ingress will be started at approximately T-90 minutes and monitoring of the Primate Spacecraft will not require flight crew participation.

Launch operation. - Following the decision by the Apollo/Uprated Saturn 1 Launch Director and AMR Safety Officer to launch, lift-off will occur. Approximately 2.5 minutes after lift-off, first stage cut-off and separation will take place followed by launch escape system jettison and S-IVB ignition. The S-IVB will insert itself and the Primate Spacecraft/CSM into a 100 nautical mile orbit.

During the 100 nautical mile parking orbit the CSM will verify that the Primate Spacecraft and primates are operating properly and will then initiate separation of the CSM from the SLA/S-IVB, leaving the Primate Spacecraft and the rack still attached to the S-IVB. The CSM then rotates 180°, verifies the safety of docking with the Primate Spacecraft, and completes the docking operation. When docking is completed, the Primate Spacecraft's 15 data points will be switched to the CM using the LEM

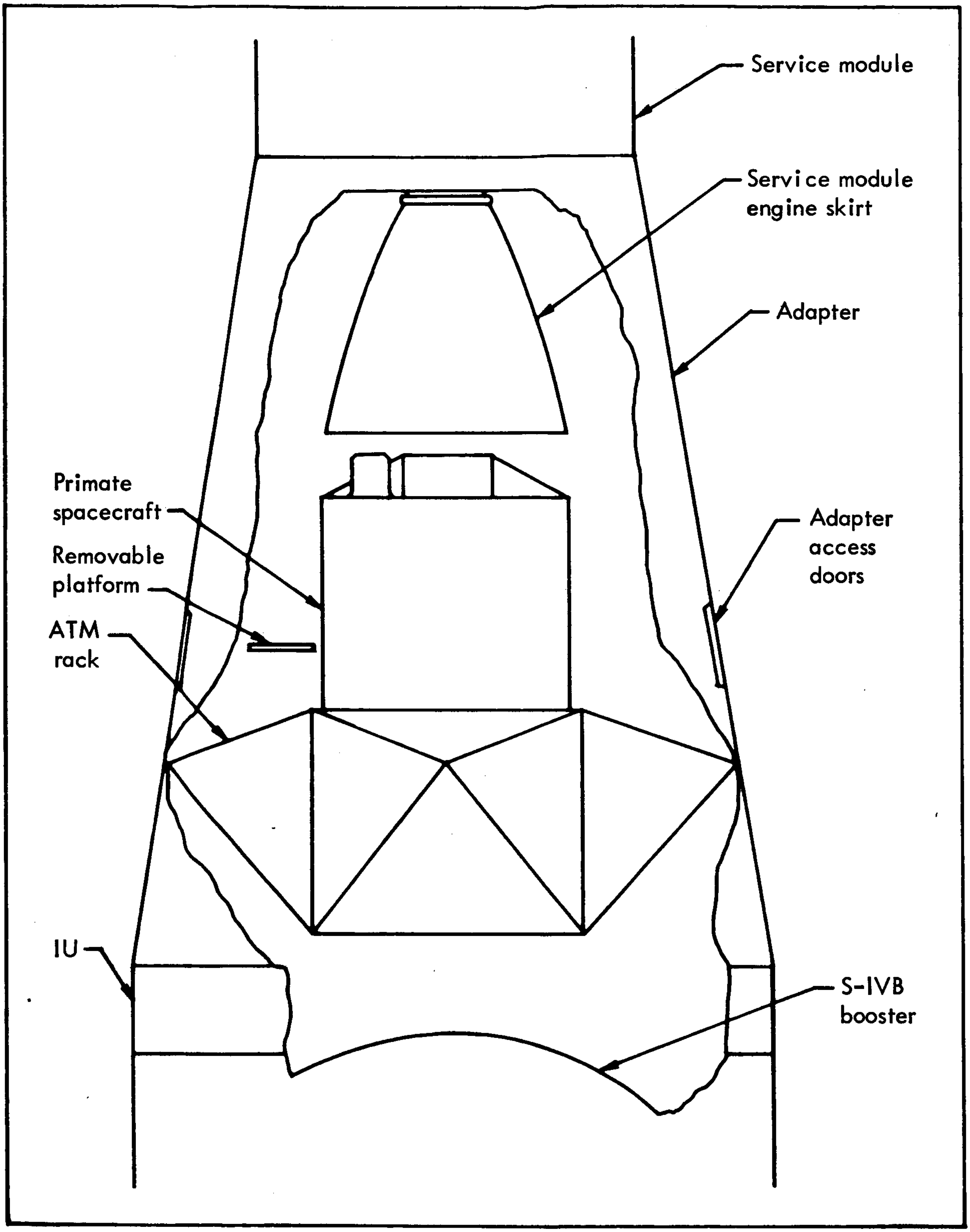


Figure D14. Primate spacecraft on ATM rack connectors in the docking collar. A command from the CM will release the Primate Spacecraft from the ATM rack and remove the cryogenic and telemetry connections. Once the spacecraft is clear of the S-IVB, the SM propulsion unit will fire to increase the orbit velocity enough to raise the apogee altitude to 250 nautical miles. After a Hohmann Transfer coast to apogee, a second SM burn circularizes the final altitude at 250 nautical miles. After the final orbit has been attained, a signal from the CM will deploy the solar panels and the data system will be switched to normal rate. Launch sequencing phases are shown in Figure D15. At the time of final separation of the Primate Spacecraft from the CSM, the experiment will be capable of operation independent of the launch vehicle that placed it in orbit.

Orbit operation. - The orbital phase of the Primate Mission begins when the Primate Spacecraft is physically separated from the CSM until an astronaut from a second Apollo CSM retrieves the primates in the recovery capsules. Spacecraft sun orientation and communications establishment with ground stations will constitute the major events to attain the following orbit:

(1) Orbital altitude of 250 nautical miles
(2) Trajectory place inclined 28.5 degrees to the equatorial plane
(3) Constant gravity level not to exceed .001 g
(4) Transient gravity level not to exceed .01 g

Once in orbit, the Primate Spacecraft will continue in orbit for a period of one year. During this period, data will be taken at least once every four hours and will be recorded on the Primate Spacecraft recorder. Upon ground command, data will be retrieved at least once each day.

Recovery operations. - Recovery operations include two phases, recovery and post recovery.

Recovery operation: The recovery and re-entry phase begins with the selection of the CSM and launch vehicle that will be used to return the primates to earth. Slight modification to the CSM will be required to accommodate the recovery capsules and life support systems and to adapt the LEM control electrical systems to interface with the Primate Spacecraft. During the CSM checkout operation at Kennedy Space Center, a mechanical fit check with the standby Primate Spacecraft will be required as shown in figure D16. This test will verity that the docking collar and electrical connectors are compatible and that Primate Spacecraft docking and recovery operations can be performed. A checkout test of the CSM Primate Life Support System and spare recovery capsules in the stowed position will also be required.

Following earth launch and rendezvous maneuver, the CSM arrives in a position to start the docking maneuver with the Primate Spacecraft. Since a RF link between the CSM and Primate Spacecraft will not be provided, the CSM will verify with the ground stations that the Primate Spacecraft is safe to dock with. The docking maneuver will then take place and when completed

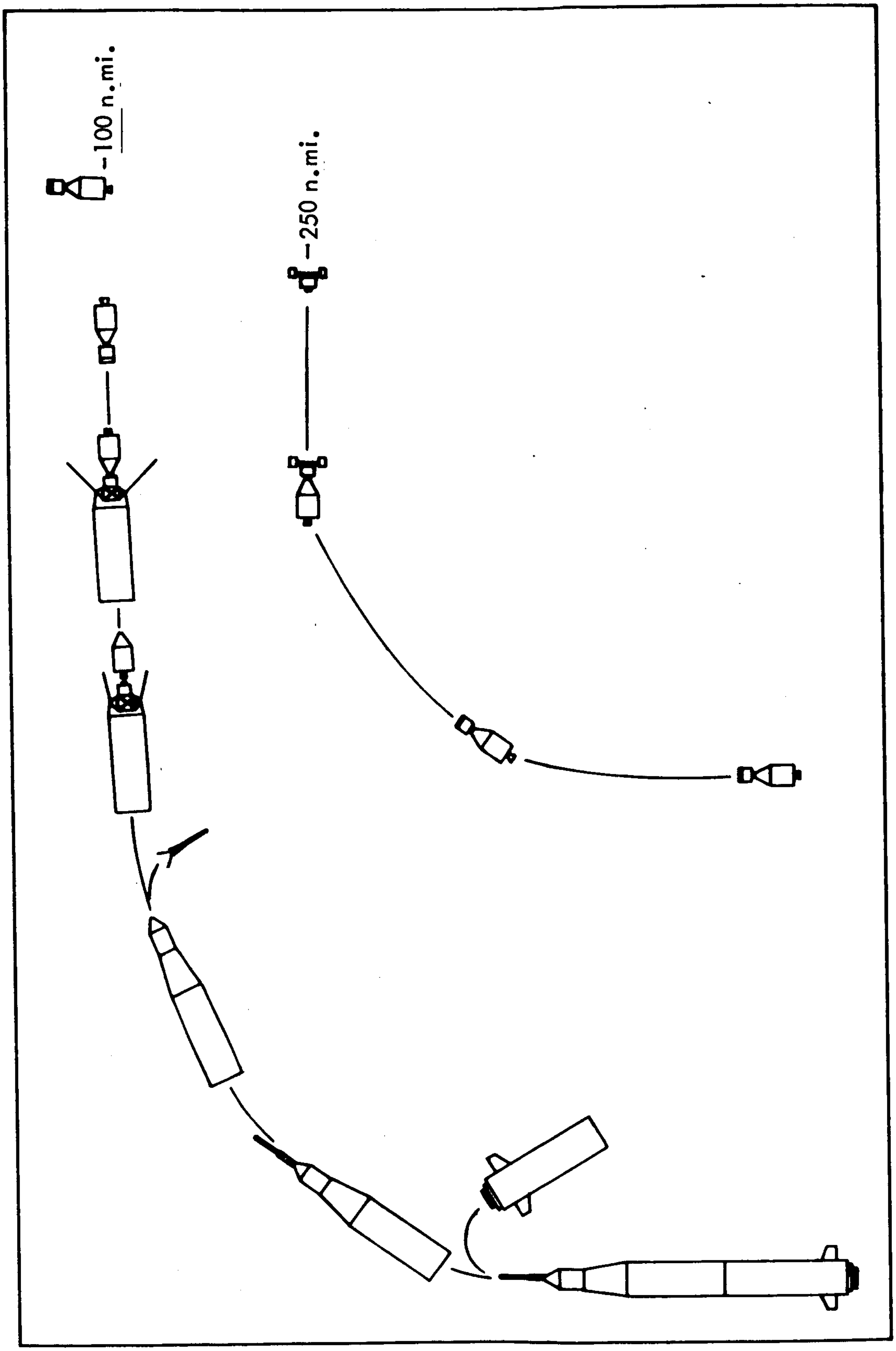


Figure D15.- Launch sequencing phases

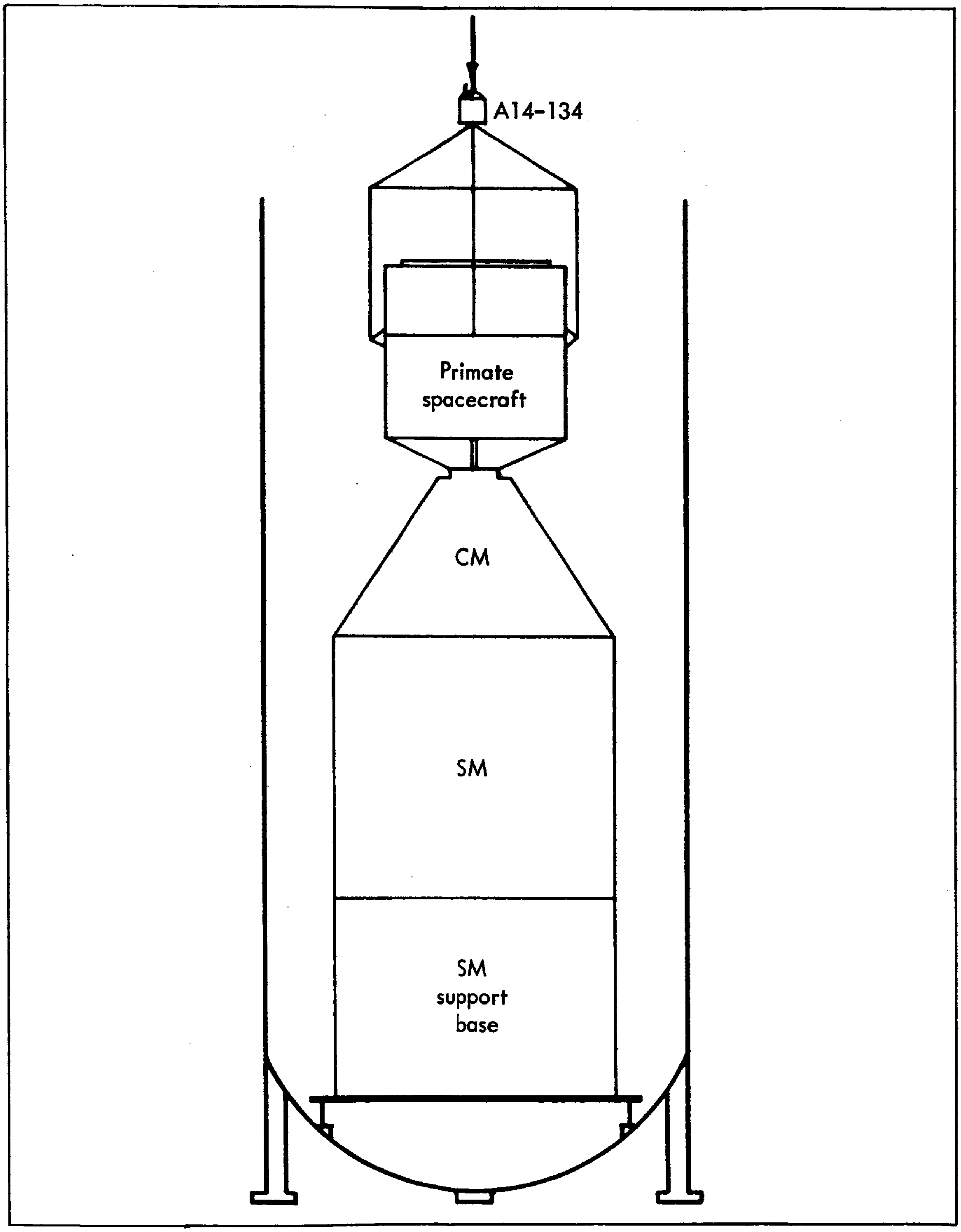


Figure D16. - East altitude chamber CM/primate spacecraft fit check the Primate Spacecraft monitor and control system will be switched to the CM using the LEM connectors in the docking collar.

Upon control acquisition of the Primate Spacecraft by the CM, the CM will send a signal causing the primates to be forced into the recovery capsules. The CM will then verify that both primates are safely in the recovery capsules and will then send a signal closing the recovery capsule doors. Door closure will be verified followed by a signal to slowly dump the Primate Spacecraft pressure while monitoring the recovery capsule pressure.

The astronauts, in a suited-up condition, will then decompress the CM in preparation for EVA. One astronaut will then perform the recovery operation by EVA. After connecting the tether, astronaut will remove one recovery capsule place protective cover over the side exposed to the Primate Spacecraft interior and hand the capsule to a second astronaut in the CSM. Upon removal of both recovery capsules, EVA operations will be complete. The recovery capsules will then be secured to the storage area and connected to the CM Primate Life Support System.

After the CM hatch is closed and the CM repressurized, separation from the Primate Spacecraft will occur. Following separation, a standard re-entry procedure will take place. A retro maneuver will be completed followed by SM jettison. After aerodynamic re-entry, the drogue and main chutes will be deployed and splash down in the CM recovery area conducted.

Post-recovery operation: The post-recovery phase begins at CM splash down and terminates when the primates are delivered to the experimenter facilities. Assuming that the CM recovery is routine (water landing at a predetermined point), the sequence of events will be as follows:

(1) The individual primate capsules are removed from the CM storage areas by an astronaut(s) or ground recovery personnel, disconnected from the CM life support system, and moved to the recovery vehicle (helicopter, small boat, etc.). In the event of heavy seas or some other operational difficulty, the primate capsules may be left in the CM to be recovered after the CM is lifted to the deck of the rescue ship.

(2) After removal from the CM, the capsules are moved to a preliminary observation station (onboard the recovery ship) where, under laboratory like conditions of cleanliness, heating, humidity, etc., each will be opened and the specimen examined. These preliminary examinations will only involve the determination of whether or not the specimen is in condition for an immediate trip to the experimenter's facility.

(3) Specimens will then be placed in individual traveling cages equipped with the proper feeding and sanitary facilities.

(4) The cages plus the recovery capsules will then be transported to the experimenter's facility by the fastest means of transportation available.

(5) Astronauts will be de-briefed and any pertinent data sent along with the primate cages.

The basic requirement is that all recovered primates be returned to the experimenter in a physical and psychological condition as close to that at recovery as possible.

MASTER TEST SCHEDULE

Figure D17 presents the master schedule of test operations.

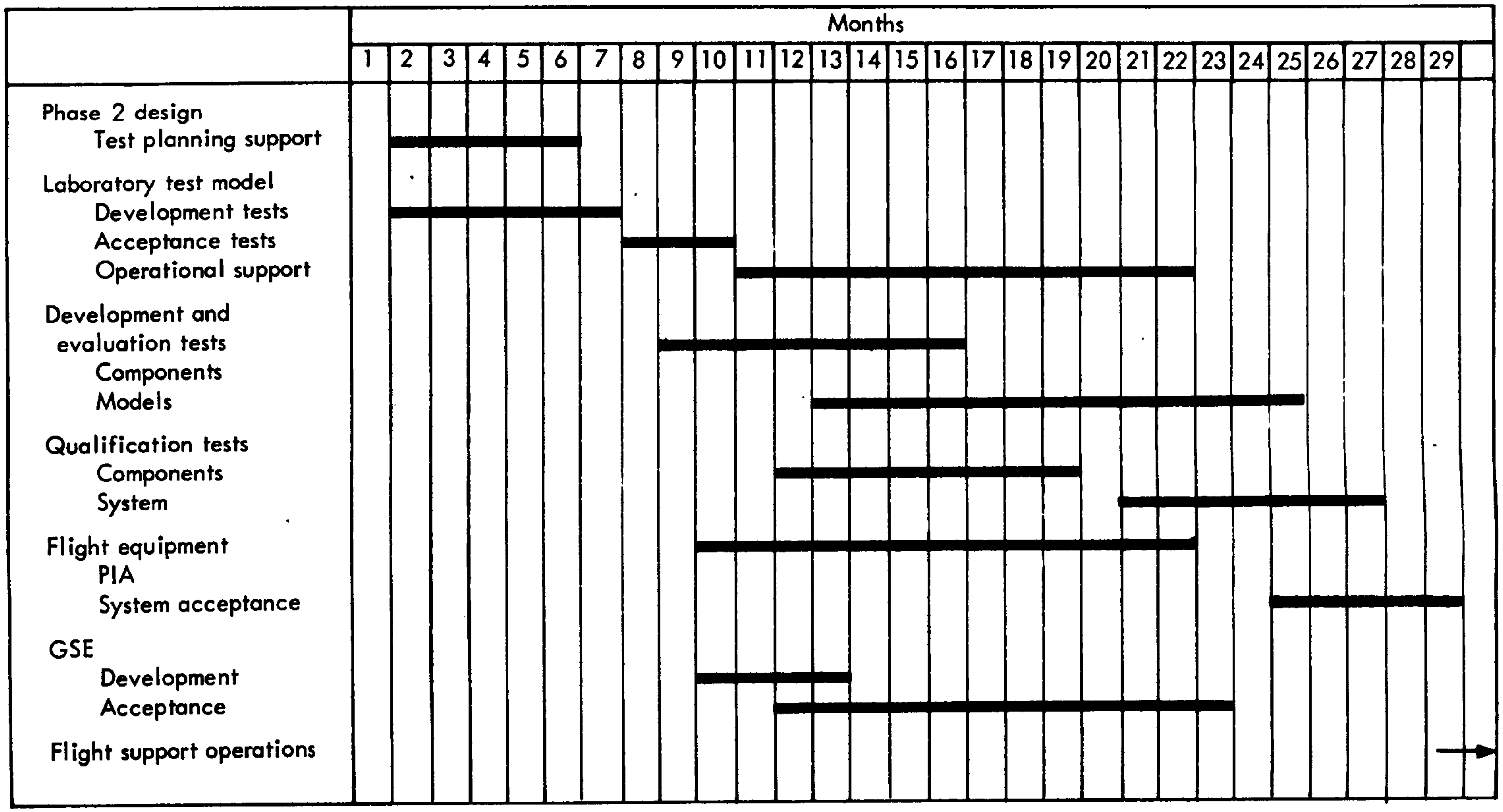


Figure D17. Test operations master schedule

APPENDIX E RELIABILITY PLAN

INTRODUCTION

Scope and Objective

This document describes the reliability activity designed to give maximum confidence in the integrity of the spacecraft in which the Orbiting Experiment for study of Extended Weightlessness will be conducted. It follows the intent and is consistent with those elements of the NASA Reliability Publication NPC 250-1, Reliability Program Provisions for Space System Contractors, dated July 1963, considered essential to the Orbiting Primate Spacecraft Program. This document describes the objectives of the Reliability Program, the reliability concepts which will lead to their accomplishment, the reliability tasks which implement the concepts, and selected hardware areas requiring special reliability analysis. These categories are subdivided into performance goals, the approaches to achievement, the choices of types of redundancy, mathematical and design evaluation techniques, the control of suppliers, testing and reliability demonstration, failure analysis, and data documentation and reports. Exceptions to NPC 250-1 reflected in the plan involve Reliability Program Control, Indoctrination and Training, Supplier Control, Maintainability, Standardization, Parts and Materials Program, Reliability Assessment, Weekly Progress Reports, and Program Control Reports. These exceptions are listed in table E6 which is located under the Documentation and Reports section of this document.

The objective of this document is to indicate the authority of the Reliability organization, the direction of the Reliability Program, and the substance of the Reliability tasks.

Organization, Management, and Facilities

Reliability personnel assigned to the Orbiting Primate Spacecraft Program are responsible directly to the Orbiting Primate Spacecraft Program Manager. They are also linked to other segments of Northrop's Reliability organization on whom they may call for centralized services to support the program as required. Some of these services include additional reliability engineers to supplement peak manpower needs; PRINCE and FARADA records, IDEP microfilm viewing and storage facilities; the Reliability and Quality Control Laboratory; internal Failure Analysis records; part, material, and process specification standards; and electronic piece parts screening and conditioning equipment for culling infant mortality parts and stabilizing device parameters. (This screening equipment is described in more detail in the paragraphs below.) The organizational structure for the Reliability effort is shown in figure E1.

Applicability

This document describes a Reliability program for spacecraft flight hardware, GSE, the Laboratory Test Model, and spares. Some of the Reliability tasks are common. Others are not.

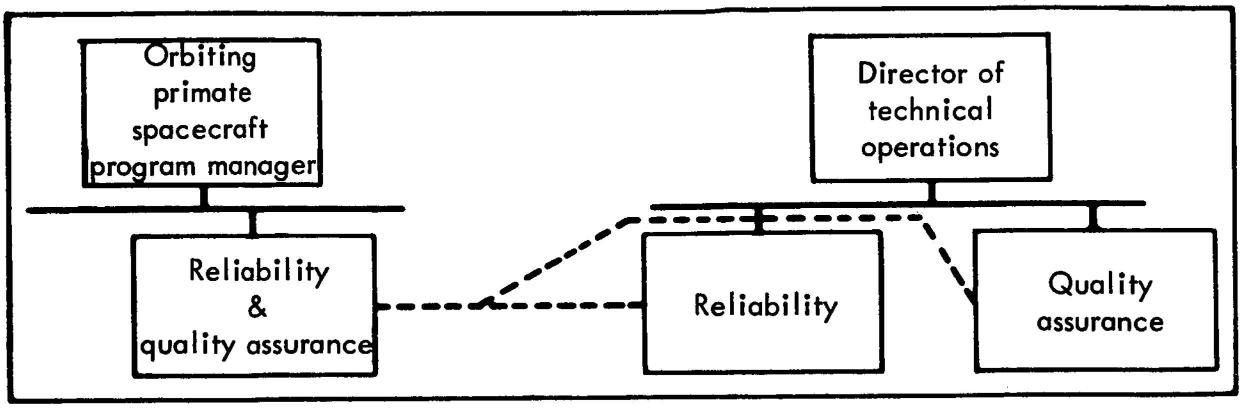


Figure E1. - Organization chart

RELIABILITY PROGRAM GUIDELINES AND CONCEPTS

Guidelines

The reliability effort described in this plan is directed towards providing an orderly and organized attack on all areas of probable failure during the mission.

Assumptions. -

(1) The mission consists of launch into orbit, normal operation of all equipment for one year, and the recovery of primates.

(2) While development of some items is anticipated, no state-of-the-art advancement is anticipated.

(3) There is no need for long shelf life without maintenance prior to the mission.

(4) Limited reliability tests supported by hardware analysis can reveal failure modes without the necessity of extensive testing of statistically significant quantities.

Approach. -

(1) The ability of novel or previously undemonstrated designs to meet performance requirements for the required life will be verified.

(2) The suitability of hardware selected from other spacecraft applications for this Program will be verified.

(3) Interactions between subassemblies will be subjected to special analysis for unexpected hazards.

Applicable reliability concepts. -

(1) Mission essential functions may be initiated by at least two independent means.

(2) Preferred designs and parts having established reliable space-application performance data will be selected, if possible.

(3) No single electronic failure will result in subsystem failure.

(4) Parts will be derated to allow ample performance margins between capability and use.

(5) The effect of external environmental stresses on the inherent properties of items will be allowed for.

(6) Maximum tolerances without failure or degradation will be the practice.

(7) Fault isolation or fail-safe mode will be inherent design wherever possible.

(8) Worst-case design techniques will be employed.

(9) Failure modes will be minimized by search, discovery, and redesign.

(10) Every attempt will be made to select high reliability standard parts and components previously qualified for similar space applications, while recognizing that parts are not perfect and every subsystem design that accommodates an unanticipated failure without impairment of subsystem function is a preferred design.

(11) Although reliability is frequently a reciprocal of complexity and quantity of items, there are exceptions where a more complicated design may be more reliable than a simplified one.

(12) The most careful screening of parts and production processes cannot eliminate all flaws. Element redundancy will employ identical elements in parallel to compensate for random failure during normal life.

(13) Functional redundancy may be used to provide two parallel independent paths composed of physically different functionally identical equipment.

(14) Degradation redundancy consisting of excess capacity will be used to allow for reduced or degraded performance.

(15) If an item is critical to survival, triple redundancy is desirable.

RELIABILITY TASKS

The reliability tasks which implement reaching the objectives of the Reliability Plan are shown in the Reliability Activity Diagram, figure E2.

The reliability activities will follow three fundamentally different approaches, starting from three different viewpoints, and all focused on the target of identifying potential failure. The three general tasks which implement the above approaches consist of: a thorough review and analysis of the design, mathematical analysis, and a series of reliability tests.

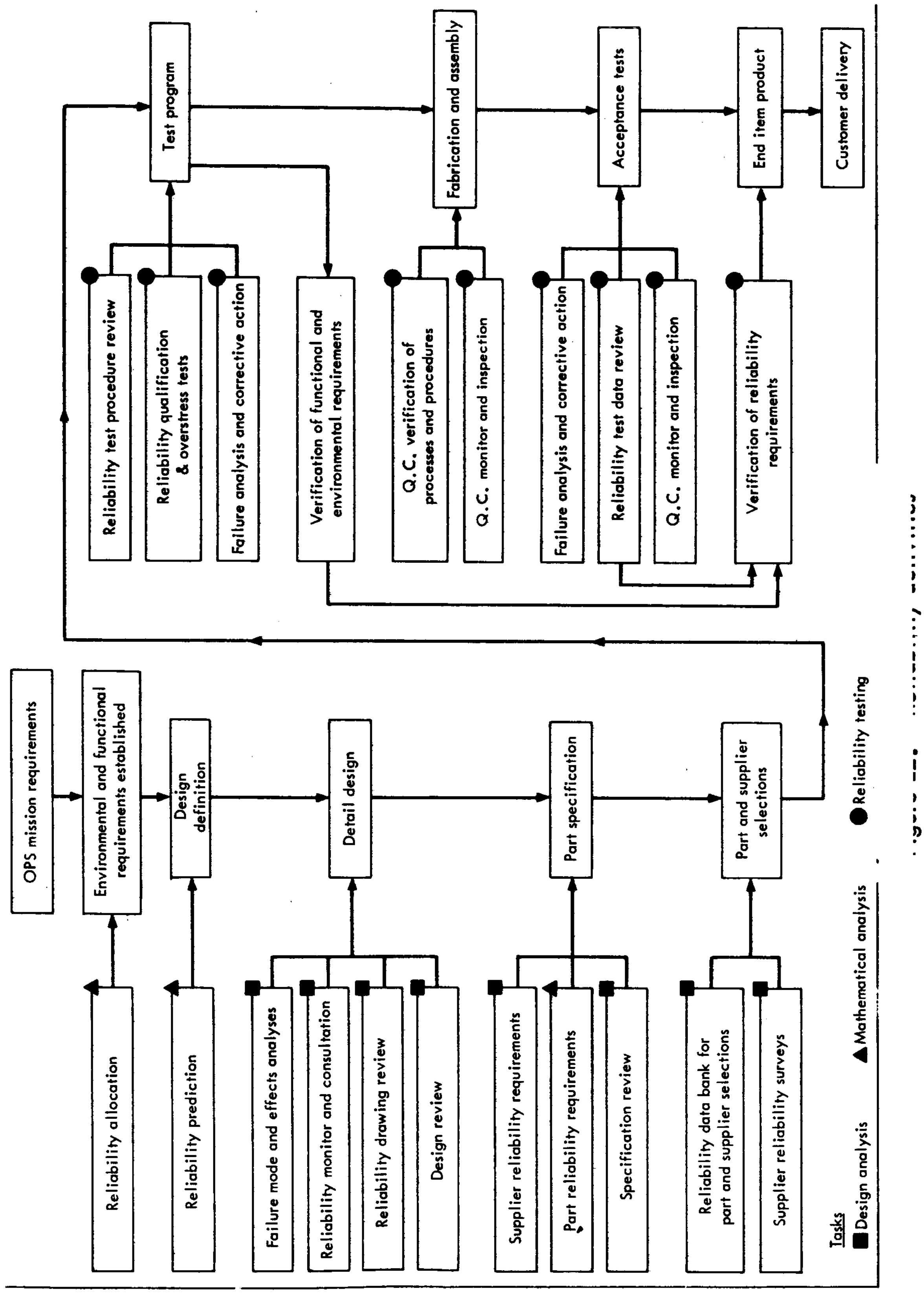
Design Analysis Tasks

Informal design review. - Informal design review will occur on a continuing basis during the design and manufacturing phases. Its use permits reliability inputs to the design and provides some of the information required from design for reliability analyses. Informal design review concerns itself with selection of the best materials, mechanisms that work with monotonous reliability, operational loads and transient stress, interface coordination, maintainability, and any other features that will improve a design's performance or reliability. An example which illustrates informal design review on the Feeder during the Definition Phase of the Orbiting Primate Spacecraft Program is located under the last paragraph of this document.

Formal design reviews. - In accordance with section 3.6 "Design Review Program," of NPC 250-1 and Exhibit XIV, "Formal Configuration Management Reviews, Inspections and Demonstrations," of NPC 500-1, formal design reviews will be held at the spacecraft, subsystem, and contractor end item levels shown on figure E3, and on GSE. Formal design review meetings will be conducted by the Northrop program personnel for the NASA personnel. The four design reviews to be conducted are: Preliminary Design Review (PDR), Critical Design Review (CDR), First Article Configuration Inspection (FACI), and Flight Readiness Review. Scheduling, procedures, responsibilities, and substance of each type of review will be as described in Exhibit XIV of NPC 500-1.

Equipment characteristics will be reviewed for interface compatibility; performance capability; drift, stability, and wear; alternate design concepts; derating for environmental stresses; materials selection; and potential failures. For example, prior to the PDR and CDR, design engineers presenting designs for review will identify, and be prepared to discuss, possible failure modes in their designs, consequences of the failure, its ability to produce failure or degradation on interfacing equipment, and which characteristics are most critical during manufacturing and flight. These reviews will be scheduled at time periods agreed upon with NASA.

Drawing and specification review. - Northrop will comply with section 3.2, "Design Specifications," of NPC 250-1. Procedurally, reliability and quality control will approve specifications and drawings prior to release. Quality control will also review purchase requisitions and approve them prior to release to Procurement. The review of all documents will be made to ascertain adequate and valid statements of performance requirements, environmental profile requirements, pertinent test criteria, safety margins, derating factors, and apportioned reliability goals as these and similar data are applicable.



OPS mission requirements
Environmental and functional requirements established
Design definition
Detail design
Part specification
Part and supplier selections
Reliability allocation
Reliability prediction
Failure mode and effects analyses
Reliability monitor and consultation
Reliability drawing review
Design review
Supplier reliability requirements
Part reliability requirements
Specification review
Reliability data bank for part and supplier selections
Supplier reliability surveys
Test program
Reliability test procedure review
Reliability qualification & overstress tests
Failure analysis and corrective action
Verification of functional and environmental requirements
Fabrication and assembly
Q.C. verification of processes and procedures
Q.C. monitor and inspection
Acceptance tests
Failure analysis and corrective action
Reliability test data review
Q.C. monitor and inspection
End item product
Verification of reliability requirements
Customer delivery
Tasks
Design analysis
Mathematical analysis
Reliability testing

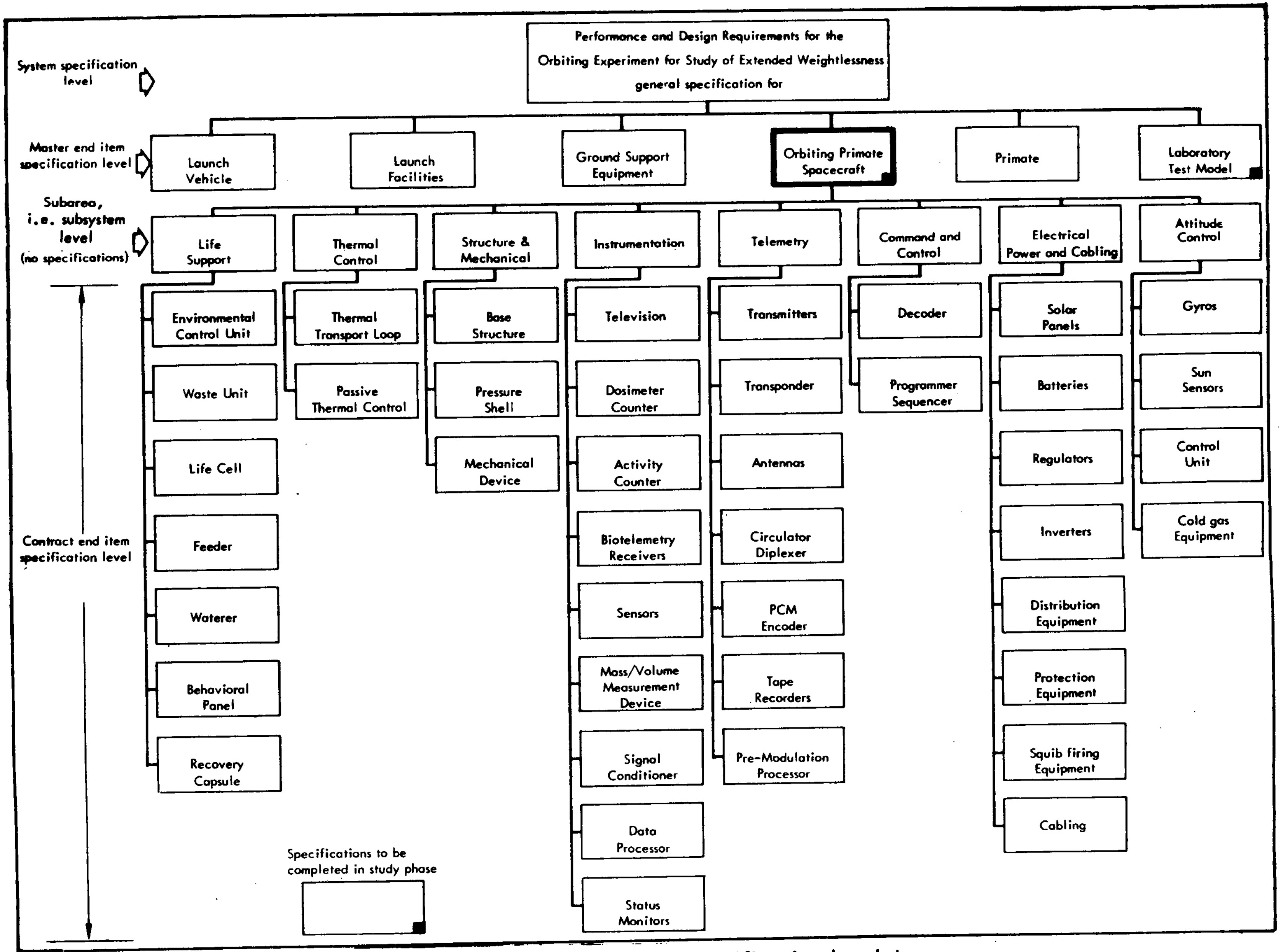


Figure E3. - Master end item specification breakdown

Failure mode, effect, and critically analysis (FMECA). - In accordance with section 3.4, "Failure Mode, Effect, and Criticality Analysis," of NPC 250-1, Northrop will perform FMECA on all eight subsystems at the subsystem level (see figure E3). In addition, a FMECA will be performed on all components which are not spaced qualified. These are the Feeder, Waterer, Behavioral Panel, Recovery Capsule, Programmer Sequencer, and like items.

The analysis sheets may present the failures in tabular form or in tree form. A sample of each as used on other programs is shown in figure E4 and E5. Format selected will be the one most clearly presenting the analysis of the subsystem or the component. The FMECA will reflect conceivable failures, anticipated causes, criticality or severity, probability of occurrence in very broad magnitudes and recommended improvement techniques. Failure severity will be classified as mission failure, limited operation possible, correctible failure due to redundancy, limited initial failure with impending accelerated degradation, or negligible. The information obtained from the FMECA will be utilized in design reviews and test planning to direct attention to the defined failure modes.

Parts, materials, and components selection. - The parts and materials used will be selected from those qualified to an appropriate NASA or military specification which matches the environments of the Master End Item Specification. All materials will be procurred from Northrop's approved list of suppliers described in the Quality Assurance Plan, Appendix F. These materials will be required to meet the environmental and outgassing requirements located under paragraph 3.4 of the Master End Item Specification, CP 10000.

Only space qualified components will be purchased, e.g., TV camera, command receiver, signal conditioning amplifiers, etc. Likely vendors will be required to supply equipment performance data and proof of flight qualification. Where a need exists but no space qualified item is available, the equipment selected will be qualified during the Qualification Test Program. Any exceptions to the foregoing, such as unique instrumentation, will be qualified as agreed upon by both NASA and Northrop when such item is selected.

Northrop will prepare and maintain a qualification status list showing the planned and completed qualification status of each part, component, subassembly, and higher level of assembly. The basis for any omission of qualification tests will be shown. Where qualification is based on similarity, reference is made to the pertinent test reports or data. The qualification status list and changes thereto will be submitted for approval at monthly intervals, in accordance with this Reliability Plan.

The procurement of non-preferred parts, materials, or non-space-qualified components will be discouraged. However, when a suitable preferred item cannot be found, a non-preferred item will be used subject to both Design and Reliability approval. Approval will be based on need, vendor's accumulated data, similarity to qualified items, and the experience of the NASA Langley Office and other spacecraft contractors.

Title Normally Open/Closed Explosive Valve

Part No. P46932 Next Ass'y No. ______

Prepared by:
Date:
Page:

Conceivable failure	Probable failure cause	Failure severity class*	Failure frequency class**	Can failure feasibly be avoided?	Change necessitated	Procedure necessitated if failure does occur
Premature or no-fire of primers	a. Open circuit in primer assembly	D_s	D_f	Yes	Improve wiring and/or potting	In event of failure unit must be replaced with new part
	b. Short circuit in assembly	D_s	D_f	Yes	Improve primer charge Q.C.	
	c. Excessive radio noise level	D_s	D_f	Yes	Improve confidence continuity check-out procedure and/or radio noise filtration.	
External or internal leakage of operating medium and causing permature depletion of N_2, N_2H_4 or N_2O_4 supply	Faulty seal or primer installation					
	a. Leak could develop before launch	D_s	D_f	Yes	Improve sealing techniques and/or confidence leakage checkout procedure	a. In event of failure unit must be replaced in system with new part.
	b. Leak could develop after launch					b. Possible loss of midcourse correction capability--mission failure. Failure severity dependent on magnitude of external leakage.

