BOEING

-DINNER- JAN 16 [illegible]

THUR 5

5 FEB 40 ST. [illegible]

1967

III 3

SPACE DIVISION LAUNCH SYSTEMS BRANCH

D5-13197

MANUFACTURING PLAN.

AAP

CONTENTS

1.0 INTRODUCTION

This Manufacturing Plan is prepared in response to the Apollo Applications Program request for proposal No.

1.1 PURPOSE

The purpose of this document is to present a Boeing plan for the manufacturing effort required to provide hardware and support for the installation and checkout of Experiment Packages and related equipment in the Apollo Systems Modules.

2.0 MANUFACTURING PLAN SUMMARY

This Manufacturing Plan is based on verbal and preliminary hardware descriptions available from the design engineers at this time. The items to be manufactured or obtained by The Boeing Company are Ground Support Equipment for test and checkout of the Experiment Hardware, Interface Tooling, Unique Hardware for Flight such as the Experiment Module Rack, Manipulator Queen and Mockup, Handling and Transportation Equipment for Experiment Hardware and Interfacing Hardware such as Wire Bundles and Tubing.

Manufacturing is established as a flexible organization providing fast response production and rework of limited quantity items. This is accomplished by maintaining a close relationship with Design Engineering through Design Support Engineers (DSE). The DSE is the engineer responsible for the production, delivery and installation of an end item. He follows that item from "cradle to grave" to obtain an intimate knowledge of forthcoming releases and assisting in the development of producible hardware and installations. From this knowledge, advance orders and procurement requirements will be initiated in ample time to support program schedules. Manufacturing will be closely controlled by the use of data processing to provide instant traceability for all components throughout the entire fabrication, assembly and installation cycles.

Assembly of components will be done in the Boeing Facility in Huntsville with installations in Manipulator Queens and Modules being accomplished at MSFC and KSC. Facilities permitting, components will be primarily

MANUFACTURING PLAN SUMMARY (continued)

fabricated in Huntsville. Source selection for components which cannot be fabricated in Huntsville will be based on capability and schedule considering other Boeing facilities, NASA laboratories, Module contractors and suppliers as sources.

A.A.P. PHASE I FLOW

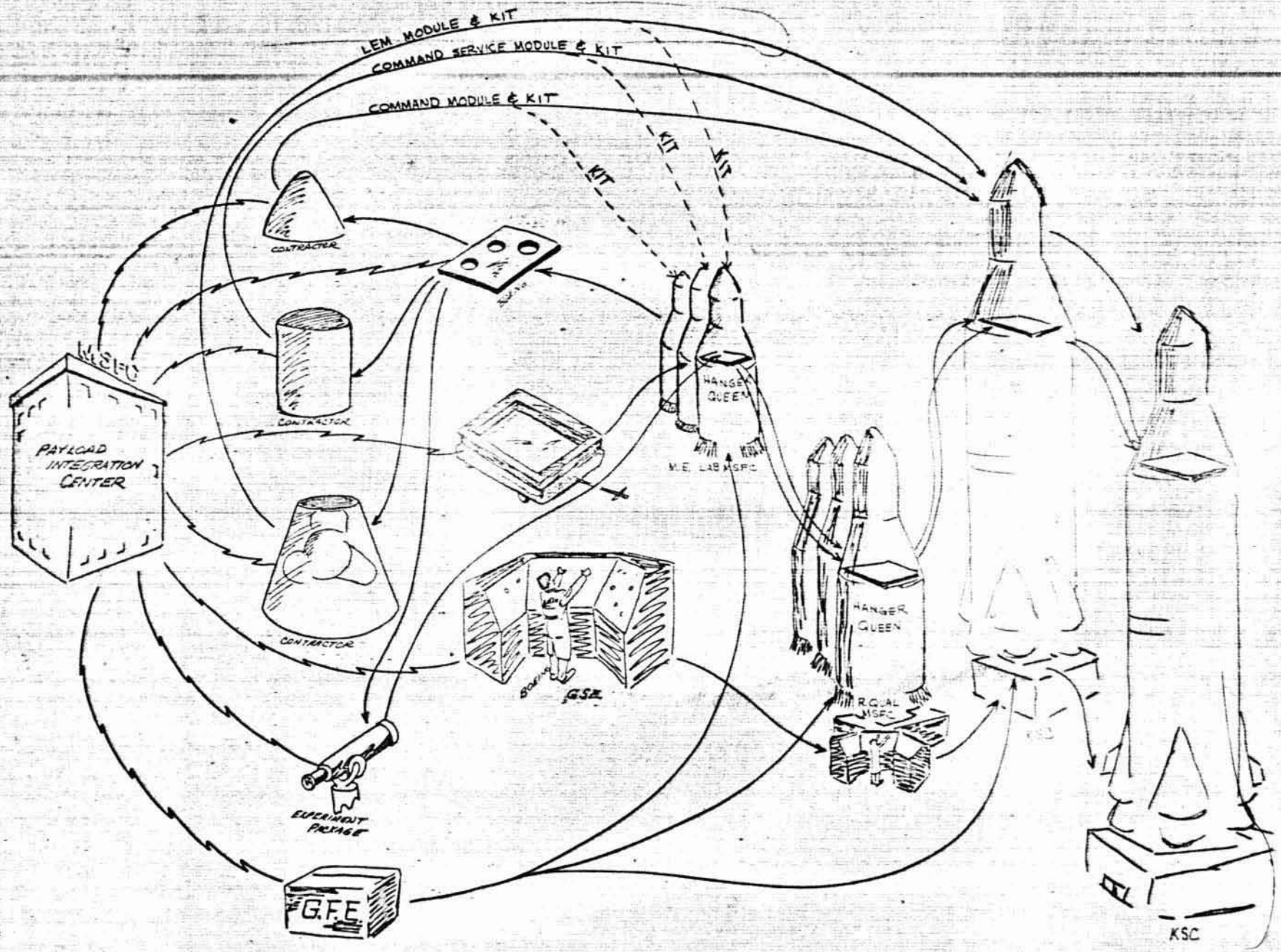
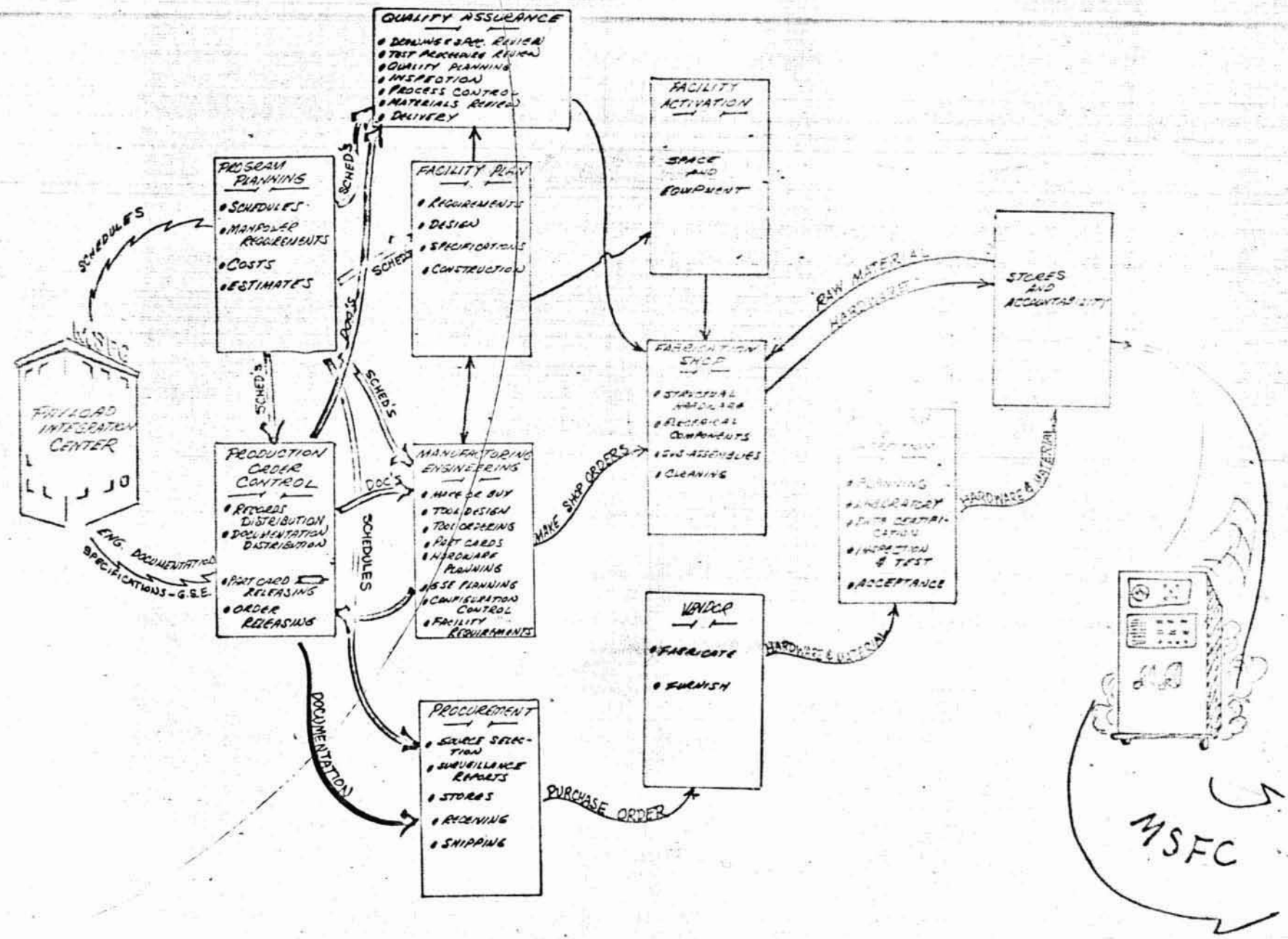
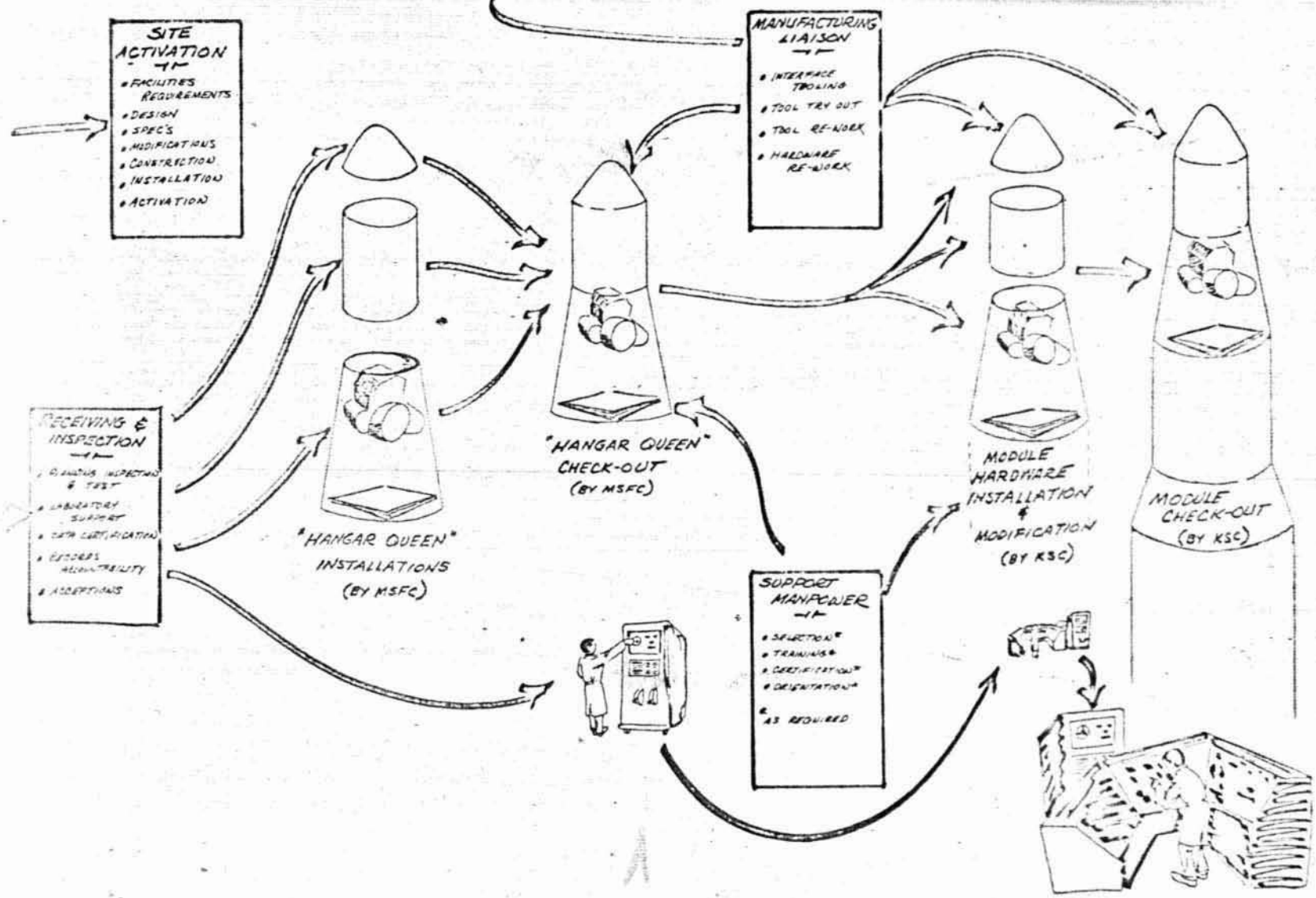


FIG 20

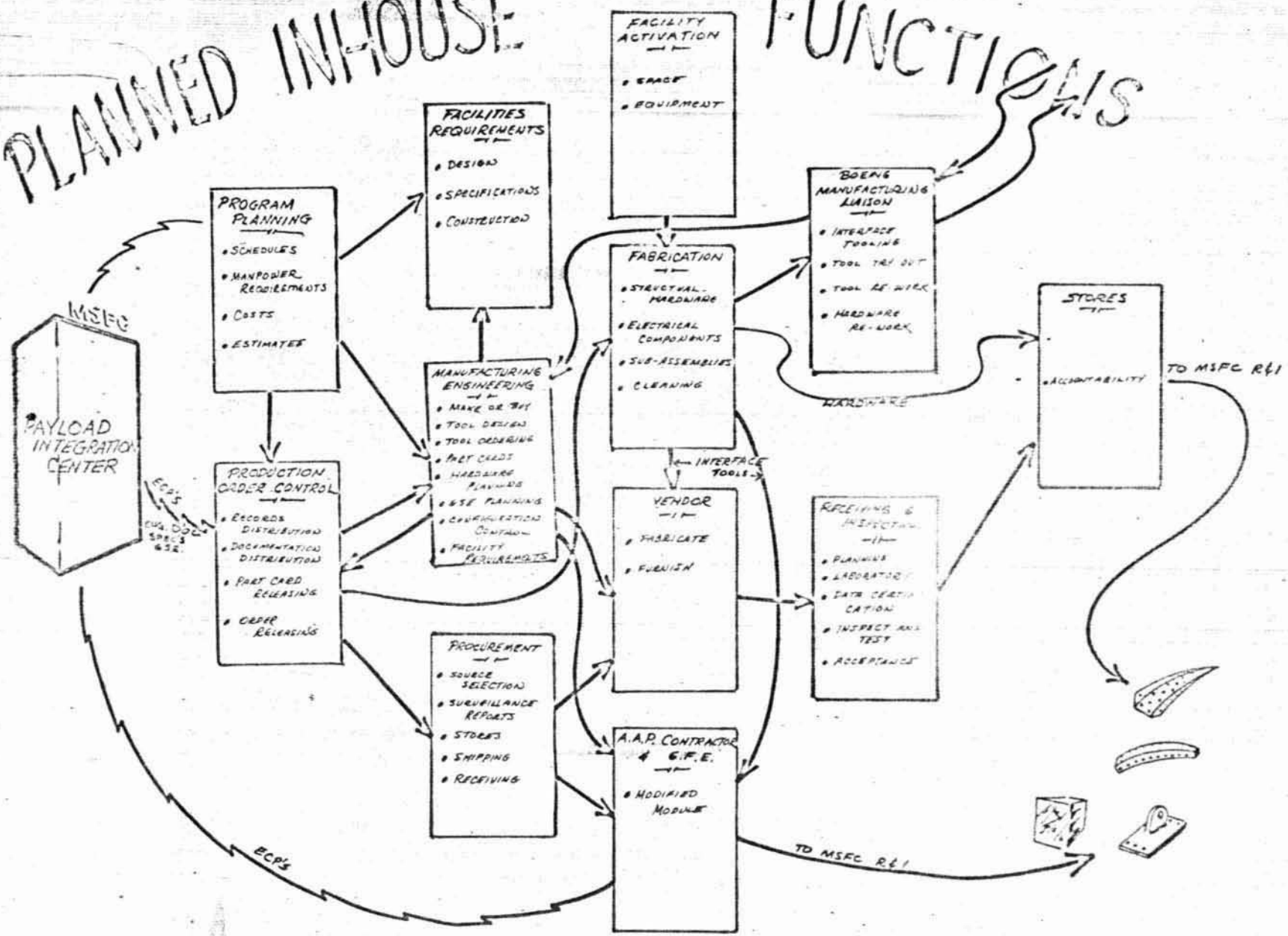
PLANNED IN-HOUSE FUNCTIONS



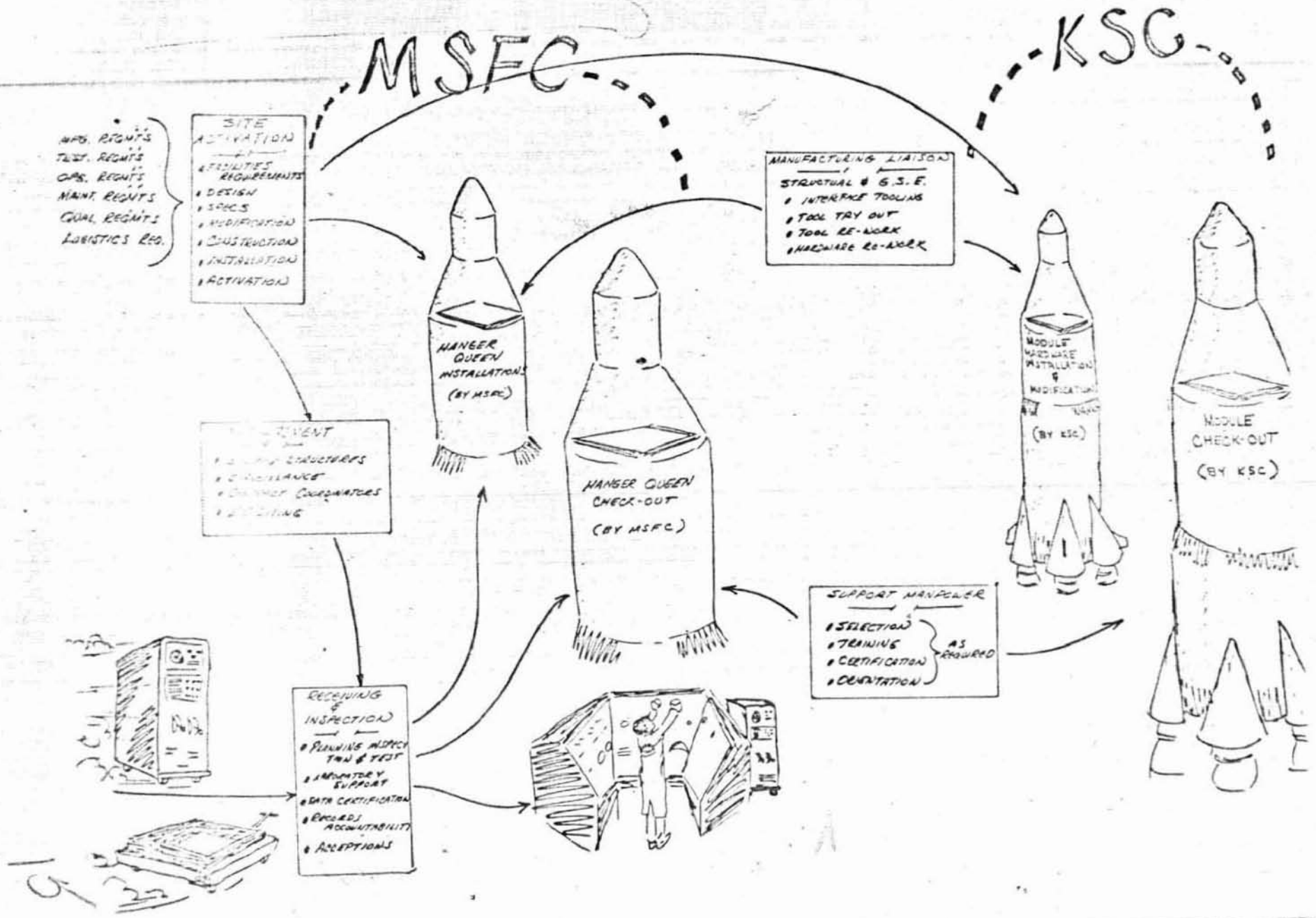
PLANNED SUPPORT FUNCTIONS



PLANNED INHOUSE FUNCTIONS



PLANNED SUPPORT FUNCTIONS



3.1 TOOL POLICY

3.1.1 INTRODUCTION

THIS SECTION DESCRIBES
~~The purpose is to establish~~ a single tooling policy for achieving the most efficient and economical tooling concepts and philosophies for the AAP Program.