*Failure severity: A_s - Immediate mission failure; B_s - Correctable failure compensated by other system elements; C_s - Operation beyond spec limits not causing mission failure; D_s - Negligible

**Failure frequency: A_f - 10%; B_f - 1.0%; C_f - 0.1%; D_f - 0.01%

Figure E4. Reliability failure mode analysis

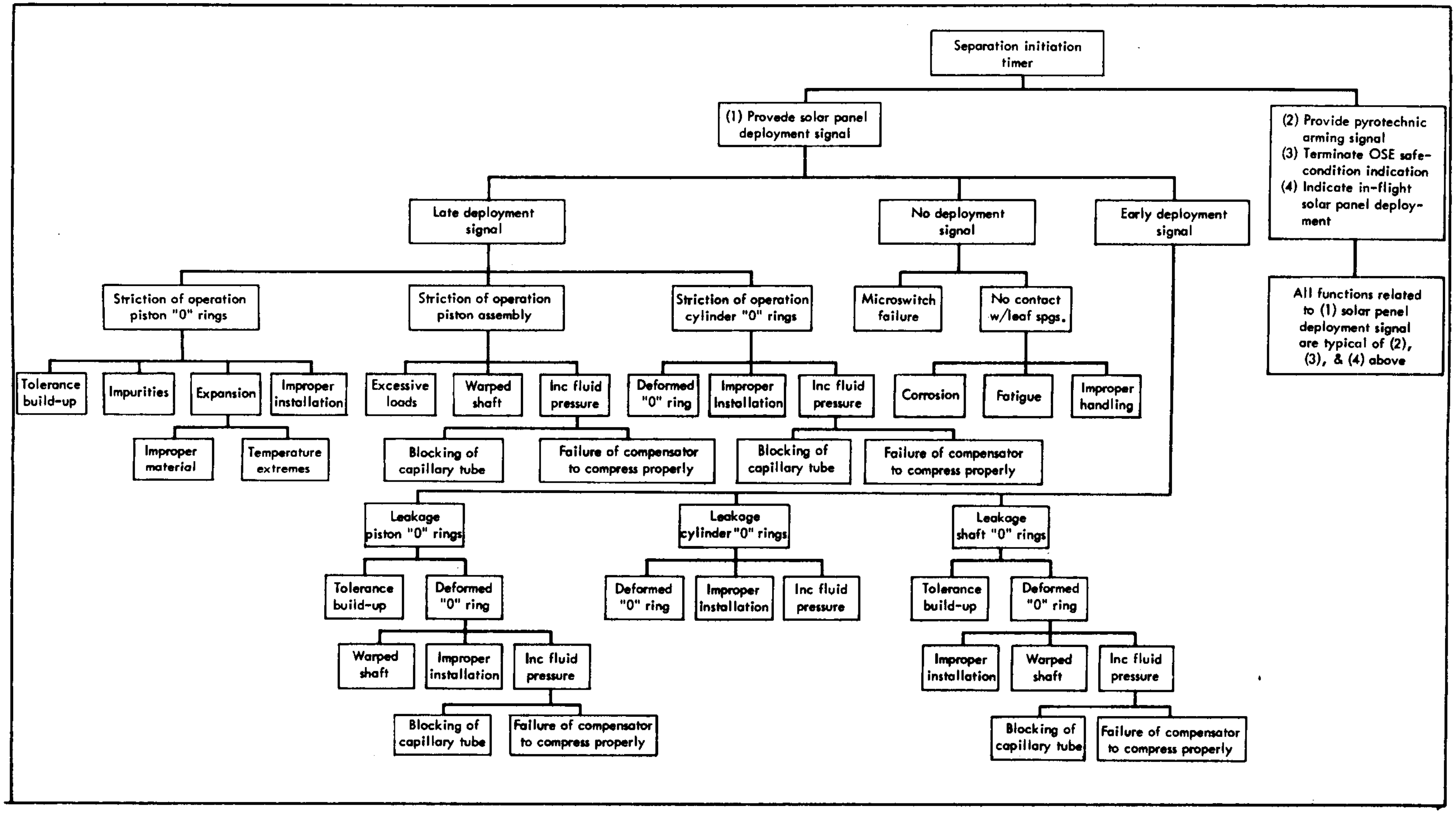


Figure E5. - Failure mode analysis tree

Electronic parts in fabricated circuits will undergo electrical and thermal stress analysis. Derating procedures will be as described in MIL-Handbook 217A, Reliability Stress and Failure Rate Data for Electronic Equipment.

Reliability indoctrination.- Paragraph 2.5, "Reliability Indoctrination and Training," of NPC 250-1, requires an effective reliability training program. The quality and experience of the Northrop personnel obviates the necessity of a formal and extensive training program in the philosophy and discipline of reliability. Yet, continuous cognizance of the importance of the reliability aspects of the spacecraft, etc., is essential to assure that these aspects are included in the design performance capability. This cognizance will be achieved by direct continuous contact and interchange of information between Reliability and Design engineers. Indoctrination and reliability concepts will be achieved by continuous informal discussion in reviewing detailed designs as they evolve.

Data bank.- Reliability engineering will use the following data bank information where it contains applicable failure history.

(1) PRINCE - Parts Reliability Information Center

(2) APIC - Apollo Parts Information Center

(3) IDEP - Interservice Data Exchange Program

(4) FARADA - Failure Rate Data Program

Maintainability and human engineering.- Reliability pesonnel will monitor design activities to assure that requirements of access for checkout, test inspection, and repair to spacecraft equipment are met. The intent, as applicable, of Paragraph 3.5, "Maintainability and Elimination of Human Induced Failure," of NPC 250-1 will be met but no special instructional material or associated training is anticipated.

Mathematical Analysis Tasks

Selection of appropriate math model. -

Failure pattern: In order to predict failures mathematically, it is necessary to have a mathematical model of the failure pattern. Northrop will use the conventional reliability model which assumes that chance failures occur at a constant rate independent of accumulated life and that a long life system is approaching a stable state exponentially. This gives the basic formula

$$R_{(t)} = e^{-t/m} = e^{-\lambda t}$$

where:

R = reliability for some mission time, t

m = mean time between failure.

λ = failure rate/unit time.

Figure E6 shows a picture of failure patterns for the Orbiting Primate Spacecraft.

Components in series: The spacecraft will contain independently recognizable components with a functional life of almost 9,000 hours. If the reliability of one item is R_1, then the total R_t of all the components in series with each other is their product.

$$R_t = R_1 R_2 R_3 R_4 \ldots\ldots\ldots\ldots R_n$$

In the analysis of the spacecraft, this formula will be used to calculate the reliability of a subsystem given the reliabilities of all its components; or of the spacecraft given all the subsystem reliabilities.

Parallel (double) redundancy: If two items of identical probability (R_1) are connected in parallel so either may perform exclusively of the other, then the reliability of the combination (R_t) is,

$$R_t = 1 - (1-R_1)^2$$

Since $(1-R_1)$ is the failure term, or the probability of failure, which is always less than one, squaring it reduces the term. This increases the probability of success.

In the mathematical evaluation of the spacecraft, this parallel redundancy formula will be used to analyze the Instrumentation Subsystem. As an example, assume approximately 100 analog sensors of data will be used. Some require additional signal conditioning amplifiers. (Others have built in signal conditioning circuits.) Hardware selection for this subsystem is still in flux, but hypothetically there would be another 100 redundant but independent sensors as back-up units, each connected to its own pair of redundant signal conditioning amplifiers.

With 100 analog sensors in the Orbiting Primate Spacecraft, power requirements, space, and practicality limit signal conditioning amplifiers to 20 to 30, a ratio of 5-6 sensors for each amplifier. This raises the thought of using only 10 amplifiers for the 100 sensors and connecting the remaining 10 in parallel redundancy. Or, the ultimate might be to use 15 amplifiers with the 100 sensors, and use 5 as standby units which can be individually switched to replace any failure anywhere among the first 15. This gives a theoretical 5-fold redundancy, The practicality of sensing failure and switching and the loss of reliability from the switching networks are questions to be explored as the design firms and actual hardware is selected.

Triple redundancy: A variation of the parallel (double) redundancy is the triple redundancy pattern whose formula is,

$$R_t = 1 - (1-R_1)^3$$

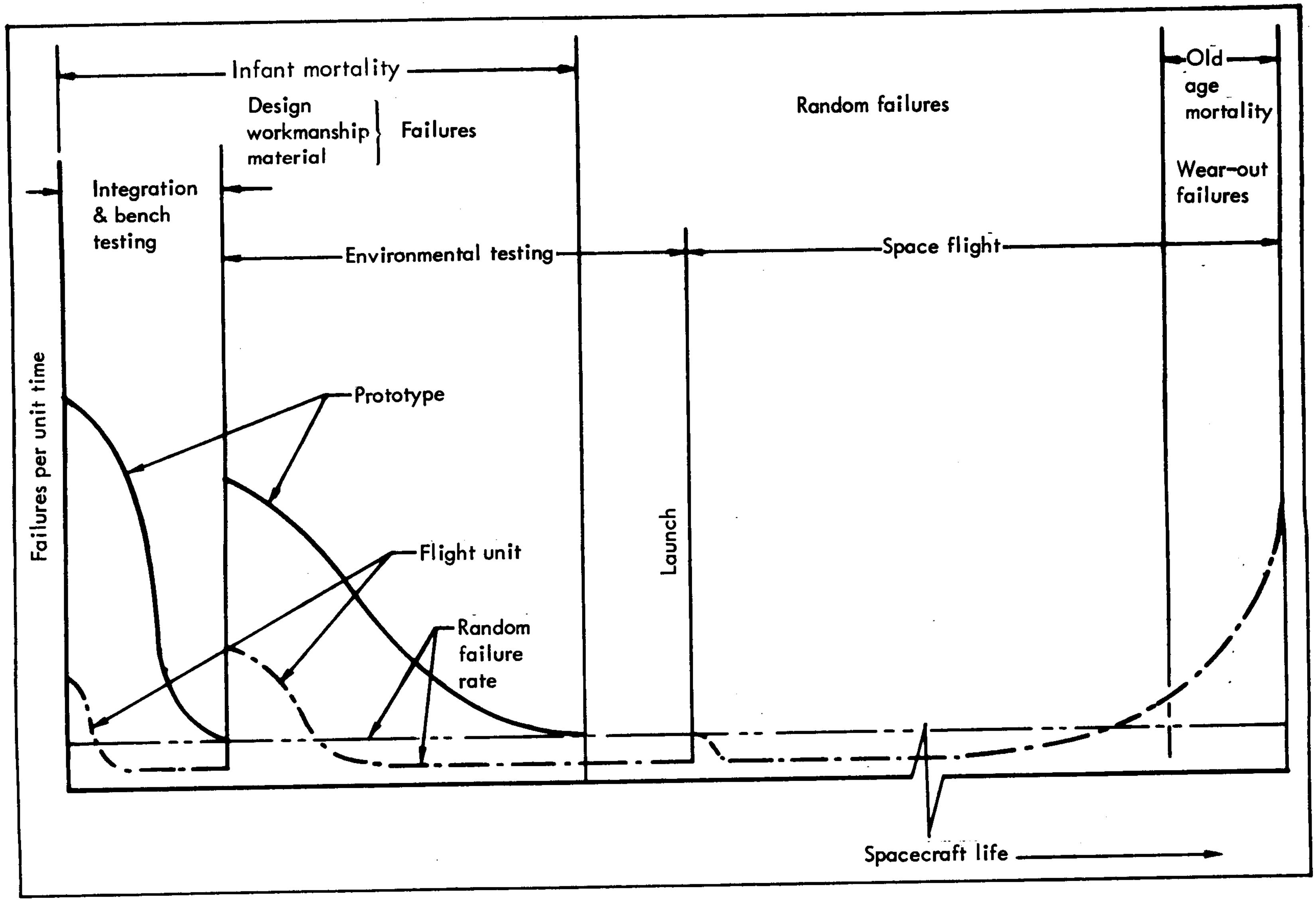


Figure E6. - Failure patterns

This formula will be used in reliability calculations, where triple redundancies to upgrade component reliability will be considered, such as coolant pumps in the environmental control area.

Series-Parallel combination with switching networks: When three pairs of doubly redundant components are in series with each other,

$$R_t = R_{sw} \left[1 - (1-R_1)^2\right]^3$$

where, R_{sw} is the reliability of the switching network. This formula will be used as part of the analysis of the communication equipment aboard. The equipment consists of the voice and data transmitter, receiver, and command decoder.

The two systems would be connected so either receiver could operate with either decoder and transmitter.

Generalized equations. The next formula is a variation of the previous one, and allows for any combination of double redundancies with unlimited interconnection of components.

$$R_t = e^{(1-x)n} \left[1 - (1-R_1)^2\right]^{xn}$$

where, x is the proportion of redundancy and n indicates the quantity of series elements.

In calculations where the redundant elements do not have the same reliability, the failure term $(1-R_1)^2$ is replaced by $(1-R_1)$ $(1-R_2)$ which can be generalized to $(1-R_1)$ $(1-R_2)$.....$(1-R_n)$ for n multiple redundancies, normally not a common design.

A block diagram of configuration patterns is shown in figure E7.

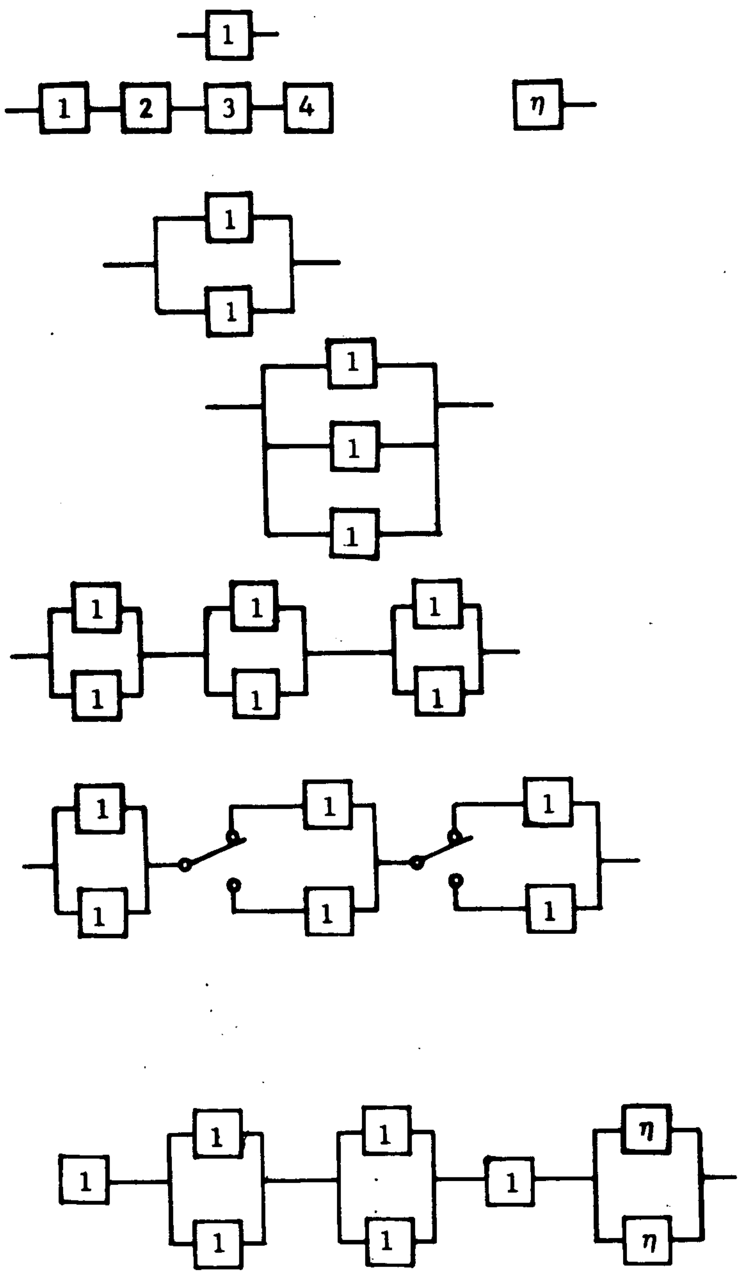
Reliability prediction. - In accordance with Paragraph 3.3, "Reliability Prediction and Estimation," of NPC 250-1, the reliability of the spacecraft will be mathematically predicted. The methods and techniques presented in this document and in MIL-Handbook 217A will be used in the calculations.

The procedure will consist of establishing reliability block diagrams showing in sequence those elements which must function for successful operation of a mission objective. Whether the blocks will reflect analysis to the part or component level will depend on the level of detailed assembly information available.

As much as possible, generic part failure rates will be used for calculations because they are most typical and most available. Where in specific cases substantive data is available to support an actual failure rate of an item, this number will be used. Generic failure numbers may be corrected for various levels and kinds of stress by special derating factors for environment or operational stress.

Note: R_t = Reliability of the total chain
R_1 = Reliability of element 1
R_{sw} = Reliability of switching network
n - number of series elements
x = proportion of redundancy

Configuration



Reliability Formula

$R_t = R_1 = e^{-t/m}$

$R_t = R_1 \; R_2 \; R_3 \; R_4 \; ....R_n$

$R_t = 1 - (1 - R_1)^2$

$R_t = 1 - (1 - R_1)^3$

$R_t = \quad 1 - (1 - R_1)^2 \quad {}^3$

$R_t = R_{sw} \quad 1 - (1 - R_1)^2 \quad {}^3$

$R_t = R_1^{(1 - x)n} \quad 1 - (1 - R_1)^2 \; {}^{xn}$

Figure E7. - Configuration patterns

In calculating GFP reliability, the contractor will omit the primate and use a generic failure rates of transducers and transmitter electronic parts for the implanted devices.

Reliability allocation. - The spacecraft reliability goal supplied by the NASA will be apportioned to the subsystem and component level in accordance with the breakdown shown previously in figure E3. This goal, when established by the Statement of Work, defines the desired probability of performing the one year mission.

Apportioned goals will be compared with predicted reliabilities calculated. A comparison of these two sets of numbers will indicate design areas with mathematically adequate reliability, and those of apparent deficiency. This will be a guide for failure mode study configurations to be redesigned or refined to achieved increased reliability, or components deserving of more thorough testing.

Reliability Testing

Several kinds of reliability tests are required. In a sense, any tests conducted at any time during the orbiting Primate Spacecraft Program are reliability tests because the results indicate equipment ability to perform to that point in time, or conversely, they discover a mode of failure. However, the tests discussed in this section are those designed to validate equipment quality to the desired level, and then by further test to determine how close failure was and which modes would be the first to malfunction. This information can then be a basis for reliability evaluation and upgrading redesign.

Qualification tests. - The use of qualified equipment is the heart of any reliability program. Many of the items selected for the spacecraft will be space qualified and a testing program will be conducted for the rest. The items which will require qualification and the test procedures to conduct such tests are described in the Integrated Test Plan, Appendix D.

Over-stress tests. - Satisfactory completion of the Qualification test will quality an otherwise unqualified item for the spacecraft. This does not complete everything which it is practical to do in the search for failure modes.

Upon completion of the Qualification test, hardware tests will be continued until failure occurs or some pre-established endurance point is passed. Even if failure occurs, it may be fixed and the test continued to the endurance point. The decision will be made by the cognizant Reliability Engineer. For example, the Feeder is required to delivery 54,750 to 65,000 pellets during the year's orbit. By accelerating the pellet delivery sequence after the qualification test is passed, the Feeder will continue to operate to an endurance limit of almost 109,500 pellets (2 refills of the food storage drum). If any malfunctions occur, a reliability determination of the likelihood that such malfunction would occur during the orbital flight will be made. If design change appears necessary, this recommendation will be submitted to the

NASA for concurrence. If no design change appears necessary, the failure will be fixed, the item still rated as qualified, the test continued to the endurance point, and the matter submitted to the NASA for information.

The ability of the tested equipment to reach specified endurance points will be satisfactory proof of full system conformance to contractual reliability requirements in accordance with Section 4, "Testing and Reliability Evaluation," of NPC 250-1. The items to be tested, test specifications, procedures, and reports for these over-stress tests are described in the Integrated Test Plan.

Failure analysis and correction action. - Northrop's failure and corrective action system is described in the Quality Program Plan. It is briefly, mentioned here for the completeness of this document.

Northrop's Failure Analysis procedure meets the requirements of paragraph 3.7, "Failure Reporting and Correction." of NPC 250-1. Figure E8 , "Quality Rejection Report," describes the originating failure report and the procedure for its use. Laboratory analysis of failures, when needed, will be conducted in the Reliability and Quality Control Laboratory, an air-conditioned facility equipped to conduct mechanical, electrical, and hydraulic evaluation tests.

Parts screening and conditioning. - All electronic piece parts will be screened and conditioned (burned in) prior to installation in any component to cull the infant mortality parts and to stabilize the device parameters. All semiconductors will be x-rayed in two views. Detailed screening procedures will be created for each part or family of parts, and will specify tests to be conducted, measurement points, parameters to be measured, and allowable degradation during burn-in. Northrop's facilities include ovens and both manual and automatic curve tracing equipment for plotting semiconductor characteristics.

Subcontractor and Supplier Control

Northrop will comply with Paragraph 2.6, "Subcontractor and Supplier Control," of NPC 250-1. Any subcontractor for Environmental Control Equipment and the Waste Management Unit will conduct the same program on his equipment which Northrop will follow on the spacecraft as specified in this document. Other suppliers will have appropriate reliability requirements selected from this Program Plan included in their procurement directives. When possible, the screening and conditioning test requirements for electronic parts will be incorporated into procurement specifications. In those cases where testing will be done by the components or parts manufacturers, Northrop Quality Control will monitor the tests. Where the manufacturer is not equipped to perform screening tests, the parts will be tested as Northrop.

Comparison of Tasks - Laboratory Test Model, GSE, and Flight Hardware

Many reliability tasks are common to all end item hardware. Others are not common because of differences in equipment purpose. Flight hardware is required to fly in space in association with a manned flight system and cannot be maintained. GSE can be maintained at periodic intervals. Other equipment is operated only in a laboratory to demonstrate the acceptability

NORTHROP NORTRONICS PRODUCT INTEGRITY PROCEDURE	PAGE 1 OF 7	NUMBER QA-14.2
	DATE 20 July 1966	REVISION A
	SUPERSEDES QA-14.2 dated 18 March 1966	
SUBJECT QUALITY REJECTION REPORT (FORM ANS-23)	Chief, Product Integrity	

I. PURPOSE

The Quality Rejection Report is used in the Receiving and Production Inspection areas to withhold nonconforming material from normal use and to authorize and document the disposition of such material. It may also be used in source inspection areas for the same purpose when specified by Quality Assurance supervision. The Quality Rejection Report shall not be used to report functional failures or to disposition malfunctioned equipment in Production Test areas.

II. PREPARATION INSTRUCTIONS

A. The following instructions have paragraph numbers corresponding to the block numbers on the form. The block title (underlined) is followed by the rejection area numbers which require this specific entry. Where practicable, the responsibility for entering the information is defined.

B. The initial entry on the report shall define the rejection area. This is accomplished by circling the proper identifying number in the rejection area block at the top of the form. Remaining entries shall be made as follows:

1. DATE - (1,2,3) - Originator - Enter date report is originated.
2. PROJECT - (1,2,3) - Originator - Enter the project name or initials when such identification has been assigned to the project.
3. PART NAME - (1,2,3) - Originator - Enter the name of the nonconforming item as shown on the drawing or L.M.
4. SERIAL NUMBER - (1,2,3) - Originator - Enter the serial number of the nonconforming item.
5. PART NUMBER - (1,2,3) - Originator - Enter the complete part number of the nonconforming item. Be sure to include dash number, letter, prefix, etc., when applicable.
6. SUPPLIER - (1,3) - Originator - Enter name of supplier. This entry is essential for reports initiated in Receiving (1) and Source (3) areas but may be omitted, if unknown, on Shop (2) rejections.
7. CONTRACT NUMBER - (1,3) - Originator - Enter supplier's contract number if nonconforming item is subcontracted.

Figure E8. - Quality rejection report

II. PREPARATION INSTRUCTIONS (Cont.)

B. (Continued)

8. P/O NUMBER - (1,3) - Originator - Enter Nortronics' Purchase Order number.

9. ITEM - (1,3) - Originator - Enter item number of nonconforming item as identified on the Purchase Order, Receiving Report, or contract.

10. UNIT COST - (1,3) - Originator - Enter the cost per unit of nonconforming item as indicated on the purchase order, Receiving Report, or contract.

11. P/P CODE - (1,3) - Originator - Enter the Product-Process Code (Corporate) when it is shown on the Purchase Order or Receiving Report.

12. ACCT. NO. - DASH - (1,3) - Originator - Enter the account number and dash number as shown on the Purchase Order or Receiving Report.

13. QTY. REC. - (1,3) - ORIGINATOR - Enter the total number of items received in the lot (Receiving) or the number of items submitted for inspection (Source).

14. VENDOR CODE - (1,3) - Originator - Enter vendor code number as shown on Purchase Order, Receiving Report, or contract.

15. SUPPLEMENTS QUALITY REJECTION REPORT NUMBER - (1,2,3) - Originator - Enter the number of the initial Quality Rejection Report when the report is prepared as a supplement to another Quality Rejection Report.

16. REWORK TIME - (Not Applicable)

17. SHOP ORDER NO. - (2,3) - Originator - Enter Production Order number when nonconforming item is traveling on a Shop Order.

18. SALES ORDER NUMBER - (1,2,3) - Originator - Enter the Sales Order number from the Production Order or procurement document. Dash numbers shall be entered on shop (2) rejections. Sales Order Dash Number 37 will be entered on all items routed to the shop for rework.

19. SECTION NO. - (2,3) - Originator - Enter section number from the Production Order.

20. QTY. REJ. - (1,2,3) - Originator - Enter the quantity of nonconforming items being withheld on this Quality Rejection Report.

21. NEXT ASSY. NO. - (2,3) - Originator - Enter the next assembly number of the nonconforming item. If the item has more than one (1) next assembly, enter "Various".

22. AFFECTED? YES-NO - (2,3) - Originator - Indicate whether or not the nonconformance has an effect on the next assembly of the withheld item.

Figure E8. - Quality rejection report (continued)

II. PREPARATION INSTRUCTIONS (Cont.)

B. (Continued)

23. RESP. ORGN. - (1,2,3) - Originator - Enter the number of the organization responsible for the nonconformance. When the supplier is responsible, enter "Supplier".

24. DISC. @ OPER. NO. - (2) - Originator - Enter the operation sequence number at which the nonconformance was produced.

25. REJ. @ OPER. NO. - (2) - Originator - Enter the operation sequence number at which the nonconformance was detected.

26. GFP - (2) - Originator - Check this block when item being withheld is government or customer furnished equipment.

27. ACCUM. TIME - (2) - Originator - Enter accumulated operating hours on functional units withheld after functional test when running time records are available.

28. SAMPLE SIZE - (1,3) - Originator - Enter the quantity of units inspected as a sample when sampling inspection is used.

29. AQL/LTPD - (1,3) - Originator - Enter AQL or LTPD number when sampling inspection is used. When AQL or LTPD varies for different characteristics inspected, enter the AQL or LTPD and sample size adjacent to the nonconformance in the "Discrepancy" block. (Example: 2.5/25; 0.1/72; etc.)

30. DISCREPANCY - (1,2,3) - Originator - Enter a description of the nonconformance. Number each discrepant condition listed so dispositioning agency has a reference number for each nonconformance.

31. QTY. (DEFECTS) - (1,2,3) - Originator - Enter the quantity of each discrepancy noted in Block 30. This quantity should be the number of times the defect occurs in each unit multiplied by the number of units in which the defect exists.

32. CODE (DEFECTS) - (1,2,3) - Originator - Enter the discrepancy code for each defect adjacent to the quantity of defects. This code is from the Quality Assurance Defect Code List.

33. REJECTED BY - (1,2,3) - Originator - Enter the signature of the individual originating the Quality Rejection Report.

34. INSP. VERIF. - (2) - Inspector - Enter the signature of the inspector verifying the rejection and the completeness and accuracy of the QRR. This entry is made only when the QRR is initiated by other than Product Integrity personnel.

35. STAMP - (1,2,3) - Inspector - The inspector signing Block 33 or 34 shall place an acceptance stamp in this block.

Figure E8. - Quality rejection report (continued)

II. PREPARATION INSTRUCTIONS (Cont.)

B. (Continued)

36. CORRECTIVE ACTION - (1,2,3) - Enter a summary of the corrective action initiated to prevent recurrence of the nonconformance.

37. EFFECTIVITY - (1,2,3) - Enter the date or unit effectivity of the corrective action.

38. SIGNATURE - (1,2,3) - Enter signature of the individual making the corrective action commitment.

NOTE: Blocks 36, 37, and 38 shall be completed by supervisory personnel of the organization responsible for producing the nonconforming material. These blocks shall be completed when the nature of the nonconformance warrants documented corrective action.

39. QAAR NO. - (1,2,3) - Quality Assurance - Enter the number of the Quality Assurance Action Report when initiated to effect corrective action.

40. DISPOSITION - (1,2,3) - Quality Review - Enter instructions for the disposition of nonconformances noted in Block 30.

41. DISPOSITION LIMITED TO _____ UNITS - (1,2,3) - Quality Review - Enter the quantity of units on which the disposition is effective.

42. SERIAL NO. OF DISP. UNITS - (1,2,3) - Quality Review - Enter serial numbers of nonconforming units on which the disposition is effective.

NOTE: Rework routing entries in Blocks 43, 44, 45, and 46 shall be entered by Quality Review and coordinated with Manufacturing Engineering when necessary to assure proper routing and sequence numbering.

43. QTY. - (2,3) - Enter the quantity of units on which each rework operation is to be performed.

44. ORGN. - (2,3) - Enter the number of the work organization responsible for performing each operation.

45. SEQ. - (2,3) - Enter the manufacturing sequence number of each operation. The first sequence number is 10 and subsequent sequence numbers are in multiples of 10. The last entry shall be Organization 5830, Sequence No. 999.

46. OPERATION - (2,3) - Enter the rework, inspection, test, etc., operations to be performed on the nonconforming unit(s).

47. WORKED BY - (2,3) - Employee completing the operation - Enter employee number or identifying stamp when operation is complete. Inspectors shall always use stamps for this entry.

Figure E8. - Quality rejection report (continued)

II. PREPARATION INSTRUCTIONS (Cont.)

B. (Continued)

48. DATE - (2,3) - Employee Completing the Operation - Enter the completion date.

49. HRS. - (Not Applicable)

50. SIGNATURE AND DATE - (1,2,3) - Authorized Materials Review Representative - Enter approval signature and date on the line appropriate to organization represented.

51. QTY. - (1,2,3) - Authorized Materials Review Representative - Enter quantity of units subject to each disposition in Column 52.

52. No Entry Required.

53. No Entry Required.

54. RWK. S/O NO. - (1,2,3) - Materials Adjustment or Manufacturing Engineering - Enter Production Order serial number when such has been initiated to authorize rework of nonconforming items.

55. REPL. P/O NO. - (1,2) - Materials Adjustment - Enter replacement purchase order number when such is issued to a supplier for replacement of nonconforming items.

56. RET. PKG. SLIP NO. - (1,2) - Materials Adjustment - Enter the Packing Slip number on which defective material was returned to the supplier.

57. MAT. ADJ. SIGNATURE - (1,2) - Materials Adjustment - Enter signature of individual authorizing Materials Adjustment action.

58. DATE - (1,2) - Materials Adjustment - Enter date of signature in Block 57.

Figure E8. - Quality rejection report (continued)

QUALITY REJECTION REPORT

FAILURE AREA (Circle One) REC 1 SHOP 2 SOURCE 3

№ 119692

1. DATE | 2. PROJ | 3. PART NAME | 4. SERIAL NO. | 5. PART NO. | DASH | LTR

6. SUPPLIER | 7. CONTRACT NO. | 8. P/O NO. | 9. ITEM | 10. UNIT COST | 11. P/P CODE | 12. ACCT. NO. — DASH | 13. QTY REC.

14. VENDOR CODE | 15. SUPPLEMENTS QRR NO. | 16. REWORK TIME Hrs Ths | 17. SHOP ORDER NO. | 18. SALES ORDER NO. | DASH | 19. SECTION NO. | 20. QTY. REJ.

21. NEXT ASSY NO. | 22. AFFECTED? YES___ NO___ | 23. RESP. ORG. | 24. DISC. @ OPER. NO. | 25. REJ. @ OPER. NO. | 26. OFF | 27. ACCUM. TIME Hrs Ths | 28. SAMPLE SIZE | 29. AQL/LTPD

30. DISCREPANCY | DEFECTS: 31. QTY | 32. CODE

33. REJECTED BY | 34. INSP. VERIF. | 35. STAMP

36. CORRECTIVE ACTION:

37. EFFECTIVITY | 38. SIGNATURE | 39. QAAR NO.

40. DISPOSITION

41. DISPOSITION LIMITED TO _____ UNITS | 42. SERIAL NO.s OF DISP. UNITS

REWORK ROUTING

43. QTY.	44. ORGN.	45. SEQ.	46. OPERATION	47. WKD. BY	48. DATE	49. HRS.

DISPOSITION SUMMARY & APPROVAL

50 SIGNATURE AND DATE	51. QTY.	52. DISPOSITION	CODE
ENGINEERING		OK AS IS	1.
QUALITY ASSURANCE		RWK TO SPEC	2.
CUSTOMER		RWK TO INST	3.
ASSOCIATE CONTRACTOR		SCRAP	4.
		RET TO VEND	5.

54. RWK [illegible] NO. | 55. REPL. [illegible] NO. | 56. RET [illegible]

57. MAT. ADJ. SIGNATURE | 58. DATE

- 38 -

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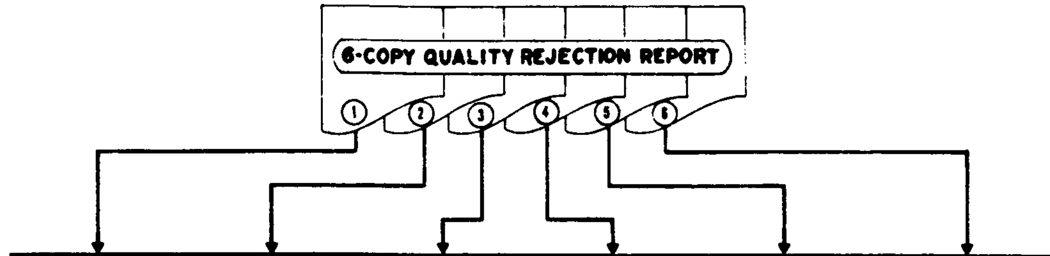
[illegible]-23 (REV 5-1-64)

Figure E8. - Quality rejection report (continued)



(1) WHITE	(2) GREEN	(3) YELLOW	(4) GOLDENROD	(5) PINK	(6) HARD BUFF
1 RECEIVING INSPECTION REJECTIONS					
REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO MATERIALS REVIEW RECORDS.	REMAINS WITH NONCONFORMING ITEM UNTIL THE DISPOSITION HAS BEEN AUTHORIZED. RECEIVING INSPECTION ATTACHES IT TO THE QUALITY ASSURANCE COPY OF THE RECEIVING REPORT AND FORWARDS IT TO QUALITY RECORDS FOR THE SUPPLIER RECORD FILE.	REMAINS WITH NONCONFORMING ITEM UNTIL THE DISPOSITION HAS BEEN AUTHORIZED. MATERIALS REVIEW FORWARDS THIS COPY TO QUALITY ASSURANCE CLERK OR QUALITY ANALYSIS, AS APPLICABLE, FOR SUPPLIER CORRECTIVE ACTION.	REMAINS WITH NONCONFORMING ITEM UNTIL THE DISPOSITION HAS BEEN AUTHORIZED. IT IS THEN RETURNED TO RECEIVING WITH THE RECEIVING REPORT AND FORWARDED TO MATERIALS ADJUSTMENT, THEN TO PURCHASING. PURCHASING FORWARDS IT TO RECEIVING FOR TYPING OF REPLACEMENT PURCHASE ORDER OR TO PRODUCTION CONTROL TO OBTAIN WORK ORDER AS APPLICABLE. RECEIVING RETURNS IT TO PURCHASING TO COMPLETE TRANSACTION.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED. RETURNED TO RECEIVING WITH RECEIVING REPORT AND FORWARDED TO PRODUCTION CONTROL. PRODUCTION CONTROL RETURNS TO RECEIVING INSPECTION FOR FILING.	REMAINS WITH NONCONFORMING ITEM UNTIL THE DISPOSITION HAS BEEN AUTHORIZED. RETURNED TO RECEIVING WITH THE RECEIVING REPORT. RECEIVING FORWARDS TO MATERIAL RELEASE.
2 SHOP INSPECTION REJECTIONS					
REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION AND ROUTING HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO MATERIALS REVIEW RECORDS.	RETAINED BY QUALITY ASSURANCE WHEN THE DISPOSITION IS AUTHORIZED AND SIGNED OFF BY MATERIALS REVIEW & REWORK ROUTING IS ENTERED. QUALITY ASSURANCE MATERIALS REVIEW REPRESENTATIVE FORWARDS THIS COPY TO QUALITY RECORDS. WHEN DISPOSITION IS "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY TO QUALITY RECORDS FOR SUPPLIER RECORD FILE.	RETURNED TO PRODUCTION CONTROL WITH NONCONFORMING ITEM AFTER DISPOSITION HAS BEEN AUTHORIZED AND REWORK ROUTING ENTERED. PRODUCTION CONTROL FORWARDS TO MATERIAL RELEASE. WHEN DISPOSITION IS, "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY TO MATERIAL CONTROL.	RETURNED TO PRODUCTION CONTROL WITH NONCONFORMING ITEM AFTER DISPOSITION HAS BEEN AUTHORIZED AND REWORK ROUTING ENTERED. PRODUCTION CONTROL FORWARDS TO MANUFACTURING COST CONTROL. WHEN DISPOSITION IS, "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY WITH ITEM TO RECEIVING.	REMAINS WITH NONCONFORMING ITEM UNTIL LAST INSPECTION ROUTING HAS BEEN ACCEPTED. INSPECTOR FORWARDS TO QUALITY RECORDS FOR UNIT INSPECTION RECORDS. SHOULD BE ATTACHED TO GREEN SHOP ORDER WHEN OPEN SHOP ORDER IS AVAILABLE. WHEN DISPOSITION IS, "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY WITH ITEM TO RECEIVING.	SHOP TRAVELER - REMAINS WITH NONCONFORMING UNIT UNTIL WORK IS COMPLETE. RETAINED BY PRODUCTION CONTROL AS MANUFACTURING RECORD. PRODUCTION CONTROL SHALL ADVISE MANUFACTURING COST CONTROL OF COMPLETION OF SHOP AND INSPECTION EFFORT. WHEN DISPOSITION IS, "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY WITH ITEM TO RECEIVING.
3 SOURCE INSPECTION REJECTIONS					
REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION AND ROUTING HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO MATERIALS REVIEW RECORDS.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION AND REWORK ROUTING HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO QUALITY RECORDS.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN ACCOMPLISHED. MAY BE USED AS A COORDINATION COPY PROVIDING IT IS CONTROLLED TO THE EXTENT THAT IT DOES NOT FAIL TO BE DISPOSITIONED WITH OTHER COPIES. AFTER DISPOSITION, THIS COPY IS FORWARDED, BY THE PERSON MAKING THE DISPOSITION, TO PURCHASING.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO PRODUCTION CONTROL FOR INFORMATION AND FOLLOW-UP. PRODUCTION CONTROL FORWARDS THIS COPY TO MANUFACTURING COST CONTROL.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED, REWORK HAS BEEN ACCOMPLISHED AND THE ITEM HAS BEEN INSPECTED AND ACCEPTED BY INSPECTION. SOURCE INSPECTOR FORWARDS THIS COPY TO QUALITY RECORDS.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED, REWORK HAS BEEN ACCOMPLISHED, AND THE ITEM HAS BEEN INSPECTED AND ACCEPTED BY INSPECTION. SOURCE INSPECTOR GIVES THIS COPY TO THE SUPPLIER FOR HIS RECORDS.
4 MAJOR SUBCONTRACTOR					
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Figure E8. - Quality rejection report (concluded) and reliability of basic concepts.

Considerations of schedule, economy, and purpose indicate different approaches to achieving the desired reliability. Table E1 lists reliability tasks which will be performed on each kind of equipment.

TABLE E1. - COMPARISON OF RELIABILITY TASKS

	EQUIPMENT		
Task	Lab. Model	Flight	GSE
Informal Design Review	Yes	Yes	Yes
Formal Design Reviews	Yes	Yes	Yes
Drawing & Spec. Review	Yes	Yes	Yes
FMECA	Yes	Yes	No
Parts/Materials Selection	Yes	Yes	Yes
Informal Indoctrination	Yes	Yes	Yes
Data Bank	Yes	Yes	Yes
Maintainability	Yes	Yes	Yes
Math Model	Yes	Yes	No
Reliability Prediction	Yes	Yes	No
Reliability Allocation	Yes	Yes	No
Qualification Tests	Partial	Partial	No
Over-Stress Tests	Partial	Partial	No
Failure Analysis	Yes	Yes	Yes
Parts Screening	Yes	Yes	Yes
Subcontractor Control	Yes	Yes	Not Applicable
Supplier Control	Partial	Partial	Partial
Equipment Log	Yes	Yes	Yes
Technical Reports	*	Yes	*

*Design Review, Failure Analysis, and Progress Reports

DOCUMENTATION AND REPORTS

Equipment Logs

Separate Equipment History Logs will be maintained for each major component subsystem, and the spacecraft system. The items on which logs will be maintained are shown on the breakdown in figure E3, less the structural components. Each log will maintain a chronological order and will account for all periods of time and movements of the items. These logs, when coupled with the referenced documentation in them, satisfy the requirements of Paragraph 3.10, "Equipment Logs," of NPC 250-1. A copy of Northrop's "Equipment History Log" procedure and appropriate forms are included in figure E9.

Equipment logs will be created only for deliverable spacecraft equipment including spares; some GSE is included. Appendix C shows the proposed format submitted for the NASA approval.

Technical Reports

These following reports will be submitted to the NASA to satisfy the requirements of Section 5, "Documentation of Reliability Program," of NPC 250-1.

Design Review Action Reports

FMECA Studies

Math Model Prediction Studies

Apportionment Studies

Failure Analysis and Corrective Action Summaries

Qualification Testing Reports

Over-Stress Testing Reports

Monthly Progress Reports

Qualification Status List

CROSS REFERENCE COMPARISON WITH NPC 250-1

The following table, E2, covers the cross reference comparison with NPC 250-1

POLICY AND PROCEDURE	P&P No. 7-11.1
NORTHROP SPACE LABORATORIES	Page 1 of 2
SUBJECT: EQUIPMENT HISTORY LOG	Effective 22 March 1965
CONCERNED: ALL	Supersedes

I. POLICY

Accurate historical and chronological records of all applicable functional equipment and components will be maintained by means of Equipment History Logs.

II. GENERAL

A. An equipment historical log will be established and maintained for each serialized functional subassembly, assembly, subsystem, system, spacecraft or end item. Serialized or unserialized parts and components will not generally be included in this group but may be included to satisfy contractual requirements or for investigative purposes.

B. Historical Logs will be serialized and include, or reference, complete descriptions of all activities, occurrences or events that the equipment and/or component experiences during manufacturing, testing, or other operations. A chronological order is required. The following information will be included when required:

1. Date and time of entry.
2. Identity of test or inspection.
3. Failure report reference.
4. Accumulated operating time.
5. Cumulative number of duty cycles to date.
6. Deviation from specifications or drawings.
7. Repair and maintenance record.
8. Identity of individual making entry.

Figure E9. - Equipment history log

II. GENERAL (Continued)

C. Historical logs will be utilized, as required, at NSL supplier facilities. Such use shall be contractually specified. NSL or NSL approved logs will be used and considered as part of the equipment to be furnished to NSL.

D. Continuous maintenance of the Equipment History Log shall be a mandatory responsibility imposed on NSL and supplier personnel who participate in the inspection, testing and handling activities of the equipment and/or components concerned.

E. The maintenance of the Equipment History Log will commence immediately upon the initial application of:

1. The first NSL Inspection either at NSL or the supplier facility.

2. Any operational alternating or direct current.

3. Any rotating or oscillatory mechanical motion.

4. Any hydraulic or pneumatic pressure.

5. Any environmental stress other than laboratory ambient.

F. The historical log will travel with and, when possible, be attached to its related equipment at all times following commencement of its use. Upon completion of all contractual requirements, i. e., acceptance by the customer, launch, mission completion, etc., the log will be returned to NSL for evaluation and disposition.

III. PROCEDURE

A. Engineering will include in the "General Notes" of assembly drawings, the requirements for the History Log, and define that equipment which is considered time sensitive.

B. Quality Control will:

1. Establish, and revise as required, the necessary log and procedure to ensure that the requirements of this policy and contractual documents are adhered to.

2. Initiate Form NSL-94, "Equipment History Log" per form instructions, during the first inspection operation.

3. Verify all entries, through final disposition of the equipment.

C. Manufacturing and engineering personnel, involved in the fabrication, assembly, test and other operations will make all necessary entries per form instructions.

Figure E9. - Equipment history log (continued)

№ 0387

SERIAL NO.

TEST HISTORY LOG

TYPE OF TEST	TEST NUMBER	PARA NO.	TIME THIS TEST	ACCUM TO HOURS	PASSED YES	PASSED NO	FAILURE RPT	VERIFIED BY	INSPECTION	DATE

EQUIPMENT HISTORY LOG (Sheet 1 of 3)

Figure E9. - Equipment history log (continued).

CONFIGURATION CONTROL RECORD

ASSEMBLY OR COMPONENT NUMBER	SERIAL NO.	DATE INSTALLED	TIME AT INSTL	DATE REMOVED	TIME AT REMOVAL	VERIFIED BY	SECTION IV MODIFICATION RECORD DATE	E.O. NUMBER	INCORP. BY	VERIFIED BY

EQUIPMENT HISTORY LOG (Sheet 2 of 3)

Figure E9. - Equipment history log (continued)

INSPECTION RECORD

[illegible]	INSPECTION REPORT NO.	[illegible]	INSP BY	DATE	NOTES ENTERED / COMMENTS AS REQUIRED	REMARKS

EQUIPMENT HISTORY LOG

EQUIPMENT HISTORY LOG (Sheet 3 of 3)

Figure E9. - Equipment history log (concluded)

TABLE E2. - CROSS REFERENCE COMPARISON WITH NPC 250-1

Paragraph no. NPC 250-1	Paragraph title appendix E (this document)	Subject	Reason for deviation
Section 1	-	Ground rules of NPC 250-1	Not applicable
2.1	Organization, Management, and Facilities	Organization	
2.2	Scope and Objective	Reliability Program Plan	
2.3	-	Reliability Program Reviews	The schedule of reviews will be jointly established with the NASA during subsequent phases.
2.4	-	Reliability Program Control	This information will be part of the Management Plan released for later phases of the program
2.5	Reliability Indoctrination	Reliability Indoctrination and Training	Northrop will use experienced personnel familiar with reliability, and indoctrination will be informal by continuous contact
2.6	Subcontractor and Supplier Control	Subcontractor and Supplier Control	
2.7	Reliability Prediction	Control of Government Furnished Property	
3.1	-	General	
3.2	Drawing and Specification Review, Mathematical Analysis Tasks	Design Specifications	

TABLE E2. -(continued)

Paragraph no. NPC 250-1	Paragraph title appendix E (this document)	Subject	Reason for deviation
3.3	Reliability Prediction	Reliability Prediction and Estimation	
3.4	Failure Mode, Effect, and Criticality analysis		
3.5	Maintainability and Human Engineering	Maintainability	
3.6	Informal Design Review	Design Review Program	The schedule of reviews will be jointly established with the NASA during subsequent phases
3.7	Failure Analysis and Corrective Action	Failure Reporting and Correction	
3.8	-	Standardization of Design Practices	Contained in MEI specifications and Northrop's Design and Process Manuals
3.9	Parts, Materials, and Components Selection		
3.10	Equipment Logs	Equipment Logs	
4.1	-	General	
4.2	Over-stress Tests	Reliability Evaluation Plan	
4.3	Qualification Tests and Over-stress Tests	Testing	

TABLE E2. - Concluded

Paragraph no. NPC 250-1	Paragraph title appendix E (this document)	Subject	Reason for deviation
4.4	-	Reliability Assessment	Laboratory tests will generally be conducted on too limited a quantity of components to warrant revision of basic generic failure rates used for Reliability Assessment. Also see paragraph 3.1.4 and 3.2.2 of this document.
4.5	-	Reliability Evaluation Program Reviews	Test results will be submitted but hardware tested and duration of tests are too limited to provide statistically valid math model data
5.1	-	General	
5.2.1	-	Weekly Summaries	Weekly summaries are incompatible with program cost and time constraints
5.2.2	Technical Reports	Periodic Progress Reports	
5.2.3	-	Reliability Program Control Reports	These Control Reports are a section of the periodic financial and management reports
5.3	Technical Reports	Summary of Technical Documentation	Appropriate reports will be selected for submittal

INFORMAL DESIGN REVIEW EXAMPLE - FEEDER

During the Definition phase of the Orbiting Primate Spacecraft Program, Feeder design was explored in preparation for building a prototype Feeder. The evaluation of Feeder (food storage and dispensing mechanism) design concepts during this phase is an example of the benefits of informal design review.

The original idea for the design consisted of food pellets contained in a plastic tube wound on a storage drum. At a point of travel, the plastic tube was split, the loose end wound on a take-up reel, and the food pellets rammed by a sealed plunger into the primate end of the mouthpiece. The plunger prevented entry of feces and urine into the mouthpiece.

A knife edge to split the plastic tube was deemed unable to hold its cutting edge. Once it became dull, the tube could split in skew fashion and jam the take-up mechanism. To improve reliability, zippered plastic tubing was selected which is opened by round guide pins directly in its path. With this change, optimum length of shroud guiding the plastic tube was selected to avoid premature opening of the zippered tube.

Next, the possibility appeared that over a period of many actuations, the ram which ejects the pellet might wear the mouthpiece insert, score the ram, and produce a buildup of pellet crumbs. The path of the pellet was changed so it was fed to a star wheel indexed by a geneva mechanism. The crank and connecting rods were replaced by a yoke. This virtually eliminates alignment problems and permits as an inherent feature easy removal of any crumbs after each pellet by a waste disposal suction line. Another side benefit was the elimination of any indexing wheel for pellet feed advance. Feed advance designs were explored but eliminated because of complexity of operation and quantity of special parts.

A constant torque spring loaded brake replaced a torque motor as a more reliable device for maintaining tension.

The tube containing the pellets is would on a cylindrical storage drum. Tension unreels the tube which leaves the drum and is guided through a right angle turn by a pulley. With a fixed pulley, the angle at which the tubing leaves the storage drum varies within wide angles as the point of departure moves from one end to the other. This created the possibility of angular whipping, kinking, alternate slack, and tension which could jam travel. A traveler moving parallel to the drum was added to the system to maintain tube tension at a 90° angle from the points of departure.

The dimensions of an early layout required the mouthpiece to be removed every time the storage drum and take-up reel were installed or removed. In order to improve accessibility and maintainability, dimensions and positions were changed to permit drum removal without first removing feeder and waterer mouthpieces.

Small rollers which change the path of the pellet tubing were used to minimize space requirements. The rollers were replaced by a pulley to provide a smoother sliding surface.

A photocell counter is used in the feeder to count delivered pellets. Two redundant photocells are provided, one at each of two points in the star wheel. This provides two opportunities for an accurate pellet count.

This history of the Feeder design evolution indicates a typical informal design review process.

APPENDIX F
QUALITY ASSURANCE PLAN

INTRODUCTION

This document describes the Quality Assurance program necessary to assure that the Orbiting Primate Spacecraft, associated Ground Support Equipment, Laboratory Test Model, and spares, meet the quality requirements of the Orbiting Experiment for Study of Extended Weightlessness. It describes the tasks and procedures to accomplish this objective. It follows the intent and is consistent with those elements of the NASA Quality Publication NPC 200-2, Quality Program Provisions for Space System Contractors, dated April 1962, considered essential to the Orbiting Primate Spacecraft Program.

Scope

A Quality Assurance program requires coordinated effort among Reliability, Quality, and Testing. Reliability effort contributes to design concepts and hardware selection criteria. Testing qualifies the ability of equipment to meet design objectives. Quality effort assures conformance to contractual requirements through control of all work operations and manufacturing processes, as well as inspections and tests. All three will be effective during the design phase interfacing with the designers and with each other. For example, in the procurement of hardware, Quality maintains a list of approved suppliers whose parts will satisfy Reliability's criteria and which match the characteristics required by design. With a selection made, Test and Quality establish test criteria and future inspection verification points. Quality Engineering will be active during the design phase planning for long lead test equipment, problems involving special tolerances or unusual measurement processes, unique test rigs, or procedures to obtain operating cycles or running time of time sensitive equipment.

The Reliability Program is the subject of a separate document Appendix E. The Testing Program is described in the Integrated Test Plan, Appendix D. This document is the Quality Assurance Plan. Its objective is to indicate the authority of the Quality organization, the direction of the Quality Assurance program, and the substance of the Quality tasks.

Organization and Management

Quality personnel assigned to the Orbiting Spacecraft Program are directly responsible to the Orbiting Primate Spacecraft Program Manager. They are also linked to other segments of Northrop's centralized services which support the program. These services include the Quality Assurance planning, inspection, and reporting by which the quality aspects of the program are controlled from the development phase through fabrication, processing, storage, and delivery. The organizational structure is shown in figure F1.

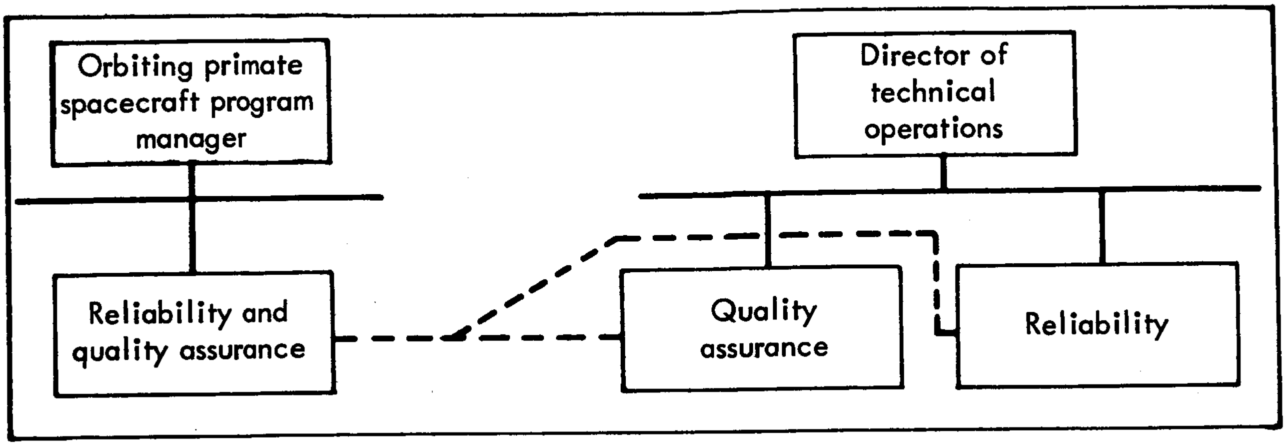


Figure F1.- Organization chart

Quality Program Operations

The purpose of the Quality program will be to assure that end items are of acceptable quality and in compliance with engineering drawings, specifications, and the NASA requirements. A flow chart showing projected tasks to achieve this purpose in the Orbiting Spacecraft Program is presented in figure F2. Each major element in the activity network is identified by its section number in this document and corresponding cross reference in NPC 200-2. The program provides for continuous quality measurement, data feedback, and corrective and preventive measures enabling Northrop to assess, revise, and strengthen spacecraft quality from the start of the Laboratory Test Model phase through the delivery of flight hardware and spares.

QUALITY PROGRAM ENGINEERING

Quality Planning

In accordance with paragraph 4.2, "Drawing and Specifion Review" of NPC 200-2, the initial planning will establish quality control provisions for manufacturing processes; determine that quality objectives and requirements have been defined sufficiently to allow adequate quality planning, and analyze quality data to measure effectiveness of the quality control system. The planning function will direct the planning, control, evaluation, and reporting of all quality aspects of the Program fabrication, installation, and checkout tasks. Review of drawings and specifications will be done on an incremental basis and will include materials applications, methods of joining, finish protection, cleanliness requirements, and fabrication techniques for subsequent process control consideration. This review will also produce information used for the timely and effective planning of inspection verification points during the program.

Manufacturing assembly and acceptance instructions will be released reflecting operational instructions, specification reference, sequence of assembly and tests, and test equipment requirements. This information will be verified prior

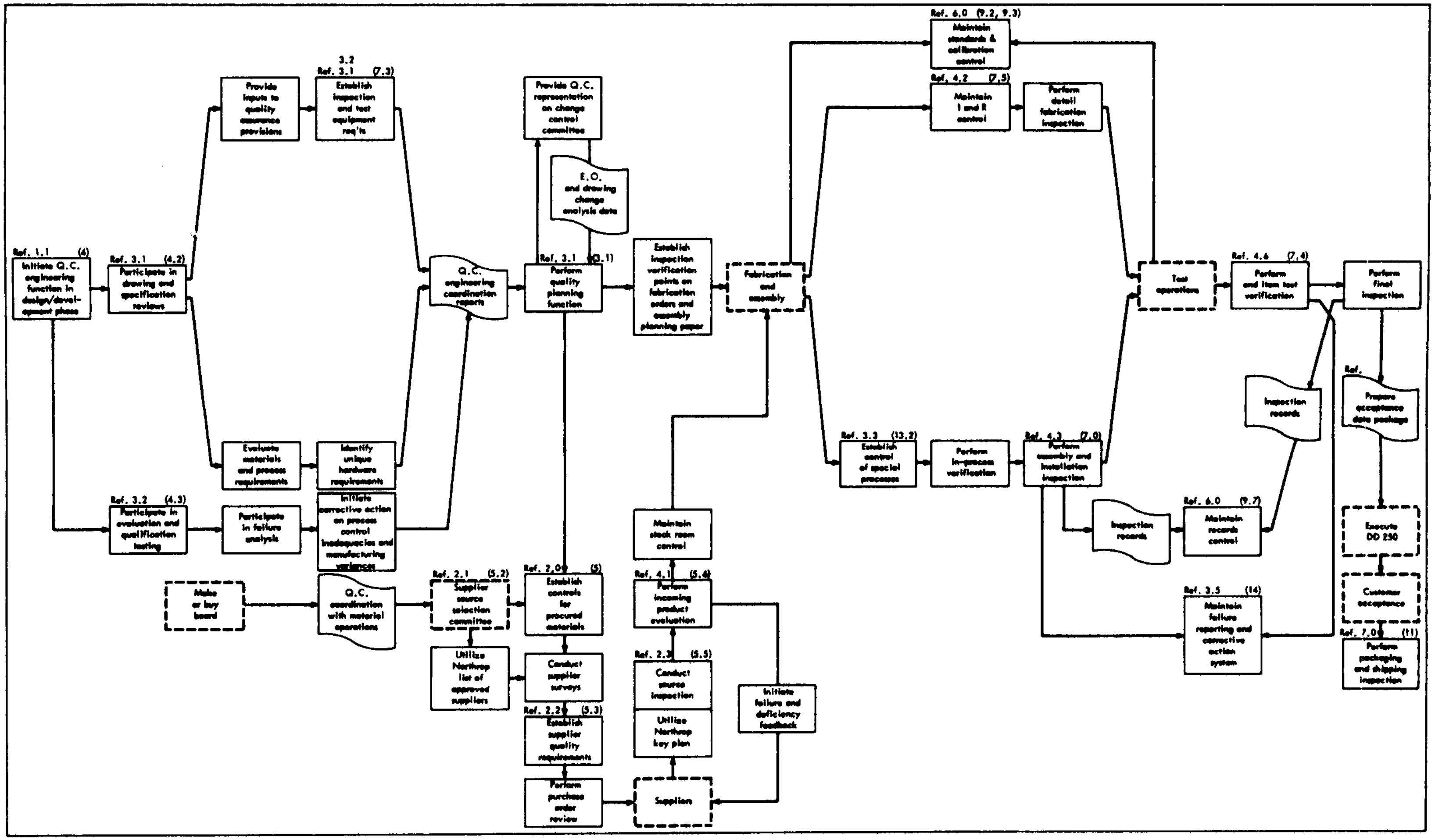


Figure F2.- OPS quality assurance activity to release by Quality Control, who then will code each job number in the Buy-off code column indicating inspection responsibility as indicated below:

Q	- In-Process Quality Control Acceptance	Requires Inspection
C	- Fabrication and Assembly	
E/I	- End Item Acceptance	
A	- Customer Acceptance	
X	- For Fabrication and Assembly Information only (does not require inspection)	

Other Quality Control planning tasks will be to assure incorporation of Change Control Board-approved changes in the Orbiting Spacecraft Program manufacturing plan, and to verify through audit of inspection records their accomplishment on the hardware. Figure F3 shows typical Quality Control activity points.

Test Procedure Review

A corollary activity to Quality Planning will be the proper preparation of test procedures. In order to assure clarity and completeness of criteria, inspection and test procedures will,

(1) Define test objectives and provide specific instructions for obtaining test data.

(2) Identify measurement and test equipment.

(3) Specify measurement methods.

(4) Specify acceptance criteria.

This will be applicable to receiving, fabrication, inspection, qualification, and acceptance tests from initiation of the Primate program through final approval by the NASA of DD-250.

Process Controls

Control of materials and processes will be an important element in the quality program. Materials, equipment, and processes will conform to applicable Northrop Process Specifications and Procedures for chemical, metallurgical, and non-destructive tests. The adequacy of in-plant processes during manufacture will be assured through periodic physical and chemical tests on materials and the continuing evaluation of equipment affecting those processes. The facilities of suppliers performing special processes (heat treat, plating, etc.) will be selected from those previously qualified as complying with applicable process specifications and requirements.

Several fabrication processes used in the Orbiting Primate Spacecraft program will require employment of certified personnel (e.g., hand-soldering,

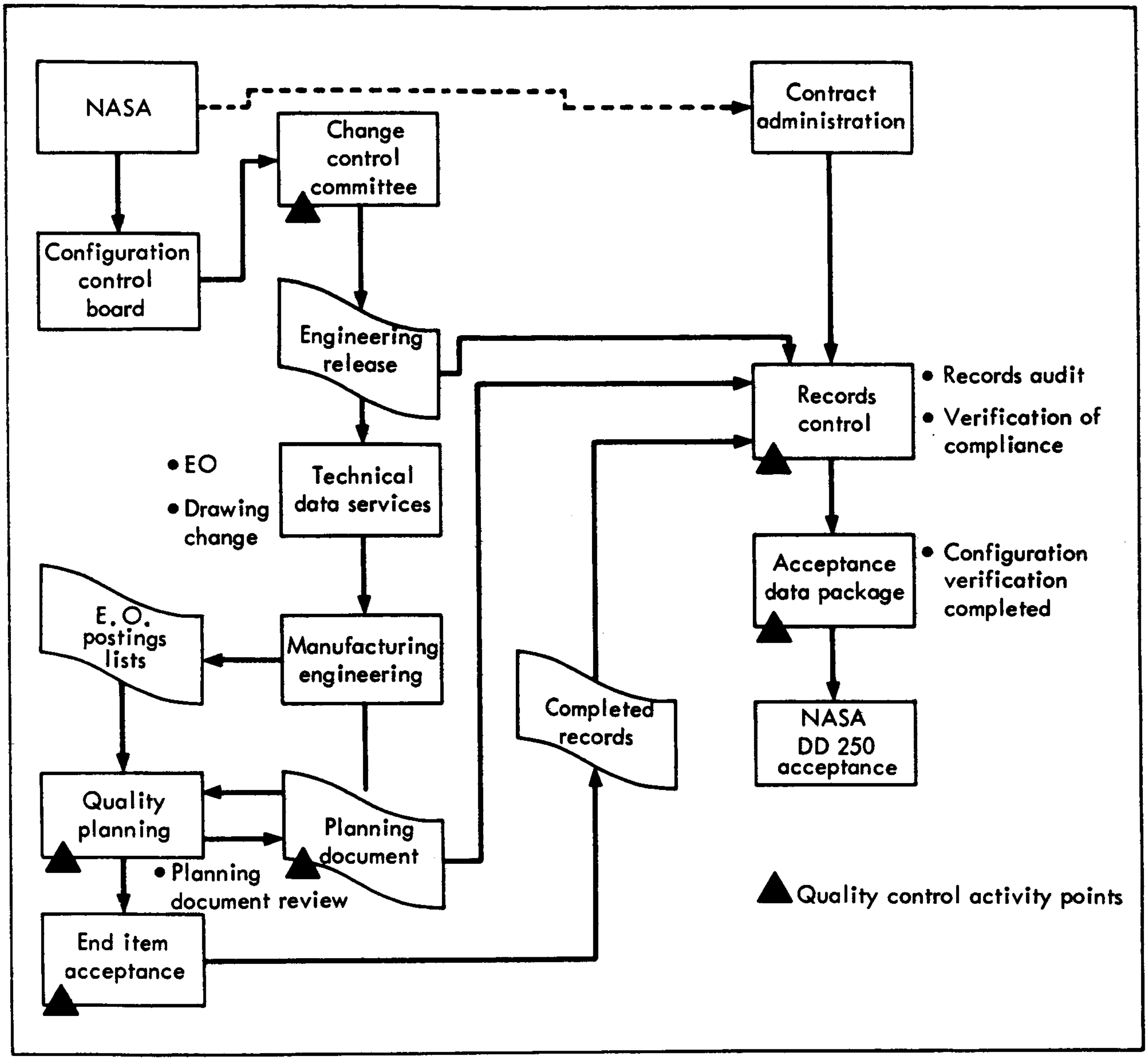
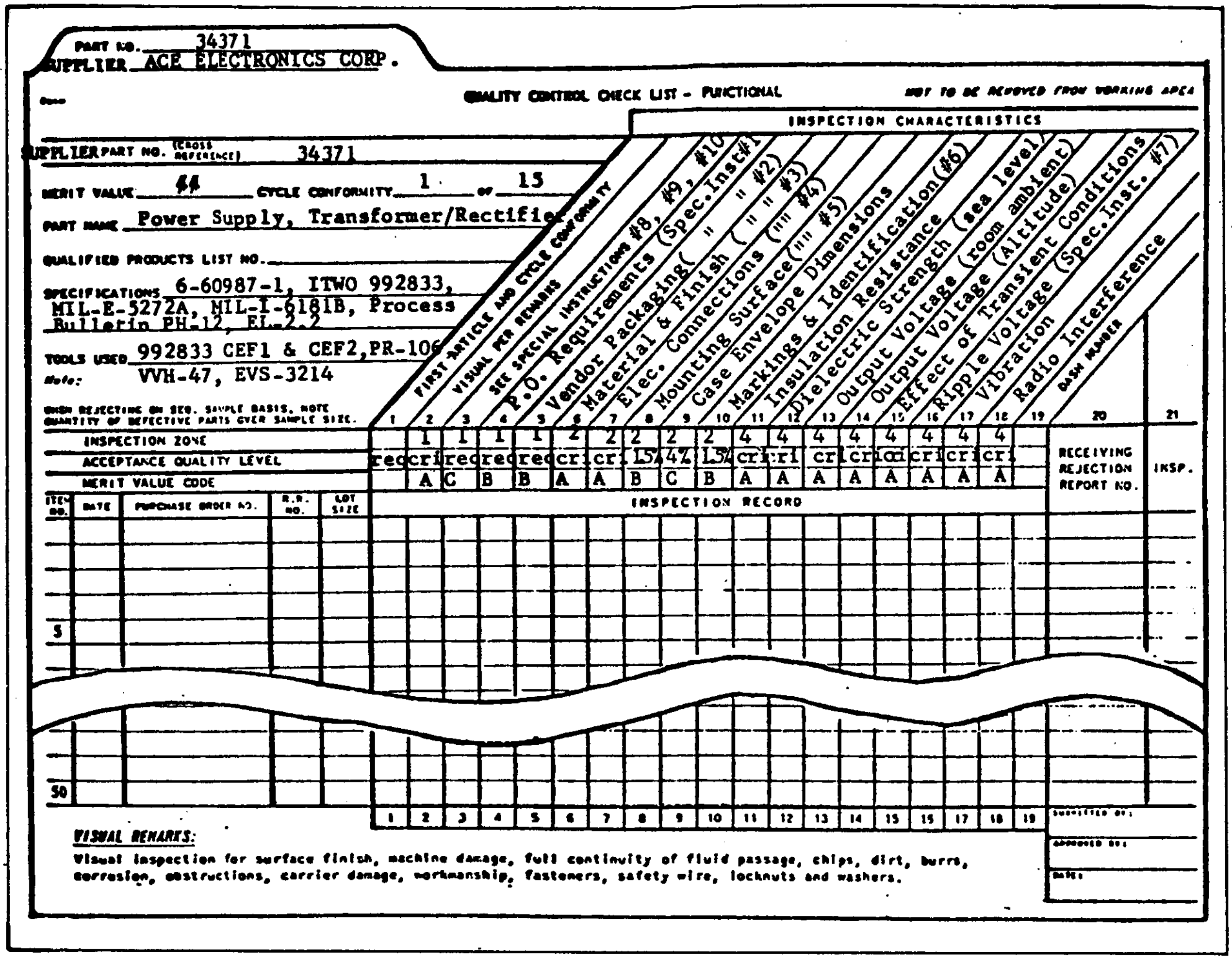


Figure F3. - Quality control activity

welding). Northrop maintains an internal certification program for such manufacturing processes as hand-soldering, welding, electrical-electronic fabrication, sealing, installation of special fasteners, etc. This certification program meets applicable NASA specifications. On the OPS program, Northrop will apply its Category II - Instructor/Examiner capabilities which meet NPC 200-4 for hand-soldering of electrical connections. A complete listing of personnel certification requirements is maintained in Northrop Standard Practice Procedure 9-1.5, "Certification of Personnel," shown in Appendix A.



PART NO. 34371
SUPPLIER ACE ELECTRONICS CORP.

QUALITY CONTROL CHECK LIST - FUNCTIONAL — NOT TO BE REMOVED FROM WORKING AREA

SUPPLIER PART NO. (CROSS REFERENCE) 34371
MERIT VALUE 44 CYCLE CONFORMITY 1 of 15
PART NAME Power Supply, Transformer/Rectifier
QUALIFIED PRODUCTS LIST NO.
SPECIFICATIONS 6-60987-1, ITWO 992833, MIL-E-5272A, MIL-I-6181B, Process Bulletin PH-12, EL-2.2
TOOLS USED 992833 CEF1 & CEF2, PR-106, VVH-47, EVS-3214
Note: WHEN REJECTING ON SEQ. SAMPLE BASIS, NOTE QUANTITY OF DEFECTIVE PARTS OVER SAMPLE SIZE.

INSPECTION CHARACTERISTICS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Characteristic	First Article and Cycle Conformity	Visual per Remarks	See Special Instructions #8, #9, #10	P.O. Requirements (Spec. Inst. #1)	Vendor Packaging (" " #2)	Material & Finish (" " #3)	Elec. Connections ("" #4)	Mounting Surface ("" #5)	Case Envelope Dimensions	Markings & Identification (#6)	Insulation Resistance	Dielectric Strength (sea level)	Output Voltage (room ambient)	Output Voltage (Altitude)	Effect of Transient Conditions	Ripple Voltage (Spec. Inst. #7)	Vibration	Radio Interference	Dash Number
INSPECTION ZONE		1	1	1	1	2	2	2	2	2	4	4	4	4	4	4	4	4	
ACCEPTANCE QUALITY LEVEL	req	cri	req	req	req	cri	cri	1.5%	4%	1.5%	cri	cri	cri	cri	cri	cri	cri	cri	
MERIT VALUE CODE		A	C	B	B	A	A	B	C	B	A	A	A	A	A	A	A	A	

ITEM NO. | DATE | PURCHASE ORDER NO. | R.R. NO. | LOT SIZE | INSPECTION RECORD | 20 RECEIVING REJECTION REPORT NO. | 21 INSP.

5

50

VISUAL REMARKS: Visual inspection for surface finish, machine damage, full continuity of fluid passage, chips, dirt, burrs, corrosion, obstructions, carrier damage, workmanship, fasteners, safety wire, locknuts and washers.

SUBMITTED BY: APPROVED BY: DATE:

Figure F4. - Quality control checklist

of supervision at the operating level in the administration of quality control policies and procedures. The system will also provide management with program visibility through issuance of periodic audit summary reports. Appendix C contains executive directives pertaining to Quality audits and sample audit reports.

SUPPLIER CONTROL

One of the major elements of Northrop's Quality activity is supplier control in order to monitor the supplier's quality practices. This task is performed by establishing quality control requirements for suppliers, by specifying supplier data and documentation verifying conformance, by source inspection of equipment for which no adequate "in-house" inspection has evolved, and by selecting procurement sources whose quality and delivery capabilities meet appropriate standards.

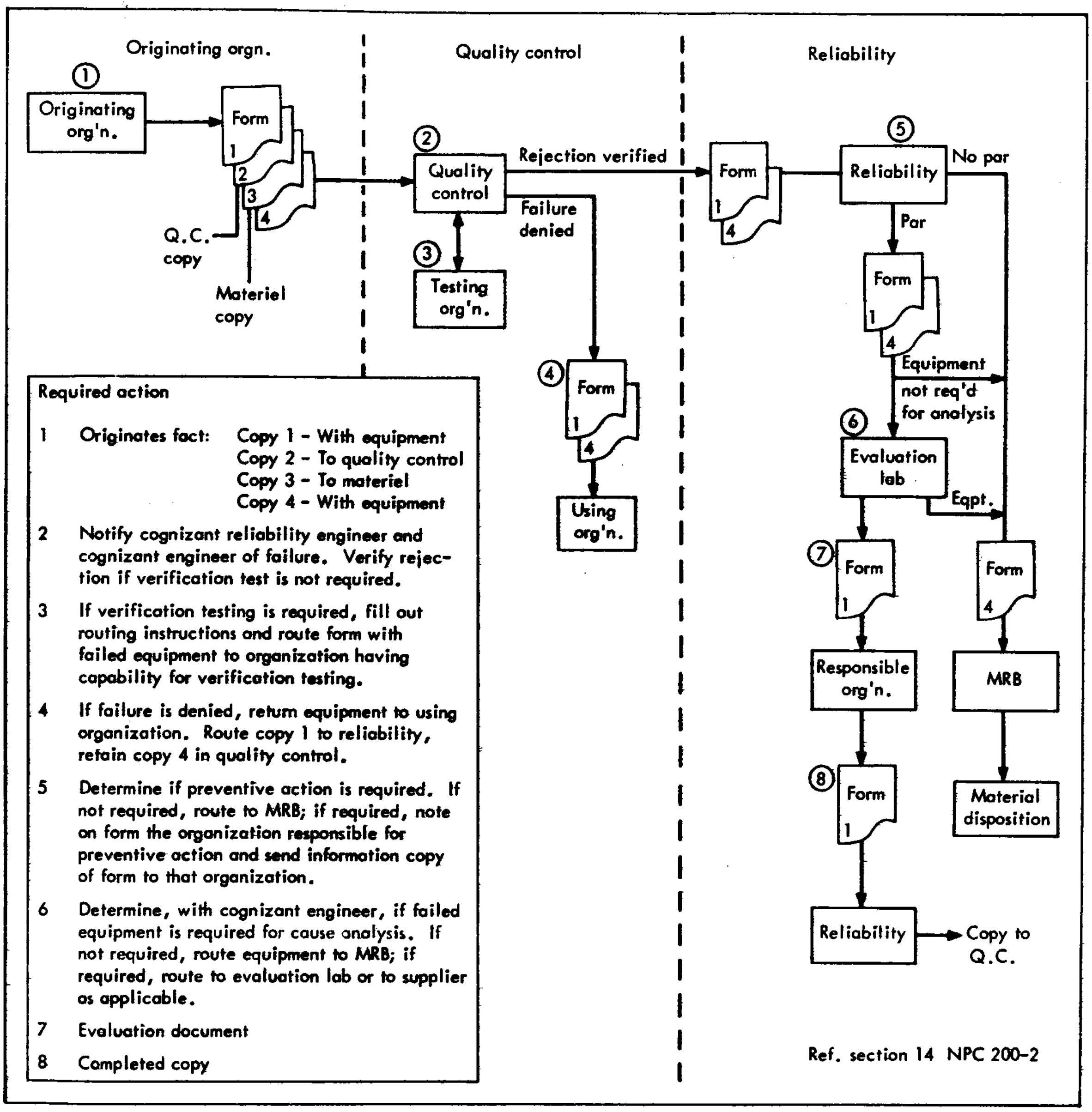


Figure F5. - Failure and correction procedure

Quality Control Requirements for Suppliers

In accordance with paragraph 5.3, "Procurement Documents of NPC 200-2," Northrop's Specification No. 500, "Quality Control Requirements for Supplier," will apply to the Orbiting Primate Spacecraft Program as a basis for specifying quality control system requirements for suppliers and for classifying sources with respect to quality control capability and performance.

A unique feature is the Applicability Index which provides for individual levels of application dependent on complexity, critical characteristics, and whether the purchased item is material or equipment. For cross reference purposes, it is stated that level 3 of the Implementation Instructions satisfies

Receiving Check Lists

Receiving Check Lists will be developed from quality data during drawing and specification reviews. These check lists identify characteristics which are subject to receiving inspection, sequence of inspections, special test equipment requirements, and controlling specifications. They will be used in the inspection of raw materials and supplier manufactured products to provide a permanent record of significant information. It is normal procedure to review and analyze entries at regular intervals for critical or repetitive failure trends to be followed up with suppliers. A typical Receiving Check List is shown in figure F4.

Failure Reporting and Corrective Action

Northrop's Failure and Corrective Action system will be applied to the Orbiting Primate Spacecraft equipment to provide effective notification, distribution, analysis, and corrective action of all reported malfunctions and failures.

Quality Rejection Reports will identify the failed item and will provide failure characteristics, symptom data, and a description of the conditions under which the failure occurred. The Failure Analysis system will function through the coordinated efforts of the cognizant Engineering supervision, Reliability, and Quality Control representatives. Where corrective action will involve purchased off-site equipment, supplier representatives will assist in the investigation and analysis of failure.

Failure reporting will be initiated at the beginning of the manufacturing program and will continue through Qualification Testing and final stages of delivery. Test data accumulated and analyzed during these tests will be used to provide basic data for reliability assessment analysis.

Since the Orbiting Primate Spacecraft Program does not involve large quantities of hardware and documentation associated with a full scale production program, the failure reporting and corrective action system paper flow will not be automated. A flow diagram of the Failure and Correction Procedure is shown in figure F5. The system will provide failure data required to support the failure summary reporting requirements of paragraph 3.7 of NPC 250-1 and will augment accumulation of basic data for reliability assessment analyses. Failure and Corrective Action summary reports will be issued monthly. Continuing follow-up action will be taken to assure the adequacy of changes to correct identified failure causes.

Quality Audit

In accordance with section 15 of NPC 200-2, Quality System audits will be performed at intervals sufficient to assure compliance of operating personnel with the Quality Control procedures. Audit assignments will be conducted by supervisors or their designees in work areas other than those in which they have assigned responsibility. The "Systems Audit" will verify the effectiveness requirements of the NASA Publication NPC 200-3. Level 1 is of lesser stringency; level 4 the most exacting. Level 1 is intended for suppliers of off-the-shelf proprietary items of non-critical nature while level 4 is intended for major subcontractors. The level assigned a supplier does not reflect the quality or reliability of his product, merely the extent to which Northrop inspects this procedures, practices, and facilities to control his inspection system. It is anticipated that levels 1 through 4, inclusive, will apply to purchased items for this program.

All purchase orders for major components and critical materials will be screened prior to release to suppliers to verify that explicit quality assurance requirements are included and to assure complete and accurate transmittal of Northrop requirements to the supplier.

Supplier Data and Documentation

Objective quality evidence will be required of the Environment Control Subsystem supplier to demonstrate compliance with equipment qualification requirements, acceptance test procedures, and procurement specification requirements. The data and documentation list, figure F6, lists his requirements. As general policy, paragraphs a through d of figure F6 will apply to other suppliers of hardware requiring space of a TV camera, a mass/volume measurement device, tape recorders, unique instrumentation, or like items subject to addition or deletion as final hardware selections are made.

Northrop Source Inspection

For selected parts and components, Northrop will perform in-process surveillance and final acceptance test verification at the supplier's facility. Source inspection is highly desirable for many items manufactured or assembled outside Northrop. For example, a proof test under clean room conditions of the tank containing Attitude Control gas is best source inspected. Once it has been tested and proven at the point of manufacturer, contamination is its greatest potential hazard. Similar advantages may occur with precision pumps, instrumentation for measuring gas mixture concentrations, etc. Where inspection requires internal disassembly, special and complex duplicate test equipment, or requires unusual skill to calibrate, source inspection can be an optimum answer.

One of the problems involved with source inspection is having a qualified inspector available anywhere in the country. Northrop's "Key Plan" source control places quality control representatives empowered to serve the needs of all divisions within the Corporation in all strategic supply centers. These representatives have extensive experience in the control of procurement source quality. The Key Plan was authorized on September 9, 1963, with the issuance of Corporate Executive Bulletin 36, "Control of Procurement Source Quality - Key Plan."

a. Data and Documentation - All drawings and test procedures applicable to this equipment that are prepared or used to meet the requirements of this specification shall be subject to review and approval of Northrop.

b. Documents to be made available to Northrop shall include, but not necessarily be limited to:

1. Supplier top level drawings and functional block diagrams
2. End-item inspection and final acceptance test procedures
3. Copies of completed failure report forms initiated by supplier during final acceptance tests.
4. Operating time data for time sensitive or critical useful life items
5. Summary of completed qualification status of equipment defined in this end-item specification. This summary shall include qualification test report numbers and applicable specifications.
6. Copy of actual test data recorded by supplier during performance of final acceptance tests.

c. Data and documentation submitted in compliance with requirements of this specification shall be sent to Northrop, 3401 West Broadway, Hawthorne, California 90250.

d. Application of Previous Qualification Tests

--- Previous qualification test data on items for other programs may be considered to be applicable to equipment defined by this procurement specification provided that the following evidence is submitted to Northrop for evaluation and approval:

1) Complete description of similar items including photographs, drawings, and performance data.
2) Test reports and test data describing previously conducted qualification tests on similar equipment.
3) A detailed comparison of the proposed equipment and the previously qualified item, listing sufficient justification to establish the validity of qualification by similarity.

e. Acceptance Test Notification

--- Provisions shall be made for the notification of the Northrop Quality Control Group of scheduled end-item inspection and final acceptance testing of equipment defined in this detail specification. This notification shall be made a minimum of 72 hours (three working days) in advance of final acceptance testing to allow for Northrop source inspection as required.

Figure F6. - Supplier data and documentation list

For the Orbiting Primate Spacecraft Program, Northrop Corporation will make use of quality control services, e.g., Key Plan supplier surveys, source surveillance, liaison activities, available from the Eastern Quality Control office located at the Nortronics Division in Norwood, Massachusetts. The location of quality control field representatives and the span of coverage provided by the Eastern Quality Control office are shown in figure F7. A "Quality Control Action Request" will be used to notify the Eastern Quality Control office that source surveillance or final inspection is required. Applicable specifications, drawings, and special instructions are forwarded with the request in sufficient time to enable the Quality Control Field Representative to familiarize himself with the equipment specifications and quality requirements. Figure F8 shows a typical action request.

Supplier Selection

Northrop follows the requirements of paragraph 5.2 of NPC 200-2 in selecting procurement sources. As outlined therein, formal approval of procurement sources is based on satisfication of one or the other of the following conditions:

(1) The supplier shall have a previous and continuous history of supplying high quality articles of the type being procured. Performance history and objective quality evidence obtained at receiving inspection are used to evaluate prospective suppliers.

(2) If no previous quality history is available, a survey of the supplier's facilities and quality control system will be performed to assure that he is qualified to supply articles which meet the quality requirements of the purchase order. Northrop's "Implementation Manual for Quality Source Evaluation" provides a uniform set of instructions for implementing Northrop quality control documents.