This policy establishes the basic ground rules for the ordering, design and fabrication of the special tooling required. Inasmuch as a good share of the requirements will be one of a kind or limited quantity, hand layout and mechanical skill will be used in lieu of tools when practical.

3.1.2 INTERFACE MASTER TOOLING

An adequate number of master models and gages will be provided to control contractual and manufacturing interchangeability. Optical methods and/or numerical control techniques WHERE PRACTICAL will be utilized in conjunction with, or in lieu of, master tools.

The following considerations will apply to the ordering of master tools.

a. Inasmuch as a good share of the interface hardware will be one of a kind, or limited quantity, dimensional control will be used for control of hole patterns, except where exceptionally close tolerances are not compatible with practical manufacturing processes.

b. In cases where dimensional control is not practical, master tools will be used to establish the actual dimensions to which production tools or parts are set to insure interchangeability or repla. ability.

[illegible] OR REPLACEABLE ITEM
[illegible] BY CONTRACT

EITHER:

DOES NOT REQUIRE A MASTER TOOL because dimensional control is practical.

OR:

DOES REQUIRE A MASTER TOOL because exceptionally close tolerances are not compatible with practical manufacturing processes.

IF MASTER TOOL IS REQUIRED

IT IS CALLED:

A MASTER TOOL IS MADE

MASTER GAGE (MG) OR MASTER DRILL GAGE (MDG)

MULTIPLE SETS OF MG'S ARE DUPLICATED BY A REFERENCE GAGE. IT IS CALLED A MASTER CONTROL GAGE (MCG).

HOWEVER

THE MATING VEHICLE SECTION MAY BE MASTERED BY A SECONDARY GAGE (SEG)

OR

MULTIPLE SETS OF MDG'S ARE DUPLICATED FROM THE ORIGINAL UNIT.

Figure ~~2.2.2~~ 2.1.2B

(B) 12/28

IN THOSE CASES WHERE DIMENSIONAL CONTROL IS NOT PRACTICAL

MASTER TOOLS ARE REQUIRED TO

ESTABLISH THE ACTUAL DIMENSIONS (WITHIN TOLERANCES) TO WHICH PRODUCTION TOOLS ARE SET TO INSURE INTERCHANGEABILITY OR REPLACEABILITY BETWEEN PARTS AND ASSEMBLIES.

PROVIDE A PHYSICAL MEANS FOR CONTROLLING ITEM CONFIGURATION, SUCH AS CRITICAL CONTOURS AND HOLE PATTERNS.

FACILITATE AND CONTROL THE FABRICATION OF COORDINATED PRODUCTION TOOLS.

Figure 3.1.2A

c. Master tools, when required, will provide a physical means for controlling item configuration such as critical contours and hole patterns.

d. Sample parts will be used where practical, developed in the mockup for tubing runs between the CM, EXP., power supply, etc.

e. Where practical, the master tools will be coordinated and developed in the mockup.

3.1.3 FABRICATION TOOLING

Generally, the nature of the part processing required, the quantity required will determine the type tooling required. The following basic considerations should influence the decision as to the type of tooling to be ordered:

a. Simple details may be fabricated in normal production shops without tools.

b. Drill jigs will be provided only in those instances where they are the only means of maintaining the required tolerances.

c. Sheet metal parts formed to a contour which is critical in order to maintain proper fair on tolerances of less than plus or minus .03 may require special controlling operations (e.g., "handwork to hydro-block," etc.)

d. Machined parts may be made without special tooling or with partial tooling by using mechanic skill and standard machine setups.

3.1.4 SUBASSEMBLY TOOLING

Subassembly will be accomplished by hand fit-up and shop aid type tools. Subassembly tools will be ordered only when required dut to size, complexity, or interchangeability.

The following considerations will be applied to the subassembly tooling.

a. Drill plates will only be used where tolerance, hole size or material hardness or thickness dictate the need.

b. Clamping will be accomplished by using standard clamps (i.e., "c" clamps, toggle pliers, etc.) whenever possible.

3.1.5 Final Assembly and Installation Tools

Final Assembly and Installation Tools will only be ordered where tolerance requirements or interchangeable requirements verify their necessity. Installation tools will be made of lightweight materials for ease of handling wherever possible. Drilling provisions will be provided when required for coordination.

3.1.6 HANDLING EQUIPMENT

Handling equipment will be ordered when required for safety of personnel and equipment.

3.1.7 PLUMBING AND ELECTRICAL COMPONENT TOOLING

The plumbing and electrical component tooling will, as required, consist of sample parts developed in the mockup.

3.1.8 SPECIAL TEST EQUIPMENT

Any piece of equipment required to perform any in-process operation in fabricating Ground Support Equipment will be considered special tooling. This type tooling will be ordered, designed and fabricated by Manufacturing as required to perform in-process test requirements.

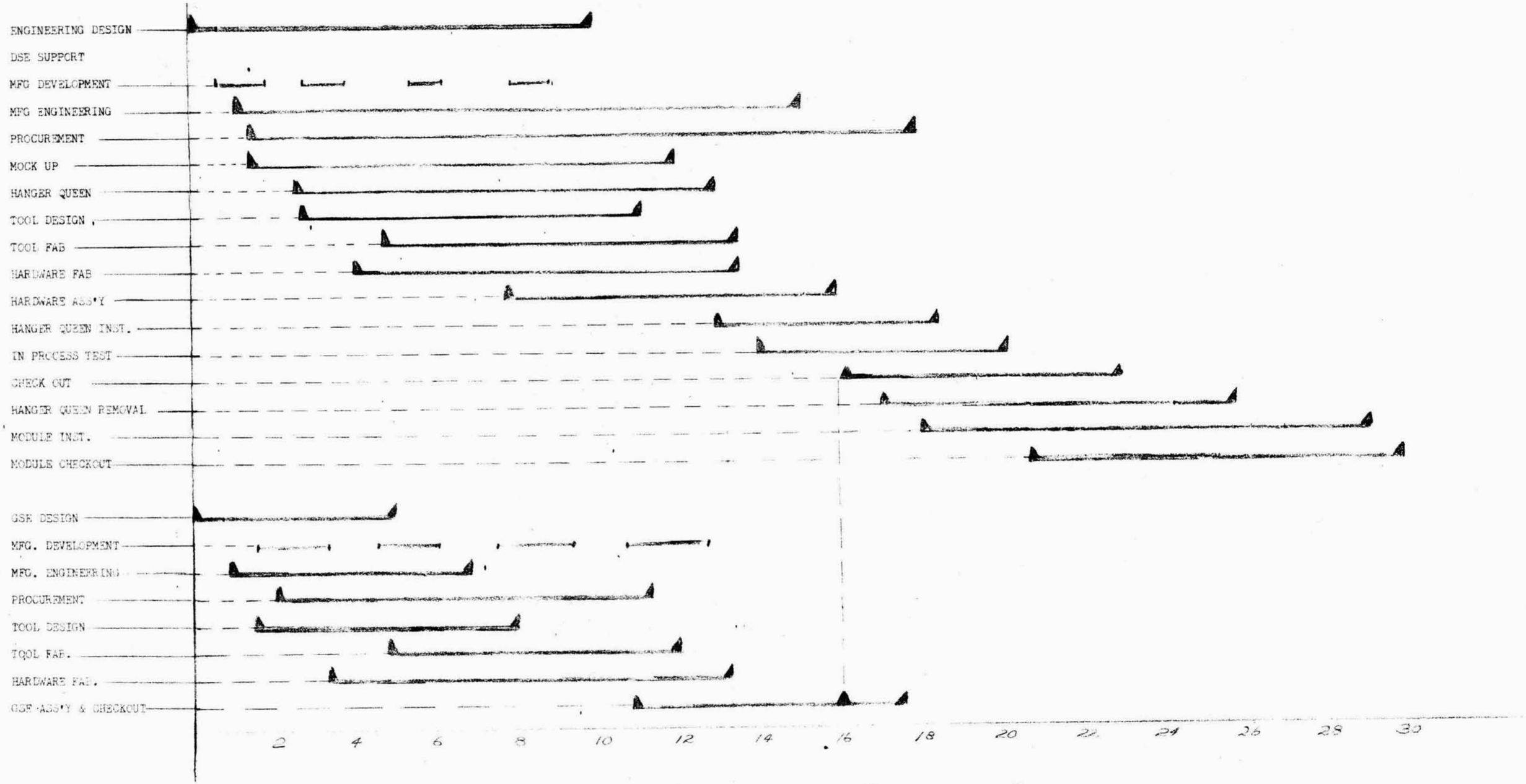
4.0 PROCUREMENT AND SUBCONTRACT

Raw materials, standard components and certain special parts and sub-assemblies are obtained from commercial sources by purchase orders and and subcontracts. Authority to purchase such materials or items is transmitted to the Materiel organization by means of a requirements release, prepared by the Manufacturing Engineer.

The source awarded the purchase order or subcontract is selected on an objective basis by Materiel accomplishes this accordance with detailed Branch and Division written procedures, a summary of which is contained in Document D5-XXXXX,"Procurement and Materials Management". Full consideration on each procurement is given to the ability of prospective suppliers to meet specifications and delivery schedules, assure quality control and provide necessary data to support Engineering and Reliability requirements. Interfaces between Boeing and its suppliers and potential suppliers are the responsibility of the Materiel organization. Materiel establishes supplier reporting requirements and follows up as necessary with inquiries and visits to the plants of suppliers, calling upon the other departments for technical support. Surveys and technical reviews are conducted to help assure satisfactory subcontract program progress.

5.0 MANUFACTURING PLAN

The Manufacturing Plan describes the methods and procedures which will be utilized to manufacture, install and test the hardware and systems in support of the Apollo Applications Program.



MANUFACTURING PHASE IN CHART

5.1 ~~MOCK-UP~~ DEVELOPMENT FIXTURE

5.1.1 INTRODUCTION

This plan outlines the requirements for a full scale, Class III Mock-up of the AAP Vehicle/Spacecraft.

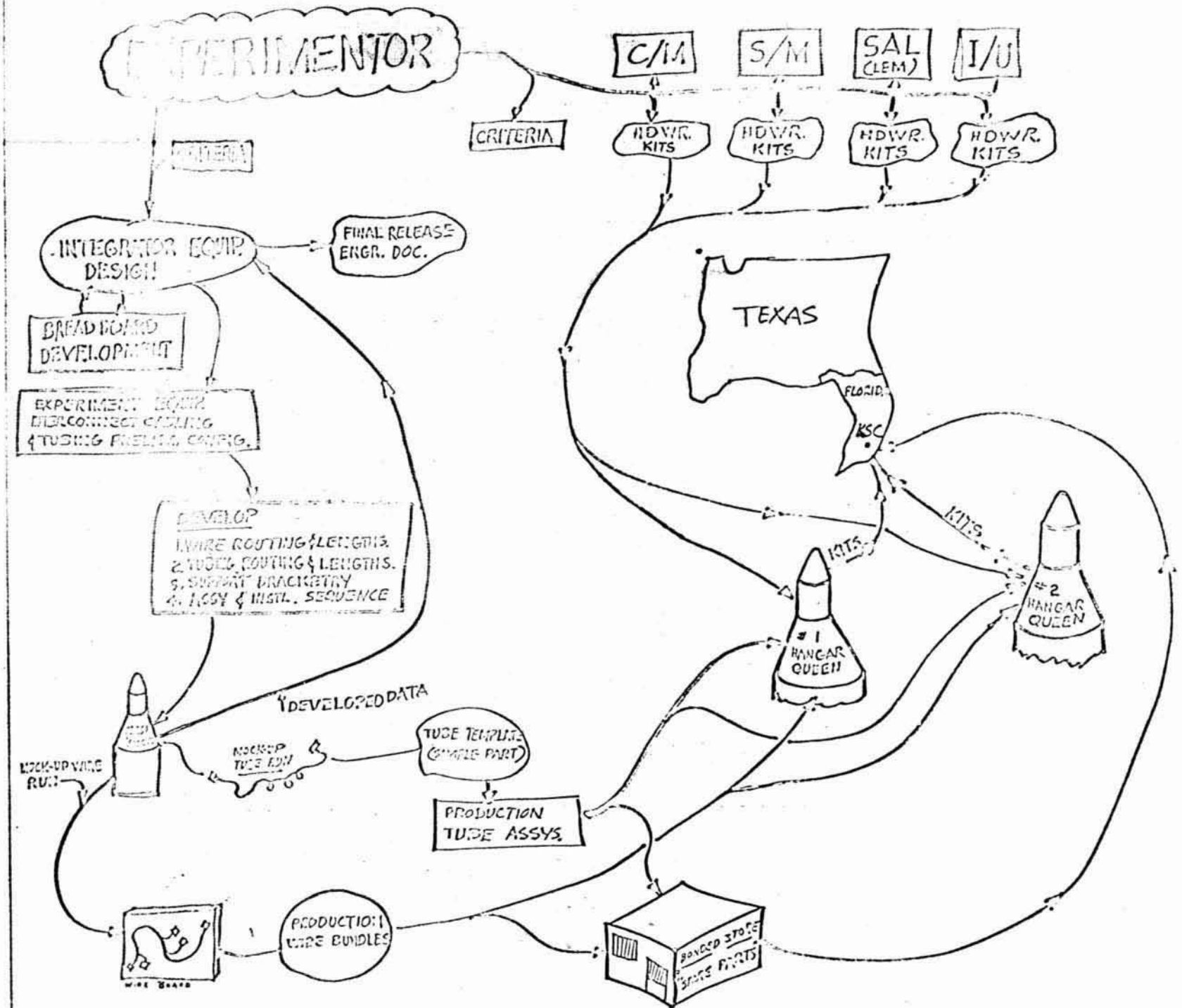
5.1.2 SUMMARY

The full scale, Class III Mock-up will provide a means for developing the basic Engineering design criteria for Vehicle/Spacecraft Experimental Systems and/or Equipment. The Mock-up will also provide Manufacturing with a means for fit-checking the first article of each system and/or equipment prior to installation into the Hanger Queen for systems integrated checkout.

The Boeing Company's approach to fabricating a Class III Mock-up is that construction consists of metal, plastic, fiber board or a good grade of wood. Structure is to production tolerances and of production materials. ~~All~~ EXCEPT WHEN ENGINEERING SPECIFIES Systems equipment is simulated. ~~Actual equipment is used whenever specified or whenever it's~~ ACTUAL OR ACTUAL EQUIPMENT IS THE MORE use is practical. PRACTICAL. (REF ILLUSTRATION ¶ 5.1.2 Pg 12A)

The primary ~~development~~ objective will be ~~for~~ THE DEVELOPMENT OF those wire bundles and tube assemblies that will be required to inter-connect the various items of equipment that are programmed for each specific experiment.

The Mock-up will also be used to evaluate the merits and feasibility of proposed changes to determine interferences and accessibility.