QUALITY INSPECTION

Quality Inspection will consist of performing specific inspections and test verifications to assure that only materials and equipment meeting established specifications are accepted. This activity includes incoming testing, in-process testing, and final inspections in accordance with appropriate manufacturing and quality control work instructions described previously. In accordance with Section 10, "Inspection Stamps" of NPC 200-2, the Contractor will use an inspection stamp control system to indicate inspections performed.

Incoming Inspection

All incoming supplies will be inspected by Receiving Inspection to determine conformance with drawings and specification requirements indicated on the purchase order. Except for Government Furnished Property, incoming inspection

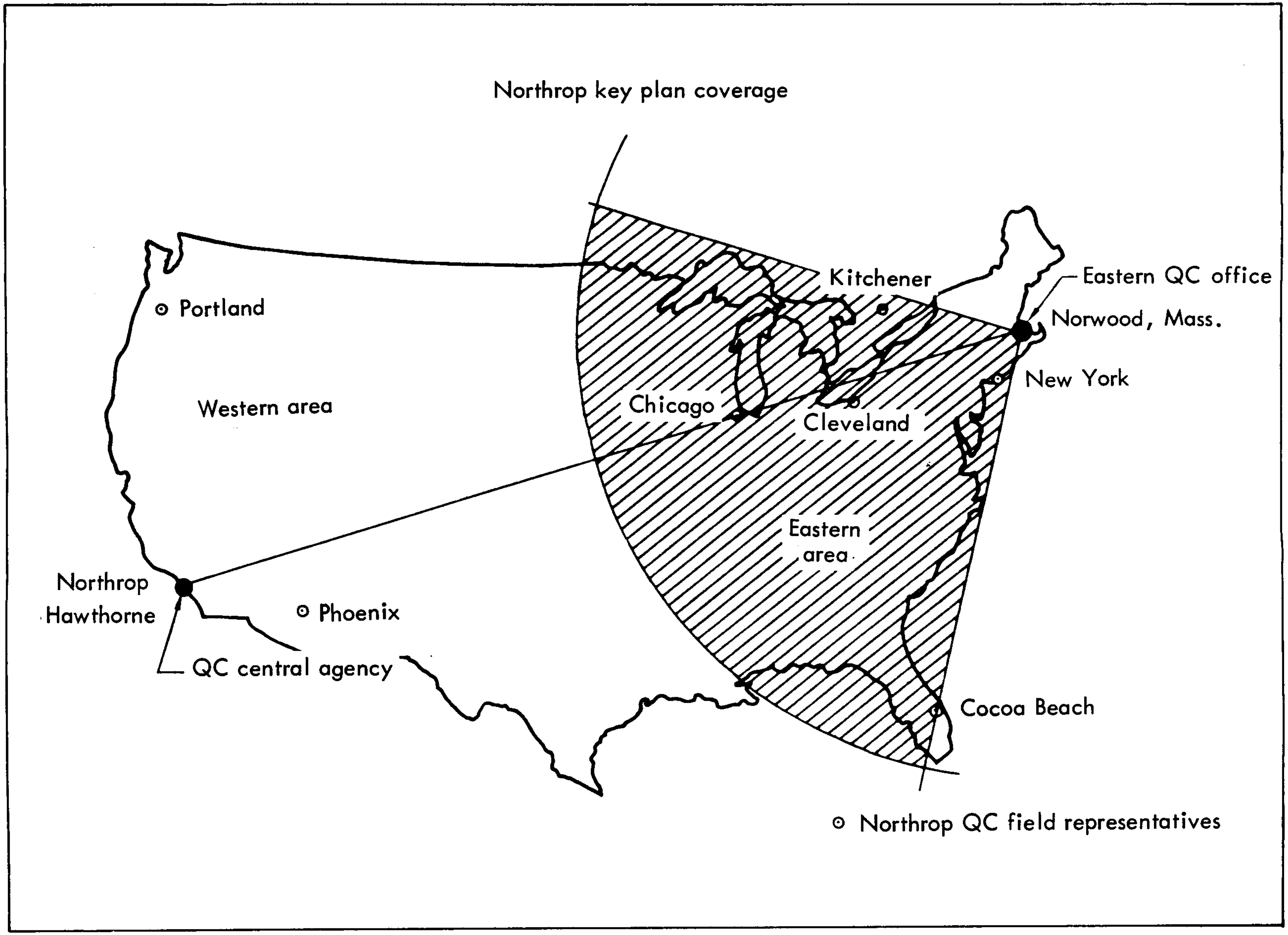


Figure F7. - Northrop key plan coverage

QUALITY CONTROL ACTION REQUEST
FORM C-71 (9-68)

NORTHROP KEY PLAN

No. 00010

1. SUPPLIER NAME	2. P.O. NO.	3. PART NAME	4. PART NO.
EAGLE-PITCHER CO.	6-08498	Battery	127-59003

5. SUPPLIER ADDRESS	6. REQUESTING DIVISION	7. PHONE	8. DATE
Joplin, Missouri	Northrop Space Laboratories	(805)258-2111	-

9. REQUESTER	10. ORGN. NO.	11. EXT.	12. BUYER	13. GROUP	14. ORGN. NO.	15. EXT.
R. Cooper	2660	2771	C. Dunlap	A-6	6510	2797

QUALITY CONTROL ACTION REQUESTED

16. ☐ **KEY QUALITY SYSTEM SURVEILLANCE** Q.C. 500 LEVEL [ ] 1 [ ] 2 [ ] 3 [ ] 4 SPECIFY FREQUENCY

17. ☐ **SPECIAL QUALITY AUDIT REQUIREMENTS**
- ☐ Procurement Control
- ☐ In-Process Inspection
- ☐ Configuration Control
- ☐ Process Control
- ☐ Quality Records
- ☐ Drawing and Spec. Control
- ☐ Materials Storage and Handling
- ☐ Nonconforming Material
- ☐ Corrective Action System
- ☐ Other (Specify) ____________

18. ☒ **SOURCE INSPECTION REQUIREMENTS**
- ☐ Inspection Check List Supplied
- ☐ In-Process Inspection [ ] 100% [ ] Sample (____ AQL) [ ] Surveillance
- ☒ Final Assembly Inspection [X] 100% [ ] Sample (____ AQL) [ ] Surveillance
- ☒ Functional Test Inspection [X] 100% [ ] Sample (____ AQL) [ ] Surveillance
- ☐ Functional Test Inspection Critical Characteristic Only - Specify in Item 20
- ☐ First Article Inspection
- ☒ Data Submittal Requirements, Specify in Item 20
- ☐ Process Control
- ☒ Shipping Inspection
- ☐ Other (Specify) ____________

19. ☐ **CORRECTIVE ACTION INVESTIGATION** DEFINE PROBLEM IN ITEM 20

20. SPECIAL INSTRUCTIONS

1. Qualification status summary to be checked prior to shipment; summary and qualification test report number to be shipped with equipment.
2. Actual readings of final acceptance test, failure reports to be submitted.
3. Verify electrical performance tests; leak test; terminal impedance; insulation test.
4. Verify preservation and packaging for shipment

21. APPLICABLE TECHNICAL DATA
(LIST AND USE "(S)" TO IDENTIFY DATA SUPPLIED WITH THIS REQUEST)

☒ ENGINEERING DRAWINGS ☒ TEST PROCEDURES ☐ PROCESS SPECIFICATION ☐ OTHER

Dwg. 127-59003

ITWO 170653 "Acceptance Test Procedure"

22. KEY CONTROL OFFICE SUPERVISOR	23. DATE	24. KEY CONTROL QUALITY REPRESENTATIVE	25. DATE

Figure F8. - Quality control action request will include visual, dimensional, functional, physical, chemical, and non-destructive testing. The results will become a permanent record of identification information (lot number, supplier, date, etc.), inspection instructions, and tested characteristics. First article parts will receive a particularly detailed review to determine specification conformance. Discrepancies discovered will be transmitted to the supplier and to Northrop engineering designers for remedial action. Inspection of Government Furnished Property will conform to the requirements of paragraphs 6.1 and 6.2 of NPC 200-2.

As previously indicated, source inspection at the supplier's facility will occur on several items. The following components of the Environmental Control System exemplify the types of components that will be subjected to source inspection: pumps, heat exchanger assemblies, coolant accumulators, waste removal filters.

Subject to the NASA approval, Government source inspection will be requested for manufacturers of basic electronic elements where it is likely these manufacturers have resident inspectors. Examples could be integrated circuits used for digital logic in a computer program sequencer, or electronic parts used in oscillators and amplifiers. Space qualified electronics parts will be purchased from approved sources wherever possible. In addition, all electronic items procured will be subjected to debugging (burn-in) tests to remove those units which suffer early failure.

Tooling Inspection

Detailed inspection of all jigs, fixtures, and templates will be conducted prior to release to fabrication work areas. This assures tooling capable of producing uniform parts and assemblies with dimensional and functional characteristics within prescribed tolerances.

Master tools, check fixtures, I&R tools, machine tools, drill fixtures, and assembly tools, will be inspected to conform with the tool design. Final acceptance will be based on first part tool proving.

Fabrication and Assembly Inspection

Completed sheet metal and machine parts will be inspected in accordance with drawing and tool order instructions to verify dimensional and physical conformity prior to release for next assembly operations. Hardness testing, process inspection, and non-destructive test methods, (e.g., magnaflux, dye penetrant, x-ray) are in an integral part of the inspection operation.

The first article and tool proving inspection will be conducted on the first release of detail parts to assure adequacy of tools, manufacturing plan and quality control requirements.

Inspection records and parts status will be maintained during all stages of fabrication. All parts will be stamped or tagged at the last inspection routing before stocking to assure identification with the shop traveler which is retained as a fabrication and inspection record. Discrepancy recording and data feedback will be maintained in fabrication areas to provide a continuous measure and historical record of area performance. Northrop's Inspection Discrepancy Report will be used to record non-conformance detected during in-process fabrication. A facsimile of this form is shown in figure F9.

Assembly and installation operations will be inspected to manufacturing assembly inspection sheets. End station final inspections include a check of the assembly for quality, configuration accountability, and conformance to workmanship standards, drawings, and specifications.

Assembly Inspection Books

Assembly Inspection books will be prepared for major assemblies to provide detail instructions for assembly installation and test. Contained in these books will also be information pertinent to interchangeability and replaceability, data recording provisions, and in-process and final inspection controls. Provisions for posting of Engineering Orders, recording of discrepancies, authorized removals, and shortages will be contained in the Assembly Inspection Book. Completed book records will be audited for completeness prior to filing.

Government Inspection

Government inspection will be conducted by a Government inspection agency designated by the NASA. Mandatory inspection points will be established by the NASA's cognizant quality assurance representative. The buy-off code column of Manufacturing Assembly and Acceptance Sheets will indicate the NASA inspection verification points. Northrop work operations will not continue beyond these check points until the cognizant government agency personnel have completed their inspection or waived the requirement.

End Item Test Verification

Final tests and inspections will be performed in a manner and under conditions that simulate end-use to the highest degree practical. The degree, duration, and number of such end item tests will be described in the Integrated Test Plan, as updated during the design phase of this program. Detailed test and inspection procedures will be available prior to initiation of tests and inspections. Actual readings obtained during end item acceptance tests will be documented in the Assembly Inspection Book and will be available for review by the cognizant NASA representative.

After end item test and inspection, the occurrence of any unauthorized modifications, repair, disassembly, or damage resulting from mishandling, will necessitate re-inspection and re-test to the extent deemed necessary for Quality Control.

NORTHROP SPACE LABORATORIES

No 0547

INSPECTION DISCREPANCY REPORT

DATE __________ 19____

PART NAME			SALES ORDER NO.	DASH	CONTRACT NO.
PART NUMBER	SERIAL NUMBER	NEXT ASSY NUMBER	PROGRAM	PRODUCTION ORDER NO.	OPER. NO.

TYPE OF INSPECTION: ☐ FIRST ARTICLE ☐ IN-PROCESS FABRICATION ☐ FINAL ☐ PACKAGING ☐ SURVEILLANCE ☐ OTHER

MATERIAL INSPECTED: ☐ MECHANICAL ☐ OPTICAL ☐ MACHINED PART ☐ ELECTRONIC COMPONENT ☐ ELECTRONIC ASSEMBLY ☐ MECHANICAL ASSEMBLY ☐ ELECTRO-MECH. ASSEMBLY ☐ OPTO-MECH. ASSEMBLY

INSPECTOR	STAMP	☐ INSPECTED AT SOURCE	SUPPLIER	SUPPLIER NO.	PURCHASE ORDER NO.

DISCREPANCY

ITEM	DESCRIPTION (BE COMPLETE AND SPECIFIC)	RWK TO SPEC	REWORKED BY	INSPEC'N BUY-OFF	DEFECTS QTY	DEFECTS CODE
		QTY ACCEPTED		QTY REJECTED		

PRELIMINARY REVIEW

☐ REWORK TO STANDARD
REPAIR ______
ITEM ______

☐ MRB DISP. REQUIRED
ITEM/S ______
MRB NO. ______

P.R. INSPECTOR DATE
ENGINEER DATE

CORRECTIVE ACTION STATEMENT (ENG., MFG., SUPPLIER)

CORR. ACTION REPORT NO.	CORR. ACTION EFFECTIVITY	SIGNATURE - CORR. ACTION RESPONSIBILITY	DATE

NSL 100-771 (B 10-68)

QUALITY CONTROL COPY

Figure F9.- Inspection discrepancy report

Materials Review

Nonconforming materials will be disposed of in accordance with Section 8, "Nonconforming Material" of NPC 200-2. The functions and responsibilities of the Materials Review Board (MRB) are defined in Northrop Product Integrity Procedure QA-14.3, Nonconforming Material, a copy of which is Appendix D. Material which will be unfit for use or will be found to be not economically repairable, may be scrapped in accordance with Procedure QA-14.3. Northrop will provide facilities for the segregation and positive identification of defective articles.

Subject to the NASA approval, delegation of MRB responsibility to Orbiting Primate Spacecraft Program suppliers may be authorized as defined in paragraph 5.8, "Noncornforming Materials" of Northrop QC Specification 500.

LABORATORY TEST MODEL PHASE

Evaluation test activities will begin at the breadboard level in the Laboratory Test Model phase and will continue through completion of Acceptance Testing of the Laboratory Test Model. The objective of all such tests will be to locate significant failure modes and by test data analysis and by failure analysis to determine if failures encountered resulted from inherent design deficiencies or from manufacturing variances outside of drawing specified limits.

Information gained during the Laboratory Test Model phase will be used to update inspection plans and to evaluate the adequacy of process control methods. One objective will be to facilitate early specification refinements and quality control plan "proofing" prior to fabrication of the first flight model.

Two kinds of hardware will be fabricated and assembled: qualification test items which are duplicates of flight end items, and laboratory model function simulators which facilitate conducting the testing. The differences in quality control inspections and procedures between the latter and the former are outlined in figure F10. The Quality Control policy for breadboards is also shown in figure F10.

CALIBRATION AND STANDARDS

Calibration facilities and standards are established by Northrop in conformance with Section 9: Inspection, Measuring, and Test Equipment of NPC 200-2. Northrop prime standards of measurement encompassing basic references to time, mass, and length are (and will be) operated in accordance with the requirements of MIL-C-45662A "Calibration System Requirements." All units of measure utilized in the manufacturing areas bear direct traceability

Requirements	Laboratory test model equipment		
Apply the requirements listed in this column for the type of model being fabricated	Breadboards as required	Function simulation equipment	Duplicates of qualification equipment flight end items
Engineering drawings and specifications	Preliminary drawings only; change control not required	Expedited release drawings; changes controlled by EO	Formal release drawings; and change control required
Parts and Materials	Engineering option	Approved parts desired; engineering approval required for non-standard parts	Approved parts required; authority required for non-approved parts
Workmanship	Sufficient for mechanical and circuit integrity	Per process manual	Per process manual
Identification and marking	Not required	Sufficient for inspection and trouble shooting	Per process manual
Finish and processing	Not required	Per process manual	Per process manual
Interchangeability and replaceability	Not required	Not required	Required
Variance authorization and material substitution	Not required	As authorized by cognizant engineer	Required
Inspection test and engineering review	Applies only to receiving inspection or upong engineering request	Applies to receiving inspection & test	Applies completely from source inspection source or receiving inspection and test until delivery to customer
Failure reporting	Not required	Implement informal failure reporting system	Implement formal failure reporting system

Figure F10. - Quality control policy laboratory test model to the National Bureau of Standards or an authorized agency having certified traceability. The calibration status of each unit of standards equipment is monitored continuously and recalibration is performed at prescheduled times.

Frequency of equipment recall is scheduled by Northrop's Standards and Calibration Laboratory in conjunction with the using organization and is established by analysis of equipment stability, purpose, and degree of usage. A master operations center keeps historical and accountability data on electronic data processing (IBM) equipment. These records high-light the number of calibrations, scheduling, repeated malfunctions, repairs made, parts replaced, and repair/calibration hours.

PACKAGING AND SHIPPING INSPECTION

In accordance with Section II, "Preservation, Packaging, Handling, Storage, and Shipping" of NPC 200-2, all shipments of Orbiting Primate Spacecraft equipment, Ground Support Equipment, and loose items will be inspected for proper preservation, general condition, and compliance with packaging requirements to preclude damage or deterioration during shipment. Shipping documentation prescribes the method of processing and packaging. Inspection verification will be performed after such typical operations as cleaning, processing, intermediate packaging, labeling, and crating. Shipping documents will be reviewed for completeness of entries for delivery location, shipping instructions, shipping authority, equipment identification, serial numbers, and the NASA approval, when applicable. For critical components or when maintenance of specific internal environments is necessary, special instructions will be included in the packaging and on the exterior package.

QUALITY CONTROL DATA AND DOCUMENTATION

Quality data and documentation maintained by Northrop for this program will be limited to off-site source, receiving, in-process, and final inspection records required to demonstrate control of equipment quality during fabrication, installation, and checkout operations. Meaningful management information such as quality trends, periodic failure report summaries, spoilage reports, and quality problems, are maintained for the NASA on-site review.

Data submittal requirements for deliverable end items are limited to equipment configuration status, minimum end-item quantitative test data, accountability of open work items, shortages, top level drawings and specifications, failure data summaries, and weight reports.

A check list will be provided to indicate the total data package shipped with each end item. A summary of deliverable quality data and documentation requirements is shown in figure F11.

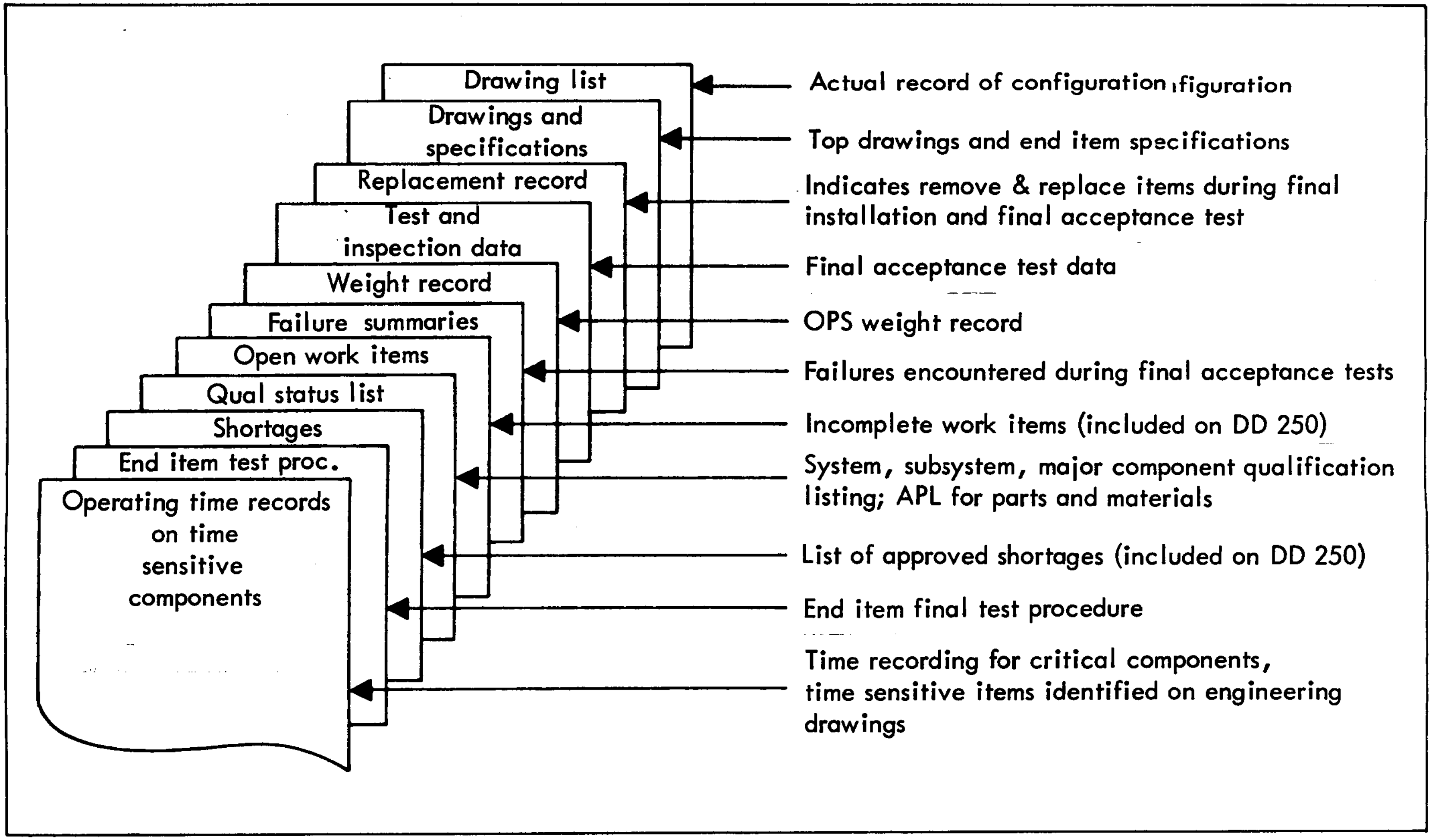


Figure F11. - Acceptance data package

LAUNCH SITE SUPPORT

At Kennedy Space Center, Northrop will inspect all incoming Orbiting Primate Spacecraft equipment, Ground Support Equipment, and loose items for evidence of in-transient damage and general condition. Historical records and shipping documentation will be audited for completeness and accuracy. Incoming items are received and stored in controlled areas in the Manned Spacecraft Operations Building (MSOB) pending release for installation and checkout.

Ground Support Equipment (GSE) and inspection test and measuring equipment will be maintained under cycles and calibration control. Historical records of modification, periodic maintenance, calibration and repair will be maintained and will be available for on-site review by the cognizant NASA representative.

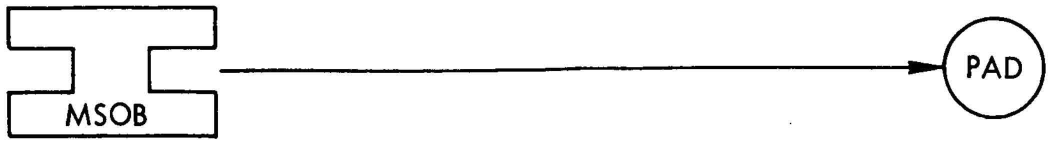
Northrop personnel at the launch site will maintain the spacecraft log book to control all break-of-inspections, and to record equipment removals and completed work items. The log summarizes and indicates quality control verification of all authorized tests performed. Inspection check-points will be established throughout equipment pre-installation checkout operations and integration with the Apollo Spacecraft.

Northrop's Failure Reporting system will be used at the launch site to report equipment malfunctions and failures. This system will assure that all required incidents are documented and that all malfunction reports are complete and valid. Copies of failure forms will be forwarded to Northrop's Hawthorne facility for additional analysis and follow-up action.

Positive configuration control of equipment undergoing checkout and prelaunch preparations will be maintained. Field-determined engineering changes will be initiated at the base site by ECR (Engineering Change Request) and ECP (Engineering Change Proposal) and dispositioned in accordance with local Change Control Board instructions. Similarly, disposition of local materials and equipment will be by local MRB (Materials Review Board). All other activities, e.g., drawing and specification changes, will be accomplished at the Hawthorne facility in accordance with previously described procedures. A flow of Quality Control activities at Kennedy Space Center is shown in figure F12.

CROSS REFERENCE MATRIX: NASA QUALITY PUBLICATION NPC 200-2 VERSUS THIS DOCUMENT

The Quality Assurance program described in this document assumes a level of effort just under the requirements of NPC 200-2 and NPC 200-3. The lessening of some of these requirements is desirable to avoid unnecessary burdensome tasks for a program of low total production units, or to reduce excessive costs for tasks whose performance will not significantly improve the quality level of the end item. Exceptions in this plan to NPC 200-2 involve:



1. Audit shipping documents and historical records on all incoming shipments of spacecraft equipment and GSE. (Note: Joint Northrop/Apollo Spacecraft contractor effort)
2. Perform visual inspection; check for evidence of in-transit damage.
3. Verify conformance to handling and storage requirements
4. Initiate and maintain orbiting primate spacecraft log book.
5. Maintain all break-of-inspection; record equipment removals and completed work items.
6. Maintain cycle and calibration control of GSE, and inspection test and measuring equipment.
7. Verify maintenance of contamination controls during installation and test.
8. Establish and maintain quality control check points throughout operations.
9. Record discrepancies on NASA DR (Discrepancy Report)
10. Perform system completion status review with Apollo Spacecraft contractor prior to installation.
11. Provide quality control support to Northrop test operations at MSOB.
12. Maintain Log Book.
13. Record test data and removal and rework of spacecraft equipment.
14. Maintain quality control interface with Apollo Spacecraft Q.A.

1\. Provide quality control support during MSOB integration and test operations.

1\. Provide quality control support during launch pad operations.

Figure F12. - KSC operations support

(1) Quality Program Documentation
(2) Identification
(3) Procurement and Document Contents
(4) Receiving Inspection
(5) Identification
(6) Coordination of Contractor - Supplier Measuring and Test Equipment and Standards
(7) Workmanship Inspection Standards
(8) Evaluation
(9) Statistical Planning, Analysis, and Quality Control
(10) Training and Certification of Personnel
(11) Data Reporting
(12) Audit of Quality Program Performance

Identification for the Orbiting Primate Spacecraft Program is defined as the engineering identity of parts and components through part numbers and the further identification by inspection and manufacturing status. This does not imply traceability which relates to the specific controls required for tracing and examining the manufacturing and processing cycle of certain parts or components back to any point in the history of the article and for identifying materials and test parameters as required.

Regarding procurement control, "Identification" and traceability requirements will not be imposed on Orbiting Primate Spacecraft Program suppliers. The potential cost savings to be realized from this exception are substantial while deletion of this requirement will not jeopardize quality. Every attempt will be made to purchase equipment which is space-proven by usage (e.g., command receivers, instrumentation sensors, solar cells) or to verify by testing, design, and manufacturing data a comparably equivalent quality (e.g., feeder, waterer, switching networks for redundant items). Sufficient documentation will be required of all suppliers to verify component quality except where specifically exempted by the NASA and Northrop concurrence.

Table F1 discusses deviations 1 through 12.

Figure F13 presents a sample of the standard practice procedure for certifying personnel.

Figure F14 presents a sample of the product integrity procedure covering the quality rejection report (form ANS-23) which will be used in the receiving and production inspection areas.

Figure F15 presents the procedure by which quality audit will be achieved.

Figure F16 presents the product integrity procedure for nonconforming material which will be used during the program.

TABLE F1. - NASA QUALITY PUBLICATION NPC 200-2/NSL
CROSS REFERENCE MATRIX

Paragraph No. NPS 200-2 "Quality Program Provisions"	Paragraph title appendix F (this document)	Deviations
Section 1: Introduction		None
2.1 General		None
2.2 Quality Program Documentation	Quality Control Data and Documentation	Limit Quality Program documentation to off-site source, in process, and final inspection records, and meaningful management information as defined in paragraph 8.0.
2.3 Change Control	Quality Control Requirements for Suppliers	None
3.1 Quality Assurance Plan Submission	Quality Program Operations	None
3.2 Organization	Organization and Management	None
4.1 General	Introduction	None
4.2 Drawing and Specification Review	Quality Control Requirements for Suppliers	None
4.3 Qualification Tests	Supplier Data and Documentation	None - Specific requirements of paragraph 4.3 NPC 200-2 are covered in NSL Integrated Test Plan, Quality Control responsibilities are covered in paragraph 3.2.
4.4 Identification		Limit serialization to components for which this requirement is specified on the engineering drawing, e.g., batteries, electronic components.
5.1 General	Quality Program Engineering	None

TABLE F1. - Continued

Paragraph No. NPS 200-2 "Quality Program Provisions"	Paragraph title appendix F (this document)	Deviations
5.2 Selection of Procurement Sources	Receiving Check Lists	None
5.3.1 Procurement Document Contents	Quality Planning and Test Procedure Review	None - Per paragraph 5.3.1 requirements apply to all tiers of procurement, as applicable. The contractor does not consider the Quality Plan applicable to all suppliers.
5.3.2 Procurement Document Review	Quality Planning	None
5.4 Government Source Inspection	Not applicable	None
5.5 Contractor Source Inspection	Process Controls	None
5.6 Receiving Inspection	Supplier Selection and Incoming Inspection	Periodic disassembly of purchased articles upon receipt is not planned. Verification of unique requirements will be accomplished at the supplier's facility for those characteristics that cannot be verified during incoming inspection.
5.7 Identification	Incoming Inspection	Traceability of raw materials and fabricated articles is not planned. Receiving Reports and Quality Control Check Lits will provide objective evidence of acceptance status for incoming parts and materials. Raw materials are color-coded and inspection stamped before release to material stores. Fabrication Orders and Manufacturing Assembly and

TABLE F1. - Continued

Paragraph No. NPS 200-2 "Quality Program Provisions"	Paragraph title appendix F (this document)	Deviations
		Acceptance Sheets will provide evidence of inspection acceptance status for fabricated articles.
5.8 Failure and Deficiency Feedback	Supplier Selection	None
5.9 Supplier Rating and Preferred Source Lists	Receiving Check Lists	
5.10 Coordination of Contractor Supplier Measuring and Test Equipment and Standards	Test Procedure Review	Formal coordination of supplier measuring and test equipment is not planned. Submittal of end item inspection and final acceptance test procedures will be required from suppliers of major components and critical items.
6.1 Inspection of GFP	Incoming Inspection	None
6.2 Defective GFP	Incoming Inspection	None
7.1 General	Introduction	None
7.2 Conformance Criteria	Quality Inspection	None
7.3 Inspection and Test Planning	Quality Control Requirements for Suppliers and Supplier Data and Documentation	None - The need to submit acceptable samples of workmanship is not anticipated.
7.4 Inspection and Test Performance	Fabrication and Assembly Inspection and End Item Test Verification	None
7.5 Fabrication Controls	Northrop Source Inspection and Tooling Inspection	None

TABLE F1. - Continued

Paragraph No. NPS 200-2 "Quality Program Provisions"	Paragraph title appendix F (this document)	Deviations
8.0 Nonconforming Material	Materials Review	None
9.1 General	Calibration and Standards	None
9.2 Calibration	Calibration and Standards	None
9.3 Calibration Facilities and Standards	Calibration and Standards	None
9.4 Evaluation		Evaluation of electronic test equipment will consist of test fixture proofing prior to initial release and controlled test procedures. First article compatibility testing will be accomplished and records of completion maintained for on-site review. Formal evaluation reports are not planned.
9.5 Maintenance and Control	Calibration and Standards	None
9.6 Written Procedures	Calibration and Standards	None
9.7 Records	Calibration and Standards	None
10.0 Inspection Stamps	Quality Inspection	None
11.0 Preservation, Packaging, Handling, Storage and Shipping	Packaging and Shipping Inspection	None
12.0 Statistical Planning, Analysis, and Quality Control	Northrop Source Inspection	Methods of statistical analysis, e.g., design experiments, analysis of variance, and statistical test planning are not applicable to the Orbiting Primate

TABLE F1. - Continued

Paragraph No. NPS 200-2 "Quality Program Provisions"	Paragraph title appendix F (this document)	Deviations
		Spacecraft program. Sampling plans, if used, will be in accordance with applicable military standard MIL-STD-105D.
13.0 Training and Certification of Personnel	Northrop Source Inspection	Special training programs such as Primate system familiarization, instruction in techniques and methods for inspection test checkout, statistical quality control, or packaging and handling are not planned. Manufacturing and inspection personnel performing or inspecting special processes shall be certified.
14.1 General	Quality Control Data and Documentation	None
14.2 Data Reporting	Quality Control Data and Documentation	Quality status reports shall be submitted on a quarterly basis. Monthly quality summaries will be combined with monthly Orbiting Primate program progress report. Laboratory and experimental data shall be maintained during qualification testing only. The collection, processing, analysis, and dissemination of quality data will commence with the qualification test program. A Narrative End-Item Report is not planned for each end item. Information contained in the Acceptance Data Package will suffice for this purpose.
14.3 Corrective Action		None

TABLE F1. - Concluded

Paragraph No. NPS 200-2 "Quality Program Provisions"	Paragraph title appendix F (this document)	Deviations
15.0 Audit of Quality Program Performance		The Quality Audit program will encompass system audits only. Product audits are not planned. System and Produce audits are defined in paragraph III, "Definitions" or "Implementation Instructions..", the attachment to this document.

NORTHROP A DIVISION OF NORTHROP CORPORATION	**STANDARD PRACTICE PROCEDURE**	S.P.P. NO. 9-1.5
SUBJECT:	CERTIFICATION OF PERSONNEL	PAGE 1 OF 5
		EFFECTIVE 24 August 1965
CONCERNED:	Manufacturing, Quality Control, Industrial Relations	SUPERSEDES Previous Issue 23 June 1964

General Revision

I. PURPOSE AND SCOPE

A. To establish the procedure for maintaining a high level of competence and capability of personnel engaged in specific tasks listed in the attachment.

B. To establish control of certification and re-certification of personnel where personnel error could be detrimental to the quality or increase cost of product.

II. GENERAL

A. **Definitions:**

1. Certification - That procedure, its requirements and evidence thereof, establishing the capabilities of personnel to perform a specific operation in a competent and proficient manner.

2. Re-certification - That procedure which, through testing, will indicate the extent of the need for updating or re-training, if any prior to re-issuance of a renewal of certification.

3. Cycle of Certification - That period of time not to exceed two (2) years during which operating personnel will be permitted to perform an authorized function before re-certification.

B. This procedure stipulates the requirements for certification and periodic re-certification commensurate with applicable military requirements, process specifications, and product quality requirements.

1. New certification requirements may be initiated by affected organizations with approval of Quality Control.

III. PROCEDURE

A. **Personnel Certification**

Figure F13. - Certification of personnel

III. PROCEDURE, A, (Continued)

1. Industrial Training shall establish and keep updated training courses and/or examinations commensurate with the latest engineering and process specifications, manufacturing techniques, etc. Personnel Development and Training, with agreement of Quality Control Engineering and affected manufacturing organizations, will determine if the change warrants re-certification of personnel in advance of the normal cycling. Quality Control Engineering will review and approve changes.

2. Organizations requiring certified personnel shall request certification of personnel by means of Form 27-610, "Employee Certification Request", which shall be forwarded to Personnel Development and Training.

3. Industrial Training shall examine and/or train personnel on operations listed in this procedure in accordance with the outline prepared. Personnel Development and Training may request the assistance of specialists in other organizations to prepare course material or conduct the training as required to effectively execute the training responsibility. Industrial Training shall determine what portion of the training shall be O.J.T., if any, O.J.T. schedules will be coordinated with the affected manufacturing organization.

4. On successful completion of such examination and/or training by applicant, Industrial Training will initiate and endorse Form 27-346, "Certification Card", and forward Form 27-346 and Form 27-610 to Records Control Unit.

5. The completed Certification Card shall indicate the expiration date, by which time employee must be re-certified. Completed certifications shall be the only authority for issuance of the related stamp.

6. Records Control Unit will initiate applicable records and issue the Certification Card and stamp; forward Form 33-58B, "Company Property Receipt", employee's copy of Form 27-610, Control Stamp, and Certification Card to the employee's organization head.

7. The organization head shall issue the stamp and Certification Card to the employee. The employee shall sign and immediately apply his stamp impression in the appropriate places on the Certification Card. Form 33-58B shall be signed by the employee and returned to Records Control Unit.

Figure F13. - Certification of personnel (continued)

III. PROCEDURE, A, (Continued)

8. Stamps shall be used only by the person to whom they are assigned, as the stamp impression signifies that the operation was performed by a certified employee who is responsible for the work performed.

9. Line supervisors are responsible for determining that operations listed in SPP Attachment 9-1.5.1 are performed only by certified personnel who have current Certification Cards and for maintaining compliance with this procedure.

10. Certified personnel shall have their Certification Card readily available for examination by Inspection, Customer Personnel, or Personnel Development and Training representatives.

B. Personnel Re-certification

1. Re-certification of personnel shall be conducted in accordance with established frequency specified in SPP Attachment 9-1.5.1.

   a. Industrial Training, with the assistance of Quality Control, will semi-annually review shop operations for certified personnel assignment, compliance with requirements, and initiate changes in specified cycle spans or individual re-examination when circumstances indicate the need for review, re-certification and training. Changes and/or re-examination will be approved by Quality Control and Production Operations representatives.

2. Employee's organization head will initiate a new Form 27-610 promptly upon receipt of re-certification notice and follow Paragraph III.A.2. thru III.A.9.

3. The organization head shall, at the time of completion of re-certification, exchange the expiring Certification Card for the new issue, collect, and forward the expired card to Records Control Unit.

4. Records Control Unit will verify updating of files and destroy old Certification Card.

C. Personnel Termination

1. Employee's organization head shall, at the time of certified employee's termination, transfer, or removal from certified assignment, return Certification Card and Control Stamp, accompanied by Form 33-58B, to Records Control Unit who will clear applicable records and, in turn, forward Form 33-58B to Industrial Training who may also clear their training records.

Figure F13. - Certification of personnel (continued)

III. PROCEDURE, (Continued)

D. Non-destructive Testing Certification

1. Requests for certification, re-certification, and retest for non-destructive testing shall be forwarded directly to Quality Control Engineering who will train and certify.

2. For original certification, the requesting organization shall forward all four (4) copies of Form 27-610 and all five (5) copies of Form 27-615, "Certification of Inspection Personnel".

3. All forms shall be completed ready for approval signatures before forwarding, including the results of the vision test specified on Form 27-615.

E. Fusion Welding Certification

1. Certification of personnel to perform fusion welding and aluminum torch brazing are controlled in accordance with other published procedures.

F. Quality Control

1. Quality Control Engineering will plan scheduled audits, on semi-annual basis, of certified personnel listed in SPP Attachment 9-1.5.1 for compliance with specifications covering the certified operation and compliance with specific certification requirements of this procedure.

2. Records Control Unit shall maintain records of certified personnel and notify the employee's organization head by means of Form 27-610 thirty days prior to required re-certification date. At the expiration of the thirty (30) day period, the person shall be considered as uncertified and shall discontinue performance of the function forthwith until re-certification is accomplished.

G. Violations

1. Form 27-328, "Certification Violation", shall be used to report specific violation of operation or misuse of equipment and/or stamp. This form may be issued by Manufacturing or Quality Control. It shall be retained for six (6) months and then destroyed.

Figure F13. - Certification of personnel (continued)

III. PROCEDURE, G, (Continued)

2. A member of the violator's supervision shall withhold the violator's certification card and stamps at the request of a reporting organization. A receipt must be issued and Quality Control Engineering immediately notified. The violation must be resolved within forty-eight (48) hours.

3. Representatives from the reporting department, violator's department, and Quality Control Engineering shall meet and investigate the violation and render a decision within forty-eight (48) hours.

4. Quality Control Engineering is responsible for certification approval and shall be the final authority on permanent revocation of certification.

Forms Used: 27-328, 27-346, 27-610, 27-615, 33-58B

Figure F13. - Certification of personnel (continued)

CERTIFICATION OF PERSONNEL AS REQUIRED

I. OPERATIONS

Operation & Code	Title	Certification Cycle	Process Stamp
A. Metal Bonding			
A. 1.00	Adhesive Mixer	12 Months	Man No.
A. 1.01	All Adhesives		
A. 1.02	Specific Adhesive identified by Document Number (Call Personnel Development and Training for document numbers)		
A. 2.00	Adhesive Applicator	12 Months	Man No.
A. 2.01	Spray		
A. 2.02	Rollercoat		
A. 2.03	Brush (Specify Document No.)		
A. 3.00	Metal Bond & Honeycomb Repair	12 Months	Man No.
A. 4.00	Chemical Process Tank Operator	12 Months	Man No.
A. 5.00	Project Sheet Loader	12 Months	Man No.
B. Assembly			
B. 1.00	Special Fastener Installer (Specify which type training required, Boeing or Norair Specification on (*) items)	18 Months	Man No.
B. 1.01	*Fluid Tight		
B. 1.02	*Hi-Shear Rivet		
B. 1.03	*Hi-Clinch		
B. 1.04	Hi-Lok		
B. 1.05	Hi-Shear Blind Bolt & Blind Nut		
B. 1.06	*Lockbolt & Stump		
B. 1.07	Chobert		
B. 1.08	Blind Bolt (Jo-Bolt & V Bolt)		
B. 1.09	*Deutsch Drive Pin		

Figure F13. - Certification of personnel (continued)

I. **OPERATIONS (Continued)**

Operation & Code	Title	Certification Cycle	Process Stamp
B. Assembly (Continued)			
B. 1.10	Dupont Rivet		
B. 1.11	*Cherry Lock Rivet		
B. 1.12	Blind Lockbolt		
B. 1.13	*Blind Rivet		
B. 1.14	Hi-Clinch Olympic		
B. 1.15	Hi-Clinch Cherry		
B. 1.16	*Huck Conical Keystone Lock		
B. 2.00	Metal Burnisher (Specify which type training required, Boeing or Norair Specification)	18 Months	Man No.
B. 3.00	Hydraulic Lines and Fitting Installer (Specify which type training required, Boeing or Norair Specification)	12 Months	Man No.
B. 4.00	Bladder Type Fuel Cell Installer (Specify which type training required, T-38A, F-5A and/or F-5B)	12 Months	Man No. & Circle T
B. 4.50	Repair Bladder Type Fuel Cells	18 Months	Man No.
B. 5.00	Sealant Mixer	12 Months	Man No.
B. 5.01	Machine		
B. 5.02	Hand		
B. 6.00	Sealant Applicator, Integral Fuel Tank (Boeing)	18 Months	Sealing
B. 6.01	Fay Surface		
B. 6.02	Pre-Pack		
B. 6.03	Fillet		
B. 6.04	Injection		
B. 6.50	Sealant Applicator, General (Specify which type training required Boeing or Norair specification).	12 Months	Man No.

Figure F13.- Certification of personnel (continued)

I. OPERATIONS (Continued)

Operation & Code	Title	Certification Cycle	Process Stamp
B. Assembly (Continued)			
B. 6.51	Fay Surface		
B. 6.52	Pre-Pack		
B. 6.53	Fillet		
B. 6.54	Injection		
B. 6.55	Form-A-Gasket		
B. 7.00	Oxygen Lines and Assembly	12 Months	Man No.
B. 7.01	Gaseous		
B. 7.02	Liquid		
B. 8.00	Drivematic Operations	12 Months	Man No.
B. 9.00	Ram Coin Dimpling	12 Months	Man No.
C. Welding			
C. 1.00	Aluminum Torch Brazer	6 Months	Fusion Weld
D. Non-destructive Testing			
D. 1.00	Magnetic Particle Inspector	24 Months	Mag. Accept.
D. 2.00	Magnetic Particle Operator	24 Months	Man No.
D. 3.00	Dye Penetrant Inspector		
D. 3.01	Type II	12 Months	DP
D. 3.02	Type II Kit	12 Months	DPK
D. 4.00	Dye Penetrant Operator Type II	12 Months	Man No.
D. 5.00	Fokker Bond Tester Inspector	12 Months	Ultrasonic
E. Functional Testing of Systems ITWO			
E. 1.00	Functional Testing of Electrical Systems	12 Months	Man No.

Figure F13. - Certification of personnel (continued)

I. **OPERATIONS (Continued)**

Operation & Code	Title	Certification Cycle	Process Stamp
E. Functional Testing of Systems ITWO (Continued)			
E. 2.00	Functional Testing of Hydraulic Systems	12 Months	Man No.
E. 3.00	Functional Testing of Landing Systems	12 Months	Man No.
E. 4.00	Functional Testing of Fuel Systems	12 Months	Man No.
E. 4.01	Fuel Indication System	12 Months	Man No.
E. 5.00	Functional Testing of Radio Communication	12 Months	Man No.
E. 6.00	Functional Testing of Heat and Vent Systems	12 Months	Man No.
E. 7.00	Functional Testing of Canopy and Ejection Systems	12 Months	Man No.
E. 8.00	Functional Testing of Stability Augmenter Systems	12 Months	Man No.
E. 9.00	Functional Testing of Oxygen Systems	12 Months	Man No.
E. 9.01	Oxygen Indication System	12 Months	Man No.
E. 10.00	Functional Testing of Flight Control Systems	12 Months	Man No.
E. 11.00	Functional Testing of Armament System	12 Months	Man No.
E. 12.00	Functional Testing of Electrical & Electronic Components	12 Months	Man No.
F. Electrical Electronic Assembly			
F. 1.00	Coaxial Cable Connector Installer (All Series). Record type of Operation Codes inclusive, e.g. F. 1.01 thru F. 1.09	6 Months	Man No.

Figure F13. - Certification of personnel (continued)

I. **OPERATIONS (Continued)**

Operation & Code	Title	Certification Cycle	Process Stamp
F.	Electrical Electronic Assembly (Continued)		
	Identify Specific Certification Required		
F. 1.01	DM Series		
F. 1.02	MB Series		
F. 1.03	AG Series		
F. 1.04	BNC & TNC Series		
F. 1.05	N Series		
F. 1.06	C Series		
F. 1.07	HN Series		
F. 1.08	LC Series		
F. 1.09	UHF Series		
F. 2.00	Wire Lugger	18 Months	Man No.
F. 3.00	Wire Splicer	12 Months	Man No.
F. 4.00	Electrical Solderer		
F. 4.01	Cup Type Connectors	6 Months	Man No.
F. 4.02	Wrap Around Terminals	12 Months	Man No.
F. 4.03	Printed Board Circuits	18 Months	Man No.
F. 5.00	Electronic Checkout Equipment Operator	24 Months	Man No.
F. 5.01	DITMCO Analyzer		
F. 6.00	Electrical Connector Potter (All Series). Record Type of Operation Codes inclusive, e.g., F. 6.01 thru F. 6.06	18 Months	Man No.
	Identify Specific Certification Required		
F. 6.01	EL 5.1 Process Specification		
F. 6.02	EL 5.2 Process Specification		
F. 6.03	EL 5.3 Process Specification		
F. 6.04	EL 5.4 Process Specification		
F. 6.05	EL 5.5 Process Specification		
F. 6.06	EL 5.6 Process Specification		

Figure F13. - Certification of personnel (continued)

I. OPERATIONS (Continued)

Operation & Code	Title	Certification Cycle	Process Stamp
G. Painting			
G. 1.00	Organic Finish Applicator	12 Months	Man No.
G. 1.01	General		
G. 1.02	Epoxy System		
G. 1.03	Acrylic System		
G. 1.04	Acrylic Nitrocellulose		
G. 1.05	BMS 10-20		
G. 2.00	Organic Finish Mixer	18 Months	Man No.
H. Plastics			
H. 1.00	Foam-In-Place Mixer and Applicator	12 Months	
H. 1.01	Epoxy-Phenolic	12 Months	Man No.
H. 1.02	Polyurethane	12 Months	Man No.
H. 2.00	Resin Mixer		
H. 2.01	Epoxy	12 Months	Man No.
H. 2.02	Polyester	12 Months	Man No.
I. Hot Forming		12 Months	Man No.
I. 1.01	Resistance Heater Operator		
I. 1.02	Hot Oil Bath & Hot Die Operator		
I. 1.03	Radiant Heater Operator		
I. 1.04	Heat Lamp & Hot Air Gun Operator		
I. 1.05	Hot Die Operator		
I. 1.06	Hot Plate		
I. 1.07	Forming Oven		
I. 1.08	Hot Sizing Press		
J. Accessory Drive Gear Box Operations			
J. 1.00	Overhaul & Testing of Accessory Drive Gear Box		
J. 1.01	P/N 2-51100	18 Months	Man No.
J. 1.02	P/N 3-51100	18 Months	Man No.

Figure F13. - Certification of personnel (continued)

I. **OPERATIONS (Continued)**

Operation & Code	Title	Certification Cycle	Process Stamp
J. Accessory Drive Gear Box Operations (Continued)			
J. 2.00	Functional Testing of Accessory Drive Gear Box		
J. 2.01	P/N 2-51100	18 Months	Man No.
J. 2.02	P/N 3-51100	18 Months	Man No.
K. Miscellaneous Operations			
K. 1.00	Acrylic Canopy		
K. 1.01	Scratch Repair	12 Months	Man No.
K. 1.02	Cementing	12 Months	Man No.

NOTES:

1. Certification Cycle - 24 months maximum in all items unless a shorter period is noted under Certification Cycle.

2. Re-Certification - Required in advance of the normal period when major changes in specifications require significant revision of training courses or proficiency examinations, or when certified personnel have been off the specific assignment for six (6) months or as determined necessary by periodic review as noted in SPP 9-1.5. In any case, all certification must be renewed each 24 months.

3. Man Number Stamps - Will be used in all cases except as noted in (4) below. When not applicable to material or surface, associated paper work will be stamped.

4. Circle "T" Stamps - May be issued to the following personnel deemed qualified by their supervision and endorsed by the General Foreman or Supervisor for these four (4) listed non-certifiable operations. Request, Form 27-610, "Employee Certification Request", shall be forwarded directly to Industrial Training who will determine his technical qualifications and (a) if qualified, enter the information on the employees certification record card and forward the request to Records Control, or (b) if unqualified, Industrial Training will return the request to the originator with a justification for rejection.

Figure F13.- Certification of personnel (continued)

I. **OPERATIONS (Continued)**

NOTES, 4, (Continued)

a. Quality Control Personnel

b. Technical Personnel

c. Manufacturing personnel performing the following operations:

(1) Proofloading

(2) Pressure Testing

(3) Spotweld Shear Testing

(4) Cycle test and repair operations

d. Justification for continued possession of Circle "T" stamps shall be reviewed each 12 months from issue by Industrial Training. Those which have not been required for six (6) months or longer will be surrendered on request. Those in continued use will be re-validated, subject to 4 (a) and/or (b) above.

Figure F13.– Certification of personnel (concluded)

NORTHROP NORTRONICS	PAGE 1 OF 7	NUMBER QA-14.2
PRODUCT INTEGRITY PROCEDURE	DATE 20 July 1966	REVISION A
	SUPERSEDES QA-14.2 dated 18 March 1966	
SUBJECT QUALITY REJECTION REPORT (FORM ANS-23)	Chief, Product Integrity	

I. PURPOSE

The Quality Rejection Report is used in the Receiving and Production Inspection areas to withhold nonconforming material from normal use and to authorize and document the disposition of such material. It may also be used in source inspection areas for the same purpose when specified by Quality Assurance supervision. The Quality Rejection Report shall not be used to report functional failures or to disposition malfunctioned equipment in Production Test areas.

II. PREPARATION INSTRUCTIONS

A. The following instructions have paragraph numbers corresponding to the block numbers on the form. The block title (underlined) is followed by the rejection area numbers which require this specific entry. Where practicable, the responsibility for entering the information is defined.

B. The initial entry on the report shall define the rejection area. This is accomplished by circling the proper identifying number in the rejection area block at the top of the form. Remaining entries shall be made as follows:

1. DATE - (1,2,3) - Originator - Enter date report is originated.
2. PROJECT - (1,2,3) - Originator - Enter the project name or initials when such identification has been assigned to the project.
3. PART NAME - (1,2,3) - Originator - Enter the name of the nonconforming item as shown on the drawing or L.M.
4. SERIAL NUMBER - (1,2,3) - Originator - Enter the serial number of the nonconforming item.
5. PART NUMBER - (1,2,3) - Originator - Enter the complete part number of the nonconforming item. Be sure to include dash number, letter, prefix, etc., when applicable.
6. SUPPLIER - (1,3) - Originator - Enter name of supplier. This entry is essential for reports initiated in Receiving (1) and Source (3) areas but may be omitted, if unknown, on Shop (2) rejections.
7. CONTRACT NUMBER - (1,3) - Originator - Enter supplier's contract number if nonconforming item is subcontracted.

Figure F14. - Quality rejection report (form ANS-23)

II. PREPARATION INSTRUCTIONS (Cont.)

B. (Continued)

8. P/O NUMBER - (1,3) - Originator - Enter Nortronics' Purchase Order number.

9. ITEM - (1,3) - Originator - Enter item number of nonconforming item as identified on the Purchase Order, Receiving Report, or contract.

10. UNIT COST - (1,3) - Originator - Enter the cost per unit of nonconforming item as indicated on the purchase order, Receiving Report, or contract.

11. P/P CODE - (1,3) - Originator - Enter the Product-Process Code (Corporate) when it is shown on the Purchase Order or Receiving Report.

12. ACCT. NO. - DASH - (1,3) - Originator - Enter the account number and dash number as shown on the Purchase Order or Receiving Report.

13. QTY. REC. - (1,3) - ORIGINATOR - Enter the total number of items received in the lot (Receiving) or the number of items submitted for inspection (Source).

14. VENDOR CODE - (1,3) - Originator - Enter vendor code number as shown on Purchase Order, Receiving Report, or contract.

15. SUPPLEMENTS QUALITY REJECTION REPORT NUMBER - (1,2,3) - Originator - Enter the number of the initial Quality Rejection Report when the report is prepared as a supplement to another Quality Rejection Report.

16. REWORK TIME - (Not Applicable)

17. SHOP ORDER NO. - (2,3) - Originator - Enter Production Order number when nonconforming item is traveling on a Shop Order.

18. SALES ORDER NUMBER - (1,2,3) - Originator - Enter the Sales Order number from the Production Order or procurement document. Dash numbers shall be entered on shop (2) rejections. Sales Order Dash Number 37 will be entered on all items routed to the shop for rework.

19. SECTION NO. - (2,3) - Originator - Enter section number from the Production Order.

20. QTY. REJ. - (1,2,3) - Originator - Enter the quantity of nonconforming items being withheld on this Quality Rejection Report.

21. NEXT ASSY. NO. - (2,3) - Originator - Enter the next assembly number of the nonconforming item. If the item has more than one (1) next assembly, enter "Various".

22. AFFECTED? YES-NO - (2,3) - Originator - Indicate whether or not the nonconformance has an effect on the next assembly of the withheld item.

Figure F14. - Quality rejection report (form ANS-23) (continued)

II. PREPARATION INSTRUCTIONS (Cont.)

B. (Continued)

23. RESP. ORGN. - (1,2,3) - Originator - Enter the number of the organization responsible for the nonconformance. When the supplier is responsible, enter "Supplier".

24. DISC. @ OPER. NO. - (2) - Originator - Enter the operation sequence number at which the nonconformance was produced.

25. REJ. @ OPER. NO. - (2) - Originator - Enter the operation sequence number at which the nonconformance was detected.

26. GFP - (2) - Originator - Check this block when item being withheld is government or customer furnished equipment.

27. ACCUM. TIME - (2) - Originator - Enter accumulated operating hours on functional units withheld after functional test when running time records are available.

28. SAMPLE SIZE - (1,3) - Originator - Enter the quantity of units inspected as a sample when sampling inspection is used.

29. AQL/LTPD - (1,3) - Originator - Enter AQL or LTPD number when sampling inspection is used. When AQL or LTPD varies for different characteristics inspected, enter the AQL or LTPD and sample size adjacent to the nonconformance in the "Discrepancy" block. (Example: 2.5/25; 0.1/72; etc.)

30. DISCREPANCY - (1,2,3) - Originator - Enter a description of the nonconformance. Number each discrepant condition listed so dispositioning agency has a reference number for each nonconformance.

31. QTY. (DEFECTS) - (1,2,3) - Originator - Enter the quantity of each discrepancy noted in Block 30. This quantity should be the number of times the defect occurs in each unit multiplied by the number of units in which the defect exists.

32. CODE (DEFECTS) - (1,2,3) - Originator - Enter the discrepancy code for each defect adjacent to the quantity of defects. This code is from the Quality Assurance Defect Code List.

33. REJECTED BY - (1,2,3) - Originator - Enter the signature of the individual originating the Quality Rejection Report.

34. INSP. VERIF. - (2) - Inspector - Enter the signature of the inspector verifying the rejection and the completeness and accuracy of the QRR. This entry is made only when the QRR is initiated by other than Product Integrity personnel.

35. STAMP - (1,2,3) - Inspector - The inspector signing Block 33 or 34 shall place an acceptance stamp in this block.

Figure F14. - Quality rejection report (form ANS-23) (continued)

II. PREPARATION INSTRUCTIONS (Cont.)

B. (Continued)

36. CORRECTIVE ACTION - (1,2,3) - Enter a summary of the corrective action initiated to prevent recurrence of the nonconformance.

37. EFFECTIVITY - (1,2,3) - Enter the date or unit effectivity of the corrective action.

38. SIGNATURE - (1,2,3) - Enter signature of the individual making the corrective action commitment.

NOTE: Blocks 36, 37, and 38 shall be completed by supervisory personnel of the organization responsible for producing the nonconforming material. These blocks shall be completed when the nature of the nonconformance warrants documented corrective action.

39. QAAR NO. - (1,2,3) - Quality Assurance - Enter the number of the Quality Assurance Action Report when initiated to effect corrective action.

40. DISPOSITION - (1,2,3) - Quality Review - Enter instructions for the disposition of nonconformances noted in Block 30.

41. DISPOSITION LIMITED TO ____ UNITS - (1,2,3) - Quality Review - Enter the quantity of units on which the disposition is effective.

42. SERIAL NO. OF DISP. UNITS - (1,2,3) - Quality Review - Enter serial numbers of nonconforming units on which the disposition is effective.

NOTE: Rework routing entries in Blocks 43, 44, 45, and 46 shall be entered by Quality Review and coordinated with Manufacturing Engineering when necessary to assure proper routing and sequence numbering.

43. QTY. - (2,3) - Enter the quantity of units on which each rework operation is to be performed.

44. ORGN. - (2,3) - Enter the number of the work organization responsible for performing each operation.

45. SEQ. - (2,3) - Enter the manufacturing sequence number of each operation. The first sequence number is 10 and subsequent sequence numbers are in multiples of 10. The last entry shall be Organization 5830, Sequence No. 999.

46. OPERATION - (2,3) - Enter the rework, inspection, test, etc., operations to be performed on the nonconforming unit(s).

47. WORKED BY - (2,3) - Employee completing the operation - Enter employee number or identifying stamp when operation is complete. Inspectors shall always use stamps for this entry.

Figure F14. - Quality rejection report (form ANS-23) (continued)

II. PREPARATION INSTRUCTIONS (Cont.)

B. (Continued)

48. DATE - (2,3) - Employee Completing the Operation - Enter the completion date.

49. HRS. - (Not Applicable)

50. SIGNATURE AND DATE - (1,2,3) - Authorized Materials Review Representative - Enter approval signature and date on the line appropriate to organization represented.

51. QTY. - (1,2,3) - Authorized Materials Review Representative - Enter quantity of units subject to each disposition in Column 52.

52. No Entry Required.

53. No Entry Required.

54. RWK. S/O NO. - (1,2,3) - Materials Adjustment or Manufacturing Engineering - Enter Production Order serial number when such has been initiated to authorize rework of nonconforming items.

55. REPL. P/O NO. - (1,2) - Materials Adjustment - Enter replacement purchase order number when such is issued to a supplier for replacement of nonconforming items.

56. RET. PKG. SLIP NO. - (1,2) - Materials Adjustment - Enter the Packing Slip number on which defective material was returned to the supplier.

57. MAT. ADJ. SIGNATURE - (1,2) - Materials Adjustment - Enter signature of individual authorizing Materials Adjustment action.

58. DATE - (1,2) - Materials Adjustment - Enter date of signature in Block 57.

Figure F14. - Quality rejection report (form ANS-23) (continued)

Nº 119692

QUALITY REJECTION REPORT

FAILURE AREA (Circle One) REC 1 SHOP 2 SOURCE 3

1. DATE	2. PROJ	3. PART NAME	4. SERIAL NO.	5. PART NO.	DASH	LTR

6. SUPPLIER	7. CONTRACT NO.	8. P/O NO.	9. ITEM	10. UNIT COST	11. P/P CODE	12. ACCT. NO. — DASH	13. QTY REC.

14. VENDOR CODE	15. SUPPLEMENTS QRR NO.	16. REWORK TIME Hrs Ths	17. SHOP ORDER NO.	18. SALES ORDER NO. DASH	19. SECTION NO.	20. QTY. REJ.

21. NEXT ASSY NO.	22. AFFECTED? YES___ NO___	23. RESP. ORG.	24. DISC. @ OPER. NO.	25. REJ. @ OPER. NO.	26. GFP	27. ACCUM. TIME Hrs Ths	28. SAMPLE SIZE	29. AQL/LTPD

30. DISCREPANCY

DEFECTS: 31. QTY | 32. CODE

33. REJECTED BY | 34. INSP. VERIF. | 35. STAMP

36. CORRECTIVE ACTION:

37. EFFECTIVITY | 38. SIGNATURE | 39. QAAR NO.

40. DISPOSITION

41. DISPOSITION LIMITED TO ____ UNITS | 42. SERIAL NO.s OF DISP. UNITS

REWORK ROUTING

43. QTY.	44. ORGN.	45. SEQ.	46. OPERATION	47. WKD. BY	48. DATE	49. HRS.

DISPOSITION SUMMARY & APPROVAL

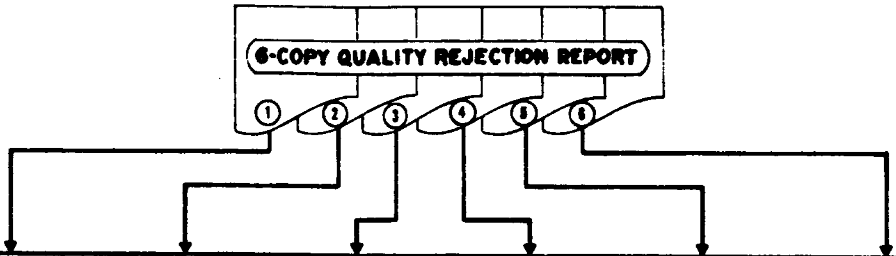
50 SIGNATURE AND DATE	51. QTY.	52. DISPOSITION	53. CODE
ENGINEERING		OK AS IS	1.
QUALITY ASSURANCE		RWK TO SPEC	2.
CUSTOMER		RWK TO INST	3.
ASSOCIATE CONTRACTOR		SCRAP	4.
		RET TO VEND	5.

54. RWK NO. | 55. REPL. P/O NO. | 56. RET SHIP NO.

57. MAT. ADJ. SIGNATURE | 58. DATE

ANS 23 (REV 6-1-64)

Figure F14. - Quality rejection report (form ANS-23) (continued)



(1) WHITE	(2) GREEN	(3) YELLOW	(4) GOLDENROD	(5) PINK	(6) HARD BUFF
1 RECEIVING INSPECTION REJECTIONS					
REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO MATERIALS REVIEW RECORDS.	REMAINS WITH NONCONFORMING ITEM UNTIL THE DISPOSITION HAS BEEN AUTHORIZED. RECEIVING INSPECTION ATTACHES IT TO THE QUALITY ASSURANCE COPY OF THE RECEIVING REPORT AND FORWARDS IT TO QUALITY RECORDS FOR THE SUPPLIER RECORD FILE.	REMAINS WITH NONCONFORMING ITEM UNTIL THE DISPOSITION HAS BEEN AUTHORIZED. MATERIALS REVIEW FORWARDS THIS COPY TO QUALITY ASSURANCE CLERK OR QUALITY ANALYSIS, AS APPLICABLE, FOR SUPPLIER CORRECTIVE ACTION.	REMAINS WITH NONCONFORMING ITEM UNTIL THE DISPOSITION HAS BEEN AUTHORIZED. IT IS THEN RETURNED TO RECEIVING WITH THE RECEIVING REPORT AND FORWARDED TO MATERIALS ADJUSTMENT, THEN TO PURCHASING. PURCHASING FORWARDS IT TO RECEIVING FOR TYPING OF REPLACEMENT PURCHASE ORDER OR TO PRODUCTION CONTROL TO OBTAIN WORK ORDER AS APPLICABLE. RECEIVING RETURNS IT TO PURCHASING TO COMPLETE TRANSACTION.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED. RETURNED TO RECEIVING WITH RECEIVING REPORT AND FORWARDED TO PRODUCTION CONTROL. PRODUCTION CONTROL RETURNS TO RECEIVING INSPECTION FOR FILING.	REMAINS WITH NONCONFORMING ITEM UNTIL THE DISPOSITION HAS BEEN AUTHORIZED. RETURNED TO RECEIVING WITH THE RECEIVING REPORT. RECEIVING FORWARDS TO MATERIAL RELEASE.
2 SHOP INSPECTION REJECTIONS					
REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION AND ROUTING HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO MATERIALS REVIEW RECORDS.	RETAINED BY QUALITY ASSURANCE WHEN THE DISPOSITION IS AUTHORIZED AND SIGNED OFF BY MATERIALS REVIEW & REWORK ROUTING IS ENTERED. QUALITY ASSURANCE MATERIALS REVIEW REPRESENTATIVE FORWARDS THIS COPY TO QUALITY RECORDS. WHEN DISPOSITION IS "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY TO QUALITY RECORDS FOR SUPPLIER RECORD FILE.	RETURNED TO PRODUCTION CONTROL WITH NONCONFORMING ITEM AFTER DISPOSITION HAS BEEN AUTHORIZED AND REWORK ROUTING ENTERED. PRODUCTION CONTROL FORWARDS TO MATERIAL RELEASE. WHEN DISPOSITION IS, "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY TO MATERIAL CONTROL.	RETURNED TO PRODUCTION CONTROL WITH NONCONFORMING ITEM AFTER DISPOSITION HAS BEEN AUTHORIZED AND REWORK ROUTING ENTERED. PRODUCTION CONTROL FORWARDS TO MANUFACTURING COST CONTROL. WHEN DISPOSITION IS, "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY WITH ITEM TO RECEIVING.	REMAINS WITH NONCONFORMING ITEM UNTIL LAST INSPECTION ROUTING HAS BEEN ACCEPTED. INSPECTOR FORWARDS TO QUALITY RECORDS FOR UNIT INSPECTION RECORDS. SHOULD BE ATTACHED TO GREEN SHOP ORDER WHEN OPEN SHOP ORDER IS AVAILABLE. WHEN DISPOSITION IS, "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY WITH ITEM TO RECEIVING.	SHOP TRAVELER - REMAINS WITH NONCONFORMING UNIT UNTIL WORK IS COMPLETE. RETAINED BY PRODUCTION CONTROL AS MANUFACTURING RECORD. PRODUCTION CONTROL SHALL ADVISE MANUFACTURING COST CONTROL OF COMPLETION OF SHOP AND INSPECTION EFFORT. WHEN DISPOSITION IS, "RETURN TO VENDOR", PERSON MAKING DISPOSITION FORWARDS THIS COPY WITH ITEM TO RECEIVING.
3 SOURCE INSPECTION REJECTIONS					
REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION AND ROUTING HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO MATERIALS REVIEW RECORDS.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION AND REWORK ROUTING HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO QUALITY RECORDS.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN ACCOMPLISHED. MAY BE USED AS A COORDINATION COPY PROVIDING IT IS CONTROLLED TO THE EXTENT THAT IT DOES NOT FAIL TO BE DISPOSITIONED WITH OTHER COPIES. AFTER DISPOSITION, THIS COPY IS FORWARDED, BY THE PERSON MAKING THE DISPOSITION, TO PURCHASING.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED. PERSON MAKING DISPOSITION FORWARDS THIS COPY TO PRODUCTION CONTROL FOR INFORMATION AND FOLLOW-UP. PRODUCTION CONTROL FORWARDS THIS COPY TO MANUFACTURING COST CONTROL.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED, REWORK HAS BEEN ACCOMPLISHED AND THE ITEM HAS BEEN INSPECTED AND ACCEPTED BY INSPECTION. SOURCE INSPECTOR FORWARDS THIS COPY TO QUALITY RECORDS.	REMAINS WITH NONCONFORMING ITEM UNTIL DISPOSITION HAS BEEN AUTHORIZED, REWORK HAS BEEN ACCOMPLISHED, AND THE ITEM HAS BEEN INSPECTED AND ACCEPTED BY INSPECTION. SOURCE INSPECTOR GIVES THIS COPY TO THE SUPPLIER FOR HIS RECORDS.
4 MAJOR SUBCONTRACTOR					
REMAINS WITH NON-CONFORMING ITEM UNTIL FINAL DISPOSITION HAS BEEN AUTHORIZED. PERSON MAKING FINAL DISPOSITION FORWARDS THIS COPY TO MATERIAL REVIEW RECORDS.	REMAINS WITH NON-CONFORMING ITEM UNTIL FINAL DISPOSITION HAS BEEN AUTHORIZED. RECEIVING INSPECTION FORWARDS THIS COPY TO QUALITY RECORDS FOR MAJOR SUBCONTRACT SUPPLIER RECORD FILE.	REMAINS WITH NON-CONFORMING ITEM UNTIL FINAL DISPOSITION HAS BEEN AUTHORIZED. RECEIVING INSPECTION FORWARDS THIS COPY TO SUBCONTRACT ADMINISTRATOR.	REMAINS WITH NON-CONFORMING ITEM UNTIL FINAL DISPOSITION HAS BEEN AUTHORIZED. RECEIVING INSPECTION FORWARDS THIS COPY TO RECEIVING.	REMAINS WITH NON-CONFORMING ITEM UNTIL FINAL DISPOSITION HAS BEEN AUTHORIZED. RECEIVING INSPECTION FORWARDS THIS COPY TO SUBCONTRACT ADMINISTRATOR.	REMAINS WITH NON-CONFORMING ITEM UNTIL FINAL DISPOSITION HAS BEEN AUTHORIZED. RECEIVING INSPECTION FORWARDS THIS COPY TO SUBCONTRACT ADMINISTRATOR.

Figure F14. Quality rejection report (form ANS-23) (concluded)

NORTHROP CORPORATION | **Corporate Executive Bulletin**

Subject: QUALITY AUDIT

No: 47

Date: 8 September 1964

I. In furtherance of the objectives of Corporate Policy Directive No. 38, "Quality and Reliability", and in conformance with Procurement Specifications NASA - NPC200-2 and Mil Q 9858A and Mil Q 21549 A and B, a uniform program of performing Quality Audits within the Quality Control organization is established to promote efficiency in determining the conformance of Northrop product to plans and specifications and compliance of operating personnel with established systems and procedures.

II. All Quality Audits performed by a Division or Northrop Space Laboratories shall be in accordance with the basic requirements of the Northrop Quality Audit Manual, unless other methods are specified under the terms of a particular contract.

III. Each Division and Northrop Space Laboratories shall develop procedures to implement the Quality Audit program set forth in the Northrop Quality Audit Manual.

IV. The Quality Audit function shall report to the highest Quality Control management level within each Division and Northrop Space Laboratories.

V. Changes to the Northrop Quality Audit Manual shall require the concurrence of all Divisions and Northrop Space Laboratories.

VI. Responsibility for monitoring the effectiveness of the program to establish a uniform method of performing Quality Audits throughout the corporation is assigned to the Technical Advisory Council on Quality and Reliability established by Corporate Policy Directive No. 38.

Wm F. Ballhaus

William F. Ballhaus
Executive Vice President

Figure F15. Quality audit

IMPLEMENTATION INSTRUCTIONS FOR THE
NORTHROP QUALITY CONTROL AUDIT PROGRAM

I. PURPOSE:

To define a uniform system of implementation for the Northrop Quality Audit Program which has been established by Corporate Executive Bulletin No. 47.

II. DISCUSSION:

A. The extent to which the Northrop Quality Audit Program is implemented shall be determined by each Division. The program adopted by each Division shall adhere to the basic requirements presented in this document.

B. The Quality Audit Program shall meet the following objectives:

1. Assess the effectiveness of management at the operating levels in the administration of all quality control disciplines.

2. Assess the adequacy of the quality control system.

3. Provide management with program visibility through issuance of periodic summary reports.

III. DEFINITIONS:

A. Systems Audit - The phrase "systems audit", as used in this document, indicates a type of audit which evaluates the adequacy of authoritative procedures and assesses the compliance of operating personnel with applicable procedures.

1. Audit assignments shall be conducted by supervisory or senior type Quality Control personnel. To preclude self audit, auditors shall be issued assignments in areas other than those in which they are assigned organizationally.

B. Product Audit - The phrase "product audit", as used in this document, indicates a type of audit which is used to verify the adequacy of quality plans and product compliance to specifications.

1. Audits shall encompass reinspection of work previously accepted by Quality Control, verification of product compliance to specification, and an evaluation of the adequacy of the associated acceptance documents.

2. Audits shall be performed by auditors with experience and familiarity with the particular product line selected for audit.

3. Audit specimens shall be selected on a random basis.

IV. GENERAL

A. Quality Audit activities shall be directed by the highest level of Quality Control management within each Division.

Figure F15.–Quality audit (continued)

B. Audit areas shall be established in each Division for the purpose of planning Quality Audit Instructions on a functional basis for each area.

C. An Audit Matrix shall be utilized to provide a means of collectively listing all functions of the Quality Audit program to provide thorough coverage, achieve program visibility and to identify each operational area affected. Each function listed on the matrix shall be analyzed to determine applicable control documents and specifications. The control documents for each function under audit shall be analyzed:

   1. For critical or pertinent requirements to be audited.

   2. To determine special instructions and references to be utilized in Audit Instructions to insure performance of an objective audit.

D. The Quality Audit system in each Division shall include a form for assignment of Auditing Instructions. This form shall include:

   1. The function or product to be audited.

   2. Applicable documents (primary and referenced) and specifications required to control the function or product in the audit area. Specific paragraphs of the controlling documents, plans or specifications shall be outlined on the form as audit tasks. The form shall indicate the status of each task as either Satisfactory or Deficient and include provisions for the auditor's signature.

E. The Quality Audit System shall provide a form for reporting of deficiencies by the auditor and for indicating corrective action taken for deficiencies reported.

F. An Audit Assignment Folder shall be provided and shall contain sections for the following:

   1. Quality Audit procedures.

   2. Audit Instructions.

   3. Blank forms for reporting deficiencies.

   4. Procedures required for audit assignment.

G. The Quality Audit program shall provide data which can be used to reflect results of Quality Audits relative to procedural and personnel compliance.

H. Quality Audit quarterly summary reports shall be submitted to the highest level of Quality Control Management in each Division.

Figure F15.-Quality audit (continued)

QUALITY AUDIT INSTRUCTION
FORM 27-082 (R.6-68)

AREA ITEM NO. B-5-2

PAGE 1 OF 1

FUNCTION	PRIMARY	REFERENCE
Machine Parts Inspection	SPM I-1	SPM's I-3, I-4, I-5, G-21 & R-4

ASSIGNED TO	ORGN. NO.	DATE	AREA ANALYZED	AUDITOR'S SIGNATURE AND DATE OF COMPLETION
A. Kendall	7050	8-20-3	Tooling & Fabrication Branch Plant 1	A. H. Kendall 8/29/63

TASK NO.	AUDIT TASK	S	D
1.	Verify organizational compliance to SPM I-1, Para. II.B. & C., regarding the removal of Inspection stamps from parts and applying stamps to split orders.	X	
2.	Verify organizational compliance to SPM I-5, Para. III.I., regarding the use of IAR & DCR for correction of errors resulting from "Proto-Part" inspection.		X
3.	Verify organizational compliance with SPM G-21, Para. III.B.6., stating that the Machine Parts Inspection group shall perform periodic surveillance checks of cutter crib, repair crib and the shop. Evidence of improper storage, handling or identification of cutters and inadequate records will be brought to the attention of the responsible supervisor for corrective action.		X

Figure F15.- Quality audit (continued)

QUALITY AUDIT DEFICIENCY REPORT
Form [illegible]

AREA ITEM NO. B-5-2

FUNCTIONS	PRIMARY	AREA ANALYZED
Machine Parts Inspection	SPM I-1	Tooling & Fabrication Branch Plant 1

AUDITOR'S REPORT

Task #2 SPM I-5 procedure should be revised to reflect the use of C.A.R. (Corrective Action Request) Forms, as referenced are obsolete for correction of errors.

Task #3 Periodic surveillance records show a "past date" condition for surveillance, for months of June and July.

AUDITOR	DATE
A. W. Kendall	29 August 1963

CORRECTIVE ACTION

Task #2 Referenced forms are used within the limitation of SPP 9-7.2. SPM I-5 procedure is in process of revision.

Task #3 August surveillance was conducted on 30 August 1963. Surveillances will be controlled from Orgn. 7330 office in the future.

APPROVED BY: (CHIEF)	DATE
[signature]	5 September 1963

Figure F15.- Quality audit (continued)

NORTHROP NORTRONICS	PAGE 1 OF 3	NUMBER QA-14.3
PRODUCT INTEGRITY PROCEDURE	DATE 4/1/66	REVISION
	SUPERSEDES	

SUBJECT

NONCONFORMING MATERIAL

I. PURPOSE

To define the methods and responsibilities for performing Materials Review on nonconforming material.

II. GENERAL

A. This establishes a Materials Review Board for review and disposition of nonconforming materials with a voting membership as follows:

Quality Assurance Representative - Chairman

Engineering Representative

Customer or Government Representative having acceptance authority

B. Members of the Board may call on other Nortronics, customer, or government personnel to act in an advisory or consultant capacity. These personnel shall have no vote in Board proceedings.

C. Disposition of the Materials Review Board which may have an appreciable effect on schedule or cost shall be coordinated with Production Control prior to the formal disposition.

D. In addition to the Quality Assurance personnel which are assigned Materials Review responsibilities, each Inspection supervisor may act as the Materials Review Representative over their respective area of responsibility.

III. RESPONSIBILITIES

A. Engineering representatives shall be responsible for:

1. Providing such details of engineering analysis as is required by other members of the Board and for documenting his recommendation for disposition.

2. Coordinating problems and dispositions with the responsible design agencies when design deficiencies are noted.

3. Assisting Quality Assurance, when requested, in making decisions relative to nonconforming workmanship.

B. Quality Assurance shall be responsible for:

1. Implementation and administration of systems for withholding, segregation, and disposition of nonconforming materials.

2. Assuring that nonconformances are accurately recorded in order to enable proper evaluation by Board members.

3. Disposition of discrepancies regarding workmanship.

4. Obtaining Engineering disposition on design or performance deficiencies.

5. Obtaining Reliability Assurance disposition on materials, process, and electrical or electronic part discrepancies.

Figure F16. - Nonconforming material

III. PROCEDURE (Continued)

B. (Continued)

6. Disposition of discrepancies of the categories of 4 and 5 above that are of a repetitive nature and for which a proper disposition has been well established by Engineering through previous dispositions.

7. Initiating Materials Review Board meetings for dispositions which result in an effect on fit, function, interchangeability, or configuration.

8. Maintaining a permanent record of all Materials Review action.

9. Assuring that corrective action is initiated on critical or chronic conditions.

10. Advising Reliability Assurance of the existence of initiated Failure Reports.

11. Coordination of all Materials Review activities with customer and government Quality Assurance representatives.

IV. PROCEDURE

A. When parts or material is first found to depart from specifications or drawings, the discrepant item shall be identified and diverted from normal flow by the attachment of a Quality Rejection Report; Failure Report; Quality Hold Tag; Quality Record; or by writing a squawk on accompanying work authority documents.

1. Discrepancies shall be written in a clear and concise manner listing location and amount of variation from specified requirements.

2. The discrepant item with the rejection document shall be referred to Inspection personnel for verification and discrepancy analysis.

3. Discrepancy analysis inspectors shall be responsible for obtaining corrective action commitments from responsible supervisory personnel prior to submitting items to Materials Review for disposition.

4. After verification and analysis, parts shall be forwarded for disposition.

B. Discrepancy Analysis (D.A.) inspectors may disposition the following without submission to Materials Review.

1. "Complete or Rework to Specification".

2. "Acceptable As Is" when the discrepancy is of a workmanship nature, noncritical or chronic, and which may actually further degrade the quality of the hardware if worked.

3. "Rework to Standard Repairs" or "Rework to Instructions" on manufacturing in-line items providing concurrence of the affected engineering agency is obtained.

4. "Scrap" if supplies are obviously unfit for use or are found to be uneconomically repairable.

NOTE: Certain "rework to specification" discrepancies may not warrant correction due to schedule, cost, or reliability factors. These items may be referred to Materials Review for subsequent processing.

Figure F16. - Nonconforming material (continued)

V. <u>PROCEDURE</u> (Continued)

C. Quality Assurance Materials Review personnel shall perform the following operations:

1. Analyze all discrepancies and determine disposition authority needed.
2. Refer items requiring Materials Review Board action to Quality Assurance supervision.
3. Disposition discrepancies in accordance with previously established dispositions made by the Materials Review Board or in conjunction with engineering agencies providing the nonconformances are similar in nature and have previously been determined to have no effect on safety, performance, interchangeability, or reliability.
4. Obtain dispositions from Liaison Engineering on items containing discrepancies affecting design.
5. Obtain dispositions from Reliability Assurance on materials, process, or component part deficiencies.
6. Disposition as "scrap" those supplies obviously unfit for use or that are found to be uneconomical to repair.
7. Positively identify scrapped items so as to preclude the possibility of being used. Scrapped parts may be "R" stamped or painted with Fire Red Fluorescent Paint and released to Engineering as requested for breadboard or development purposes.
8. Sign concurrence with all dispositions made on rejecting documents submitted to Materials Review assuring complete and explicit instructions.
9. Assure that immediate action is, or has been, taken to prevent recurrence of the discrepancy.
10. Maintain all records prepared during the review process or which provided information used as a basis by Materials Review for making decisions.
11. Dispose of parts removed by engineering change and submitted on "Parts Disposal Envelop", Form No. 1465. Such parts shall normally be scrapped but shall not be included in scrap cost analyses.

A. B. Lipscomb
Chief, Product Integrity

Figure F16. Nonconforming material (concluded)

APPENDIX G
MANUFACTURING PLAN

INTRODUCTION

This Manufacturing Plan describes the objectives, approach, and detailed plan for the manufacturing planning, schedules, procurement, operations, controls, and documentation tasks which will be required of the prime contractor to fabricate, assemble, and integrate systems of development and deliverable end items for the NASA Orbiting Experiment for Study of Extended Weightlessness. It also includes planned actions and controls relative to fabrication of mock-ups, breadboard electronics, test specimens and tooling.

The Plan presented is subdivided into Manufacturing, Facilities and make or Buy. These three principal categories are described in the following paragraphs.

Manufacturing

This category covers a description of the configuration and deliverable end items, along with organization, schedules, tooling, operational procedures, and restrictions which will assure compliance with design specifications, acceptable manufacturing practices, and program objectives.

Facilities

This category describes electronic and mechanical manufacturing equipment and capabilities recommended for the fabrication of components and subsystems. It also includes quality assurance, system integration, and test facilities required to accomplish the work tasks dictated by the design configuration and specifications.