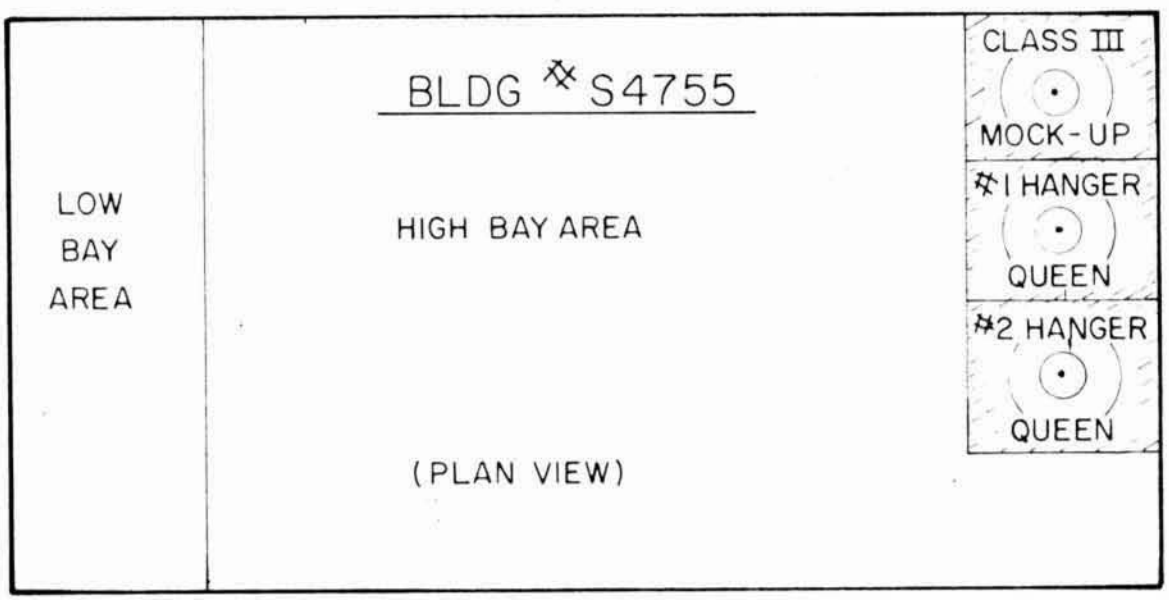

EXPERIMENTOR
C/M
S/M
SAL (CLEM)
I/U
CRITERIA
HDWR. KITS
HDWR. KITS
HDWR. KITS
HDWR. KITS
INTEGRATOR EQUIP DESIGN
FINAL RELEASE ENGR. DOC.
BREADBOARD DEVELOPMENT
EXPERIMENT EQUIP INTERCONNECT CABLING & TUBING INSTALL'N ENGRG.
DEVELOP
1. WIRE ROUTING & LENGTHS
2. TUBE ROUTING & LENGTHS.
3. SUPPORT BRACKETRY
4. ASSY & INSTL. SEQUENCE
DEVELOPED DATA
TEXAS
FLORID
KSC
KITS
KITS
KITS
#1 HANGAR QUEEN
#2 HANGAR QUEEN
MOCK-UP WIRE RUN
MOCK-UP TUBE RUN
TUBE TEMPLATE (SIMPLE PART)
PRODUCTION TUBE ASSYS.
PRODUCTION WIRE BUNDLES
BONDED STORE
STORE PARTS

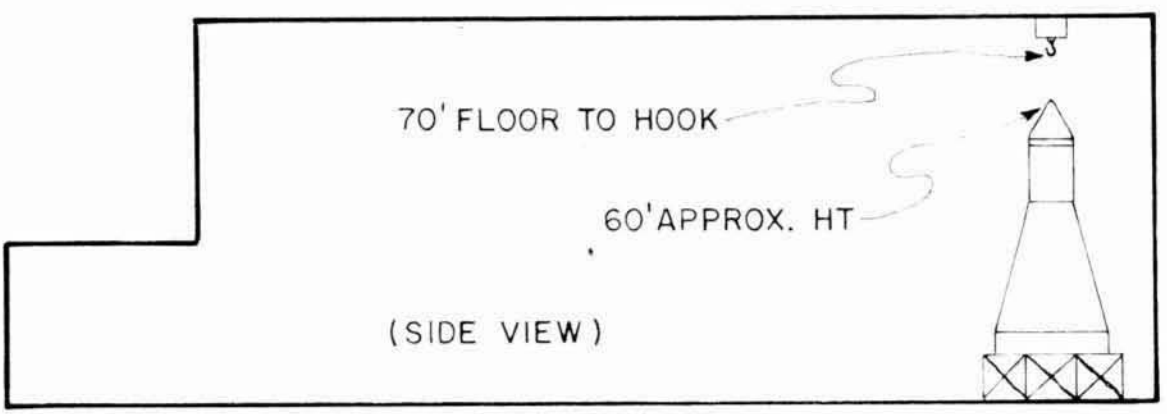
"PROPOSED MOCK-UP & HANGER QUEEN"
FACILITY AT MSFC
(NOT INCLUDING ACE & GSE AREA)

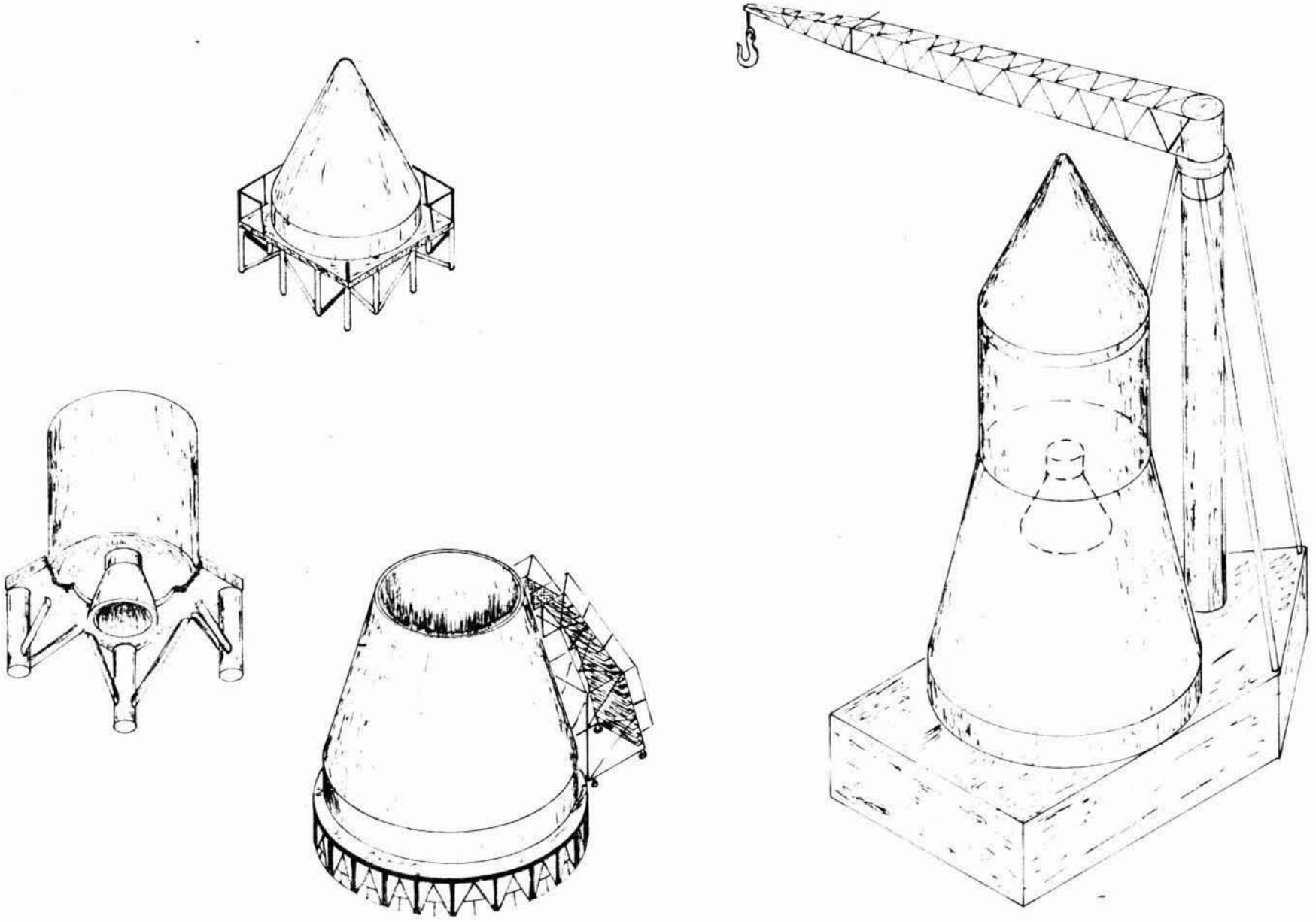
MSFC MFG ENGINEERING
BLDG # S4755
(ENVIRONMENTAL CONTROLED)

TRUSS CLEARANCE	CRANES NO. & TONS	HOOK HEIGHT	SQ. FEET
86.0' (HIGH BAY)	(2) - 90	70.0'	45,000
45.0' (LOW BAY)	(1) - 20	35.0'	8,000

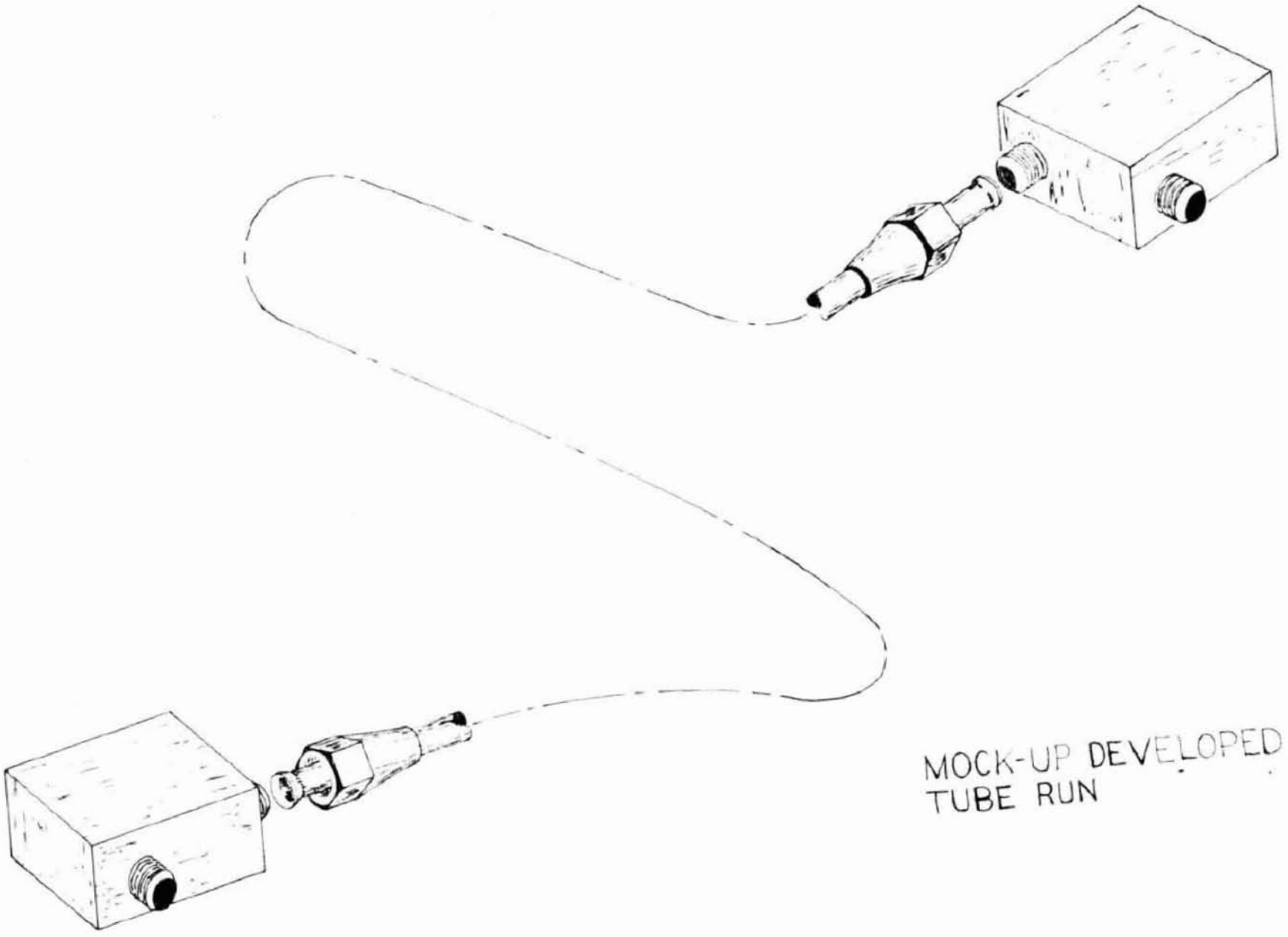
	CLASS III MOCK-UP AREA	# 1 HANGER QUEEN AREA	# 2 HANGER QUEEN AREA (IF REQ'D)	TOTAL AREA REQ'D.
1.	2,500 SQ FT	2,500 SQ FT	——	5,000 SQ FT
2.	2,500 SQ FT	2,500 SQ FT	2,500 SQ FT	7,500 SQ FT



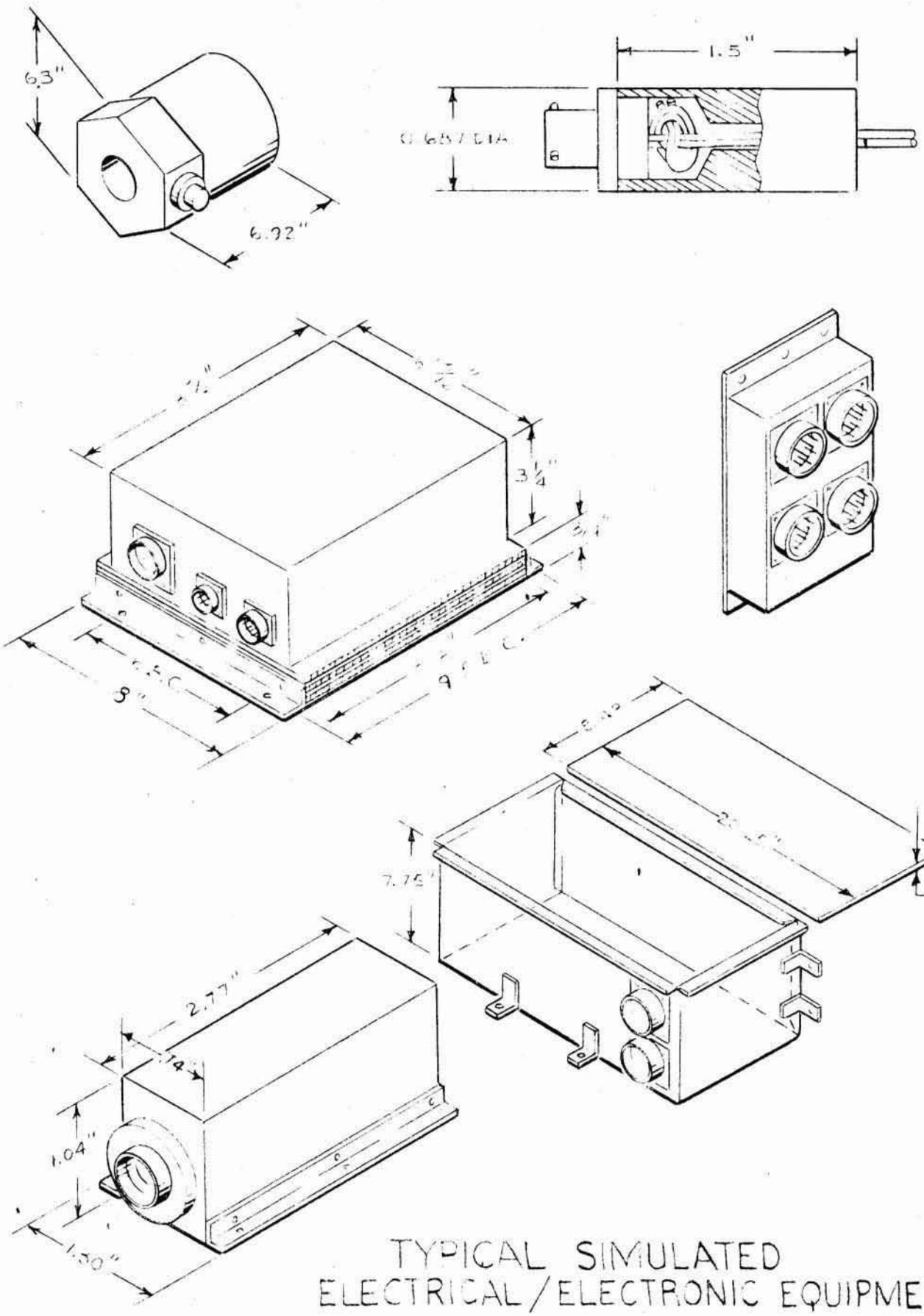




CLASS III MOCK-UP



MOCK-UP DEVELOPED
TUBE RUN



TYPICAL SIMULATED
ELECTRICAL/ELECTRONIC EQUIPMENT

5.1.3 PLAN

5.1.3.1 Mock-up Major Structure

The Mock-up will consist of the following three major sections.

a) Spacecraft LEM Adapter Section, including the Instrument Unit, which extends approximately 31.0 feet from Station 3222.6.

b) Service Module Section, including the Booster Engine and the Command Module Fairing, which extends approximately 15.5 feet forward from Station 3594.6 and 9.3 feet aft from Station 3594.6.

c) Command Module Section, which extends approximately 12.7 feet from Station 3761.6

The three major sections will be designed and built in separate Launch attitude positions; however, provisions will be provided for the stacking of any interfacing combinations and/or, all three major sections together. Internal and external work platforms will be available, as required, to provide accessibility to Manufacturing and Engineering personnel.

All basic internal Apollo Manned Lunar Landing Systems Components will be included in the three major sections.

The Mock-up will be modified for each specific experiment that requires Vehicle/Spacecraft Modification.

5.1.3.1 (Continued)

It is assumed that the Mock-up Modification specifications will be generated from the Vehicle/Spacecraft Modification requirements. These specifications must be available to allow maximum lead time, as required, to support the Modification schedules.

Optical tooling and an optical reference system will be provided for locating the simulated equipment onto the Mock-up structure.

Wiring and tubing runs will be developed on the Mock-up for each experiment's requirements. From preliminary Engineering data, Manufacturing will develop wire routing, breakout points, support bracketry, assembly and installation sequences. After Quality Assurance AND DESIGN ENGINEERING has accepted the developed Mock-up wire run, the developed data will be submitted to Project Engineering for recording onto formal Engineering Drawings.

Manufacturing will then proceed to fabricate forming boards from the Mock-up cable configuration. The ~~first production~~ ADDITIONAL wire bundles will then be assembled on the forming board.

Tubing runs will be developed similarly except that templates will be developed from Mock-up tube configuration. ~~The first production~~ ADDITIONAL tube assemblies will then be fabricated from the template.

30

5.1.3.1 (Continued)

After the development cycle of the Mock-up wiring runs and tubing runs have been satisfied, the runs will then be re-installed into the Mock-up.

5.1.3.2 Engineering Resp.

a) Provide Engineering documentation, as required, to build and/or modify the Mock-up.

b) Provide Mock-up liaison Engineering support to the Mock-up development effort.

5.1.3.3 Manufacturing Resp.

a) From Project Engineering documentation plan and release planning orders to Materiel for the procurement of all raw material, standards and purchased equipment; also, release shop orders to the Manufacturing factory shops for the fabrication, assembly and installation, as required, to build the Mock-up.

b) Maintain adequate configuration controls on all Planning records.

c) Establish interface coordination with the Facilities Organization.

d) Provide Mock-up liaison planning support to the Mock-up development effort.

5.1.3.4 Quality Assurance Resp

a) Verify the accuracy of all fabricated Mock-up structure and simulated systems equipment prior to installation into the Mock-up. After installation of the equipment, the accuracy of the critical interface points and surfaces will be checked.

b) Verify the as built configuration on shop orders released by Manufacturing Engineering.

5.1.3.4 (Continued)

c) Approve the developed Mock-up wiring runs and tubing runs, wiring boards and tubing templates.

5.1.3.5 Materiel [illegible]

a) Procure, expedite and store all Mock-up raw material, standards and pruchased equipment ordered on Manufacturing planning orders.

b) Provide the necessary receiving, shipping and reporting support to the total Mock-up [illegible] effort.

A5.1 AAP HANGER QUEEN

A5.1.1 INTRODUCTION

This plan outlines the requirements for a full scale prototype of the AAP Vehicle/Spacecraft which will be identified as a Hanger Queen.

A5.1.2 SUMMARY

The Hanger Queen will provide a means for fit-checking and testing of the integrated systems and/or equipment for each experiment prior to delivery to the source point of installation.

A5.1.3 PLAN

A5.1.3.1 Hanger Queen Major Structures

The Hanger Queen will consist of the following three major sections.

a) Spacecraft LEM Adapter Section, including the instrument unit, which extends approximately 31.0 feet from Station 3222.6.

b) Service Module Section, including the Booster Engine and the Command Module Fairing, which extends approximately 15.5 feet forward from Station 3594.6 and 9.3 feet aft from Station 3594.6.

c) Command Module Section, which extends approximately 12.7 feet from Station 3761.6.

The three major sections will be designed and built in separate launch attitude positions; however, provisions will be provided for the stacking of any interfacing combinations and/or all three major sections together.

A5.1.3.1 (Continued)

Internal and external work platforms will be available, as required, to provide accessibility to Manufacturing, Test and Engineering personnel.

All basic internal Apollo Mod. d Lunar Landing Systems Components will be included in the three major sections. Wherever possible, flight hardware or flight type hardware will be used; however, in some cases, where the function of the equipment will permit, it will be necessary to use Mock-up simulated equipment in order to minimize costs.

The Hanger Queen will be [illegible] for each specific experiment that requires Vehicle/Spacecraft Modification. During modification, the Hanger Queen will be used as the basic control media for interface tooling. See Interface Tooling Plan in Section 3.4.

It is assumed that the Hanger Queen Modification specifications will be generated from the Vehicle Spacecraft Modification requirements. These specifications must be available to allow maximum lead time, as required, to support the modification schedules.

Test Equipment will be provided and programmed into the test equipment for the ACE System, as required, to perform each experiment's integrated systems testing.

A5.1.3.1 (Continued)

Optical tooling and an optical reference system will be provided for locating equipment and checkout of various experiments.

A5.1.3.2 Engineering

a) Provide Engineering documentation, as required, to build and/or modify the Hanger Queen.

b) Provide liaison Engineering support to the various Manufacturing shops, as required.

A5.1.3.3 Manufacturing

a) From Project Engineering documentation plan and release planning orders to Materiel for the procurement of all raw material, standards and purchased equipment; also, release shop orders to the Manufacturing factory shops for the fabrication, assembly and installations required to build the Hanger Queen.

b) Maintain adequate configuration controls on all planning records.

c) Provide representation to the make/buy committee.

d) Provide representation to the Design Review Committee.

e) Establish interface coordination with the Facilities organization.

f) Provide liaison Engineering support to the various Manufacturing Shops, as required.

g) Provide representation to the configuration management organization.

A5.1.3.4 Quality Assurance

a) Verify the accuracy of the fabricated Hanger Queen structure. After installation of the equipment, the accuracy of the critical interface points and surfaces will be checked.

(19)

45.1.3.4 (Continued)

b) Verify the as built configuration on shop orders released by Manufacturing.

c) Provide the necessary support to the total Hanger Queen effort.

45.1.3.5 Materiel

a) Procure, expedite and store all raw material, standards and purchased equipment ordered on Manufacturing planning orders.

b) Provide the necessary receiving, shipping and reporting support to the total Hanger Queen effort.

5.2 HARDWARE FABRICATION AND SUB-ASSEMBLY

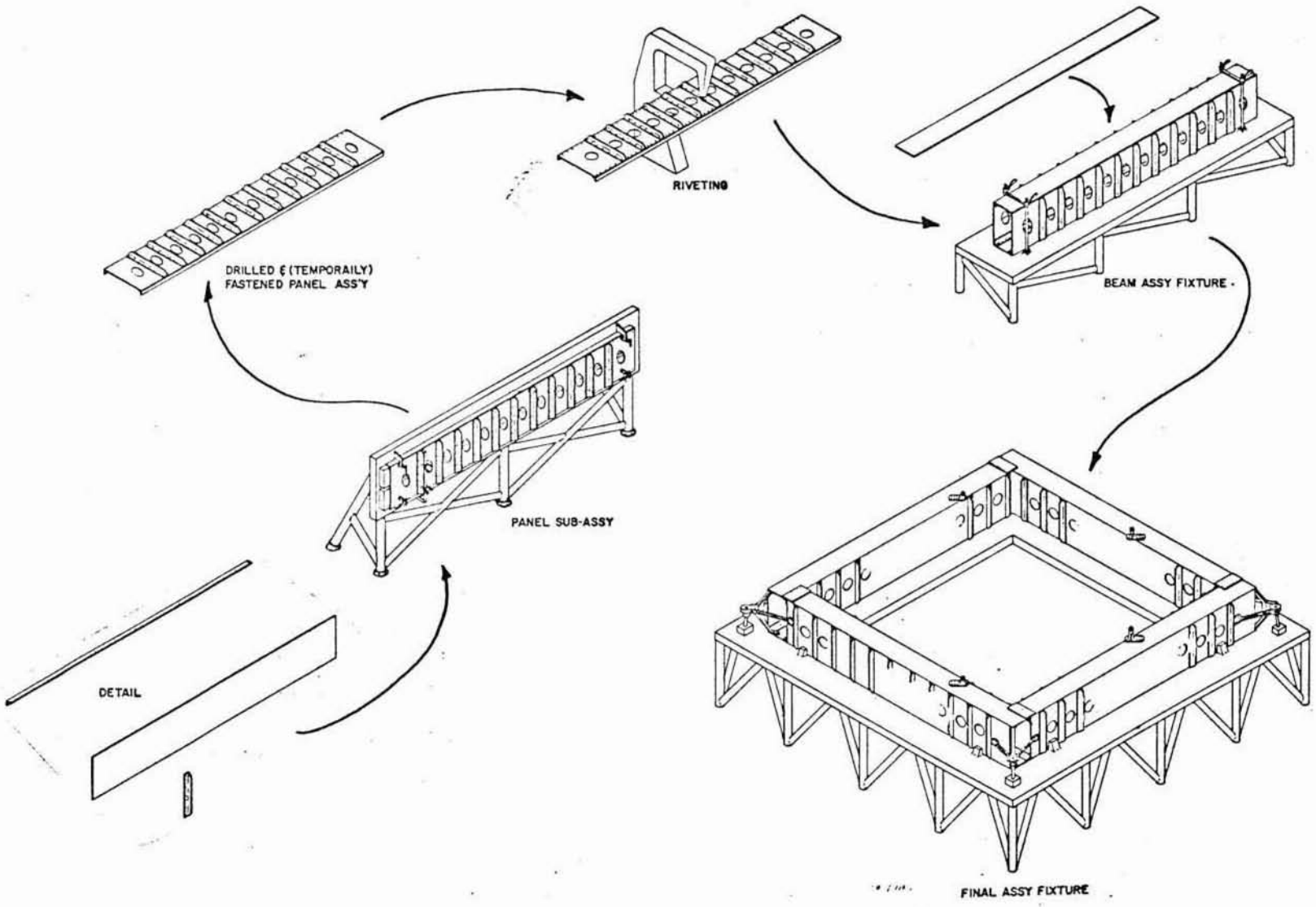
To provide the necessary hardware for the AAP, Manufacturing will be oriented as a fast response development-type organization. As experiments are advanced from concept through design to breadboard and to final production, Manufacturing Engineers will work with design engineers to become familiar with the hardware requirements. This close relationship will enable Manufacturing to start basic planning functions such as tool design, long-lead procurement and raw material procurement, in parallel with the hardware design. Utilization of this approach will allow production to commence almost immediately upon release of Engineering documentation. Tooling for detail hardware will be limited and will be designed for short-run application as described in Section 3.0, Tooling Policy.

Decisions to Make or Buy hardware will be predicated on in-house capability and schedule requirements. Make items will be ordered from one of three Boeing facilities - Huntsville, Michoud, or Wichita. Selection of the in-house source will be preferenced in the order indicated and will be governed by the extent of the facilities required to produce the desired component. Since it is anticipated that the hardware will be fabricated from aluminum, of average complexity and minimum in quantity, most of the manufacturing will be done in Huntsville. Complex parts requiring special tooling, contour milling, or other intricate operations will be ordered from Wichita. The Michoud Facility is being upgraded in capacity and capability and will be available at the time work and hardware will be required.

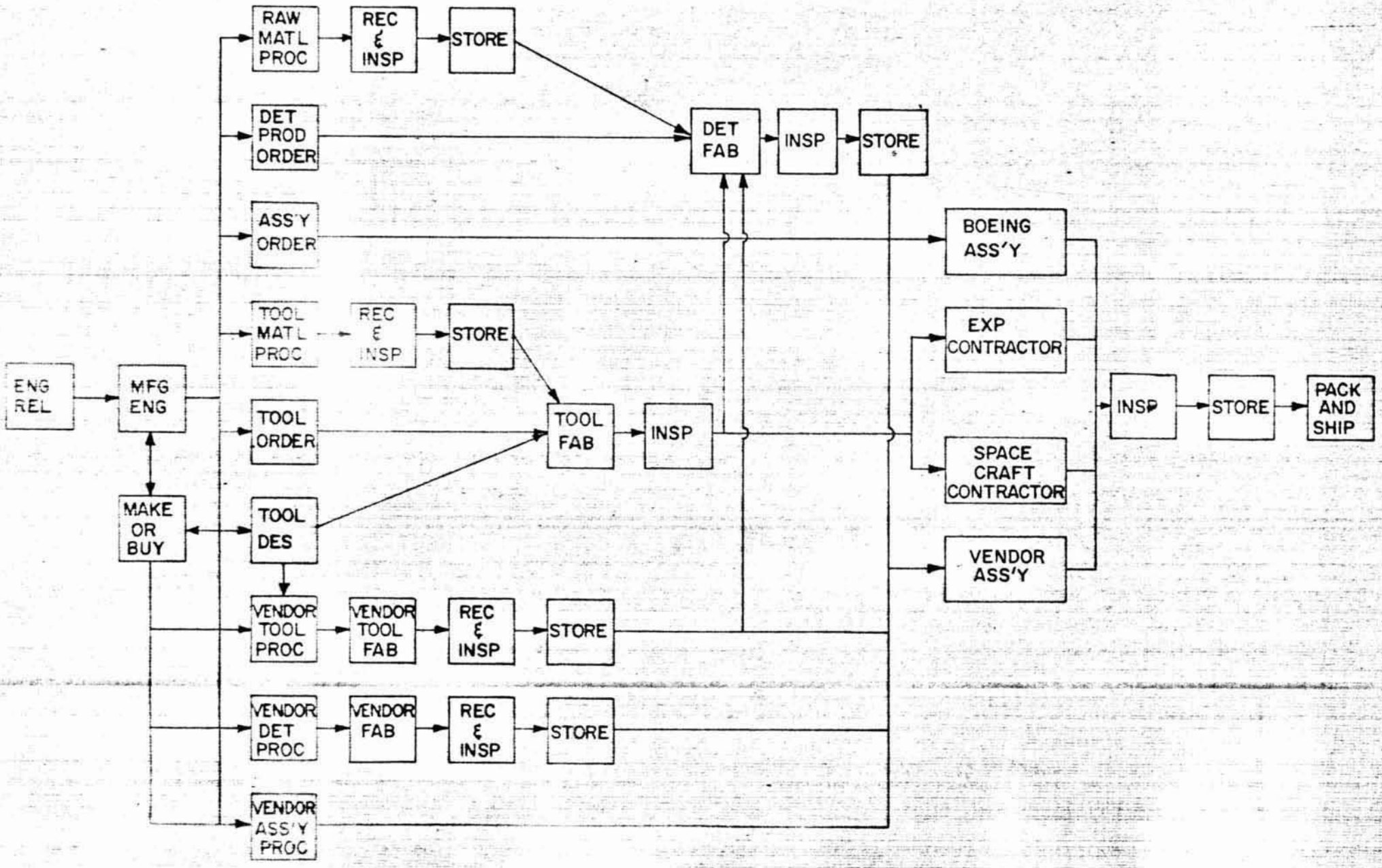
Shop orders will be simplified to provide a minimum of paper flow time. Manufacturing engineers, working in close conjunction with the shops, will furnish liaison support for tool tryout and will revise and incorporate engineering changes into shop orders as necessary.

Since this is a limited production program, sub-assemblies will be made using shop aid type tooling and hand fit-up. Complex tooling will not be used unless demanded by tolerances which cannot be met by hand fit-up or where the size of the assembly makes hand fit-up impractical. An example of this is the exp. module rack. Tooling will be required to build this structure. All sub-assembly work will be done in Huntsville, except in cases where the assembly is too large or where special skills and/or equipment are required. In these cases, the work will be done at Michoud. All hardware, detail and sub-assemblies will be inspected as prescribed in Section and then routed to Boeing stores for packaging and shipment to MSFC.

L. E. M. EXPERIMENT RACK ASS'Y



MANUFACTURING FLOW



5.3 FINAL ASSEMBLY AND INSTALLATION

Installation of hardware and equipment into the Hanger Queens and Modules will be done by MSFC and KSC Personnel assisted as required by Boeing personnel. Close technical support will be provided on all installation functions by assigning skilled mechanical and electrical/electronic engineers to work directly with MSFC and KSC personnel. Their prime function will be to correlate installation data and to transmit this data to the Payload Integratinn Center. These engineers called Design Support Engineers(DSE) will work closely with MSFC, KSC personnel, design engineering, manufacturing and quality on such items as interference fits, installation improvements, checkout and test, schedules, space requirements, and MRB actions. The use of Design Support Engineers will provide for a smooth flow of hardware and installations through the MSFC and KSC Facilities.

At the initiation of the program to properly familiarize the Design Support Engineer with the program, they will be assigned to the Module and Experiment Contractors Facilities. Here they will spend approximately two months of familiarization working and teaming with Engineering, technical and shop personnel.

As design requirements are defined and installation and checkout commences in the hanger queens, these engineers will be assigned to MSFC and will then follow the program through installation of the experiment package in the module. Later as the program enters Phase II, they will be again assigned to Module Contractors to where they will perform Liaison Engineering functions.

The Boeing Company, as prime contractor for the S-IC, assigned over 500 engineering and manufacturing personnel to MSFC and has acquired considerable experience in establishing an efficient Design Support Engineer Program.

5,4 IN PROCESS TESTING

This section contains a description of the activities, services and equipment required to support the in process test of experimental hardware, GSE and their installation and check-out.

5,4,1 SFC EQUIPMENT

This equipment is referred as Special Facilities Contract (SFC) Equipment since it will be under the facilities provisions of the A. A. P. Contracts.

Finance and Facilities are responsible for further identification of this equipment as Special Test Equipment or Industrial Facilities Equipment.

5.4.1.1 ACQUISITION

The SFC equipment required for the installation and checkout will be determined by IPT and GSD. This equipment will be ordered through Huntsville Facilities by IPT Test Operations.

This equipment will be delivered to Boeing at Huntsville direct from vendor sources, if not available. Materiel at Huntsville will receive the equipment. Upon completion of Q&RA receival inspection, Finance will identify the equip-. ment and record it for accountability. The receival inspection will include initial test and calibration.

5.4.1.2 CALIBRATION AND CERTIFICATION

After receiving the SFC, Q&RA will route the equipment to the MSFC calibration laboratories for initial calibration. Q&RA will provide calibration/ certification and maintenance support services for all SFC equipment. IPT Stage TEst Operations will provide Q&RA with a list of this equipment based on GSD requirements for use in determining Q&RA support requirements. It is anticipated that approximately 200 items of equipment will require calibration by Q&RA.

Recalibration of the SFC and commercial equipment will be performed on a cycled basis to assure maximum availability and minimum loading of the calibration facilities. Q&RA will establish equipment cycling to conform to this plan and will enter calibration information for this equipment in the Calibration/Certification Records System per D5-XXXXX or an equivalent Saturn Booster Branch document. An IBM print out will be provided to IPT/Test Operations and will be used for scheduling recalibration.

5.4.1.3 STORAGE AND CONTROL

After calibration by Q&RA the equipment will be delivered to the IPT Instrument and Equipment Crib by Q&RA and stored until required for use. Records for all equipment will be maintained and a charge-out system used for control and location. All equipment going to or from Q&RA for calibration will be entered on the crib records.

5.4.1.4 PHASING

This SFC equipment is available within all Boeing Complex.