Make or Buy

This category describes the policy governing Make or Buy decisions and recommended Make or Buy List, categorized by subsystems and components in accordance with the Configuration Tree Charts included as part of this plan.

SCOPE

The Manufacturing Plan will be implemented to satisfy all objectives for the following scope of work.

Phase 2

The prime contractor shall plan and provide for adequate facilities and personnel to breadboard and test critical electronic and mechanical components and subsystems in support of engineering detailed definition of the Orbital Primate Spacecraft system design. Likewise, fabrication facilities and personnel shall be furnished to build and maintain, in current configuration, a full-scale soft mockup model of the complete spacecraft incorporating all subsystems. This mockup being required to verify fits, clearances and interfaces in the final design of the spacecraft subsystems and integrated system configuration.

Laboratory Test Model (LTM)

The prime contractor shall provide facilities and personnel to produce components, fabricate, assemble, and acceptance test an integrated laboratory model, incorporating prototype life supporting subsystems, which will sustain two primates with implanted sensors, in an isolated environment which simulates that expected during space flight (except for gravity) for a period of one year.

Upon NASA acceptance and delivery of the LTM and associated support equipment to the Naval Aerospace Medical Institute (NAMI), Pensacola, Florida; the prime contractor shall furnish personnel and hardware spares, to sustain and maintain the operation of the LTM system; supporting the Principal Investigator and his staff in the conduct of the laboratory test which will simulate the orbital flight experiment, using two Macaca mulatta monkeys.

Phase 3

On completion of final design, and NASA approval of base-line configuration and master end item specifications, the Manufacturing Plan for Phase D of the OPS Program shall provide for all prime contractor and subcontractor manufacturing capabilities and functions encompassing the fabrication, assembly, checkout of development hardware, test components and subsystems, and the manufacture, acceptance test, qualification, and delivery of integrated flight spacecraft systems, spares and ground support equipment to assure the successful conduct of the Orbiting Experiment for Study of Extended Weightlessness, using two Macaca mulatta (Rhesus) monkeys as the experimental subjects. In addition, the prime contractor shall provide a Spacecraft Simulator (to be retained at his facility) and a Spacecraft Trainer.

DESCRIPTION OF DELIVERABLE SYSTEMS

Spacecraft Mockup Model

The spacecraft Mockup Model shall be a full-scale soft model, constructed of wood, plastics, and metals as deemed necessary, duplicating the prototype spacecraft system in all respects relative to fit and form. Where feasible, structural bulkheads and shell shall be fabricated of transparent plastics to provide interior visibility. The mockup will incorporate readily removable panels for accessibility to internal areas. However, the configuration of all parts and access doors included in the prototype configuration shall be duplicated, as designed.

As Phase 3 fabrication progresses, development or reject structural members and components may be used to replace mockup units, proving they satisfy the external fit and form criteria of the latest configuration. Electrical connectors preferrably shall be hard goods, having the same number of pins and external configuration as the prototype system, to provide appropriate interface for layout of electrical cabling and harnesses. Similarly, all plumbing connections shall duplicate the fit, form and orientation of those used on the prototype system, to provide means of verifying bends, lengths and clearances when connected. All subsystems and structure framing shall be appropriately color coded and painted to provide visual ease of identification and traceability of subsystems.

Laboratory Test Model (LTM) and Support Equipment

The LTM will contain all of the equipment that normally interfaces with the primate during actual space flight and will be used to provide uninterrupted life support to two animals for one year. Thus it will accommodate supplies of expendables and consumables sufficient for this period of time.

The fabricated LTM shall comply with configuration provided by design drawings and Master End Item Specification CP20000 Laboratory Test Model (NSL 67-323). Figure G1 shows the general layout of the installed LTM. This illustration includes the pressure vessel on its support platform with piped expendible supplies which include oxygen, nitrogen and water, stored in suitable containers on weight scales adjacent to the pressure vessel. Also shown is the command and control console. A Behavioral Control Interface Unit will be incorporated in this console to accommodate interface with a government furnished 418 computer and relay rack, for behavioral task monitoring and control.

The LTM System Configuration will consist of three major categories:

(1) Pressure Vessel
(2) Command and Control Console
(3) Support Platform, Electrical Cabling and Handling Equipment

A description of the major components included in each category follows:

Pressure vessel. - The basic mechanical layout of the pressure vessel is shown in figure G2. The primary feature of this design is the complete accessibility of all components, including the primates, while the test is in progress. This will be accomplished through the use of flat-sided pressure shell walls, quick-insert solid orifice plates and hand-inserted rubber plugs to temporarily close pressure shell openings left by the removal of system components.

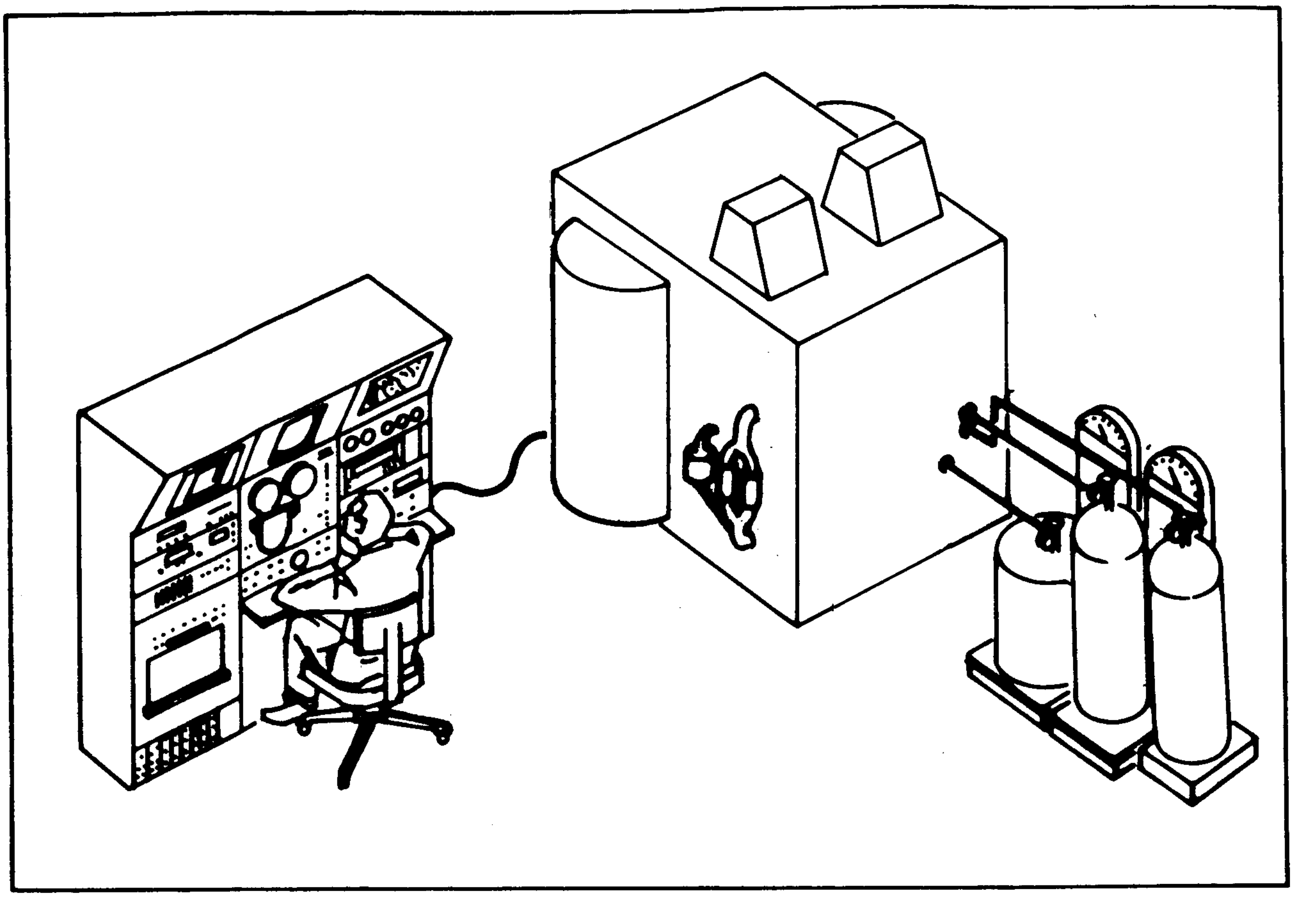


Figure G1. - Laboratory test model installation

The unit contains the following assemblies and major components:

(1) Structure and Mechanical

Pressure Shell
Life Cell
Television Cameras and Microphones
Mass/Measurement Device
Behavioral Panels
Insulation Panels (external)

(2) Feeder

(3) Waterer

(4) Environmental Control Unit

(5) Waste Management Unit

(6) Recovery Capsule

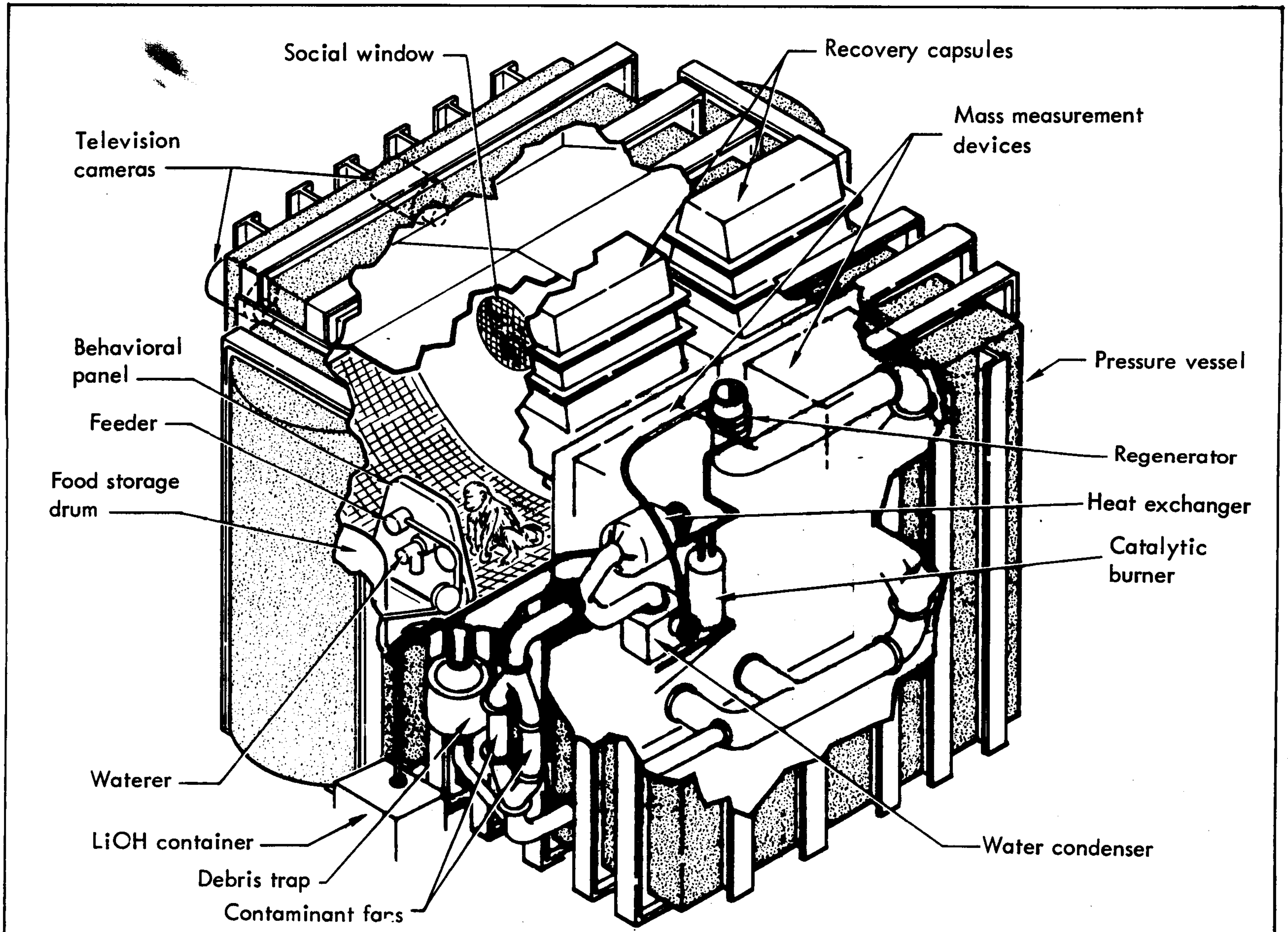


Figure G2. - Pressure vessel

(7) Electrical Subsystems

Command and control console. - This console incorporates all the electronic equipment not normally a part of the Pressure Vessel. It also contains all power supplies, controls, instrumentation recorders and displays essential for one man to monitor the experiment. Figure G3 illustrates the general arrangement of instrumentation to be provided in the console.

Cabling, handling equipment and support platform. - Cabling connections will include electrical power and signal interface between the Pressure Vessel, Command and Control Console and the computer. Handling equipment will include special slings to handle experiment hardware. The support platform will be provided to support the pressure vessel during experiment operation.

FLIGHT SPACECRAFT AND SUPPORT EQUIPMENT

The design, construction and performance requirements for the Orbiting Primate Spacecraft and associated support equipment are definitized in Master End Item Specification CP10000 Orbiting Primate Spacecraft (NSL 67-320). The deliverable flight spacecraft will be a completely integrated assembly incorporating all structural, environmental control, electronic and mechanical requirements of the CSM interface and the NASA Experiment for Study of Extended Weightlessness.

The flight system is subdivided into eight major subsystems which are as follows:

(1) Life Support
(2) Thermal Control
(3) Structural and Mechanical
(4) Instrumentation
(5) Telemetry
(6) Command and Control
(7) Electric Power and Cabling
(8) Attitude Control

Figures G4 and G5 illustrate the general configuration of the Flight Spacecraft.

LIST OF DELIVERABLE PRODUCTS

Phase 2 and LTM Deliverable Products

Phase 2 of the OPS Program and the LTM provide for the manufacture and test of the following deliverable end item products:

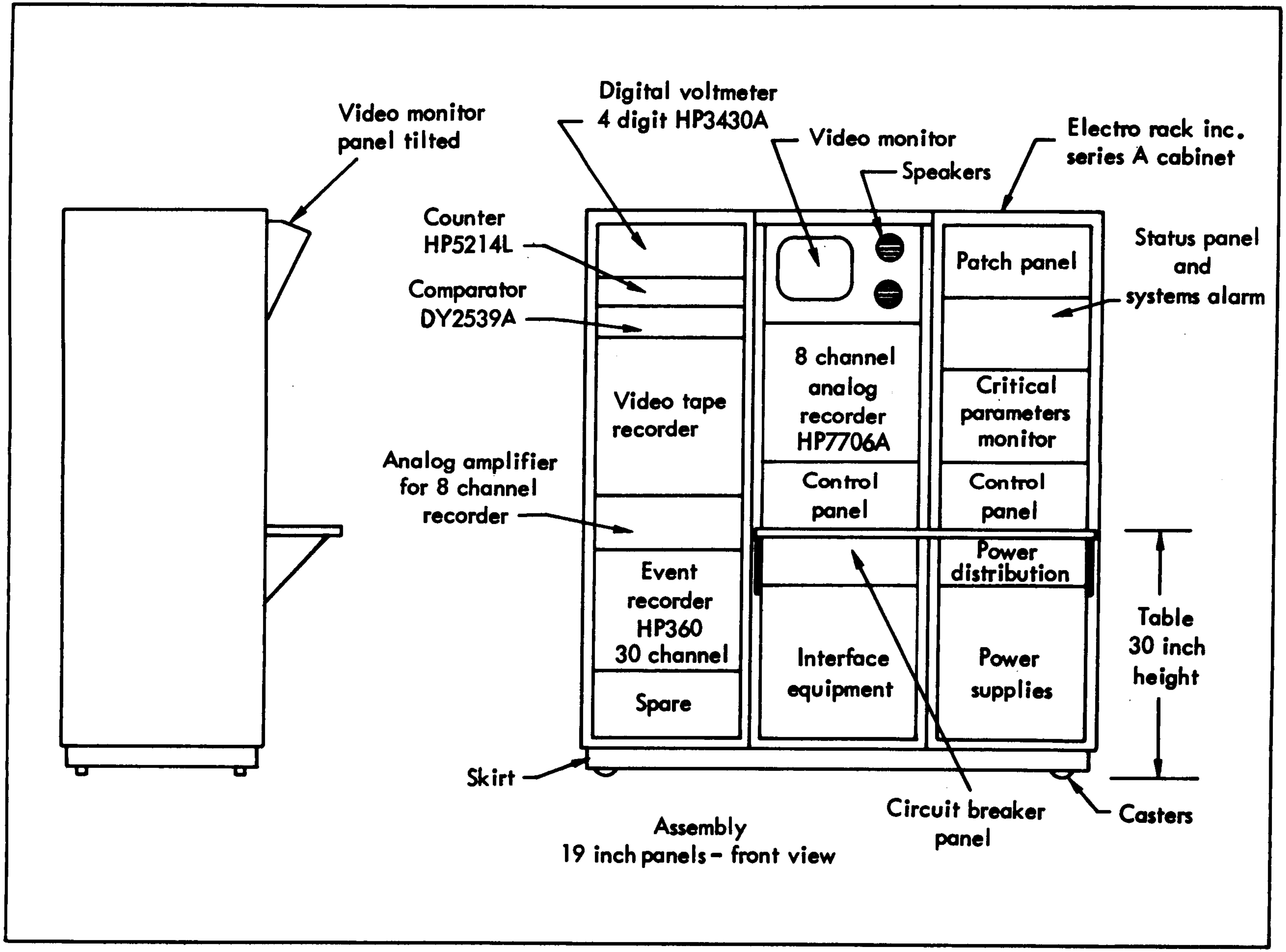


Figure G3. - Command and control console

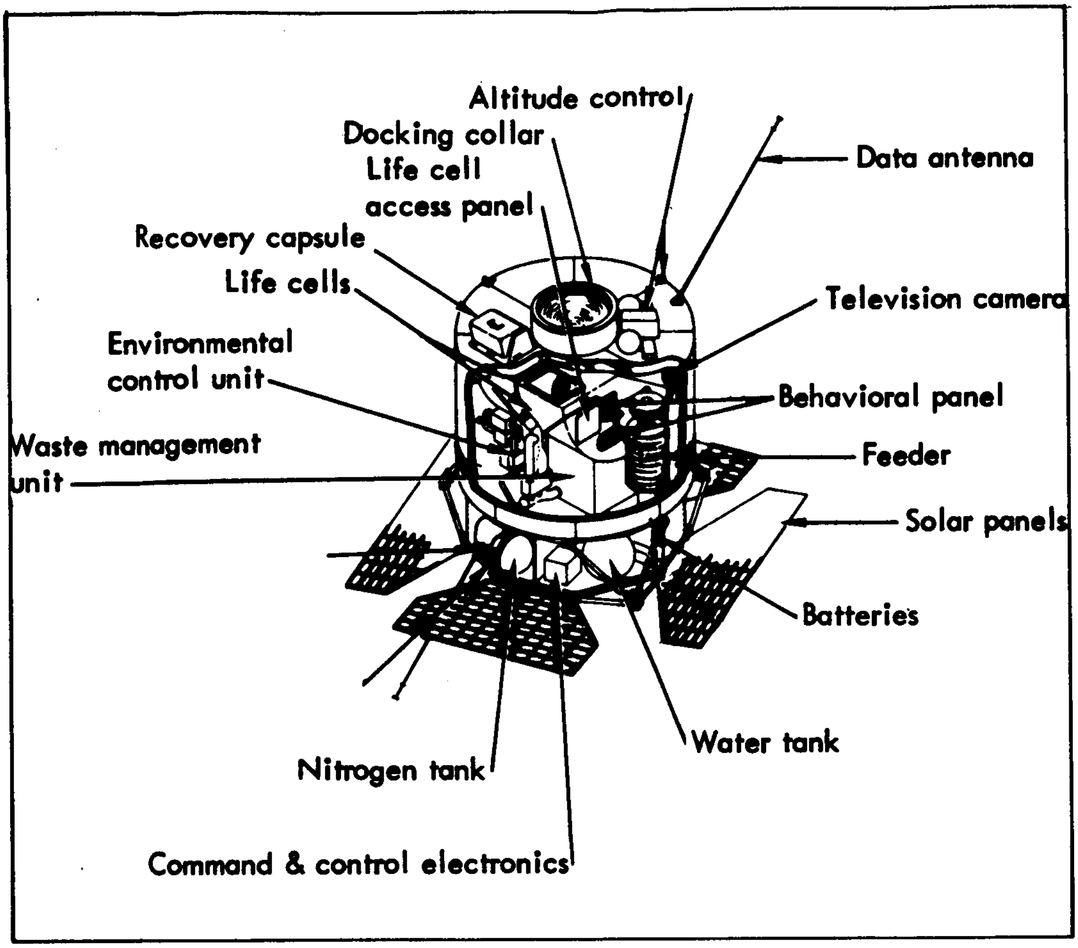


Figure G4. -Primate spacecraft configuration

(1) Spacecraft Mockup
(2) Laboratory Test Model and Support Equipment
(3) Set of spares for the LTM
(4) Set of tooling for the LTM

Spacecraft mockup. - The configuration and construction of the spacecraft mockup has been described above under Description of Deliverable Systems. This deliverable item will be retained at the prime contractor's facility until completion of the program, at which time disposition will be in accordance with NASA directive.

Laboratory model and support equipment. - The configuration of the LTM and associated support equipment has been previously described under Description of Deliverable Systems. The Make or Buy List-Laboratory Test Model (Drawing No. 148-20001) and subsystems constitute the LTM. This complete system will be packaged and delivered to NAMI, Pensacola, Florida to inititate the Laboratory Test Program.

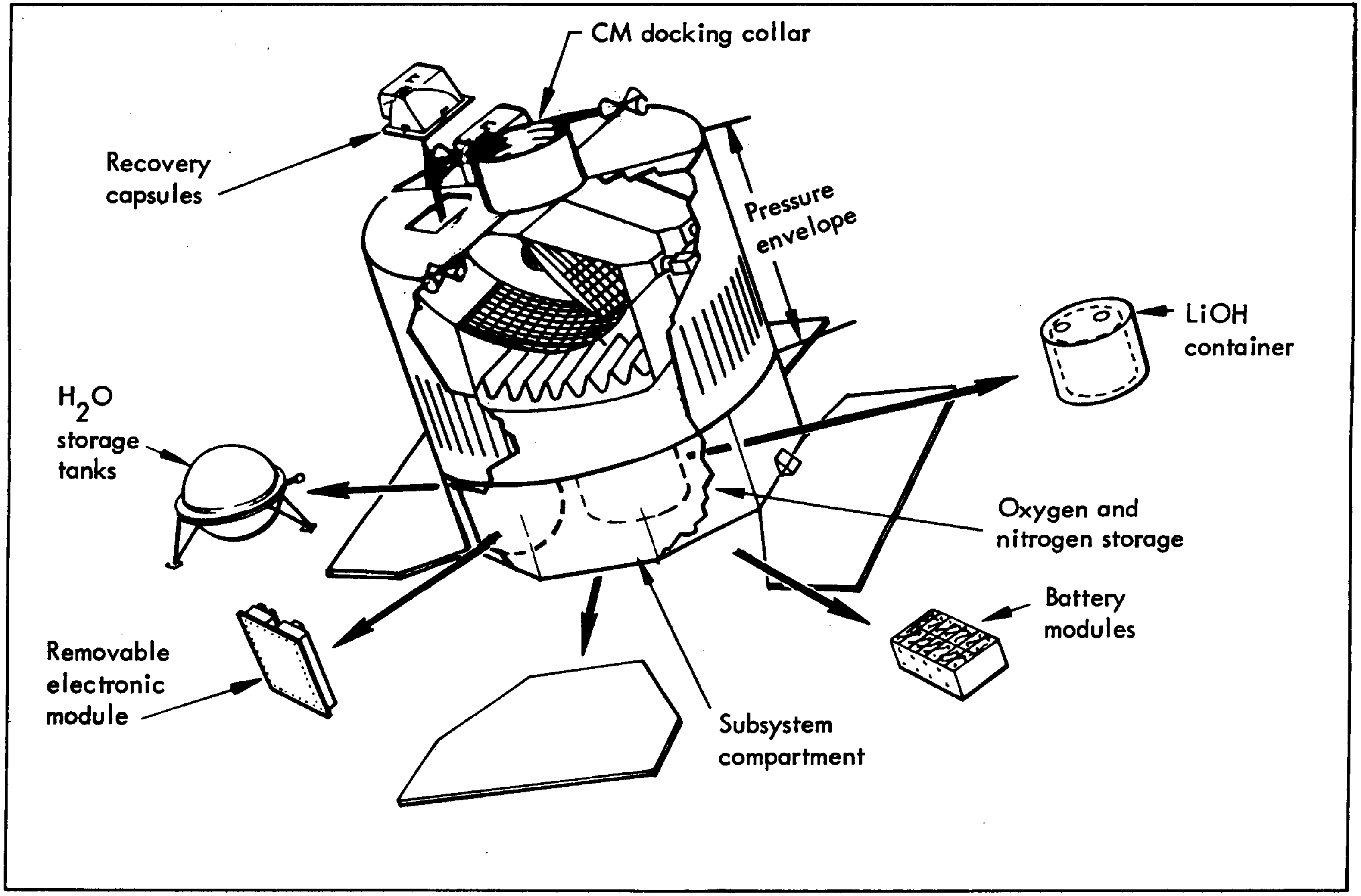


Figure G5.—Primate spacecraft configuration

Spares for the laboratory test model and support equipment. - The Laboratory Test Model will be operated for a period of one year. To assure operability of this development equipment, during the course of its operating period, spares as shown in table G1 will be provided for critical components, which are not readily available, and the failure of which can abort the experiment. In effecting this policy, spare parts will not be furnished for any of the commercial instrumentation provided in the Command and Control Console, except for a few critical redundant components.

TABLE G1. - LIST OF ANTICIPATED SPARES REQUIRED FOR THE LTM

Item number*	Quantity	Description
1100.0--Environmental Control and 1200.0 Waste Management Units		
1.2	1	Circulation Fan
1.6	1	Contaminant Fan
1.14	6	Lithium Hydroxide (Cartridge only)
1.19	2	Ultraviolet Light
1300.0--Life Cell		
1300.6	8	T-5 Flourescent Light (Tubes only)
1400.0--Feeder		
1400.1.1	1	Gearmotor, Planetary, No. 102A190-9, 306:1, 27 vdc
1400.2.2	4	Ball Bearings, Sealed, No. AN KP-8A
1400.4.2	1	Gearmotor, Planetary, No. 193-11, 941:1, 27 vdc
1400.5.1	2	Switch
1400.6.1	4	Ball Bearing, Sealed, No. AN KP-10A
1400.6.2	1	Torque Motor, 1.5 ft/lb, 28 vdc
1400.8.1	4	Ball Bearing, Sealed No. AN KP-4A
1400.8.2	2	Limit Switch, 4 MTR

TABLE G1. - Concluded

Item number*	Quantity	Description
1400.8.3	2	Linear Ball Bearing, No. A-B1420
1400.9.1	55,000	Food Pellets
1400.9.2	2,200 feet	Zipper Tubing, No. ZT-0500-63-20-B
1500.0--Waterer		
1500.2.2	2	Gearmotor, Planetary, 102A 193-10, 941:1, 27 vdc
1500.2.3	4	Ball Bearing, Sealed, SR4PP
1500.2.6	2	Switch
1600.0--Behavioral Panel		
1600.1.3	4	Micro Switch, No. 11 SM23
1600.1.5	3	Lever Enclosure
1600.1.6	6	Lights, T - 1 3/4 - 11 C-2F B1 - PIN, 28 vdc
	24	Lamp, GE No. 7387
4300.0--Activity Counter		
4300.0	1	Monkey Motion Monitor
6000.0--Command and Control		
6200.2.2	1	Biotelemetry Signal Selection Box
6300.6	6	Manual Switches
6700.0	1	Behavioral Control Interface Unit

*Refers to item numbers shown on the Equipment Description List-Laboratory Test Model located in the attached drawing package.

Tooling for the laboratory test model. - The manufacture and test of most components and subsystems, which are integrated into the LTM and support equipment, can be accomplished using conventional equipment and shop aids. Manufacturing tooling will be kept to a minimum and will be limited to compliance with those fit, form and shape criteria which cannot be accomplished solely with conventional manufacturing equipment. Accordingly, all special purpose tooling, designed and fabricated specifically for this program, will be identified by tooling numbers and, at completion of the program, will constitute deliverable hardware available for disposition as directed by NASA, with waiver of delivery inspection.

Tooling Policy and Requirements include a list of the major tooling which will be required for the fabrication and test of the Laboratory Test Model.

Phase 3 Deliverable Products

Phase D of the OPS Program, defined under the scope paragraph of this document, provides for the manufacture and test of deliverable end item products which are described in detail within the following paragraphs.

Development hardware. - This includes all development components and subsystems required to test verify design criteria and the fit, form and function of baseline configuration. Such hardware are primarily provided only for those components which are newly designed for this program and have no prior qualification or operational history.

Qualification test components. - Where the flight spacecraft approved configuration specifies components which have not previously been space qualified, two sets of such components (manufactured with production tooling in accordance with the flight article production methods) will be provided by the prime contractor, subcontractors and/or suppliers, for component qualification testing. Each unit furnished for this purpose will have satisfactorily completed flight article acceptance tests. One unit of each article to be qualified will be subjected to design limit tests. The second unit will be subjected to endurance tests. Further details of the administration and performance of component qualification tests are described in the Integrated Test Plan (Appendix D).

The prime contractor may optionally assign the performance of component qualification tests to subcontractors and/or suppliers furnishing respective flight articles, where these sources retain NASA approved facilities and can satisfactorily perform and document the prescribed tests.

Qualification test subsystems. - In order to minimize the possibility of failure occurrences at the Spacecraft Qualification Test Level, qualification tests will be performed at the subsystem level for newly designed critical subsystems. The most significant items in this category are:

(1) Spacecraft Environmental Control Unit
(2) Recovery Capsule Environmental Control Unit
(3) Feeder
(4) Waterer

One additional set of these subsystems will be manufactured or procured for the performance of Subsystem Qualification Tests. Where feasible, these qualification tests may be performed by the supplier or subcontractor.

Structural test model (STM). - One STM will be manufactured to verify structural design criteria by static pressure and vibration tests. The structure of this model will be fabricated to the approved flight configuration and will include subsystem hardware, or the equivalent mass distribution of same.

After completion of the structural tests, delineated in the Integrated Test Plan, Appendix D, this model will be refurbished for use as the Spacecraft Checkout Crew Trainer.

Thermal test model (TTM). - The TTM shall be a partial system, fabricated to the flight configuration. It will be used to evaluate the thermal balance of the system and the design characteristics of the thermal control subsystem. This system will include the spacecraft structure, thermal control subsystem and tube and fin radiator. Electric heaters will be incorporated in the model to simulate the heat output conditions for both equipment and the primates.

Further details, encompassing the thermal vacuum tests which will be conducted on the TTM, are provided in the Integrated Test Plan (Appendix D).

Qualification test model (QTM). - One fully integrated spacecraft will be manufactured and documented to the approved flight configuration, and on completion of flight acceptance tests, will be designated as the Qualification Test Model. This system will be subjected to the prescribed tests designated in Appendix D.

On completion of qualification tests, this model will be refurbished and designated as the Spacecraft System Orbit Simulator.

Flight spacecraft (FSC). - Two Flight Spacecraft will be manufactured to the NASA approved flight configuration, checked out, acceptance tested, and fully documented to NASA requirements. After NASA acceptance and issuance of DD-250 Forms, both of these systems will be packaged in an approved-type container and shipped to KSC for final checkout integration with launch vehicle and insertion in earth orbit for the conduct of the extended weightlessness experiment.

One of the above systems will be selected for flight. The other will be used as a backup system. If flight system failures occur at any period of time at KSC, the backup system will provide a readily available source of spares. On direction from NASA the prime contractor will furnish replacement components to maintain the backup system as an operational spacecraft.

The Make or Buy List--Orbiting Primate Spacecraft identifies the principal components and subsystems included in this integrated system. These systems will be integrated with the launch vehicle which will be inserted in earth orbit for conducting the extended weightlessness experiment.

Spacecraft system simulator. - One Spacecraft System Simulator will be furnished by refurbishing the Qualification Test Model. This system will be re-acceptance tested and assigned to the prime contractor, as government owned property, on NASA issuance of a DD-250 Form. This simulator will be retained at the prime contractor's facility, along with one set of GSE, for use during the period of time the flight spacecraft is in orbit.

Spacecraft checkout crew trainer. - One Spacecraft Checkout Crew Trainer will be furnished by refurbishing the Structural Test Model with component and subsystem qualification tested hardware, in compliance with the End Item Specification for this trainer (to be formulated during the Phase C Program). On NASA acceptance this system will be packaged and delivered to KSC for use as the Checkout Crew Trainer Simulator.

Ground support equipment (GSE). - Two sets of Ground Support Equipment will be assembled, checked out, acceptance tested and furnished for the conduct of the orbital experiment. Since this Ground Support Equipment does not include any mission essential equipment, it will not be subjected to environmental qualification tests. The acceptance test criteria will be in accordance with Appendix D.

On NASA acceptance and issuance of DD-250's, one set of GSE will be packaged and shipped to KSC to support final checkout of the spacecraft system and flight operations. The other set will be retained at the prime contractor's facility for the duration of the program. The prime contractor will use the GSE Control Console to check out flight spacecraft systems before delivery to KSC. Also, it will be used in conjunction with the Spacecraft System Simulator for the duration of the orbital mission, after which, NASA will designate disposition.

The Make or Buy List--Ground Support Equipment identifies the principal components and end items to be included as Ground Support Equipment.

Spares. - Spare components and parts are to be provided, or be readily available, to support the operability of all subsystems of the following deliverable end items:

(1) Flight Spacecraft
(2) Spacecraft System Simulator
(3) Ground Support Equipment Console

Discussion of policy relative to spare parts and components for the above end items, and specific definition of spares, follows.

Flight spacecraft and Spacecraft System Orbit Simulator: Spares will be required to support checkout and launch operations of the Flight Spacecraft at KSC and to support the operation of the Spacecraft System Orbit Simulator, at the prime contractor's facility, during the one year operating period of the orbiting experiment.

At this point in time, it is not contemplated that additional spare parts will be furnished for the Flight Spacecraft. Any malfunctioning components can be replaced by cannibalizing the backup system. On direction from NASA, the prime contractor will furnish replacement parts and components to maintain the backup system as an operational spacecraft.

For the Spacecraft System Orbit Simulator, it is anticipated that adequate space replacements will be available by using re-acceptance tested parts and components available from component qualification tests. Accordingly, it is not anticipated that additional quantities of major components will be furnished to support the operation of this system.

Ground support equipment console: The GSE Console must be operable for the duration of the spacecraft checkout, launch and orbiting period. This represents a total period of 20 months.

Spares are required for both the GSE console delivered to KSC and the unit retained at the facility of the prime contractor. The policy governing GSE spares is that replacement components will be provided for both consoles to assure availability for uninterrupted, or limited interruption of critical instrumentation essential to the conduct of the mission. Accordingly, no replacement components will be provided for non-critical instrumentation which can be readily dismantled and repaired with attainable commercial quality parts.

Following is a list of anticipated spares required for the two GSE Consoles:

Two (2) dc power supplies
Two (2) ac power supplies
Two (2) temperature monitors
Two (2) receivers
Two (2) 1.024 mc discriminators
Two (2) 1.25 mc discriminators
Two (2) bi-phase modulators 70 kc
Two (2) bi-phase modulators, approximately 1 mc
Two (2) 70 kc bandpass filters
Two (2) 1 mc bandpass filters
Two (2) crystal controlled transmitters.

<u>Manufacturer and test tooling</u>. - All special purpose tooling, designed and fabricated specifically for this program, will be identified by tooling numbers. On completion of the program, these tools will constitute deliverable hardware available for disposition, as directed by NASA, with waiver of delivery inspection.

Tooling Policy and Requirements includes a list of the major tooling which will be required for the fabrication and test of Phase D deliverable end items.

Shipping and storage containers for deliverable end items. - All deliverable end items will be shipped in containers, which comply with structural design, cleanliness and environmental control and identification markings suitable to the end item, as dictated in the Master End Item Specification CP10000--Orbiting Primate Spacecraft, and MIL-STD-794 (WP).

MANUFACTURING ORGANIZATION AND CONTROLS

Responsibility

The manufacturing responsibility encompasses the multiple activities required to manage, plan tool, fabricate, assemble and control all of the hardware which constitutes the LTM and Primate Spacecraft System, Spares and Ground Support Equipment.

The manufacturing plan gives purpose and direction to all manufacturing efforts. Schedule control ensures that the plan is being accomplished in a timely manner. The functional operations required to carry out this plan and the associated schedule controls are discussed in the subsequent paragraphs.

Organization

The organization which will perform manufacturing activities is the OPS Program Manufacturing Group of the Manufacturing Operations Section. This group consists of a Manufacturing Engineering Branch and a Fabrication and Assembly Branch. The organization and function of these elements are illustrated as figure G6. This type of organization is commonly referred to as a "projectized" operation; i.e., specific organizational elements staffed with selected, highly skilled personnel, charged with specific responsibilities relative to a single contract effort.

Figure G7 shows the relationship of the Manufacturing Group to other segments of the OPS Program organization. In addition, this figure charts the flow of documents through this organization.

The Manufacturing Group shall be staffed with experienced personnel, with significant specialized capabilities in planning, scheduling, liaison, fabrication, assembly, control and documentation as applicable to aerospace operations on projects similar in scope to the OPS Program. Thus, these persons shall have the versatility to accomplish all aspects of their identified job functions from inception to completion. These functions, identified on figures G6 and G7 are further detailed in subsequent paragraphs of this section.