5.4.1.5 TYPE AND QUANTITY OF SFC EQUIPMENT

ITEM	MFG.	MODEL	QUANTITY
Analyzer, TV	B&K	1076	1
Analyzer, Wave	HP	302 A	1
Analyzer, Wave Dist.	HP	330 D	1
Bridge, VHF	HP	803 A	1
Bridge, Impedance	ESI	250 CI	1
Bridge, Wheatstone	L&N	5303 S-2	2
Camera, Oscilloscope	TEK	C12	2
Converter, Frequency	HP	525A	1
Converter, Frequency	HP	525C	1
Converter, Frequency	HP	526A	1
Counter	HP	524C	1
Decade Box, Capacitance		1419A	2
Decade Box, Capacitance		1419B	2
Degausser, Tape	CED	TD-2093	1
Detector, VHF	HP	417A	1
Flowmeter, 10-125 SCFM	F-P		1

5.4.1.5 Continued

ITEM	MFG.	MODEL	QUANTITY
Gage, Pressure	Heise	0-25 PSI	2
Gage, Pressure	Heise	0-50 PSI	2
Gage, Pressure	Heise	0-200 PSI	3
Gage, Pressure	Heise	0-3000 PSI	2
Gage, Pressure	Heise	0-500 PSI	2
Gage, Pressure	Heise	0-1000 PSI	2
Gage, Pressure	Heise	0-2000 PSI	2
Gage, Pressure	Heise	0-5000 PSI	2
Gage, Pressure	Heise	0-15 PSI	2
Gage, Pressure	Heise	0-4000 PSI	3
Generator, Pulse	Data Pulse	102	4
Generator, Sweep	Boonton	240A	1
Generator, Function	HP	202A	2
Generator, Signal	HP	205AG	1
Generator, Signal	HP	608C	2
Generator, Signal	HP	612A	2
Generator, Sine Wave	Hathaway	N-2	2
Jig, Camera	Res & Lin Chart		1
Meter, Frequency	Beckman	7360	5
Meter, Differential	Fluke	803B	10
Meter, DC Micro Volt	HP	425A	2
Meter, Megohm		301B	2
Meter, Power	HP	431A	1
Meter, RMS	Fluke	910A	2

5.4.1.5 Continued

ITEM	MFG.	MODEL	QUANTITY
Meter, VTVM	HP	400L	2
Meter, VTVM	HP	410B	2
Milliammeter, Clip-on	HP	428B	1
Multiplier, Period	HP	526C	1
Oscillator, Test	HP	650A	1
Oscillator, Test	HP	202C	2
Oscillator, Transfer	HP	540B	1
Oscillograph	M-H	1508, W/8 M-5000 Galvos	2
Oscilloscope	HP	130B	1
Oscilloscope	TEK	310A	1
Oscilloscope	TEK	535	1
Oscilloscope	TEK	545	5
Oscilloscope	TEK	555	1
Oscilloscope	TEK	661 W/4S1 & 5T1 Plug Ins	1
Oscilloscope	TEK	585	1
Plug In, Oscilloscope	TEK	CA	7
Plug In, Oscilloscope	TEK	L	2
Plug In, Oscilloscope	TEK	M	2
Plug In, Oscilloscope	TEK	Z	2
Processor, Oscilloscope	CEC	23-109B-P6 W/23-001A Mag.	1
Supply Power	NJE	LC-35-10	2
Regulator, Press	Tescom	26-1027	2

5.4.1.5 Continued

ITEM	MFG.	MODEL	QUANTITY
Supply, Power 18 VDC	NJE	ECR 36-30	6
Supply, Power	Kepco	SC-32-0.5	2
Tester, Tube	Kickok	539C	1
Tester, Relay	TR	905	1
Tester, Dead Weight	Ashcraft		1
Unit, Time Int.	HP	526B	1
Actuator, Shutter	TEK	016-205	1
Amplifier, Probe	TEK	015-011	2
Attenuator, VHF	HP	355C	1
Attenuator, VHF	HP	355D	1
Cable, Terminated Output	HP	608A-16D	1
Cart, Oscilloscope	HP	AC-115B	1
Cart, Oscilloscope	TEK	500/53 A Mod. 741A	7
Case, Thermocouple	Alnor	4025	2
Coupler, Directional	HP	764D	1
Decade, Resistance Box	ESI	DB-52 .1 ohm	2
Decade, Resistance Box	ESI	DB-52 1.0 ohm	2
Decade, Resistance Box	ESI	DB-52 10 ohm	2
Decade Resistance Box	ESI	DB-52 100 ohm	2
Degausser, Head	Ampex	704-61	1
Filter, Low Pass	HP	360A	1
Fuseholder	HP	608A-95A	2
Filter, Low Pass	HP	360C	1
Flowmeter	Fischer & Porter	10A1735B	1
Hood, Viewing (5")	TEK	016-001	7

5.4.1.5 Continued

ITEM	MFG.	MODEL	QUANTITY
Hood, Viewing	HP	10175B	1
Hood, Viewing (3")	TEK	016-002	1
Meter, Amp.	Weston	931	2
Meter, VOM	Simpson	270	7
Meter, Milliamp	Weston	931	2
Meter, VOM	Triplett	630-NA	7
Meter, Clamp-On Volt AMP	Weston	633	1
Mount, Thermistor	HP	478A	2
Plug-In, Oscilloscope	TEK	Type D	3
Plug-In Oscilloscope	TEK	Type H	3
Probe	TEK	010-070	4
Probe, Voltage Divider	HP	AC 21A	2
Probe, Trigger	TEK	010-100	1
Probe, Cath, Follower	TEK	010-108	1
Pyrometer	Alnor	2300 B	1
Probe, General Purpose	TEK	010-024	3
Probe, Oscilloscope, Low Frequency	HP	AC-21J	2
Probe, AC Current	TEK	010-037	2
Probe, Air Temp Thermocouple	Alnor	2450	1
Probe, Flexible Wire Thermocouple	Alnor	2450	1
Probe, Immersion Thermocouple	Alnor	2480	1
Probe, Surface Thermocouple	Alnor	2545	1
Probe, Passive	TEK	010-110	1
Probe, Passive	TEK	010-111	1

5.4.1.5 Continued

ITEM	MFG.	MODEL	QUANTITY
Stroboscope	Mercury	451-AL	1
Termination, Oscilloscope	TEK	011-045	4
Termination, Coaxial	HP	908A	4
Tester, Transistor	Hickok	850P	2
Tip, Probe	TEK	206-045	10
Transformer	HP	AC 60B	1
Valve, Manual 0-6000 PSI	Robbins	SSTA250-4T	6
Valve, Manual 0-6000 PSI	Robbinsl	SSTG250-4T	6
Variac	Ohmite	VT8G	1
Variac	Ohmite	VT20B	1

5.4.2 TECHNICAL PROCEDURES

5.4.2.1 ACCEPTANCE AND FUNCTIONAL TESTS

Test procedures prepared by Inplant Test are designated as either acceptance test procedures or functional test procedures based upon the requirements of NPC 200-2. Test procedures for non end items are designated functional test procedures. End item test procedures that require NASA approval are designated acceptance test procedures.

5.4.2.1.1 PART AND COMPONENT TEST

The Test Procedures Group will prepare and document functional test procedures for all vendor fabricated and Boeing fabricated parts and components for which tests are required.

5.4.2.1.2 INPROCESS TESTS

Test procedures for drawer level tests will be prepared by the procedures group and shall conform to the test requirements released by GSD Experiment Test Requirements Group at Huntsville.

5.4.2.1.2 Continued

In the event schedules do not permit the release of formal test requirements for particular drawing or experiment assemblies, IPT Test Engineering shall determine an abbreviated test to be performed. The Procedures Group will prepare procedures for the abbreviated test and obtain concurrence from GSD TEst Requirements prior to testing. A test will be accomplished on each drawer at Huntsville.

5.4.2.1.3 GSE RACK AND CONSOLE TESTS

All completed test racks, consoles or carts will be subjected to acceptance or functional tests. Test Procedures will be prepared and documented by IPT Procedures Group. The procedures will include any necessary test setup instructions. A selected portion of these tests, as determined by GSD Test Requirements Group will be performed prior to shipment. Calibration Procedures for those units (racks, consoles or carts) requiring calibration will be prepared and documented by the IPT Procedures Group. These procedures will include steps or instructions for adjustment of those items of commercial off-the-shelf equipment requiring frequent adjustment or calibration.

5.4.2.2 GSE INSTALLATION INSTRUCTIONS

Installation instructions will be prepared by planning on M or TP's to allow flexibility during installation. If a requirement for documented installation procedures exists due to the complexity of the equipment installation, the IPT Procedures Group will prepare and document these as required.

5.4.2.3 TEST STATION CALIBRATION AND CHECKOUT PROCEDURES

The overall GSE test station will be subjected to an acceptance test to verify that the performance of the test station will meet all test requirements of the mission and that functional compatibility exists between

5.4.2.3 Continued

each unit of the test station and the stage simulator, The IPT Stage TEst and Checkout Unit will prepare and document the procedures for system level checkout and calibration.

5.4.2.4 OPERATING INSTRUCTIONS

Normal Engineering design documentation will be used as operating instructions for Boeing designed and fabricated test equipment unless authorization througp A. A. P. Systems Office is obtained to prepare special manuals. It will be prepared and documented by the organization which designed the equipment. Operating instructions for "buy" items should be furnished by the vendor. Operating instructions for all test equipment will be referencdd or incorporated in the test procedures prepared by IPT.

5.4.2.5 PARTICIPATION IN VENDOR TESTS

Representatives of IPT may participate as observers in acceptance tests of "buy" items at the vendors' site to monitor and familiarize themselves with the vendors' test methods and test procedures. The vendors' test procedures may be used or incorporated into IPT Test Procedures.

5.4.2.6 PROCEDURE VERIFICATION

The IPT test procedures for common and repetitive items will be verified during the first-part tryout of the procedure. Verification will be witnessed be representatives of Engineering, Q&RA and IPT.

Upon completion of a successful verification, Engineering, Q&RA R-Qual and IPT representatives will sign the vellum of the verification page. If the procedure must be changed, a decision will be reached on the spot to determine if a new verification is required. If only minor change is needed, an agreement will be reached concerning signing of the verification. The Engineering signature attests that the test procedure with the associated

5.4.2.6 Continued

test equipment satisfactorily accomplishes a comprehensive test of the item being tested. The Q&RA signature indicates that the procedure verification has been accomplished with test equipment inspected and functionally tested or calibrated to applitable documentation, and that the verification has met contractual requirements. The IPT signature indicates that authorized personnel have conducted and observed the procedure verification and that it can be accomplished by IPT with the equipment and procedures provided.

5.4.2.7 TECHNICAL PROCEDURE DOCUMENTATION

5.4.2.7.1 Numbering System

The technical procedures prepared by Inplant Test will be issued as Class 2 drawings ~~under the NASA drawing system~~. They will be written on standard 8½ x 11 drawing sheets and identified with numbers.

5.4.2.7.2 Test Level Identification

The level of test for which the procedures will be used is indicated by a dash number of the Documentation Release List (DRL) which releases the procedures. There will be a correlation between the DRL dash number and the level of test will be similar to the following:

Level of Test	DRL Dash No. (Huntsville)	DRL Dash No. (Vendors)
1	-211	-221
2	-212	-222
3	-213	-223
4	-214	-224
5	-215	-225
6	-216	-226

5.4.2.7.3 Technical Procedures Index

A cross reference to identify the correct procedure to use when testing or calibrating a particular item will be provided by the Technical Procedures Index. The Index will be prepared and maintained by the Huntsville IPT Procedures Group. The Index will be an IBM printout issued and released as a Class I document.

5.4.2.8 Interfaces

5.4.2.8.1 Engineering Interfaces

Acceptance criteria in the form of engineering test requirements will be utilized by IPT to prepare test procedures. The test requirements

will be provided to IPT in document form by the GSD Test Requirements Group. All problems with the test requirements will be coordinated with the GSD Test Requirements Group. The GSD Test Requirements Group will approve each test procedure prior to release indicating that the test procedure satisfies the test requirements. In addition, an Engineering representative will be present at the verification of all procedures and will sign the verification page upon acceptance of a successful verification.

5.4.2.8.2. R-Qual Interfaces

The IPT Test Procedures Group will coordinate with R-Qual in matters pertaining to the review and approval of test and calibration procedures. Test procedures will be routed to R-Qual for review or approval in accordance with MPC 200-2. An R-Qual representative will be present at the verification of all procedures and will sign the verification page upon acceptance of the verification.

5.4.3 PLANNING

5.4.3.1 GSE Planning

All planning records associated with the AAP and Experiment set of GSE will be accomplished in accordance with the provisions of Document D5-XXXXX. The SRC will provide the historical records and configuration and calibration. In addition, the limited release system will provide for the control and recording of temporary configuration changes during the fabrication, assembly, installation, evaluation and testing of the GSE.

Design Support Engineering and R-Qual Support Planning will initiate and maintain appropriate planning and configuration control during the fabrication and assembly of the GSE. These records will be under the

surveillance of Q&RA. The reproduction planning paper is the responsibility of Production Control.

GSE Planning will initiate and maintain appropriate planning and configuration control during installation, evaluation and testing of the GSE. They will provide an order release system to meet program requirements, a record and file system, a data collection and distribution system. They will initiate requests to other organizations for services. These records and the work accomplished in accordance with these records will be under the surveillance of Q&RA and systems test.

Responsibility for modification planning will be determined by the Change Action Committee for committed changes and by the organization controlling the affected hardware for non-committed changes.

5.4.3.2 GSE Receival Records at Factory

5.4.3.2.1 Received from Manufacturing by IPT

The records accompanying the GSE delivered to IPT for functional test will consist of an M or TP, SRC and the EEL. The tested GSE will be returned to Manufacturing on M or TP to be packaged and shipped.

5.4.3.3 Receival of GSE Records at Factory from Subcontractor
Boeing subcontractors will provide records for GSE per Purchase Order notes in accordance with Engineering Specs. These records will be checked by Q&RA during receiving, inspection, and design support engineering or manufacturing support planning for completeness. The configuration of subcontractor equipment will be transferred from subcontractor records to the PLP & SRC form by DSE/Planning.

5.4.3.4 Test Records of GSE at Michoud and R-Qual
DSE Planning or Manufacturing Support Planning will submit released planning records on GSE delivered to IPT.

The applicable test procedure will be referenced on the IPT released planning records after it has been screened to ensure that the procedure is commensurate with the part to be tested. Q&RA will be responsible for assuring that the test is conducted and the test results are in accordance with the applicable test procedure.

5.4.3.5 Planning Records Transfer with GSE from Michoud to Huntsville
The packet of planning records necessary to accompany the GSE equipment that is transferred to Huntsville is listed below:

PLP - Parts List Page

TDS - Test Data Sheets

SRC - Service Record Card

T&CL - Time & Cycle Log

TECL - Test Equipment Configuration Log

Production Control will be responsible for assemblying this record packet and preparing it for shipment. These records will be itemized on the MSFC Form 57 that is used for the GSE transfer. Q & RA will assure that all planning records in this packet have been properly processed and

bought-off and that the necessary records are included.

5.4.3.6 GSE Installation Records

5.4.3.6.1 Installation

DSE Planners will write and release M or TP's and provide other necessary planning records for installation of the assembled racks of GSE in the test complex in accordance with released installation documentation. Q & RA will verify compliance with this documentation.

5.4.3.7 Rework Records

During the IC&C, malfunctions, engineering changes and refinements to the GSE will require rework. All rework will be scheduled, described and accomplished in accordance with the applicable SRC forms. All rework and its planning will be monitored by Q&RA to assure compliance with released documentation. The malfunctions, engineering changes and refinements to the GSE may necessitate acquiring new parts. The process of procuring new parts is as follows:

> DSE Planning will initiate a coordination sheet, concurred with using organization, to Manufacturing Engineering. It will include type, quantities and dates required to meet the IC&C schedule and will request immediate action from the factory. DSE will initiate authorization to Material for acquisition of the parts. If they cannot meet the required dates, Operations must re-evaluate the impact upon the schedules and determine the most expeditious methods of obtaining parts necessary to accomplish the change or repair.

5.4.3.8 Calibration/Certification Records

DSE Planning will provide the M or TP's authorizing the calibration and certification of all GSE at MSFC. Applicable calibration procedures will be referenced on the M or TP. Calibration data will be recorded on calibration procedure test data sheets, oscillographic recordings and computer printouts. GSE cal/cert operations will be scheduled for minimum interference with the test operations and the work load of the Q&RA cal/cert lab.

5.4.3.9 GSD and IPT Engineering Evaluation Records

DSE Planning will document the changes made by GSD and IPT Engineers. The system for documenting this evaluation is tentatively the limited release system. This record in its final form should consist of an M or TP and the SRC. It is to be used to control configuration in this "make-operable" period prior to final checkout and calibration, for systems test acceptance test, to accommodate the necessary changes without going to final documentation until the changes are firm.

5.4.3.10 Acceptance Test Records

The final acceptance test of Test and Checkout stations will be documented on the SRC. It will be witnessed by Q&RA and R-Qual. Q&RA will maintain a complete historical record of planned and unplanned events. This record will be presented to System Test

5.4.3.10 Acceptance Test Records. (Continued)

by GSFA and DSE for acceptance. Upon acceptance, System Test and Customer will sign the ITEC Form 7/1.

IPT/Test Engineering will prepare the Test and Checkout Narrative Summary Report of the test station. It will provide identification of the test period, a summary of problems encountered, corrective action taken with reference to ADCN if applicable, incomplete tests, and those changes to be incorporated at a later date. The report will be available upon request to other interested organizations.

Acceptance test data includes all data generated from component acceptance through the final acceptance test of the GSE. All test data during IC & C will be recorded by IPT/Test Engineering and routed to the IPT/Data Evaluation personnel for processing. Test data will be in the form of PCM magnetic tape (if available), RCA 110 magnetic tape, punched paper tape, oscillographic recordings and test procedure test data sheets.

IPT/Data Evaluation will perform evaluation of problem areas encountered during testing, calculate performance trends and analyze corrective action requirements. Data, performance trends and problem area reports will be provided to interested organizations as requested. Evaluations and reports will be based upon test objectives and engineering criteria.

5.4.4 CONFIGURATION CONTROL

The configuration of GSE and Supporting Test Equipment while under IPT responsibility will be controlled by the DSE.Planning Group through the use of the SRC and released engineering drawings and orders. Drawings, will describe the configuration desired at the particular point in time. The SRC will define the actual configuration at any point in time.

5.4.5 SPARES

Spares in support of the R-Qual GSE will be provisioned through Operations overages to support the (C&C task.

5.4.5.1 Deliverable Spares

The deliverable spares are not involved in the IC&C of the GSE set at R-Qual.

5.5 GROUND SUPPORT EQUIPMENT SUMMARY

A Design Support Engineering (DSE) approach shall be used in producing the AAP GSE. This approach recognizes that the demands of the AAP are flexibility, fast response, QUALITY, FIRST and good configuration control AND FACTORY. These conditions are similar to the ONE which Boeing HAS found in ~~the [illegible]~~ OTHER Programs AND which the DSE concept HAS PROVEN was used effectively. The DSE is the engineer responsible for the production, delivery and installation, if requested, of an end item. He is teamed with the design engineer TO ~~or~~ brings to the design concept all producibility concepts that Boeing knows about and that the state of the art has available now. He follows that end item from "Cradle to Grave."

As part of the DSE concept, the limited release system has been developed. Briefly it is a system in which four copies of the drawing ARE ~~is~~ released. One of each copy is given to the design engineer, the DSE, the factory and quality control, the original is kept in a vault. During the development of the GSE, the DSE becomes the liaison engineer and manufacturing engineer. The DSE, after agreement with his design engineer, has the authority to red-line the drawing. ~~This~~ THE changes will then be transferred to all four copies and subsequent to a final release drawing. Changes to the original planning will be entered in a Service Record Card which will remain with the hardware until final acceptance. All throughout the process, Quality Control will monitor the system.

5.5.1 PRODUCTION OF GSE

Most of the AAP GSE will be of the "one of a kind" type. For this reason the design, development and production will run in the same time cycle. The DSE will be the producer and will use all sources available to him to produce the hardware in time at minimum cost. He will use vendors, Huntsville facilities, Michoud, Wichita, BATC and Seattle when necessary. The following are the activities that the DSE will perform with the help of Materiel, Industrial Engineering, Fabrication Shop, In-Plant Test, Shipping and Field Support.

a. Initiate Procurement of vendor assemblies, sub-assemblies, details, and raw material. Coordinate through Material in vendor technical or production problems. GFE items will be handled through contract administration and other facilities.

b. Issue all fabrication releases for tools and hardware to Production Control and monitor that these get to the shop for fabrication.

c. Devise and negotiate manufacturing schedules which are reasonable, achievable, and compatible with mission and program requirements. The DSE shall monitor these schedules for accomplishment. The DSE unit shall devise management controls, reports and presentations to keep upper management and program executives informed of program status.

d. Translate design specifications and test requirements into processes and test procedures which will be monitored and controlled by Quality.

e. Initiate shipping operations after end item acceptance and coordinate end item deliveries to installation site. Provide instruction services and hardware if requested.

f. Provide maintenance and modification support by spares, kits and installation procedures to GSE users.