Manufacturing engineering branch. - The responsibility for optimum performance in fabrication and assembly operations rests within the Manufacturing Engineering Branch, where the initial planning functions establish guidance and instructions for all sections turning detail drawings and specifications

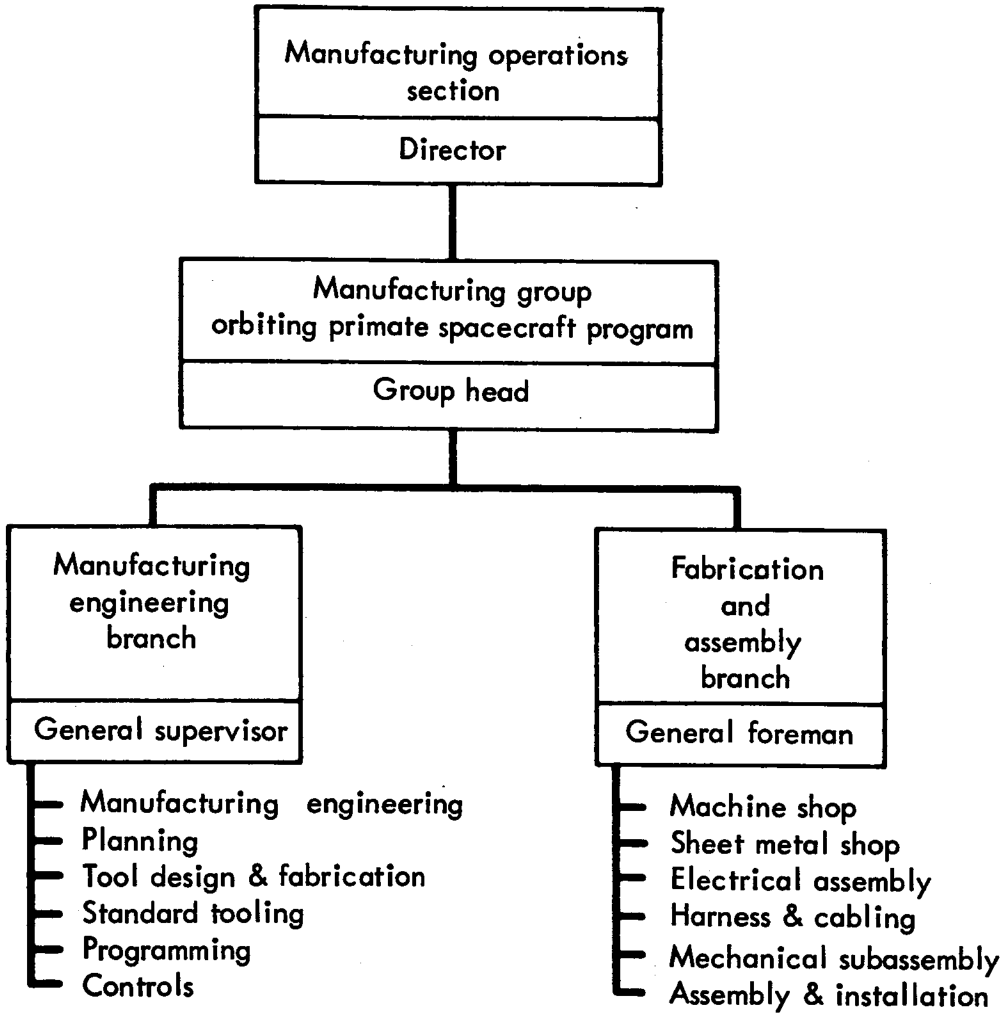


Figure G6. - Organization and functions of manufacturing operations section

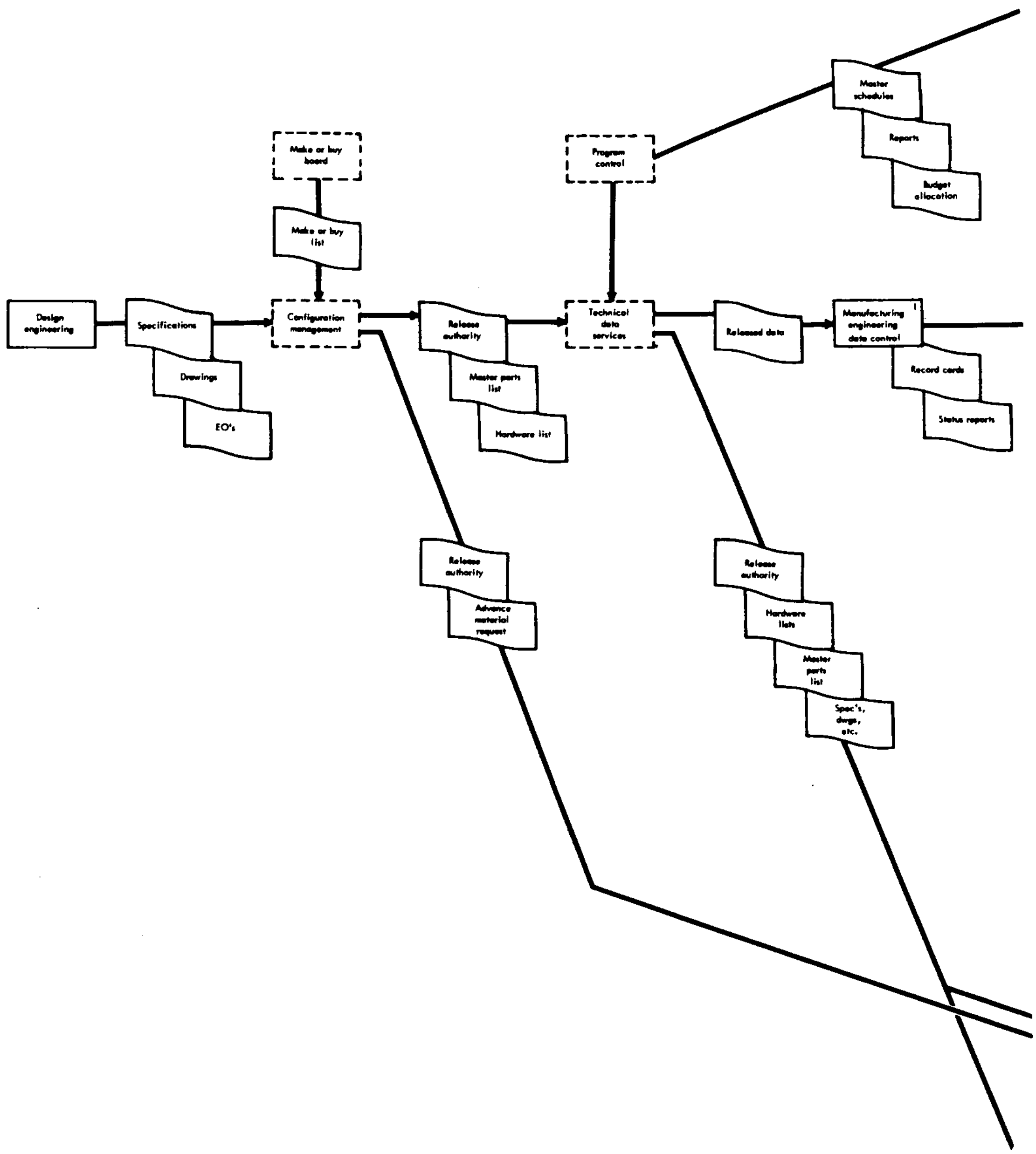


Figure G7. - Document flow and functional interface manufacturing operations section organization

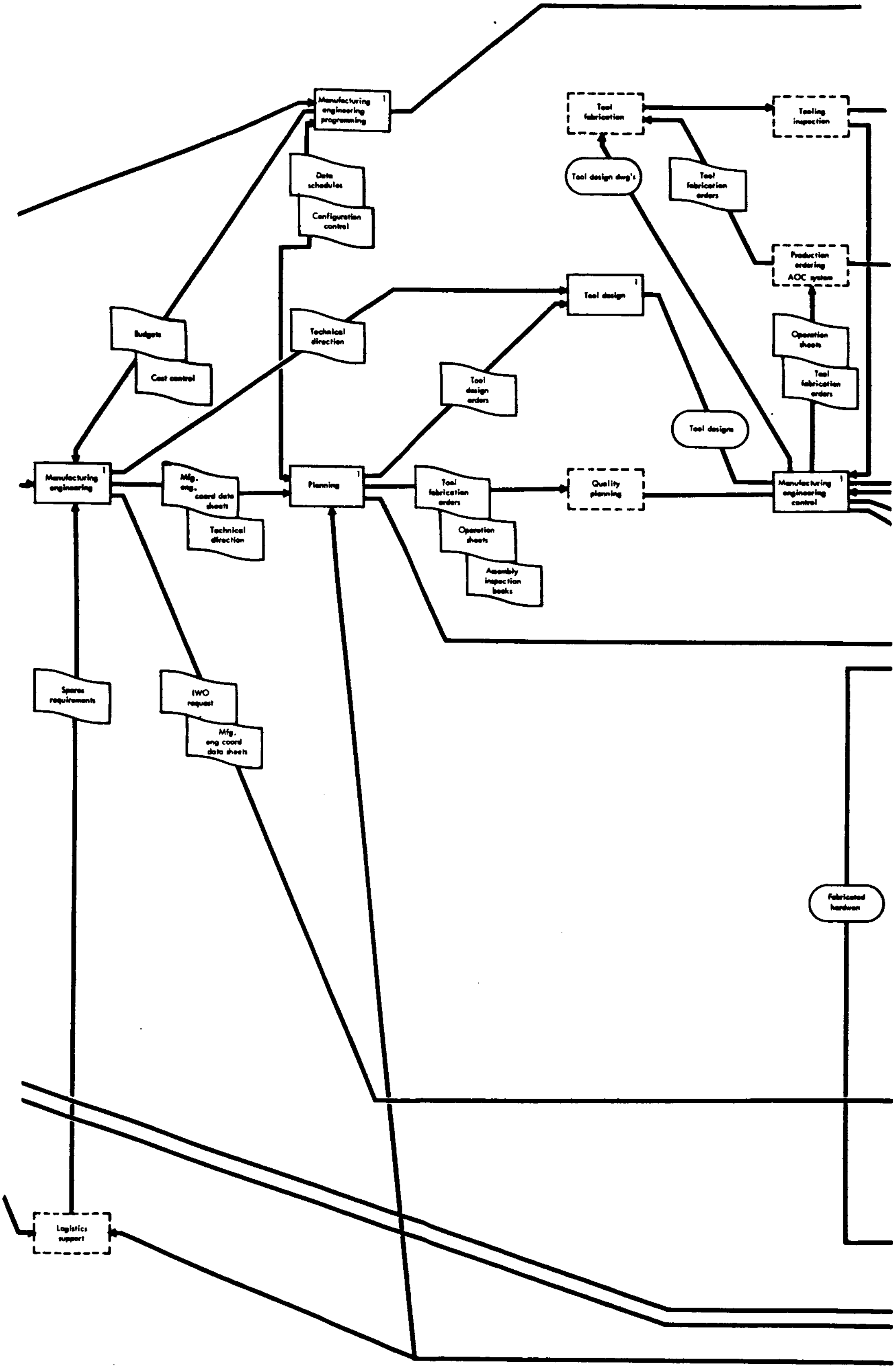


Figure G7. - Document flow and functional interface manufacturing operations section organization

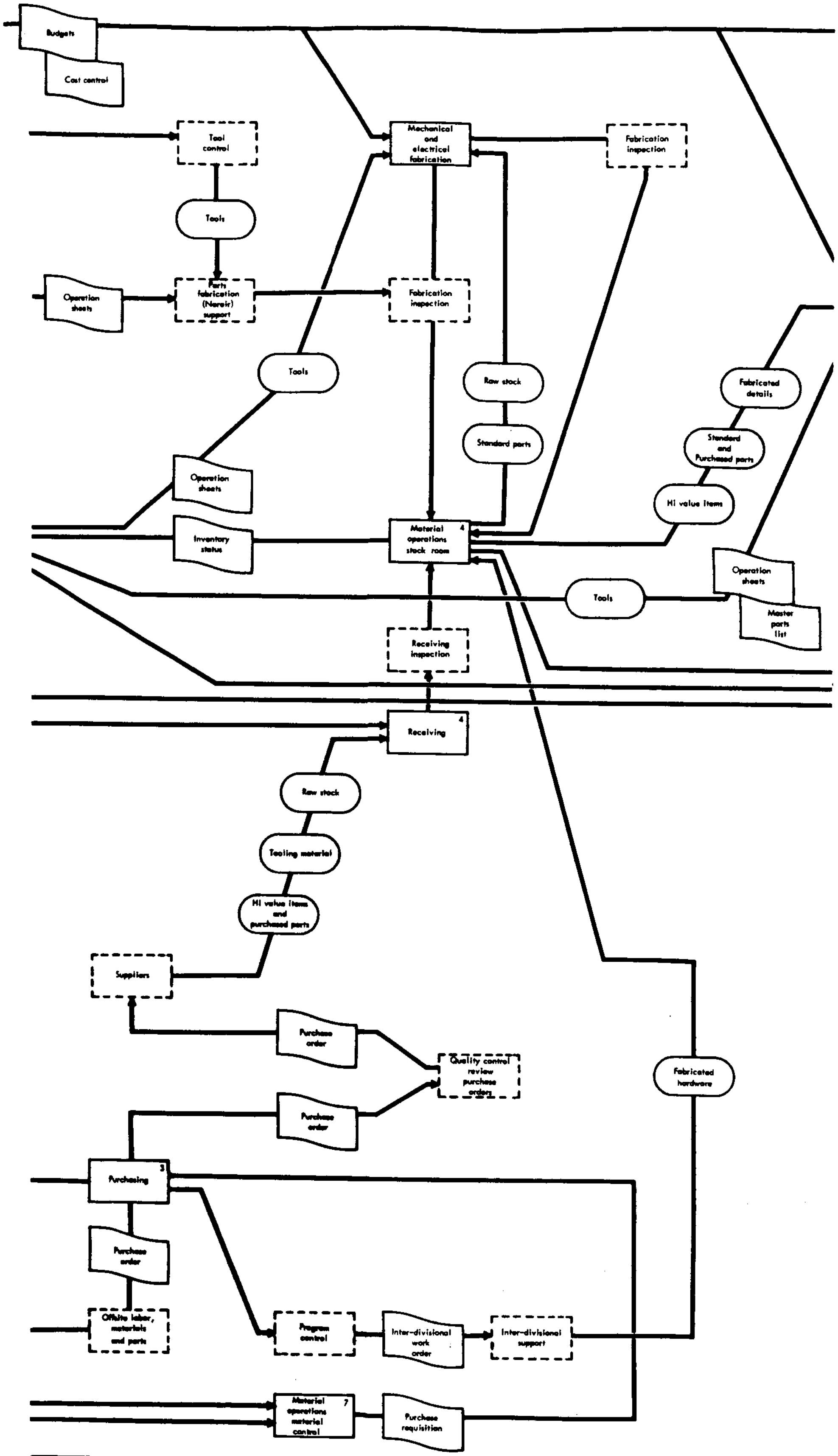


Figure G7. - Document flow and functional interface manufacturing operations section organization

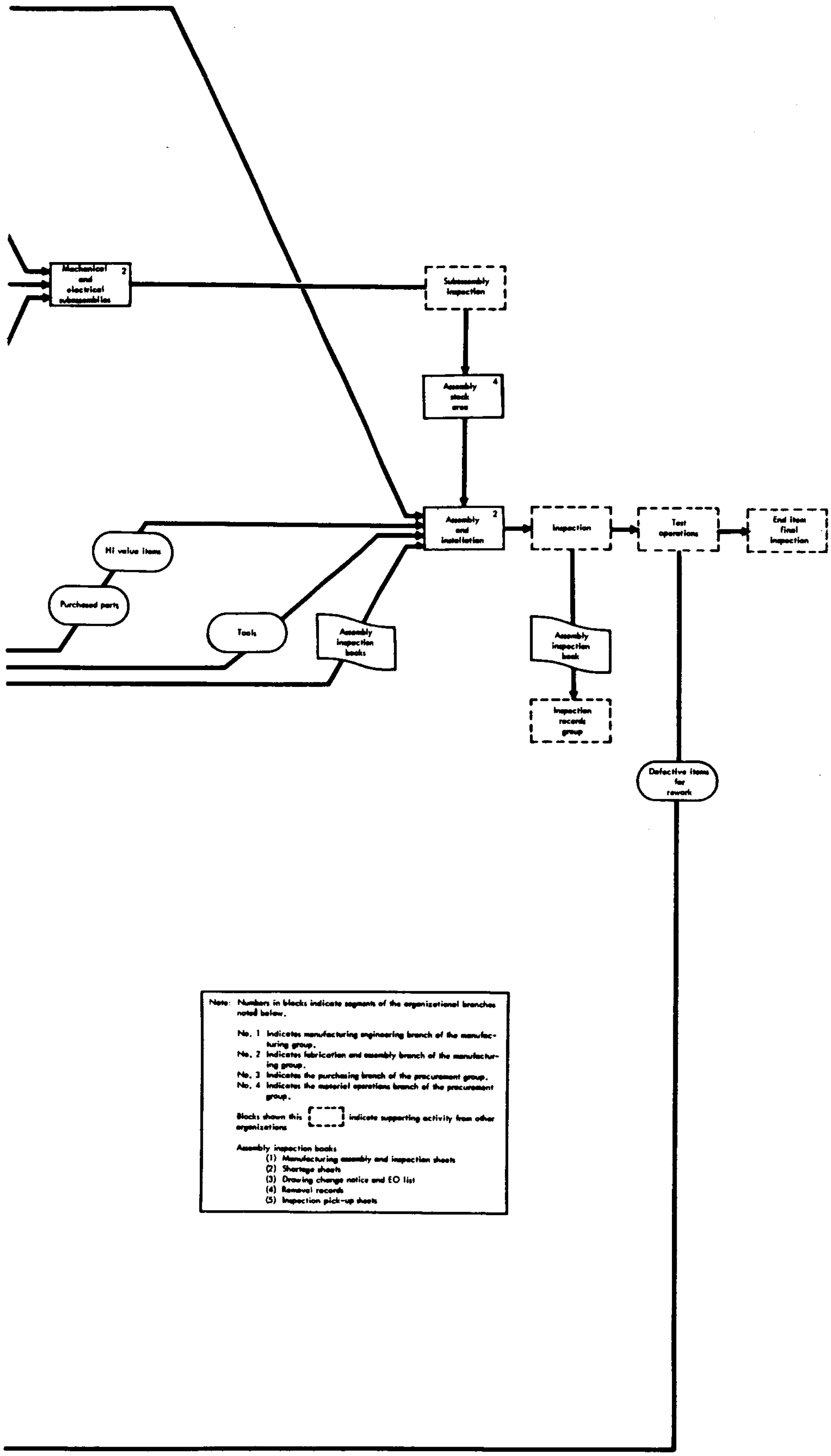


Figure G7. - Document flow and functional interface manufacturing operations section (concluded) into finished hardware. To fulfill this responsibility and to achieve a balanced manufacturing program, manufacturing engineers are assigned to work with the design engineers to advise on approved fabrication methods, processes and procedures, and to analyze various design concepts from a manufacturing-cost standpoint. This close coordination between Engineering Design and Manufacturing Engineering results in finalized designs which can be fabricated and assemblied with a minimum of effort, and which meet or exceed the hardware quality and performance requirements. Manufacturing engineers assigned to the program also monitor performance and coordinate the tooling activity on subcontract work to ensure compatibility with in-plant requirements. As manufacturing liaison with the OPS Program Office, they establish a priority system for the release of engineering drawings, based on the planned assembly sequence.

Manufacturing engineers establish and coordinate the elements of the manufacturing plan with planning, tool design and tool fabrication to assure continuity and compliance. They also establish coordination with the Manufacturing Fabrication and Assembly organizations and maintain same on a continuous basis, to assure Manufacturing Management that a single course of action is being followed.

The Manufacturing Engineering Branch exercises full management responsibilities for assuring compliance with performance, cost and schedule during fabrication and assembly of OPS hardware and associated GSE. The organization also assures that all materials (hardware and software) needed to accomplish fabrication, assembly, and test of the OPS and associated GSE are available as needed.

Fabrication and assembly branch. - Mechanical fabrication and assembly operations encompass sheet metal fabricating, machining, welding, processing, subassembly of detail parts and plumbing, final structural assembly, and the installation of functional components.

Electronics assembly operations include component preparation, assembly and functional checkout of subsystems and total systems. Processes include fitting, soldering, microwelding, harnessing, cabling, continuity and high-potential testing, cleaning, identification marking, encapsulatings, and conformal coating and baking.

Backed by adequate manufacturing and assembly facilities, manufacturing specialists, and manufacturing research and development capabilities, the OPS Program Fabrication and Assembly Branch will translate engineering designs into working prototypes which can be consistently reporduced in quantities required.

Manufacturing Programming

The Programming segment of the Manufacturing Engineering Branch has the responsibility for budgeting, cost controls, participation in preparation of PERT networks, project reports and reviews, special systems and procedures peculiar to manufacturing, and detail scheduling. Internal schedules are prepared and maintained to assure that the manufacturing activities are consistently on schedule. Recovery schedules are immediately prepared for any segment of the operation for which a requirement may occur.

Controls

The Controls segment of Manufacturing Engineering has responsibility for providing and coordinating the specialized service operations required for manufacturing activities, including the control and analysis of work in process, and the preparation and issuance of status reports for the OPS Manufacturing Group. In addition, this segment has responsibility for the timely processing of all materials requirements and their availability to the user. Implicit within this function is schedule incorporation and accomplishment of required tasks in accordance with detailed project schedules.

As a part of the responsibility for timely authorization of work, the Control segment has the responsibility for shoploading and the subcontracting of work. To perform this function, the Control segment maintains constant cognizance of all in-plant facilities, equipment and manpower capabilities, in addition to being knowledgeable of the capabilities of approved suppliers and subcontractors. Specific tasks and control media applicable to the Controls segment of Manufacturing Engineering are discussed in the following paragraphs.

Operations Control Reports constitute the principal tool by which Management can evaluate manufacturing progress and performance. They must contain timely and accurate information for management decision-making, based on frequent periodic review. To be effective, an Operations Control System, which is the source of operations reporting, must incorporate all key tasks and a forecast schedule for their accomplishment. This must be aligned with continuous reporting of performance status, against forecasts and programmed schedules, for all actions occurring throughout the manufacturing cycle. The outputs of the Operations Control System provide the following pertinent information, at timely intervals.

(1) Progressive and priority schedules.

(2) Manpower requirements covering periods up to one year.

(3) PERT forecasts and data necessary to identify manufacturing milestones.

(4) Schedule compliance reports covering planning, tool fabrication and parts fabrication.

(5) An integrated series of performance and cost measurement reports.

(6) Information on all phases of manufacturing such as holding factors, quality control information, tool accountability data, operational analysis, and the data required to calculate indicated costs to complete.

The Operations Control System, through which all work-in-process control data is integrated and processed for status reporting, represents an operation of proven capabilities in product manufacturing. It provides Management with a real-time means of forecasting manufacturing capabilities, applying schedules, and enforcing the schedule compliance of various major projects being performed simultaneously.

The expediting function of the Controls segment uses the Operations Control System for shortage reporting, order releasing, accounting for the fabrication and assembly activity versus schedule, and other related uses. This segment's responsibility is to provide and maintain shortage lists, and to coordinate the resolution of shortage problems between Manufacturing Engineering, the fabricating or procuring agency and the using organization.

The Controls segment of Manufacturing Engineering also dispatches manufacturing and tool orders to the shops, obtains and furnishes all tools, blueprints, and technical data pertaining to each job, and retains accountability and control over all blueprints and related data.

Planning Methods and Procedures

Manufacturing planners assigned to this program, and under the direction of the cognizant manufacturing engineer, analyze all engineering drawings, specifications, and documents to determine the fabrication, subassembly, assembly, and installation operation requirements.

Planning paper denoting detail step-by-step fabrication and processing procedures is created by the planners for use by the Manufacturing Shops on all items to be fabricated and subassembled. The paper to be used on the Program is a standard planning form known as a Production Order (see figure G8). These orders provide authority and instructions for the fabrication and subassembly of parts per engineering requirements and planned conditions on limited production type programs.

Planning instructions relative to purchased or subcontracted components and assemblies are issued by the Manufacturing Planner only in those cases where, due to planned assembly or installation methods and sequences, the delivered item must differ from the specification and drawing. Usually, this amounts to such minor differences as the elimination of holes in a subcontracted part which must be drilled on assembly, or the addition of more material for machining or trimming.

Final assembly and installation procedures for the OPS are established and controlled through the use of Assembly Inspection Books which are created by Planning and issued as individual books for each OPS System. The planning paper contained in the Assembly Inspection Books provides a complete list of parts, detailed assembly and installation instructions, and a historical record of production, inspection, and customer "buy-off" for each specific unit manufactured. The contents of each book, by section, are as follows:

(1) Section 1, Manufacturing Assembly and Acceptance Sheets - used to

PRODUCTION ORDER-PRODUCTION ORDERING COPY
NORTRONICS FORM 46A (11-60)
OPERATION SHEET

SPLIT ORDER	U
EST. TOOL HOURS	BY
PART NAME	SCHED. CODE
ISSUE NO. / ISSUE DATE / SUPERSEDES ISSUE OF / EFF	P S OF
THIS ISSUE WRITTEN BY	PHONE
IN WORK	COMPL.
TOOL ABREV.	
PART NO.	

A/C CODE	DV	SALES ORDER	DASH		QUANT. ORDER

REVISION NOTES:

PART NO.	UNIT REQMTS. L	R	PROD. NEXT ASSEM.	MODEL

MATERIAL

TO ORGN.

VARIABLE INSTR.

DATE

	PROD. ORGN.	ORGN. & INSP. SIGN OUT QTY.	DATE	BY	OPER. & EQUIP. CODE	OPERATION & TOOL PLANNING	SET UP / RUN PARTS INV. TYPE	L	R	TOOL NUMBER AND ABBREV	ORGN. TO MAKE TOOL	TOOL [illegible] ON UNIT	TOOL SET BACK	TOOL CHGE.
1														
2														
3														
4														
5														
6														
7														
8														
9														

Figure G8.—Sample operation sheet

provide a complete list of parts and assemblies, detailed assembly and installation instructions and a historic record of production, inspection and customer buy-off for each task performed (see example, figure G9).

(2) Section 2, Shortage Sheets - used by Manufacturing to list all shortages (see example, figure G10).

(3) Section 3, Advance Drawing Change Notice (ADCN) and E.O. List - used to provide Manufacturing and Quality Control with a current listing of changes (E.O.'s, drawings, and Materials Review Disposition Records) affecting the work being performed (figure G11).

(4) Section 4, Removal Records - used by Manufacturing to list items which must be removed (see example, figure G12).

(5) Section 5, Inspection Pickup Sheets - used by Assembly Inspection to record discrepancies encountered during inspection (see example, figure G13).

Manufacturing Engineering, Fabrication and Assembly, Quality Control, and Manufacturing Control have specific functional responsibilities for the development, maintenance performance, and surveillance of elements of the Assembly Inspection Books. These responsibilities by functional organizations are as follows:

Manufacturing engineering functions. - These functions are listed as follows:

(1) Originate and review planning paper as necessary.

(2) Establish the work plan and inspection sequence on new engineering releases as received.

Inspection sequence and inspection content of the work plan to be approved by Quality Control prior to release to Fabrication and Assembly.

(3) Prepare the Manufacturing Assembly and Acceptance Sheet (MAAS) masters.

(4) Authorize work expenditures by reproducing and issuing copies of the MAAS to affected fabrication and assembly organizations.

(5) Receive changes and revise Manufacturing Assembly and Acceptance Sheets and Drawing Change Notice and E.O. lists as required.

(6) Prepare Assembly Inspection Books for each unit produced as per schedule and maintain with current revisions of planning paper.

Fabrication and assembly functions. - These functions are listed as follows:

(1) Perform work according to work plans, cooperate in the preparation of work plans, verify the quality of work performed, and request necessary or advantageous changes to the Work Plan.

MANUFACTURING ASSEMBLY AND ACCEPTANCE SHEET | TITLE (1 | PAGE – OF 2 | DRAWING NUMBER AUXILIARY NO. 3

LINE NO.	JOB OR BIN NO.	PART TYPE	NO. REQ'D. L	NO. REQ'D. R	JOB DESCRIPTION: PART NO.	JOB DESCRIPTION: PART NAME	JOB DESCRIPTION: REMARKS	UNIT SHORT: SETUP	INVEN.: RUN	PROD. O.K.	DATE	CO. O.K.	DATE SQK. NO.'S	CO. O.K.	CUST. O.K.	BUY OFF CODE
1.	4	5	6		7	8	9			10	11	12	13	14	15	16
2.						17										
3.																
4.																
5.																
6.																
7.																
8.																
9.																
10.																
11.																
12.																
13.																
14.																
15.																
16.																
17.																
18.																

PLANNER 18 | INSP. PLANNER 19 | CHECKED BY 20 | DATE 21 | EFFECTIVITY 22 | PROJECT 23 | PAGE OF | O.K. TO FILE | DRAWING NUMBER

EFFECTIVITY OF CHANGE AND REVISION NOTES: 29 | SECTION NO. 24 | ISSUE NO. 25 | 26 | MFG. SERIAL NO. 28

COPIES TO 27

FIGURE 1

(DO NOT WRITE BELOW THIS LINE)

Figure G9.—Manufacturing & acceptance sheet

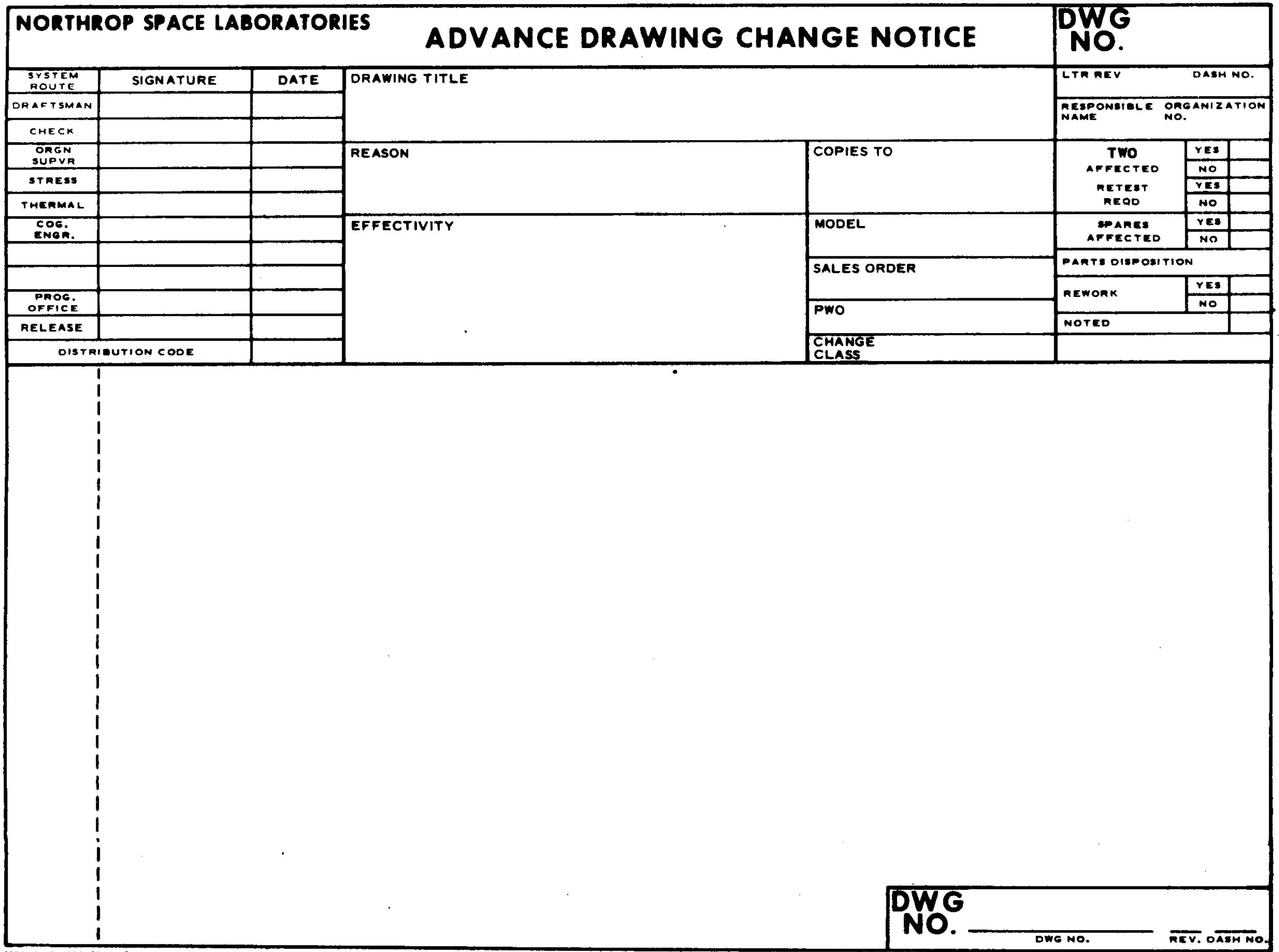
SHORTAGE SHEET - NSS FORM 196 (11-62)

1. IF SQUAWK SHORTAGE, NOTE SQUAWK NUMBER UNDER PAGE AND ITEM.. EXAMPLE........ PAGE & ITEM: SO / 37
2. IF SHORTAGE ORIGINATED ON SHOP ORDER, NOTE "SO" UNDER BOOK NUMBER.
3. IF REMOVAL ITEM SHORTAGE, NOTE "REM" AND BOOK NUMBER UNDER BOOK NUMBER AND REFERENCE PAGE AND ITEM NUMBER OF REMOVAL CARD.
4. SHORTAGES RESULTING FROM EOS WILL HAVE THE EO NUMBER LISTED UNDER "ASSEMBLY FROM WHICH SHORTAGE FIRST ORIGINATED" COLUMN.

NO.	SHORTAGE SOURCE			SHORTAGE PART NO.	QTY.	DESCRIPTION OR NAME OF SHORTAGE	ASSEMBLY FROM WHICH SHORTAGE FIRST ORIGINATED	DATE, ENTERED BY	INSP. APPROV.	DATE, WORKED BY	INSPECTION		
	BOOK NO.	POS. NO.	PAGE & ITEM								DATE	1ST	ACCP.
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													

LINE TITLE	ASSEMBLY NO.	MODEL	SHORTAGE SHEET NO. ____ OF ____	COMPLETED	INSPECTION BOOK	PLANE SERIAL

Figure G10.–Shortage sheet



NORTHROP SPACE LABORATORIES

ADVANCE DRAWING CHANGE NOTICE

DWG NO.

SYSTEM ROUTE	SIGNATURE	DATE
DRAFTSMAN		
CHECK		
ORGN SUPVR		
STRESS		
THERMAL		
COG. ENGR.		
PROG. OFFICE		
RELEASE		
DISTRIBUTION CODE		

DRAWING TITLE

REASON

COPIES TO

EFFECTIVITY

MODEL

SALES ORDER

PWO

CHANGE CLASS

LTR REV DASH NO.

RESPONSIBLE NAME ORGANIZATION NO.

TWO AFFECTED	YES	
	NO	
RETEST REQD	YES	
	NO	
SPARES AFFECTED	YES	
	NO	
PARTS DISPOSITION		
REWORK	YES	
	NO	
NOTED		

DWG NO. ________ DWG NO. ___ REV. DASH NO.

SHEET OF

NSL 130-711 (9-63)

Figure G11.—Advance drawing change notice

REMOVAL RECORD
NSS FORM 121 (8-62) FRONT

(INSPECTOR MUST ALWAYS NOTE DATE ABOVE HIS STAMP IMPRESSION)

ITEM	PART NO. / PART NAME	REASON FOR REMOVAL	OK TO REMOVE				OK TO INSTALL				REINSTALLATION				OPERATION	
			SER. NO.	MECH.	DATE INSP.	USAF	SER. NO.	MECH.	DATE INSP.	USAF	SER. NO.	MECH.	DATE INSP.	USAF	MECH.	DATE INSP.
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																

ASSEMBLY NO.________ ASSEMBLY NAME________ SERIAL NO.________

BOOK NO.________ REMOVAL RECORD NO.________ MODEL________ COMPLETED________

Figure G12.—Removal record

INSPECTION PICK-UP
NSS FORM 77 (7-62) (FRONT)

(SQUAWKS TO BE NUMBERED CONSECUTIVELY - USE ONLY BLUE/BLACK INK - STAMP IMPRESSIONS MUST BE LEGIBLE)

SQK. NO.	REFERENCE POS. / PAGE	REFERENCE ITEM	DISCREPANCY STATE SPECIFIC DEGREE OF ERROR. GIVE EXACT LOCATION - STATION NUMBER - WATER LINE - LEFT OR RIGHT HAND - INBOARD OR OUTBOARD - UPPER OR LOWER - INCLUDE PART NUMBERS.	REPORTED DATE	REPORTED BY	ATTENDED TO DATE	ATTENDED TO BY	ACCEPTED DATE	ACCEPTED BY

BOOK NUMBER ______ PAGE ______ MODEL ______ UNIT SERIAL NO. ______ OK TO FILE ______

PREP. FOR FLIGHT NO. ______ OTHER: ______

CHECK ONE: (✓) ☐ PALMDALE ☐ EDWARDS AIR FORCE BASE

(CONTINUED ON REVERSE SIDE)

Figure G13.—Inspection pick-up

(2) Complete all work as assigned by Manufacturing Engineering on Manufacturing Assembly and Acceptance Sheets, Drawing Change Notices and E.O. Lists.

(3) Denote completion of work by affixing the man number of the individual performing the job to the corresponding inspection item.

(4) Submit all work performed as specified by the inspection callouts on the MAAS.

When an MAAS item cannot be installed due to shortages, these shortages are listed by job number on the Shortage Sheet prior to the continuation of work on other tasks.

(5) Pick up inspection squawks from Inspection Pickup Sheets as required.

(6) Make all entries on the Shortage Sheet.

(7) When an MAAS item can be submitted to inspection in spite of parts shortages:

Enter all parts "not installed" and/or shortages on Shortage Sheet.

Enter the job number for which the shortage originated.

Notify Inspection that the item is ready by use of man number sign-off by the individual performing the task.

(8) Subassembly Shortages; when an assembly which carries a "Subassembly Shortages" tag (see figure G14), with shortages listed, is installed in an assembly which has an Assembly Inspection Book, Fabrication and Assembly is responsible to:

Transfer shortages to the Shortage Sheet and Note "S" or,

Notify Inspection that the item is ready for verification of transfer by a man number sign-off.

(9) Make all entries on Removal Record Sheets when it is necessary to remove a part or an assembly already installed and inspected.

Notify Inspection that the item is ready for verification by a man number sign-off by the individual performing the operation.

(10) Expedite shortages

(11) Notify Fabrication and Assembly when shortages are cured.

Quality control functions. - These functions are listed as follows:

(1) Prior to release of the Manufacturing Assembly and Acceptance Sheet

SUB-ASSEMBLY SHORTAGES

ASSEMBLY NO. SHOP ORDER SERIAL

COMPONENT ASSY. SHORTAGES CHECKED

QTY	PART NO.	PART NAME	DATE	MECH.	INSP.

Form 6U-1
1R 9 4?

Items on this tag must be entered on Shortage Sheet when attached assembly is issued to shop.

TRANSFERRED TO SHORTAGE ON SHIP NO.__________

Date__________ Transferred By: __________

O. K. to File__________ Date __________
Insp.

THIS TAG TO BE REMOVED BY INSPECTION ONLY

Figure G14.–Subassembly shortage tag

master for reproduction and distribution, Quality Control codes each job number in the Buy-Off code column of the MAAS as indicated below:

Q - In-Process Quality Acceptance

C - Fabrication and Assembly Responsibility

E/I - End Item Acceptance

A - Customer Acceptance

X - For Fabrication and Assembly Information only (does not require inspection).

(2) Performs inspection according to Work Plan, verifies the quality and compliance to Engineering specifications of work performed, participates in preparation of Work Plan and requests changes necessary in improving released work plans.

(3) Inspection shall:

Verify shortages.
Approve removal items when requested.
Use Standard Inspection Stamp for buy-offs.

MASTER SCHEDULE AND SEQUENCE OF MANUFACTURING TASKS

As indicated in the first part of this report, the Primate Spacecraft Program will be divided into three phases which are as follows:

(1) Phase 2 - Design Definition for Phase 3
(2) Laboratory Test Model
(3) Phase 3 - Development / Operation

Figure G15, Primate program master schedule, shows the planned sequence of accomplishing the major tasks of design, development fabrication, assembly and testing, which will be required of the prime contractor, subcontractors and suppliers to comply with the total objectives of all the above listed phases.

During Phase 2, the prime contractor's manufacturing group will procure parts, fabricate a spacecraft mockup and breadboard hardware, in support of spacecraft subsystems "definition." In addition, manufacturing programmers and planners will schedule, plan and program procured hardware lead times, manpower, equipment, tooling and facilities for the accomplishment of the major manufacturing tasks to be performed during Phase 3.

Manufacturing detail scheduling, planning, procurement and fabrication for the Laboratory Test Model will be concurrently performed with the Phase 2 effort in order to manufacture, check out and deliver this system within the

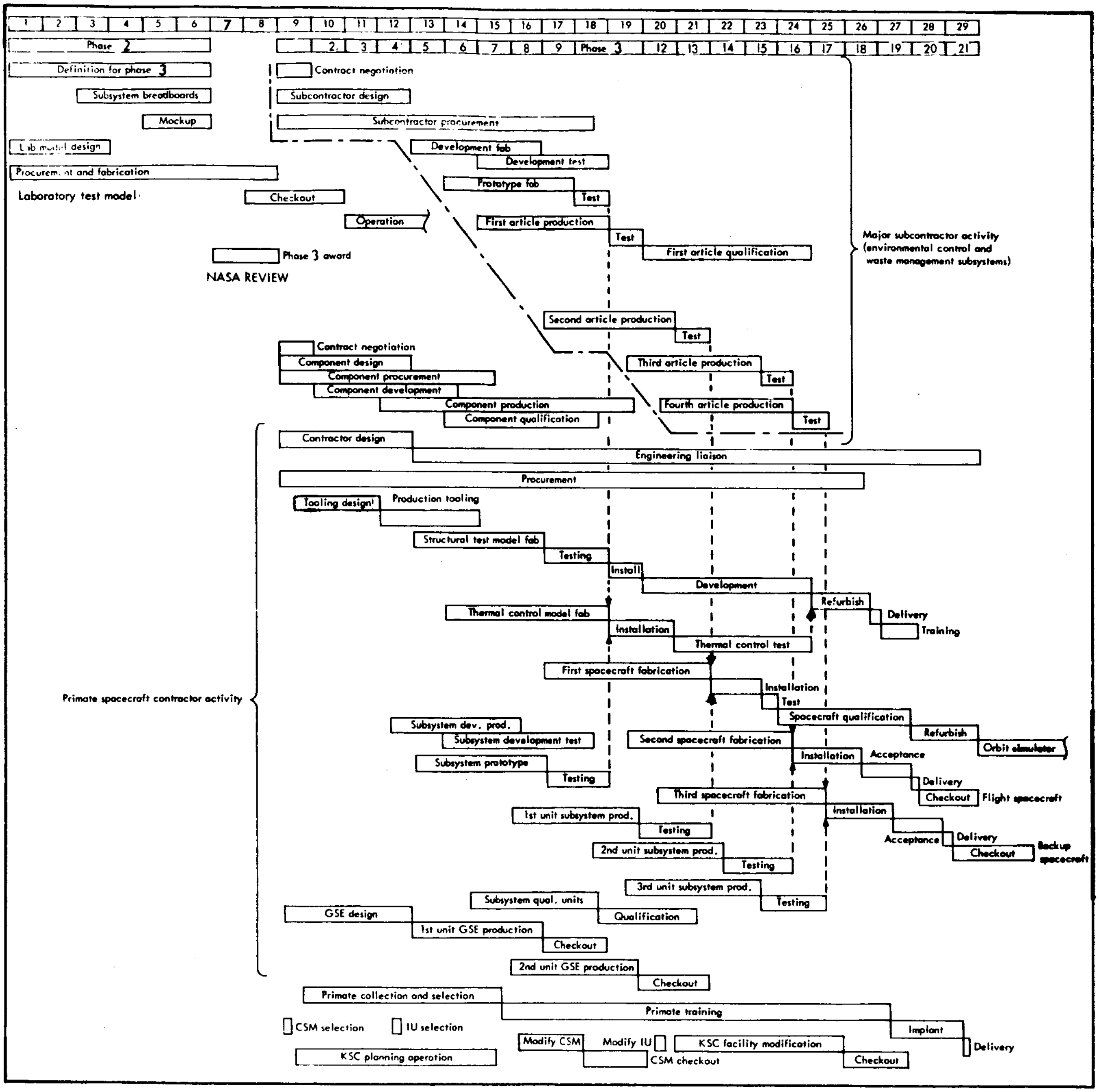


Figure G15 - Primate program master schedule program period of ten months, shown in the Program Master Schedule. The Major Subcontractor, furnishing the Environmental Control and Waste Management System for the Laboratory Test Model, will require eight months to complete designs, procure parts, manufacture and check out these units. Accordingly, the schedule provides two months to complete the integration of the LTM and to check out the system with the Control Console which was also manufactured, by the prime contractor, during this period of time.

On authorization of a Phase 3 Contract, the prime contractor will immediately initiate procurement activities for major long-lead items already definitized. This will be particularly true for the development and prototype configurations of the Environmental Control and Waste Management Units, which will be subcontracted. Other significant long-lead procured items include the television equipment, solar panels, batteries and electronic components and parts. The lead-time required for most electronic subsystems will be critical, due to the high reliability requirements to be imposed on all flight-type hardware. This will necessitate close coordination between the prime contractor and suppliers, with respect to technical direction, quality control and delivery schedule compliance. Early anticipation of problem areas, and effec- planning and follow-up, will minimize occurrence of assembly kit shortages.