5.5.2 SCHEDULES & LOADS

During the preliminary phase of the AAP, THE GSE requirements for Make-or-Buy document shall be written and approved by Boeing management and the customer. The Make-or-Buy document will be one of the base-lines to negotiate Design Releases and Type of releases. At this point, teams of Design Engineers, DSE, Buyer and Factory people will negotiate release schedules. Time phase studies will be made and flow bars for the entire cycle of production will be established. A procurement and factory load will be established which, coupled with manpower, skills and facilities will show the whole manufacturing operation. In addition to the total load, detail schedules and PERT analysis will be made to help monitor the entire operation.

5.5.3 PROCUREMENT

As described in ~~DPC~~ SEC 4 the Make-or-Buy will be the basis for procurement. Procurement will start with the Development of Source. The DSE group engineers will assist the Buyers and Quality Surveillance to select sources, assiting them in assessing vendor manufacturing capabilities, skills and schedule commitments. Liaison support will be established as required.

Assisted by a Planner and Production Control personnel, the DSE will prepare a part list which will serve as procurement authorization. The Buyer will negotiate ~~deliverable~~ deliveries and prices and will issue the Purchase Orders. During the procurement, assistance will be given to the vendor if necessary.

GFE items will be handled through Contract Administration personnel who will establish the customer requirements for handling, maintenance and control of GFE.

5.5.4 FABRICATION AND ASSEMBLY OF ELECTRICAL/ELECTRONIC GSE.

5.5.4.1 Generaly, there are three main processes in the manufacturing of the AAP GSE; these are: fabrication, assembly, and wiring. Testing is a verification of a functional design and workmanship. The fabrication of details for the AAP GSE may use some of the following operations:

a. Shearing, blanking or routing of flat patterns.

b. Trimming, sawing, shaping, or forming extrusions.

c. Drilling, piercing, stock drilling holes and cutouts.

d. Brake forming or folling flat or extruded stock.

e. Engraving, decreasing, conversion coating and painting.

f. Packaging detail for storage.

5.5.4.2 DRAWER PANEL ASSEMBLY

Boeing designed and assembled drawer panels will utilize Boeing built or bought details. Standard chassis will be bought and modified to suit all electronic components, such as resistors, transistors, capacitors, etc., will be bought. Illustration No. 1A shows a typical drawer/panel assembly and contains the following sequences.

5.5.4.2.1 Structural - All structural components that were fabricated as details are fitted, bolted, welded, rivited, etc., into an integrated structural drawer/panel assembly which provides the ~~enclosure~~ ENCLOSURE for the electronic omponents. (See Illustration 16)

5.5.4.2.2 Wire Bundle Assembly - Wire bundle assemblies destined to be installed into drawer/panel units will be completed prior to assembly requirements. Standard bundle assembly techniques, utilizing forming boards for routing, cutting, coding, sleeving, terminating, potting, bundling and testing will be employed to complete wire bundle assembly

configuration. Continuity checks to verify wire bundle electrical configuration will be made using Ditmco type testing apparatus prior to assembling the wire bundle within the drawer assembly. (See Illustration II)

5.5.4.2.3 Electronic Assembly - The following operations constitute the processes required to complete a drawer/panel assembly prior to functional test.

a. Mounting of electronic hardware within the structure.

b. Installation of the bundle assemblies.

c. Silkscreening.

d. Paint Finishing (See Illustration IB)

5.5.4.2.4 Function Test - A manufacturing sequence, consisting of a functional test checkout of the drawer/panel unit, must be successfully completed before the inspection buy-off can be accomplished. The drawer/panel level of functional test will verify bundle assembly continuity and assembled electronic component functionability within the limits prescribed. (See Illustration II)

5.5.4.2.5 Tooling - Tooling required to assemble and test drawer/panel assemblies includes a trunnionated drawer/panel support fixture which will provide full accessability and portability to drawer level OPERATIONS ~~operations~~ and specially designed test cable assemblies.

5.5.4.3 Cabinet/Console Assembly

5.5.4.3.1 Cabinet/Console Structure - Concurrent with the assembly of the drawer/panel assemblies, the structural details and subassemblies required for the cabinet/console assembly will be assembled. The basic manufacturing processes involved will include, riveting, welding, bolting, etc. (See Illustration IIa)

5.5.4.3.2 Electronic Assembly and Wire Bundle Installation - Upon completion of the structure assembly, the drawer/panel assemblies and wire bundles will be installed. The sequence of installation will vary with each cabinet/console dependent upon the individual interference problems.(See Illustration III B)

5.5.4.3.3 Functional Test - As in the drawer level test operation, the cabinet functional test sequence will verify the cabinet bundle assembly installation continuity. Also the test will checkout drawer/panel assemblies operating within cabinet environment. (See Illustration IV)

5.5.4.3.4 Tooling - Typical tooling required to support the assembly and test operations for Boeing assembled cabinet/console units includes:

a. Cabinet Mounting and Transportation Fixtures.

b. Cable Assemblies for Functional Test.

c. Test Simulators for Functional Test. (See Illustration IV)

5.5.4.3.5 Inspection and Shipping - After cabinet functional test, the end item will be inspected and routed to a pre-shipping area. A data package and shipping papers will be prepared and end item will be transferred to the shipping area to be shipped to the user.

5.5.4.4 Cabinet/Console Assembly-Vendor supplied

5.5.4.4.1 Details - The only details required for this type of HARDWARE ARE those ~~necessitated by~~ NEEDED FOR rework or modification ~~to~~ OF the vendor supplied drawers and panels. These details will be fabricated as outlined in Para. 5.5.4.1 d. through f.

5.5.4.4.2 Drawer Assembly - Purchased drawer/panel assemblies will be accepted into production after their release from implant receiving test. In particular situations where receiving inspection tests reveal non-acceptable status within the drawer/panel assembly or it is necessary

to incorporate vendor modifications at the Boeing facility, modification planning will be processed for inhouse drawer rework. Implant rework orders will be released only after vendor authorization.

5.5.4.5.3 Cabinet/Console Assembly

5.5.4.5.3.1 Cabinet/Console Structure - Standard structure assemblies will be supplied by the vendor, all modifications required by special fit problems will be accomplished by Boeing.

5.5.4.5.3.2 Electronic Assemble and Wire Bundle Installation - Upon completion of the structure assembly, the drawer/panel assemblies and wire bundles will be installed. The sequence of installation will vary with each cabinet/console dependent upon the individual interference problems. (See Illustration VI B)

5.5.4.5.3.3 Functional Test - As in the drawer level test operation, the cabinet functional test sequence will verify the cabinet bundle assembly installation continuity. Also the test will checkout drawer/panel assemblies operating within cabinet environment. (See Illustration IV)

5.5.4.5.3.4 Tooling - Typical tooling required to support the assemble and test operations for Boeing assembled cabinet/console units includes:

a. Cabinet Mounting and Transportation Fixtures.

b. Cable Assemblies for Functional Test.

c. Test Simulators for Functional Test. (See Illustration V)

5.5.4.6 Boeing-Vendor Relationship

The two types of assemblies outlined in Para. 5.5.4.3 and 5.5.4.4 are the two extremes in fabrication and assembly sequences. The first represents complete Boeing fabrication and assemble while the second represents complete vendor supplied details and subassemblies.

These two cases are by no means the only enternatives, either one may be employed completely or any combination thereof may be employed.

3.5.5 MANUFACTURING PLAN FOR A TYPICAL MECHANICAL AAP/GSE EQUIPMENT.

5.5.5.1 Detail Fabrication - Tools, machinery and facilities to perform the below noted operations will be required to support the detail tubing fabrication.

a. Shearing or cutting tubing to length.

b. Forming to specified configuration.

c. Prepering tubing ends for assembly.

d. Burring and cleaning of machined surfaces.

e. Braze, weld, or wrench torque ends to connecting components.

Detail chassis parts and brackets for attaching vendor purchased components, i.e. heat exchangers, filters, etc., will be fabricated concurrent with tubing fabrication utilizing facilities for the following operations:

a. Emalking sheet stock to flat pattern layout configuration.

b. Trimming, saving, shaping, and form extruded stock.

c. Drilling, piercing, stackdrilling holes and cutouts in flat and extruded stock.

d. Brake forming, stretch forming and hydroforming sheet stock and roll forming extruded stock.

e. Engraving, degreasing, priming, painting, and coating.

5.5.5.2 Chassis Assembly - All structural components that were purchased or fabricated as detail are fitted, bolted, welded or riveted into chassis assemblies which provides the enclosure for the mechanical checkout equipment. (See Illustration VI a)

5.5.5.3 Drawer/Assembly - Upon completion of the chassis accepted purchased components will be mounted and interconnected with tubing and wire harnesses

if necessary. The sequency of assembly will vary with each unit and its interference problems and cleaning requirements. All "Lox Clean" requirements will be actively enforced and areas will be provided for "lox Clean" assembly procedures. Essentially, the assembly of mechanical AAP/GSE will be dictated by the specific requirement of the experiment which it is going to support.

5.5.5.4 Functional Test - The functional test of mechanical AAP/GSE will consist of electrical/electronic testing and pneumatic testing. Mechanical drawer will be submitted to these tests as required prior to final assembly.

5.5.5.5 Final Assembly - After functional test, drawers will be returned to the final assembly area for installation. The cabinet drawers, and cables will come together at final assembly. Problems of fitting drawer to cabinet, cable slack, tubing slack and fit will be solved at final assembly.

5.5.5.6 Final Test - The final functional test will determine whether the total integrated package works and performs according to design, Leakage will be found and corrected, total calibration will be made and final configuration will be established. Final shipping will be done per Para. 5.5.4.3.5.

5.5.6 Manufacturing Plan of Typical Item of AAP Experimental Handling and Transportation Equipment

5.5.6.1 General Description - A single set of Handling and Transportation Equipment consists of the following:

a. (to be included)

For the purposes of this document, only the Manufacturing Plan of the Experimental Pack Handling Equipment will be detailed. The manufacturing sequence will be typical of both other stands.

5.5.6.2 Detail Fabrication - The materials are to be selected and cut to size for the frame members, gate, pads, brackets, fittings, gussets, mounting beams, pins, check-linkage arms, and the vertical beams.

Tools, machinery and facilities to perform the below noted operations will be required to support the detail fabrication.

a. Sawing, Flame cutting, Shearing.

b. Trimming, Shaping, Filing.

c. Fitting, Clamping, Welding, Chipping, Heat Treat.

d. Drilling, Forming, Machining, Alignment (Optics).

e. Clean, Prime, Paint, Identify.

5.5.6.3 Sub-Assembly -

a. The frame members and mounting beams are to be positioned, clamped, and welded into the support frame weldments. The pads, brackets, fittings, gussets, and vertical beams will be clamped and welded in position on the support frame weldments. The weldments will then be machined for true mounting surface.

b. The frame members and brackets will be positioned, clamped, and welded into the gate weldments which will then be machined.

c. Check-linkage arms will then be welded to the brackets and machined.

d. All welds will then be chipped, cleaned and heat treated, if necessary.

e. The subassemblies will then be degreased, primed and painted.

5.5.6.4 Final Assembly - The fittings, pins, check-linkages and other assemblies are bolted or mounted in the support frames and test loaded.

5.5.7 Handling of GFE Items - It is assumed that the Boeing Company will be the dustodian of the GFE items from the time these are received inhouse to the time they are relocated to another program. The GFE item will be received and inspected with witness acceptance by the government representative. If accepted, the GFE will be stored in a bonded storage and distributed per schedule and specific assignment. If rejected, negotiations will be established whether Boeing brings the items to configuration or is returned to the government.

5.5.8 Spare Support - The GSE will be supported with manufacturing overage up to the point of installation and possibly to mission completion, depending on the wishes of the customer. Stock spares, however, shall be negotiated.

PRODUCTION DRAWER ASSEMBLY

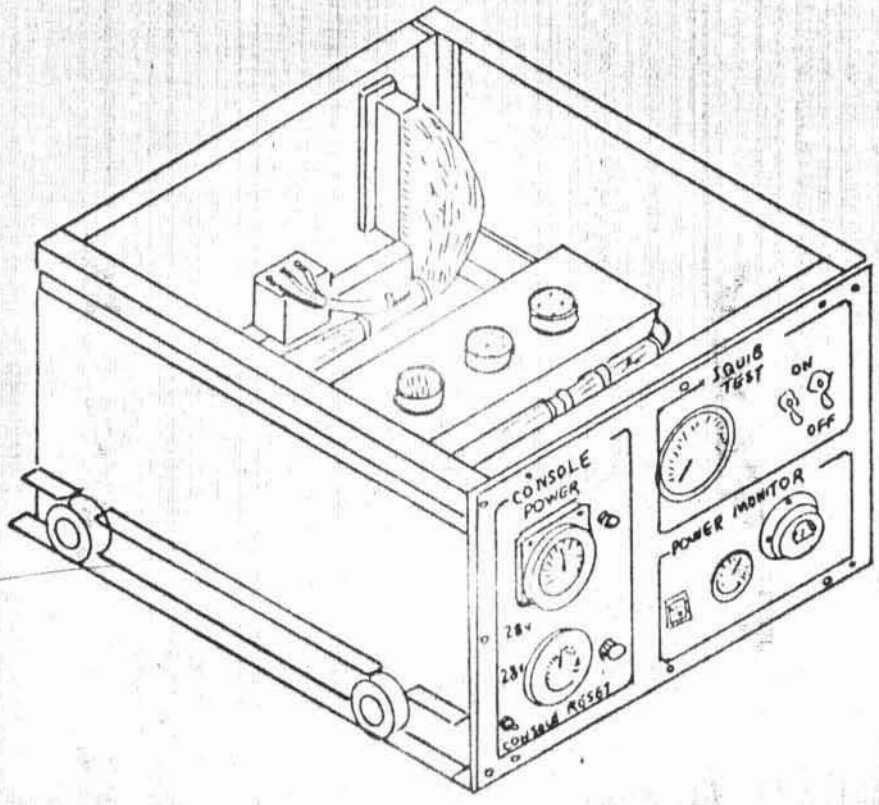


ILLUSTRATION 16

DRAWER ASSEMBLY COMPONENTS & BUILD-UP

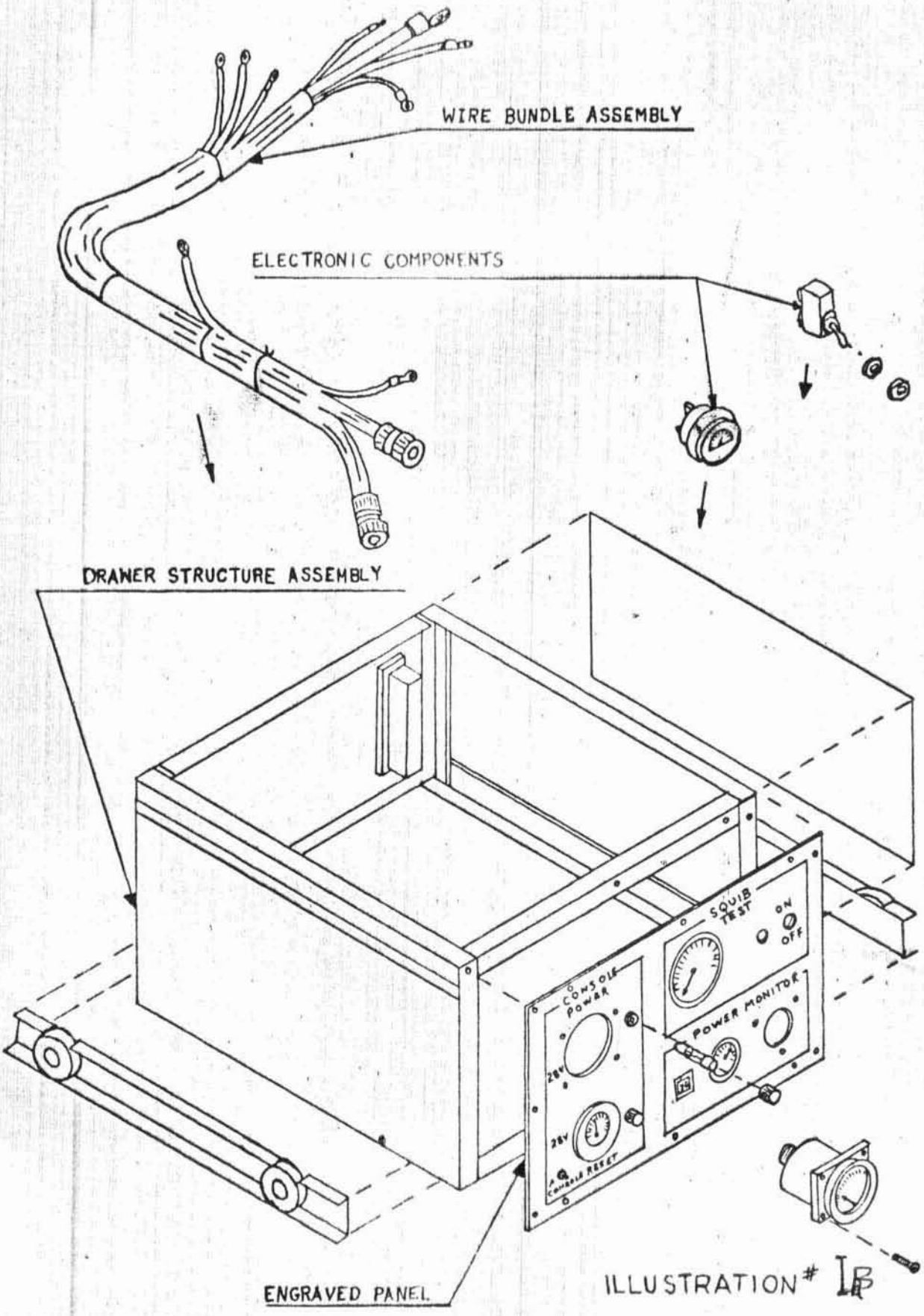


ILLUSTRATION # 1B

CR 8-29-63

PRODUCTION DRAWER TEST SET-UP

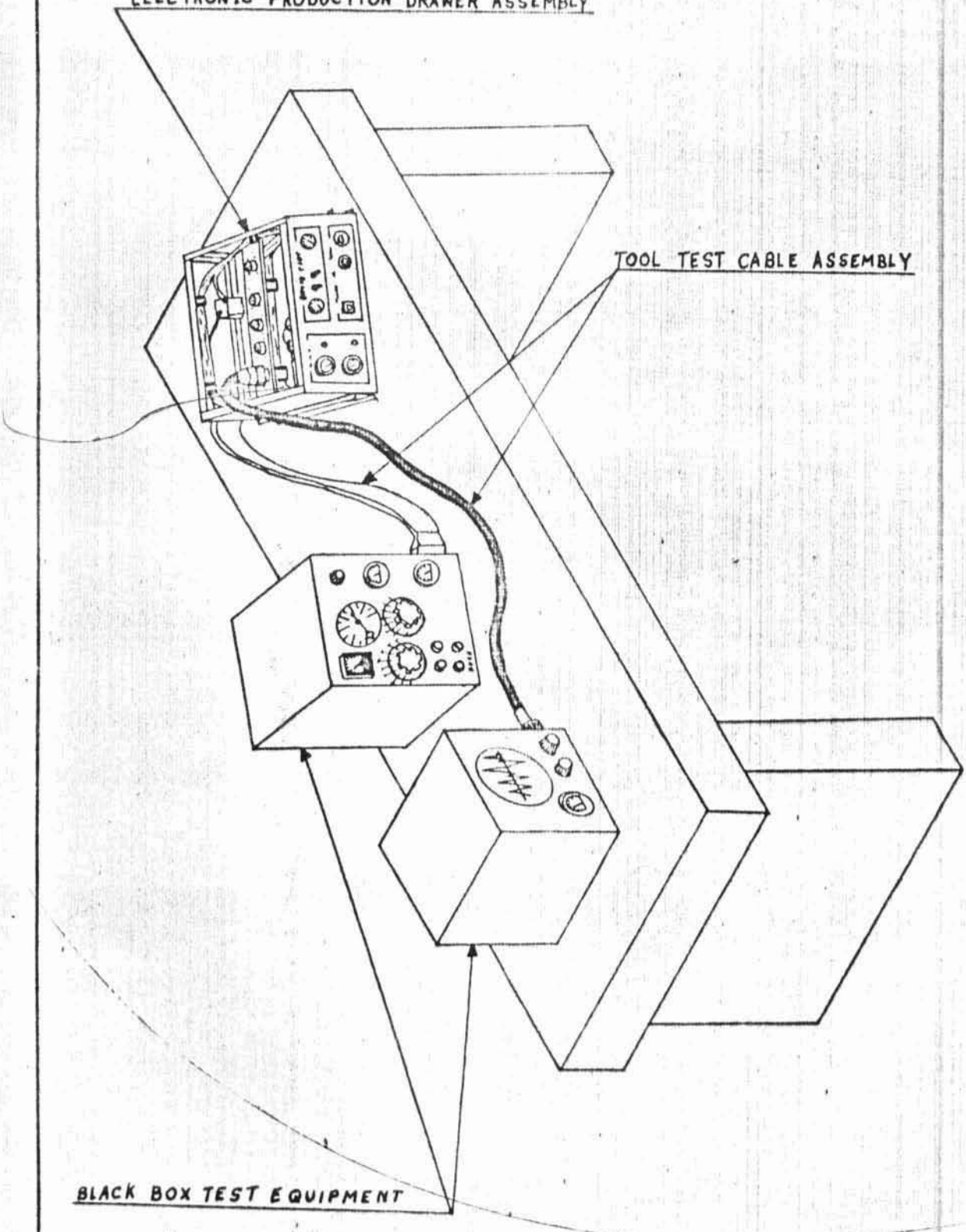


ILLUSTRATION # II

CABINET ASSEMBLY COMPONENTS & BUILD-UP

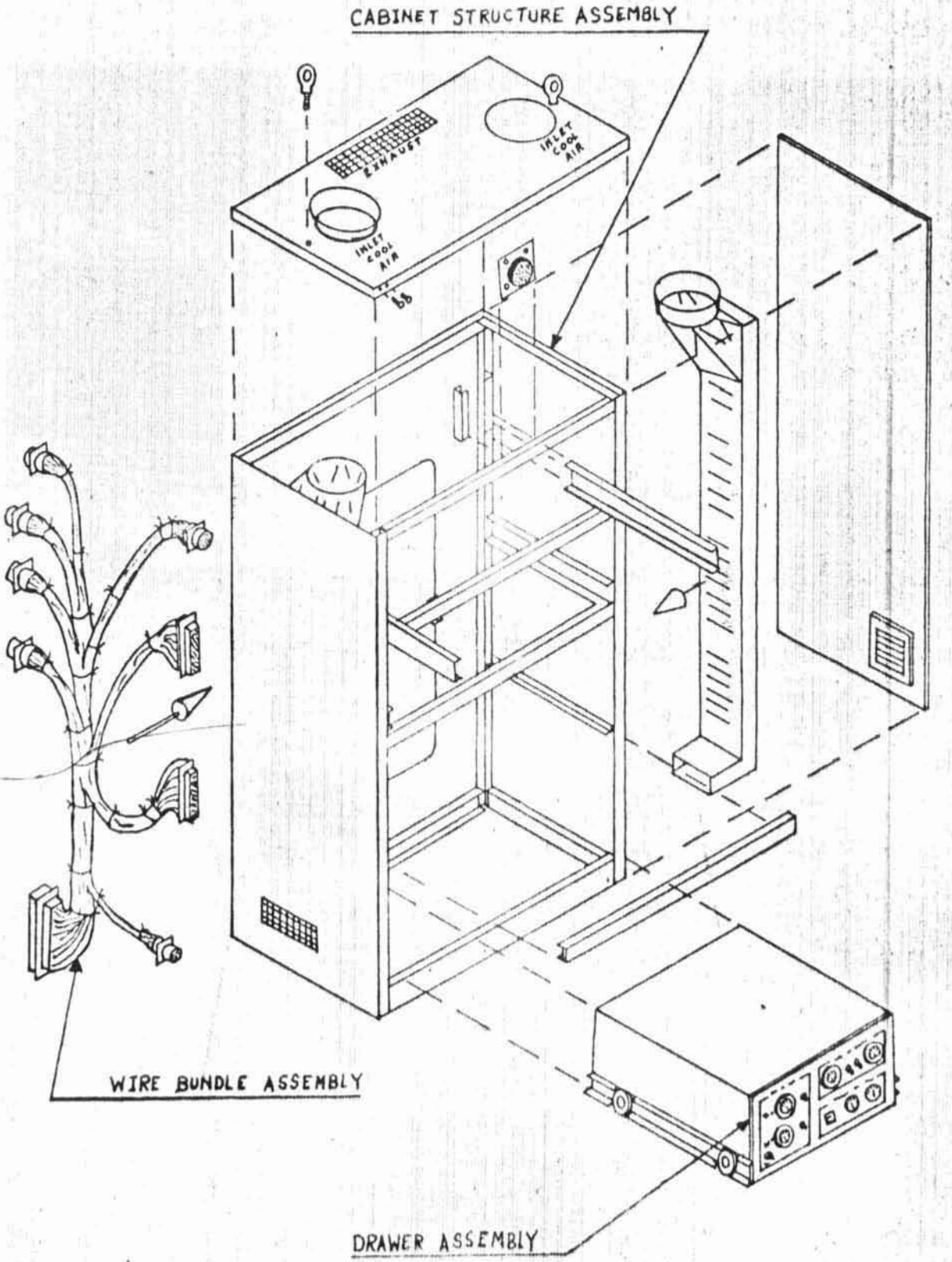


ILLUSTRATION # IIIa

CABINET ASSEMBLY WITH TYPICAL DRAWER ASSEMBLY INSTALLED

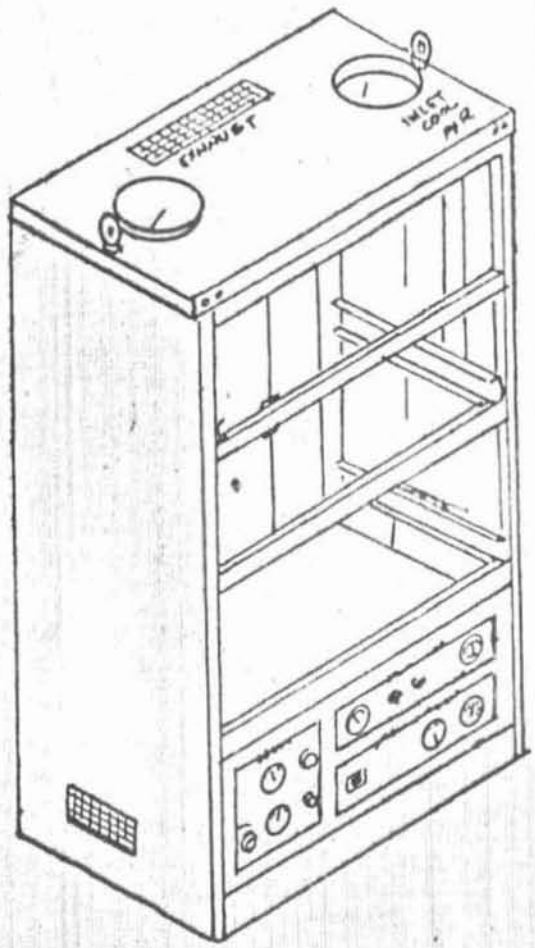


Illustration III b

PRODUCTION CABINET TEST SET UP

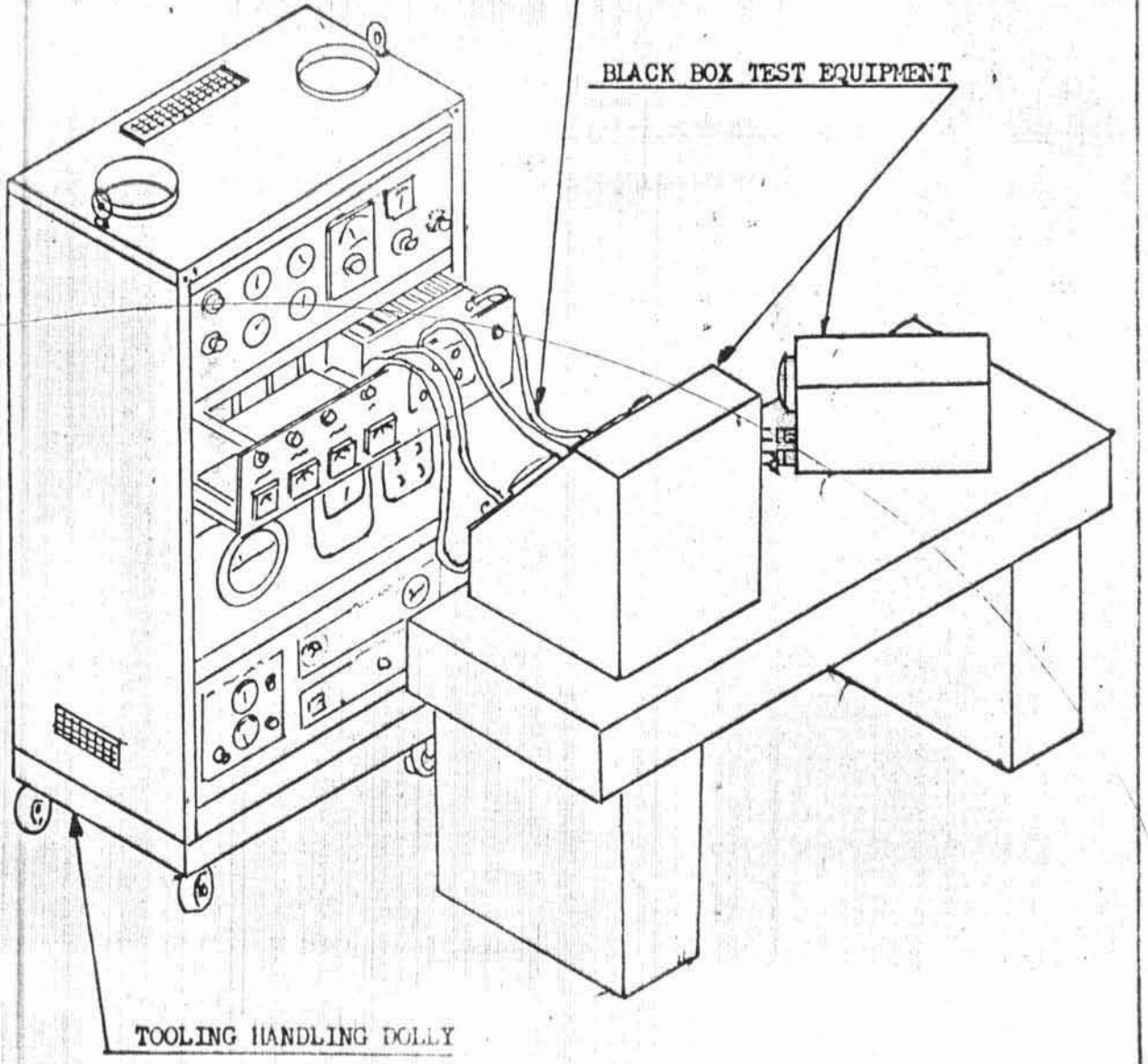


ILLUSTRATION IV

HANDLING TOOLS

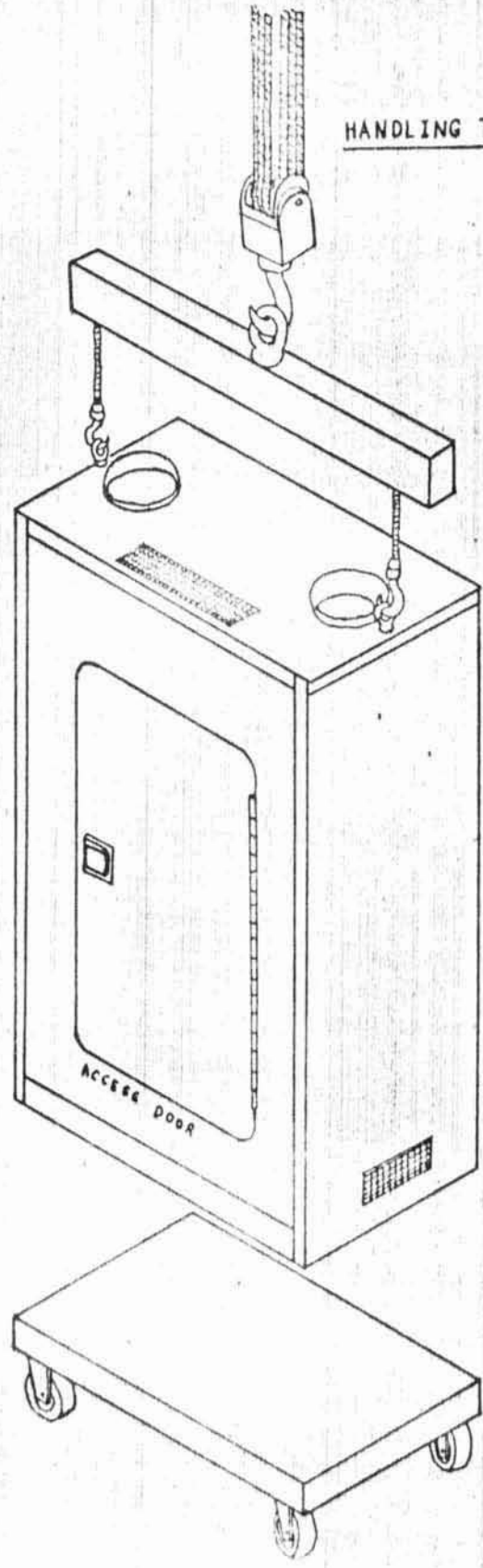


ILLUSTRATION V

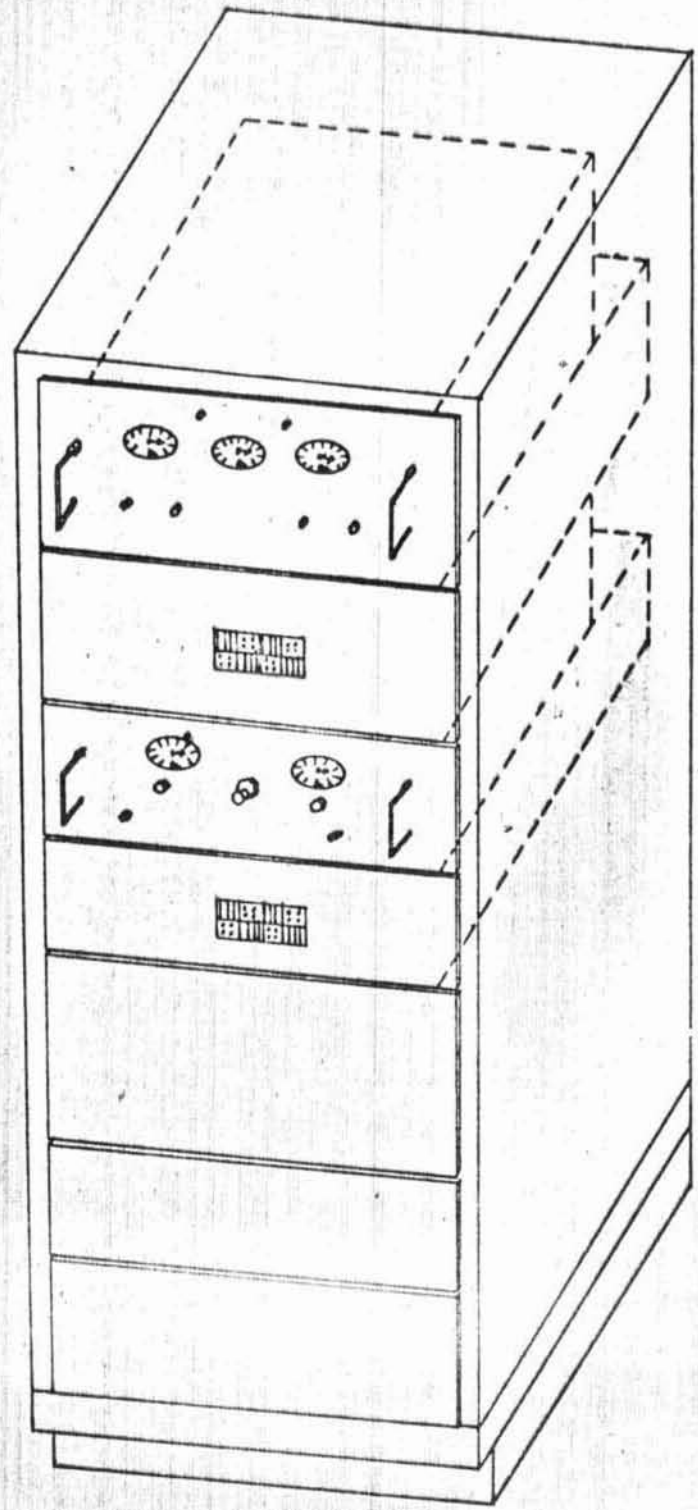


ILLUSTRATION VI b

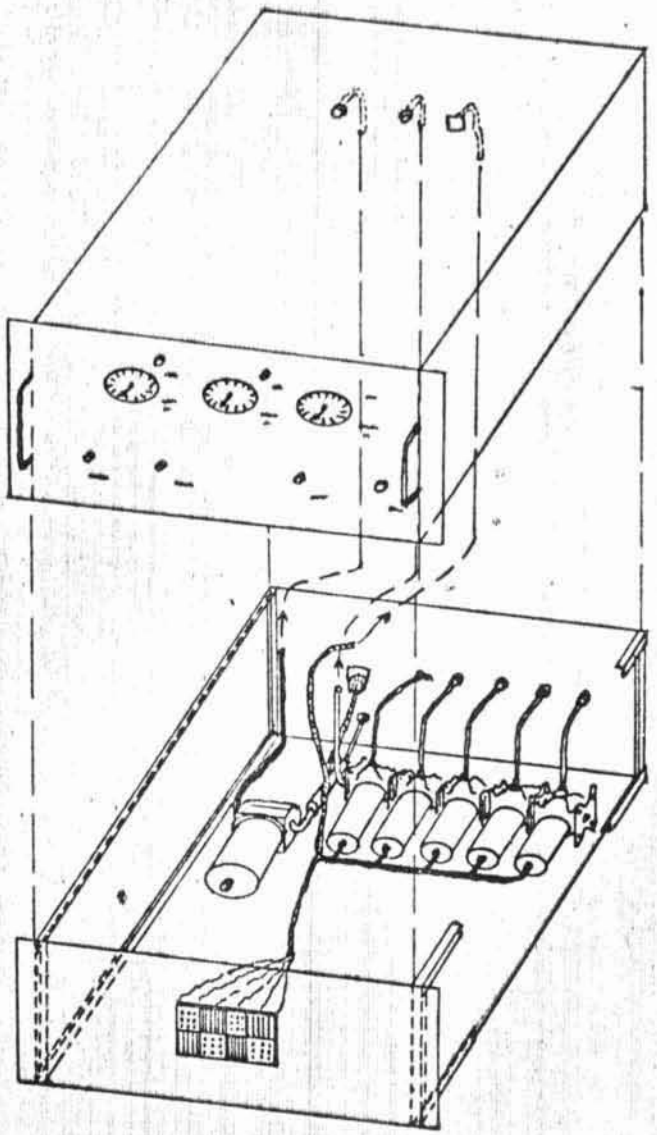


ILLUSTRATION VIa

5.[illegible] INTERFACE TOOLING

THIS SECTION DESCRIBES
~~The purpose is to establish~~ a coordinated Boeing plan for design, fabrication, or procurement, inspection, and utilization of interface tooling fixtures.