HARDWARE CONSTRAINTS

Following is a primary list of constraints which will govern policy and procedure relative to material conformance, manufacturing procedures, qualifications of personnel and quality of end items produced for development subsystems, the LTM and integrated OPS Systems.

Development Hardware

Development hardware includes all structural, mechanical and electronic subsystems manufactured to verify the functional concept of the design.

With respect to manufacturing restraints, development hardware automatically implies limited restraints. Workmanship should generally be to acceptable levels comparable to good laboratory or commercial practices, except where parts and materials are being used to formulate manufacturing processes and procedures applicable to flight systems, or where the quality of workmanship can affect the functional test of specific electronic components, circuits or cabling. For these, or similar instances, more stringent instructions, direction and control will be used.

Limited inspection will be performed on development hardware, unless specifically specified by the cognizant engineer. Similarly, MRB action is not applicable. Variances from requirements will be reviewed by the cognizant engineers and disposition or corrective action will be made on an informal basis.

Procured components and parts, particularly those involving electronics, will be of commercial quality unless otherwise specified by engineering. High reliability components are not generally required for this type of hardware.

The manufacturing organization will work to verbal instructions, schematics or sketches. However, identification records and operation controls will be maintained for all work performed.

Laboratory Test Model

The low manufacturing and material cost figure, incorporated in the budgetary estimate for the construction of an LTM, reflects the use of commercial quality components and workmanship for mechanical, structural and electronic subsystems integrated into the LTM and its associated Control Console. However, all pressure vessels will comply with ASME Standards.

This policy conforms to MEI Specification CP20000, Laboratory Test Model, and is compatible with the customer's objectives for the following reasons:

(1) This model is a verification of the functional aspects of the design concept.

(2) The design of the LTM structure provides accessibility to subsystem hardware, permitting repairs and/or replacement of parts and components with limited or no interruption to the conduct of the experiment.

(3) Since this is not a flight system, and is maintainable, there is no necessity of utilizing extremely costly, high-reliability components and parts which require long-lead procurement time.

The manufacturing organization will work to drawings and specifications issued by the Engineering Department. All work will be to planning documents and all electronic components and cabling will be checked out according to good manufacturing practices, before performing functional tests.

Quality Assurance will verify that all procured and manufactured hardware conforms to applicable drawings and specifications. Variances will be reviewed by cognizant engineers and disposition or corrective action will be on an informal basis.

NASA inspection will verify the configuration and functional acceptance of the integrated LTM System, along with documentation records and, on approval, will issue a DD-250 for this system.

Qualification and Flight Spacecrafts

All parts, components, subsystems and integrated systems used for qualification tests and flight spacecraft systems shall conform to MEI Specification CP10000, Orbiting Primate Spacecraft, and specifications issued by NASA as applicable to the OPS Flight System. Following is a summary of significant constraints, applicable to the manufacture of qualification and flight systems of the OPS.

(1) High reliability components will be utilized in each system, to provide maximum confidence of mission success.

(2) No hardware or equipment will be used which will preclude a twelve month life of the OPS.

(3) Maximum use will be made of previously qualified and space flown components, equipment and hardware.

(4) Only components which have been tested to demonstrate their capability of satisfying Qualification and Acceptance requirements will be used on the qualification OPS and flight OPS.

(5) All OPS hardware must operate satisfactorily after launch and insertion in orbit.

(6) Preferred Parts Lists will be used as a basis for selecting reliable electrical and mechanical parts in accordance with NASA requirements.

(7) Non-standard electrical and mechanical parts (i.e., those which do not qualify by the definition of preferred parts) will be selected and used as a last alternative, in accordance with the NASA restrictions.

(8) All materials, parts and processes, including protective treatment, will conform to NASA requirements, as specified in prime contractor released drawings and specifications.

(9) All hand soldering will be in accordance with NASA Publication NPC 200-4 and personnel performing this work will comply with the visual acuity and soldering certification specified in this document.

Supplementing these constraints, contractual requirements specify that NASA Specification NPC 200-2 shall apply, "where applicable" for this configuration. Accordingly, the Quality Control Plan will define the extent of compliance for procurement, in-process fabrication, final assembly and test operations. Integrated manufacturing and inspection planning and MRB action will delineate procedures and provide for inspection verification and documentation of all fabrication, assembly and test phases of the spacecraft construction, according to design drawings, specifications and the workmanship standards required.

Effective configurations and change order controls will be enforced, and all hardware and documentation will be identified by part number and change letter.

All manufacturing and quality assurance planning will be submitted to the Resident NASA Inspection Representative, for his review and approval, before release. At this point in time, he may designate any operation elements of the work sequence at which NASA inspection is desired. Likewise, he will be advised of all tests, so he can witness same--at his discretion--and approve test results. After final acceptance test of each system is completed, the system will be cleaned and presented, with the complete document log book, for final NASA inspection and buyoff, by the issuance of a DD-250, on acceptance.

The above procedure will be aplicable for all qualification components, subsystems and integrated OPS Systems, before performance of qualification tests. Likewise, this procedure will apply to all Primate Spacecraft Flight Systems and Spares.

Ground Support Equipment

GSE equipment will comply with the MEI Specification for GSE and NASA instructions at the time of performance. Generally--all parts, materials and workmanship will conform with Military Specifications and acceptable NASA Standards for Aerospace Ground Support Equipment.

TOOLING POLICY AND REQUIREMENTS

Tooling Policy

Manufacturing engineering operations in support of the fabrication and assembly effort provide the planning, technical assistance, and tooling required to fabricate, assemble, and check out the deliverable hardware items for the OPS Program shown on the Primate Program Master Schedule.

Since the number of units to be manufactured is limited, only those tools which are mandatory for producing a qualified and reliable article are fabricated by the tooling organizations. However, in programs such as this, it is common practice to fabricate simple tooling aids (as required) to supplement the planned program. These tools or aids fall into the so-called "soft tool" category and are not suitable for full scale production programs.

Generally, the OPS mechanical subassembly and subsystem fabrication and assembly work is accomplished with general purpose tools and equipment. The tooling is consistent with technical requirements, and is as simple, economical, and easy to handle and store as possible. Duplication of tooling is avoided. Multiple usage of individual tooling is employed where practical. The special tooling and test equipment required for the manufacture of functional electronic subsytems consist primarily of conventional fabrication and assembly items such as wiring harness boards, encapsulation fixtures, and chassis holding fixtures.

Where fabrication tooling and assembly jigs, fixtures, and dollies required for this program are critical as to schedule, early planning is instigated. Key planners and manufacturing engineers are physically located with, or in the immediate proximity of, the cognizant engineers. This permits the early release of tool design drawings on critical items prior to the release of fabrication drawings. To assure product conformance and compliance with specifications during the manufacturing cycle, manufacturing engineers participate in all design review meetings and expedite advance material releases.

All major assembly fixtures, master control gages, check fixtures, and handling equipment required in support of the OPS Program are designed by the Tool Design segment. Tool design drawings are provided by this segment for the more complex machine tools, test tools, and specialized fabrication and installation tooling. Table G2 lists the major tools anticipated on the OPS Program.

TABLE G2. - PRELIMINARY LIST OF TOOLING FOR THE ORBITAL PRIMATE SPACECRAFT PROGRAM

Subsystem No.	Subsystem description	Tool No.	Tool description
1100	Environmental control system	101 through 106	Checkout tools for formed tubes in piping system.
		107 & up	Tooling requirements of major subcontractor (not known at this time)
1200	Waste management limit	201 & up	Tooling requirements of major subcontractor (not known at this time)
1300	Life cell	301	Access door drill jig
		*302	Bottom grate bar form die
		*303 through 306	Special metal form dies
		*307	Movable wall bracket drill jig
		*308	Floor grate assembly and weld fixture
		*309	Movable wall assembly and weld fixture
		310	Top plate assembly and weld fixture

TABLE G2.- Continued

Subsystem No.	Subsystem description	Tool No.	Tool description
		311 & 312	End plate assembly and weld fixtures
		*313	Life cell assembly and weld fixture
		*314	Life cell transport dolly (wood)
		315 & 316	Behavioral panel drill jigs
1400	Feeder	*401	Drum welding fixture
		402 & up	Miscellaneous special tooling
1500	Waterer	501	Miscellaneous special tooling
1600	Behavioral panel	601 & 602	Behavioral panel drill jigs
1700	Recovery capsule	701	Shell corner form die
		702	Capsule flange drill jig
		703 through 705	Shell form dies
		706 & up	Miscellaneous special tooling
2000	Thermal control	801 through 803	Miscellaneous special form and fit-up tools
3100	Base structure	901 through 905	Small assembly and weld fixtures

* Refers to tooling used to manufacture the Laboratory Test Model.

TABLE G2. - Continued

Subsystem No.	Subsystem description	Tool No.	Tool description
		906	Base structure final assembly and weld fixture
		907	Flange machining fixture
		908	Flange drill jig
		909	Base structure handling dolly
		910 & 911	Support strut machining fixtures
		912 & 913	Support strut assembly and weld fixtures
		914	Assembled support strut master inspection gage
		915	Base structure handling sling
		916 & up	Base structure miscellaneous special tooling
3200	Pressure shell	1001	Docking collar assembly and weld fixture
		1002	Flocking collar machining fixture
		1003	Skin form die
		1004	Skin handling rack (wood)
		1005	Flange machining fixture
		1006 through 1008	Strut machining fixtures
		1009	Shell assembly and weld fixture
		1010 through 1013	Miscellaneous subassembly and weld fixtures

TABLE G2. - Concluded

Subsystem No.	Subsystem description	Tool No.	Tool description
		1014	Handling slings
		1015	Pressure shell handling dolly
		1016 through 1020	Miscellaneous special tooling
4000	Instrumentation	1101 & up	Miscellaneous electronic assembly tooling
5000	Telemetry	1201 & up	Miscellaneous electronic assembly tooling
6000	Command & control	1301 & up	Miscellaneous electronic assembly tooling
7000	Electric power & cabling	1401	Solar panel frame assembly and weld fixture
		1402 & up	Miscellaneous electronic assembly tooling
8000	Attitude control	1500 & up	Miscellaneous jigs and fixtures
0000	Spacecraft integration	1601 through 1604	Spacecraft assembly platforms
		1605 through 1606	Spacecraft handling dollies
	Test tooling	2001 through 2005	Vibration test fixtures
		2006	Vacuum chamber spacecraft suspension fixture
		2007	Vacuum chamber radiant heater panel
		2008 & up	Miscellaneous shock and vibration test fixtures for components

Because a higher degree of product reliability is obtained from tools fabricated from formal designs than from those fabricated from layout type drawings or sketches, formal designs are the general rule. A minimum amount of design information is left to tool fabrication shop practices. Manufacturing engineers monitor all designs to stress and assure clarity and simplicity. All designs are approved in the "light-line" or layout stage by the manufacturing engineers assigned to the program, and coordinated with fabrication and assembly and Quality Control supervision prior to release to the Tool Fabrication Shops.

Tool Ordering Criteria

The determination by the Manufacturing Engineering and Planning organizations of the tooling needed to support the fabrication, subassembly, assembly, and installation activities are based on the following ground rules.

(1) Machine tools are provided only in those cases where hand layout and standard machine setups do not meet required tolerances, nor produce parts of assured quality.

(2) As a general rule, small subassembly tools are furnished unless they could eliminate requirements for a duplicate major assembly fixture, or unless they are necessary to meet the quality and reliability requirements of the finished article.

(3) Designed handling fixtures and slings are provided only in those cases where GSE designs cannot be used or modified for in-plant usage, or where specific manufacturing requirements dictate the design of a new fixture.

(4) Handling equipment for in-plant handling of components is ordered only when alternate methods cannot suitably perform the job, or where excessive handling may compromise the quality of the assembly.

(5) GSE is used to verify the integrity of the manufacturing process to the fullest extent possible, consistent with the manufacturing and delivery schedule. If GSE delivery prevents its full utilization, an identical unit is built (as a contract tool) for use in manufacturing.

(6) The test equipment developed during in-plant design, qualification, and functional testing is utilized throughout the manufacturing phase where possible. Again, such equipment is duplicated as a contract tool if the original equipment cannot be used due to prior commitments.

(7) Where the equipment requirements cannot be fulfilled by items (5) and (6), special contract tooling is designed and built.

(8) Mechanical and electronic inspection fixtures are designed and fabricated to support receiving inspection if the part or component to be tested cannot be readily inspected with existing standard test equipment, purchased duplicate vendor test equipment, or designed and developed ground support

equipment. In any case, the ultimate quality and reliability of the detail or component part being inspected and tested dictate the requirement for a check or inspection fixture.

(9) Sheet metal templates are provided for all sheet metal parts requiring flat pattern or contour development work. These templates are fabricated from photographs of original glass cloth layouts.

(10) Formed parts are made on "low production type" form blocks, drop hammers, or stretch press dies.

Tool Fabrication

Tool fabrication will be accomplished in the Manufacturing Group by qualified personnel, capable of holding close tolerances on precision machine tools. The manufacturing engineer will perform liaison guidance on all hard tools (tools which require design drawings) to assure that the tool will produce parts and assemblies that will meet the engineering design specifications. He will also offer suggestions and make recommendations on soft tools (manufacturing aids).

This method results in a better understanding of the purpose and use of the tool by the person who fabricates the parts and assemblies. Greater efficiency is realized and control problems are reduced.

Standard Tools

The standard tools required for the OPS Program will be provided by the manufacturing engineer responsible for the acquisition and control of plant equipment (Class B nonperishable property), perishable tools (Class C property), and contract standard tools which are peculiar to the program. He will also be responsible for the establishment, operation, and maintenance of the standard tool cribs within the organizations performing tool fabrication, and manufacturing fabrication and assembly.

Preliminary List of Tooling

Based on the concept of the Orbital Primate Spacecraft configuration and preliminary designs of subsystems resulting from a Phase 1 Study Program, a list of anticipated hard tooling requirements has been formulated for the manufacture and test of OPS Systems to be performed during a Phase 3 Program. This is shown as table G2.

Some of the components and subsystems incorporated in the LTM are of the same configuration as the prototype system. Where these criteria exist, and the manufacturing requirements are sufficiently critical to require hard tooling, they will be fabricated for use on the LTM System. Such tooling items are marked with an asterisk, in the attached list.

FACILITY REQUIREMENTS PLAN

Introduction

In undertaking a program of the magnitude and complexity of the Orbital Primate Spacecraft Program, it is mandatory that the prime contractor and major subcontractors have adequate facility capabilities, in addition to the means of scheduling and implementing their use in proper time phasing, to comply with the Program requirements. Successful performance of the OPS Program requires established facility capabilities within the areas of engineering development--electronic, mechanical and structural manufacture--system integration and test. The scope of work will range from microminiature component manufacture to major aerospace structure fabrication.

Hardware requirements will progress from breadboard electronics and wood mockups, during the Phase 2 Program; to development, tooling and manufacture of highly sophisticated and reliable flight spacecrafts, along with necessary ground support equipment, to be accomplished during a Phase 3 Program.

Accordingly, the manufacturing and test capabilities will become more complex and stringent as the program progresses. The same applies to the supporting functions and laboratory activities affiliated with these operations.

At this point in time, the spacecraft design does not incorporate any exotic requirements for new manufacturing techniques or advancements in the "state of the art." However, the reliability prerequisites are such that very rigid requirements will be placed on cleanliness and quality of workmanship. Thus, a significant portion of the manufacturing and assembly tasks will be performed in temperature controlled, clean room environment. In some instances white rooms will be required for precision work, such as the manufacture of gyros and delicate electronic instrumentation.

Within the scope of this section, the term "facility" is defined to include assigned areas (of types and sizes noted) and conventional processing machinery and equipment required to fabricate and assemble development hardware and end items which satisfy contractual commitments of the Primate Spacecraft Program.

It is considered that, within its capabilities, the prime contractor will furnish all facilities essential to this program, except those required to develop, manufacture and checkout the Environmental Control and Waste Management Systems. These systems will be furnished by a major subcontractor.

A summary of facility capabilities, which will be required during the progressive phases of the OPS Program, is included in the following presentation.

Phase 2

This is the "Design definition" phase of the program and the prime contractor will require only limited facilities capable of making breadboard electronic assemblies and testing them, and building a full-size soft mockup of the prototype configuration of the primate spacecraft.

The primary manufacturing facilities required for this phase of the program consist of the following:

(1) A well equipped electronic assembly and test laboratory.

(2) Mockup shop capable of fabricating wood and plastic assemblies.

(3) Paint shop.

(4) Assembly area to integrate the full-size spacecraft mockup.

(5) Receiving inspection and parts storage area.

Laboratory Test Model

This is not a spacecraft configuration. However, all subsystems which interface with the primates will be to the presently conceived configuration for the flight system. This includes the life cells, behavioral panels, waterer, feeder and the environmental and waste management units (except for power drives, radiators and gas tanks.) Where not critical, commercial quality components and less costly materials will be used.

Facilities and workmanship requirements for the LTM will be those required to produce a functional system equivalent to commercial quality. The limited period of time scheduled for the accomplishment of this phase of the program dictates that the prime contractor and his major subcontractors, must not only have the capabilities to accomplish all the work tasks essential to fulfillment of program objectives, but also must provide timely phasing of work by having the facilities available for use when they are required.

For this model, the following facilities are required:

Program management. - Adequate office support equipment to administrate and control the course of the program, in compliance with all objectives.

Engineering. - Office space and drafting facilities for engineering and drafting efforts required to detail the LTM configuration.

Fabrication. - Fabrication of Laboratory Test Model will be achieved by using machine shop and an electronic development and assembly type facility.

Machine shop: Conventional equipment, including: Engine and turret lathes with capacities of 1 to 18 inches diameter; bench and pedestal drill presses; radial drill press with 6 foot minimum radial arm; internal, external and surface grinding machines, milling machines, powered hacksaw, bandsaw, and miscellaneous deburring and cleaning equipment.

The above equipment must be capable of performing work within a ±0.001-inch tolerance.

Sheet metal and structural shop: Plate shear (1/4 inch capacity), hacksaw, bandsaw, 10 foot brake, arc welder, brazing tools and miscellaneous powered hand tools, i.e. grinders, clippers, buffers, etc.

Electronic assembly: An electronic development and assembly laboratory type facility, with adequate work bench space and soldering equipment to assemble discrete components to terminal boards and circuit boards, microwelding, a cable and harness facility, and a fully instrumented electronic checkout and test facility. In addition adequate provisions should be available for encapsulation operations. A subassembly area should be available to check out assembled subsystems.

The entire electronic assembly facility shall be air conditioned and maintained in a clean orderly manner at all times.

Quality assurance. - In order to adequately comply with inspection requirements a well-equipped electronics and mechanical inspection facility will be required to inspect and accept all purchased hardware, maintain surveillance of work-in-process and conduct buyoff of subsystems and the integrated LTM.

Final assembly. - A high-bay facility is required to perform final assembly and integration of the LTM and associated Control Console. This facility shall be equipped with adequate storage, work benches and open assembly area. An overhead hoist or crane shall be available with a minimum overhead work clearance of 24 feet and a minimum load capacity of 5 tons.

Test. - Laboratory Test Model components, subsystems and integrated system will be functionally tested. Likewise, leak checks and static pressure testing will be conducted on the Pressure Vessel. Adequate space and equipment will be provided for the functional test to be performed in the final assembly facility. However the system will be placed in a fragmentation cell for pressure testing.

Phase 3

This phase of the OPS Program includes fabrication and test of development hardware; and the manufacture, assembly and test of all components, subsystems and integrated spacecrafts for qualification and deliverable flight spacecrafts. It also includes the manufacture, assembly and checkout of ground support equipment to be delivered with the spacecraft systems.

This configuration must satisfy all of the requirements of the Primate Spacecraft Program, in that it is deliverable flight hardware and will incorporate all of the structural, electronic and mechanical systems to fulfill the requirements of the CSM interface and the NASA Orbiting Experiment for Study of Extended Weightlessness.

During this phase, the scope of work increases significantly. Likewise, the quality requirements, as previously indicated, will be stringently enforced to assure a high reliability of delivered spacecraft systems. As for the LTM, a heavy workload will continually exist during the conduct of the Phase 3 Program. Accordingly, manpower requirements will be maintained at a high level and adequate facilities and equipment must be continually available to fully utilize the available crew.

Following is a review of the tentative facilities which the prime contractor will need to perform the Phase 3 Program.

Program management. - Same as for the LTM, with some increase in support personnel and support equipment.

Engineering. - Space, office equipment and drafting facilities will be increased.

Test. - Significantly from that required for the combined performance of Phase C and LTM Programs.

Fabrication. - Fabrication during Phase 3 will be achieved as follows:

Machine shop: The same type of equipment will be required, as was used for the LTM. In addition a 10-foot-diameter vertical lathe with a 10-foot-diameter capacity and a group of tree mills will be required. Also the quantities of machine tools in use will increase for this phase.

Sheetmetal and structural shop: Space and equipment requirements increase significantly. Similar equipment will be required, as used for the LTM. However, additional welding equipment will be needed. Several TIG welders should be assigned for full-time use on this program. Adequate provisions will be made for locating subsystem assembly and weld fixtures. Likewise a large area will be set up to integrate the total structure of at least two systems at one time.

Electronic assembly: Assembly of all electronic components and subassemblies will be performed in a clean room environment and all soldering of flight hardware will be to NASA NPC 200-4. Accordingly, adequate lighting, tooling, checkout and inspection equipment must be available to assure the production of quality hardware.

Specific equipment requirements include: clean room assembly benches, cable and harness assembly area, ultra-sonic cleaning tanks, vacuum encapsulation and baking chambers, pull testers to verify micro-welds, terminal installation equipment, test and checkout instrumentation, and miscellaneous small tools and accessories which will enable the performance of all work in compliance with the NASA and military specifications applicable to the OPS Phase 3 Program.

An adequate clean room area will also be provided to integrate and check out electronic subsystems and to assemble and check out the GSE Consoles.

Quality assurance. - A complete well equipped and staffed Quality Assurance facility is required. A screening facility is required to sample and verify the reliability of electronic parts. Also, completely equipped facilities are required to fully comply with inspection and documentation requirements for receiving inspection, surveillance of work-in-process, and final buyoff of subsystems and integrated primate spacecrafts.

Final assembly. - As for the LTM, a high-bay facility is required to perform final assembly and integration operations of the total primate spacecraft. Adequate space is to be provided to work on two complete systems, and several subsystems, simultaneously. Likewise, the plan will include a bonded parts storage area, in close proximity to the assembly area, to store all acceptable component kits and subassemblies to be used in the integrated spacecrafts.

Figure G16 illustrates a reasonable layout for the final assembly and functional checkout of the Primate Spacecrafts. This plan includes a Biomedical Test Area which may be utilized by the prime contractor to perform specific tests and experiments using primates in the spacecrafts model.

Test. - An elaborate test program is required to develop, acceptance test and qualify components, subsystems and integrated spacecraft systems. The scope of these tests are included in the Integrated Test Plan (Appendix D).

The primary facilities which will be required to conduct the Test Program are listed as follows:

The primary facilities which will be required to conduct the Test Program are listed as follows:

Environment	Description
Thermal-vacuum	12 foot diameter by 15 foot long chamber, 1×10^{-8} Torr 5-foot-diameter chamber, 1×10^{-8} Torr
Vibration	30,000 pound shaker, sine & complex
	60,000 pound shaker, sine & complex
Salt fog	25 by 48 by 34-inch chamber

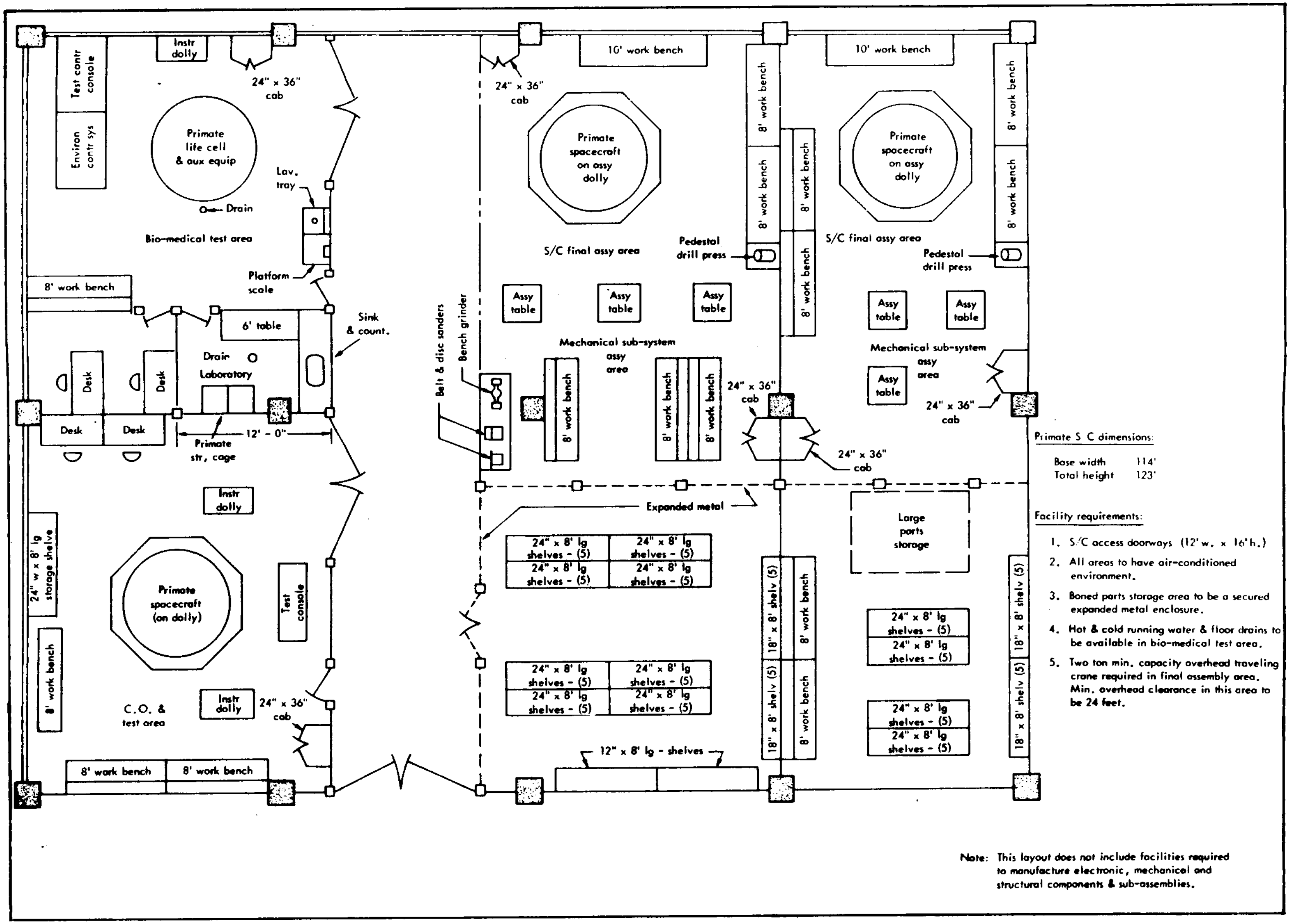


Figure G16. - Primate spacecraft - system assembly facility

Electro-magnetic interference	Screen room, 12 feet by 12 feet by 8 feet high
Humidity	Chamber, 4 feet by 4 feet by 4 feet high with control and monitoring console
Shock	40,000 force-pound, 100 G/MS 1/2 sine or sawtooth
Pressure test	Fragmentation test cell, 12 feet by 12 feet by 12 feet high

Other test equipment:

Hydrostatic test system
Helium mass spectrometer
Class B electronic test equipment
Weight and center of gravity test stand
Rate table

MAKE OR BUY PLAN

Make or Buy policies and decisions (see figure G17) are to be administered in accordance with ASPR 3-902. A Make or Buy Board chaired by a responsible corporate executive, reviews all programs of contract value over $500,000 which involve deliverable hardware or the fabrication and assembly of laboratory prototypes. The decisions of this board are made after a detailed study of the many factors involved, such as:

(1) In-plant capability and experience in the design, tooling, and manufacture of substantially similar items.

(2) Fabrication requirements which may directly or indirectly establish the need for changing or expanding existing facilities, or for the acquisition of new equipment.

(3) Overall effect on cost.

(4) The effects upon workload or capacity due to the specific program being evaluated against other in-house programs.

At the time of this review, the Make or Buy Board also designates items which are to be considered as subcontract on the program. A subcontractor item is one which, because of special significance, complexity, cost, or for other reasons, requires greater control than normal material procurement action. This control is applied in the area of engineering and procurement through special techniques of source selection, evaluation, and administration.

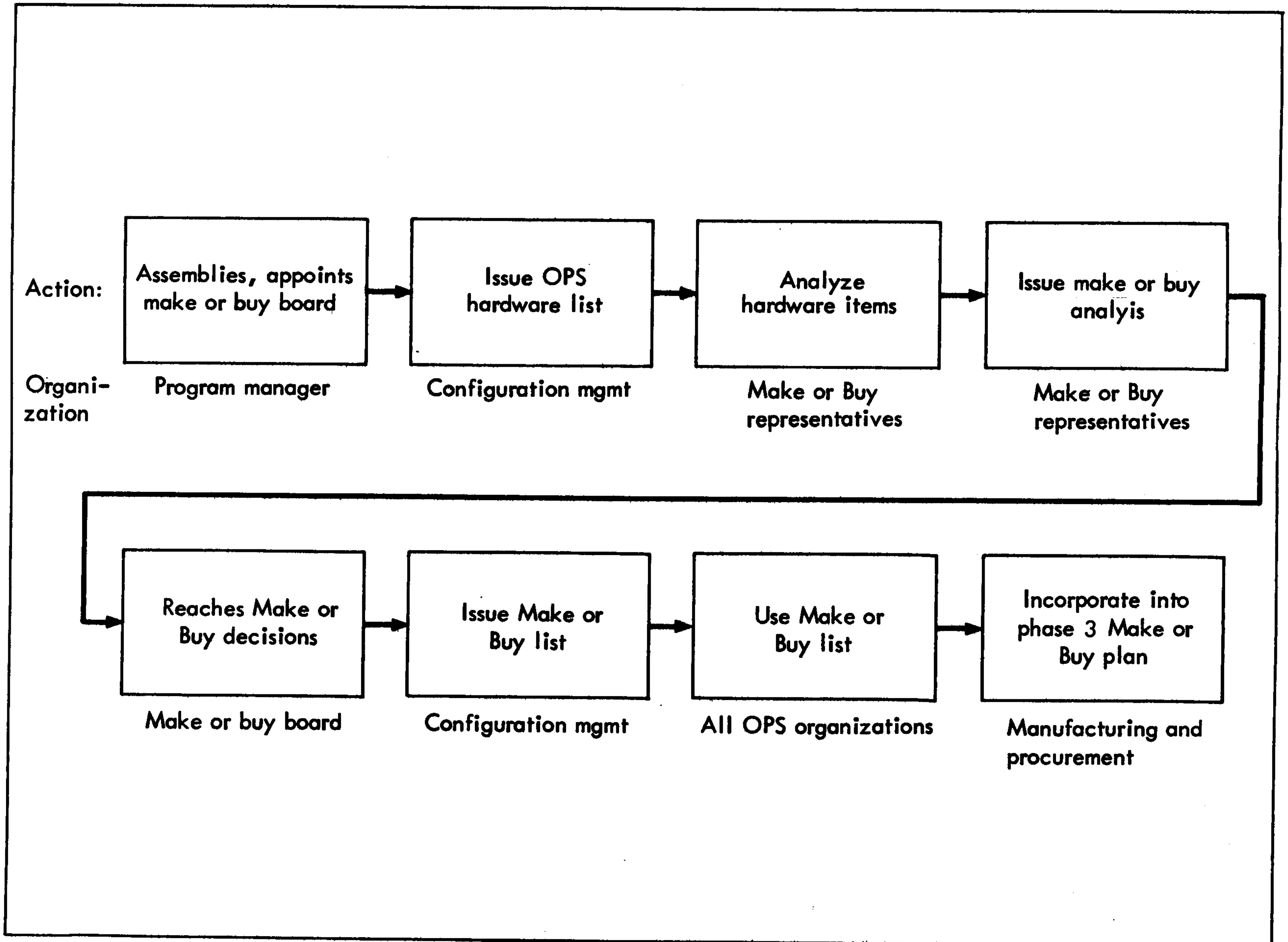


Figure G17. - Make or Buy steps

The Make or Buy Board appoints a Source Selection Committee to handle all activities leading to the selection of a successful subcontractor. This Source Selection Committee is selected from middle management, or higher, and assists the procurement group in approving lists of potential bidders, preparation of quotations, implementing supplier surveys, evaluating submitted proposals, and making the final recommendations for subcontractor selection to the Make or Buy Board for approval and decision. After final approval of selected subcontractors by the Make or Buy Board, the results are forwarded to the Corporate Office for review by the Senior Vice President of Manufacturing Administration.

At the direction of the OPS Program Manager, the Engineering organization and the Manufacturing and Procurement Groups conduct a study of the OPS hardware configuration and submit a recommended Make or Buy List to the Make or Buy Board for approval. Certain products fall outside of the prime contractors capability and are immediately classified as "buy." These include such items as: communications equipment, elements of the data subsystem such as commutators, etc. Make items may be classified as "buy" even though the prime contractor may have an existing capability, due to excess workloads prevalent during the time span of the OPS Program. To ascertain these loads, the Manufacturing organization contacts the affected devisions and determines their planned loads for the time span required. Figure G17 diagrams the make or buy steps used on the OPS Program.

The Make or Buy Lists, have been established for the OPS Program as a result of actions described above.

Figure G18 shows the MEI Configuration Tree of the LTM and identifies the component items of all subsystems which constitute the LTM.

Figure G19 shows the MEI Configuration Tree of the OPS and identifies the component items of all subsystems which constitute the OPS.

Drawing No. 148-10002 contains the Make or Buy List of the Orbiting Primate Spacecraft.

Drawing No. 148-20002 contains the Make or Buy List of the Laboratory Test Model.

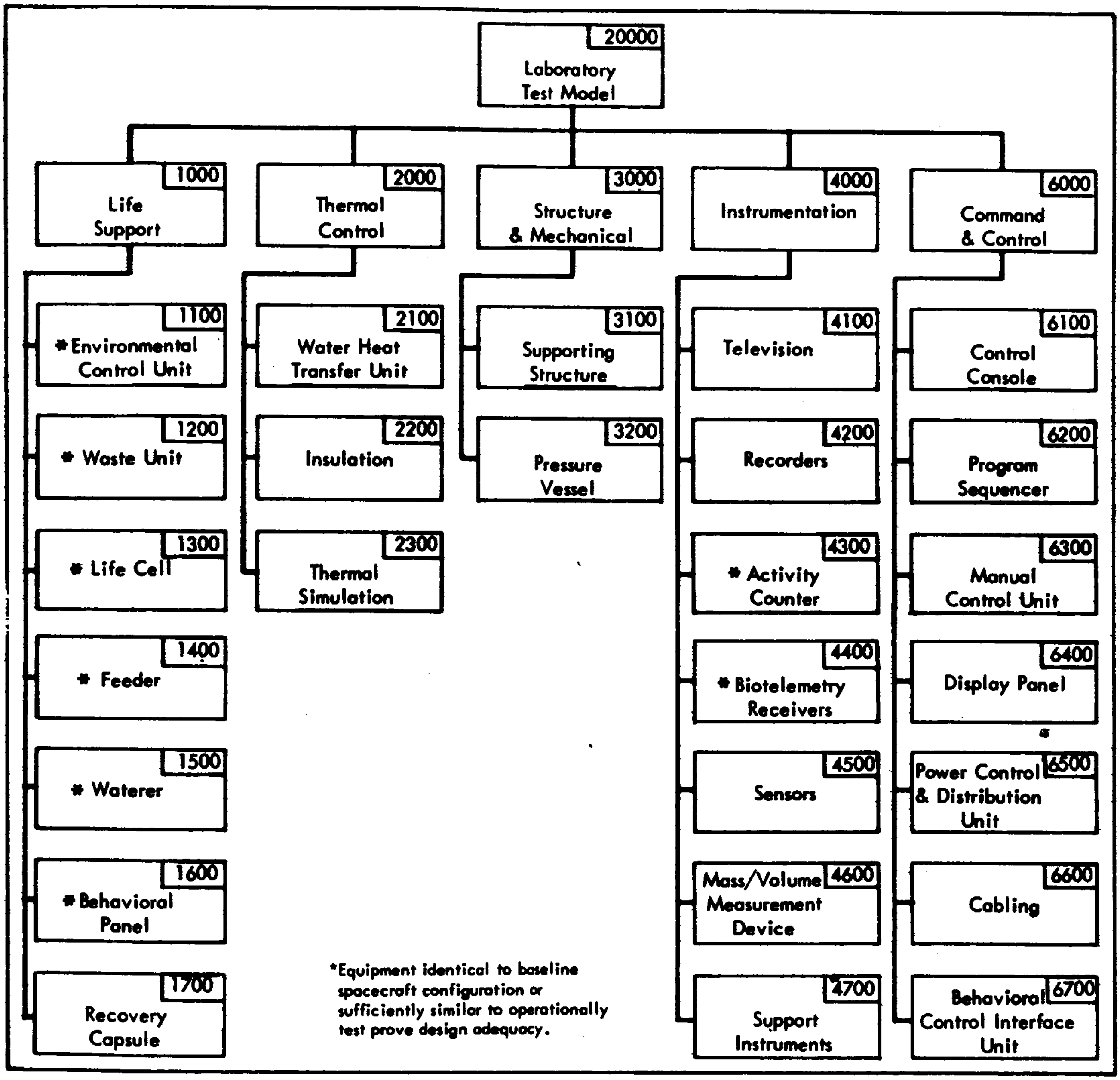


Figure G18. - Master end item configuration tree

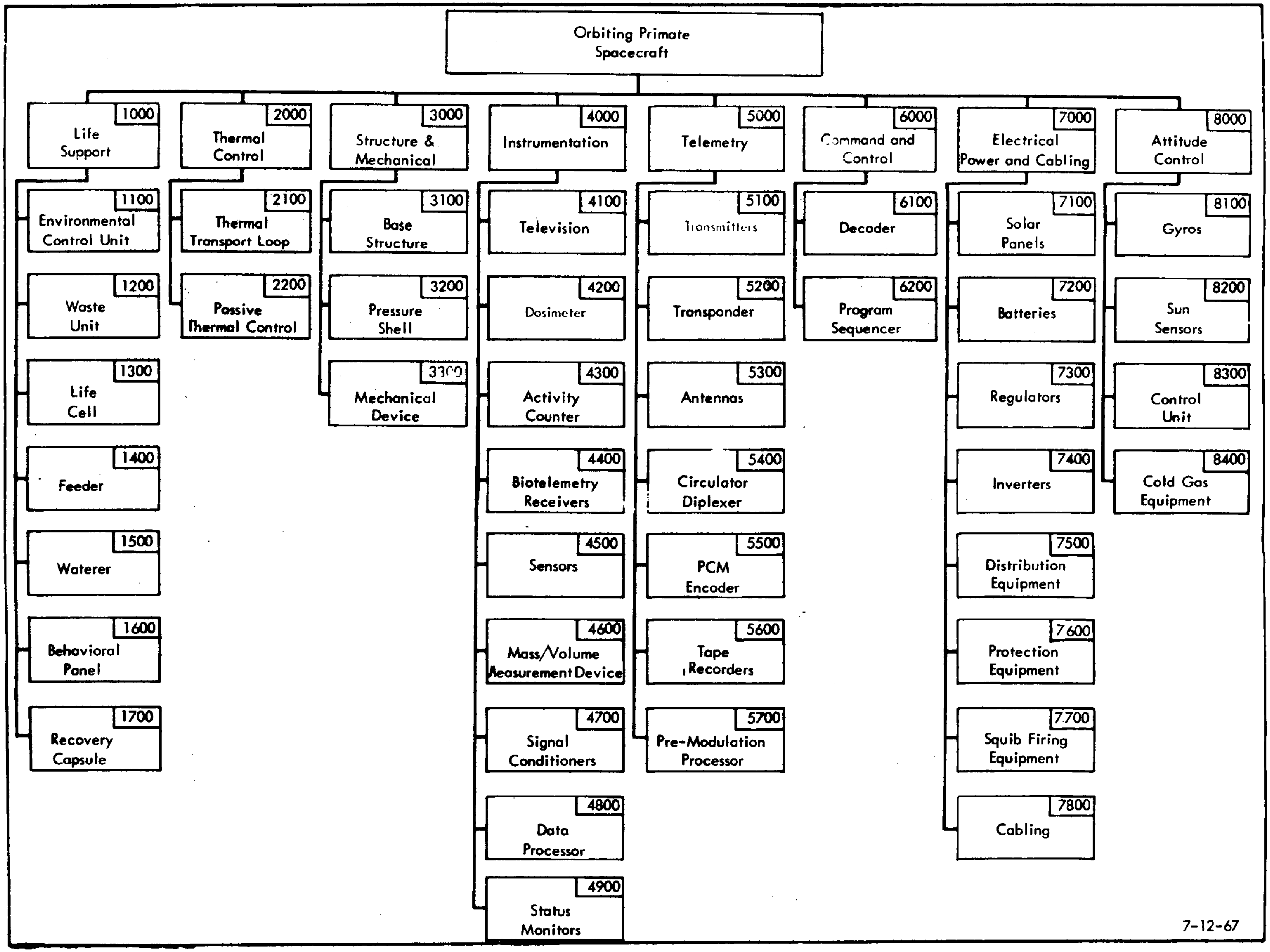


Figure G19.–Orbiting primate spacecraft master end item configuration tree