This plan is predicated on verbal and preliminary information inasmuch as the interface with the experiments have not been designed. It will include the interface types and the tooling PLAN ~~policy~~ as applied to the Apollo Applications Payload Integration Program.

5.[illegible].1 INTERFACE TYPES

Master gages or master drill gages will be required to control the hardware from the responsible contractors for the following interface types.

a. Installation of experiment module rack in LEM.

b. Installation of experiment on the experiment module rack.

c. Installation of the pallet in the service module.

d. Installation of the experiment on the pallet.

e. Installation of control packages in the [illegible] module.

f. Interface between gimballing device and experiment or spacecraft.

The mockup will be utilized for development of:

a. Mechanical propulsion tubing run.

b. Electrical cables.

5.5.2 TOOL PLANNING

The manufacturing engineer will coordinate with the design engineer to become familiar with the engineering requirements and provide support as required.

5.6.2.2 The manufacturing engineer will issue design orders, if required. After design completion, determine make or buy requirements and issue fabrication orders and/or purchase requirements.

5.6.2.3 Manufacturing engineering will be responsible for coordinating all facits of the interface master tooling requirements as follows:

a. Coordination with Design Engineering;

b. Coordination with AAP Program Integration directors;

c. Coordinate interface requirements with experiment and spacecraft contractors;

d. Coordinate interface with GSE;

e. Perform liaison with tool fabricators.

5.6.3 TOOL DESIGN

The Tool designer will prepare drawings; working from engineering documentation and planning instructions. Tool design criteria will satisfy the requirements of manpower, schedules, and Boeing fabrication capabilities, however, selective use of industrial capability may be required for special purpose equipment, processes, and skills.

5.6.3.1 The Tool Designer will perform additional functions as follows:

a. Coordinate with the tool planner and design engineer;

b. Assist with liaison activity during tool fabrication;

c. Make tool design revisions to incorporate engineering changes.

5.6.4 FABRICATION OR PROCUREMENT

The required master tool will be fabricated by Boeing in existing facilities at Huntsville. It is anticipated that most of these gages will be fabricated by the Boeing Model Shop at Huntsville Industrial Center.

Only those gages requiring unique or special machines, processes or skills

will be procured. Local Huntsville vendors will be utilized, if possible, to minimize costs for the transportation and handling. Extremely large gages may require procurement from Wichita-Boeing facility.

5.6.5 ACCOUNTABILITY

The tool order and drawing system that will be utilized for the AAP Program will provide a method of establishing accountability; a means of releasing advance information to tool fabrication shops for the purpose of maintaining schedules.

Accountability records by tool serial number will be maintained by Production Control throughout the program and will eventually show complete disposition of each tool.

5.7 MANUFACTURING DEVELOPMENT, AND PROCESS CONTROL PLAN

The purpose of this manufacturing development and process control plan is to define general problem areas.

The development effort will be divided between state-of-the-art type development and application of existing techniques type development. Manufacturing development programs will be conducted to ensure the availability of adequate process information and its utilization to accomplish on-schedule AAF manufacturing tasks. These programs will include sustaining development to ensure that the manufacturing processes continually reflect the most reliable and economical methods available.

In addition, this plan defines the general requirements for manufacturing process controls and provides methods for implementation and surveillance of these controls in the manufacturing operation.

5.7.1 DEVELOPMENT PROBLEM AREAS

Specific areas requiring development are not as yet defined. However, it is anticipated Development will be required in the electrical/electronic manufacture and installation areas. Development for the manufacture of structural components will not be required provided the components are of common materials and can be made utilizing present "state-of-the-art" fabrication techniques. Introduction of new or under development materials would require development support.

5.7.1.1 Electrical/Electronic Development Areas.

This section defines the present anticipated areas requiring development (1) Assembly and installation of Laser components; (2) Flat cable development and installation; (3) Fabrication of multiple layer electronic assemblies;

(4) Micro-miniturization of electronic components (5) Bonding and encapsulation of electronic components and assemblies.

5.7.2 MANUFACTURING PROCESS CONTROLS

This section covers the controls necessary to ensure that essential manufacturing process information is properly utilized in the manufacture of the S-IC stage.

5.7.2.1 General Requirements.

Manufacturing process controls will be required for those fabrication operations that materially effect end-product reliability. These controls, in the form of approved documentation will supplement engineering design and process requirements.

5.7.2.2 Implementation

All manufacturing process control information shall be released in shop manual form. These documents will be reviewed on a regular basis to ensure that the information contained is compatible with current manufacturing techniques and effectively assures reliability in the manufacturing operation.

The manufacturing process control documents shall be incorporated into the detailed manufacturing planning orders either by reference or direct insertion and will control the operations called out on the planning order.

5.7.2.3 Control

Adherence to the manufacturing process control requirements will be ensured by Boeing's Quality and Reliability Department. Periodic inspection during processing and the criteria for inspection shall be established by the Manufacturing Engineering Section and maintained on a current basis.

5.0 MANUFACTURING CONTROLS AND RECORDS

5.0.1 INTRODUCTION

This section contains the production control plan and defines the concept, approach, controls, and paper processes required to control the manufacture of AAP hardware. It provides a plan for accountability and reliability of records.

This plan will establish methods that supply a historical record of each AAP experiment.

The items to be discussed are:

a. Order Control Plan.

b. Manufacturing Planning System.

5.0.2 ORDER CONTROL PLAN

This section of the plan will outline methods and functions to be performed in the following areas:

a. Engineering Drawing Release.

b. Engineering Specification.

c Release of Planning Data to the Factory.

d. Release of Planning Paper to Materiel.

e. Order Control Ledgers and Records.

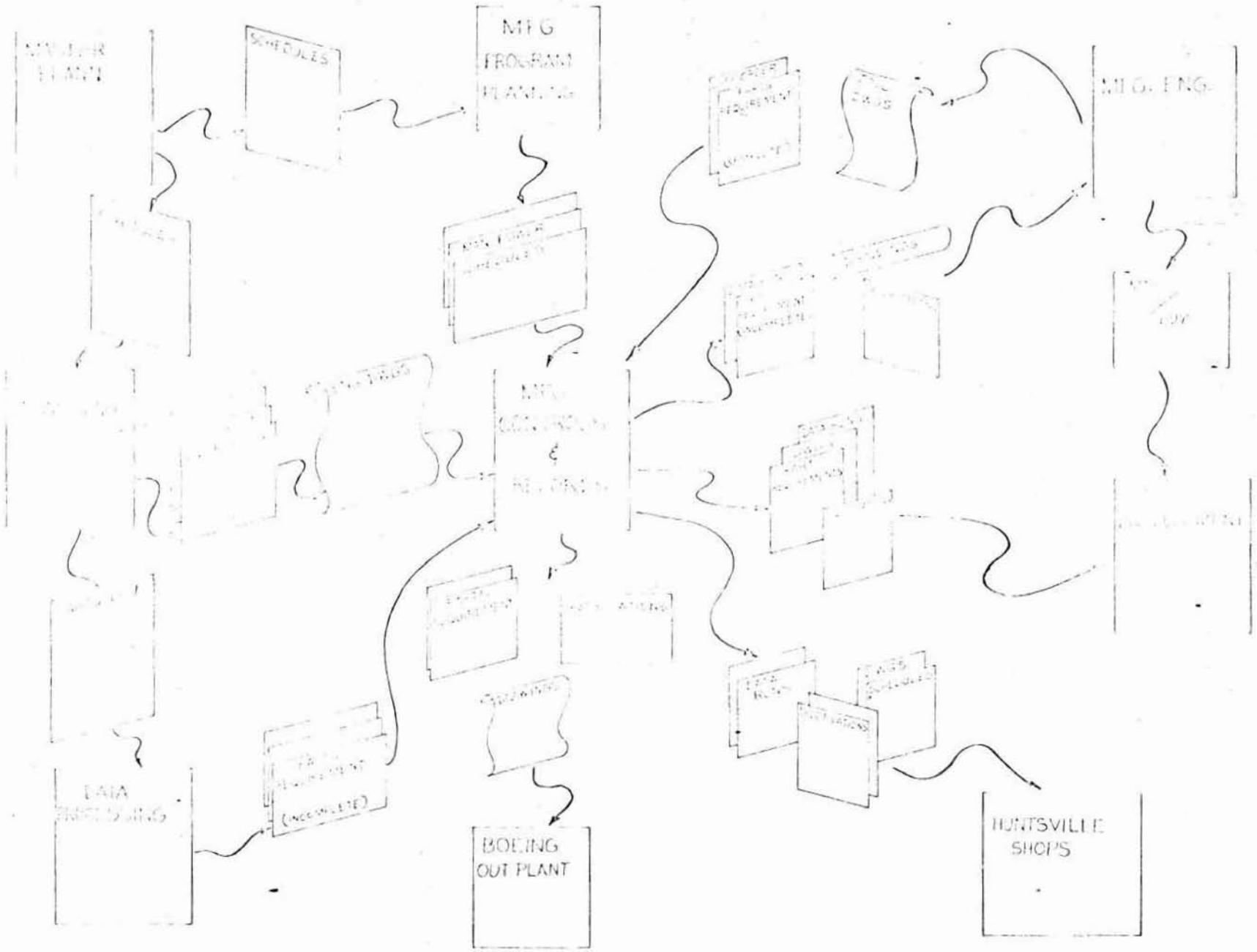
f. Reproduction Facilities.

g. Tool Control and Tool Drawing Files.

5.0.3 ENGINEERING DRAWING RELEASE

Engineering drawings will be released to the order control group for distribution and filing.

MFG CONTROLS & RECORDS
PAPER FLOW



From the engineering drawings, data processing will issue a manufacturing authorization in the form of a ~~part~~ REQ'MT card (Figure ____). Each part and assembly will have a card. These cards will contain all items referenced on the engineering drawing such as Part Number, used on number, quality, latest changes and material requirements.

The ~~part~~ REQ'MT card will be the approval for procurement to purchase all necessary raw materials, standards, purchased parts or purchased equipment.

5.8.3.1 The card will be logged in from data processing by the order control group and sent to the manufacturing engineer. He will complete ~~[redacted]~~ the card by adding schedules, tool ~~layout~~ TRYOUT parts, certification parts, work order numbers and he will code the card to indicate how the part will be obtained. Examples of this coding are: Fab W - make at Wichita; Fab M - make at Michoud; BPD - Buy Per Drawing; FAB H - make at Huntsville. Once coded, the card will be returned to the order control group for distribution and permanent file. Receiving groups will respond in accordance with direction indicated on the card.

Change order drawings follow the same procedure - cards and information will be automatically cancelled or superceded as required, distribution made and accountability recorded. The master ~~part~~ REQ'MT card file will be the permanent history of all releases and active parts on order.

5.8.3.2 Provisions for periodic data processing runs of this information will be simplified through the use of mechanized ~~part~~ REQ'MT cards and will allow for quick accurate checks on source schedules, etc., as well as supplying stores and dispatch with a listing to record parts to be received and stored.

When engineering provides advance notice of material required, this information will be forwarded from engineering to the production order control group for routing to Manufacturing Engineering. If priority notices are received, the Manufacturing Engineering Organization will manually originate the REQ'MT card for material requirements and process through the production order control group for delivery to Materiel.

5.8.3.3 Engineering Specification Releases

These specifications will be released from Engineering in the same manner as drawings and recorded by the order control group. They will be filed after routing to Manufacturing Engineering for review. The files will be maintained on a current basis and specifications checked out daily to authorized personnel.

5.8.4 RELEASE OF PLANNING DATA TO THE FACTOR

The planning authorization, work order coverage and schedules must be furnished to the factory for the necessary hardware fabrication. To accomplish this, the Manufacturing Engineering Group after having received the release described in 5.8.3 prepares a production order. This order contains the work order information, sequence of operations to be performed, Quality Control requirements, and shop routing. The planner upon completion of his functions, routes the plan to the Order Control Group, where start and completion schedules [redacted], are entered on the order.

It is then reproduced, a copy maintained in the order control group for use by the Manufacturing Engineer in making any future changes, and routed to the expediting control group for issuance to the first shop on on the routing.

The schedules within each shop are controlled by the minus-days system, using 0 day as in-stores requirements and applying established work standards to all proceeding functions. Upon completion of factory operations, parts and orders are routed to stores, completions are recorded and orders are returned to the order control group for posting and inventory control purposes.

5.8.5 RELEASE OF PLANNING PAPER TO MATERIEL

The release referenced here is for the procurement of components from vendor sources. This will be accomplished in one of two ways, either by use of AN OUTSIDE PROCUREMENT ORDER or by issuing a document requirement when it is necessary to establish definite parameters and criteria. The OUTSIDE PROCUREMENT AUTHORIZATION is to establish the control for ordering purchased parts from out-plant production sources. The function of the order is to inform concerned organizations of schedules, requirements, and specifications plus endrouting to a designated storage area.

5.8.6 ORDER CONTROL LEDGERS AND RECORDS

All ledgers and records used in the Production Control section will, to the fullest extent possible, be compatible in format to enable the extended use of data processing. REQ'MT cards will contain all pertinent information relating to the part, such as schedule, lot and increment codes, position code, etc.

The entry portion will contain the ordering and completion information posted against the contractual requirements and as such serve as the historical record as well as the basis for inventory accountability. Other records handled in this group will be special engineering release records, tool drawings, document releases, and all other data to meet any further customer requirements. The REQ'MT card and record philosophy

and plan as discussed here will be applied and implemented in the areas of GSE, inplant-fabricated hardware, vendor-supplied hardware, GFE, spares and standby parts.

5.8.7 REPRODUCTION FACILITIES

The Order Control Group will establish the necessary space and equipment to reproduce orders and required data. Ditto, copy flex and like items are expected to be used. Existing equipment will be used where available.

5.8.9 TOOL CONTROL AND DRAWING FILES

The Production Order Control Section will control tool drawings by use of a charge-out system from tool order control. As a tool-designer requires a design, he will check this out by tool type and number with the tool order control clerk who records this information. On completion of design, the vellum is given to the Tool Order Control Clerk who records all information, runs necessary copies, handles distribution, and files vellum in the vault.

5.8.10 MANUFACTURING PLANNING SYSTEM

A Records System will be established and implemented which will provide for compatibility of format from the initiation of manufacture to launch. This system will incorporate provisions for planned sequence of operations in the factory from detail to final assembly, as well as through functional checkout, static test and assembly and checkout at the launch site. Inherent in this system will be provisions for adequate positions of Quality Assurance and Reliability surveillance and buy-off. The system will provide for rapid "on-the-spot" changes to manufacturing procedures, processes, methods, etc., as well as the capability to repair and rework in-line. Further it will assure continuity of production with a high degree of quality and records reliability. The system will also provide for rapid Engineering coverage to support in-line change. The Manufacturing

Records System will be able to accept rapid incorporation of committed changes affecting form, fit or function.

In summary the system will provide accuracy, integrity, accountability flexibility, reliability and historical record of events.

The system will be adaptable to all types of hardware such as GSE, Interface, vendor supplied, and customer furnished property.

5.8.11 CONFIGURATION CONTROL

Configuration Control is a function of the Engineering Drawing; the Production Control Section supports the implementation of changes. At present, the type of control media has not been established. After an agreement between MDAC and Boeing has been established, a system of coordinated change control, the Production Control plan will include documentation to support its objectives. Manufacturing will commit capability and, based on schedule, commits to an incorporation point. The incorporation point will always be aimed at in-line change; however, circumstances dictate at times that immediate incorporation is required and Manufacturing will commit to an out-of-sequence change and incorporate as soon as possible with no interruption to schedules. A final change release will be issued and all allied paper affected by the change will be up-dated at the point of change.

The final system will be used for all AAP hardware, GSE hardware, and vendor-supplied components and systems.

5.9 TRAINING

To provide trained personnel to assist MSFC and KSC in Hanger Queen and Module installations at the start of the program, a nucleus of selected experienced personnel will be obtained from Huntsville, Michoud, and Base Installation sites preferenced as indicated. Additional personnel required at MSFC and KSC will be transferred from Michould assembly areas,trained as required, and then assigned to MSFC. Certification of personnel for operations such as potting and bonding will be accomplished during the training period. The Boeing Company has training facilities and personnel both in Huntsville and at Michoud. At Michoud, approximately 5,000 people have been trained and certified and more than 170 training courses have been conducted. These courses covered many phases of the S-IC booster assembly including items such as welding, riveting, bonding, electrical potting, cable assembly, electronic assembly, and LOX cleaning.

6.0 Manufacturing is composed of basically five organizations. These are: Factory, Manufacturing Program Control, Manufacturing Engineering, Manufacturing Development and Process Control, and Production Control. They are aligned as shown below reporting to the Manufacturing Manager.